Results of the Babine River Remote Video Enumeration Project

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ABSTRACT

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The project operated between October 3 and October 22, 2008. Power was produced using three Ampair UW 100 water powered generators and a 30 watt solar panel. Power was stored in a bank of six 12 volt, 100 amp hour batteries. Fish moving upstream or downstream through a camera viewing box were recorded with a DVR6 Extreme, 4 channel mini stand alone mobile DVR. Additional recordings were made with a low cost, solid state, pocket sized digital motion detecting audio and video recorder (PVR) the DM1AV.

Totals of 438 coho salmon (*Oncorhynchus kisutch)*, 97 sockeye (*O. nerka)*, 21 chinook (*O. tshawytchsa)*, 27 rainbow (*O. mykiss)*, 3 steelhead (*O. mykiss)*, 1 bulltrout (*Salvelinus confluentus)*, 1 Dolly Varden (*Salvelinus malma)* and 51 unidentified fish were counted during the recording period of October 3 to October 22. Whitefish were observed daily moving both upstream and downstream.

INTRODUCTION

The Department of Fisheries and Oceans Canada (DFO) has operated a counting weir on the Babine River since 1946. This weir or fence as it is sometimes described, is located approximately 1.8 km downstream of the outlet of Nilkitkwa Lake. The site is 125 km from the northern British Columbia community of Smithers (Fig. 1).

The counting fence operation begins in July when the water level has dropped below the level of the counting chutes on the upstream side of the fence trap boxes. High water levels in years like 2007 can delay operations until as late as mid August. The counting operation continues daily until early October. The focus of the counting program during this period is sockeye salmon (*Oncorhynchus nerka).* Most of the chinook salmon (*O. tshawytchsa)* population passes the counting fence location prior to the fence grates being installed. The population of coho salmon (*O. kisutch*) is only partially counted by early October.

Attempts have been made to keep the fence in operation through the coho migration period. The fence was kept in operation until mid December in 1999 (M. Jakubowski, DFO Prince Rupert, pers. comm.). Coho were found to migrate over the period of mid October to mid December. However, they migrated through the fence in bursts. Short periods of relatively large migration, 1000 over two days in November, were followed by long periods of little or no coho migration. The cost of maintaining the field camp coupled with short periods of daylight made this program both prohibitively expensive and difficult on the field crew. Snow and cold weather conditions also made keeping the operation going very difficult.

The purpose of this project was to investigate using closed circuit digital video recorders and waterproof cameras to record the migration of coho salmon and other species past the end date of the regular fence operation. To avoid having to operate the camp diesel generator, power would be generated on site using a combination of micro-hydro and solar or wind power.

METHODS

POWER GENERATION

An Ampair water powered generator, (http://www.ampair.com/ampair/waterpower.aspwater) the UW 100 was used as the main source of power generation. The initial configuration used two of these generators. The final power system configuration used three UW 100’s plus a 30 watt solar panel as a secondary source of power.

The UW 100 water powered generators were wired as per manufacturers’ specifications independently through an amp meter and an Ampair charge controller to a bank of batteries. The battery bank consisted of six 100 amp hour (Ah) deep cycle batteries. The 30 watt solar panel was wired through a separate charge controller to the same bank of batteries. The solar panel was kept separate to help determine power production from each source.

All three UW 100 water powered generators were initially installed on the upstream side of the counting fence. One was installed on the upstream side of counting bay 2 and two were installed on either side of the downstream end of counting bay 3. These locations were chosen for maximum flow at a distance of not more than 50 meters from the battery bank to reduce power loss between

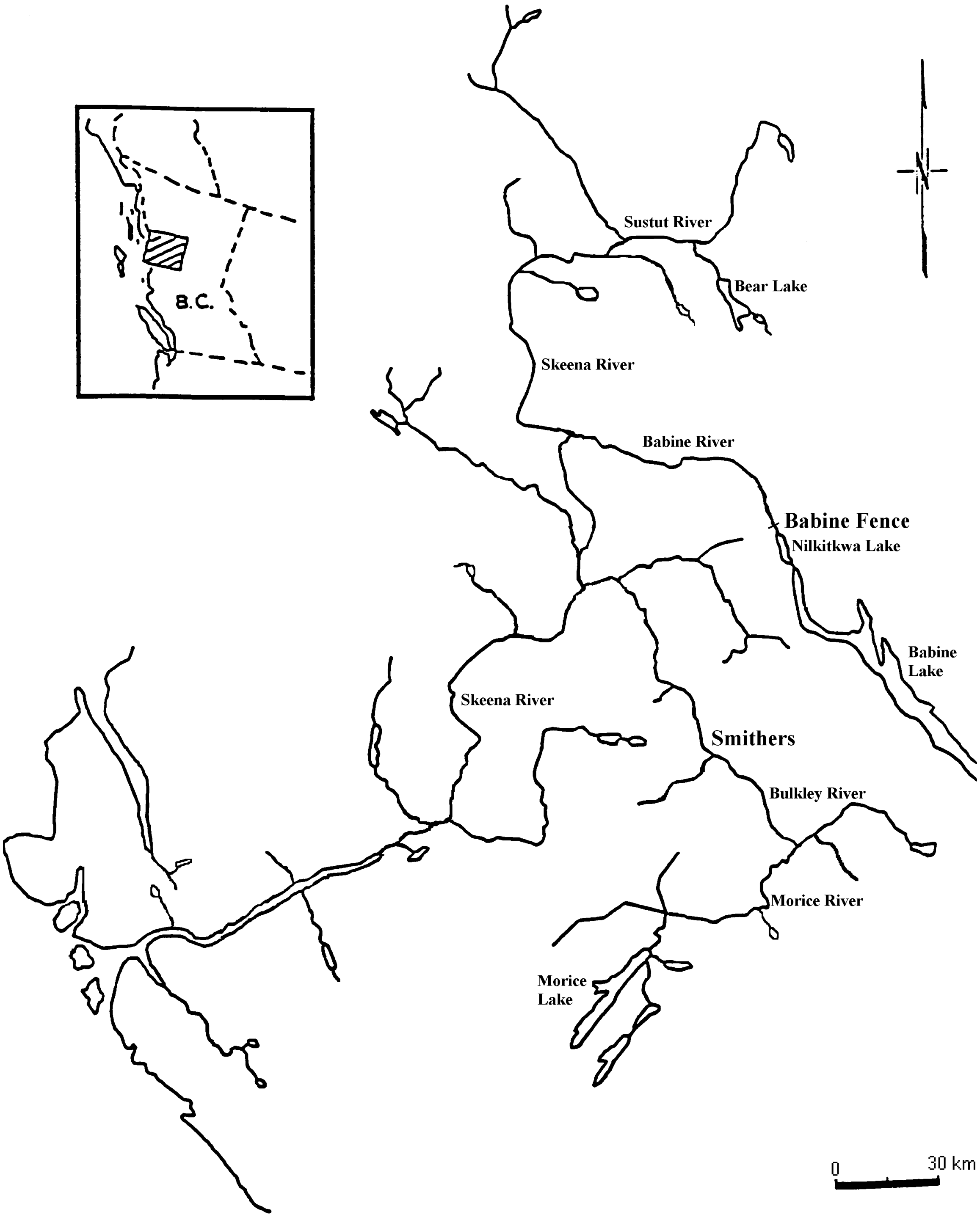

Figure 1. Babine fence and general area.

the generators and the battery bank. The battery bank was located inside a shed on the river right abutment of the counting fence. Just prior to the end of the project, one UW 100 was tested on the downstream side of the counting fence directly downstream of counting bay 3 (Appendix A).

Power was transmitted between the generators and the battery bank using 10 gauge, cab tire type wire. A 0-10 amp ammeter was installed in line. Next came an Ampair S1B charge control regulator. A 10 amp fuse was fitted between the charge controller and the battery bank.

The 30 watt solar panel was installed on the wall of the river right abutment storage shed. This site was chosen because it was partially protected from the elements and it faced due south. A 200 watt solar panel was ordered for the project. However, it did not arrive in time to be used for the 2008 program. Wind power generation was considered but the lack of consistent wind made it a poor choice for this location.

VIDEO RECORDERS

Three types of mobile digital video recorders (DVR) were purchased for this project. A Sentry SMD 04 HC was initially purchased as the main recording system for the project. Extensive testing in the office failed to get this DVR to either record or download properly. Major difficulties with software and hardware operation could not be resolved. The Sentry SMD 04 HC was subsequently shelved due to time constraints.

A CVC Mobile DVR6 Extreme, 4 channel mini stand alone mobile DVR was used as the main recording system for the project in 2008. The system was configured for 2 camera inputs. It was supplied in a waterproof Pelican 1450 case with a built in 7 inch LCD colour monitor. This system was purchased with an installed 40 GB hard drive plus an extra 40 GB drive. A USB hard drive docking station and PC viewer software was also purchased. The extra 40 GB hard drive was to be swapped with one in the field to allow for in-season video review. The system was configured in the office and transported to the Babine fence site for final set up. A DLS 15 series M 12 volt charger and converter was used to provide 12 volt power during set up.

The DVR was configured to record 24 hours a day for a minimum of 10 seconds after detecting motion. Motion detection was set up on site based on actual fish movement through the viewing box. The system was configured to detect all upstream motion. This meant that turbulence and debris would also be detected and recorded. It was determined that for the 2008 season this was acceptable in order to detect all fish movement. Recording quality was set on normal based on preliminary results in the field.

A low cost, solid state, pocket digital motion detecting audio and video recorder (PVR) the DM1AV was also purchased for the project from CVC Mobile. This recorder was to be used as a back up and to provide a simple, low power demand recording system. A 7 inch LCD monitor purchased for use with the SMD 04 HC was used for configuration and field set up of the PVR. The PVR came with a 2 GB SD card. A Verbatim 15 in 1 card reader was purchased to read and transfer data from the SD card to PC.

CAMERAS

Three types of cameras were purchased for the project. A Sentry Model 5324 IR weatherproof was used for the first ten days in trap number 2. This was replaced with a Lorex CVS 1000 submersible colour camera. A Lorex CVS 1000 camera was initially installed in trap number 1. This camera failed after 2 days and was replaced with a Seaviewer Sea Drop 950 colour underwater video camera.

The cameras were bolted to 2 meter lengths of 2x4 inch pressure treated lumber. The wood was then clamped to the inside bars of traps 1 and 2. This allowed for the cameras to be rapidly moved both up and down and side to side as required.

TRAP VIEWING BOXES

The aluminum V-shaped entrances inside traps 1 and 2 were removed and replaced with camera viewing boxes. These viewing boxes were constructed from 2x4 inch pressure treated lumber, plywood and ¼ inch plexiglass. The 2x4 lumber formed the frame of the viewing box. Clear plexiglass was used on the top and right hand side of the box. The bottom and left hand side of the box was made from ½ inch plywood painted with white porch and floor enamel paint. The finished viewing box opening was 22 inches (56 cm) deep and 18 inches (45.7 cm) wide. The boxes were situated in the trap box opening so that all fish moving upstream had to pass through the viewing box. The trap box lids were left open to allow for maximum light.

The counting chutes were removed from traps number 1 and 2. These are located on the upstream side of the trap box. Removing them allowed for maximum water flow through the trap box and camera viewing box. Removal also allowed fish to pass freely out of the trap box after passing through the counting box. It also allowed for downstream passage.

RESULTS

POWER GENERATION

The Ampair UW100 generators were in operation from September 30 until October 23, 2008. Maximum power generation from any one generator was 6 amps. Each of the three UW 100 generators averaged 3 amps of power generation. The installation of the UW 100 generators upstream of the fence panels allowed for the manipulation of water levels and therefore power generation by selective cleaning and impounding water. While this did maximize peak power generation, debris was an issue throughout the operational period.

Lake vegetation (*Potamogeton sp*.) drifting downstream from Nilkitkwa Lake proved to be a major challenge over the entire operational period. The UW 100 turbine easily passed leaves and other small debris. However, strands of lake vegetation routinely became wrapped around the propeller shaft. As the propeller rotated these strands would wind up tightly around the shaft slowing rotation and decreasing power production. Installation of a propeller guard did not improve the situation. Lake vegetation passed through the guard and again wound around the shaft. The guard then made it very difficult to remove the weeds. The turbines required cleaning on a regular basis, approximately every three days.

The 30 watt solar panel provided between 0.3 and 0.6 of an amp power production during daylight hours even under heavy cloud cover. Despite the lake weed problem, power production was sufficient throughout the operational period to maintain battery power levels.

One UW 100 turbine was moved to a location on the downstream side of trap 2 just prior to the end of the program to test power production. Power production was lower at 2.5 – 3 amps. However, the lack of weeds on the downstream side may compensate for lower peak power production.

VIDEO RECORDERS

The DVR 6 Extreme video recorder was found to be well suited to this type of application. Set up for motion detection was easy. Time of recording for this project was set to 24 hours. Results indicated that recording through the night was not required therefore the option of setting recording times would be useful for future projects. Data recovery was excellent. The removable hard drive with USB docking station made data review simple and convenient. Playback options for fast forward and review by frame made identification of targets simple. Capture of sections of recordings for playback in other programs was reasonable, however, some content was lost during conversion. Capture of JPEG images from recorded video was found to be poor and of no value. The DVR 6 Extreme required only 650 mA for operation. This was substantially less than other comparable systems considered for this project. The rugged waterproof case and built in monitor made for a complete, compact and robust recording system.

The DM1AV solid state DVR had some interesting features and some drawbacks. Its power requirement of only 350mA was attractive. The small total memory size of only 2 GB in an SD card made this system somewhat limited for remote use where significant numbers of fish could be recorded. The SD card system however was extremely easy to use, both for card replacement and downloading of images. Set up of the DM1AV was very simple with on screen menus. The need for a small portable screen added to the set up complexity and power requirements but was found to be acceptable. The set up for motion detection was found to be excellent. The DM1AV software allowed for detection of background motion. This meant that significant amounts of turbulence could be eliminated while the required setting for actual fish detection could be quickly determined. Motion detection triggering however, was found to have a slight lag of 1-2 seconds. This lag seriously compromised the DM1AV's ability to capture video of all fish moving through the viewing box. Fast moving fish were able to jump across the field of view in testing. Photo mode was found to be much more reliable and captured pictures of fish moving through the viewing box consistently. Unfortunately in photo mode the direction of travel was hard to determine and therefore the DM1AV was less well suited to this type of project.

CAMERAS

All of the cameras used on this project worked well. During daylight hours all had similar picture quality. Surprisingly the Sentry Model 5324 IR Weatherproof camera performed as well as the much more expensive Lorex CVS 1000 submersible and the Seaviewer Sea Drop 950 underwater camera. It should be noted that the cameras were only submerged 0.3 – 0.75 m. This may have contributed to the lack of differences between the cameras. Field of view was similar in each camera.

All of the cameras had difficulty in low light and dark conditions. The IR lights in each camera appeared to illuminate all of the turbulence caused by bubbles in the water. This in turn caused the DVR to record motion. The end result was almost continuous recording after dark. No solution was found for this problem during the project.

TRAP VIEWING BOXES

The trap viewing boxes were adequate for this project. The gloss white paint used was found to be too bright under some conditions. It may have also contributed to the problem of turbulence illumination after dark. A flat more neutral colour such as gray may have been a better choice. The overall size was appropriate however a longer length would have permitted a greater range of camera positions. A much wider box that incorporated the camera might be useful in future projects to help reduce turbulence around the camera.

FISH COUNTS

A variety of species were recorded moving upstream through the viewing boxes between October 3 and October 21, 2008 (Table 1). Totals of 438 coho, 97 sockeye, 21 Chinook, 27 rainbow, 3 steelhead, 1 bulltrout, 1 Dolly Varden and 51 unidentified fish were counted during the recording period of October 3 to October 22. Whitefish were observed daily moving both upstream and downstream. Due to the numbers noted and the difficulty in tracking upstream and downstream movement, whitefish were simply noted as present each day. Virtually all of the fish movement was in daylight hours between 0830 and1800 hours. Only 2 fish were recorded after dark, one rainbow trout and one whitefish.

Coho salmon were noted moving into the viewing box and dropping back downstream again throughout the recording period. Whitefish (*Prosopium williamsoni)* were found to move upstream and downstream throughout the recording period. Underwater observations around the Babine fence showed a large population of whitefish. Two chinook salmon kelts and one chinook salmon carcass were recorded moving downstream.

The project was stopped seven days earlier than planned due to the lack of fish and a forecast of heavy snowfall.

Examples of fish images captured during this project are shown in Appendix B. Appendix C shows examples of some of the types of turbulence and debris problems encountered during project. Appendix D shows one of the fish, a rainbow trout, recorded after dark.

MAINTENANCE ISSUES

One of the main objectives of this project was to be cost effective another was low maintenance. With low numbers of pink salmon returning in 2008 (23,996) it was hoped that fence cleaning would not be an issue. However, chinook salmon carcasses proved to be a major issue throughout the operational period. chinook carcasses had to raked or pitched off the fence panels

Table 1. Daily counts by species of fish recorded moving upstream through the Babine fence viewing boxes between October 3 and October 22, 2008.

Date	coho	sockeye	chinook	rainbow	steelhead	unidentified	bulltrout	Dolly Varden	whitefish
October 3	3	1	2						present
October 4	81	20		3		9			present
October 5	199	17	9	1	2	14			present
October 6	24	10	6	1		7			present
October 7	No recording due to electric connection problems								
October 8	28	7	3	1		6			present
October 9	5	1				3	1		present
October 10	19	2		1		4		1	present
October 11	9	7		2	1	3			present
October 12	23	5		1		2			present
October 13	18	12		7		2			present
October 14									present
October 15	7	6		2					present
October 16									present
October 17	19	9		5		1			present
October 18									present
October 19	3		1	3					present
October 20									present
October 21									present
October 22									present
Totals	**438**	**97**	**21**	**27**	**3**	**51**	**1**	**1**	

every 3 days. Debris like leaves and weeds were less of an issue. The rate of build up from weeds and leaves suggested that if the Chinook carcasses had not been present, the fence would have needed cleaning about every 6 or 7 days.

The UW 100 generators required maintenance about every 3 days to remove lake weeds from their propeller shafts. The other power generation components required no maintenance. The cameras required occasional cleaning. The DVR 6 Extreme recorder had enough memory to operate for 3 weeks without being downloaded.

DISCUSSION

POWER GENERATION

The results of this project showed that it is possible to generate enough energy with a combination of hydro turbines and solar energy to power a basic digital video recording system. It should be noted however that the total amount of power generated was modest, averaging only about 12 amps. While this was enough to maintain a battery bank supplying 12 volts to the recording equipment, it would not have been enough power to operate recording equipment requiring 110v AC. This modest power production limited the choice of recording and camera equipment.

VIDEO RECORDERS AND CAMERAS

The DVR 6 Extreme mobile DVR used as the main recording device for this project was a good choice for this type of project. Its low power requirements and ease of operation made it well suited to this environment. The problems encountered with the DVR and the recordings produced were almost entirely related to turbulence and debris in the water. Some minor changes could be made to reduce turbulence and capture debris before it entered the viewing box. This would reduce some of the unnecessary recordings made. Setting the recording time of day would eliminate a large amount of unnecessary recordings. The results showed that only 2 fish moved after dark over the recording period. This is similar to previous studies at the Babine fence where efforts to count fish through the night determined that fish migration stopped after dark (M. Jakubowski, DFO Prince Rupert, pers. comm.)

All of the cameras used for use project were found to be suitable. Of interest was the fact that the lowest cost weatherproof camera performed as well as the higher cost submersible and waterproof cameras. This is likely in part due to the shallow depths of submersion needed for this project. Maximum submersion depth did not exceed 0.75 meter. Short duration of submersion may also have been a factor.

FISH COUNTS

Although relatively few fish were counted over the recording period this reflects the nature of coho salmon migration at this site. This sporadic type of migration made conventional counting with a crew of at least 2 people very frustrating. Long periods of no migration are followed by short periods of hectic movement. Even with a significant amount of unnecessary recording, images from this project were easy to review. By using the DVR hard drive docking station and PC viewer software the recorded images could be quickly and accurately reviewed.

Species identification was good throughout the project. Only 8% were classified as unidentified. Careful camera positioning to provide recordings over a longer distance could reduce this number in future. Future projects could also position 2 cameras side by side to provide two opportunities to identify fish moving through the viewing box.

MAINTENANCE

The results indicated that while this project was low maintenance it was not maintenance free. The build up of chinook carcasses on the fence panels is unavoidable given the design of the counting fence. A counting fence with self cleaning or even manually rotated screens would be a good candidate for this type of recording system. Maintenance issues like fence panel cleaning may decrease over time as spawning chinook numbers decline. Therefore remote counting with cameras may be more viable in November and December at the Babine fence site.

Maintenance of the UW100 turbines would be greatly reduced by moving them downstream. This move could however create power production issues as water levels decline. It might be possible to locate the turbines on the upstream side at the fence mid point near counting bay 4 where fewer weeds seemed to accumulate. Back up power with one or two larger 120 watt solar panels would also be beneficial.

CONCLUSION

The results of this project showed a proof of concept. It was possible to generate enough power using a combination of micro-hydro and solar to power a simple 12 volt recording system and cameras. Although this was only the first year of operation the results were encouraging. Problems with turbulence and weeds triggering the motion detection and being recorded were frustrating during the set up period. In the end these difficulties were easily overcome during playback and review.

More time will be required to refine the operation of all of the equipment. Further some caution will be needed when using these techniques. Attempting this type of counting during years of high pink salmon escapement would be very difficult. Once refined this technique may be well suited to operation later in the season, particularly November and December.

Expansion of this type of recording and counting methods to other locations will be site dependent. Some locations may lend themselves to this method others will not. It would be of interest to design a location with this type of recording in mind. Features such as self cleaning fence panels would help to reduce required maintenance.

Appendix A. Aerial view of the Babine river counting fence. Traps 1-3 are on the right hand side. The building used to store the batteries and recording equipment is on the right hand abutment.

Appendix B. Examples of coho salmon images captured during the Babine River remote video enumeration project between October 14 and October 16, 2008.

Appendix C. Example of a sockeye salmon image captured during the Babine River remote video enumeration project on October 14, 2008.

Appendix D. Examples of whitefish images captured during the Babine River remote video enumeration project between October 14 and October 16, 2008.

Appendix E. Examples of rainbow trout images captured during the Babine River remote video enumeration project between October 14 and October 16, 2008.

Appendix F. Examples of debris and turbulence images captured during the Babine River remote video enumeration project between October 14 and October 16, 2008.

Appendix G. Example of a rainbow trout image captured during the Babine River remote video enumeration project on October 15, 2008 at 23:30 hours.