Development of Video Technology to Measure Catch-Per-Unit Effort

Using a Fish wheel on the Yukon River, Alaska

A Final Report to the Yukon River Panel

By

Stan Zuray[1]

Tevis Underwood[2]

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[1] P.O. Box 172, Tanana, Alaska 99777 (907) 366-7114

[2] U.S. Fish and Wildlife Service, Fairbanks Fishery Resource Office, 101 12th Ave., Room 222, Fairbanks, Alaska 99701 Telephone: (907) 456-0219

Authors

Stan Zuray has been a fisherman and trapper in the Tanana area for over 26 years. During the last four years he has had a contract with the U. S. Fish and Wildlife Service Fisheries Resource Office in Fairbanks to run fish wheels for their salmon tagging program at the "Rapids". P.O. Box 172, Tanana, Alaska 99777 (907) 366-7114

Tevis Underwood is a Fishery Biologist with the U.S. Fish and Wildlife Service and works at the Fairbanks Fishery Resource Office in Fairbanks Alaska. 101 12th Ave, Box 17, Fairbanks 99709, (907) 456-0219

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Table of Contents

List of Tables

List of Figures

Summary

The video system that was developed this summer at the Rapids was capable of producing fish counts as accurate as the live box method. The mean counts of fish obtained by hand netting fish (x=204.5) and those obtained by video (x=203.2) were not significantly different in a paired t-test (*P*=0.54, n=22). To set up the same equipment on the wheel again would probably take only a little more time than a live box set up. Considering the extra money being spent to reduce the holding time of fish (≅ $11,000), the costs of a video project on a fish wheel would be comparable or less. Video projects could be easily run by one person or one person could keep the wheel running and a second person attend to the tapes and computer side of the operation. In this second case the costs would need to be that of only one person per day. The day to day operation would take no more time and in the case of wheels counting say 200 or more a day, video capture would be much less effort and at point be an even a faster method. The stress of counting (netting and releasing) fish would also be eliminated. The system we developed was capable of working in the broad range of environmental circumstances present. It functioned day and night, without any manual changes of settings to camera, lights, or the computer program during the tapes playback. Results of the video counts were consistently within ± 5% of the control counts by the end of the project.

Introduction

Fish wheels are commonly used as a capture method for management and research activities in the Yukon River drainage. Specifically, management fish wheels provide catch-per-unit-effort (CPUE) data at various locations. These fish wheels use live boxes to store fish until the researchers or contractors process and release the fish. Crowding and holding times greater than two hours are common, but data suggests that delayed mortality (Underwood et al. 1999) and reduced traveling rates (Melegari , *In preparation*) may be associated with capture, holding, or crowding. Radio tagging studies on chum salmon, currently underway, should provide additional data on this subject. Also, the Fish and Wildlife Service is currently reviewing much of their data from the Rapids /Rampart Tagging Program to explore the possibility of fish being harmed through the use of live boxes (Underwood et al. In preparation; Melegari in preparation). Video technology, and elimination of live boxes, could avoid all of the handling and live box crowding by eliminating the use of live boxes. Video cameras could record images of fish for daily counting as they pass the chute where fish exit the fish wheel basket.

Video systems have been used in counting windows at dams in the Columbia River basin (Hatch et al. 1998). Systems developed by Hatch et al. (1998) have proved to be efficient and able to provide accurate counts. They have, however, been designed for use in developed areas where standard power is available and environmental variables are controlled. In transferring this technology to a fish wheel on the Yukon River it was necessary to deal with site specific and environmental conditions that did not occur in prior applications of this technology.

This report covers the major equipment used in the project, the field video taping procedures, and computer image capture procedures. We will describe the data and provide a brief statistical comparison of the data. We discuss aspects of the project that may help someone implement their own project and recommendations for further work. Finally, we include an appendix describing the day to day experimentation (trial and error) and final video tests that shed light on the practical aspects getting our project to work.

Study Area

The project was conducted on a fish wheel 40 miles upriver from the village of Tanana at an area locally known as "The Rapids", a narrow canyon 1,176 km from the mouth of the Yukon River. Traditionally and at the present time it is an area known for its abundance of a wide variety of fish species.

Methods

Field Procedures

A two-basket fish wheel equipped with a live holding box (Figure 1) was used to capture chum salmon and other species. The baskets were 16 ft. long and 10 ft. wide. Nylon seine netting was installed on the sides of the baskets to minimize injury to the fish as they were lifted clear of the water. Plastic mesh was placed on the bed or sliding portion of the baskets for the same reason. Holding boxes were eight feet long, four feet deep and two and one half feet wide and contained many two and one half inch holes to allow a continuous flow of water while preventing heavy current that could damage or weaken fish. The fish wheel was put in the water in mid-June and was assembled to running order within a week's time. During early July we mounted the water generator and associated electronics gear on the wheel. By mid-July we had received all of the electronics gear to be used on the fish wheel. This included direct current (DC) powered surveillance cameras, time-lapse video tape recorders (VCR), portable monitor, and four battery 12-volt storage units.

On July 19th we proceeded with the first experiments. At first, counts were not our primary concern. Instead we were more concerned with picture quality and getting the equipment working. When system reliability and picture quality were sufficient, we then focused on getting operations of the Rapids/Rampart tagging project, were used for

Figure 1.— Two-basket fish wheel, equipped with padded chute and live holding box, used to collect fish during the marking and recapture events. A. Aerial view. B. Side view with arrows indicating the direction of wheel movement in response to the current.

comparison with counts produced by video image capture. We collected counts for some of the nighttime testing, when the tagging project was not in operation. The idea was that all of the fish in the live box had to go past the camera's field of view and so the counts from the live box should equal the video counts if the video system is working correctly.

A new tape was started prior to initiating the wheel for the tagging project each day. The 12-volt power was turned on and a tape placed in the VCR. Camera lens and white chute background was cleaned and small video monitor was viewed to check for correct focus. Usually this took about ten minutes. The wheel was then started and the time was noted. The fish wheel was usually checked a couple of more times during the day to ensure proper operation. The video portion of the project would run unattended. During the experimentation phase, daily operations were much more complex because of the many problems (discussed below) that had to be worked out

Video Image Capture Procedure

When a 12 or 24 hour time lapse recording was complete, the tape was retrieved from the VCR on the fish wheel and processed at the Fish and Wildlife Service camp where generated power was available for the desktop computer and a second VCR. The tapes were played at normal speed (24 h of time lapse tape was equivalent to 4 h real time) into a computer via an image capture program. The S-VHS output was connected to the input on the video capture card in the computer. This program was capable of comparing a video image with a previously captured image and an algorithm "decided" if there had been a change. Images different than the standard were stored. Images that had fish on them were successfully stored along with some images without fish because sometimes the standard image had a fish then some images without fish were stored until a new standard was selected. It appears that the standard is selected often and possibly the standard was the previously captured frames. Images were stored by placing them in a file which could then be viewed for counting. During these two hours the computer and VCR ran unattended. A 24-hour recording in time-lapse would contain about 432,000 frames, of which the capture program would store 500 to 4,000 frames depending on the number of fish caught that day and irregularities that triggered storage.

Extensive experimentation with the computer settings was needed to obtain reasonable images to count. We used Adobe Premiere version 5.0 to view individual images and for counting. Premiere worked on smaller files, but was slow to advance the frames forward and impossibly slow in reverse. A second program, a "Windows Explorer" file utility, was found to work better. The program comes with the NT operating system and can be found under, "File", "Properties", "Preview" in Windows Explore. With this program a person could easily count stored images from one day in approximately 10 to 40 minutes. During experimentation counts were also obtained by viewing the fish as they were caught in the fish wheel baskets and counting fish directly off the original VCR tape. All final test counts (designated by a T then a sequential number) were obtained from the live box.

Equipment

1. Power:

   A. "Aquair Underwater" propeller driven water generator. Originally, we hoped that this generator would be our primary source of power. Unfortunately, we overestimated the current speed at the fish wheel and the generator had very little output at the water velocity present. We could only produce 1-2 amps and at times less than 1 amp. While we were able to run our daytime video tapes, recharge, and keep a full charge on the batteries, we recommend its use only after carefully assessing the situation at each site in light of the cost ($2,000.00) and work of setting up. We are looking into other water driven generators.

B. Honda 1000 watt generator ($800). With our color video camera running at higher shutter speeds, production of quality images at night required the light of two 90 watts bulbs. This plus other equipment (camera, VCR, and inverter) meant our power requirements were about 300 watts which our generator easily handled on a lower RPM setting, a feature of this model. The low RPM setting also boosted gas economy to 10 hours per tank. An extended gas supply could easily be run into the generator if more hours were preferable. The 28 pound generator ran in a vented enclosure right on the wheel raft. An ground fault circuit breaker was used for safety purposes.

C. Lights and weatherproof fixtures ($50): Two 90-watt halogen 27^{0} beam GE floodlights. One bulb was run on an AC/DC inverter from the batteries in case the gas generator ever shut down. During a generator failure one light could produce a dark yet fully countable video. The other light ran directly off of the generator. Each light had an adjustable light sensor wired in and was quite workable with each light coming on independent of the other as darkness progressed.

D. Inverter for light ($20): An inexpensive 150-watt modified sine wave inverter worked well and drew minimum power.

E. Battery charger ($60): Ours was a 10 amp, taper charge, automobile battery charger. This was adequate but it often ran constant at 8 amps when lights were on. Possibly a 15-amp charger would be a better choice, as it would not run so close to the upper limit.

F. Batteries ($400): Four 6-volt, deep cycle batteries supplied the stored 12-volt power. While fewer batteries could be used a nighttime generator shut down could necessitate the use of this much reserve power to keep the video running. Also this kind of reserve allowed us to not have to run the generator in the day as except for night lights, very little power was needed then. The batteries all sat neatly in an inexpensive waterproof plastic tote in the bottom of the equipment enclosure.

2. Fish wheel modifications

   A. The chute: On fish wheels equipped with live boxes a "chute" is used to pass the fish from the baskets over the raft logs to the live box (Figure1). Wheel sites do exist that do not require vertical adjustments to the axle; however, ours does in times of lower water. The chute, therefore, had adjustable up and down to match up to the changing level of the baskets. This adjustment decreases fish injuries caused by fish dropping rather than sliding into the chute. Consequently, the camera, enclosed sides of the chute, and the chute must be one unit to eliminate the need to refocus the camera during bad weather and when the wheel axle/baskets needed to be raised. An enclosure with a fish entrance and exit was built on the chute to control light and shadows. The enclosure was the source of some of our greatest trials and tribulations. The sides needed to be high enough to block out direct sun shadows from the moving wheel baskets. It was open on top to allow the floodlights to shine in at night. The exit was a piece of dense black close cell foam one inch thick. It acted, as it's own hinge and gently released the fish uninjured, and then sealed back up after the exit of the fish. The entrance was trickier as it opened inward and if windy could blow into the cameras view triggering unnecessary frames to be captured by the computer program. This was taken care of by installing spring-loaded wooden rods against the fabric used to seal the entrance. The exit and entrance blocked the sun shadows, as did the enclosed sides. Currently we are exploring the development of a computer capture program capable of being triggered by some type of motion sensor. This would be the elimination of the need to shield the camera from sun shadows and the building of all the related enclosures. The bottom (viewing area) of the chute was lined with white ultra-high-molecular-weight (UHMW) plastic 3/16''' thick. It was easily cleaned and stayed white which was the preferred color background.

3. Cameras

A. Waterproof miniature camera ($199), unknown manufacture, with built in light source composed of infrared LED diodes. This black and white camera was auto-iris with 360 lines horizontal resolution. The lens was fixed focus. This was the first camera we tried.

B. Remington brand- Waterproof, auto-iris, limited manual focus, black and white surveillance “bullet” camera ($200). Poor quality picture 420 lines horizontal and not good for identifying fish specie due to the number of lines horizontal and auto-iris feature. This is the second camera we tried.

C. Panasonic color 1/3” format closed circuit television (CCTV) camera (model WV-CP454) with 480 lines horizontal ($600). This camera has many user selectable features including shutter speed which was critical for providing quality images. -The camera has direct current power input and standard BNC video connectors for video output. Numerous lenses are available. The lens we selected is described below. This is the camera that worked for us.

D. Lens by Computar vari-focus model TG272814FCS-2, 2.8-6mm, F1.4 TV lens ($100), this lens was used on the Panasonic camera. A nice piece of equipment and gave us the pictures that made the system work. The color, zoom, and focus capabilities of this camera were essential features. The camera mounts and waterproof case were under $100. Waterproof camera case was necessary and we kept a good amount of silica desiccant in it at all times to absorb water. Originally the waterproof case was homemade and later a store bought one was used. Both worked well.

4. Electronics:

A. Color LCD monitor ($200) 3X5 inch powered via the 12 volt system provided a picture of the camera's view for focusing, zooming, positioning and camera parameter settings. All of these of course needed to be done on the wheel. It was supplied with 6 ft long wires and could be put right next to the camera during these adjustments for easy viewing. A quick look at this monitor at the start of each tape confirmed all system working.

B. Video tape recorders (VCR): Video cameras were connected to a direct current video recorder (Panasonic AG-1070dc $800) with 12 and 24-hour time-lapse capability. The video recorder was placed in a waterproof Pelican® case and wires ran to the outside via waterproof connectors. The video recorder stored images on the videotape at a rate of approximately 5 frames per second on the 24 hour setting and it had a date and time stamp feature that was used at all times. A second video recorder was used to play images into the video capture card/computer, a Panasonic AG-5710 editing VCR with shuttle/jog features ($1300). The slow motion and single frame viewing was need during testing. Because the video was recorded at approximately 5 frames a second f/sec, normal playback to the computer at 30 f/sec reduced playback to the computer to 4 hours for a 24 h tape.

C. Computer ($3,500): A Gateway brand computer with a 550 mhz Pentium III processor, 256 mb of ram memory, and the Windows NT operating system (Service Pack 4) were used to run the video capture software. The computer was equipped with a Intel Smart Video Recorder III PCI board for video capture as well an Adaptec 2940UW ultra-wide SCSI PCI card, and a 8.4mb SCSI hard drive for storage and retrieval of video images. Stored image files were backed up using a 2gb Jaz drive by Iomega.

5. Software: Image-capture software comes with most video capture PCI computer boards. Custom software for processing captured images was provided by the Columbia River Intertribal Fish Commission biologists Doug Hatch and Jeff Fryer. Previous versions of the software were described by Hatch et al. (1998). Current versions do not require storage of processed images on videotape, rather, images are stored on computer disk in standard video

formats, so called AVI files. The name AVI comes from the three-character extension which is placed and the end of the filename.

Statistical Analysis

A paired t-test of means was used to compare live box counts with counts from video image capture. The data was also fit to a line using least square regression to obtain a correlation coefficient and residual values. The residual values were plotted and examined for anomalies.

Results and Discussion

A paired test of means (data Table 1) indicated that mean values were not significantly different (P = 0.54). The mean count for manually dipping fish was 204.5 (S.E. 18.6) while mean counts from the new procedure was 203.2 (S.E. 17.5). Correlation of paired observations (n=22) between live box counts obtained by manually dipping fish using a net and counts obtained via video image capture was greater than 0.99 (Figure 2). Plots of standardized residual from the regression based on the counts showed they fell on both sides of zero (Figure 3). No unexpected patterns in standardized residuals were apparent. We conclude that CPUE collected via computer video image capture produces counts similar to those collected by manually dipping fish from a live box with a hand net.

Considerable effort was expended on getting quality video images and getting images that worked efficiently in the image capture program. Video quality was improved with a white background, a high quality color camera, and a faster shutter speed that is associated with more light. Prior to switching to a white background fish appeared washed out making identification next to impossible. Lower quality cameras with fewer pixels caused blurring of the image even though light requirements of the cameras were less than the Panasonic camera . Cameras that do

Table 1.— Data used for a comparison of manually obtained live box counts and counts obtained through the video image capture process. Mean values were not significantly different from one another (n=22).

Test label	Live box count	Count from Video
T1	346	321
T3	206	187
T4	270	268
T5	351	344
T6	270	268
T7	299	298
T8	268	268
T9	298	292
T10	267	258
T11	195	182
T12	184	177
T13	224	232
T14	202	199
T15	162	169
T16	162	172
T17	206	201
T18	120	127
T19	139	154
T20	157	168
T21	83	90
T22	31	36
T23	60	60

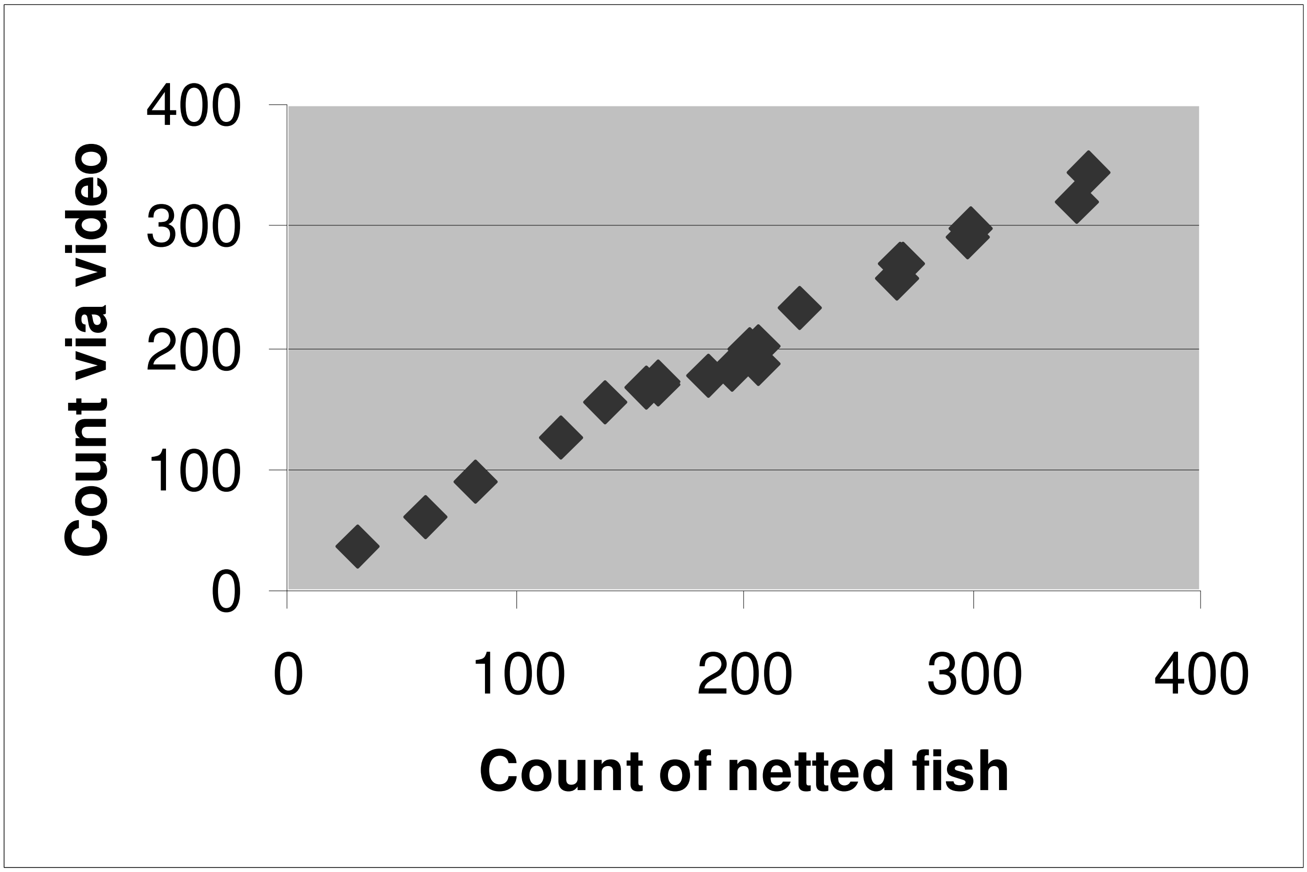

Figure 2.— Plot of counts, netted versus video, collected during sample trials (n=22) on a fish wheel in the Yukon River. The correlation coefficient produced by least square regression of video count as a predictor of counts from netting was 0.99.

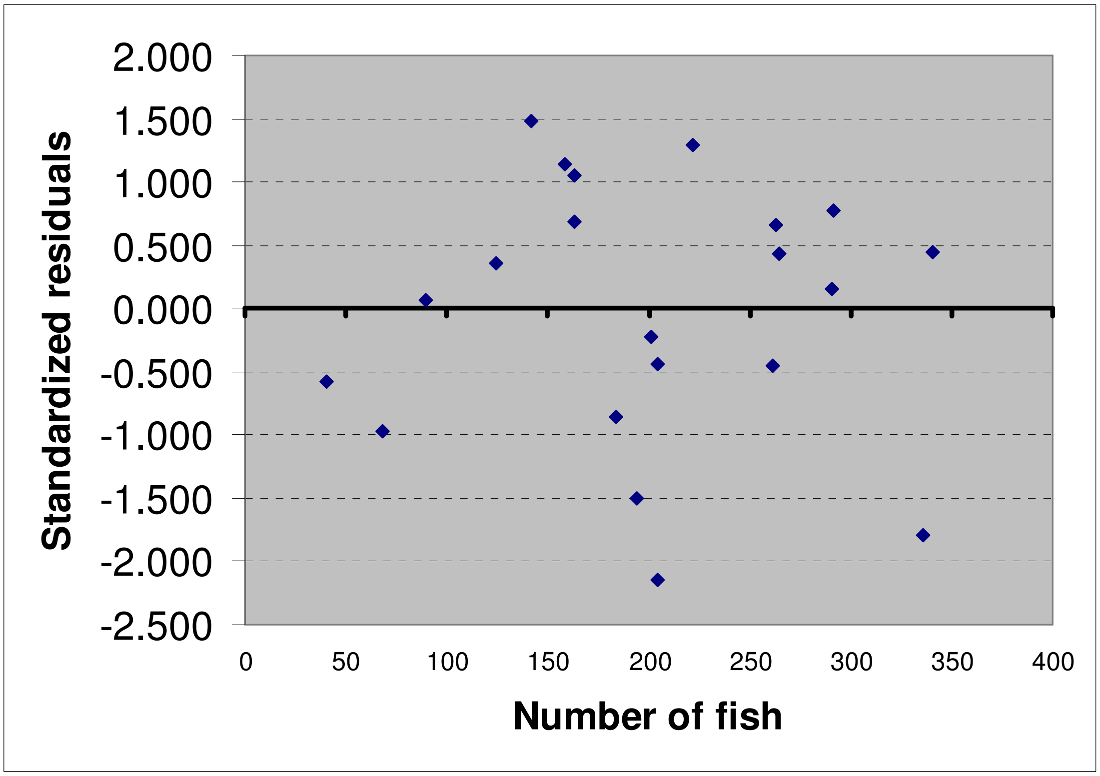

Figure 3.— Plots of standardized residuals of the regression of video count (X) as a predictor of manually obtained counts (Y). Residuals are spread on both sides of zero and no unexpected patterns were apparent.

not have adjustable shutter speeds or are automatic did not produce clear images. We found that for our application two 90 watt flood light mounted approximately 8 ft above the surface produce good amounts of light for clear images while a single 90 flood light was adequate but less than desirable.

Getting images that worked well in the image capture program required considerable control of natural light (no shifting shadows or varying sunlit areas) and movement on surfaces present in the video image to be used. Moving shadows caused excessive numbers of frames to be saved by the computer program and was one of the biggest problems encountered. The daily circumpolar rotation of the sun along with the moving parts of the fish wheel caused moving shadows to be cast from many directions. Construction of an enclosure worked, eventually, but design and construction material was found to be important because a very small beam of light shining through a hole or moving surfaces such a blowing tarps would cause the computer program to store extra frames. The entrance and exit to the chute were especially prone to light changes and wind movements that were troublesome.

Video image capture via computer allows an array of options and thus, requires an array of decisions by the user. Options come with the software of the PCI capture card as well as the computer program that makes the “store or not decision”. It is beyond the scope of this report to make the complexity understandable and much can be accomplished with little knowledge of the details as demonstrated here. However, documentation is scarce so below are a few settings used successfully. We used North American standards (NTSC) of video transfer. Our computer files were stored in standard “AVI” file format. Various vendors have different compression/decompression algorithms, known as (CODECs). Each required a specific computer file or driver. If the specific driver is not available for the AVI CODEC on the computer, the file cannot be viewed. We used the CODEC for or called “Intel Indeo video recorder 4.3”. Several other CODECs came with the video capture card and possibly any would do, but if you are transferring AVI files to another computer, the new computer may or may not be capable of running the file properly. We also found that within the capture program the quick compress mode had to be toggled to the "on" position.

The quality of the final video is greatly dependent on the level of compression which the user selects. Less compression allows higher quality images, but requires more storage capacity. In the past electronic storage has been limiting, but the price of harddisk drives and other storage devices has been reduced so that limited storage is less of a problem. We found that selecting an 80 to 85% compression level (compressed 20%) allowed for high quality images that did not overwhelm our processor nor our storage capacity. Another image quality question was the setting of picture hue, saturation, brightness, and contrast. We found that for color pictures a slightly exaggerated hue and saturation increased the effectiveness of the video capture program.

We found some incompatibilities between VCRs. Although our VCRs were of the same manufacturer, during testing we often examined a particular video frame on a monitor connected to the VCR, but were not able to view the same image on the computer screen. Evidently the VCR would send one frame to the monitor and a second to the computer at the same time. In fact, some frames that were present on the tape could not be viewed on the computer screen. However, when we connected the time-lapse VCR to the capture card for playback to the computer all images were captured and could be viewed. We interpreted this, after conversations with the technical support group of Panasonic Inc., as a problem caused by the difference in distance between the video heads, the location where the videotape is read. To avoid this problem one could make sure that the original taping and playback are on the same model of VCR.

Mention should be made about the accuracy of the figures used in the testing of this system. We are aware that fish can and do jump out of the live box on occasion. This is something that probably occurs more often at longer holding times. Also the tagging crew is recording an enormous amount of data daily and mistakes counting errors could have been made.

Recommendations

After running 28 experimental tapes, 23 major test tapes and developing a system capable of providing CPUE in an efficient and cost effective manner, we have developed recommendation on equipment, and supplies. Deficiencies have also been identified, for example, the computer program used for image capture and decision making needs improvements that would make it more compatible with Alaska environmental parameters and more adaptable. Below are a few ideas relevant to placing this system on other wheels.

Currently we are using a borrowed computer capture program for which we have no source code. This means we can't change it and can not explore the way it works. This program was not designed for use in an area where environmental variables are present. Even if we had the source code and the ability to modify its inner workings it is possible it could be as much effort as writing one from scratch. We recommend that an improved program be written and made available for use in Alaska including the source code. This is the most important recommendation I have. A new program could incorporate many improvements, for example, a analog tripwire mechanism that could eliminate the need for the fish chute enclosure and its related sunlight/shadow problems. Other features we have identified could improve the programs ease of use, improve documentation, increase efficiency, and the source could be maintained in the public domain. Alternative triggering mechanism might be used for the capture program as mentioned above. Motion detectors and light or laser beams have been discussed and should to be investigated.

An improved screening program would speed up this aspect of the project. The viewing programs used, Microsoft Explorer and Adobe Premiere 5.1, have memory buffers forward, but not back. The result is that viewing images in the forward direction is smooth but if you need to go back the program is bogged down.

This summer all our video information went directly into a VCR and then was run into the computer program using a second VCR. Because of the limitations of video tapes and differences between VCRs we found ourselves restricted in ways that would not exist if we were able to store the information on a laptop computer right at the wheel. In addition the four hour playback to the computer would be eliminated and one would have more control of the frame rate. One of the video capture files (number 27) is a simulation of what would be possible using this method. In this file you can easily identify all species and can even consistently pick out the spaghetti tags on the marked fish.

To apply this system to other fish wheels the only changes needed would be the size and fit of the equipment enclosure and the camera/ fish chute set up. This would be simple construction technique to anyone capable of building a fish wheel. A fish wheel would need to be of a single chute design (which many are) in order to fit this application. All the fish must be able to leave the baskets on one or the other side of the axle uprights if only one camera is to be used. This can be controlled by many factors such as basket chute angle and slipperiness, basket mounting on the axle and distance of basket chute from the axle.

The presence of expensive equipment at remote sites that are presently unmanned may not be practical. Each situation would be different. In our situation the site had a camp within sight of the wheel. Other sites such as the Rampart tag recovery wheels are in sight of the village and could probably be run successfully. Of importance also is the design of the fish wheel in doing its part in not harming the fish being video captured. It is counter productive to have a video system installed on a wheel and have the fish damaged by wire and pole sided baskets or have fish dropping onto a chute because its not adjustable. There are, without question, many ways to change a wheel and run a wheel that greatly reduce injury to fish.

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Appendix

This appendix has been written in a test by test, day by day format. It includes the shorter tests, which were used to arrive at a usable system and the longer final tests (identified by a capital letter after a number) used to evaluate that system.

Test #1 was made on July 19$^{TH.}$. We used a black and white surveillance camera and ran the VCR on 24-hr time lapse. The camera, having limited focus, was mounted fairly close (30 inches) to the fish chute and was prone to splashing from the fish blurring the image

July 20TH, Tape #2. It was partly sunny and the sun coming through the turning fish wheel caused moving shadows on the chute. The computer capture program mistook the shadows for fish and captured thousands image where there were no fish. Rain that day convinced us a shelter for the VCR was needed. The waterproof box did not keep the tapes, video monitor and VCR dry while when opening was required in the rain. Picture quality was poor and it was also hard to tell a whitefish from a salmon. Work continued reading images into the computer using various levels of data compression, contrast, brightness, and threshold sensitivity.

July 21st we ran tape #3 from 11:03am- 3:03pm. We put a white nylon blanket on the chute in an attempt to control the shadows. Some of our fish counts on the capture program were not bad (approx. 80%) but we can't tell species properly at all. We ran the video through the program at different brightness, contrast, saturation, and hue settings. We experimented with various controls on the VCR. Picture quality was poor, but we found a sharpness setting on the VCR that worked better when maximized. We also experimented with a black tarp on the chute and found the white background preferable.

July 22nd - To understand our picture quality problems better, we ran Tape # using a Sharp's $600 video camera to take pictures of the fish at the same time. At camp we compared both by running them into the computer and decided that we need a color camera. The pictures of fish were still not real clear on the video camera but the color aided in fish identification.

July 24TH-- For Tape #6 we set the VCR to 12 hour time lapse to increase the number of frames each fish for identification. A white fleece cloth was used to line the chute to get rid of glare from the sun on the white nylon since the glare triggered the capture program like the sun shadows do. The watercan that keeps the fish wheel chute wet was modified to put out a spray rather than a stream that caused unwanted images to be saved. We tried a second type of camera used to see if we could improve video quality, an infrared-enhanced, black and white camera. We change camera position to maximize the viewing area so we get more images per fish. Less washout is seen with a white background. More experiments with contrast and brightness, and compression, frame by frame comparisons using “Premiere” software.

July 25TH-With Tape #7 we switched back to the first camera (Remmington) as we think it makes tapes clearer (has more resolution according to specs.) We put the white nylon back on because the fleece lining in the chute was now dark from the build up of silt from the river.

July 26TH -For Tape #8 a tarp and wood frame enclosure is built around the chute to block moving wheel shadows. This is difficult because of the fish wheel axle and lifting methods conflicting with construction. It is cloudy so we can’t test it. We collect images in the 12-hour mode to see if more fish frames get captured for better identification of species. Each fish is often hard to identify. The final counts are variable. We can’t pin down the cause at this point.

July 28TH, Tape #9 The controller that regulates the DC current produced by the water generator caught on fire, and had to be replaced. We got no usable information.

July 29TH (Tape #10) and July 30TH (Tape #11.) These tapes bring some encouragement because we are missing just one in ten fish with the capture program. The control of shadows and sunlit spots has improved our ability to capture the images we need. The picture quality is still poor however. We moved the camera around and adjusted the focus. We make more iterations of adjustment to computer and software settings and rerunning tape sections.

July 30TH Tape #12. Our first night tape although it doesn't get fully dark. Camera does surprisingly well in low light but still poor quality. Move camera again to get more chute length and so more fish frames and better identification. Looks better than before .

August 2ND- With Tape #13 we put the infrared enhanced camera back on and try a night run. We put a small 6-watt light 7 feet above the enclosure. We get poor counts on the capture program. It is clear that the infrared diodes that come attached to the camera will not produce adequate light for our purposes and that a supplemental light source will be needed.

August 3RD brings Tape #14. We went to the Remington camera again and put light (6 watt) inside enclosure. Counts are still poor; we are missing a fourth of the fish going past the camera. The quality and identification is also still poor.

August 4TH -. For Tape #15 we reworked the enclosure putting on entrance flaps to allow fish in and keep sun shadows out. Also better sides for camera access and sun blockage as sun glare and dark areas are hard for camera and image capture program to deal with at the same time.

August 5TH - For Tape #16, we used a new $600 Panasonic color auto-iris, zoom and focus super camera. We made a waterproof box with a glass window to put it in. We then mounted it, adjusted it, and ran the camera. The picture was nicer and the color really helped in identifying the fish, but we can now see the need to keep the sunrays out of the enclosure even more. The whitefish and silver chum salmon glare much more so we need a lighter chute material since the white nylon is no longer white. We can also see the need to do something about the affects of sunlight when a fish crashes through the flaps and lets in a flash of sunlight at the same time the fish is getting it's picture taken.

August 5TH- Tape #17 is the first color test run, and it is done with the VCR set on 12 hour time-lapse to get more frames per fish. This ran through the night. When it started to get darker outside, it also got darker on film and it became apparent that the color camera needs more light than the black and white one did. The computer also started to capture all of the frames, even when there weren't any fish because of this lighting

August 7TH - The second color test was done on Tape #18. We put on a piece of white UHMW plastic for the chute lining. It worked great. Shiny fish can be seen now. We adjusted the image capture program parameters and camera settings of brightness, contrast, hue and saturation, and finally got a picture that runs all night. We still need more light though. It is still basically poor quality, just now in color. We are not capturing fish any better (about a quarter missed,) and there is still light flashing in the chute.

August 11TH, Tape #19. We go out around midnight to experiment with the darkness and also focus tests on fish at different distances from the camera. The daytime portion of the tape the next day was not any good as the sun flashes and wheel shadows were so strong (very sunny day,) that it made the tape no good for running through the capture program.

August 11TH, Tape #20. we decided on a new path of action. We take the enclosure off as a way of getting rid of the sun flashes that are caused by the fish entering the dim interior light of the enclosure. The camera cannot seem to adjust fast enough to handle a flash of sunlight in a controlled environment. We then used two 12 volt sealed beams (automobile headlights) aimed at the chute from 9 ft. to try to clear the chute of sun shadows. It's only partly sunny all of the day and it looks okay, but we worry about full sun. We then ran through the entire spectrum of shutter speeds: 1/100, 1/250, 1/500, 1/1000, 1/2000, 1/4000, and 1/10,000 and matched some to the parameter settings in the camera.. The picture is not color blurred and is sharper at higher shutter speeds. We need more light and the computer program parameters are more critical at these speeds. It is apparent that a careful compromise among lights and computer settings is necessary to account for differences between sunny days and dark nights.

August 13TH -Tape #21. We experimented with lights on and off while moving dead fish around and settled on 1/2000 shutter speed. We used the camera monitor for most of the tests, but I did run a small tape and it is looking better.

August 13TH - First big test- Tape #1T. The VCR was set on 24-hour time lapse, the camera on 1/2000 shutter speed, 2 sealed beam lights 9' above the chute. Upon running the finished tape through the capture program we proceeded to miss many fish. Tried adjustments to the computer program and checked the grid line positions, and parameters hoping to get to the bottom of the problem. It is clear that the computer program is not operating as we thought it was supposed to. As fish pass these grid lines on the video screen, they are supposed to trigger an image "capture" by the program. These lines are movable yet moving them doesn't change the outcome. The VCR skips frames when passing them along to the computer and so we miss fish for the final counts. Matching VCR for recording and playback would solve the problem. Alternatively we could output camera data directly to a computer at the wheel and eliminate the playback from the VCR.

August 14TH Tape #22 was run to explore the missing VCR frame problem. The VCR was set on 6-hour time lapse to produce lots of frames per fish. It captured 95% of the chum salmon and produced a beautiful video. So clear and so many frames per fish you could tell the color of any tag on the fish. With a good viewing program and a laptop you could run plenty fast through hundreds of fish in 15-20 minutes and identify all of them. This was very encouraging.

August 15TH More tests were run with Tape #23, using lights to get rid of shadows from sun. Overcast hampered this effort.

August 15TH Tape #2T. We ran 24 hours of tape at the 12 hour setting on the VCR. We manually turned the light on as it began to get dark. It was sunny so it was a good test day for shadow/light setup. The tape started well, but when sun got to a certain angle the shadows caused huge numbers of frames to be saved. We couldn't even finish the program. The tape was basically a failure, but clearly pointed out a problem.

August 17TH Tape #3T is our response to the past two failed main tests. The VCR was set to 12 hour time lapse, shutter speed was 1/2000 and parameter changes to the capture program such as brightness, contrast, saturation and hue. The biggest change physically is a whole new chute enclosure was built after we saw that flood lights can't overwhelm shadows of natural sunlight within practical limits of the number of floodlights and needed power. The enclosure is open on top to let in skylight. We also made a more elaborate entrance door. Results were really good. It was a little dark at night, but 187 of 206 chum salmon were identified. Screening took about one hour for 1050 frames.

August 19th, Tape #4T and #4T2. It was a sunny day and the program started missing fish on the video tape. Only now shadowing was not a factor with the new doors on the entrance and exit.. We experimented the parameter setting on the capture program running the brightness and contrast slightly darker. This exaggerated fish colors a little. On one tag segement (#4T) the adjustments reduced misses by half. Further adjustments successively darker contrast improved image capture to nearly 100%. We chose basic parameter settings and ran #4T2 full length and got 268 of 270 chum salmon on the video properly classified. We also found a AVI file viewing utility that is part of Windows NT Explorer that is immensely faster than the Adobe Premiere 5.1 program we were using. Counting was cut from one hour for 1000 frames to 10 minutes for 1000 frames.

August 20TH -Tape #24 was made on a dark night (12:00am to 2:00am) to test the new lights (50 watt incandescent and a 90 watt flood light), heights to mount them and spread of beam, etc. I tried to get a level of light that can use the same video capture parameter settings as daytime light does. This is actually fairly easy to set up. Floodlights work the best and are set at a rather high level (7 feet off of the chute.)

August 21ST - Tape #5T is run at the new settings that are good during the night and day. The VCR is set at 24 hour and .2 threshold (which in the past picked up shadows and light flashes too easily.) We did three video counts of #5T and got 353, 349 and 350 chum salmon. The live box total was 351.

August 23^{RD} - Tape #25 was a night test using some 12 volt 50 watt incandescent lights. It was nice diffused light but it had to be close to the chute to give good video brightness. We can see the use of a higher wattage to get the lights away from moving fish and splashing water.

August 23^{RD} - The taping of #6T was done on a sunny day and we got an excellent count (268 of 270 chum salmon.). We found that adjusting the hue parameters before running the video capture program can get good results for tag color identification on recaptured fish.

August 24^{TH} - For Tape #7T we played with the camera picture, moving 2 inches away from the entrance door to help concentrate frames in the center more. The video quality was good and we got 298 of 299 chum salmon.

August 24^{TH} - Tape #26 was a one-hour test zooming the camera in on the center of the chute to eliminate frames by the entrance and exit flappers, and give more to the center. It ended up not being as good for identifying the fish. Maximizing the viewing time allows more images for identification. Also, having a small light on shows us fish more vividly colored in times when light is not fully needed as in evening or on a cloudy day.

August 25^{TH} -Tape #8T was done on a cloudy/sunny day. We got a perfect count today, but got a few extra frames from sun through a problem corner in my flapper set up (easy to fix.).

August 26^{TH} -Tape #9T was done on a windy day with white caps in the middle of the river at Rapids, which is unusual. we got a good count today, 292 of 298 chum salmon, but ran into yet another environmentally caused problem. The wind was lifting up the entrance flappers and letting in sun and fish wheel shadows thus causing extra frames to be captured. Although counting time was still acceptable.

August 27TH -Tape #10T was also on a windy day and ended up with some extra frames as in #9T. There are good counts and a good picture. We also put a black tarp on the main sun side (down river) today to eliminate green hue in the picture from the green transparent tarp on there before (black tarp works better.)

August 28TH -Tape #11T It is still a windy and sunny day. We used wooden rods attached to slotted HWMP (to form a spring loaded hinge) to make an improved spring-loaded entrance door and the wind problem was eliminated.

August 30TH - Tape #12T; 177 of 184 chum salmon and a fine picture.

August 30TH -Tape #27 is from 8:50pm to 2:58am. This is a night run with new 90-watt halogen 27 degree beam floodlights just flown in. We have both lights wired into light sensors and set to go on different levels of darkness. One is wired to 12-volt batteries and an inverter and the other goes to a 120-volt generator. We set the time lapse to 6 hour to simulated frames possible if we go to a laptop set up instead of a VCR as we have now. The lights worked great and matched the same parameter settings as prior daytime tapes we have been making. The inverter used on one light saved that tape segment when the generator stopped accidentally (12 volt battery backup is very handy.) The tape was perfect, as was the count and we got so many frames per fish on the 6-hour laptop simulation set up that fish identification and tag color identification was excellent.

August 31ST -Tape #13T was started in darkness. The auto lights were on, and it was raining. The lights went off at their different times and all worked good.

September 1ST -Tape #14T; good video, good count (199 of 202 chum salmon.). At this point we feel that good video and counts are consistently possible.

September 2ND - Tape #28 tested the shutter speeds and many other parameter changes on the camera settings to see if any changes could be better suited to match our current lighting and physical chute set up. We did fish motion/blurring tests by using a dead fish on a string. It may be possible to go to 1000-shutter speed some day especially with a more solid chute and camera mounting. Fish now not only move themselves, but cause noticable vibrations in the camera when the fish landed on the chute.

September 3RD - Tape #15T was another good run (169 on video versus 162 chum salmon counted.) We made a small change in the “Special Menu” portion of the video camera and changed the auto-brightness control setting (ATW to AWG.) Anyway these changes were barely detectable, but we wanted to explore the cameras features fully before we finish up the project.

September 4TH - Tape #16T was cloudy and windy. Lights operated automatically as the daylight arrived. The wind caused no problems. Counts are good.

September 6TH - Tape #17T was a 24-hour run. We started the tape with the lights on which then went off automatically and came on again at dark. All the settings were left the same, day or night. This video was turned on and then turned off 24 hours later and that was all that was done. It took 32 minutes to count fish from 24 hours of tape (356 fish) after the video capture program compressed the tape, but this included interruptions from people.

September 13TH –Tape#18T was made after a week of no tapes. We had run out of blank tapes. Good tape good counts.

September 14TH –Tape 19T was made on a sunny/cloudy and very windy day. Wind caused minor sun shadows to get in chute area but not a problem. The synthetic fleece material on the entrance flapper is getting stretched out. The last time we cut it, we did so too much so now a little light sometimes gets in.

September 15TH –Tape 20T was a 36hr video with a quick tape change after the first one got nearly full. The longest we can record on one tape is a little more than 24 hours. A few extra frames were present from checking focus and raising the chute up. As the chum salmon numbers drop off and the amount of whitefish to chum salmon becomes more equal, it becomes increasingly accurately access the species viewed. To mistake 10% of the broad whitefish for chum salmon when the catch was 300 chum salmon and 10 broads is not that bad. To do the same on a day when the catch was 50 chum salmon and 50 broads is a different story.

September 19TH –Tape 23T was our last. It was a 22 1/2hr tape and of the 60 chum salmon the crew counted during this period the video capture program captured all of them.