Final Report
Water Temperature Monitoring of Yukon River Chinook Salmon Spawning and Migration Habitats in Canada

Yukon River Restoration and Enhancement Fund
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Al von Finster
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Abstract

The Temperature Monitoring of Yukon River Chinook Salmon Spawning and Migration Habitats in Canada Program (the Program) is completed. Serial temperature data was collected from a sample of Canadian Yukon River Chinook Salmon adult migration- and spawning streams. The Program started in the summer of 2011 and extended to the autumn of 2023. The data was collected as a public service. It may be utilized by all persons to better understand the life histories of Yukon River Chinook Salmon. It is available for a multitude of other purposes. The data is stored on the Yukon River Panel website at https://www.yukonriverpanel.com/publications/ under Data Sets.

Acknowledgements

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Cover: These data loggers were used for the Program. They faithfully collected data. Eventually their battery levels dropped and they were retired. The "X" is a mark of their retirement and an acknowledgement of a job well done.

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Introduction

This is the Final Report of the "Water Temperature Monitoring of Yukon River Chinook Salmon Spawning and Migration Habitats in Canada Program" (the Program). The Goal of the Program was to develop a robust and publicly available baseline of water temperatures of selected Yukon River Chinook Salmon spawning and migration habitats in Canada. The baseline was to be representative of the thermal regimes of different types of streams and rivers. The three types – broadly – are lake outlet, mainstems, and smaller streams.

This goal has largely been achieved. "Largely" is used advisably. Data in many monitored streams have data gaps. These were periods when loggers were above the water surface due to low water levels, human/mammalian disturbance or other causes. In winter, some loggers were frozen due to ice formation processes. Some loggers were carried away by high flows. Others could not be accessed. Data to late summer 2020 has been stored on the Yukon River Panel website. The remainder has been submitted to the Panel for inclusion.

Interest in the data has increased as the data sets became longer. The much-publicized summer Chum Salmon die off in tributaries of the Alaskan section of the Yukon River in 2019 excited interest in the scientific community. Publication swiftly followed of new (von Biela et.al. 2020) and archival (Eiler et.al. 2023) reports of potential affects to Yukon River salmon. A number of researchers have requested the data directly from me. I have provided recent data and have referred them to the Panel website.

In the following report I will describe the genesis, design, data collection, analysis and results of the Program. The public distribution of the data will be described. A very short conclusion statement will end the report.

Genesis of the Program

The genesis of the Program was the sudden infestation of Yukon River Chinook salmon with ichthyophonus in the late 1990s. The infestation coincided with a rapid reduction of the adult Chinook population in the river. Staff of government agencies, fishers and the interested public linked the two events. A possible cause for the infestation was high(er) water temperatures in some location(s) in the Yukon River. It may have also been associated with above average water temperatures in the Bering Sea.

In the 1990s measurement of water temperatures did not fit neatly within the mandates of Canadian salmon fishery management agencies or co-management entities. There was a general but somewhat vague understanding that water temperatures were important. Many agency staff members or others had been collecting "point" data when they were conducting their duties. A thermometer would be lowered into the water to measure the instantaneous temperature. This technique had limitations. It was almost entirely collected during working hours. It did not show daily rise, peak, decline and minimum temperatures or longer-term data.

In the 1980s digital data loggers were starting to be used to collect “serial” data. These were placed in the water and measured and saved data at specified intervals. They could measure data over extended periods. This provided understanding of the ranges of daily and seasonal temperatures. The data logger technology improved. By the 1990s and 2000s individuals adopted data loggers to measure temperature in streams both for environmental monitoring purposes or at projects. However, there were no protocols, shared data sets or other structures in place to allow others to use the data.

Other agencies active in the Yukon River Basin could also conceivably have been using data loggers to collect water temperatures. There was a hope that one of these agencies would have data sets that could be used. Potential holders of Yukon River water temperature data sources were approached on both sides of the border. I undertook it on the Canadian side. Staff of the Alaska Dept. of Fish and Game undertook it on the American side. We found no serial water temperature monitoring had been or was being conducted in the Yukon River basin.

The ichthyophonus infestation tailed off and became a memory. The issue of lacking water temperature baseline(s) in the Yukon River remained. At some point in the future it would become important. On a personal level it was worth collecting information to inform the managers and researchers of the future.

Design

Between 1997 and 2009 I served as the Yukon River Resource Restoration Biologist (RRB) for the (then) Habitat and Enhancement Branch of DFO. I was able to travel widely within the Canadian Yukon River basin and maintain contact with First Nations and communities. I was also a member of the DFO Salmonid Enhancement Program (SEP). This gave me access to the larger community-of-interest using and developing thermal regime monitoring in British Columbia and the US Pacific North-West.

My interests were in the rationales used by agency and other staff placing loggers in the locations they did. An additional interest was the instruments chosen and, again, the rationale for the choice. In Canada I found that most data loggers were placed where it was convenient to do so. The Fraser River ewatch, where water temperature and discharge were measured through out the Fraser River Basin was under development. The ewatch allowed managers to assess the risk that salmon, and particularly Sockeye Salmon, could and would reach spawning beds. Many people were using data loggers, but the degree of standardization was low. With the exception of the Fraser River ewatch, there seemed to be no interest in bringing water temperature data into a common data base.

Agencies and institutions in the US Pacific Northwest seemed to be in a worse situation. In the 1990s there were two schools of thought. One was to use submersible data loggers that directly measured water temperatures. The other was to seal non-submersible data loggers in some type of waterproof packaging.

Neither country (or agency) specified the interval that the water temperature measurements were made at. The influence of ground water discharges into surface waters was seldom addressed. The effects of mixing zones seemed to be weakly understood or understood only as a function of a thermal refuge.

I considered this overall lack of direction to be licence. I chose 3 principles to be followed in the design of a species dependent water temperature monitoring program. Species dependent was important: all fish, all salmon and all populations cannot be considered to be equal in their tolerance to water temperatures. Yukon River Chinook Salmon were the species that the Program would focus on. The principles were that all data collected must be representative, comparable, and repeatable.

In early 2010 I retired. That summer I toured Heather Leba of the Alaska Department of Fish and Game (ADFG) around a selection of Canadian Chinook Salmon spawning rivers and streams. These were accessible by truck. They became candidates for a basin wide Water Temperature Monitoring Project. Monitoring opportunities were chosen from the candidates. Our arrangement was that ADF&G would send me loggers. I would then deploy them at the chosen locations. The three principles would be addressed in site selection and a Station would be the result. The loggers would be replaced and returned to ADF&G for download. I also set one of my loggers at each Station to ensure that the data remained in the Yukon.

The ADF&G project ended in 2012. I took over the operation of the Canadian portion of their project and gave it a descriptive name, the “Water Temperature Monitoring of Yukon River Chinook Salmon Spawning and Migration Habitats in Canada Program”. It became the base from which the Program grew. The goal of my design was to develop a water temperature baseline. The baseline would be, nominally, 10 years in length. The data in the baseline would be for the use of others.

The Yukon River Panel (YRP) Restoration and Enhancement Fund (R&EF) annually provided partial funding for the Program. To obtain the funding I had to design the Project to indicate the utility of the data in both America and Canada. Annual applications were made to the Fund. The applications were first reviewed by the YR Yukon River Joint Technical Committee. The JTC is a joint US/Canadian body and is dominated by biologists. The biologists generally have an understanding of habitat, but – in my experience – lack knowledge of the geomorphology and hydrology which lie at the base of fisheries habitat. After reviewing the applications the JTC assigned a rank. The rank was taken to the Panel, and largely determined funding.

Difficulty was experienced when the review ranking process was periodically changed by the Yukon River Joint Technical Committee. As an applicant I had to meet the needs of the JTC to gain the funding. The needs were not clearly articulated. I found myself writing into a vacuum. In fairness, this was most pronounced early in the Program. The process then ran more smoothly. The problem is, however, in the structure of the process. If the review process can be changed by fiat, it will be at some point.

The final component of the plan was to compose Annual Reports for submission to the YRP. This was no problem for me. My first task for any project is to start composing the necessary report once funding is confirmed. This materially reduces the effort that is expended in reporting.

Data collection

The rivers of the Canadian Yukon River Basin are almost entirely unregulated. They run free. To accommodate this lack of regulated flows the Program was adaptively managed. If new opportunities were identified Stations could be added to address them. Stations were moved or abandoned if loggers were consistently lost, disturbed, if the development of the river channel rendered the data collected questionable, or access the site dictated.

Water temperatures were measured at the Stations. The Program included all Stations where water temperatures were measured. The term “Project” was for the benefit of the Panel. It refered to the annual cycle of data logger deployment or replacement and the applications and reports to justify continued funding.

Safe and rapid access to each Station at most water levels was a prime consideration. This was particularly appropriate as I tended to work alone. An additional factor was cost. Servicing several Stations per day was preferrable to doing only one Station each day.

Again, the principles of measurements being representative, comparable and repeatable were used to assess if Stations remained valid. Each Station was assessed each time I attended it.

Meeting the Principle of representativeness required consideration of the purpose of the monitoring. The Program was focussed on the upstream migration of adult Chinook Salmon and their subsequent spawning habitats. Adult migration habitat was relatively easy to determine. It was where a spawning population migrated upstream to reach destination spawning locations. Of note, migratory routes for one population may pass through the spawning locations of other population(s). As an example, Chinook Salmon spawning in Sidney Creek migrate through the spawning habitats of the Yukon River near Minto, the Teslin River south of Teslin Lake and the Nisutlin River to reach the spawning destination in Sidney Creek.

Use of habitats by 0+ fry for rearing and overwintering was not a focus. Similarly, the period of high early season growth and subsequent seaward migration of 1+ juveniles was not a focus. The data collected, however, could and hopefully will provide insight to habitats used by these live stages.

Yukon River Chinook Salmon spawning habitats may to be one of three types. These types include lake outlet; mainstem river; or small streams. Lake outlet spawning includes Chinook Salmon spawning in moving water at the lake outlet or downstream of it. At some point below the lakes spawning may be better termed mainstem- or small creek types. Lake outlets have often been used as the “go to” areas by staff to enumerate adults using aerial counts. Spawning adults are concentrated in these areas and the water is clear. Mainstem spawning types are located in rivers too large to be dammed by beaver. The main-stem section may be very large, such as the Yukon River in the Minto area. It may be much smaller, such as the Takhini River. Many or most main-stem areas will have some degree of turbidity some or most of the time. Aerial enumeration of adults will suffer as a result. The small streams are equivalent, roughly, of the southern concept of “wadable streams”. In the unregulated Yukon River context, the ability to wade them will depend on flows at the time of investigation. This type tends to be vulnerable to damming by beaver. The upstream migration of adults may be obstructed as a consequence.

Lake outlet type Stations will have a thermal signature affected by the upstream lakes. The downstream temperatures reflect conditions in the lake: as an example, an extended period of high wind over the lake will result in significant cooling of the river below it. The temperature of mainstem rivers may be affected by thermal plumes from upstream tributaries. These can be extensive – if a tributary has a different turbidity than the river the plume can be observed kilometers downstream. During the open water period the effects of ground water discharges into the stream channel will be minor. In winter ground water discharges may constitute the majority of a stream- or rivers flow. Ground water discharges may be hard- to impossible to determine in the summer. Their affect is most pronounced in the winter.

Meeting the Principle of comparability centered on using the same instrument and measuring at identical intervals. Only Onset TidBit v2 data loggers were used. They will be described later in the report. The interval used was one measurement per hour, measured on the hour. My rationale for doing so was that the interval had to be simple and easily understood. An additional factor was cost. Loggers collect a finite amount of data before the instrument’s storage capacity is met. Sampling at 1-hour intervals allowed the loggers to be used twice as long as at 30 minute intervals.

Meeting the Principle of repeatability is to allow future monitoring to capture data reflecting the purposes that the Program’s monitoring did. Co-ordinates were taken of the Station. This is simple in the age of GPS. Photographs are useful. They can show the location and other features of the original site. Google earth or similar products can widen this window significantly. A time series of photographs can show what the conditions were like in the past and are at present. This is important. Floods may change channels. Long term incremental channel development may be accommodated.

Only Onset Tidbit v2 Water Temperature Data Loggers loggers were used. Image 1 shows the instrument. They are waterproof to 305 meters and accurate to within 0.2^0 C. The instrument stability, or drift, is less than 0.1^0C per year of use. The memory capacity is approximately 42,000 temperature measurements. This is about 5 years of collecting hourly data. Each logger is sealed in an epoxy case. The epoxy case has a tab pierced by a hole. A wire or other connector may be passed through the hole to secure the logger. There are two epoxy pins through which the logger is programmed and downloaded. The epoxy case and pins are vulnerable to abrasion or impact.

Image 1. Onset Tidbit v2. A Canadian two-dollar coin provides scale. The hole used to secure the logger is visible on its lower right side**.**

Abrasion or impact were avoided through use of flow-through housings. The housings were manufactured from 40 mm inner diameter black PVC pipe. Black pipe is much less visible than white pipe. It was less likely to be disturbed by curious or destructive humans or other mammals. Concerns the housings might heat under conditions of intense sunlight were mitigated by:

- the logger measuring the water temperature directly rather than the air temperature within a waterproof case;
- ensuring that no part of the measuring portions of the logger touched the housing. Heat from solar warming of the housing was not transferred directly to the logger;
- deploying housings and loggers in moving water, allowing a constantly renewed supply of water to flow over the logger; and

- deploying the housings where they will be shaded for most- or all of the day.

Each housing was ~120 mm long. Eight 18 mm diameter holes were drilled through the wall of the housing, with 4 at each end. The holes were at roughly 90-degree angles and 10 – 15 mm from the end of the housing. Each logger was placed in the housing with the hole in the epoxy case facing toward the nearest end. The logger was then secured with 2 cable ties. Two loggers were placed in each housing. Commercial plastic-coated metal clothesline secured the housing to a weight and to a feature on shore such as a rooted tree. The clothesline was passed through the end of the housing and through one of the 18 mm holes. It was then passed through an 18 mm hole near the opposing end of the housing and through the end itself. The weight was tied to one end of the clothesline. This maximized the strength of the clothesline if the housing was displaced by ice or debris. The weight was usually a 1 kg or heavier piece of scrap metal. The housing was cable tied to the clothesline at the desired distance from the weight. The distance varied depending on the observed characteristics of the stream or river. Risks of the logger being buried in the river's deposition zone were mitigated by placing the logger above the zone. Cable ties were applied to all knots to reduce the possibility that they might slip. The housing, weight and clothesline securing them were termed a "data logger string". Image 2 provides an example of a data logger string being prepared for deployment.

To the extent possible data logger strings were set in an area that would be shaded through all- or most of each day. Locations with turbulent flow during the open water period were chosen. The weight was placed in the river with the housing at the desired distance above it. An effort was made to ensure that the loggers would be underwater throughout the open water period. The clothesline above the water surface was concealed under debris or in a cut made in the soil of the riverbank. Moss or forest floor material was used to conceal the portion of clothesline around the tree. One or more photographs were taken.

Loggers were launched prior to leaving for the field. When possible, one new- and one older logger were deployed at each Station. The serial number of each logger and the Station it would be deployed to were entered into a Master Data Logger Tracking spreadsheet. The loggers for each Station to be replaced (Annual) or deployed (Seasonal) were tied with a length of flagging on which the Station name was written in indelible ink. Replacement loggers were cable tied into the housing and returned to the stream or river.

At each Station where the loggers were being replaced the clothesline was checked for damage. Beaver gnawed at the clothesline and cut through the plastic coating. The steel cable could then rot/rust away. All damaged clotheslines were replaced.

Image 2. Data logger string. Note the scrap metal weight. The logger housing is located above the weight, allowing it to move with the current. The loggers are within the housing. The clothesline is tied to the weight and passes through the housing. Cable ties hold the shield at the preferred distance from the weight. The clothes line will be tied to a tree or other relatively unmovable object.

Each logger returned from the field was first cleaned. It was then downloaded. The battery and memory status were checked. The logger was placed in storage or discarded if the battery level was too low. The data from both loggers at any given station was graphed and visually compared. If the graphs matched, the data from the newest logger (highest serial number) was accepted as the data set of record. The downloaded data from each Station was exported and saved to an Excel Workbook.

Quality Control of data was conducted during download by scanning each graph to determine periods where the data may have been questionable. This included periods during the winter when the logger may have been frozen in ice or dewatered. This was relatively easy to determine, as the recorded temperatures were below -0.2^0 C. The -0.2^0 C value was chosen for three reasons:

- the V2 data loggers are accurate to 0.2^{0}C;
- slush/frazil ice is usually slightly below 0^{0}C. It often accumulates during freeze-up and again during the spring; and
- winter flows in rivers of the Yukon River Basin depend on ground water discharge in most locations. Most ground water has elevated levels of total dissolved solids (Brabets et. al., 2000). This is likely to result in a minor freezing point depression, as 0^0 C is the freezing point for pure (ie distilled) water.

During the open water periods loggers might have been removed from the water by wildlife, people or high stream flows. They might have been dewatered during extreme low flow conditions. Both would result in the daily range of temperatures being wider than expected if the loggers were measuring water temperatures. Additionally, air temperatures become warmer earlier in the day and cool more quickly in the evening. The dates of when the loggers were out of the water is generally simple to determine.

Periods when the loggers were below -0.2^0 remained in the data sets. Periods when the loggers were above the water surface were excluded from the data sets. The rationale for this was that sub-zero temperatures are easily determined but periods when the loggers were out of the water are not.

Loggers were placed in locations with turbulent flow. This is where water was mixed from the bed to the surface. Water levels in unregulated streams and rivers rise and fall seasonally and as a result of precipitation (or lack thereof). As a result, depth was not a meaningful metric in measuring river temperatures in the CYRB.

Seasonal Stations were located on rivers used primarily for upstream adult Chinook Salmon migration. These rivers experience mechanical ice breakups. Ice jams, shore thrust and other processes where the bed and banks of the river may be affected by moving ice may occur. The risk of losing the loggers during mechanical breakups was considered unacceptable. Seasonal loggers were deployed in the early summer and removed in the fall.

Annual Stations recorded temperatures throughout the year. They were located on Chinook spawning streams and rivers which did not generally experience mechanical ice breakup. Loggers at Annual Stations were replaced in spring and again in autumn.

The Program was based on Watersheds. The Watersheds are the principal tributaries to, or main-stem segments of, the Yukon River in Canada. Most watershed models start at the headwaters and proceed downstream. Anadromous fish of salmon and other species are best considered- and managed by watershed models that start at the ocean and proceed upstream. The Yukon River starts at the Bering Sea and ends in a multitude of headwater tributaries in Alaska, the Yukon and British Columbia. From the US/Canadian border below Eagle, the Watersheds were the:

Yukon River North Mainstem, from the Yukon-Alaska border to immediately upstream of the mouth of the Selwyn River and including all tributaries except for the White and Stewart Rivers. The upstream boundary was based on the limit of recent glaciation, and the First Nation language boundary between the Han and Tutchone language groups;
Stewart River and all tributaries to it;
White River and all tributaries to it;
Yukon River Mid-Mainstem, from the downstream boundary with the North Mainstem to the confluence of the Teslin and Yukon Rivers, and all tributaries to it except for the Pelly River;
Pelly River, and all tributaries to it;
Teslin River, and all tributaries to it; and
Yukon River Upper Lakes, including all tributaries to it and the lakes they flow from.

Analysis

The data was analysed for two main purposes. First, to provide information to members of the JTC indicating possible risks to upstream migrating adult salmon; and second, to provide some indication of the potential biological/habitat productivity of the monitored streams. This would (or will), by inference, allow understanding of their potential to support 0+ and 1+ juvenile Chinook Salmon.

The information provided to members of the JTC required calculation of the Mean Daily Temperatures (MeDT) and sorting to find the Maximum Daily Temperatures (MaxDT) Only Stations with full 24-hr daily data sets were used. A “day” was from 0100 to 2400 hours.

Potential risk to Chinook Salmon from elevated water temperatures was determined for each Station through the American Standards and Canadian Thresholds that existed in 2010. Analysis was limited to periods when Chinook Salmon would be considered likely to be migrating past- or spawning in the watercourses.

The American Standards are based on the requirements of the United States Clean Water Act (US CWA). This compelled States and Tribes to set Water Quality Standards that included water temperatures. Alaska has complied with the US CWA and has prepared temperature standards, or accepted southern water standards as their own. The standards are based on Maximum Daily Temperature and were:

- For migration, not to exceed 15 degrees C;
- For spawning, not to exceed 13 degrees C;
- For egg and fry incubation, not to exceed 13 degrees C;
- For rearing, not to exceed 15 degrees C.

The Standards are highly restrictive. The Standards include non-salmonoid species in addition to salmon such as the Dolly Varden and Bull Trout.

The Canadian process reflected the legal and socio-economic characteristics of Canadian in 2010. Water is, constitutionally, a provincial area of responsibility. Fisheries and fish habitat is a federal responsibility. Water temperature was not recognised as a statutory quality of water by either level of government except for a limited number of specified purposes. A drought resulted in high water temperatures and apparent collapses of up-river sockeye populations in the Fraser River in the 1990s and 2000s. Results of scientific investigations and local information were used to set water temperature risk thresholds for the Fraser River. The Fraser River ewatch monitors and now predicts the river temperature relative to the thresholds. The thresholds are based on Mean Daily Temperature and are:

- 18°C - Decreased swimming performance;
- 19°C - Early signs of physiological stress and slow migration;
- 20°C - Associated with high pre-spawn mortality and disease;
- 21°C - Chronic exposure can lead to severe stress and early mortality.

The number of days with maximum daily temperatures above 13, 14, 15 degrees, and those with mean daily temperatures above 18, 19 and 20 degrees were reported for each Station to summer of 2021. Should there be interest, the Annual Report for the 2021 project has the analysed data by station. It can be accessed through the Yukon River Panel Web Page.

The second purpose of analysis was to determine the amount of available thermal energy in each stream. Habitat managers (should) consider the biological productivity of streams and rivers as important. Thermal energy may be calculated as Accumulated Thermal Units (ATU). Over a calendar year this becomes Annual Accumulated Thermal Units (AATU). Analysis of a number AATUs at a Station becomes the Mean Accumulated Thermal Units (MeAATUs).

MeAATUs are an indicator of a stream or river's potential habitat productivity. As a rule, a warm(er) stream in a north temperate environment such as that of the South- or Central Yukon will support a more diverse and numerous invertebrate community than a cool(er) stream (Castella et. al., 2001). Calculation of AATUs required an entire calendar year of data. Stations can be used if they are frozen during portions of some winters. This due to the very small contributions made to the AATU under winter conditions.

AATUs also provide a means of comparing and classifying streams in the Canadian (and perhaps the Alaskan) Yukon River Basin. Which types of streams have the greatest number of AATUs, and which have the smallest? Should the actual or inferred AATUs be a factor in agencies or institutions conducting algal or invertebrate investigations in the future?

Results

Performance of the Stations. These were the periods that temperature data was successfully collected. If data collected at a Station would not allow AATU analysis the year when it occurred was not included. The total number of years at each Station included the year of start- and the year ending the measurements. As an example, McIntyre Creek's successful data collection was 12 years, but data suitable to calculate MeAATUs was 10 years.

Seasonal Stations collected data for the adult Chinook Salmon upstream migration. Stewart River at Stewart Crossing and Pelly River downstream of Pelly Crossing each had 8 years of data collection. Yukon River above the Klondike Highway and Teslin River at Hootalinqua each had 5 years of data collection.

Annual Stations collected data continuously. Blind Creek above/below abandoned bridge, Tatchun River downstream of Tatchun Lake, North Klondike River at North Fork Road, and McIntyre Creek downstream of Mountainview Drive collected data for 12 years or portions thereof; Little Salmon River at Canoe Landing for 11 years; Takhini River downstream of Kusawa Lake, Nordenskiold River at Elk Sign, Ibex River at WSC Station, and Yukon River at Anson Bend for 10 years; Yukon River at Policemans Point for 6 years; Tatchun River above Klondike Highway and Mcquesten River below Klondike Highway for 5 years; and Teslin River above Hootalinqua for 4 years.

Detailed performance of individual Stations is included in Appendix 1.

Annual Accumulated Thermal Units

The AATUs by Station and calendar year, the range of AATUs for the period of record and the mean AATU (MeAATU) of each Station may be found in Appendix 2.

The AATUs are a measure of temperature related habitat productivity of streams. Habitat productivity may be defined as the "Capacity or ability of an environmental unit to produce organic material" or the "Rate of formation of new tissue or energy use by one or more organisms" (Armantrout, 1998). Higher water temperature in northern streams has been related to greater productivity at multiple trophic levels (Hannesdóttir et.al, 2013). Increases in stream temperatures related directly- or indirectly to climate change at high latitudes are anticipated to result in increased habitat productivity (Prowse et.al., 2006).

There is no universally accepted method of classifying streams on the basis of water temperature. Most classification systems and processes have reflected the purpose for which the classification was made, the role or function of the person or agency that developed it, and the geographical area in which it originated (Coker et al., 2001; Chu et al., 2009; Nelitz et al, 2007). There is also an understandable bias toward mid-temperate regions of our continent. The majority of the North American population- and research institutions are located in these regions. In addition, the lands and waters that contribute to fish habitat have been under greater development stresses in mid-latitudes than those located at higher latitudes.

Mean AATUs (MeAATU) were used to classify streams. Table 1 presents the MeAATUs of all annual Stations in ascending order, the range of each Station's MeAATUs and the number of calendar years of data used in the calculations.

Table 1. 2022 - Classification of Stations using MeAATUs

Station	Years of Data	Range AATU	MeAATU
Cold (<1300)			
N. Klondike R. at North Fork Bridge	10	892 - 1121.5	995.1
Ibex R. at WSC Station	6	1046.6 – 1297.6	1158.6
Blind Cr. at abandoned bridge	10	1135.1 - 1407.9	1259.9
Cool (1301 - 2200)			
Mcquesten below Klondike Hwy	4	1464.3 - 1811.7	1587.8
Nordenskiold R. at Elk Sign	9	1565.5 - 1811.7	1670.0
Little Salmon R. at Canoe Landing	8	1444.0 - 1837.4	1666.6
McIntyre Cr. below Mountainview	10	1702.2 – 2008.9	1824.1
Teslin R. above Hootalinqua	2	1781.3 - 1971.2	1876.3
Takhini R. below Kusawa L.	7	1732.9 - 2105.3	1952.8
Yukon R. at Anson Bend	8	1986.9 - 2440.6	2145.1
Warm (>2200)			
Tatchun River above Klondike Hwy	3	2309.0 -2599.7	2435.9
Tatchun R. below Tatchun L.	10	2416.8 - 3013.7	2659.7

For the purposes of this Program, streams and rivers were provisionally classified as:

- Cold – MeAATU - 1300 or less;
- Cool – MeAATU - more than 1301, less than 2200;
- Warm – MeAATU – more than 2201.

These seemed to reflect natural breaking points in the thermal characteristics of streams. The classifications were originally developed early in the Program. They have been followed since then.

The wide range of thermal environments used by spawning Yukon River Chinook salmon is noteworthy. It implies some degree of genetic adaptation by individual populations or a high degree of resiliency within the greater (ie Yukon River in Canada) population. Resolution – or at least investigation - of this matter deserves attention. It is of interest due to recent Chinook Stock (population) restoration initiatives. Replicating the environmental conditions of habitats used by donor stock when restoring populations has been a central tenet of stocking elsewhere, but not in the Yukon.

The North Klondike River at North Fork Bridge had the lowest MeAATU at 995.1 ATU. This implies that the Chinook incubation/alevin stages could take a full year if generally accepted Chinook bio-standards are applied. The rearing period for 0+ juveniles following emergence would be correspondingly limited. Adult enumeration is not carried out in the North Klondike River. The status of the adult population is unknown.

The Tatchun River below Tatchun Lake had the highest MeAATU at 2659.7 ATUs. The river is small and supports a major Chinook spawning population. Habitat productivity has not been determined but appears to be considerable. At replacement of the loggers the housing was generally encrusted with attached benthic organisms and crawled with mobile organisms in both spring and fall.

Distribution of Data

Early in the Program I contacted the research institute of the day at Yukon College. I was hoping to have them host the data I collected and provide public use to it. The principle of “citizen scientists” was gaining traction at the time. I found little interest by the staff in hosting the data. I left with the impression that the College was undergoing a process of constant reorganization. Having been employed with DFO this was familiar ground to me. I recognized how difficult it was to store and steward data under such conditions, and withdrew. This was, however, 13 years ago and the College is now a University. It is possible that conditions have improved.

Following my failure at the College, I asked a relative specializing in data management to develop a website and find a provider to host it. He did so. The cost was high: the annual cost was between ~350 and ~450 dollars a year Cdn. There were added costs and, worse, added effort to operate and maintain the website. My intent from the start was to have the data available after my death. I found someone who would accept funds to maintain the website for ~20 years after my death. However, the effort required in operating and maintaining the network was difficult to predict.

In 2019 Michael Folkes, DFO Senior Stock Assessment Biologist offered to proof the data collected. He exercised his influence to have the data entered on the Yukon River Panel website. He did so, and in the summer of 2020 the Yukon River Panel agreed to host the data from this Program on their website. The data to 2020 is now publicly available at https://www.yukonriverpanel.com/publications/data-sets/ The final data from 2020 to 2022 has been submitted to the Yukon River Panel, with a request to add it to the data already entered.

Conclusions

The “Temperature Monitoring of Yukon River Chinook Salmon Spawning and Migration Habitats in Canada Program” is complete. Water temperatures may be collected at some Program Stations in the future: there is definite interest, but it is up to the people concerned to announce their intent.

Overall, tending to the Program has been interesting and rewarding. All the best to whomever uses the data. And, of course, to whomever collects water temperature data in the future.

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Appendix 1. Stations - description and performance

The Stations which comprise the Network are described below. The following terms and identifiers are used.

Stations are named after geographical features such as lakes or long-standing structures such as bridges, signs, landings or historical events. Of necessity, many of the names are local and will not be familiar to some readers. The coordinates provided allow stations to be located with Google Earth or another mapping tool.

Seasonal Stations. Captured data during the adult Chinook Salmon upstream migration.

Annual Stations. Captured data throughout the year.

Sides of streams or rivers. "Right" or "left" is determined by looking downstream.

Use by Chinook – Only migration, spawning and incubation are covered. However, all spawning rivers and streams are also utilized by rearing Chinook Salmon. Juvenile 0+ Chinook from upstream spawning populations enter and use non-spawning and spawning rivers and streams for rearing and overwintering. Overwintering of 0+ Chinook will occur in most or all spawning- and in most non-spawning rivers and streams. Essentially all successfully overwintering 1+juvenile Chinook Salmon migrate to the ocean in the following late spring or early summer.

Seasonal Stations

Stewart River at Stewart Crossing.

Type of habitat at Station: Mainstem
Watershed: YR Stewart River
Coordinates: NAD 83 63 22.947/136 41.036
Use by Chinook: upstream migration
Rationale for inclusion: The Stewart River is a principal tributary of the Yukon River. It is a major adult Chinook Salmon migration route. The Station is downstream of 8 documented spawning rivers/streams in the mid- and upper Stewart River Watershed. The upper Stewart River Watershed is poorly explored. It is likely that there are more Chinook spawning rivers there than currently documented. The Station is in an excellent location, on the right side of river, against a bedrock bluff.

Access is by vehicle via the Klondike Highway and a short but steep scramble down the river bank.
Performance: Loggers were dewatered due to low river levels in 2017. Loggers had to be adjusted in 2019 due to low water. In 2020 & 2021 the loggers could not be retrieved and may still be in place. Performance by year:

2012 – Loggers in place July 4 to September 14
2013 - Loggers in place July 3 to September 8
2014 - Loggers in place July 1 to September 14
2015 - Loggers in place June 17 to September 22
2016 - Loggers in place June 17 to September 17
2017 - Loggers in place May 25 to August 4
2018 - Loggers in place June 6 to September 16
2019 - Loggers in place May 22 to September 1
2020 – Loggers placed, could not retrieve
2021 – Loggers placed, could not retrieve

Pelly River downstream of Pelly Crossing.

Type of habitat at Station: Mainstem
Watershed: YR Pelly River
Coordinates: NAD 83 62 50.467/136 40.988
Use by Chinook: upstream migration
Rationale for inclusion: The Pelly River is a principal tributary of the Yukon River. It is a major adult Chinook Salmon migration route. The Station is downstream of all 22 documented spawning rivers in the Pelly River Watershed. It is in an excellent location, on the right side of river, against a bedrock bluff. Access is by vehicle via the Pelly Farm Road.
Performance: Loggers were dewatered From July 30 – Aug 7, 2018 due to low river levels. In 2021 the Selkirk First Nation posted “no access” signs on the access to the Pelly Farm Road. I accepted their wishes and did not set loggers at the Station. In 2022 the water levels were too high to set loggers. Performance by year:

2012 – Loggers in place July 4 to September 14
2013 - Loggers in place July 3 to September 8
2014 - Loggers in place July 1 to September 14
2015 - Loggers in place June 17 to September 22
2016 - Loggers in place June 17 to September 7
2017 - Loggers in place May 25 to September 27
2018 - Loggers in place June 6 to September 8; out of water from July 30 to Aug 7 - data deleted
2019 - Loggers in place May 22 to September 16
2020 – Loggers in place June 19 to Sept 15
2021 – Road to Station closed
2022 – Water too high to set loggers prior to adult migration

Yukon River above the Klondike Highway

Type of habitat at Station: Mainstem
Watershed: YR Mid-Mainstem
Co-ordinates: NAD 83 62 05.684/136 16.275 (2016 – 2019)
62 07.339/136 13.825 (2020)
Use by Chinook: Chinook spawning downstream; migration to upstream tributaries of the Min-mainstem, Teslin and Upper Yukon River Watersheds.
Rationale for inclusion: locations of Chinook spawning in the Yukon River within the YR Mid-Mainstem is poorly defined. Most probably occurs downstream of the Station. All salmon spawning in the Big and Little Salmon Rivers, Walsh Creek and the Teslin and Upper Yukon River Watersheds migrate past the Station. The Station was located on the left side of river ~150 meters above Klondike Highway bridge but the landowner fenced off the access. It was then located on the right side of the Yukon River. It is accessible by foot from the Robert Campbell Road.
Performance: The new Station worked very well in 2020. In 2021 and 2022 the Yukon River flooded back into the bush – as in, exceeded full bank level – in June at the Station. It stayed that way until September and loggers were noy set. Performance by year:

2016 - Loggers in place June 18 to September 9
2017 - Loggers in place June 5 to Sept 24
2018 - Loggers in place June 28 to September 12
2019 - Loggers in place June 12 to September 16
2020 – Loggers in place June 27 to Sept 17
2021 & 2022 – Water in Yukon River too high to deploy loggers

Teslin River at Hootalinqua.

Type of habitat at Station: Mainstem
Watershed: YR Teslin River
Co-ordinates: NAD 83 61 35.118/134 53.897
Use by Chinook: upstream migration past the Station
Existing data: 2011 – 14; no data for 2015
Rationale for inclusion: The Teslin River is a principal tributary of the Yukon River and a major adult Chinook Salmon migration route. The Station is downstream of all 21 documented spawning rivers in the Teslin River Watershed. The Station was at the confluence of the Yukon and Teslin Rivers, and upstream of where the mixing zone between the two rivers reached across the river. Access was by boat from the Deep Creek Launch on Lake Laberge.
Performance: Commissioned on July 18, 2011. Initially an Annual Station. Then changed to a Seasonal Station. Moved to Teslin River above Hootalinqua in 2016. Performance by year:

2011 – clean data set
2012 – Loggers in place June 24 to September 23
2013 - Loggers in place June 24 to September 9
2014 - Loggers in place July 3 to September 12
2015 - Loggers in place June 30 to September 22
2016 - Loggers in place June 17 to September 30

Annual Stations

These Stations recorded temperatures throughout the year. Many Annual Stations experience temperatures below -0.2^0 C during portions of some winters due to ice formation processes. If the temperatures measured were consistent with a submerged logger recording water- or ice temperatures the data is considered "continuous" for analysis. Extreme low river flow or disturbance could result in loggers reading air rather than water temperatures during open water periods. All data was checked and any questionable measurements were deleted.

North Klondike River at North Fork Bridge

Type of Habitat at Station: Mainstem
Watershed: YR North Mainstem
Coordinates: NAD 83 - 64 00.102/138 35.761
Use by Chinook: spawning and incubation.
Access: by vehicle via the Dempster Highway and North Fork Road.
Rationale for inclusion: The North Klondike River is a mid-sized mountain river. It is considered typical of Chinook spawning rivers flowing south from the Ogilvie Mountains. These include Coal Creek, Fifteen Mile River and Twelve Mile (Chandindu) River, and possible spawning tributaries in the little explored upper South Klondike River and Stewart River. The Station is located at or near the apex of the alluvial fan that the North Klondike River has formed in the Klondike Valley.
Performance: Commissioned August 6, 2011. The loggers record freezing temperatures in some winters. This is due to the location of the winter river channels varying from year-to–year. In summer of 2019 the loggers had to be moved to deeper water due to low river levels. Performance by year:

2011 – Logger read below -0.2 on Oct 10; from Nov 3–5; on Dec 23 & from Dec 27 - 31
2012 – Logger read below -0.2 from Jan 1 to Apr 17; Oct 24 to 27
2013 – Logger read below -0.2 from Oct 23-25; on Oct 27; on Nov 4; from Nov 7-9; on Dec 5-31
2014 – Logger read below -0.2 from Jan 1 to April 19
2015 – Logger read below -0.2 on April 19; Nov1-3; on Nov 5. Out of water Apr 17 – 24 & data deleted
2016 – Logger read below -0.2 from April 10-11

2017 – Logger read below -0.2 from Mar 10-Apr 1; Nov 26-Dec 17; Dec 19-31
2018 – Logger read below -0.2 from Jan 1-Apr 27
2019 – Logger out of water from May 8-10; July 2-5 – data deleted
2020 – Logger read below -0.2 from Jan 18-22; Feb 15-22; Mar 1-3; Mar 7-10; Apr 1-4; Oct 23-25
2021 – Clean data set
2022 – Clean data set
Last reading - September 15, 2022

Mcquesten River below Klondike Highway

Type of habitat at Station: Mainstem
Watershed: YR Stewart River
Coordinates: NAD 83 - 63 33.318/137 24.912
Use by Chinook: spawning and incubation. Upstream migration to the confluence of the North- and South Mcquesten Rivers and then to spawning locations further upstream on each fork.
Access: by vehicle via the North Klondike Highway
Rationale for inclusion: The Mcquesten River is the primary Chinook spawning river in the Stewart River Watershed.
Performance: Station was commissioned on July 6, 2014. Some difficulty was experienced in setting loggers due to high spring flows. Loggers were lost in 2020 and Station was decommissioned. Performance by year:
2014 – Clean data set
2015 – Clean data set
2016 – loggers read below -0.2 from Oct 25-28; Nov 17-18
2017 – loggers read below -0.2 from Nov 11-13. Loggers out of water from April 8-24 – data deleted
2018 - loggers read below -0.2 from Jan 14-15; Jan 18-Apr 27; Apr 25-29; Nov 6-7. Loggers not deployed June 15 – Sept 18.
2019 - loggers read below -0.2 from Jan 1-Mar 17; Mar 30-Apr 10; Apr 15-18; Apr 25-29; Nov 6-7. Loggers out of water May 8-10; Loggers read ground water July 7-10 - data deleted.
2020 – Clean data set
Last reading September 9, 2020

Blind Creek above abandoned bridge

Type of habitat at Station: Small stream
Watershed: YR Pelly River
Coordinates: NAD 83 62 11.30/133 10.51
Use by Chinook: Spawning and incubation.
Access: by vehicle via the Blind Creek Road and the original Faro Mine Access Road.

Rationale for inclusion: Blind Creek is a small stream draining minor headwater lakes. It is typical of many spawning streams tributary to the Pelly- and upper Stewart River. There was an enumeration fence located downstream of the Station but it has been abandoned. The Station is located at or near the apex of the alluvial fan Blind Creek has formed in the Pelly Valley.

Performance: Commissioned on July 19, 2011. Creek channel shifting resulted in increasing icing of the loggers. In 2019 a significant freshet event occurred and caused a washout of the access road. A replacement Station was installed at Blind Creek below abandoned bridge and has worked well. The data sets may be combined for analysis. Performance by year:

2011 – clean data set
2012 – clean data set
2013 – clean data set
2014 – clean data set
2015 - loggers read below -0.2 from Feb 9-14; Mar 2-6; Mar 11-20 from Mar 24 – 26; Nov 27-Dec 31
2017 - loggers read below -0.2 from Jan 1 to Apr 28; Nov 15-Dec 8; Dec 11-31
2018 - loggers read below -0.2 from Jan 1-Apr 12; Dec 22-26; on Dec 31
2019 - loggers read below -0.2 from Jan 1-Mar 30; Apr 1-11
Station decommissioned on June 11, 2019

Blind Creek below abandoned bridge

Coordinates: NAD 83 62 11.512/133 10.854
Station commissioned: June 11, 2019

2019 – clean data set
2020 – clean data set
2021 – clean data set
2022 – clean data set
Last reading – Sept 21, 2022

Tatchun River downstream of Tatchun Lake outlet

Type of habitat at Station: lake outlet/small stream
Watershed: YR Mid-Mainstem
Coordinates: NAD 83 62 17.216/136 14.31
Use by Chinook: spawning and incubation.
Access: by vehicle via the Tatchun Lake Road
Rationale for inclusion: Tatchun River is small and has significant lake storage. It is typical of certain highly productive Chinook Salmon spawning streams of similar size distributed across all Watersheds of the CYRB except for the YR North Mainstem Watershed. These include,

among others, Tincup Creek in the White River Watershed; Janet Creek in the Stewart River Watershed; Glenlyon River in the Pelly River Watershed, the Swift River (North) in the Teslin River Watershed and Michie Creek in the Yukon River Upper Lakes Watershed. These streams often support very high densities of spawning Chinook and may have extensive spawning dune complexes. They are vulnerable to direct effects of periods of low flow/high water temperatures, and to indirect effects such as beaver damming of spawning streams.

Performance: Commissioned on July 11, 2011. Performance by year:

- 2011 – clean data set
- 2012 – clean data set
- 2013 – clean data set
- 2014 – clean data set
- 2015 – clean data set
- 2016 – clean data set
- 2017 – clean data set
- 2018 – clean data set
- 2019 – clean data set
- 2020 – clean data set
- 2021 – clean data set
- 2022 – clean data set
  - Last reading – Sept 22, 2022

Tatchun River above Klondike Highway

Type of Station: lake outlet/small stream

Watershed: YR Mid-Mainstem

Coordinates: NAD 83 62 16.925/136 18.632

Use by Chinook: spawning and incubation.

Access: by vehicle from Klondike Highway

Rationale for inclusion: The Tatchun River is described above in the Station description for Tatchun River downstream of Tatchun Lake. The lake outlet Station is located at the effective upstream limit of Chinook spawning. The Station above the Klondike Highway is located at the effective downstream limit of Chinook spawning. Data collected at the two Stations may be compared to start to develop an understanding of the thermal regimes within a single highly productive Chinook Salmon spawning stream.

Performance: Commissioned on Aug 29, 2016. Loggers worked very well until a spring flood carried away the bank that they were set below. Loggers were lost and Station was decommissioned. Performance by year:

- 2016 – clean data set
- 2017 – clean data set
- 2018 – clean data set
- 2019 – clean data set

2020 – clean data set
Last reading - September 9, 2020

Nordenskiold River at Elk Sign

Type of habitat at Station: Mainstem
Watershed: YR Mid-Mainstem
Coordinates: NAD 83 61 51.438/136 06.539
Use by Chinook: spawning and incubation. Upstream migration to Hutshi Lake outlet and Kirkland Creek.
Access: by vehicle via the Mayo Road/North Klondike Highway.
Rationale for inclusion: The Nordenskiold River is a mid-sized river during wet weather years. Much of its drainage basin is in the rain shadow of the Coastal Ranges. There is only limited high elevation terrain to provide seasonal water storage. During drought periods flows in the river are greatly reduced. The river is vulnerable to the direct and indirect effects of climate change. A Chinook Salmon stock on one tributary, Klusha Creek, has been extirpated due to extended droughts and associated effects of low stream flows.
Performance: Station was commissioned on January 1, 2011. Loggers record freezing temperatures in some winters, as the location of the stream's winter channel varies from year-to–year. Performance by year:

2011 – loggers were out of water Aug 1-Sept 28 – data deleted
2012 – clean data set
2013 – clean data set
2014 – clean data set
2015 – clean data set
2016 – clean data set
2017 – clean data set
2018 – clean data set
2019 – clean data set
2020 – clean data set
2021 – clean data set
Last reading – July 7, 2021

Little Salmon River at Canoe Landing

Type of Station: Mainstem
Watershed: YR Mid-Mainstem
Coordinates: NAD 83 62 05.610/135 18.381
Use by Chinook: spawning and incubation. Upstream migration to Bearfeed Creek and Drury Creek.
Access: by vehicle via the Campbell Highway
Rationale for inclusion: The Little Salmon River is typical of a number of mid-sized rivers with lake storage and Chinook Salmon spawning extending for some distance downstream from the lake outlet. These

include, among others, the Woodside River below the Pelly Lakes; the Morley River below Morley Lake; and the Big Salmon River below Big Salmon Lake. These streams often have pockets of very high densities of spawning Chinook. Many of the lakes are located in glacial troughs and are deep and cold.

Performance: Commissioned on September 28, 2012. Performance by year:

2012 – clean data set
2013 – clean data set
2014 – clean data set
2015 – clean data set
2016 – clean data set
2017 – clean data set
2018 – clean data set
2019 – clean data set
2020 – clean data set
2021 – clean data set
2022 – clean data set
Last reading - Sept 14, 2022

Teslin River above Hootalinqua

Type of Station: Mainstem
Watershed: YR Teslin River
Co-ordinates: NAD 83 61 34.047/134 53.949
Use by Chinook: upstream migration past the Station and spawning within 30 km upstream

Rationale for inclusion: The Teslin River is a principal tributary of the Yukon River and a major adult Chinook Salmon migration route. The Station is downstream of all 21 documented spawning rivers in the Teslin River Watershed. The Station was formerly located at the confluence of the Yukon and Teslin Rivers and upstream of where the mixing zone between the two rivers reaches across the river. It was difficult to service at high water levels and was dewatered under low water conditions. Access is by boat from the Deep Creek Launch on Lake Laberge.

Performance: Commissioned on June 29, 2016. Servicing this Station was difficult when flow conditions in the Teslin River were high or extreme. This occurred in 2020 and the loggers were not replaced. In 2021 flows were extreme. The Government of Yukon imposed a navigation closure on the Southern Lakes. Reports of erosion in the area implied that the Station had been washed away. The Station was decommissioned. Performance by year:

2016 - loggers read below -0.2 from Dec 5-7; Dec 14-15
2017 - loggers read below -0.2 from Nov 13-17; on Nov 22; from Nov 26-30

2018 – loggers out of water May 9-11 data deleted
2019 – loggers out of water May 7-15 data deleted
Last reading – September 13, 2019

Yukon River at Policeman's Point

Type of Station: Mainstem
Watershed: YR Upper Lakes
Coordinates: NAD 83 60 56.808/135 5.647
Use by Chinook: upstream migration.
Access by vehicle or boat from Lake Laberge or Whitehorse.
Rationale for inclusion: The Yukon River at this location is a large river. All documented spawning in the Yukon River Upper Lakes Watershed (spawning downstream of Lake Laberge is suspected but not yet documented) occurs upstream of the Station. The river ice rots out in the spring rather than breaking up. This reduces the risk of loss to an acceptable level and allowed an annual Station to be maintained.
Performance: Commissioned May 7. 2011. High rates of upstream erosion resulted in heavy deposition of sand at the Station. Considered no longer reliable in 2015. Decommissioned on June 2, 2015. Performance by year:

2011 – clean data set
2012 – clean data set
2013 – clean data set
2014 – clean data set
2015 – clean data set
Last reading June 2, 2015

Takhini River downstream of Kusawa Lake

Type of Station: Lake outlet
Watershed: YR Upper Lakes
Coordinates: NAD 83 60 38.593/136 07.410
Use by Chinook: spawning and incubation.
Access: by vehicle via the Kusawa Lake Road
Rationale for inclusion: The Takhini River is a mid-sized river. It is the only unregulated Chinook spawning river to receive significant input from actively melting glaciers. Augmentation of flows from glacier melt has been increasing in the South West Yukon, particularly in late summer. Glacier mass has been decreasing. A tipping point where the glacial augmentation begins to decline is anticipated. When this occurs late summer flows in rivers directly draining the glaciers will be reduced (Moore et. al., 2009). Flows in rivers located downstream and mediated by lakes will also be reduced, including the Takhini River below Kusawa Lake.

Performance: Commissioned October 1, 2012. Generally good during open water period, but at some risk of disturbance from persons unknown or other mammals. Performance by year:

2012 – clean data set
2013 – clean data set
2014 – loggers out of water June 18-July 3; Aug 10-12; Aug 29-Sept 12 – data deleted
2015 – clean data set
2016 – clean data set
2017 – clean data set
2018 - loggers read below -0.2 Mar 11-15; Apr 3-9
2019 – clean data set
2020 – clean data set
2021 – loggers out of water May 26-30 data deleted
2022 – clean data set to October 4, 2022
Last reading October 4, 2022

Ibex River at WSC Station

Type of Station: Small stream
Watershed: YR Upper Lakes
Coordinates: NAD 83 60 43.539/135 29.175
Use by Chinook: Chinook Salmon spawn downstream, and there is local/traditional knowledge of spawning upstream of the Station.
Access: by 4X4 or ATV via the Ibex River Road
Notes: The lower Ibex River has a small population of Chinook Salmon at present. Local/traditional knowledge implies that the area of river used was significantly larger in the past and the Chinook population size was considerably greater. Bio-physical assessments funded under the Yukon River Interim Salmon Agreement determined that the river was a candidate for habitat- and possibly stock restoration (Zurachenko and Finnson, 1998). There has been interest in Chinook restoration by DFO and KDFN. A complicating effect will be that flows from a significant area of the watershed are diverted to Porter and thence McIntyre Creek for the purposes of electrical power generation.
Performance: Commissioned July 4, 2013. In autumn of 2021 the road into the Station was flooded. In September 2022 I attended the Station. The clothesline had been severed and the loggers lost. Performance by year:

2013 – clean data set
2014 – clean data set
2015 – clean data set
2016 – clean data set
2017 – clean data set
2018 – clean data set

2019 – clean data set
2020 – clean data set
Last reading September 30, 2020

McIntyre Creek downstream of Mountainview Drive

Type of Station: Small stream
Watershed: YR Upper Lakes
Coordinates: NAD 83 60 45.578/135 06.045
Use by Chinook: spawning and incubation.
Access: by vehicle via Range Road.
Rationale for inclusion: McIntyre Creek is a small spawning stream with regulated flows. It supports the only Yukon River Chinook Salmon stock that is known to have developed during the 20th century. The capture of watershed area by a hydro-electrical development in the early 1950s increased the effective size of the creek's watershed at the expense of the Ibex River. This action, and the release of a constant volume of water in the winter for electrical generation, created habitat for adult Chinook to enter the creek and then successfully spawn and incubate. The Yukon Government is actively looking for hydro-electrical sites. These may include projects with similar characteristics to McIntyre Creek. The creek provides an opportunity to investigate the effects of water regulation on a small stream in a northern environment.
Performance: Commissioned May 4, 2011. Performance by year:
2011 – clean data set
2012 – clean data set
2013 – clean data set
2014 – clean data set
2015 – clean data set
2016 – clean data set
2017 – clean data set
2018 – clean data set
2019 – clean data set
2020 – clean data set
2021 – clean data set
2022 – clean data set
Last reading – October 4, 2020

Yukon River at Anson Bend

Type of Station: Mainstem - regulated
Watershed: YR Upper Lakes
Coordinates: NAD 83 60 56.808/135 5.647
Use by Chinook: possible spawning and incubation. Upstream migration to M'clintock River, Michie Creek and Byng Creek.
Access: by boat from the Schwatka Lake East Boat Launch

Rationale for inclusion: The Station is in the first Chinook Salmon spawning area in the Yukon to be documented (Dawson, 1887). The local population was negatively affected and possibly extirpated by dams at the outlet of Marsh Lake and at the Whitehorse Rapids. Whitehorse Rapids Hatchery fry have been released near the Station (JTC, 2013).
Performance: Commissioned June 4, 2011. This was a difficult Station to maintain. Beaver were very active and the clothesline had to be replaced several times. Recreational paddlers disturbed the loggers at least twice.
Performance by year:

2013 - loggers out of water on Nov 6; Nov 15-16 data deleted
2014 - loggers out of water from May 2-12 data deleted
2015 – clean data set
2016 – clean data set
2017 – clean data set
2018 – clean data set
2019 - loggers read below -0.2 from Nov 24-25
2020 - loggers read below -0.2 from Jan 1- Mar 3; Mar 5-22; Mar 30-Apr 4. Loggers out of water April 30 – May 7 data deleted
2021 - loggers out of water from May 22-23 data deleted
2022 - clean data set

Last reading – May 26, 2022

Appendix 2. Annual Accumulated Thermal Units

North Klondike River at North Fork Bridge

Commissioned August 8, 2011	
Calendar year 2012	991.3
Calendar year 2013	973.6
Calendar year 2014	953
Calendar year 2015	983
Calendar year 2016	1017.9
Calendar year 2017	1066.7
Calendar year 2018	892.8
Calendar year 2019	1121.3
Calendar year 2020	955.9
Calendar year 2021	996.5
Mean ATU	**995.9**
Range	**229.5**

Blind Creek at abandoned bridge (both stations joined)

Commissioned July 18, 2011	
Calendar year 2012	1164.8
Calendar year 2013	1258.1
Calendar year 2014	1257.3
Calendar year 2015	1294.3
Calendar year 2016	1407.9
Calendar year 2017	1244.2
Calendar year 2018	1135.9
Calendar year 2019	1391.4
Calendar year 2020	1213.0
Calendar year 2021	1232.7
Mean ATU	**1259.9**
Range	**272.8**

Tatchun River below Tatchun Lake

Commissioned July 20, 2011	
Calendar year 2012	2416.8
Calendar year 2013	2604.9
Calendar year 2014	2504.9
Calendar year 2015	2749.6
Calendar year 2016	2827.9
Calendar year 2017	2757.0
Calendar year 2018	2676.9
Calendar year 2019	3013.7
Calendar year 2020	2499.9
Calendar year 2021	2542.2
Mean ATU	**2659.4**
Range	**596.9**

Nordenskiold River at Elk Sign

Commissioned July 20, 2011	
Calendar year 2012	1575.3
Calendar year 2013	1707.8
Calendar year 2014	1667.4
Calendar year 2015	1734.0
Calendar year 2016	1811.7
Calendar year 2017	1615.7
Calendar year 2018	1565.5
Calendar year 2019	1766.8
Calendar year 2020	1586.0
Mean ATU	**1670.0**
Range	**246.2**

Little Salmon River at canoe landing

Commissioned September 28, 2012	
Calendar year 2013	1610.8
Calendar year 2014	1626.3
Calendar year 2015	1837.4
Calendar year 2016	1826.3
Calendar year 2017	1759.2
Calendar year 2018	1595.3
Calendar year 2019	1809.1
Calendar year 2020	1444.0
Calendar year 2021	1490.2
Mean ATU	**1666.6**
Range	**393.4**

Teslin River above Hootalinqua

Commissioned June 27 2016	
Calendar year 2017	1971.2
Calendar year 2018	1781.3
Calendar year 2019	not retrieved
Mean ATU	**1876.3**
Range	**189.7**

Takhini River below Kusawa Lake.

Commissioned October 1, 2012	
Calendar year 2013	1899.1
Calendar year 2014	Loggers disturbed
Calendar year 2015	2099.6
Calendar year 2016	2102.9
Calendar year 2017	1889.9
Calendar year 2018	1840.2
Calendar year 2019	2105.3
Calendar year 2020	1732.9
Mean ATU	**1952.8**
Range	**256.5**

Ibex River at WSC Station

Commissioned July 4, 2013	
Calendar year 2014	1085.9
Calendar year 2015	1164.2
Calendar year 2016	1297.6
Calendar year 2017	1170.3
Calendar year 2018	1046.6
Calendar year 2019	1203.3
Mean ATU	**1158.6**
Range	**251.0**

McIntyre Creek below Mountainview Drive.

Commissioned May 12, 2011	
Calendar year 2012	1738.2
Calendar year 2013	1866.5
Calendar year 2014	1723.7
Calendar year 2015	1924.4
Calendar year 2016	2008.9
Calendar year 2017	1815.8
Calendar year 2018	1702.0
Calendar year 2019	1976.6
Calendar year 2020	1732.9
Calendar year 2021	1760.7
Mean ATU	**1824.1**
Range	**306.7**

Yukon River at Anson Bend.

Commissioned June 19, 2013	
Calendar year 2014	2076.7
Calendar year 2015	2321.7
Calendar year 2016	2440.6
Calendar year 2017	2156.3
Calendar year 2018	2083.5
Calendar year 2019	2187.3
Calendar year 2020	1986.9
Calendar year 2021	1922.0
Mean ATU	**2146.9**
Range	**453.7**