2014 Taseko River Dual-frequency Identification Sonar (DIDSON) Feasibility Study

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Project Partners:

Tsilhqot'in National Government

Upper Fraser Fisheries Conservation Alliance

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Introduction

The Tsilhqot'in National Government (TNG), along with the Upper Fraser Fisheries Conservation Alliance (UFFCA) have been strong advocates for protecting and learning about the Taseko River and the salmon species that return to its watershed. Portions of the Taseko River are within the “Caretaker Area” defined by the Williams Case and entirely within the Tsilhqot’in Traditional Territory. Proposed resource development (example: Prosperity and New Prosperity) proposals would present an unknown risk to the salmon population in the Taseko watershed. As a result of these issues, combined with the understanding that the Taseko River is classified as both a data poor conservation unit (floating carcass count only) and a “Red Zone” Sockeye Conservation Unit under the wild salmon policy the TNG and the UFFCA partnered to explore a collaborative opportunity to improve upon the Taseko River salmon information, and better inform First Nations and fisheries management.

Knowledge gaps for Taseko salmon include adult return estimates, migration timing and migratory behaviour.

To initiate the process of filling knowledge gaps alternative methods of adult salmon enumeration were explored, which resulted in the decision to implement a Dual-frequency Identification Sonar (DIDSON) feasibility project. The Taseko River is a nearly opaque glacial-origin system that precludes standard visual enumeration techniques, and volatile throughout its course. This makes a DIDSON one of the only suitable method to enumerate adult salmon.

The TNG and UFFCA conducted a site evaluation field test of the DIDSON site identified by the UFFCA, TNG and DFO via helicopter in 2012, and field reconnaissance in Spring 2013. The 2013 site evaluation occurred from August 12th to August 24th. The methods, results and recommendations from the 2013 project were written in a report to the TNG and UFFCA, which is available upon request.

Since 2013, a single Long Range DIDSON unit has been utilised on the Taseko River to test the feasibility, suitability and effectiveness of DIDSON enumeration methodology, which has few possible locations within the watershed due to the extremely remote and limited access to the river and turbulent nature of the river hydrology. The 2013 and 2014 projects were conducted with the objectives of forming a better understanding of what is needed locally for full operation and to provide preliminary data on the Taseko sockeye run and its migration timing.

Project Overview and Objectives

Building off the knowledge and successes of the 2013 Taseko River DIDSON project, the 2014 project focused on matching (with a very limited budget and feasibility objective) the methods and procedures detailed in the Quesnel DIDSON projects from 2009-2010[1].

The Taseko DIDSON is a small project geared towards developing the utilization of DIDSON technology for the purposes of enhancing enumeration information on the Taseko and supporting the long term goal of producing high quality information on run timing and population size of sockeye and Chinook stocks returning to the watershed.

The first steps, in 2013 were to test the quality of the site that was selected in 2012 via aerial and ground surveys. The site was selected based on several influences: accessibility, safety, river flow characteristics, bank depth/slope, possible migration patterns, and ability for future site improvements (Reference Holmes et al). See appendix 1.

The goal of the 2014 project was to further assess the site and improve on information collected in 2013. With accessibility improved, the site has the potential to develop a long term camp that will better serve the project in years to come.

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[1] Upper Fraser Fisheries Conservation Alliance (UFFCA). 2010.

The primary objectives for this year's project were the following:

- Expand on the successes of 2013 by extending the field of view with the DIDSON out to 20m
- extend the recording time to 24 hours
- develop the site into a local stay camp
- increase the number of days monitored during migration
- attempt to capture the peak migration
- Provide additional information to spawner estimates.

The secondary objectives were as follows:

- evaluate the site for improvements
- and refine the DIDSON recording process to suit the river and the estimated migration timing for both Chinook and sockeye

Overall, the site required little improvement during the setup of the weir and DIDSON mount, as the site and DIDSON viewing window were clear of rocks and debris, a result of efforts to improve the site in 2013. However the addition of a fish deflection weir in 2014 made for a better and safer work site, as well as improving the DIDSON window by preventing migrating salmon from coming too close or swimming inside of the DIDSON "blind zone". Allowing for all right bank migration to be accounted for, during our 20 minute files. Additionally, the expanded recording time of the project let us develop a better picture of day to day migration.

When the DIDSON is not recording the unit has the ability to present an image that can be watched in real time. This provided the technicians with an opportunity to manually record what could be seen when watching the monitor in real time, on site. As a result, an additional fifteen salmon were observed migrating up-stream, usually within minutes either before or after a recording. These occurrences were not treated the same as the recorded salmon as the monitors were not being watched all the time, however they do aid in displaying the utility of the DIDSON at this site.

Materials and Methods

Power supply equipment and weir material

1. Laptop Computer
2. Tent
3. Honda Generator (model 2000)

4. Deflection Weir (Aluminum panel and Snow Fence)
5. DIDSON Ladder Mount
6. Single High Frequency long range DIDSON unit.
7. 2 - 1 TB External Hard Drives
8. Handheld counter
9. Secchi Disk

A Laptop computer controlling the acoustic systems was housed in a small mesh counting tent located on the top of bank in the general worksite away from the river shore. The power for the DIDSON and the computers was provided by a small Honda generator that was operational for the entire project.

Approximately 5m of sectional fish deflection weir and an additional 5m of orange snow fence were installed to prevent any fish passage around the DIDSON unit. The snow fence was used for the distance where water depth was minimal. The DIDSON unit was installed on the upstream side of the weir and was approximately 1m back from the end of the weir to ensure hydro acoustic coverage and decent counting conditions.

Methods

Acoustic Data Collection

A single High frequency DIDSON unit was used for data collection, operating at a 20m window with a window start length of 0.83m, and a frame rate 8 frames per second in high frequency mode (1.2 MHz) for the first 20 minutes of every hour. Each file recorded resulted in data files of 230 megabytes. The 20 meter window was used to determine the migration pattern for the right bank[2]. The field of view for the unit was 14º vertical and 29º horizontal.

The DIDSON software was programed to create new files (time and date stamped) for each recording, which began automatically at the start of every hour. All the recordings, programming and post-processing of fish counts were conducted using version 5.25.53 of the DIDSON operating system software (Sound Metrics Corporation 2013). Due to the number and size of files being created the data were recorded directly to an “always on and always connected” 1Tb external hard drive. To ensure data security a system was set in place to back up all the recordings on a daily basis to a second 1Tb external

[2] Extended from the 10 meter tests run in 2013.

drive every morning. This ensured that minimal data would be lost if something was to happen to the connected hard drive.

The DIDSON was deployed on an adjustable mounting apparatus (ladder mount) anchored to the riverbed (Enzenhofer and Cronkite 2005) approximately 7m from the edge of the shore. The installation was conducted following the aiming procedures and protocols described in Holmes et al. (2006). As water levels dropped, the DIDSON unit was gradually lowered to maintain a submerged depth. The system was positioned so that the lens was 10cm to15cm below the water surface and the transducer was aimed at -8° angle relative to the water surface and 15° downstream to prevent feedback from the rock cliffs on the far shore. Using this aim, the DIDSON beams ensonified the entire area within the 20m window length. The upstream/downstream boundaries of detection were confirmed safely even in the strong currents using a spinning rod and salmon analog (2L pop bottle filled with tinfoil, rocks and water). The upstream/downstream boundaries of detection were confirmed by having the analog cast out and retrieved through the ensonified field and observing the DIDSON monitor at the same time. The vertical boundaries were also confirmed similarly by reducing the water in the bottle.

DIDSON Fish Counting

All DIDSON data files (1 file per hour; 24 files per day) were counted manually using a hand held counter (tally whacker) and the numbers of upstream and downstream fish were recorded on a spreadsheet. All the recordings were slowed to a play back speed set to 20 frames per second (fps) and counted twice. The spreadsheet was designed to calculate the net upstream count and the expansions for the un-sampled portions of the hour. With all the files being counted twice and there having been two observers, the average count was used in the spreadsheet to calculate the hourly net upstream passage. Visual counts were conducted on seven file recordings. This was done in an attempt to maintain consistency with other DIDSON projects and adherence to the methods described in Holmes et al. The visual counts were quickly determined to be useless, (the river is completely glacial and has a secchi depth of 1.75cm), and the visual counts were abandoned after the attempt.

Due to the nature of the Taseko, heavy glacial rock flower, the use of background subtraction could not be used as it missed some of the fish movement and made the job of counting files much harder. All the data files were counted using the tools and software packages outlined in the DIDSON operation manual (Version 5.22).

The flow of the river in this particular site is very fast and in turn it is thought that this that this caused the sockeye salmon to exhibit a migration behaviour that is forced to the near-shore edge of flow (river right at the site). The salmon are constrained by flow and this causes them to swim in a single file band primarily within the first 2m of the DIDSON unit. Chinook (species verified by swim pattern and digital measurement) are forced into migrating in the same manner but migration was observed to extend out to 9m. This location made for an extremely shore oriented migration, which in turn made for easier file counts in the 20m recording window.

Downstream moving fish and the flux model

The hourly count data obtained with the DIDSON system were used in a simple model[3] to estimate the net upstream flux (fish per unit time) of salmon passing through the acoustic site. This model is:

N = U – D

(Where N = the net upstream flux, U = the upstream actively migrating fish and D = the downstream actively migrating fish).

Milling fish can be accounted for in this model, provided these fish eventually move upstream through the acoustic beam. Spawned-out moribund fish have to be removed from the downstream estimate since the model relates only to actively migrating fish. Summed over 24 hours, this model produces daily escapement estimates that can be compiled to estimate the spawning population of a river so long as both banks are monitored.

Overall, because the DIDSON site is located a considerable distance below all Taseko system spawning populations and the characteristics of the river at this site, downstream movement of salmon is assumed to be zero (no downstream migration was observed during the 2013 or 2014 projects). Milling in this site is also reduced to zero due to the stream channel and flow characteristics of the site. The estimate generated by this model will only provide information on the estimated passage of salmon on the right bank.

Species Identification

The Taseko river is home to a several resident species, most common are rainbow trout (*Oncorhynchus mykiss*), and Bull trout (*Salvelinus confluentus*). The migration

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[3] Xie et al, 2002

behaviour of these species and the average size of them, as describe by local residents make them easily identified on the Sonar file. In addition, the resident species of this site displayed a tendency, also experienced during the Quesnel DIDSON project in 2010, to mill within the ensonified area as they migrate upstream. Whereas, sockeye and Chinook typically display directed upstream migration.

Two species of salmon co-migrate at the same time, sockeye and Chinook, and these two species have both a distinct size difference and migration swim pattern. These behaviour and biological characteristics were documented in the 2010 Quesnel DIDSON report where it was determined by visual counts that Chinook and sockeye salmon could be appropriately separated in the DIDSON files due to their size, spatial and behavioural differences.

Sub-Sampling Analysis

The estimate of migration enumeration passage was based on sampling a total of 20 minutes out of every hour. Procedures outlined in Holmes et al. 2005 were followed in order to estimate variance caused by the temporal expansion from 20 minute counts into hourly estimates. The method of successive difference was used to estimate a variance caused by temporal expansion from 20 minute counts into hourly estimates[4,5]. In this method, the variance can be estimated strictly from adjoining pairs of counts using the systematic sample-variance estimator (Holmes et al. 2005).

Data recording was stopped on Saturday July 16th Due to a supply run into town. No salmon were recorded for this day and no extrapolation was attempted as the river was not fully covered and this would introduce high uncertainty.

[4]Wolter 1985; Eggers et al. 1995

[5] Lijha et al. 2007

Results

Estimate of Sockeye Salmon Population

The 2014 pre-season estimate of escapement for sockeye in the Taseko system was unknown as it is combined with a mixed stock grouping of Early Summer Miscellaneous (Early Shuswap and Taseko), which was forecast at a P50 of 982,000. This has little bearing on the actual return for the Taseko sockeye. The information we do have for the Taseko is very limited and consists of estimates based on floating carcass counts done year to year.

The 2010 estimate (brood year of 2014) expanded DFO Taseko sockeye estimation was 1117. In comparison the 2014 DFO Taseko floating carcass count provided an expanded estimate of 107 sockeye. It is well understood that these estimates are made on poor quality data and are thought to be biased low, and should be considered a relative index of abundance rather than escapement estimate, due to the method of enumeration (carcass count) and also that the observations are often at the mercy of the lake and river's turbidity's as well as carcass removal by predators.

The 2014 Taseko DIDSON project provided a direct count from 12 days of DIDSON recordings of 105 Sockeye and 35 Chinook totaling a count of 137 salmon that passed the right bank DIDSON site (See figures 1 and 2). The expanded values are 315 sockeye and 105 Chinook. The use of spatial migration, swim pattern and the measuring tool software are the only ways of determining a difference between the sockeye and Chinook in this feasibility study as visual assessment is impossible due to the glacial origins of these waters.

From the data collected in 2014, the sockeye migration into the Taseko River appears to have started prior to the August 12th project start date as three sockeye were counted on this date. On the last day of recording, August 24th, four sockeye were recorded. This would suggest that the start and end time for migration both occurred outside the project time frame. The time frame does indicate that a peak migration was reached on the 20th (see Figure 3), however this peak could potentially be bimodal or even trimodal in nature, and an expanded sampling time frame would be needed to determine the true nature of the migration.

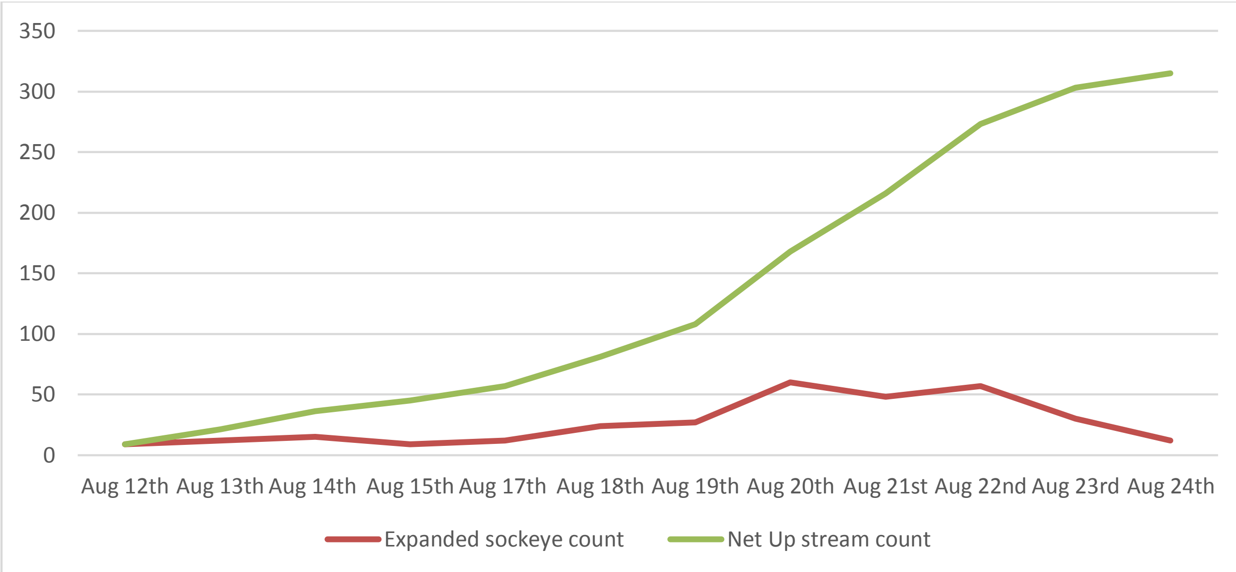

Figure 1 Cumulative expanded sockeye upstream migration and day to day expanded sockeye migration.

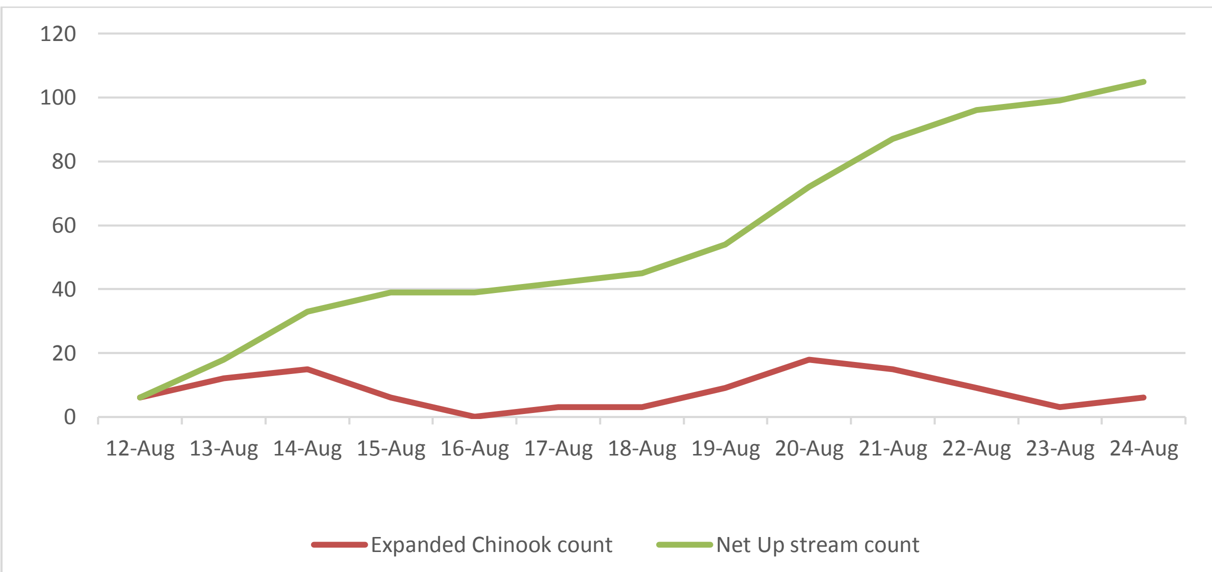

Figure 2 Cumulative expanded Chinook upstream migration and daily expanded Chinook migration.

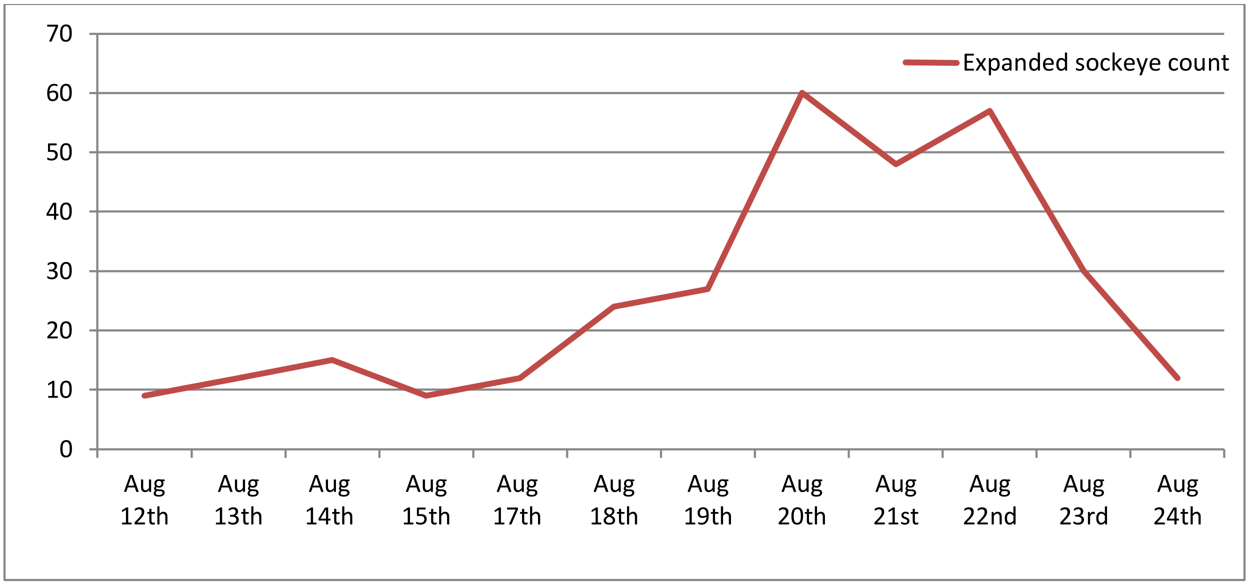

Figure 3 Daily Expanded Sockeye migration count.

With the recordings being expanded to a 24 hour basis for this project, it was possible to look into the timing of migration up the Taseko River. In figure 4 the graph depicts the total number of sockeye and Chinook to pass the DIDSON as a sum for each hour. These numbers were compiled by looking at the total passage of fish over all the days by each hour. The sockeye and Chinook appear to reduce or eliminate their passage up river between 20:00 and 05:00 the next morning. This coincides with the timing of sun rise and sun set in August. The bulk of the sockeye migration appears to occur between 11:00 and 20:00 while the Chinook appear to run consistently throughout the day between 08:00 and 20:00. Only 24% of the total sockeye migration moved during the night (20:00 to 08:00) and only 11.4% of the Chinook passage occurred during this time frame. This makes for the bulk of the total migration occurring during day light hours.

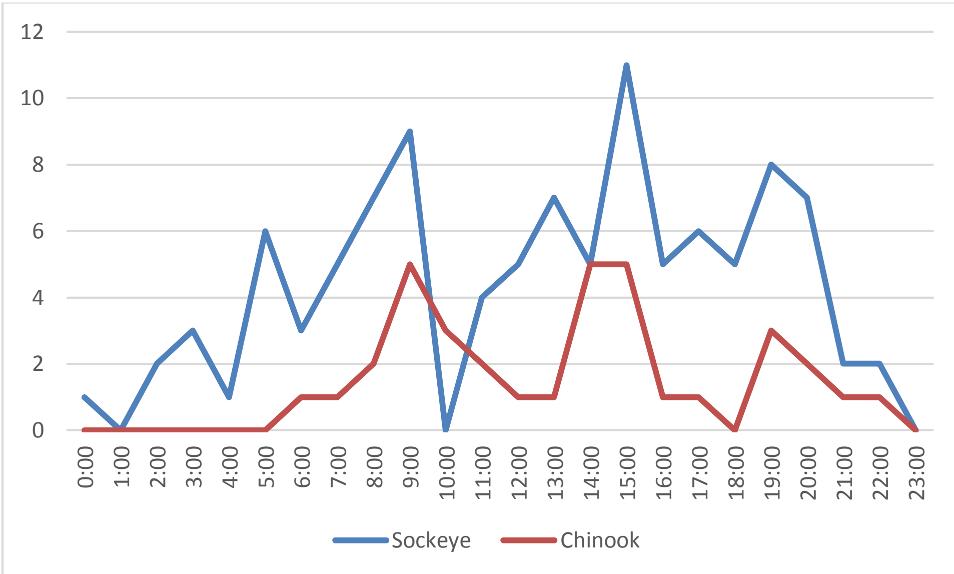

Figure 4. Expanded migration incidents by time of day. Showing time of day migrations occurring through the project timeframe.

As per protocol, the distance that each salmon traveled past the DIDSON at was recorded and was used as part of the method for species identification between sockeye and Chinook (the DIDSON software measuring tool was also used for species identification). The Taseko site was in high water for the majority of the 2014 project and this caused an unexpected similarity in migration between the two salmon species. Due to the velocity and force of the Taseko River both the Chinook and sockeye are heavily shore oriented and without the weir would likely migrate closer to shore. (Figures 5 and 6).

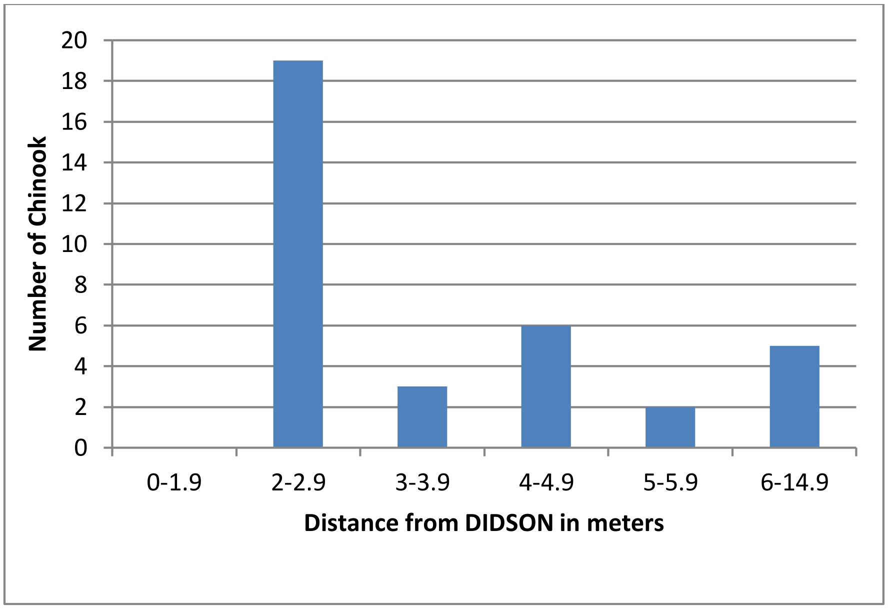

Figure 5 Chinook migration pattern as relates to distance from the DIDSON (1Chinook was recorded out past 10m).

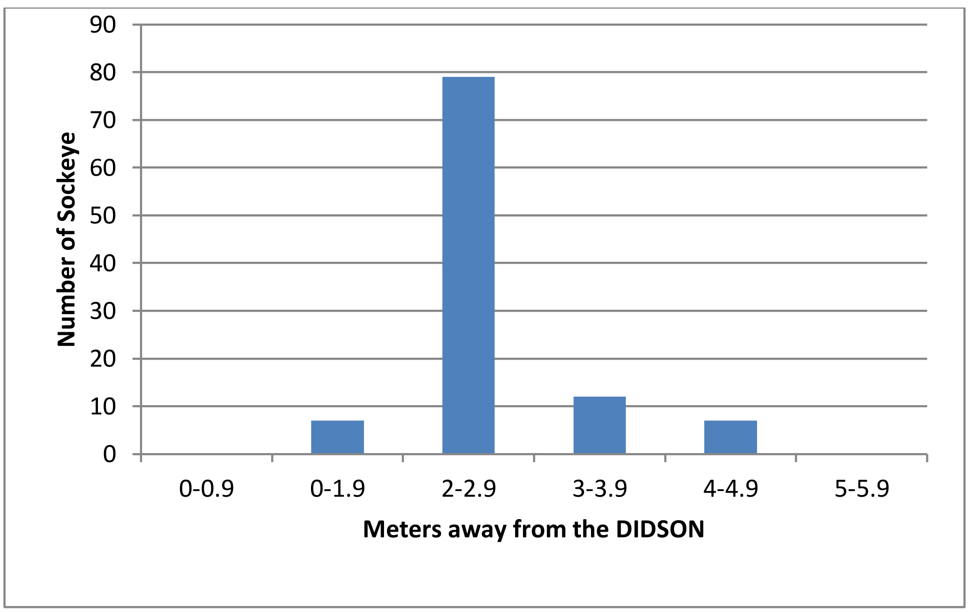

Figure 6 Sockeye migration pattern as it relates to distance from the DIDSON.

Discussion and Recommendations

This being the second year of this site feasibility study, the 2014 TNG Taseko River DIDSON project has met all the project objectives established in the preseason and proved to be a measurable improvement to the 2013 project.

Objective 1: Site improvements for accommodation to aid in the operation of the DIDSON for 24hours a day throughout the project.

This objective was met.

The access trail used in the 2013 project was improved upon and developed enough to accommodate trucks to the top landing. This provided the crew with a level of safety and allowed for a camp to be set up on the site. Other improvements included: a tarp covered kitchen and cooler storage area, the computer hut and generator site were improved and moved further away from the river to provide a fire safe location for fuel and the generator. Moving the generator further away from the river provided us with two benefits. The traditional knowledge for this river suggest that the salmon in it are very sensitive to movement and vibration. In 2013 the generator sat on a bedrock bench on the shore of the river, whereas in 2014 we used a steel trailer located well away from the DIDSON site. This trailer provided a fire proof perimeter around the generator and due to its design, it also provided vibration dampening through its four quad tires. All these improvements along with fire equipment provide the project with the ability to operate the DIDSON on a 24 hour basis.

Objective 2: Installation of a deflection weir to better guide the migrating salmon into the ensonified field at an appropriate distance.

The project met this objective.

The weir deployed at the site provided adequate fish deflection that succeeded in diverting the migrating salmon out into the 2 m window of the DIDSON unit and prevented salmon from swimming through the DIDSON blind spots (window start range). The weir deployment, and other improvements, allowed for a far more successful year count-wise, taking us from a direct count of 7 in 2013 to a direct count of 139 salmon in 2014. Expanded numbers are estimated to be 315 sockeye and 107 Chinook. This again is only an estimate on the passage of the right bank as only a single bank was monitored.

Objective 3: Extend the number of days of DIDSON deployment to increase the knowledge of the Taseko run time

The project met this objective.

The project ran from 11:00 hrs on August 12th till 10:00 hrs on August 24th. During this time sockeye salmon were recorded migrating in the very first and very last hour of the project. This indicates that the migration time has a start and end date outside of this projects window of operation. However a peak migration date of August 20th is estimated due to the daily migration rates recorded. All these estimates are only suggestions, as only one bank of the river was monitored.

Objective 4: Increasing the knowledge of the project and showcasing it to visitors.

This objective was met.

In 2013 it was recognized that the Taseko project would be a great learning and teaching opportunity, however the access to the site made doing so impossible. The improvements made to the site in 2014 made it possible for groups of people to come down to the site, through invitation, and experience the project and get to know more about it and how it works. Five groups of people come through the site in 2014, including DFO employees, members of TNG communities, TNG staff, and local residents from Scum Lake. It is looking like this will be expanded on for next year's project.

Objective 5: Increase the DIDSON window to 20m to form a better picture of salmon migration pattern at the site.

This objective was met.

A 20m DIDSON recording window was used during the entire 2014 project, improving upon the migration information gained by the 10m window used in the 2013 study. Due to the river's characteristics and flow the salmon migrated within the 2m mark most of the time with slight variances between sockeye and Chinook. The Chinook were capable of using the faster water further out, but both species preferred to use the 2m passage.

Recommendations

The location selected in 2012 has illustrated its potential as a location for enumerating sockeye and Chinook returns to the Taseko system via DIDSON technology. With further refinement, this location has the potential to become a permanent DIDSON enumeration site for Taseko salmon populations as well as a central camp for expanded projects in the area. It is recommended that this site be used again for a more comprehensive project and that the "Taseko-Sasha mount" (designed based on our specific need at this site) be employed to the right bank location, thus reducing downtime and disturbance due to water level and turbulence. Further improvements to this project would be to extend the partial weir further out into the flow of the river, allowing for the DIDSON beam to be focused out to an optimal distance for a clearer and more accurate recordings. It is also recommended that a second DIDSON unit be deployed on river left thus ensuring 100% coverage of the location for migrating sockeye and Chinook. Obtaining a second unit and improving access to the far bank are part of the next steps.

It is also recommended that the recording schedule for the DIDSON be extended to 30min files, which would reduce some uncertainty in dealing with low numbers of fish per file. Twenty-four hour recordings have been considered, however this would require many hours of data analysis and larger investment into data storage and protection. Along with this and in consideration of the results from this year's 20m window recordings it is suggested to go back to the 10m windows as that window length captured 100% of the sockeye and 98% of all the Chinook as they migrated upstream this year.

Since 2013, accessibility to the site has been greatly improved, it is recommended that continued improvements such as widening the trail in spots and clearing the loose rocks would improve access and safety. At the DIDSON site, some work developing a dedicated structure/computer hut and a generator site, cleared of possible fire hazards, would add greatly to the run time and long-term implementation of the site.

Additional recommendations for subsequent Taseko DIDSON projects are as follows:

- Visit the site before water level increase to clean up and prepare the exposed river bed for DIDSON view improvements during high water and locate a safe crossing point.
- Road and quad trail maintenance/upgrade for ease of use and safety.
- Further improve the site to house a camp for the technicians and provide a safe site for training.

- Extend the project to include some other testing in the spawning grounds (boat drift DIDSON), netting or trapping to verify DIDSON measuring tool and species classification

Summary

The 2014 TNG Taseko DIDSON project was intended to further assess the location and feasibility of a DIDSON in the Taseko River with the goal of improving our knowledge of the sockeye and Chinook that return to the system and thereby improving on the limited data available for the Taseko. With this project it was determined that the selected site provides a great workspace, with ever-improving access. The river conditions at the site are conducive to the recording of migrating salmon, and the observed behaviour on river right is that of active migration salmon.

The site shows significant potential and, the right bank DIDSON location has provided us with great information this year as the 20 meter window has depicted a migration that is heavily shore-oriented and provides us with a complete and clear viewing window. The weir provided sufficient salmon deflection to place them in the two meter viewing range, and the twenty four hour recordings provided a far better representation of the run and its timing. The use of the expansion formula used at the Quesnel DIDSON gives us a better understanding of the numbers of sockeye and Chinook that are passing on the right bank. For these reasons it is recommended that the Tsilhqot'in National Government with the support of the UFFCA continue with this project, progressing towards testing and developing the site as a fully operational two DIDSON location.

Appendix 1: Site map with GPS location identified.

Appendix 2: Project pictures.

1.) Bringing in supplies. Trailer and quad used to get equipment to site trailer was also used as our generator housing.

2.) Setting up ladder mount


3) Laying out the DIDSON cable and setting the DIDSON view.


4) DIDSON site with weir in place. Note the change in water level.


5) Computer hut, note the generator trailer in the back ground.

 

6) Camp kitchen and Tent set up.

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