

**Babine River Steelhead, 1993/94:
Population Estimate and Weir Assessment**

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ABSTRACT

This steelhead study included a) a population estimate of the upper Babine River and b) a trial operation of the Babine River Weir for future enumeration of the upper Babine and Boucher Creek populations. A mark/recapture study was conducted to assess the 1993/94 fall population of steelhead in the upper 15 km of the Babine River mainstem. Only 123 steelhead were tagged in a volunteer tagging program during September, October, and November, 1993. From April 12th-14th 1994, 269 steelhead were sampled with only 7 recaptures of fall 1993 tags; the resultant Petersen population estimate for Babine River fall population was 4185 (95% C.I. = 2174-8810). The Babine River Weir was operated using new fence panels with 3.75 cm spaces that reduced impacts on sockeye smolt migration. The existing adult sockeye traps at the fence were unsuitable for trapping steelhead and require several modifications for future use. Due to the inability to trap steelhead, a 2.5 m opening in the fence was used to monitor steelhead migration. Steelhead migrated through the fence at two peak times of day: 5:00-8:00h, and 16:30-20:00h. During this study (April 20th - May 16th), upstream migration was most active during the first week of May, and downstream migration occurred from May 11th to May 16th. The onset of spawning migration coincided with an increase in water level, when maximum daily water temperatures reached 4 °C. Recommendations are to repeat spring fence operations with a few modifications, and to redesign mark/recapture experiments to assess winter distribution of different sub-stocks in the Babine watershed.

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1.0 INTRODUCTION

The Babine River is a major tributary to the Skeena River, and is one of only five streams in British Columbia that are managed under "Class 1" sport fishing regulations for control of annual fishing pressure. The mainstem of the Babine originates from the north end of Babine Lake and flows 97 km into the Skeena mainstem (Figure 1). There are several major tributaries to the Babine River which add large volumes of sediments to the mainstem during freshets. Spawning of steelhead (*Oncorhynchus mykiss*) in the lower reaches of the Babine is believed to be minor due to spring freshet, heavy siltation, and minimal suitable habitat. However, several of the tributaries contain suitable spawning habitat for steelhead and have potential to support distinct stocks or substocks of steelhead in the Babine watershed. Previous studies of juvenile steelhead, and their densities at various locations in the Babine watershed provide indirect evidence of steelhead reproduction in the Boucher, Nilkitkwa, Nichyeskwa, and Shelagyote tributaries (Sebastian 1987). In general, the extent of spawning distribution in the Babine watershed is not well documented, but two radio telemetry studies provide some additional understanding of adult spawning migration (Beere 1991, Beere *in prep.*). Present knowledge indicates that Babine River steelhead overwinter in the mainstem, and then disperse to tributaries and the upper 2-3 km of the mainstem to spawn in May/early June.

Adult steelhead are known to migrate into the Babine River from August to November. There is little scientific evidence, but steelhead are believed to distribute variably over the entire mainstem of the river during the winter (Bison, 1994). Some adult steelhead have been observed in late fall and winter near the confluence of Boucher Creek which implies that some fish overwinter at the head of the river or possibly in Nilkitkwa Lake (Jakubowski *pers. comm.*). Because Boucher Creek and Nilkitkwa Lake are upstream of the Babine River weir, it is implied that spring steelhead counts at the Babine weir may under-estimate the total number of steelhead

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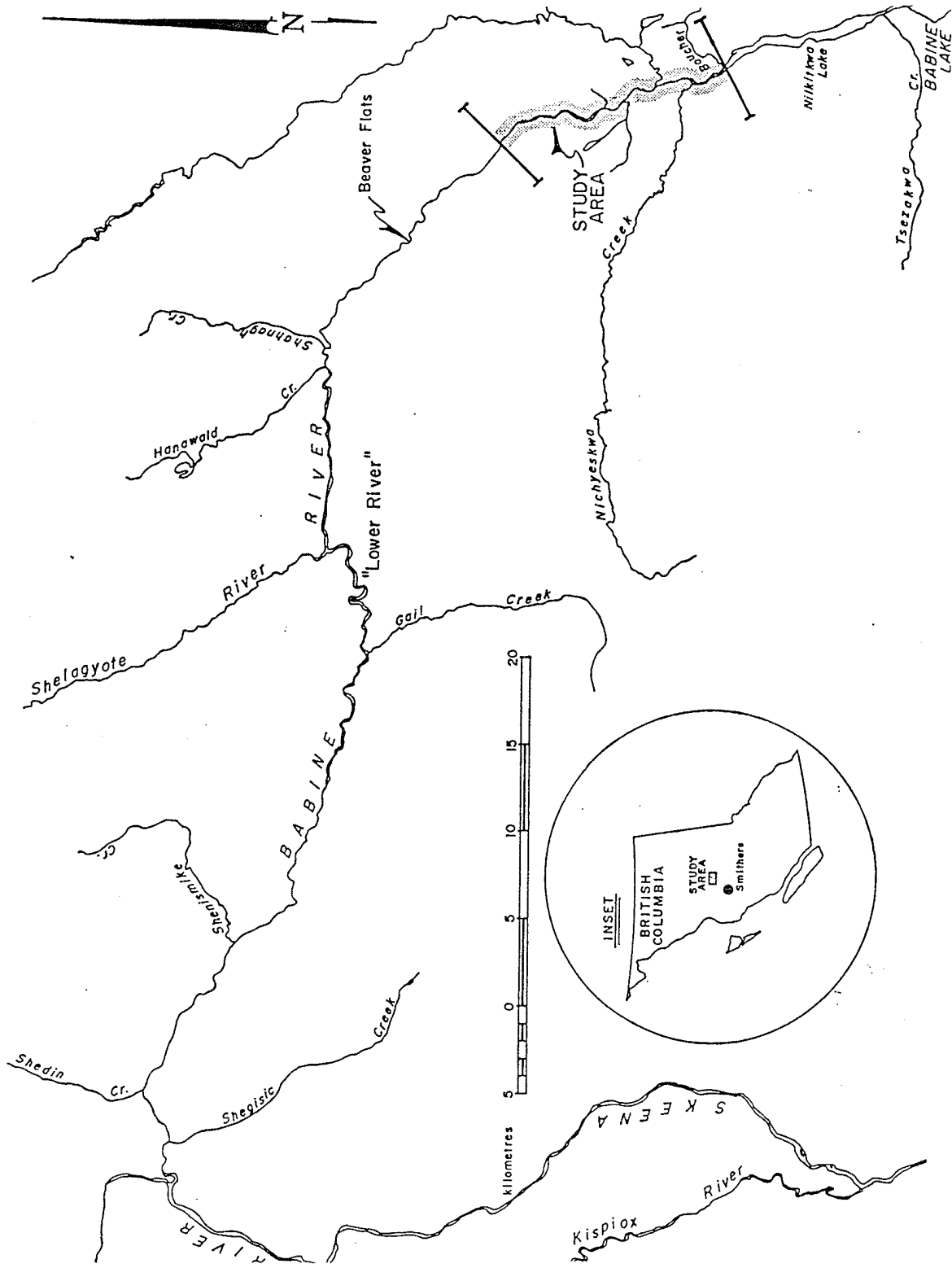


Figure 1. The Babine River and its major tributaries.

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spawning above the weir. However, previous fence counts of steelhead conducted incidently by the Department of Fisheries and Oceans during adult sockeye enumeration, indicate that the number of steelhead passing the weir in the fall is insignificant. Nevertheless, the count of steelhead at the Babine River weir may allow enumeration of the steelhead that overwintered in the mainstem below the weir.

Management of summer-run steelhead stocks has become an important issue due to the economic value of the steelhead sport fishery, and due to the impacts of the commercial and native fisheries on steelhead abundance. Development and implementation of steelhead population estimates are necessary to justify any new regulations required to sustain wild steelhead stocks. Accurate population estimates of wild stocks are extremely difficult to obtain, but methods can be tailored to account for the variable attributes of different stocks. It is evident that the Babine River steelhead stock is representative of a significant proportion of all Skeena River summer steelhead. Consequently, the Babine River steelhead is an appropriate index stock, and annual assessment of its status will help evaluate management actions in downstream fisheries.

The primary objectives of this study were:

1. To complete a trial of spring fence operation in order to assess its value for population estimates of a major proportion of the Babine River steelhead.
2. To test and re-design adult sockeye fence traps for sampling steelhead for a mark/recapture population estimate of the Babine River mainstem.
3. To monitor steelhead migration, and to record physical variables in the Babine River during the steelhead spawning migration.
4. To survey the new application and implications of sockeye smolt trapping at the Babine River Weir, and to assess its impacts on steelhead migration.

2.0 MATERIALS and METHODS

2.1 Study Site

The Babine River weir is situated approximately 2.5 km downstream of the Boucher Creek confluence (Figure 2). General surveys of the Babine River indicate that the majority of mainstem spawning habitat for steelhead is located upstream of the weir. However, some suitable spawning habitat exists directly below the weir and may also exist in unidentified areas further downstream. Observations from aerial surveys have also identified suitable spawning habitat in several tributaries including Boucher, Nichyeskwa, Nilkitkwa, Shelagyote, and several smaller streams (*see* Figure 1).

2.2 Mark/Recapture Population Estimate

Angling guides and their clients reported tagging 123 steelhead with orange anchor tags in the upper Babine River from September to November, 1993. A Petersen, single census, mark/recapture estimate (Ricker 1975) of the fall population was conducted with a recapture sample using angling methods from April 12th - 14th, 1994. For this sample of Babine steelhead, four Ministry of Environment (M.o.E.) employees angled the upper 15 km of the river below the weir. Tag number, tag colour, sex, and fork length (cm) of recaptured steelhead were recorded. In addition, yellow anchor tags were applied to all previously untagged steelhead to facilitate a second mark recapture estimate of the Babine River population. The second estimate was to be developed at the weir as steelhead migrated to known spawning areas upstream.

2.3 Babine River Weir

The Babine River weir was renovated in 1992 on concrete foundations with heavy metal frames. The weir was primarily designed to enumerate adult sockeye stocks that return to artificial spawning channels (Pinkut Creek and Fulton River) and some natural tributaries of Babine Lake. The enumeration of adult steelhead during spring

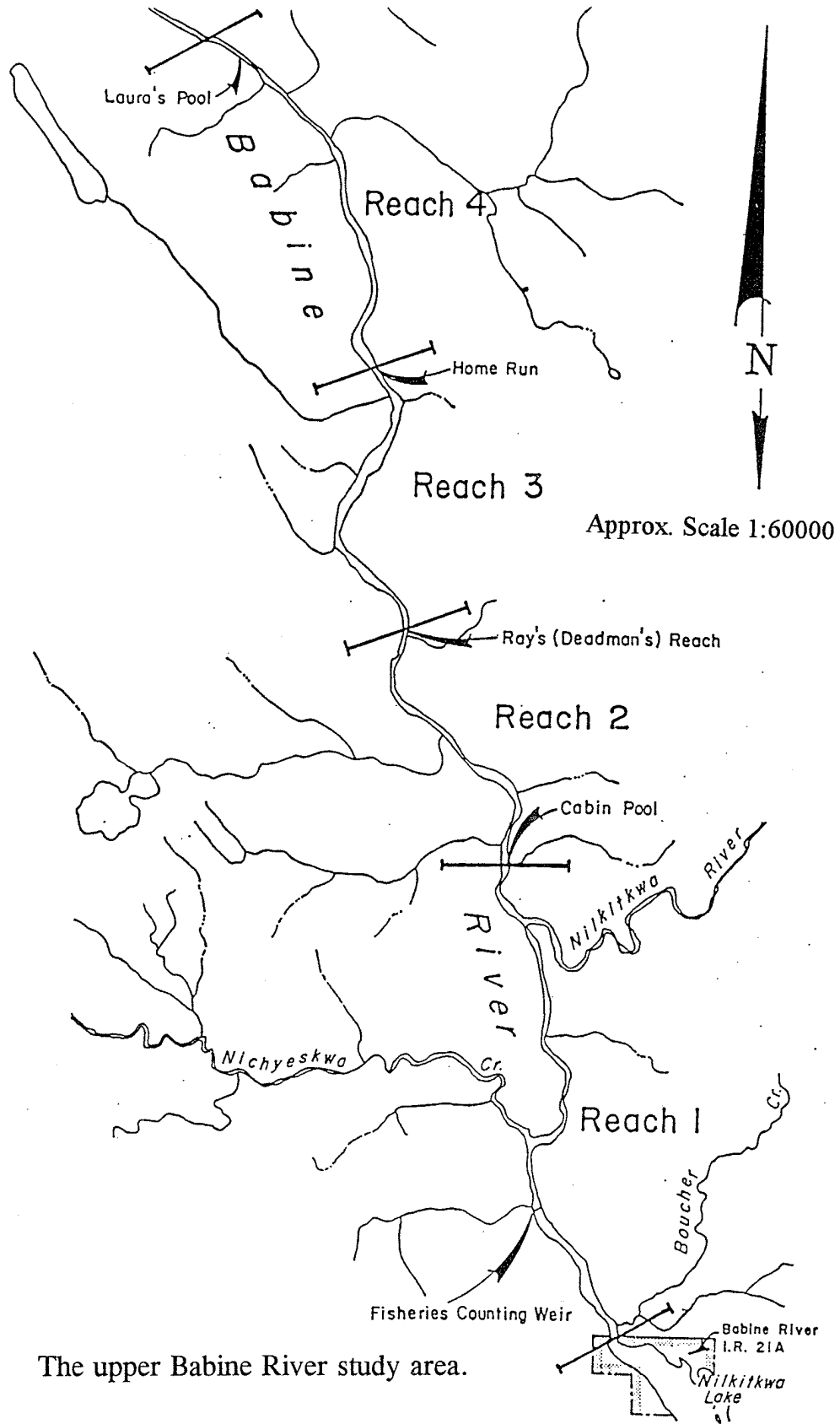


Figure 2. The upper Babine River study area.

migration was not considered in the design of this fish fence. In particular, the fence panels were made with inadequate spacing between bars to permit downstream sockeye smolt migration. In addition, the adult fish traps were designed to capture fish during upstream migration of large numbers of sockeye and appear to be unsuitable for trapping steelhead without seriously delaying their movement to the spawning grounds above the weir. Several modifications were tested to assess the potential use of these traps for steelhead enumeration and/or as a sampling tool for estimation of the mainstem overwintering steelhead population.

Between April 20th - 28th (prior to the installation of fence panels), three layers of stop logs (5 x 25 cm) were placed across the fence to impede passage of steelhead and to concentrate migrating fish at one section of the fence which was not blocked (two adjacent 1.25 m sections). This "opening" was observed for as many hours as possible to assess time of day and rates of steelhead migration.

Fence panels were installed on April 28th and were cleaned daily until their removal on May 18th. Two different types of fence panels were used to minimize maintenance to allow down-stream sockeye smolt migration, and to regulate adult steelhead migration. For this trial of fence operation, 60 panels (60 cm high x 1.25 m wide) were constructed with 3.75 cm spaces between 2.5 cm aluminum pipes. Older panels from a previous fence (2.1 m high x 1.25 m wide with 2.5 cm spaces between 3 cm diameter aluminum pipes) were installed at alternating intervals with new panels (two new panels were stacked) to restrict upstream migration (Figure 3). Two 1.25 m spaces were left open to allow observation of steelhead migration as compensation for the poor performance of adult traps (Figure 4).

Several modifications were made to the adult sockeye funnel traps in order to catch steelhead. In total, there were seven traps, of which only three were available to trap



Figure 3. Photograph of the Babine River weir in May 1994. Note arrangement of fence panels.

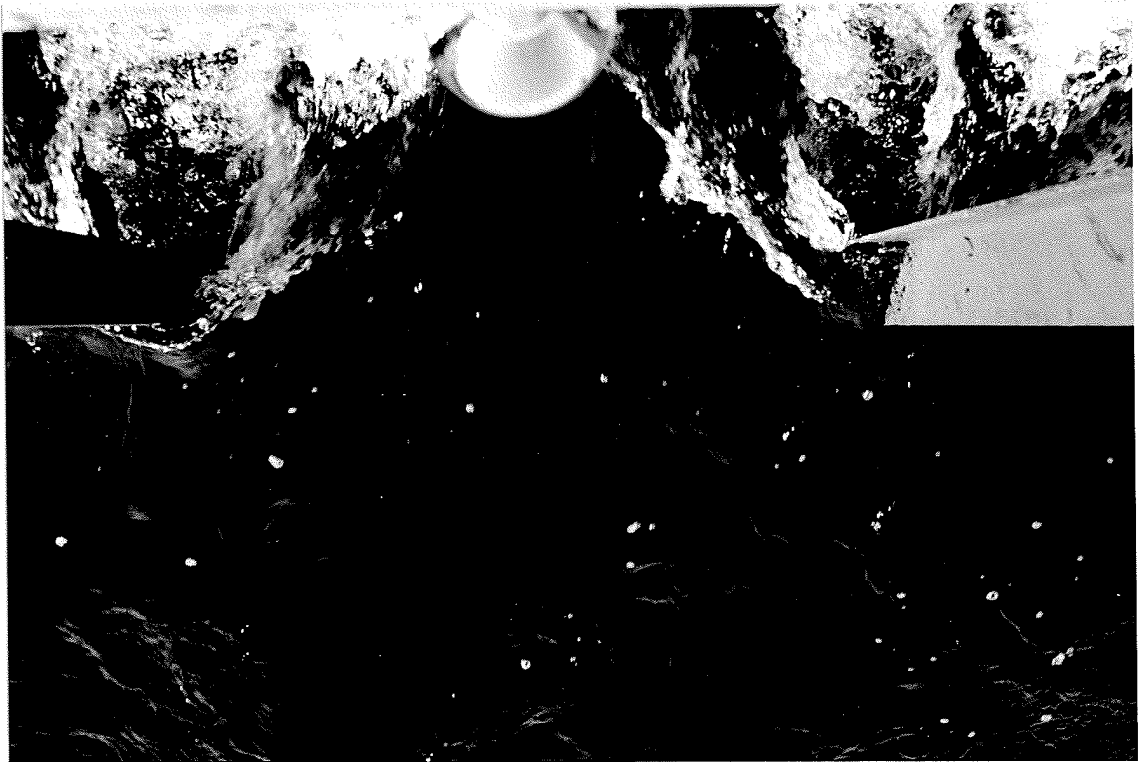


Figure 4. Photograph of the opening in the fence used to observe steelhead migration.

steelhead migrating upstream; four traps were used by the Department of Fisheries and Oceans (D.F.O.) to capture sockeye smolts moving downstream. The three traps used to trap steelhead were the first, third, and seventh traps from the west shore. Traps were 1.8 m wide x 2.6 m long and were fenced by 3 cm aluminium pipes with 2.5 cm spaces. Upstream sides of the three steelhead traps were blocked 60 cm on both sides to create some holding water in the traps. Funnels, 60 cm long with a 20 cm opening, were added to the interior of two traps in order to deter fish from exiting the trap. A specialized 1.25 m funnel, with a 10 cm opening, was constructed for the third trap. The general flow of water was directed through the center of the traps toward the funnel openings in order to reduce escapement.

2.4 Staff Gauge and Temperature Records

Staff gauge and temperature readings were taken twice daily from April 20th - May 18th, 1994: 08:00h and 18:00h (additional data was provided by D.F.O.). Staff gauge readings were taken 2.5 meters below and above the fence on the east shore of the Babine River and at the Water Survey of Canada staff gauge on the west shore (20 m below the fence, WSC08EC013). Air temperature was recorded at the station, and water temperature was taken from both shores.

3.0 RESULTS and DISCUSSION

3.1 Mark/Recapture Population Estimate

In total, only 123 adult steelhead were reported as tagged by volunteers in the upper Babine River, during fall 1993. During the 12th - 14th April 1994, 269 steelhead were sampled from the upper 15 km of the river. This sample included 14 recaptures from various tagging efforts (Table 1). Of these recaptures, seven were tagged in the upper Babine during fall of 1993. Petersen's method estimates the 1993 fall population with 95% confidence limits to be 4185 (2174 - 8810). This is similar to the 1992 fall

Table 1. List of tagging dates and locations of the marked steelhead recaptures in the upper Babine River during April 12th - 14th, 1994 (94/04/--). Total number of steelhead sampled was 269.

TAG DATE	TAGGING LOCATION	TAG #	RECAPTURE DATE
Fall 1993	upper Babine	C7876	94/04/--
		C7793	94/04/--
		C7815	94/04/--
		C7790	94/04/--
		C7766	94/04/--
		C7767	94/04/--
		C7926	94/04/--
93/08/04	Birnie Island	C3094	94/04/--
93/08/13	Steelhead Barge	S4968	94/04/--
92/10/29	upper Babine	S0486	93/09/25 94/04/--
92/10/29	upper Babine	S0089	94/04/--
91/09/30	upper Babine	C7807	94/04/--
Not Reported	(Babine*)	C7807	94/04/--
Not Reported	(Native Non-Tidal**)	35513-SFC	94/04/--

* Tag number matches tags used at the upper Babine in fall 1993

** Tag number matches tags used by Native Non-Tidal Council in fall 1993

Table2. Single census mark/recapture population estimates of fall population size in the upper Babine River mainstem, 1992 and 1993.

Year	Number Tagged	April Sample # Captured	April Sample # Recaptured	Fall population	95% Confidence Interval
1992	473	236	30	3623	2688-5234
1993	123	269	7	4185	2174-8810

population in the upper Babine of 3623 (2688-5234) steelhead. However, the large confidence intervals of these estimates reduces the value of this comparison in documenting population trends (Table 2).

Of the 269 steelhead handled during the spring census (12th - 14th April 1994), 255 were tagged with yellow anchor tags. However, due to an early spring freshet, an angling based effort to estimate the spring population in the upper mainstem was not undertaken. In fact, there was already a notable migration of steelhead toward the end of April. This early movement of steelhead, and the impact of the early freshet, indicated that the second sampling event of the single census population estimate should have been initiated in late March/early April.

The attempt to analyze the movement of tagged fish through the weir in relation to the original spatial and temporal distribution of tagging was unsuccessful due to the inability to trap a representative number of steelhead. This study indicates that tagging and sampling must be increased to produce reliable angling-based mark/recapture estimates of the entire Babine mainstem population. However, the existing fence traps at the weir were found to be inappropriate for sampling steelhead. Due to sampling difficulties at the weir, spring escapement of upper Babine River steelhead was not accomplished in this study.

3.2 Discharge and Temperature

Spring arrived earlier than average in 1994, as discharge began to rise in the first week of April. Discharge continued to increase steadily, with the staff gauge reading rising 59 cm from April 20th to May 16th (Figure 6). Maximum daily water temperature rose above 4° C for the first time on April 28th, and continued to increase until mid-May when it ranged between 7 - 10° C (Figure 5). Minimum daily temperatures remained above 4° C after May 1st. The change in temperatures implies that steelhead migration and spawning in the mainstem would begin during late April.

3.3 Adult Sockeye Funnel Traps

Throughout the study, only one steelhead was trapped in the adult traps which were operated. Several factors contributed to these results. Aside from the observation opening allowing easier passage, the height of the new panels was insufficient to completely block steelhead migration (especially at high water levels). Also, the adult traps were designed for the enumeration of several hundred thousand fall sockeye (*O. nerka*) and not for the sporadic movement of relatively few (ca. 1000 - 5000) adult steelhead. The 4 m long, enclosed entrance funnels appeared to be a deterrent to most steelhead. The flow through the funnel entrances of the adult traps was highly turbulent, characterized by inconsistent current direction and heavy aeration. The large area inside these traps allowed steelhead to turn around easily and swim back out of the trap. Even when the internal funnel of the trap was lengthened and narrowed, no steelhead were found in the traps.

The sampling of adult steelhead in these traps was important for collecting data on mark recaptures. Due to the ineffectiveness of the adult traps it was not possible to address some of the objectives of this study. Observations of the traps, and the experience gained with their design during this study, indicated that the water flow

RESULTS and DISCUSSION

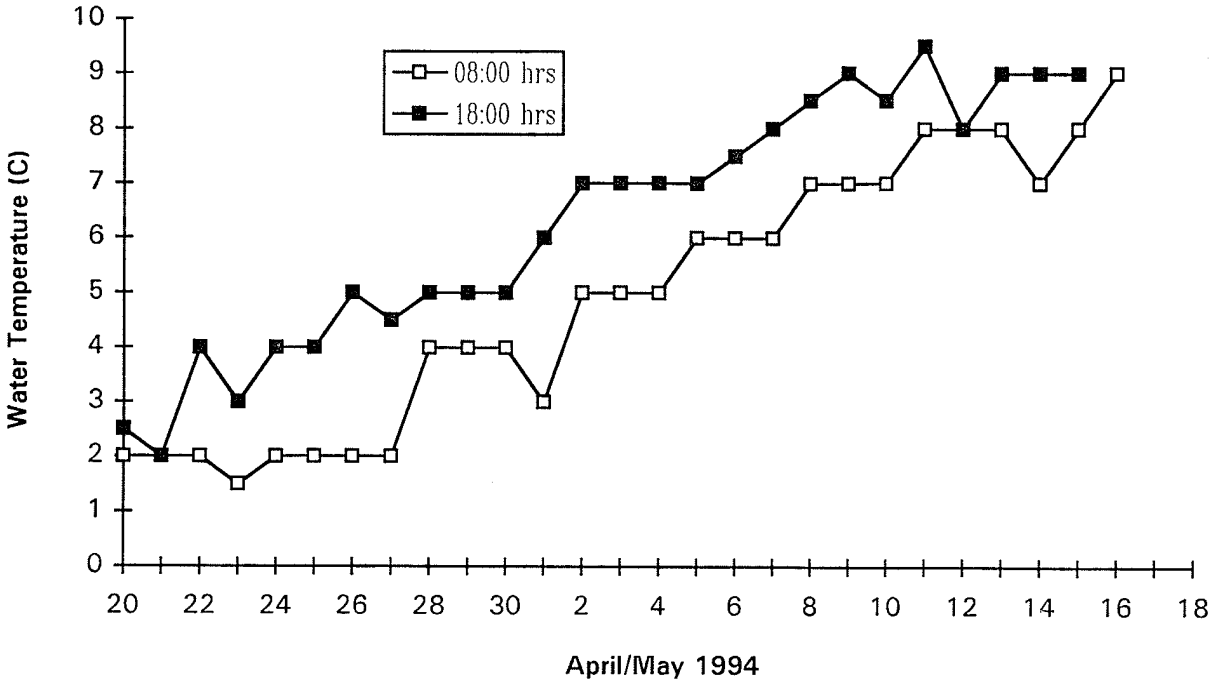


Figure 5. Daily water temperatures (°C) in the Babine River from the Water Survey of Canada Station (WSC08EC013) below the Babine weir from April 20th - May 18th, 1994.

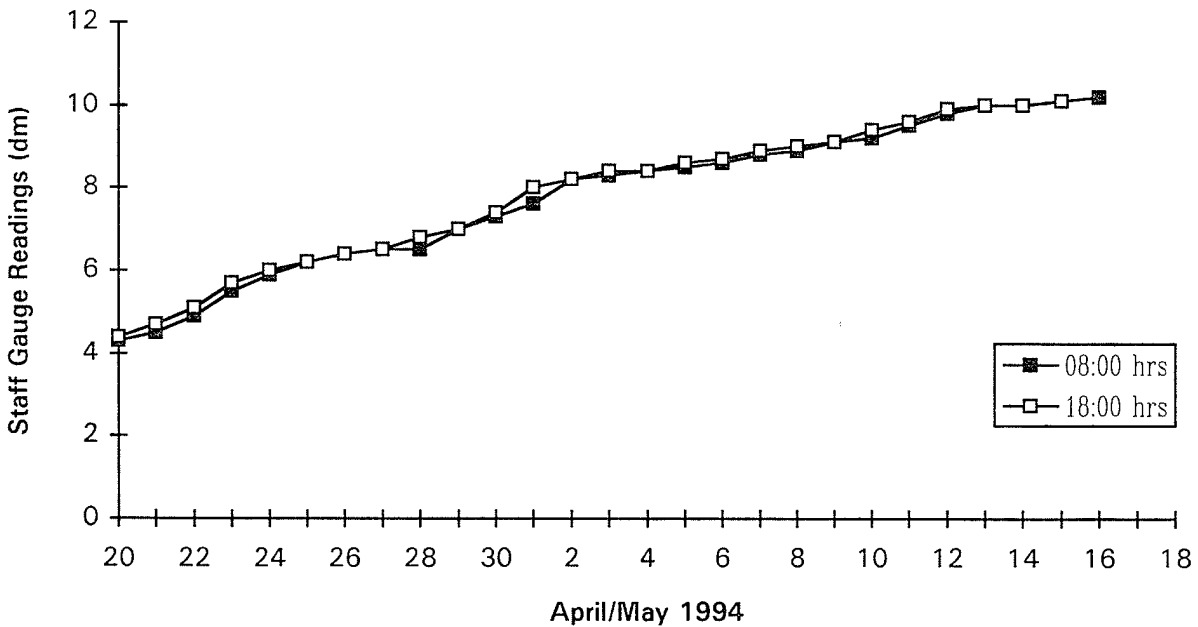


Figure 6. Water levels (dm) in the Babine River at the Water Survey of Canada Station (WSC08EC013) below the Babine weir from April 20th - May 18th, 1994.

around the entrance funnels requires modification if trapping is an objective. Solid walls along the sides of the trap and funnel would produce a more consistent flow. The sides of the traps could also be modified to reduce the width and discourage trapped steelhead from turning and exiting.

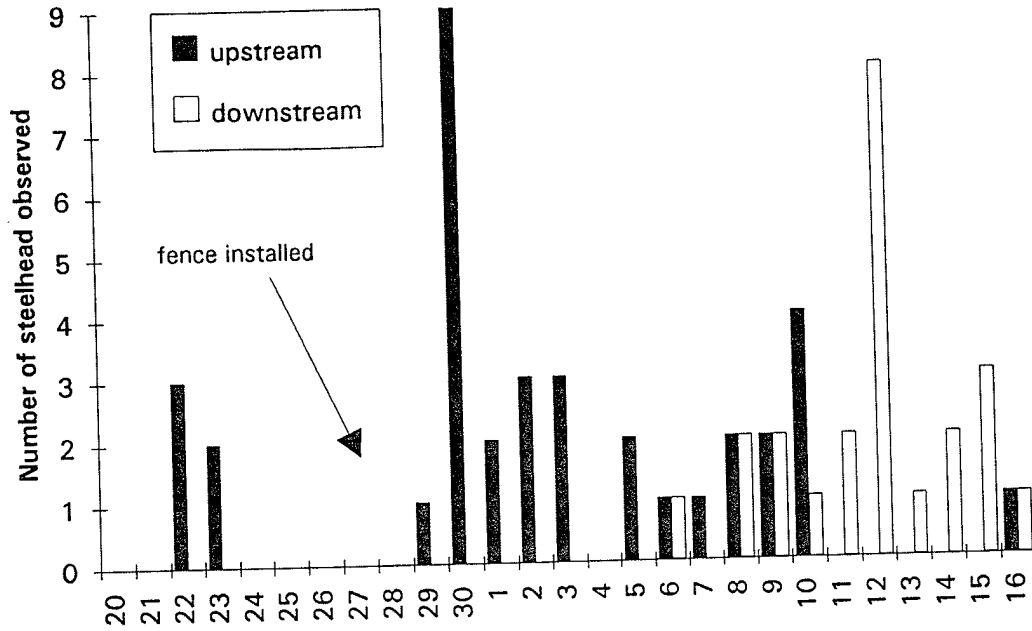
3.4 Steelhead Migration Observations

A total of 39 steelhead were observed moving upstream, and 23 were observed moving downstream through the fence opening. Among these 62 fish, three were observed to have one yellow tag attached to the left side of the dorsal fin (tagged in the upper Babine on April 12th, 13th, or 14th). No orange tags applied in either the fall sport or commercial fisheries, and no fish with two yellow tags that were tagged with radio transmitters were identified. However, six radio transmitters were located above the weir before the fence was lifted on May 16th (Beere, *pers. comm.*). The observed low proportion of migrating fish was likely due to a combination of the timing and duration of observations as well as high water levels that allowed fish to jump "closed" sections of the fence.

For the initial 13 days of the study, the majority of fish movement was upstream toward the known spawning area below the Boucher Creek confluence. Downstream migration was first observed on May 6th, and dominated over upstream migration from May 11th to May 16th (Figure 7). Some movement upstream and downstream is known to occur among spawning adult steelhead, especially males. Any such movements in the present study may have contributed to multiple counting due to uncertainty regarding the spawning status (pre- or post-) of the fish.

The fence opening was observed at as many different times of day as feasible. A light was installed immediately above the fence opening (250 W, white light). It was not scientifically tested whether this light may have deterred or attracted fish, but it did

(A)



(B)

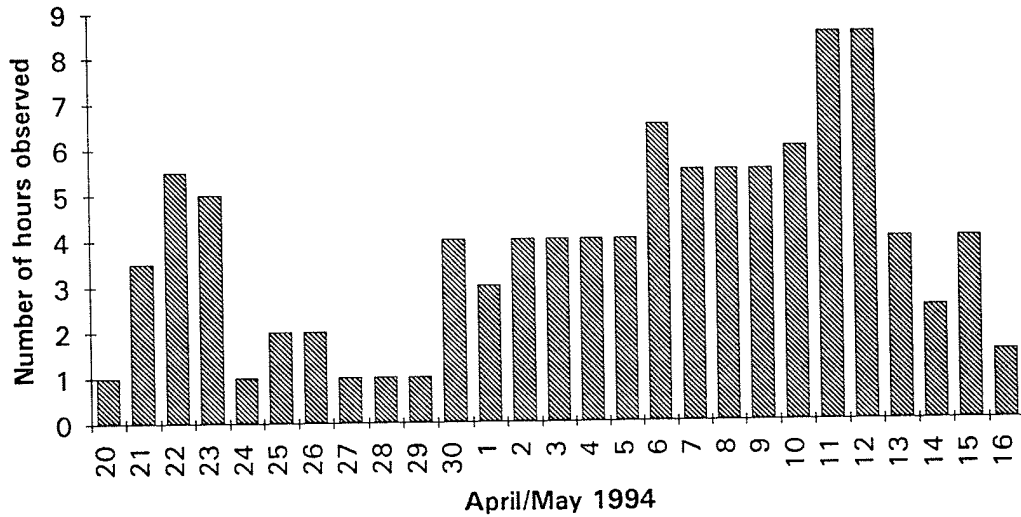


Figure 7. (A) Numbers of steelhead that were observed migrating upstream or downstream, and (B) the respective hours of observation during each day of this study.

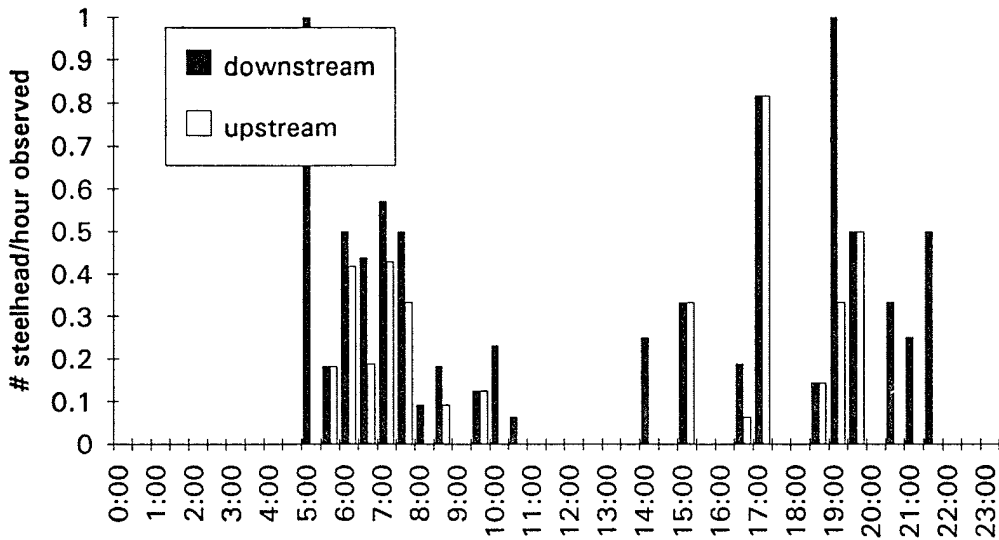


Figure 8. Steelhead migration timing and comparative rates of migration (steelhead observed/hour) during sequential observation periods (0.5 hours/observation).

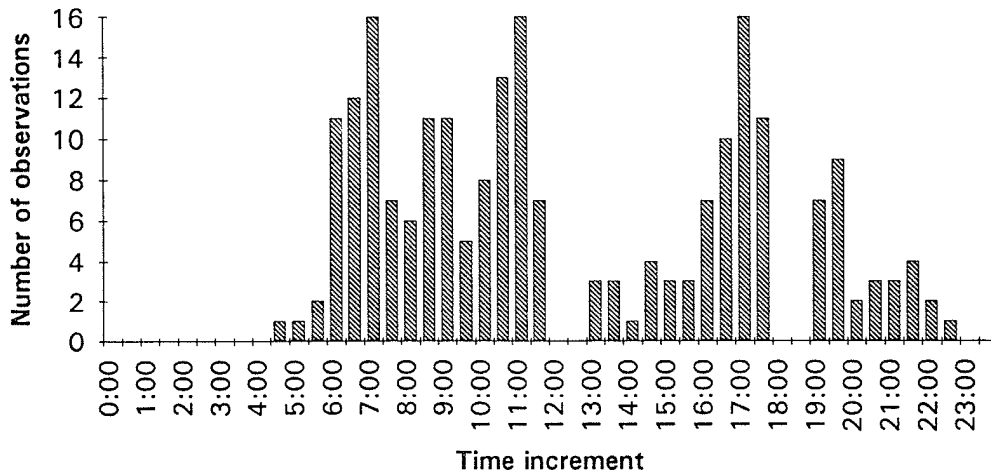


Figure 9. Graph summarizing the number of times that the fence opening in the Babine River weir was observed for each unit of the day (0.5 hours).

not appear to have a significant effect on either. Figure 8 displays the different rates that steelhead moved upstream and/or downstream through the fence during different times of day. Figure 9 summarizes the number of half hour observations that were conducted for each time period between April 20th and May 18th. These data demonstrate that few fish migrate between 11:00 and 16:00 hours (mid-day). In fact, no fish were seen during mid-day on sunny days. The fence was not observed between 22:30 and 04:30 hours, and it is therefore unknown whether steelhead move at this time. However, during observation periods the majority of upstream movement occurred in the morning between 06:00 and 08:00 hours, and in the evening between 15:30 and 19:30 hours.

The fence was left open 24 hours/day for the majority of the study period in order to minimize the potential delay of migrating steelhead. The fence was closed between observations from May 3rd to May 6th, but this appeared to reduce migration during observation times. The coincident radio telemetry study at the Babine River (Beere 1994) also suggested that the fence held steelhead back. In fact, seven additional radio tagged fish (total 13) moved upstream of the weir after the fence was removed on May 16th. It is likely that the fence restricted passage and reduced the number of attempts by steelhead to pass the weir.

The older panels that were used in the fence created a strong vibrating noise which may have discouraged steelhead passage. Another difficulty with the fence operation was that water levels rose considerably higher than expected due to the exceptionally early spring. By the end of this study, the water flowed over the new panels (two 60 cm panels high) by approximately 10 cm (Figure 10). However, 10 panels were observed for 10 hours and no steelhead were observed jumping over the fence. The older panels were higher and were impassable. The narrower spaces between the bars of the old panels appeared to clog more quickly than the new panels and may have



Figure 10. Photograph of fence on May 18th, when discharge overflowed the new fence panels by approximately 10 cm.

been too narrow to allow easy passage of sockeye smolts. In addition, the narrow spaces and larger diameter pipes of the old fence reduced waterflow more than necessary. Future spring operation of this fence will require construction of 120 more panels to facilitate sockeye smolt migration and better enumeration of adult steelhead.

3.5 Sockeye Smolt Migration

Sockeye smolts were captured in the weir smolt traps commencing in the first week of May (Jakubowski *pers. comm.*). Smolts were observed passing through both 2.5

cm and 3.75 cm spaces in the fence without any obvious difficulties. Smolts approached the fence facing upstream and went through the fence tail first. There appeared to be no threat to the smolts except where large amounts of debris had collected. Three smolts (1 tagged) were discovered dead against the old panels (2.5 cm spaces) where grass debris had heavily clogged small areas ($< 1 \text{ m}^2$). No fish were found trapped against the new fence panels which had 3.75 cm spaces. With daily maintenance, debris accumulation was minimized. Because the new panels collected less debris, they are strongly recommended for future installations of this fence for steelhead enumeration.

The new design of sockeye smolt traps at the Babine weir had no direct impact on steelhead migration. The traps were simple adaptations to four of the seven adult traps. The four adult traps adapted for smolts were unsuitable for trapping steelhead because the smolt traps blocked the majority of waterflow. It is recommended that the funnel entrances to traps not used for adult steelhead enumeration be blocked to prevent steelhead from exploring these traps.

4.0 RECOMMENDATIONS

1. It is recommended that fence operation for spring steelhead enumeration at the Babine River Weir use fence panels constructed as described in this report. Panels with 3.75 cm spaces between 2.5 cm diameter aluminum pipes provides adequate strength and less collection of debris. The height of panels may be increased to 120 cm to reduce the number of panels stacked, but the space between horizontal support bars must remain at 60 cm to avoid vibration.
2. It is recommended that the fence be monitored for 8 - 10 weeks (mid April to mid June) until the spawning time of the Babine steelhead is better defined. Accurate population estimates of spawners above the weir may also require samples of downstream migrating kelts to account for fish that overwintered above the weir.
3. Complete assessments of the overwintering distribution of Babine mainstem and Boucher Creek steelhead are important for future management of the Babine River steelhead. It is recommended that steelhead be winter-tagged at 5-10 km intervals along the entire mainstem, prior to spawning migration and operation of the weir. Original tagging locations of recaptures at the weir should be distinguished by tag numbers or different colour tags. Tagging would be feasible at locations such as above the Nilkitkwa, below the Nilkitkwa, Home Run Pool, Laura's Pool, Beaver Flats, and Shelagyote confluence. Efficient recapturing at the Babine weir will locate general proximities of other spawning habitats and will provide a useful description of the overwintering distribution of other substocks from the Babine River and its tributaries.
4. In coordination with the modification of the adult traps, it is recommended that the Can-Polar Video System be tested at two 2.5 m fence openings. Combining these two operations will reduce the effects of the fence on migration, and may effectively reduce the workload of observers. This system should be designed to identify tagged steelhead.
5. It is recommended that additional effort be applied toward assessing the

RECOMMENDATIONS

populations of steelhead in Boucher and Nichyeskwa Creeks, and Nilkitkwa River.

6. A radio-telemetry study of upstream and downstream steelhead movement through the Babine weir will assist in determining the extent of bias in the population estimate from repeat encounters with the same fish. It is recommended that 20 - 30 radio tags be applied downstream of the weir to aid in this effort. The distribution of radio tagged spawners will further evaluate the proportion of the overwintering population which ascends the weir.

5.0 ACKNOWLEDGEMENTS

Special thanks to Regina Saimoto for her preparation, organization, and thoughts that went into this preliminary study at the Babine River. Regina helped the Ministry of Environment and Department of Fisheries and Oceans work together at the Babine weir with the difficult and different objectives. Gratitude is also given to D.F.O. (Mike Jakubowski) for readily accepting this steelhead study at the federal study site. The assistance of Cynthia Barwell, Ian Bergsma, Jim Hanson, and Judy Snider with fence maintenance and observations were greatly appreciated.

The tagging portion of the program would not have been possible without the effort of the guides and their guests. Mark Beere, Sig Hatlevik, and Jeff Lough were indispensable. Comments provided by Dana Atagi and Bob Hooton on earlier drafts contributed to the final presentation of results in this report.

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