Stored Video Images as an Alternative to Fishwheel Live Boxes for the Collection of Chinook Catch Per Unit Effort Data – 2000

Using a Fishweel on the Yukon River, Alaska

A Final Report to the Yukon River Panel

By Stan Zuray

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Summary

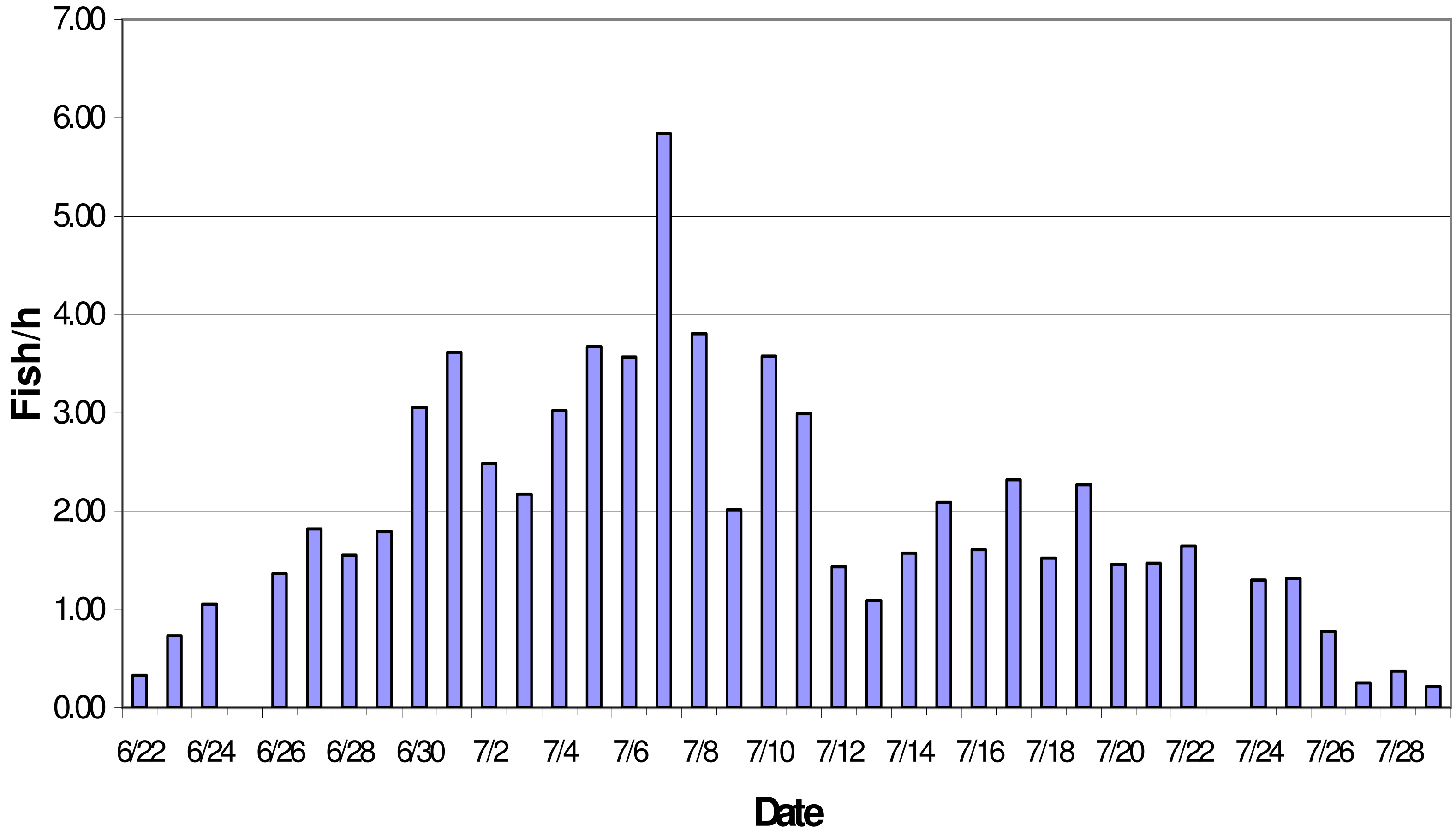
The video system that was developed in the fall of 1999 at the Rapids was used for the chinook 2000 project. It proved capable of producing fish counts as accurate or better than the live box method. Setting up the same video equipment used in 1999 on the fishwheel again took only a little more time than a traditional live box set up. Considering the extra money being spent currently to reduce the holding time on fish waiting to be counted in live boxes, by hiring more workers, the costs of this video project are very comparable to present livebox projects. Also preliminary data points towards those reduced holding times being still to stressful. One person was reasonably able to run the video project. The running of the day to day operation took no more time, and in many ways, video capture was much faster and less effort. The stress on released fish of counting (livebox holding, netting and releasing) was eliminated. While some equipment changes will happen in the near future, the system used in summer of 2000 was capable of working in the broad range of environmental circumstances present. It functioned day to day without any manual changes of settings to camera, lights or the computer program during the tape playback

Catch-Per-Unit-Effort (CPUE) data on chinook, summer chum, sheefish plus broad, humpback, and cisco whitefish was supplied daily, by satellite phone, to the Department of Fish and Game. Worksheets were supplied in season occasionally by satellite phone e-mail and hand delivery. The project ran from the start of the run (4 chinook on 6/22/00), till the end (3 chinook on 7/29/00) for 12-hour daytime periods. At the peak of the run, counted chinook numbered in a range of 2 to 6 per hour. No down days or days when data was compromised were experienced. This was particularly a bad year because of the large amount of high water and driftwood present for a large portion of the project. The large amount of subsistence activity in the immediate area helped make for a safer situation for the fishwheel as everyone was on the lookout for logs headed for nets and wheels.

Table 1. Chinook 2000 Video Summary

Start day	Tape	Date	Start Time	End Time	King Livebox	King Video	Total Time Ran Hour:min	Time in Hours : Percent/hour	CPUE Kings/hr	Comments	Chum Video	Chum CPUE	Shee fish	Broad whitefish	Humpback whitefish
Thursday	1	6/22	9:57	22:01	2	4	12:04	12.07	0.33	Fish jumping out of box	0	0.00	1	0	0
Friday	2	6/23	9:32	21:47	8	9	12:15	12.25	0.73		0	0.00	0	0	0
Saturday	3	6/24	9:27	21:47	9	13	12:20	12.33	1.05		0	0.00	0	0	0
Monday	4	6/26	9:35	22:00	15	17	12:25	12.42	1.37		1	0.08	0	1	1
Tuesday	5	6/27	9:31	21:36	18	22	12:05	12.08	1.82		0	0.00	0	0	0
Wednesday	6	6/28	9:33	21:47	18	19	12:14	12.23	1.55	Netting over entire trap	0	0.00	1	1	0
Thursday	7	6/29	9:40	21:57	22	22	12:17	12.28	1.79		3	0.24	0	0	1
Friday	8	6/30	9:54	21:01	0	34	11:07	11.12	3.06		3	0.27	1	0	0
Saturday	9	7/1	9:55	0:18	0	52	14:23	14.38	3.62		2	0.14	0	0	0
Sunday	9A	7/2	5:00	14:39	0	24	9:39	9.65	2.49	a night run	3	0.31	0	0	0
Monday	10	7/3	10:25	22:51	27	27	12:26	12.43	2.17		2	0.16	0	0	0
Tuesday	11	7/4	10:15	22:49	38	38	12:34	12.57	3.02		1	0.08	0	1	0
Wednesday	12	7/5	9:21	23:47	52	53	14:26	14.43	3.67	21 king into deadbox	4	0.28	0	0	0
Thursday	13	7/6	10:16	22:19	42	43	12:03	12.05	3.57	42 King-9.3 lb Average	2	0.17	0	0	0
Friday	14	7/7	9:54	22:14	72	72	12:20	12.33	5.84	1st large sheefish	1	0.08	2	0	0
Saturday	15	7/8	16:00	23:06	0	27	7:06	7.10	3.80	partial tape-see data book	3	0.42	1	0	0
Sunday	16	7/9	8:25	20:51	25	25	12:26	12.43	2.01	fish drop universal (Rapids)	15	1.21	2	0	0
Monday	17	7/10	9:18	23:00	48	49	13:42	13.70	3.58	all gear up (Rapids)-2 tags	15	1.09	4	0	0
Tuesday	18	7/11	10:21	22:03	34	35	11:42	11.70	2.99	missing tag king	6	0.51	0	1	0
Wednesday	19	7/12	10:22	22:54	18	18	12:32	12.53	1.44	all gear down (Rapids)	14	1.12	2	1	0
Thursday	20	7/13	9:59	21:55	0	13	11:56	11.93	1.09	all gear down (Rapids)	9	0.75	0	0	0
Friday	21	7/14	10:13	22:18	19	19	12:05	12.08	1.57	less small fish	16	1.32	0	1	0
Saturday	22	7/15	9:14	22:10	27	27	12:56	12.93	2.09		34	2.63	1	1	1
Sunday	23	7/16	10:01	22:27	19	20	12:26	12.43	1.61		28	2.25	2	0	1
Monday	24	7/17	10:32	23:28	0	30	12:56	12.93	2.32		32	2.47	2	0	3
Tuesday	25	7/18	11:04	23:33	0	19	12:29	12.48	1.52		39	3.12	0	0	0
Wednesday	26	7/19	10:00	22:47	0	29	12:47	12.78	2.27	100 chums, Bear Creek	41	3.21	0	0	0
Thursday	27	7/20	9:39	22:41	0	19	13:02	13.03	1.46	all gear down (Rapids)	23	1.76	0	0	2
Friday	28	7/21	9:20	22:15	0	19	12:55	12.92	1.47	10% red (chums)	41	3.17	1	0	1
Saturday	29	7/22	9:15	22:01	0	21	12:46	12.77	1.64		35	2.74	1	0	1
Monday	30	7/24	8:48	21:53	0	17	13:05	13.08	1.30		32	2.45	0	0	2
Tuesday	31	7/25	9:50	21:15	0	15	11:25	11.42	1.31	50% red (fall run start)	37	3.24	3	0	1
Wednesday	32	7/26	8:51	21:41	0	10	12:50	12.83	0.78	all gear down (Rapids)	57	4.44	0	0	2
Thursday	33	7/27	9:48	21:46	0	3	11:58	11.97	0.25	70% red	46	3.84	0	0	1
Friday	34	7/28	8:58	22:25	0	5	13:27	13.45	0.37		75	5.58	2	1	2
Saturday	35	7/29	8:34	22:20	0	3	13:46	13.77	0.22	85% red	93	6.76	3	1	0

Figure 2. Chinook per Hour (Video), 2000



Introduction

Currently no other in-season project in Alaska provides assessment data on Canadian chinook salmon in the Yukon River above Pilot Station. Catch per unit effort (CPUE) data on chinook and the numerous other species counted will become increasingly valuable the more years the project is run. While daily subsistence chinook CPUE was supplied by satellite phone in 1999 from this site, this was the first year operating as a funded and more accurate project.

Fishwheels are commonly used as a capture method for management and research activities in the Yukon River drainage. Specifically, fishwheels have provided CPUE data at various locations. The majority of these fishwheels use live boxes to store fish until the researchers or contractors process and release the fish. Crowding and holding times greater than four hours are common and a growing body of data suggests that delayed mortality and reduced traveling rates are associated with holding, crowding or processing, (Underwood et al. 1999), (Underwood, U.S. Fish and Wildlife Service, Fairbanks, personal communication), (Eiler, National Marine Fisheries Service, personal communication), (Melegari, in preparation). A 1998 radio tagging project done on Sheefish showed excellent results from fish tagged immediately as they were caught and released with no time in the livebox (Brown. 1997-1998). 1998 and 1999 radio tag livebox holding studies done on fall chum salmon show very poor results from holding times in the 4-6 hour range (Eiler, National Marine Fisheries Service, personal communication concerning preliminary data).

In the fall of 1999 a development project was undertaken to address the increasing concerns over held fish and come up with an alternative using video (Zuray, Underwood, 1999). Video technology, as an alternative to live boxes, avoids all of the handling and live box crowding by eliminating the use of it altogether. Video cameras record images of fish for daily counting as fish exit the fishwheel basket. A specially built fishwheel is used having many features designed to reduce possible injury to fish.

Video systems have been used in counting windows at dams in the Columbia River basin for several years (Hatch et al. 1998). These systems have proved to be efficient and able to maintain 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 fishwheel on the Yukon River it was necessary to deal with many problems that did not exist in prior applications of this technology.

This report will cover all the major equipment used in the project, the field video taping procedures, and computer image capture procedures. Data will be described, counts compared, and a statistical comparison of the data provided. Aspects of the project that may help someone implement their own project and recommendations for further work are discussed. Finally, we include an appendix describing the day to day operations of the chinook 2000 project that shed light on the practical aspects of making a video project work.

Study Area

The project was conducted on a fishwheel 40 miles upriver from the village of Tanana at an area locally known as “The Rapids”, a narrow canyon 1176 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.


8-22-00 12H
23:02:18

8-26-00 12H
23:41:05

8-26-00 12H
22:01:51

9-03-00 12H
5:28:22

6-26-00 12H
11:06:42

9-03-00 12H
4:00:00

8-23-00 12H
1:59:55

9-16-00 12H
20:27:28







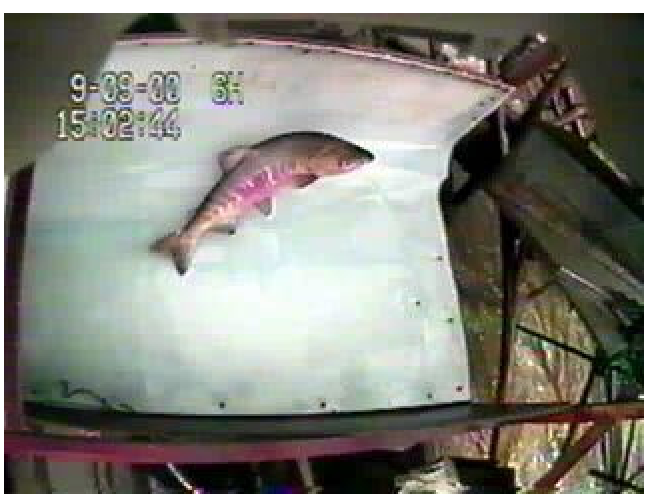



Figure 3. On the first page of pictures are 8 examples of frames, of different species, used in typical CPUE assessment.

Figure 4. The previous 13 frames give an idea of the number of views available during a single fish capture (VCR in 6 hour time-lapse). In future video capture systems presently being developed, number of frames per fish will be easily adjustable to suit a projects needs.

Methods

Field Procedures:

A two-basket fish wheel equipped with a live holding box was used to capture 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. The fishwheel was put in the water during the first week of June and was assembled in running order within a week. The water generator and associated electronics gear was mounted on the wheel. By mid-June all of the electronic gear to be used in the video project had been received (was stored by the U. S. Fish and Wildlife Service Fisheries Resource Office, Fairbanks). This included the surveillance camera, video tape recorder (VCR), portable monitor, desktop computer and 2 generators. A tent and oil stove was also set up at this time to house the equipment.

The project proposal stated, " The first Chinook salmon arrive as early as mid June or as late as the first week of July. Because of the large amount of subsistence gear in the river at the Rapids prior to the arrival of the Chinook salmon and the applicants own participation in this fishery monitoring the arrival of the first fish is always easy". This was precisely what happened. Nets were in the water starting June 10th. Reports were being followed from Pilot Station Sonar Project. On June 19TH 2 chinook were caught in a net. When 5 per 24 hour were caught on the 21ST in the same net, the test fishwheel was started. Running for 7hrs 15 min. on June 21ST produced 0 chinook. The next day (June 22ND), with video cameras running, the project officially started.

Two alternative sources of data were used in assessing proper data collection by the video capture program. 1. The original VCR tape or parts thereof were viewed as the capture program ran. It was easy to spot if frames having fish on them were being captured or not. The program even has a bell sound to signal when a fish is video captured. As a final assessment, five complete 12 hr original VCR tapes were viewed and compared to the corresponding video captured files. The original VCR tapes do contain all fish that pass through the chute. 2. Livebox data was also used for comparisons with the video files. The idea was that all of the fish that ended up 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. Nineteen 12 hr daytime periods out of 35 days were used for these comparisons. All 35 days were not used because subsistence restrictions did not allow for the taking of chinook during project hours after July 17TH. From this date on we relied only on the original VCR tape for validation. One of the project goals was to not use the livebox for validation unless all the fish would go into the subsistence fishery, thereby eliminating livebox held fish being released back into the river. Because of the applicant's participation in the subsistence fishery, the normal sharing of salmon at this time of year, and a large number of subsistence fishermen in the Rapids area, no livebox fish were released in 2000. After discussion with Keith Shultz of the Department of Fish and Game the proposed schedule for running was 12 hours per day, 6 days per week. Reasons for schedule were as follows:

a. Because of the high amount of drift in the river at this time of year, continuous nighttime (unattended) running of the fishwheel is not advisable. This was clearly the case in 2000.

b. 12 hours would reduce the amount of chinook processed by wheel yet still provide the data needed.

c. The logistics of one person running a site 40-miles from the nearest town necessitate one day a week being needed for a resupplying trip to Tanana. In 2000 some weeks this was not needed and a count was taken (Sundays).

Start up for each day was a routine procedure:

1. Arrival at the fishwheel – make sure wheel is adjusted for running (the most complicated part).

2. Switch on water generator and lower into water.

3. Open electronics cabinet, turn on DC power from batteries, turn on VCR and place a blank tape in VCR.

4. Check LCD monitor to make sure camera is on, in focus and positioned (rarely changes)

5. Wipe window clean on camera case (splash marks) and clean chute background (for

nice pictures).

6. Turn on fishwheel.

7. Start recording VCR tape.

12 hours later: (at least one trip was made to wheel mid-day and often more when drift was heavy).

1 Remove VCR tape, turn off VCR and main DC power.

2 Turn off fishwheel and lift baskets up to protect from nighttime drift.

3 Lift water generator out of water and turn off DC current to controller.

Video Image Capture Procedures:

After a 12-hr time lapse recording was finished it was brought back to the U.S. Fish and Wildlife Service camp, one half mile down river from the fishwheel, where the tape was placed in another identical time-lapse VCR. Tapes were played back in 2-hr mode into a computer image capture program using an analog capture card. This program was capable of comparing one video frame with the previously viewed frame and letting an algorithm decide if there had been a change in pixel luminescence between the two. Images with fish present differed from the standard (empty frames) and were stored in a computer generated video (AVI) file. This file could then be viewed and the fish on that file counted. During these two hours the computer and VCR ran unattended. A 12-hour recording in time-lapse would contain about 200,000 frames, of which the capture program would store 500 to 4,000 frames containing fish. The number of frames captured depended on the number of fish caught that day and the amount of environmental factors causing luminescence changes within the chute area. Using the Windows 98, default video viewer found in Windows Explore, a person could easily count the fish on those frames in approximately 10 to 30 minutes. Settings for the capture program in the 2000 season are listed in Figure 6

Equipment:

<u>Power:</u>

Aquair UW" propeller driven water generator. This generator had very little output at the water speed by the fishwheel. It could only produce 1-2 amps. Because the project was run in the daytime hours (no lights needed), the camera and VCR was able to run on this and keep a full charge at the batteries. Its use is recommended only after carefully assessing the water current at each site, power needs of the project and it's cost ($2000.00) and work of setting up. On a positive note it seems like a durable, continuous use piece of equipment.

Honda 1000 watt generator (EU1000I): With the color video camera running at higher shutter speeds, it required about 180 watts of light at night to produce a nice picture. This plus other equipment (camera, VCR, and inverter) came to under 300 watts which this generator easily handled on a lower RPM setting that this generator was equipped with. This also boosted gas economy to 10 hours per filling. An extended gas supply was run into the generator's carburetor for more use without refueling however. When not in use the extended gas supply was lowered to a level below the generator to avoid possible problems associated with a leaking carburetor needle valve. The generator was light and ran on the shore in a converted dog house with an open front and a 6" square hole in the back for the exhaust to blow out. A 100' extension cord ran from shore along the fishwheel spar pole to the equipment enclosure. Because the project was run in daytime it was used infrequently. Depending on site or project it could be the main fishwheel power source however.

Honda 2500 watt generator (EB2500): was used at camp to run computer tent

Batteries: Four 6-volt deep cycle batteries supplied the stored 12-volt DC power. While fewer batteries could be used a generator shut down could necessitate the use of this much reserve power to keep the video running. Also this kind of reserve allowed the water generator to not have to run the on days when drift was especially bad. The batteries all sat neatly in an inexpensive waterproof plastic tote in the bottom of the equipment enclosure.

Battery charger: A 10/30/50 amp (Schumacher SE-1250), taper charge, automobile type, charger was used. As the charger will run constant at 8 amps at night with lights on, any taper charge, 15 amp or larger should be fine.

Inverter for light: An inexpensive 150-watt modified sine wave inverter worked well and drew minimum watts. A 300 watt modified sine wave inverter was used also and had the advantage of a power off switch.

Lights: Two 90-watt halogen 27^{0} beam GE floodlights. One was run off an inverter from the DC batteries in case the gas generator system ever shut down. The other light ran directly off the generator in case the DC inverter system failed. 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. During a generator, light or inverter failure, one light could produce a dark yet fully countable video.

The Fishwheel

The chute: On wheels equipped with live boxes a "chute" is used to pass the fish from the wheel baskets over the raft logs and into the live box. Wheel sites do exist that do not require vertical adjustments to the axle; this site however does in times of lower water. The chute, therefore, had to be adjustable in that it must go up and down to match up to the changing level of the baskets or fish injuries increase from fish dropping rather than sliding into the chute. This means the camera, enclosed sides of the chute and the chute must be one unit to eliminate refocus of camera, especially in bad weather, in times when the wheel axle/baskets are needed to be raised. The chute enclosure was the source of some of our greatest trials and tribulations. The sides must be high enough to block out direct sun shadows from the moving wheel baskets. It is open on top to allow the floodlights to shine in at night. This leaves the entrance and exit of the chute. 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 camera's 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 simple switches on the exit doors. This would serve many purposes, one of which would be the elimination of the need to shield the camera from sun shadows to such an extreme degree and the building of all the related enclosures. The bottom (viewing area) of the chute was lined with white UHMW 3/16'' thick plastic. It was easily cleaned and stayed white which was the preferred color background.

Fishwheel construction: It is counterproductive to install a video system only to have fish injured by the fishwheel unnecessarily. The fishwheel used was specially built to try to eliminate injuries. Basket sides have seine webbing and no braces creating a sort of trampoline in the critical areas. The basket bed is lined with high-density plastic webbing instead of wire. All entrance and exit doors are lined with closed-cell foam. Easily removable paddleboards of different sizes allow much control of the fishwheel rotation speed. Rotation needs to be consistent with no prolonged hesitations but should not be so fast as to lift the fish high before it has a chance to migrate towards the basket chutes.

Electronics

Panasonic color 1/3" format CCTV camera (model WV-CP454) with 480 lines horizontal: 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 selected is described below.

Lens: By Computar vari-focus model TG272814FCS-2, 2.8-6mm, F1.4 TV lens, color 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 $1000. Waterproof camera case was necessary and we kept a good amount of silica gel in it at all times to absorb water vapor.

Monitor: 3”X5” color LCD wired to the 12 volt system and the VCR 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 or not.

Video Recorders: Video cameras were connected to a direct current video recorder (Panasonic AG-1070dc) 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 matching, second video recorder was used to play images into the video capture card/computer. A Panasonic AG-5710 editing VCR with shuttle/jog features was used in the 1999 fall chum project. While it was a useful tool in the 1999 development project and was available for use in this project, money would be better spent on a less expensive spare Panasonic AG-1070dc. These VCRs have factory-cleaning recommendations of every 60 hours. Conditions at the wheel are very clean and dry and new tapes are used but use is pushed well beyond the 60 hours.

Computer: A custom built computer with dual 600 mhz Pentium III processors, 256 Mb of ram memory, and Windows 98 operating system 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 PCI ultra 2 SCSI card and two hard drives (12 Gb and 9 Gb) for storage and retrieval of video images. Stored image files were backed up using a 2 Gb Jaz drive.

Software: Image capture software comes with most video capture PCI computer boards. Custom software (V cap, version 1.07) for processing captured images was provided by the Columbia River Intertribal Fish Commission biologist Doug Hatch and Jeff Fryer. Original software was described by Hatch et al. (1998).

Statistical Analysis and Comparisons:

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, the correlation coefficient calculated, and plots of the residual values examined. Finally video capture counts and original VCR tape counts for the 5 tapes used for final post-season assessment are compared and the number of fish experiencing video capture misses calculated.

Results and Discussion

Correlation of paired observations (n =19) between chinook live box counts obtained by manually dipping fish using a net and counts obtained via video image capture was over 0.99 (Table 2). A paired test of means indicate mean values were significantly different (P = 0.003). The mean count for manually dipping fish was 27 (S.E. 3.95) while mean video counts was 28 (S.E. 3.85). Livebox counts were found to be inaccurate because of fish escapement (see appendix- June 23RD to June 28TH). After the livebox was completely covered, livebox counts were either equal to or one less than the video count (Table 2).

Comparisons between original VCR tapes and video capture counts were made. There were approximately 60 hours of final assessment viewing of original VCR tapes (Table 3). All fish on the original VCR tapes larger than small cisco whitefish (425 in all) were video captured with no error (100% accuracy). Video capture of cisco whitefish failed 10 out of 190 times (94.7% accuracy).

In 1999 considerable effort was expended on getting quality video images and getting images that worked efficiently in the image capture program. In this project those 1999 settings were used and getting started was suprisingly easy. Some improvements were made to the capture program by the Columbia River Inter-tribal Fish Commission and so some experimentation was necessary to make sure it performed properly within our 1999 parameters. Also some of those parameters could now be changed because of the more sensitive, improved program.

Video quality is best with a white background, a high quality color camera, and a faster shutter speed (that is in need of more light). We found that for our application two 90-watt floodlights mounted approximately 8 ft above the surface worked well.

Getting images that worked well in the image capture program required considerable control of natural light and movement on surfaces present in the video image. Moving shadows caused excessive numbers of frames to be saved by the computer program. 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 a enclosure was found to be important because a very small beam of light 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. Because of the use of matching VCRs in this project and an excellent viewing program, this is not a large problem anymore but rather a large irritation.

The quality of the final video is greatly dependent on the level of compression, which is user selectable. Less compression allows higher quality images, but requires more storage capacity. In the past electronic storage has been limiting, but the price of hard-disk drives and other storage devices has been reduced so that limited storage is less of a problem. Selecting an 80 to 85% compression level (compressed 20%) allowed for high quality images that did not overwhelmed neither the processor nor the storage capacity. Image quality also depended on proper setting of picture hue, saturation, brightness, and contrast. For color pictures a slightly exaggerated hue and saturation increased the effectiveness of the video capture program.

Incompatibilities between VCRs exist and matching models should be used at the fishwheel and at camp. A simple matter to remedy once realized, this was by far the most important technology breakthrough this summer. While we became aware of it during the development project in 1999, the lack of matching VCRs kept us from appreciating all the improvements caused by their use in the final viewing of the AVI files for counting. There are no hesitations at regular speed. You can go in reverse, frame to frame, using the mouse as fast as your eyes could see. Last fall, with unmatched VCRs, the mouse could barely work reverse at all and using the keyboard controls was erratic. Of more importance this year was the elimination of the problem of the missing frames caused by unmatched VCRs. Some of those frames had chum salmon on them. This summer not a single instance of the livebox having more fish in it than the video file took place and not a single instance of a missed fish larger than small cisco whitefish has been observed. Originally the livebox counts were supposed to be used to assess the accuracy of the video system. During this project video counts ended up being the standard that was used to improve the accuracy of the livebox method (appendix – June 23RD to June 28TH).

Another improvement took place this year because of the newer luminescence program from Columbia River Inter-tribal Fish Commission biologists. The simple addition of extra triggering grid lines in the capture program means we can now count small cisco whitefish accurately without raising the triggering sensitivity to problematic levels. Cisco counts in 1999 were not accurate.

Recommendations

After running over 100 time-lapse VCR tapes through computer capture programs plus operating and adjusting a fishwheel to allow for this, some ideas on future changes that would be valuable stand out.

1. <u>Complete the development of a new capture program</u>. Currently this project is 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. A new capture program is currently being developed, for the U.S. Fish and Wildlife Service Fisheries Resource Office in Fairbanks. Field-testing is scheduled for this fall (Restoration and Enhancement Fund Project, Stored Video Images as an Alternative to Live Boxes for the Collection of Fall Chum CPUE Data, Zuray). This is a first step. The program will be held in public domain with the source code available. It can be changed and it's workings understood.

2. <u>Upgrade equipment</u>. Funding needs to be made available so important parts of this

latest capture program can be run simultaneously with the current programs and likewise proven. Equipment is needed to make this changeover. A laptop computer or motherboard and components could be installed on the fishwheel. Instant decisions could be made on fish presence triggered by a signal from a simple signaling switch mounted on a chute exit door. Fish frames would be stored in a moveable disc at the fishwheel and brought back to camp to be counted with no processing time other than counting fish. Use of this method would allow control over what and how many fish frames were kept and could be tailored to a project with simple program settings. All the above is existing technology. Some of it such as the fishwheel laptop capture, signaling switches and transferring of files have already been done at this project's site with borrowed equipment and donated time. Presently there is a need for more than one counting method to make sure new ways work. As this technology becomes more used, proven and excepted, equipment needs will become refined and costs can lower. This is the most important equipment modification recommended. It would eliminate the worst problem (chute enclosure), be easier to set up, faster to count, more accurate to view (fish features, external tags and sex) and be the biggest step towards having a video counting system capable of being transferred around the state and set up easily.

3. <u>Eliminating the need for livebox counts</u>. This would allow a project to operate without any of the adverse impacts associated with holding and handling. During this project livebox counts were found to be often unreliable and unnecessary. The only use seen for these counts is in the case of the fish being used for subsistence anyway. In that instance a carefully covered livebox could produce counts accurate enough to assess the day to day operation of the video system. If fish are not needed for subsistence, viewing the video capture, as the original VCR tape runs for certain time periods each day seems to be sufficient. For final assessment original VCR tapes are much more accurate and provide a permanent record of actual fish passage that could be replayed for post- season data verification.

4. <u>Expand current video project to other sites</u>. To apply a video system to other 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 fishwheel. A fish wheel would need to be of a single live 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. Of importance also is the design of the fishwheel in doing its part in not harming the fish being video captured. As mentioned, 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 calendar format. As opposed to the development project of 1999, many days went by with no significant failures or breakthroughs. The intent of this section is to convey a sense of day to day operations of a video CPUE project to those interested or contemplating running one. To others it may be a bit boring or wordy.

June 22^{ND} was the first official data collection day. The wheel and livebox were being watched closely making sure all was okay and wondering if kings were going to get caught. At one check, 3 kings were seen in the livebox but not taken out. Hours later when the livebox was emptied only one was found in there. At the end of the day when the video count was taken 4 kings were seen on video. Only 2 were taken out of the livebox. The real shock was that this livebox had been used for years to collect kings for sale during commercial openings. The sun was much stronger and higher than in the fall of 1999. Many extra frames were captured because of the sun/wheel shadow problem. Counting was no problem however.

June 23^{RD} to June 28^{TH} – During this time king salmon showed how resourceful they were at escaping. Every day webbing was added to more and more of the top of the livebox. When entirely covered it was found it could not have even have a loose corner. Care had to be given each time the netting was put back on. Finally on the 29^{TH} the livebox count was as high as the video count. Originally the livebox at this site had sides 13" above the water. Front and rear the box was covered with a board. Each year tagging crews had spent many hours each day, during fall chum season, tending this same livebox. Chums were never seen escaping like these kings. It was a surprise to everyone including fishermen in the area. After the 28^{TH} livebox counts were either equal to or one less than the video count. On those days when the video count was more, one could usually spot the loose webbing where the king got out.

June 26^{TH} - Dave Daum from the Fisheries Resource Office in Fairbanks came out to check out the operation of the project. He looked over my data recording methods, ran an original VCR tape himself, did some video fish counting and ran many different settings to understand how the program functioned. It was valuable to have someone who has a critical eye looking over everything and I encouraged him to find mistakes and make suggestions.

June 30TH - Today was the first day I am unable to use the fish caught for subsistence so the livebox underwater door is opened and video is the only system relied on. This is the case for 2 more days. Up until now video counts have been very accurate so these 3 days do not concern me. I am also let know that some local residents were skeptical of the project sticking to the goal of no livebox held fish being released back into the river. With this in mind I spend a lot of time seeing if viewing the original VCR tape is a valid alternative to livebox counts.

July 2ND - Sunday is a scheduled day off for resupply trips to Tanana. Don't need to go this week so decide to run a night video to check out lighting system and related equipment. This is a necessary component to the daytime program and needs to be functional and ready to go on short notice. In the event of a daytime failure a night tape needs to be made to get data for that day even though time would be off to some degree. Data is collected and recorded for this day.

July 5TH - Caught 53 kings on video and 52 in livebox. From repeated jumping the kings in the livebox knocked out a divider board between the livebox and the fishwheel raft deadbox. There were 21 kings in the deadbox. That many fish found that small opening and jumped out, again showing their resourcefulness. An interesting thing was noticed on this subject. When arriving at the fishwheel kings that had been in there a while would be so intent on getting out that the box would have to be banged a few times to scare the fish away from the surface. If this was not done as soon as the netting was removed from the top of the box a king would often see the opening and with a flick of its tail be gone.

July 6TH - Got 42 kings out of livebox today. While this seems like a lot of fish, subsistence fishermen in the area are commenting on the extremely small average size of them day after day. Took and weighed all 42 and came up with an average weight of 9.3 lbs. The entire peak of the run was like this in 2000.

July 8TH - Has been extremely tense at times because of the high water, fast current and large amount of big logs floating down river. Only one net eddy in the Rapids has been fishable, the entire Tanana area has largely been unable to run any fishwheels and similar reports are coming in from downriver. The unique currents at the Rapids allow the good fishwheel spots there to somewhat avoid this river drift. In the 1999 king season however an entire basket was ripped apart by a tree as long as the fishwheel. On this day a small tree hit the wheel and stopped its rotation for an unknown amount of time. This of course destroyed the ability to calculate CPUE accurately. Another tape was started and 7 hours 6 min. of data was collected. It was decided to put off the next days (Sunday) trip to Tanana in order to run another 12 hour video and make up for the missing hours on Saturday.

July 9TH - Have been getting a few sheefish every day now. Their ability to cope with 6 hours in a livebox does not seem good. Most of them are dead or very near. When dealing with this condition the project goal of not releasing any livebox held fish back into the river, while debatable as to its biological necessity is important from an ethical point especially when equally valid alternatives exist.

July 20TH - No livebox count again as cannot use fish for subsistence. A unique situation developed this summer because of the high water, drift, and rumored then finally real lack of commercial fish openings in this area. Many fishermen did not set up their camps as usual and put fishwheels and nets in the water themselves. More sharing of subsistence fish was seen than usual. As the project fishwheel is participating in this fishery it allowed for more livebox counts than might have been possible on a normal year. Because of the inaccuracy seen in livebox usage for CPUE data and the use of original VCR tape counts for evaluation this should not be a consideration in coming seasons.

July 17TH - From this day on because of declining quality of the average king salmon, lack of use for fish for subsistence purposes but mostly the subsistence restriction put in place because of the low passage of king salmon, no livebox counts were used to assess the video counts. While this may seem of concern to people outside of the project operations, (the livebox was originally supposed to be the standard by which the video system was evaluated) within the project the video system had long ago become the daily standard by which the livebox counts were assessed.

July 18TH - July 29TH - Drift was slowing down, king numbers decreasing, chum numbers increasing, video system running well, the project stopped after counting 3 video kings in 13 hours and 46 minutes on July 29TH.

October 19TH - Have finished final assessment of original VCR tapes. This was a boring and time-consuming process that required setting up all the computer equipment again back in the village. Five original VCR tapes were then watched at the same time the capture program ran. What was required was to sit and stare at a movie of a fish chute in which only occasionally a fish would dart through. Any fish seen but not indicated as being captured was noted and later checked out more thoroughly. Each movie was 2 hours long and any movement of the eyes from the center of the screen was forbidden as it only takes an instant to miss a fish. The boredom was rewarded with results that were better than had been expected at the start of the project.

Table 2. — Data used for a comparison of manually obtained live box counts and counts obtained through the video image capture process. Mean values were significantly different from one another (n=19). Only chinooks were counted below.

Test label	Live box count	Count from Video
1	2	4
2	8	9
3	9	13
4	15	17
5	18	22
6	18	19
7	22	22
10	27	27
11	38	38
12	52	53
13	42	43
14	72	72
16	25	25
17	48	49
18	34	35
19	18	18
21	19	19
22	27	27
23	19	20

Table 3. Chinook 2000 Worksheet - Final Assessement

Fish found on original VCR tapes but not captured by video are noted below. Five complete original VCR tapes were viewed using Monday of each week for selection.

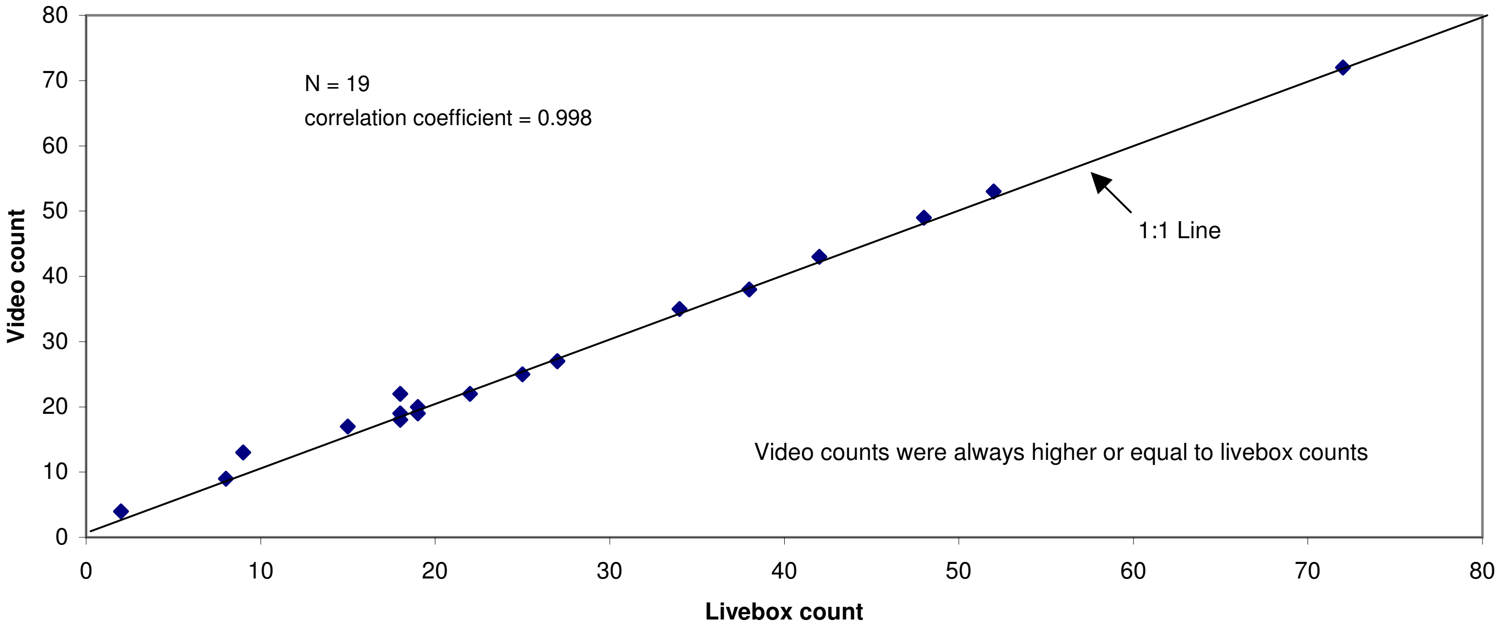
Start day	**Tape**	King missed	Chum missed	Sheefish missed	Broad Whitefish missed	Humpback Whitefish missed	Cisco Whitefish missed
Monday	4	0	0	0	0	0	0
Monday	10	0	0	0	0	0	0
Monday	17	0	0	0	0	0	0
Monday	24	0	0	0	0	0	2
Monday	30	0	0	0	0	0	8

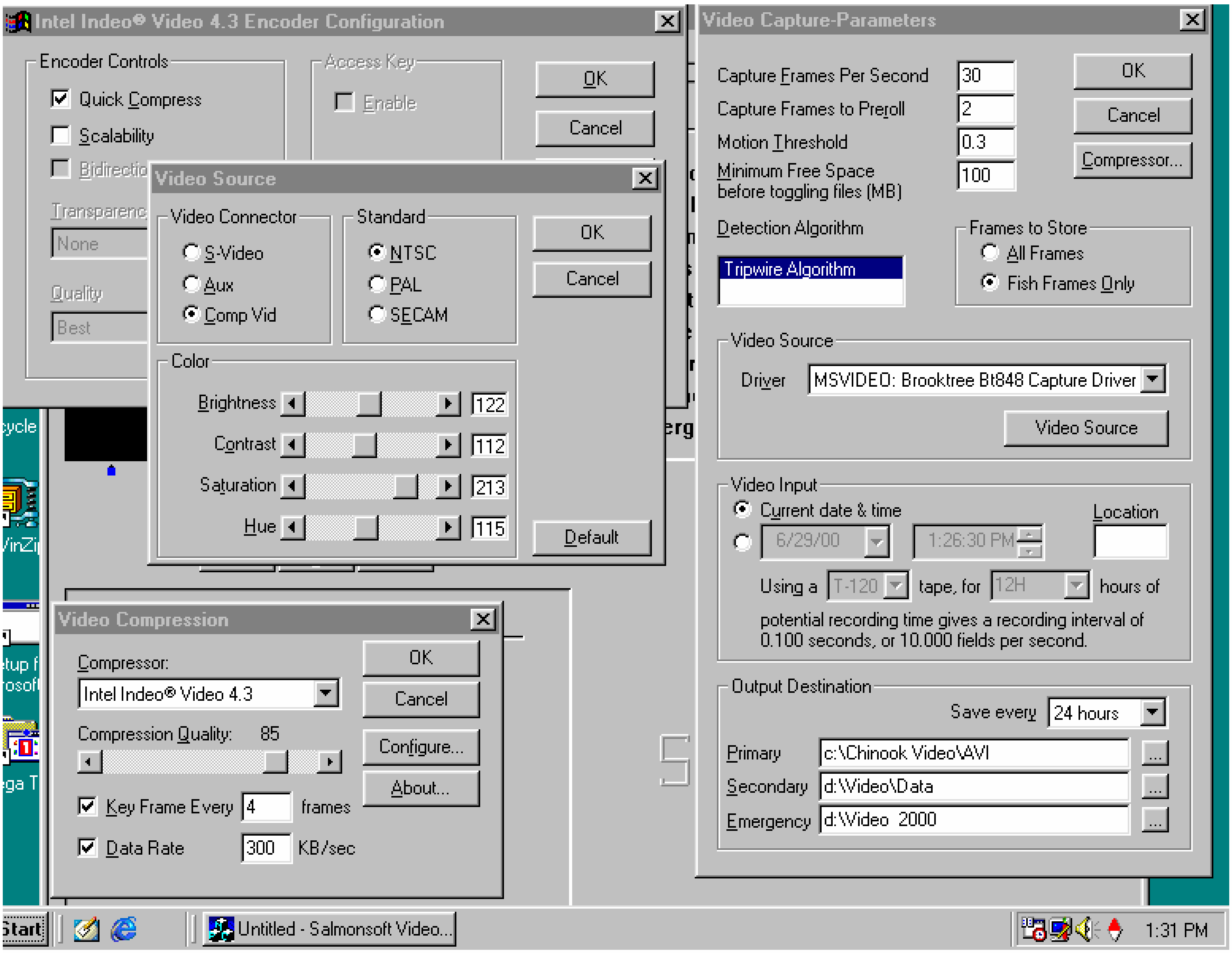
All final assessement chinook, chum, sheefish plus broad and humpback whitefish (235 total) experienced 0 misses.

All final assessement fish taken together (425 total) experienced 10 misses.

All final assessement cisco whitefish (190 total) experienced 10 misses.

Figure 5. Comparison of Video to Livebox Counts




Intel Indeo® Video 4.3 Encoder Configuration
Encoder Controls
Quick Compress
Scalability
Access Key
Enable
OK
Cancel
Video Source
Video Connector
S-Video
Aux
Comp Vid
Standard
NTSC
PAL
SECAM
OK
Cancel
Color
Brightness 122
Contrast 112
Saturation 213
Hue 115
Default
Video Compression
Compressor:
Intel Indeo® Video 4.3
Compression Quality: 85
Key Frame Every 4 frames
Data Rate 300 KB/sec
OK
Cancel
Configure...
About...
Video Capture-Parameters
Capture Frames Per Second 30
Capture Frames to Preroll 2
Motion Threshold 0.3
Minimum Free Space before toggling files (MB) 100
OK
Cancel
Compressor...
Detection Algorithm
Tripwire Algorithm
Frames to Store
All Frames
Fish Frames Only
Video Source
Driver MSVIDEO: Brooktree Bt848 Capture Driver
Video Source
Video Input
Current date & time
Location
6/29/00
1:26:30 PM
Using a T-120 tape, for 12H hours of
potential recording time gives a recording interval of
0.100 seconds, or 10.000 fields per second.
Output Destination
Save every 24 hours
Primary c:\Chinook Video\AVI
Secondary d:\Video\Data
Emergency d:\Video 2000
Start
Untitled - Salmonsoft Video...
1:31 PM