Assessment of Sockeye Fry Passage at the Babine River Adult Salmon Counting Fence

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ABSTRACT

Skeena Fisheries Commission (SFC) conducted a study to investigate whether the Babine River Counting Fence prevented sockeye fry that drifted downstream of the structure from migrating back upstream to suitable rearing habitat in June 2015. An engineering study to propose permanent modifications to the Babine River Counting Fence to mitigate the potential negative effects of the structure on sockeye fry upstream migration was also initiated.

A simple marking technique was used to monitor the movement of sockeye fry from downstream of the Babine River Counting Fence to upstream of the facility. Sockeye fry were captured downstream of the counting fence, marked using Bismarck Brown Y dye, and released at the same location. Observations of captured sockeye fry upstream of the Babine River Counting Fence were not as conclusive as hoped as the dye appeared to wear-off from the fish too quickly. However current velocity measurements and under-water video footage suggest that the Babine River Counting Fence creates a velocity barrier precluding sockeye fry upstream migration during periods of high water discharge in the Babine River.

Results from the engineering study were not made available in time to be included in this report. The engineering study will hopefully provide permanent options to improve upstream sockeye fry passage at the Babine River Counting Fence.

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INTRODUCTION

The wild Babine River sockeye salmon population has declined considerably since the early 1970's (Figure 1), and now represents a significant conservation concern for the Lake Babine Nation Fisheries (LBN-F), Skeena Fisheries Commission's (SFC) member nations, and the federal Department of Fisheries (DFO). The declining trend in the wild Babine River sockeye escapement is mostly due to the sharp decline in the escapement of the Lower Babine River sub-population observed since the 1970's, while the escapement of the Upper Babine River sub-population has maintained mostly stable over the same period (Figure 2).

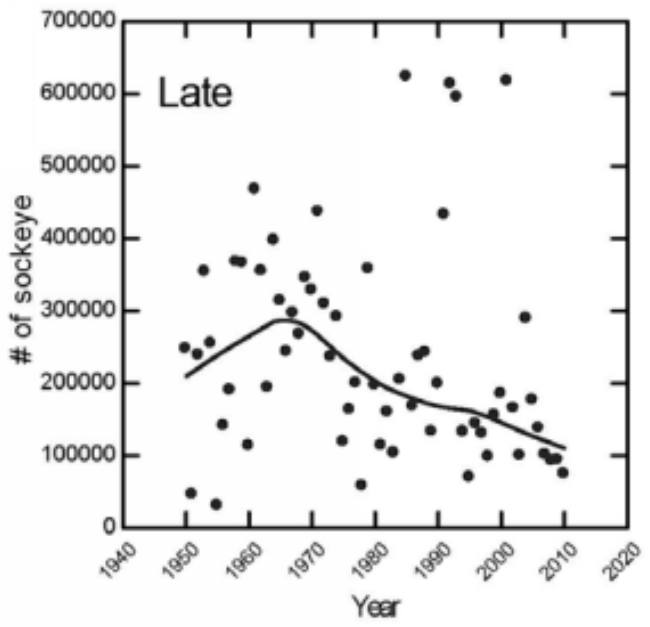

Figure 1. Escapement trend for the late-timing, wild Babine River sockeye salmon population.

The wild Babine River sockeye salmon, including the Lower Babine River sub-population, are genetically unique with a distinctive late run-timing. Furthermore, unlike all other known Skeena River sockeye salmon populations, both the Upper Babine River and Lower Babine sub-populations are outlet spawners. Fry from these sub-populations migrate upstream from their natal streams to their rearing lakes. McCart (1967), Clarke and Smith (1972), and Lake Babine Nation Fisheries (2016) observed that following their emergence from gravel in the Upper and Lower Babine River, sockeye fry drift downstream with the current, while swimming perpendicularly to the current to reach calmer water close to shore. The sockeye fry continue to develop in low velocity areas along the stream margins, for days to weeks, until attaining a developmental stage and size to allow them to swim upstream in low water velocity areas along the stream margins, and into their nursery lake, either the North Arm of Babine Lake for Upper Babine River fry, or Nilkitkwa Lake for Lower Babine River fry (Figure 3). This rare upstream migration life history characteristic may be a contributing factor in the decline of the Lower Babine sockeye population.

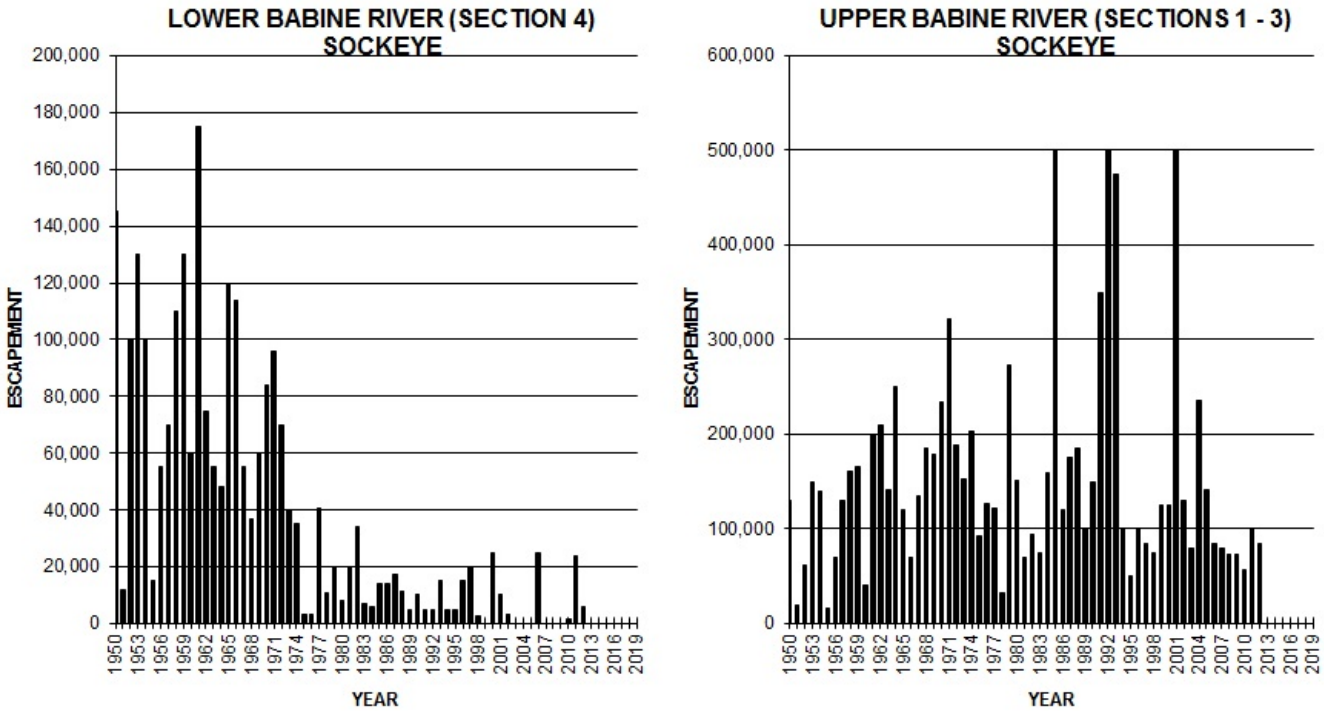

Figure 2. Historic escapement of the Lower Babine River (left) and Upper Babine River sockeye salmon sub-populations.

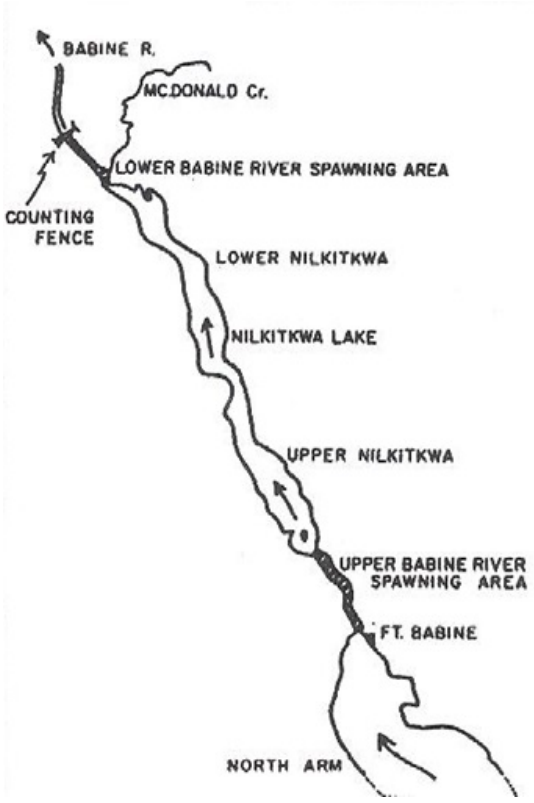

Figure 3. Map showing Nilkitkwa Lake, part of the North Arm of Babine Lake, and the Lower and Upper Babine River sockeye spawning areas.

Figure 4. Map of the Lower Babine River showing the location of the sockeye spawning habitat, and the location of the Babine River adult salmon counting fence.

Newly emerged sockeye fry with limited swimming ability are washed downstream once they emerge from the spawning Lower Babine River areas located upstream of the Babine River adult salmon Counting Fence (Figure 4). Some of them drift downstream of the Babine River Counting Fence, and may not be able to migrate back upstream to reach Nilkitkwa Lake, or their upstream migration may be delayed. There are no suitable juvenile sockeye rearing habitats downstream of the Babine River Counting Fence. The proportion of fry washed downstream of the fence may be greater in years of high and early flow compared to years of lower flow. Clark and Smith (1972) estimated that a minimum of 7.5 million (or 18%) of the fry produced in 1966 drifted pass the Babine Counting Fence, and fry were unable to swim back upstream through the fence to reach their nursery habitat at Nilkitkwa Lake, however Clarke and Smith also reported that an estimated two million fry ascended an improvised temporary ladder by-passing the area of high velocity current under the fence on the western side of the Babine River. Clark and Smith assumed the fry that did not migrate upstream of the fence were lost, but this assumption was never verified.

Following the Clarke and Smith study in 1966, which showed that an estimated two million fry used an improvised temporary ladder to its full capacity (Figure 5) for over almost 20 days (Clarke and Smith 1967), a permanent fry migration channel made of sheet pilings and baffles was installed along the western shore to by-pass the area of high velocity current under the fence created by the approximately 60 cm fence sill (Figure 6). Over the following years fry effectively used the fry migration channel (Cameron West and David Southgate, pers. com.), however during the 1992-1993 winter the fence was totally redesigned and rebuilt with a sill leveled with the river bed. The sheet pilings making the fry migration channel were removed from the area downstream of the fence, but the sheet pilings upstream of the fence were left in place without baffles (Figure 7). The channel created by the remnant sheet pilings upstream of the fence is referred as the “remnant fry migration channel” throughout this report.

In May and June 2015, large schools of sockeye fry were observed along the western shore of Babine River, immediately downstream of the Babine River Counting Fence (Lake Babine Nation Fisheries 2016). As there are no known significant spawning areas downstream of the Babine fence, it is likely that these fry were washed downstream in the river current from spawning areas upstream of the counting fence (Figure 4). They appeared to not be able to

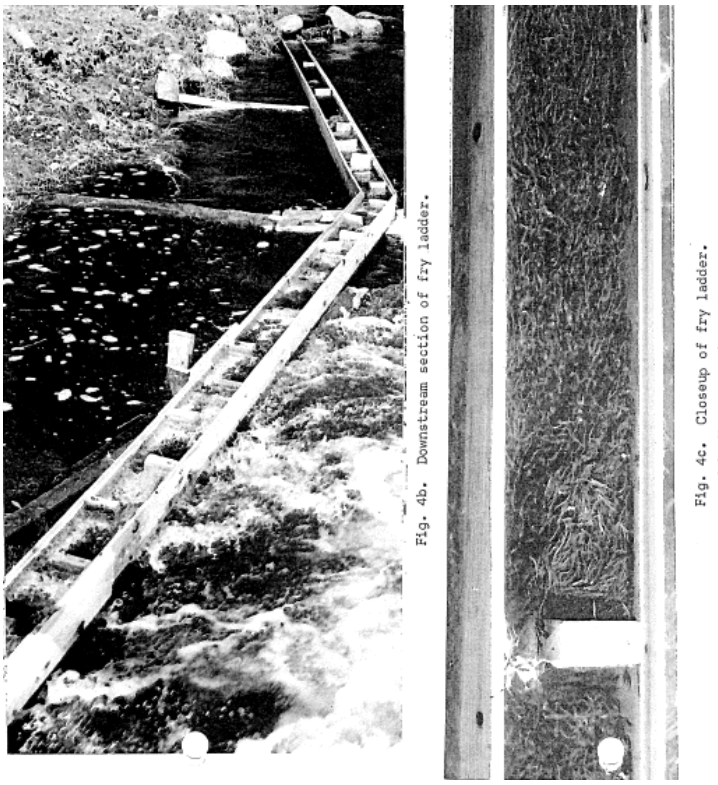

Figure 5. Two different views showing fry using the improvised temporary fry ladder built by Clarke and Smith in 1966 to by-pass the area of high water velocity at the Babine Counting Fence.

Figure 6. Downstream view of the permanent fry migration channel made of sheet pilings and baffles.

migrate upstream through the fence because of a water velocity barrier through the fence, including the “remnant fry migration channel”.

The specific objective of this project was to investigate whether the Babine River Counting Fence prevents fry that have drifted downstream of the structure from migrating back upstream to suitable rearing habitat.

A second objective of this project was to initiate a preliminary engineering study in consultation with Department of Fisheries and Oceans personnel to propose permanent structural modifications to the Babine River Counting Fence to allow fry to swim upstream through the fence at all water flows.

Figure 7. Upstream view of the “remnant fry migration channel” showing high velocity flow above 1.5m/s on average. June 20, 2015.

METHODS

Fry upstream migration monitoring - fry dyeing

We monitored the movement of sockeye fry from downstream of the Babine Counting Fence to upstream of the facility using a simple marking technique. Sockeye fry were captured with a seine net in a back eddy created by a boat launch approximately 30 m downstream of the Babine Counting Fence, on the West side of the Babine River (Figure 8). Sockeye fry were dyed using Bismarck Brown Y following the instructions described in Lawler and Fitz-Earle (1968). Two groups of fry were died on two different days: June 11th, 2015, when approximately 20,000 fry were dyed, and June 16th, 2015, when approximately 40,000 fry were dyed. The number of fry dyed was approximated as counting them would have been time consuming and may have increased mortality. Large containers were used to hold the sockeye fry in the dye solution (Figures 9 and 10). Battery powered bubblers were used and the dye solution was agitated to keep oxygen at a safe level (Figures 9 and 10). Dyed fry were brightly brown colored when they were released at the location of their capture (Figure 11). Every day fry were dyed and released, a small group of dyed fry was kept as control to monitor survival of dyed fry, and the fading rate of the dye. The control dyed fry were kept in pierced containers which were kept in the back eddy downstream of the Babine Counting Fence (Figure 10).

Figure 8. Seine net being set-up to capture sockeye fry at the boat launch approximately 30 m downstream of the Babine Counting Fence. June 11, 2015.

Figure 9. View of the fry dying containers and crew. June 11, 2015.

Figure 10. View of the fry dying container used on June 16, 2015. Note the control containers in the background.

Figure 11. View of sockeye fry just out of the dye solution. June 16, 2015.

Figure 12. View of the boat launch located approximately 45 m upstream of the Babine Counting Fence, and the seine net used to capture sockeye fry. June 13, 2015.

On June 12th, 13th, 14th, 15th, 16th, 18th, 20th, and 22nd sockeye fry were captured in a back eddy created by a boat launch approximately 45 m upstream of the Babine Counting Fence, on the west side of the Babine River (Figure 12). Once captured, the sockeye fry were kept in containers until they were examined for signs of Bismarck Brown Y dye on their fins and body. After the examination, all fry captured were transported upstream where they were released to prevent re-capture of the same fry. Some of them were transported a few hundred metres upstream by foot, the rest were transported by jet-boat to the outlet of Nilkitkwa Lake, approximately 1.4 km upstream.

Water velocity measurements

Water velocity was measured in the "remnant fry migration channel" of the Babine Counting Fence throughout the duration of the project using a Swoffer 2100 current velocity meter.

Under water video monitoring

GoPro cameras were used to record under water video footage of sockeye fry in the vicinity of the Babine Counting Fence.

Engineering study

A site visit at the Babine Counting Fence was organized and occurred on March 8th, 2016. Sandra Devcic (DFO – Resource Restoration Engineer), Sarah Wilson (DFO - Real Property, Safety & Security – Project Engineer), Graham Hill (Allnorth Consultants - Hydrology Engineer), Barry Finnegan (DFO - Biologist), Donna Macintyre (LBNF - Manager), Ken Rabnett (LBNF - Consultant), and Janvier Doire (SFC - Biologist) were present. The purpose of this site visit was to initiate a preliminary engineering study to propose potential structural modifications to the Babine River Counting Fence that would improve upstream sockeye migration at all flows.

RESULTS

Fry upstream migration monitoring – fry dyeing

Table 1 presents the estimated number of sockeye fry captured upstream of the Babine Counting Fence, and the results of their examination for sign of Bismarck Brown Y dye.

Table 1. Estimated number of sockeye fry captured and examined for sign of Bismarck Brown Y upstream of the Babine Counting Fence.

Date	Time	Sockeye fry #	Dyed fry #	Maybe dyed fry #
June 12	6:30	550	0	0
	19:40	1,500	0	0
June 13	7:40	600	0	0
	19:00	2,000	0	0
June 14	8:00	550	0	0
	18:00	1,000	0	1
June 15	8:00	500	0	0
	18:30	1,600	0	0
June 16	8:00	600	0	0
June 18	14:00	550	0	2
June 20	13:30	1,000	0	0
June 22	11:00	200	0	0
Total		10,650	0	3

An estimated total of 10,650 sockeye fry were captured upstream of the Babine Counting Fence between June 12th and June 22nd. None of them were observed to be dyed with Bismarck Brown Y dye without a doubt. A total of three sockeye fry captured on June 14th and June 18th may have been dyed, however the difference in coloration on these three individuals could also have been due to natural pigmentation variation. The observers were not certain whether these fry had been dyed or not. Although the control dyed fry kept in containers still showed obvious signs of dye five (5) days after the dye treatment, the dye may have worn-off quicker from the experimentally dyed fry that were immediately released into the Babine River. Exposure to natural water flow could have removed the dye from an individual fry's scales and fins.

Water velocity measurements

Table 2 presents the average water velocity measured mid-way through the "remnant fry migration channel" in mid-June 2015.

Table 2. Water velocity at different depths through the "remnant fry migration channel".

Depth (cm)	Water velocity (m/s)
5 - surface	1.31
50	1.30
75	1.96

Water velocity through the "remnant fry migration channel" was high, with an average above 1.5m/s between the surface and 75 cm depth (Table 2 and Figure 7).

Under-water video monitoring

Under-water video footage taken below the Babine Counting Fence, and through the "remnant fry migration channel" shows sockeye fry caught in high flows and highly turbulent water. Fry appear to not be able to hold position (Figure 13). When some attempt to move upstream, they quickly drift back downstream because of the strong current. The under-water footage also shows a bull trout heavily feeding on the struggling fry.

Figure 13. Image from an under-water video showing sockeye fry in turbulent water downstream of the western abutment of the Babine Counting Fence. Mid-June, 2015.

Engineering study

Graham Hill produced a report following the March 8th site visit. M. Hill's report is appended to this report.

DISCUSSION

Overall the results from this project appear to suggest that in June 2015, the Babine Counting Fence negatively impacted the upstream migration of sockeye fry that drifted downstream of the structure following their emergence. Although the fry dyeing study using Bismarck Brown Y dye completed as part of this project was not fully conclusive because the dye appeared to wear-off from the sockeye fry too quickly, the current velocity measurements and under-water video footage showed that in June 2015 water flowed through the "remnant fry migration channel" at a much greater rate than the estimated sockeye fry burst swimming speed of 76 cm/s (Craig and Smith 1972), and created a velocity barrier.

Water discharge data for the lower Babine River is not available before 1972, however data available for spring 2015 from Environment Canada's Water Office's website, show that discharge in the lower Babine River was relatively high compared to the average peak flows of 148 m^3/s recorded in the lower Babine River since 1972 (Figure 14). The fence structure and debris (logs and pieces of wooden docks, and boats) accumulating upstream obstructed and backed up the water, creating a significant difference between the water elevation upstream and downstream of the fence, and causing the increase in water velocities through the fence and the "remnant fry migration channel".

Results from a hydroacoustic survey conducted at Nilkitkwa Lake and the North Arm of Babine Lake in September 2015 (Doire *et al.* 2015) show that the estimated Nilkitkwa Lake fall fry per Lower Babine River spawner ratio was significantly lower for brood year 2014, than for brood years 2010 and 2013, the only other brood years for which hydroacoustic surveys were conducted at Nilkitkwa Lake. By contrast, the fry per spawner ratio observed in the Upper Babine River/North Arm system for brood year 2014 was similar to the fry per spawner ratio estimated for brood year 2012. These observations suggest that the factors controlling low fry recruitment in Nilkitkwa Lake in 2014-2015 are unique to that system. The Babine Counting Fence may have precluded a significant number of sockeye fry from reaching their rearing habitat in Nilkitkwa Lake in 2015.

The results from the engineering study part of this project were not made available in time to be included in this report, however it appears imperative to design and implement a solution to improve upstream sockeye fry passage through the Babine counting fence during a wide range of water discharge levels to prevent the loss of significant proportions of sockeye fry emerging in the Lower Babine River in future years.

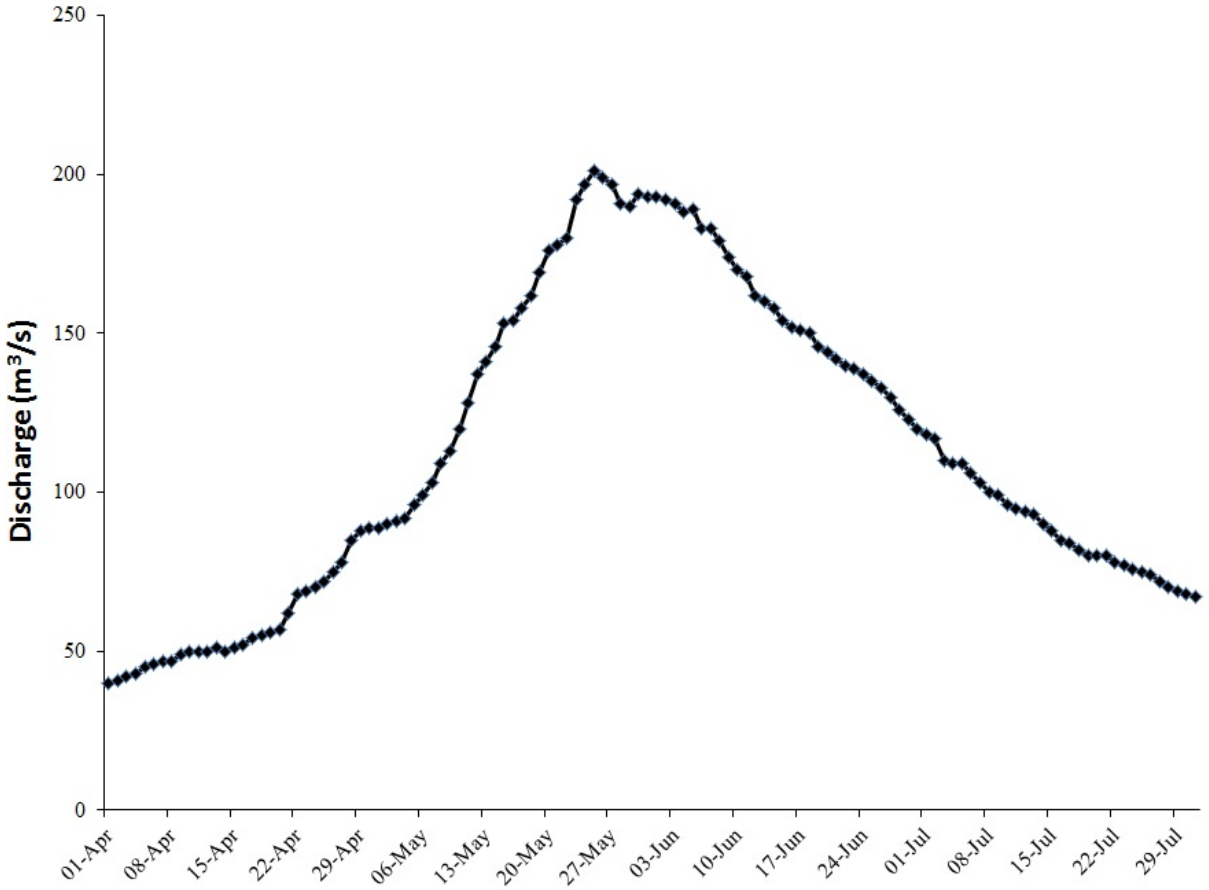

Figure 14. Discharge in the Lower Babine River in the spring of 2015. Data from Environment Canada's Water Office's website.

CONCLUSIONS

The specific objective of this project was to investigate whether the Babine River Counting Fence prevents fry that have drifted downstream of the structure from migrating back upstream to suitable rearing habitat in Nilkitkwa Lake.

Although the sockeye fry dyeing study was not as conclusive as hoped, water velocity measurements and under-water video footage suggest that during the period of high discharge observed in June 2015, the Babine Counting Fence negatively impacted the upstream migration of sockeye fry that drifted downstream of the structure following their emergence, by creating a velocity barrier.

The results from the engineering study, part of this project, were not made available in time to be included in this report. The engineering study will hopefully provide permanent options to improve upstream sockeye fry passage at the Babine River Counting Fence.

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