# Results of the Kloiya River Resistivity Counter 2009

Skeena Fisheries Report SK 155

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## *Executive Summary*

A Logie 2100C resistivity counter was installed at the Kloiya River on March 25, 2009. The counter electrodes are located within a plastic tube 150 cm in length with an inside diameter of 37.5 cm. The tube was placed in the fishway near the top of the structure. Steelhead migrating through the fishway passed through the culvert resulting in a change in conductivity that was analysed by an algorithm and recorded by the counter. A row of data for each event was comprised of the date, time, direction of travel and peak signal strength. Electrical power was provided by a stream engine that utilizes the head of water provided at the site to generate hydro electric power. Hourly water and air temperatures were collected on Optic Stowaway temperature data loggers during the project. Temperature loggers in the fishway were lost on recovery. Manual water temperatures were recorded on May 1, 7 and 21.

The first migration data was collected on May 1, 2009, and the last migration data was collected on May 31, 2010. Increased activity appeared to coincide with warmer water temperatures. The highest daily upstream count was recorded on May 13.The steelhead escapement, upstream of the Kloiya River dam, is estimated to be 25.

## *Table of Contents*

## *List of Figures*

## List of Tables



## *List of Pictures*



## List of Appendices

## *1.0 Introduction*

The Kloiya River watershed is located approximately 15 km southeast of Prince Rupert, B.C. (Fig 1). This coastal watershed provides spawning and rearing habitat for populations of chinoook salmon (*Oncorhynchus tshawytscha)*, chum salmon (*Oncorhynchus keta)*, coho salmon (*Oncorhynchus kisutch)*, sockeye salmon (*Oncorhynchus nerka)*, steelhead (*Oncorhynchus mykiss)*, coastal cutthroat trout (*Oncorhynchus clarkii)*, Dolly Varden (*Salvelinus malma*), pink salmon (*Oncorhynchus gorbuscha)*, general sculpins (*Cottidae*) and threespine stickleback (*Gasterosteus aculeatus*) (*Habitat Wizard. Aug 2007*). The Kloiya River is a fourth order stream with an approximate length of two km. A dam with a vertical height of approximately seven meters was constructed in 1949 two km upstream of the Kloiya River estuary. This structure was built to provide a source of water for the Skeena Cellulose pulp mill. A vertical slot fishway approximately 50 meters in length was incorporated into the dam's construction to facilitate fish passage upstream of the structure.

Kloiya River winter-run steelhead are known to spawn and rear in the mainstem Kloiya River as well as tributaries to Taylor Lake (Diana Creek) and Prudhomme Lake (Prudhomme Creek) (*Tredger, 1981*). The river provides the closest winter-run steelhead angling opportunity for anglers from Prince Rupert and Port Edward. The recreational steelhead fishery typically begins in late November and continues into April *(Beere pers. comm)*. The short fishable section of the river below the dam is subject to significant and rapid fluctuations in flow and stage, and has a limited number of angling locations that are accessible by trail.

Prior to 2006, information about the Kloiya Watershed steelhead population is limited to a study undertaken in 1981 by Ministry of Environment commissioned by the Salmonid Enhancement Program. This study was limited to quantifying juvenile steelhead abundance and estimating values for habitat capacity thresholds. Since 2006, the Ministry of Environment (*MoE*) has utilized the resistivity counter to document steelhead abundance and run timing in the Kloiya River Watershed. This report compiles information from project years 2006, 2007 and 2009.

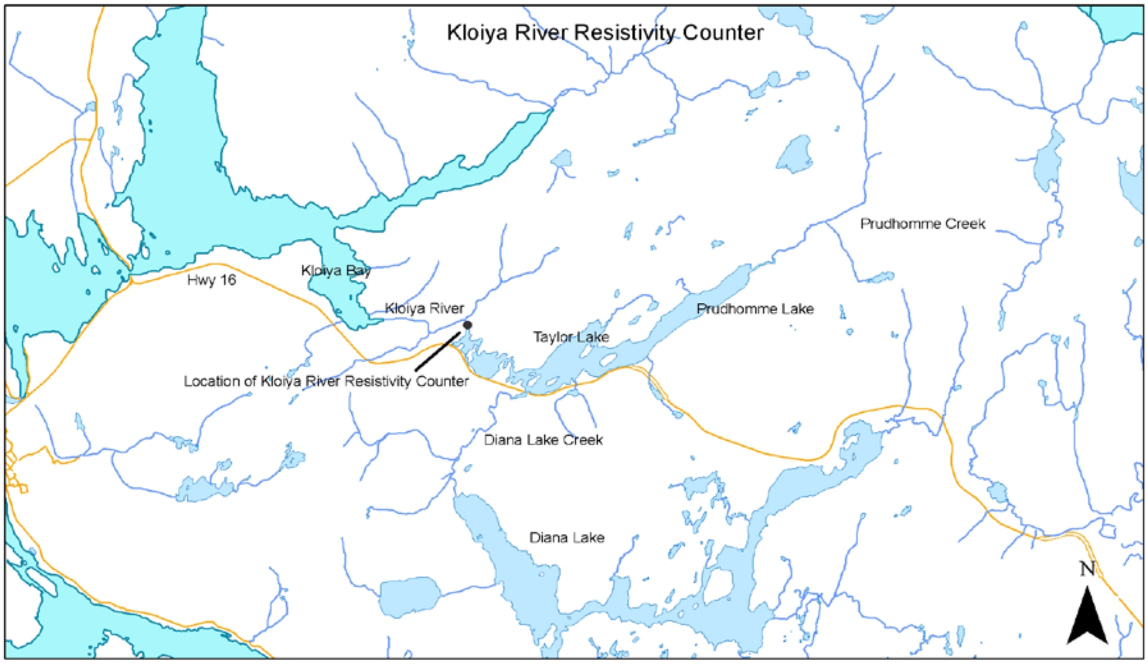


Figure 1. Location of Kloiya River resistivity counter.

## *2.0 Project Design/Methods*

The Kloiya River was surveyed in November 2005 to determine a suitable location to install and operate a Logie 2100C resistivity counter (*Aquantic Ltd. Scotland*). All resistivity counters operate in conjunction with three electrodes placed on top of a fixed weir, transportable flat pad, or inside of a tube. The three electrodes create a field that monitors the resistance of the water within the field. The counter recalibrates the measured resistance every 30 minutes. When a fish passes through the field the change in resistance is recorded by the counter. The signal is analyzed by an algorithm and a row of data is produced indicating the date, time, direction of travel and peak signal size. Changes in conductivity not determined to be caused by a fish are classified as events. The fishway was selected as the location for the counter based on several advantageous attributes. The location was adjacent to a secure storage shed to store the electronic equipment, the site was accessible by vehicle, the head of water at the dam could be used to generate power for the equipment and fish migrating through the fishway would be forced to swim through the resistivity counter tube. The tube type counter was developed and tested on the Bonaparte River near

Cache Creek, B.C. (*McCubbing 2003*). The counter tube on the Kloiya River has an inside diameter of 37.5 cm and an overall length of 150 cm. The tube is attached to aluminum grate and lowered into existing concrete slots in the fishway (Pic 1).

Picture 1. Kloiya River resistivity counter tube.

The location of the counter was selected due to the high probability of successfully enumerating adult steelhead at that location. Although steelhead are known to spawn in the Kloiya River below the dam, the decision was made to locate the counter at the fishway and enumerate a proportional representation of the Kloiya River steelhead escapement. At capacity, spawning tributaries upstream of the fishway represents 53% of annual watershed smolt production, and the adult steelhead capacity in the watershed above the dam is estimated to be 66 (*Tredger 1981*). A subsequent qualitative habitat survey of the Kloiya River below the dam, in April 2006, indicated that there is a limited amount of spawning and fry habitat available below the dam. This infers that a majority of the steelhead recruitment occurs in tributaries above the fishway (Beere pers. comm).

In 2009, trace data was not collected at the site due to the satisfactory counter efficiencies recorded in 2007. The 2009 counter settings remained the same as 2007 and counter efficiency is expected to be comparable.

Electrical power for the counter system was generated by a Stream Engine (*Energy Systems and Design Ltd, Sussex NB*) which utilized the head of water at the site to keep the batteries charged and the equipment functioning.

# 3.0 Equipment Settings

## 3.1 Logie Counter Settings

Logie 2100C counter settings are dependent upon several parameters. Water conductivity is the primary metric for determining counter settings. Specific conductance and Total Dissolved Solids (TDS) values for the Kloiya River are very low, 15 µmhos/cm and 10mg/l respectively. In 2007 and 2009 counter gain was set at a value of 400 to compensate for the low conductivity. In comparison, counter gain was set at 250 in 2006. Threshold values required for fish identification was set at 20. Counter software used during the 2009 project was version 9.10.

# 4.0 Results

## 4.1 Counter Efficiency

The Kloiya River resistivity counter was installed and operational on March 25, 2009. The first fish record was recorded on May 1, 2009 and the last fish record was recorded on May 31, 2009. Rows of data prior to May 1, 2009 were from manual testing of the counter to ensure operational status as functioning. Between May 1 and May 31, the counter recorded 45 up counts, 18 down counts and 19 events. Events indicate a change in conductivity that was not recognized by the counter algorithm as a fish. A total of 82 rows of data were recorded as upstream counts, downstream counts and events (Table 1).

| Date | Time | Description | P.S.S |
|---|---|---|---|
| 1-May-09 | 13:59:57 | U | 65 |
| 1-May-09 | 14:00:37 | E | 70 |
| 1-May-09 | 19:20:22 | U | 49 |
| 1-May-09 | 21:24:56 | E | 91 |
| 1-May-09 | 21:57:15 | E | 37 |
| 1-May-09 | 22:01:52 | D | 80 |
| 1-May-09 | 23:25:57 | E | 40 |
| 2-May-09 | 15:49:20 | U | 61 |
| 2-May-09 | 17:09:15 | U | 55 |
| 3-May-09 | 11:03:36 | U | 56 |
| 3-May-09 | 13:04:14 | U | 69 |
| 3-May-09 | 13:16:12 | U | 57 |
| 3-May-09 | 13:40:37 | U | 61 |
| 4-May-09 | 23:52:56 | E | 43 |
| 5-May-09 | 11:50:25 | U | 61 |
| 5-May-09 | 12:09:57 | U | 64 |

Table 1**.** Example of text data collected from counter in 2009**.**

To estimate counter efficiency, counter data is calibrated with trace data. The trace data provides a visual record of the counter data that can be compared to the counter algorithm's classification. Trace data was not available for comparative analysis in 2009. Counter settings were consistent with those utilized in 2007 and counter efficiencies are expected to be comparable. In 2007, 115 or (74%) of the counter records had corresponding trace data that can be used for analysis (Peard 2008). These data were collected between March 8 and May 13, 2007. Two letter codes were used to compare text and trace data and determine event classification (Table 2).

| | |
|---|---|
| UU | Upstream fish classified as a upstream fish |
| UE | Upstream fish classified as a event |
| DD | Downstream fish classified as a downstream fish |
| DE | Downstream fish classified as a event |
| EE | Non fish event correctly classified as a event |

Table 2. Codes used to compare trace and text data.

Counter efficiency for upstream counts was determined by dividing the number correctly classified up counts UU (83) by the total number of up counts UU+UE (88). This results in a upstream efficiency estimate of 94%. This is a significant improvement compared to the 80% upstream efficiency calculated in 2006 (Peard 2007). Counter efficiency for downstream migrants was calculated by dividing the correctly classified number of down counts DD (19) by the total number of down counts DD+ DE (25). Therefore, the counter efficiency for downstream migrants was calculated to be 76%. Downstream efficiency also benefitted from a higher gain setting. The 2006 downstream counter efficiency was estimated to be 58% (Peard 2007). The remaining eleven events were changes in conductivity that were not related to fish passage. Classification errors, upstream or downstream, primarily involved are fish traces not breaking the threshold required to be identified as fish. This may be due to very low conductivity in combination with changes in swim height as the fish migrates through the field. Figures 2 and 3 shows examples of downstream and upstream migrants, recorded in 2006, incorrectly classified as an event.

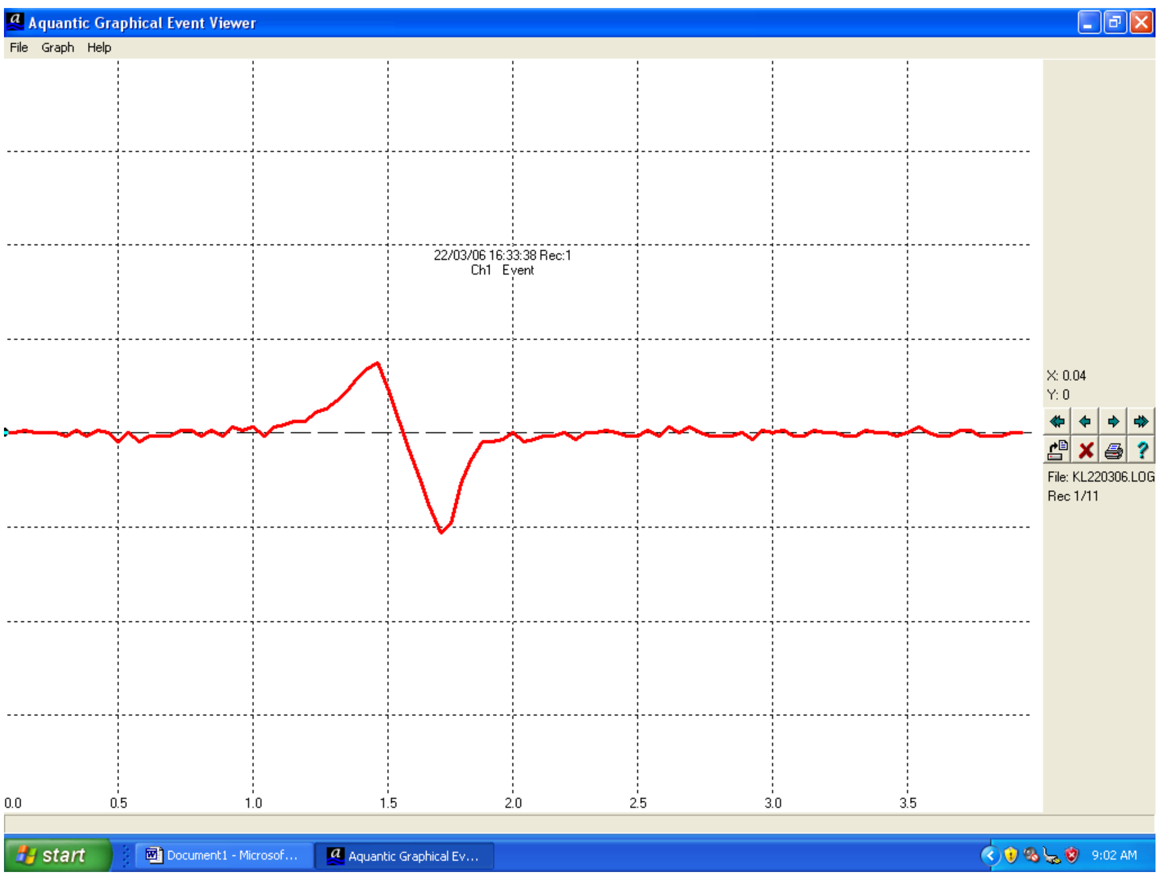


Figure 2. Downstream migrant incorrectly classified as a non fish event.

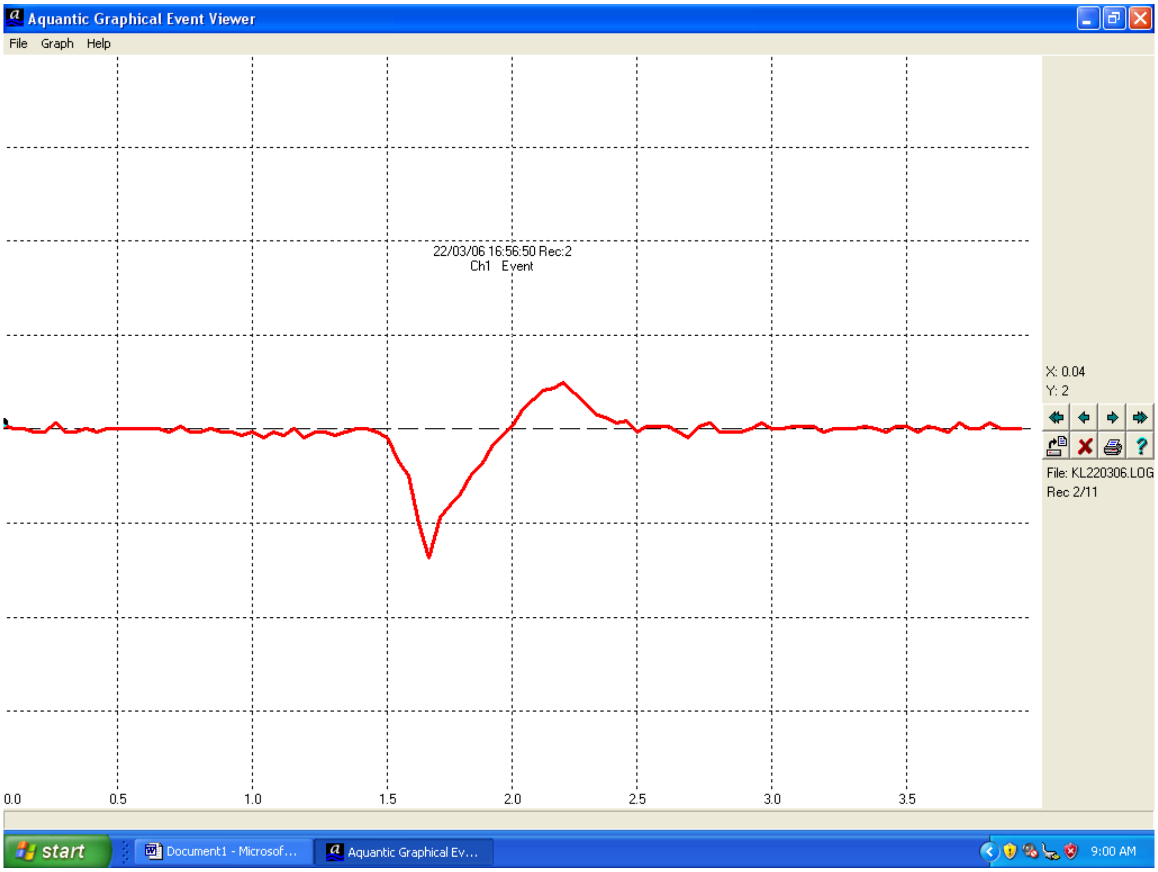


Figure 3. Upstream migrant incorrectly classified as a non fish event.

Sudden changes in water conductivity not related to fish migration are also recorded by the counter. Some examples of non fish events recorded by the counter include river otters, beavers, air entrainment and sudden changes in water flow (*MCcubbing pers. comm*). These trace patterns are significantly different from fish traces and visual analysis can distinguish between changes in conductivity related to fish and non fish events. Figure 4 is an example of a change in conductivity not related to fish migration.

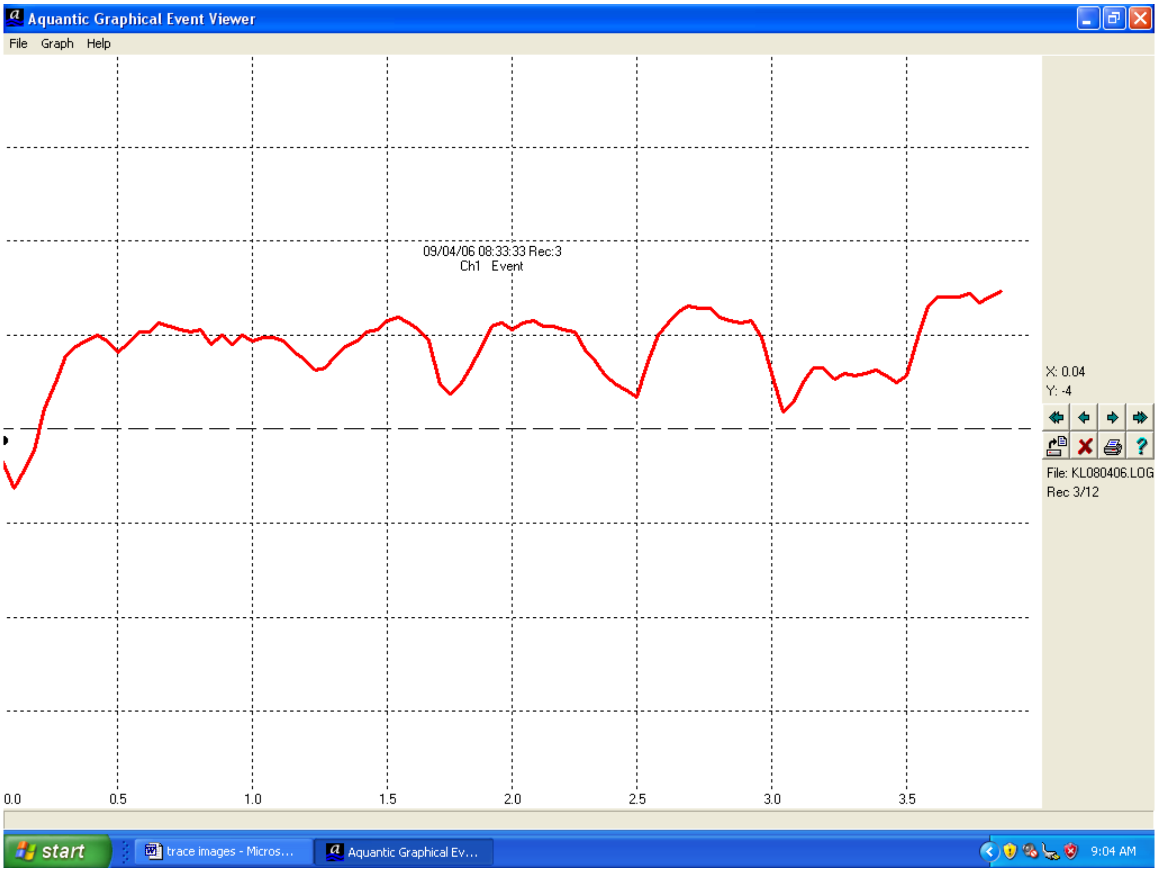


Figure 4. Change in conductivity correctly classified as a non fish event.

## *4.2 Escapement Estimate*

Since daily down counts did not exceed daily up counts, near the end of the project, it is assumed that kelt emigration did not bias the results. A correction factor is applied to the rows of data logged as events (not indicated as up or down migrants) where trace data is unavailable. Trace data analysis in 2007 indicated that 22% of the events logged by the counter were upstream migrants. In comparison, 30% of the events were downstream migrants. These values are applied to events where trace data does not exist. These values were applied to the 2009 escapement estimate calculation. There are 19 logged events where trace data does not exist. To estimate up counts, 19 is multiplied by 0.22. Therefore, it is estimated that 4 upstream migrants were not correctly classified. The estimate for downstream migrants is 19 multiplied by 0.30. It is estimated that 6 downstream migrants were not correctly classified. The escapement estimate for Kloiya River winter run steelhead is estimated by subtracting down counts from the up counts recorded during the project.

*U+UE-D+DE=escapement (45+4) - (18+6) = 25*

The counter was removed on May 31, 2009. Unlike previous years there was no steelhead recorded until May 1, 2009. In previous years steelhead migrating in between March 25 and April 30 represented 21% (2006) and 48% (2007) respectively. In 2009, 0% of the escapement estimate was represented during this time period. Figure 5 shows the escapement estimates for 2006, 2007 and 2009.

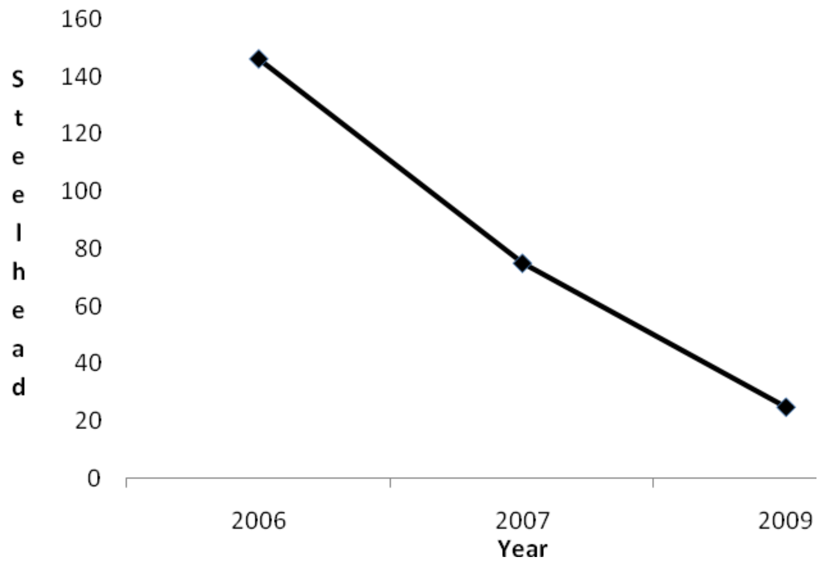


Figure 5. Kloiya River steelhead escapement estimates 2006, 2007 and 2009.

### *4.4 Run Timing*

Anglers begin to capture Kloiya River steelhead in the month of November with peak catch reportedly occurring in March and April *(Beere pers. comm).* The counter was installed and operational on March 25, 2009. Information from anglers suggests that there are typically steelhead present below the Kloiya Dam in December, January and February. However, the first steelhead recorded by the counter occurred on May 1. This indicates that Kloiya River steelhead run timing into the lower river is significantly different from the migration through the fishway. For the purposes of this report run timing refers to the migration through the fishway and into Taylor Lake.

To gain a better understanding in run timing trends, uncorrected daily net up counts are used to demonstrate run timing. Although the counter was operational from March 25, 2009 to May 31, 2009 there were no counts recorded until May 1, 2009. Between May 1 and May 31, 100% of the steelhead recorded migrated into Taylor Lake. Daily net upstream counts, during this time period, ranged from zero to six. In comparison, maximum net daily upstream counts ranged from eight in 2007 and 17 in 2006 (Peard 2008) (Peard 2007). The peak daily upstream count occurred on May 13 (Fig 6).

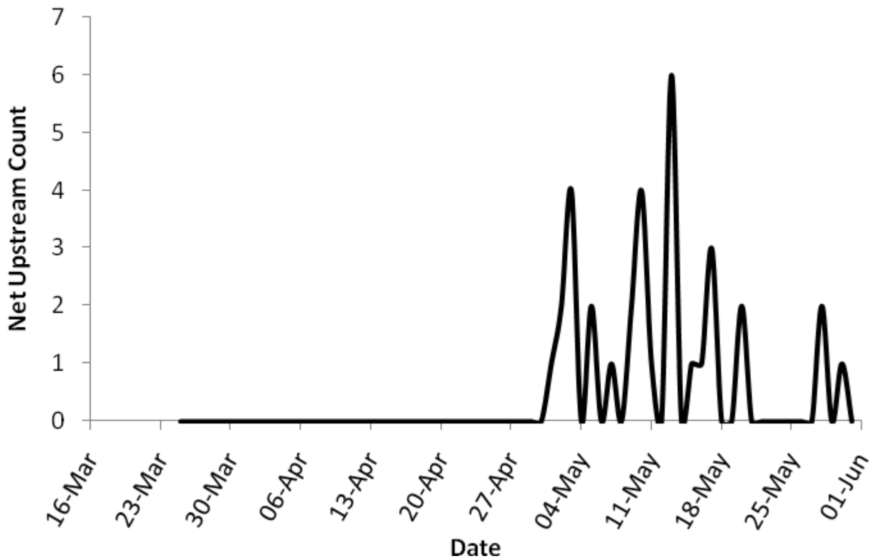


Figure 6. Uncorrected net daily up counts March 25 to May 31 2009.

Run timing in 2009 was significantly different compared to run timing in 2006 and 2007. Limited upstream migration was observed in 2006 and 2007 until early April when upstream counts increased. In 2006 and 2007, the 50% migration date counts occurred on April 24 and April 26 respectively. In 2009, the 50% migration date was 17 days later (Fig 7).

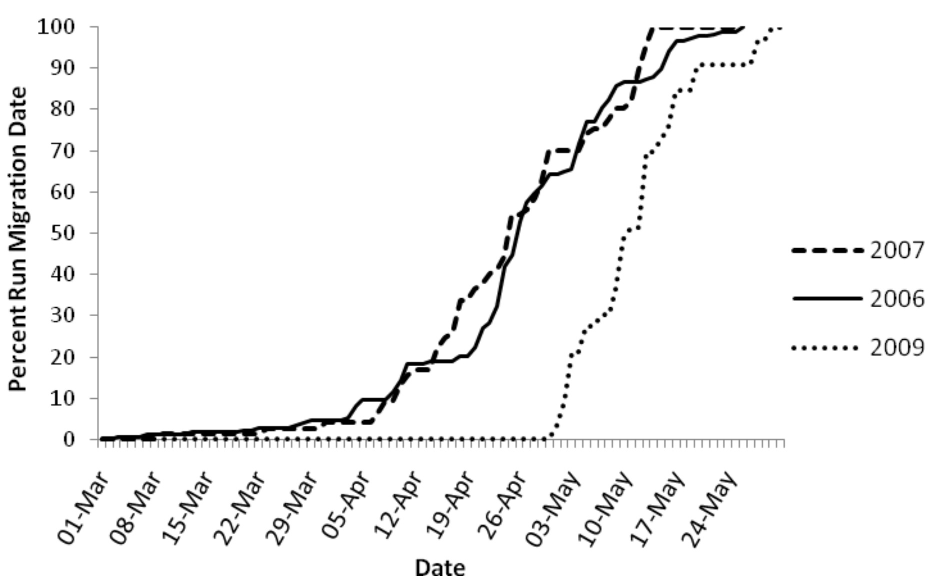


Figure 7. Cumulative percent migration date 2006, 2007 and 2009.

Compared to the previous two years steelhead run timing was later and the migration period was condensed into a shorter period of time (Fig 8).

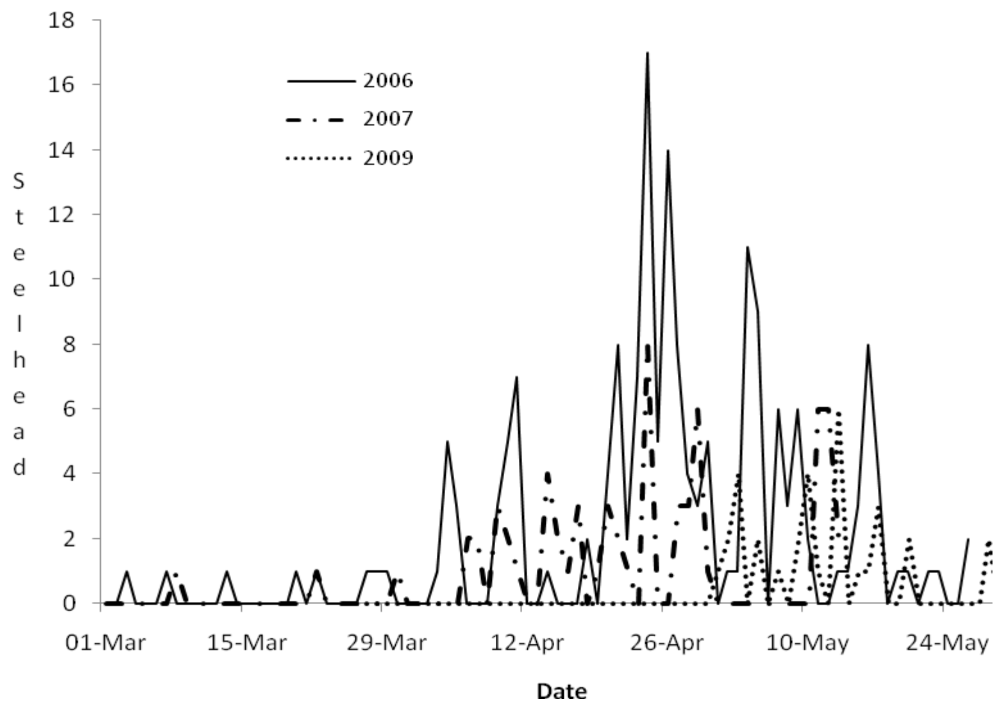


Figure 8 Kloiya River steelhead run timing 2006, 2007 and 2009

## *4.5 Environmental Parameters*

Two Optic Stowaway temperature data loggers (*Onset Computer Corporation, Pocasset, MA)* were deployed in the fishway on March 25, 2009. The data loggers were lost on retrieval and water temperature data is limited to manual recordings during site visits.  Water temperatures were recorded on May 1, May 7 and May 21. Water temperatures recorded on those days are plotted against daily water temperature data collected in 2006 and 2007 in (Fig 9).

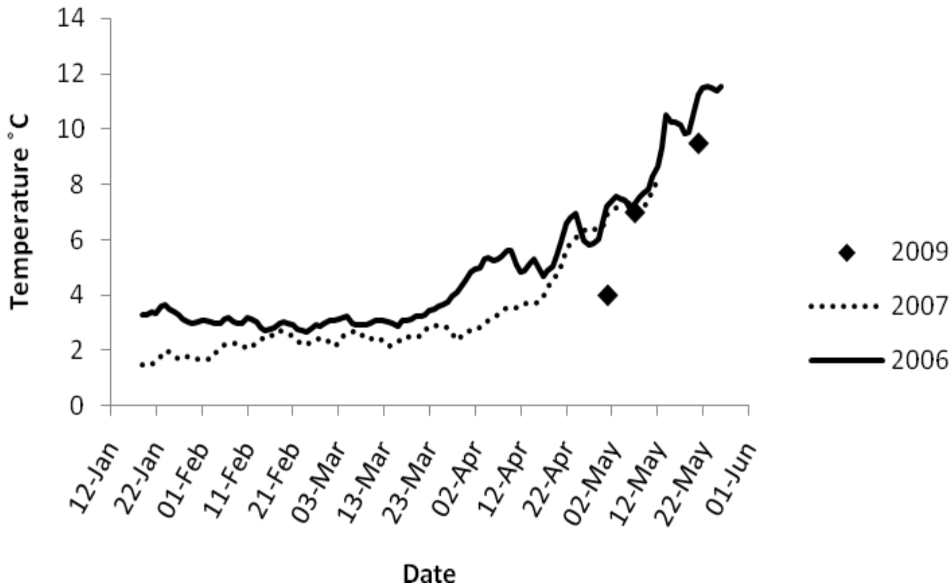


Figure 9. Daily water temperatures 2006, 2007 and 2009.

Kloiya River level and flow is controlled by the Kloiya River Dam. A water survey station maintained by Environment Canada is located approximately 300 meters downstream of the structure. The station collects and records data that is accessible from the Environment Canada website. Water flow down the fishway can be manipulated independently of the dam's gate, however, visual observations in 2009 indicated that the fishway flows remained consistent during the project and were independent of flows in the mainstem. Flows in the fishway remained at or near capacity. This is not what was observed in previous years and may be the result of alterations made to the stop logs at the head of the fishway the previous summer. The height of the stop logs were altered to attempt to reduce the water velocity the top of the fishway during high flows (*Hjorth pers. comm*). Water level data from the Environment Canada website indicates that daily mean water level ranged between 0.77 m and 1.13 m from March 25 to May 31, 2009. Mean level in the same time period was 0.89 m (SD=0.076).

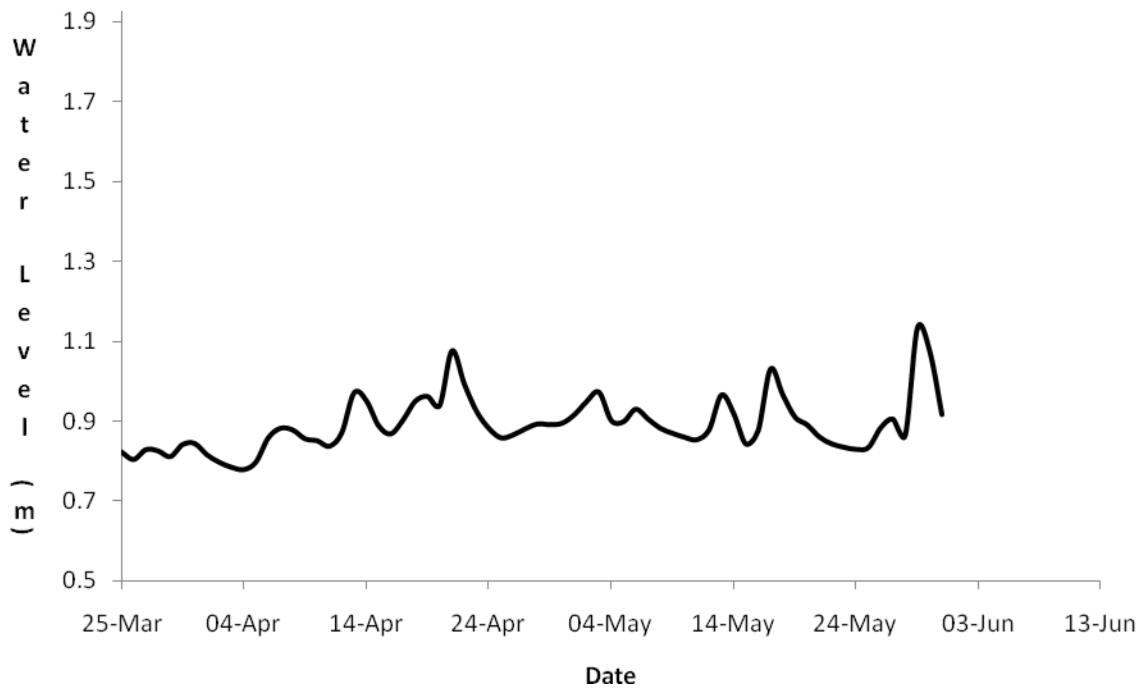


Figure 10. Mean daily water level (m) in the Kloiya River March 25 to May 31, 2009
(Env Canada survey station Kloiya River)

## *4.6 Migration Behaviour through the Fishway*

When the Kloiya River dam was built in 1949, a vertical slot fishway was incorporated into the construction to facilitate fish migration above the structure. The fishway is approximately 50 meters long with a small entrance in the opposite direction of the natural flow (Pic 2). Halfway along its length the fishway turns 180˚ before reaching the Taylor Lake. To access the lake, fish must migrate through a square hole located in the bottom corner of the stop logs at the head of fishway (Milino pers. comm).

Picture 2. Entrance to Kloiya River fishway.

Daily upstream migration ranged from zero to six fish during May peaking on May 13 (Fig 8). Increase in migration activity coincided with increasing water temperatures (Fig 9). On May 1 water temperature was 4˚C reaching 9˚C over the next 21 days. In 2007, water temperature/ steelhead migration data indicated that water temperatures exceeding 3˚C coincided with increased activity in the fishway (Peard 2008). In 2006, increased activity occurred when temperatures reached 5˚C (Peard 2007).

## 5.0 Discussion

Prior to 2006, The Ministry of Environment did not have a winter-run steelhead index in the Skeena Region. The Kloiya River was investigated, as a possible winter-run index, due to it’s size and proximity to Prince Rupert and the Smithers Regional MoE office. It also provided the infrastructure to securely store the equipment while in operation, and the dam provided a potential opportunity to generate electrical power precluding the need to operate generators. Resistivity counter technology was selected as the enumeration method since the technology required limited maintenance, and the successful use of the technology to enumerate steelhead populations on the Keogh, Bonaparte and Deadman rivers in British Columbia. The Kloiya River design was based on the tube type counter installed in the Bonaparte River.

Steelhead abundance in 2009 was very poor relative to 2006 and 2007. One potential explanation may be the cool water temperatures that persisted until early May. It is unknown how steelhead behaviour was affected by the cool water temperatures.

The stream engine proved to be a consistent source of electrical energy throughout the project.

The goals and objectives of the Kloiya River resistivity counter project were met again in 2009. MoE now has three years of escapement data to compare and analyze in future years.

## 4.0 Recommendations

- Investigate options for facilitating fish migration through the fishway.
- Install a staff gauge in the fishway to record water levels.
- In future years, when abundance counts are below expectations, a snorkel swim in the two kilometre section of river below the dam may provide some indication of steelhead abundance below the fishway.
- Expand the scope of the project to incorporate genetic and life history information into the analysis.

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Appendix 1. Counter data

| Date | Time | Description | PSS |
|---|---|---|---|
| 2009-05-01 | 12:20:47 | D | 119 |
| 2009-05-01 | 12:20:48 | E | 119 |
| 2009-05-01 | 13:51:15 | U | 72 |
| 2009-05-01 | 13:59:57 | U | 65 |
| 2009-05-01 | 14:00:37 | E | 70 |
| 2009-05-01 | 19:20:22 | U | 49 |
| 2009-05-01 | 21:24:56 | E | 91 |
| 2009-05-01 | 21:57:15 | E | 37 |
| 2009-05-01 | 22:01:52 | D | 80 |
| 2009-05-01 | 23:25:57 | E | 40 |
| 2009-05-02 | 15:49:20 | U | 61 |
| 2009-05-02 | 17:09:15 | U | 55 |
| 2009-05-03 | 11:03:36 | U | 56 |
| 2009-05-03 | 13:04:14 | U | 69 |
| 2009-05-03 | 13:16:12 | U | 57 |
| 2009-05-03 | 13:40:37 | U | 61 |
| 2009-05-04 | 23:52:56 | E | 43 |
| 2009-05-05 | 11:50:25 | U | 61 |
| 2009-05-05 | 12:09:57 | U | 64 |
| 2009-05-05 | 23:04:12 | E | 40 |
| 2009-05-07 | 11:51:42 | U | 53 |
| 2009-05-08 | 1:09:45 | D | 34 |
| 2009-05-08 | 1:13:16 | U | 120 |
| 2009-05-08 | 3:37:24 | D | 37 |
| 2009-05-08 | 12:11:16 | U | 127 |
| 2009-05-09 | 1:52:43 | U | 115 |
| 2009-05-09 | 20:34:48 | U | 63 |
| 2009-05-09 | 22:25:17 | U | 127 |
| 2009-05-09 | 22:25:30 | E | 57 |
| 2009-05-09 | 23:46:25 | D | 49 |
| 2009-05-10 | 0:11:00 | E | 44 |
| 2009-05-10 | 9:33:20 | U | 64 |
| 2009-05-10 | 12:38:33 | U | 48 |
| 2009-05-10 | 13:42:10 | U | 46 |
| 2009-05-10 | 17:37:34 | U | 100 |
| 2009-05-11 | 2:15:20 | E | 34 |
| 2009-05-11 | 7:11:03 | U | 127 |
| 2009-05-11 | 22:45:55 | E | 33 |
| 2009-05-13 | 1:06:11 | U | 119 |
| 2009-05-13 | 6:35:04 | U | 106 |
| 2009-05-13 | 9:15:01 | U | 63 |
| 2009-05-13 | 10:06:19 | U | 59 |
| 2009-05-13 | 10:15:03 | U | 67 |

| | | | |
|---|---|---|---|
| 2009-05-13 | 10:57:56 | U | 55 |
| 2009-05-13 | 11:02:32 | U | 52 |
| 2009-05-13 | 15:27:39 | D | 36 |
| 2009-05-14 | 14:49:46 | D | 123 |
| 2009-05-14 | 14:49:47 | U | 120 |
| 2009-05-14 | 14:51:05 | D | 127 |
| 2009-05-14 | 22:40:26 | D | 49 |
| 2009-05-14 | 23:40:10 | D | 43 |
| 2009-05-15 | 8:50:57 | U | 127 |
| 2009-05-16 | 2:00:48 | E | 60 |
| 2009-05-16 | 2:00:56 | U | 120 |
| 2009-05-17 | 7:25:10 | U | 58 |
| 2009-05-17 | 7:25:21 | U | 73 |
| 2009-05-17 | 7:25:25 | E | 99 |
| 2009-05-17 | 7:25:48 | U | 127 |
| 2009-05-17 | 7:25:51 | D | 127 |
| 2009-05-17 | 7:25:56 | E | 60 |
| 2009-05-17 | 14:28:40 | U | 59 |
| 2009-05-17 | 14:28:53 | D | 120 |
| 2009-05-17 | 14:36:11 | U | 60 |
| 2009-05-17 | 21:48:32 | U | 127 |
| 2009-05-17 | 23:11:40 | D | 67 |
| 2009-05-19 | 5:37:01 | E | 120 |
| 2009-05-19 | 22:40:36 | D | 47 |
| 2009-05-20 | 7:56:34 | U | 91 |
| 2009-05-20 | 10:18:43 | E | 120 |
| 2009-05-20 | 10:48:00 | U | 120 |
| 2009-05-21 | 0:30:53 | D | 36 |
| 2009-05-21 | 14:44:45 | U | 60 |
| 2009-05-22 | 9:36:45 | D | 40 |
| 2009-05-22 | 16:02:40 | U | 57 |
| 2009-05-24 | 13:12:13 | D | 127 |
| 2009-05-25 | 17:48:20 | E | 36 |
| 2009-05-26 | 4:26:01 | E | 36 |
| 2009-05-28 | 17:43:45 | U | 66 |
| 2009-05-28 | 18:39:46 | U | 56 |
| 2009-05-30 | 16:32:43 | U | 64 |
| 2009-05-31 | 11:19:11 | D | 119 |