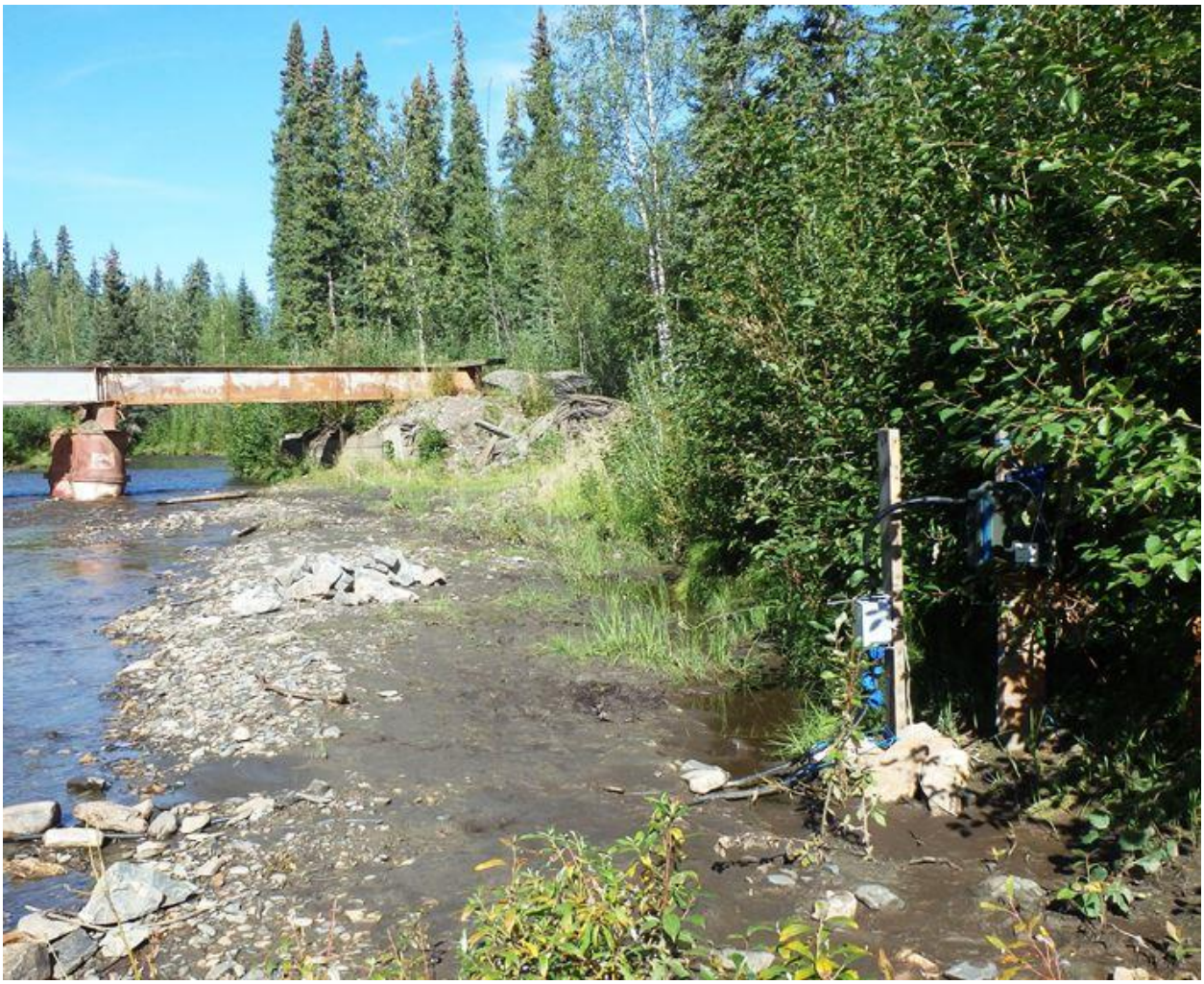
Investigations of Movements of Arctic Grayling in a small stream near Dawson City.

Results Report



Prepared by: Al von Finster
Funded by: Yukon Fish and Wildlife Enhancement Trust
Project # 2016-17-25

Cover image: Monitoring Station from downstream. The electronic equipment is to the right of the image and the antenna extend to the left. Note the rocks used to stabilize the antenna.

Acknowledgements: This project could not have been conducted without the support of the Yukon Fish and Wildlife Enhancement Trust as the principal funder, Jody Mackenzie-Grieve of Fisheries and Oceans Canada's Federal Contaminated Sites Action Plan as project partner, and Earl Rolf and Sandra Viasvil for allowing the monitoring station to be placed on their property. The contribution of Sebastian Jones, Lonny Laroque and Matt McHugh in setting up and taking down the Monitoring Station is acknowledged. Thanks to all.

Table of contents

Introduction

This project centered on the introduction of Passive Integrated Transponder (PIT) technology to the study of the seasonal movements of Arctic Grayling in a small stream in the Yukon. The PIT tagging system used was self-contained. Once in place, it required only periodic downloads of the data logged. The study functioned as a pilot project and an opportunity to test the technology in a field setting.

Beyond the introduction of the technology, the primary project Goal was to determine the movements of Arctic Grayling seasonally exiting from a small stream draining the unglaciated area of the Yukon. If successful, the information gained would add to Local and Traditional Knowledge of Arctic Grayling movements. It could provide better information than the existing Scientific/Technical knowledge of grayling movements in streams. Most of this knowledge has been based on studies conducted at the southern edge of the species distribution, areas impacted by development, or both. Examples include the Black Hills of Montana (relict population, southern edge of distribution), Alberta (multiple stressors), and the NWT (Diamond Mines).

The secondary Goal was to introduce the technology to interested parties in the Dawson area, including but not limited to the DDRRC and the THFN.

The project was conducted in partnership with the Federal Contaminated Sites Program (FCSP) of Fisheries and Oceans Canada (DFO). The Clinton Creek Asbestos Mine is a Federal Contaminated Site. FCSP provided equipment, training and assistance with the installation and decommissioning of the monitoring station. Fish were captured, sampled and tagged by DFO staff. Project staff assisted with the testing, installation, operation and decommissioning of the receiver station.

Address of Project Goals and Objectives

The activities undertaken provided an understanding of the benefits and challenges of PIT tagging projects in small streams and particularly in those with limited buffering of flows. PIT tags were applied to 44 Arctic Grayling in Clinton Creek. A Monitoring Station was established about 7 km downstream of the tagging location. Solar arrays and batteries were deployed, electronic equipment installed and the antenna placed in a loop on the stream bottom. The system operated reliably for the length of the investigation but was negatively affected by a series of high- to extreme stream flow events in Clinton Creek. The antenna was repeatedly displaced, resulting in significant periods when it was unable to record any tagged fish which may have passed. A total of 3 Arctic grayling were recorded moving downstream at the Monitoring Station. One Arctic Grayling moved downstream on July 24 in apparent response to a high water event. The remaining two moved out on the 17th and 21st of September and are believed to represent the annual autumn out migration. No tagged fish were recorded moving upstream past the Monitoring Station.

Variances

Variances to the Work Plan included:

- The field work started about 3 weeks later than planned due to equipment logistics issues.
- The proposed upstream station was not installed due to changes in bank and bed configuration at the planned site.
- DFO conducted the capture of the Arctic Grayling.
- Only 30 tags were proposed in the application. The 44 tags applied exceeded this by 14, or nearly 50%.
- Casual workers were proposed to operate the Monitoring Station. However, in consideration of the size and weight of the monitoring equipment their efforts were best spent in installing and decommissioning the Monitoring Station.

Contribution to the protection of Arctic Grayling and their Habitats

The benefits will initially be indirect, by introducing and field-testing a new tool for fisheries and fish habitat managers. This will, hopefully, result in future investigations where knowledge of seasonal migrations by stream- and river dwelling (fluvial) Arctic Grayling stocks can be incrementally increased. This includes both the non-glaciated and glaciated portions of the Yukon.

The fish that were recorded passing the Monitoring Station acted in accordance with Local and Technical Knowledge. Captures of stream dwelling fish, including Arctic Grayling, in poorly buffered Yukon streams tends to be low following high water events, implying downstream displacement. The Arctic Grayling recorded moving downstream on July 24 did so during a high water event. The Arctic Grayling recorded moving downstream on September 17th and 21st represented the substantive movement to overwintering habitats.

Lessons Learned

1. The PIT tagging system used was reliable and – when the antenna was in the desired configuration – worked well. It provides a cost effective means of conducting projects within the capabilities of the equipment;
2. Environmental conditions, and specifically high water events, exerted a dominant influence on the conduct of the project. These effects could be mitigated by conducting future studies on a different type of stream such as a lake-buffered stream in an glaciated area or a ground water-dominated stream or spring brook in a valley bottom. However, the results may not be applicable to the non-glaciated area of the Yukon, or to creeks with greater flow or higher gradients;
3. The schedule of system checks was generally maintained, but proved insufficient to ensure that the system remained functional. A stream closer to a town should

be considered in future projects, or funding obtained to support a remote site with associated facilities to ensure that maintenance can be conducted.

Communications

The project has been described to the THFN Lands and Resources and the Dawson District Renewable Resources Council, and mentioned in all discussions with any persons with interests in Arctic Grayling. The Trust is acknowledged as the funder in all communications. Once accepted by the Trust, electronic copies of the report will be distributed to those whom have indicated interest.

Field Study – Activities completed

Pre-field activities:

- Jody Mackenzie-Grieve, DFO, acquired the necessary tagging and monitoring equipment;
- The equipment was assembled in Whitehorse. Electronics Technologist Rand Wilson checked all connections and systems.
- The author drove to Clinton Creek on July 3, described the project to Earl Rolf, the land owner of the past Clinton Creek townsite. Mr. Rolf granted permission to use his land for a Monitoring Station.

Installation and setup

- On July 6 Jody Mackenzie-Grieve drove up from Whitehorse. We attended the creek and first conducted a reconnaissance to determine Monitoring Station locations.
- The site where the upstream Station was planned to be installed was determined to be unsuitable due to a combination of high water and changes to the bed of the creek.
- The lower site was workable. We established the Monitoring Station downstream of the ford and far enough from the bridge structure to address possible effects of the metal on the antenna performance.
- Equipment included a solar array comprised of 2 x 285W solar panels, a lockable battery box containing 4 x 200 lb. batteries, an IS 1001 Standalone Receiver (24 V system), a J Box for tuning the antenna, and a 25 foot corded antenna.
- The equipment was transferred from the DFO Ford F250 which had transported it from Whitehorse onto a smaller and more maneuverable Toyota Tacoma and moved to the Station location (Photo 1).
- A spruce tree about 100 mm in diameter and about 5 meters back from the stream bank was cut off about 1.6 meters above ground level. The solar array was attached to the stump, pointed to the south, and wired to the battery box (Photo 2). Shrubs were cleared from in front of the solar panels to increase the amount of sunlight intercepted. The shrubs along the stream bank were not disturbed to obscure the panels from casual users of the ford.

- The battery box was carried into the bush, placed above the ordinary high water mark, batteries were installed and connected to the solar array.
- Two 2X6 boards were placed vertically in holes excavated into the gravel bar. The holes were backfilled and the boards were tied back to trees on the river bank for additional support.
- The Receiver and the J Box were each attached to one of the boards above the ordinary high water mark, and electrical cables were installed connecting them to the battery box (Photo 3).
- The corded antenna was then connected to the J box. The antenna was 25 feet in length. To hold it in place we cut 2 inch plasticized cloth hose into 0.6 m lengths, filled them with sand, cable tied them shut at each end and cable tied them to the antenna. The antenna was then laid in a loop on the stream bottom.
- The weights were insufficient to hold the antenna in place. A load of angular rocks up to ~30kg was transported to the site from a roadside cut.
- The rocks were placed on the stream bottom along the path that we wanted the antenna to lie on. The antenna was then, with difficulty, draped around the upstream side of the rocks.
- The angular shape of the rocks enhanced their ability to stabilize the antenna on the stream bottom without damaging it or affecting the detection ability.
- An extra load of rock was stockpiled near the Station for maintenance purposes.

Tagging and testing system

First Round of tagging - July 7 and 8, 2016.

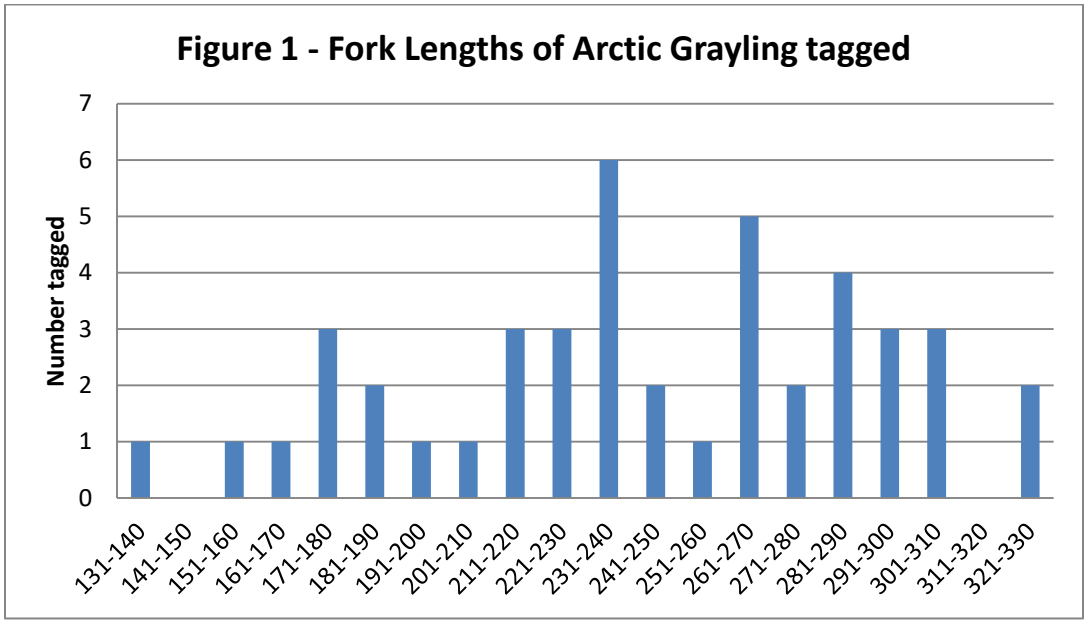
- The first round of tagging was conducted above the mouth of Wolverine Creek by Jody Mackenzie-Grieve.
- The tags used were 12 mm FDX-B PIT tags supplied by Biomark Inc (Photo 4). Each tag has a unique code, allowing individual fish to be tracked. This is the most common type of PIT tags and can be applied to a wide range of fish sizes. Tags were inserted into fish using a bevelled needle supplied by Biomark. We used the inter-muscular tagging method (pelvic) technique, where the tag is lodged into the muscle behind the pelvic girdle.
- A total of 33 Arctic Grayling was tagged. Each fish was angled using sports fishing gear, anesthetized and measured from the tip of the nose to the fork of the tail (Fork Length). The PIT tag was applied (Photo 5). The fish was allowed to recover and then released back to the creek (Photo 6).
- Tagged fish were marked with orange elastomer inserted under the skin about 2/3 the length of the dorsal fin on the left hand side of the fin.

Second round of tagging – July 28, 2016.

- The second round of tagging was conducted above the mouth of Wolverine Creek by Jody Mackenzie-Grieve.
- A total of 11 Arctic Grayling were tagged. The same process was followed as in July 7 & 8, with the following exceptions:
    - the tags were inserted into the body cavity of each fish; and
    - the final four tags had not been code checked and the fork length/weight measurements could not be attributed to a specific fish.

Summary of tagging

- A good representation of the size range of the Arctic Grayling population was tagged. The smallest Arctic Grayling had a FL of 137 mm and the largest had a FL of 330 mm. Figure 1 shows the numbers of the Arctic Grayling tagged by 10 mm increments.



Testing and tuning of the antenna and start of logging

- One fish died during capture. It was tagged and used test the antenna. This allowed us to address the effects that the fish flesh could have on signal transmission. A tag in a plastic tag was also used to assess detection distance from the antenna and influence of tag orientation relative to the antenna.
- The tests were satisfactory. Although the antenna did not span the entire creek, the tests indicated that, at the water levels at the time of testing, PIT tags would be read across almost the entire creek.
- The antenna was tuned and data logging commenced. Once the initial tuning was conducted, the antenna had some capacity to tune itself.

Data logging, environmental conditions and antenna maintenance

Data logging

- The logged data was stored to a USB flash drive located within the Receiver box.
- The flash drives could be field downloaded, but we chose to periodically replace them with fresh drives.
- The flash drives removed from the Receiver Box were submitted to DFO for download and post-field season analysis.
- The Monitoring Station was attended on:
    - July 10;
    - July 21;
    - July 28;
    - August 1;
    - August 22;
    - September 11;
    - September 16; and
    - October 6.
- The antenna was checked at each site visit and returned to the desired configuration as required.

Environmental measurements

- Flows in Clinton Creek were measured by the Yukon Government Water Resources at an upstream Hydrometric Station at 15 minute intervals.
- Water temperatures in Clinton Creek were measured and logged hourly at Stations located above Wolverine Creek and above Eagle Creek with Onset Tidbit V2 data loggers.

Decommissioning Phase

- The Monitoring Station was decommissioned on October 7 by Jody Mackenzie-Grieve, Matt McHugh and the author.
- Some difficulty was experienced in removing the antenna due to shore ice having formed on Clinton Creek.
- The installation process was reversed, with the equipment once more transhipped to the DFO Ford by the Tacoma. All materials were removed from the site.

Results

Tagged Arctic Grayling moving downstream past the Monitoring Station

- Three tagged Arctic Grayling (AG) were recorded moving downstream past the Monitoring Station. Date of tagging, Fork Length (FL) at tagging, and times and dates of passage downstream for each fish were:
    - AG #1 - tagged on July 7 with a FL of 225mm. Passed downstream on July 24 at 0043 hours;

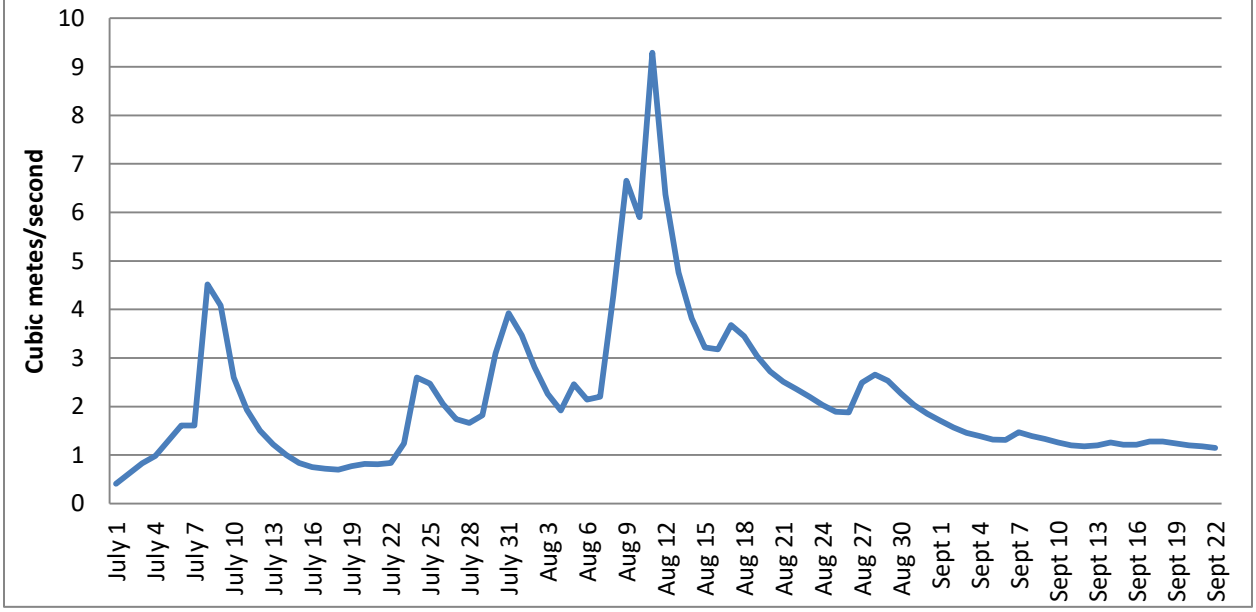
- AG #2 - tagged on July 8 with a FL of 330mm. Passed downstream on September 17 at 0243 hours;
- AG #3 – tagged on July 8, but was one of four tags applied that did not have pre-recorded numbers. Passed downstream on September 21 at 2030 hours.

Environmental conditions

Flows

- Clinton Creek experienced a succession of high flow events over the summer of 2016. The Mean Daily Flows (MeDF) were calculated and are presented in Figure 2.
- The creek had a base flow of 0.6 m^3/sec on July 1, 2016. Measurable high water events occurred on:
  - July 7 – MeDF – 4.5 m^3/sec. Peak flow – 5.2 m^3/sec;
  - July 24 - MeDF – 2.6 m^3/sec. Peak flow – 2.9 m^3/sec;
  - July 30 - MeDF – 3.9 m^3/sec. Peak flow – 4.0 m^3/sec;
  - August 10 - MeDF – 9.3 m^3/sec. Peak flow – 11.1 m^3/sec. Both values estimates due to very high flows;
  - August 16 - MeDF – 3.7 m^3/sec. Peak flow – 3.8 m^3/sec; and
  - August 27 - MeDF – 2.7 m^3/sec. Peak flow – 2.7 m^3/sec.

Figure 2. Mean Daily Flows - Clinton Creek
July 1 - September 22, 2017

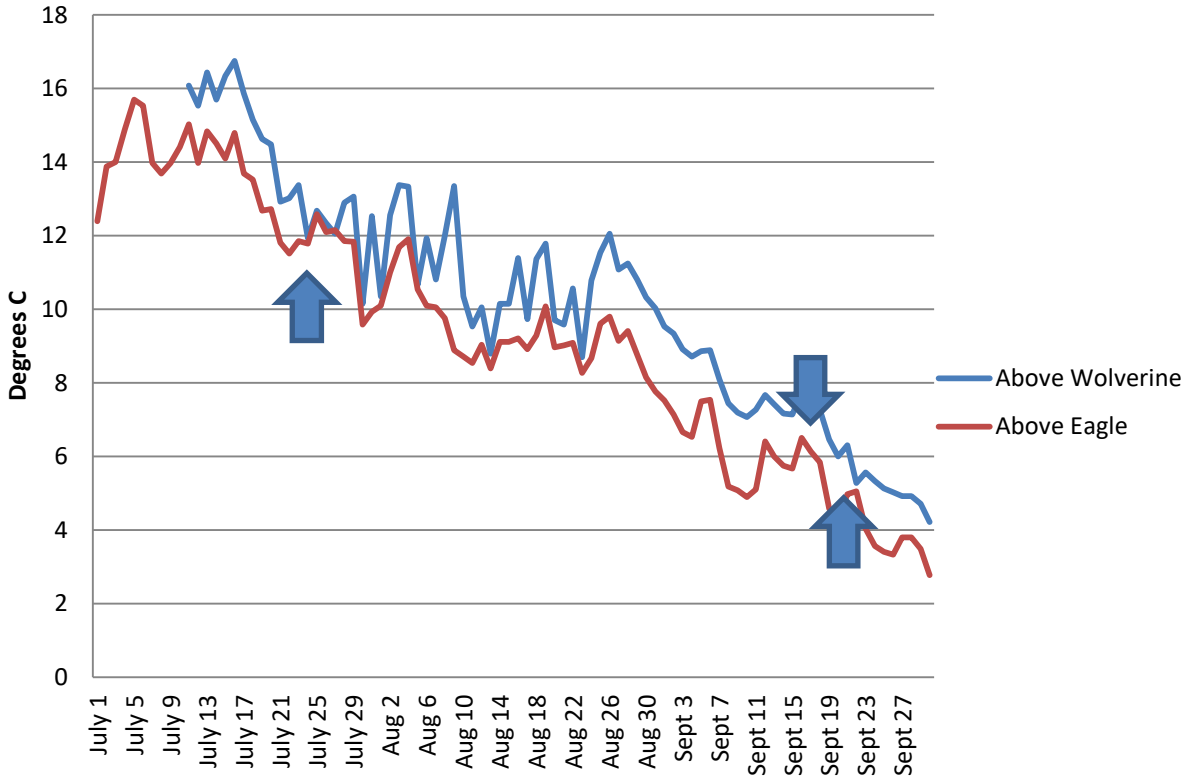


- The base flow rose over the summer. MeDF dipped below 1.0 m^3/sec between July 14 and 21 and then remained above it until the end of the project.

Temperatures

- Water Temperature Monitoring Station Clinton Creek above Eagle Creek is a long standing station. Clinton Creek above Wolverine Creek was established on July 10, 2017 and recorded its first full day of data on July 11.
- Minimum Daily Temperatures (MinDT) were calculated for each Station and are presented in Figure 3.
- MinDT recordings at Clinton Creek above Wolverine Creek were warmer than Clinton Creek above Eagle Creek at almost all times during the course of the study.
- The highest MinDT at Clinton Creek above Eagle Creek was recorded on July 5.
- The highest MinDT at Clinton Creek above Wolverine Creek was on July 16.
- MinDTs at both Stations then generally fell as flows increased and recovered as flows decreased. Clinton Creek above Wolverine Creek showed more short term variation than Clinton Creek above Eagle Creek.

Figure 3. Clinton Creek - Minimum Daily Temperatures above Wolverine Cr. and Eagle Cr. & timing of outmigrant Grayling



Discussion

Capture of fish and operation of system

- Arctic Grayling were easily captured and effectively and efficiently tagged.
- There was sufficient sunlight to charge the batteries and power the Monitoring Station at all times.
- The components of the monitoring system and particularly those above the flood stage experienced during the study, required minimal maintenance.
- Replacing the Flash Drives rather than downloading them in the field was an effective and efficient means of transferring data.
- The antenna functioned as designed and continued to do so until removed.
- However, the antenna was repeatedly displaced by the series of high water events that occurred over the course of the study (Photo 7).
- The antenna signal strength depends, in part, on the configuration of the antenna. The antenna was displaced from the desired "loop" at each high water period (Photo 8). On August 22, for example, the upstream section of the loop was found to have crossed over the downstream section of the loop.
- A consequence of antennal displacement was that antenna performance varied considerably throughout the project. It detuned regularly between July 20 - 31, from August 6 - 24 and on September 1. Signal strength occasionally dropped to 0 in August and September.
- Despite the repeated displacements the antenna showed little sign of wear or damage.

Downstream migration.

- The three tagged Arctic Grayling that passed the Monitoring Station comprised 6.8% of the total tagged.
- Arctic Grayling #1 passed the Monitoring Station at 0043 on July 24, at a flow of 2.79 m^3/sec. This was in the latter part of a high water event, and during a cooling phase. Downstream movements of stream-dwelling northern fish associated with high water events have been inferred through noticeable reductions in sampling success following such events.
- It is likely that some and perhaps many of the tagged Arctic Grayling were displaced downstream during the August high water event. Flows exceeded 4.0 m^3/sec from August 7 – 12 inclusive.
- Arctic Grayling #2 and #3 passed the Monitoring Station on September 17 at 0246 hrs and September 21 at 2030 hrs, respectively. No additional grayling were recorded passing the Monitoring Station after September 21.
- As lower, stable flows in mid/late September and early October resulted in good antenna functionality, it is unlikely that significant Grayling migration occurred undetected during this period.

- It is therefore considered likely that the tags recorded on the 17th and 21st of September represented the substantive outmigration of Arctic Grayling from Clinton Creek in 2016.
- Flows were relatively stable at 1.31 m^3/sec on the September 17 and 1.16 m^3/sec on September 21. Flows are not considered to have been a trigger for out-migration.
- On September 17, the MinDT at Clinton Creek above Wolverine Creek was 7.4^O and at Clinton Creek above Eagle Creek it was 6.1^O C. On September 21, the respective MinDT were 6.6^O C and 5.0^O C. The location(s) of the two grayling in the creek prior to their initiating downstream movement and the speed at which they moved is not known.
- Declining temperatures were probably a trigger: if so, and assuming a relatively rapid downstream movement, the initiating MinDT probably lie in the range between 7.4^O C and 5.0^O C.
- All three Arctic Grayling passed the Monitoring Station late in the evening or early in the morning. This is consistent with the scant local information regarding the time of day that migration takes place. The late Donald Frost recounted a mass early morning migration of Arctic Grayling across the bar between the mouth of David Lord Creek and the Porcupine River in mid-September, characterizing the sound made by many thousands of fish splashing in the shallow channels across the bar as a "roar".

Overall conduct of the study

- Clinton Creek is on the edge of the unglaciated area of the Yukon and is subject to rapid response to precipitation events;
- The number and intensity of high water events was not anticipated, resulting in extended periods when the antenna was not effectively working;
- Clinton Creek was too distant to be able to visit easily, and the condition of the road limited travel to pickups or SUVs;
- This limited the number of people who could have serviced the site.

Conclusions

The 2016 investigation was effective as a pilot study. The following conclusions are offered:

1. The PIT tagging system used was reliable and – when the antenna was in the desired configuration – worked well. It provides a cost effective means of conducting projects within the capabilities of the equipment;
2. Environmental conditions exerted a dominant influence on this project. They could be mitigated by conducting similar studies on a different type of stream such as a lake-buffered stream in an glaciated area or a ground water-dominated

stream or spring brook in a valley bottom. However, the results may not be applicable to the non-glaciated area of the Yukon;

4. The schedule of system checks was generally maintained, but proved insufficient to ensure that the system was functional. A stream closer to a town should be chosen, or funding support a remote site with associated facilities to ensure that maintenance can be conducted.

Appendix 1 – Photographs.

Photo 1. Sebastian Jones and Lonnie Laroque transferring batteries from Ford (left) to Tacoma.

Photo 2. Jody Mackenzie-Grieve and Sebastian Jones finishing installation of the solar array.

Photo 3. Antenna extends to left and is attached to the bottom of the J Box. The cable at the top of the J Box is connected to the Receiver Box. Note the rocks piled at the bottom of the 2X6 boards to support them during floods. The rocks piled in front of the Tacoma were to provide a ready supply of material should it be required.

Photo 4. Example of PIT tag. Each tag has a unique identity. The Receiver reads the tag as it passes, and logs the date and time of passage.

Photo 5. Jody Mackenzie-Grieve applying a PIT tag.

Photo 6. Post-tagging Arctic Grayling recovering from the anesthetic. The individual on its back has just been tagged. The other 3 are ready for returning to the creek.

Photo 7. Monitoring Station, showing signs of flooding including sediment deposition, standing water, grass lying down in the direction of stream flow and leaves stripped from the pioneering vegetation on the gravel bar.

Photo 8. August 22 at about 2.2 m^3/second. The antenna was normally held by the large rock in upper center of photo, and was displaced downstream during the major storm on August 10 during which the creek peaked at ~11 m^3/second. This exceeded the J Box's ability to self-tune.