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TECHNICAL REPORT 10-01

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2009 Spring Chinook Escapement to the Upper Basin of the Klickitat River Based on DIDSON Sonar Counts

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March 2010

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Please cite as:

Galbreath, P. F., C. R. Frederiksen, P. E. Barber and Saang-Yoon Hyun. 2010. 2009 Spring Chinook escapement to the upper basin of the Klickitat River based on DIDSON sonar counts. Columbia River Inter-Tribal Fish Commission Technical Report 10-1, Portland, Oregon. (http://maps.critfc.org/tech_rep.htm)

ACKNOWLEDGEMENTS

We gratefully acknowledge the assistance of Joseph Zendt and Bill Sharp of the Yakama Nation Fisheries - Yakima Klickitat Fisheries Project, in the successful completion of this project.

This research was enacted with funding from the Bonneville Power Administration, as part of the Three Treaty Tribes Memorandum of Agreement project: Basinwide Supplementation Evaluation (2009—009-00), Contract No. 42361.

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EXECUTIVE SUMMARY

A Dual-Frequency Identification Sonar (DIDSON) sonar was deployed to observe fish passage through the Castile Falls Fishway on the Klickitat River, and to obtain an estimate of spring Chinook escapement to the upper basin. The DIDSON continuously recorded sequential 1-hour files from late May until late September 2009, except for occasional interruptions due to technical problems. "Echograms" were processed from the original DIDSON video files, and upstream passage events observed in the echograms of large fish deemed to be spring Chinook were noted. The resulting data were analyzed to account for periods when DIDSON files were unavailable, producing an estimate for total 2009 spring Chinook escapement to the upper basin of 24 fish (95% confidence interval = ± 4). This estimate is higher than the estimate of 12 fish based on an expansion of the total redd count for the year (4 redds, times an expansion factor of 3 fish per redd). A brief discussion of possible reasons for this difference is provided.

INTRODUCTION

The Yakama Nation (YN) is actively involved in efforts to rebuild the spring Chinook population in the Klickitat River (YN 2008; see www.ykfp.org/klickitat/). These efforts have included projects to renovate the Castile Falls Fishway Complex. Castile Falls (rkm 103) is a series of 11 natural falls with a total vertical drop of 33 m over 1.0 km, located in the Klickitat River Gorge within the boundaries of the YN reservation. These falls created a near-total barrier to upstream migration of anadromous salmon (spring Chinook and steelhead) into the upper basin of the Klickitat River (Figure 1). Upstream of Castile Falls, the Klickitat and its tributary streams comprise 72 rkm, much of which would be prime spawning and juvenile rearing habitat for spring Chinook. Access to the upper basin would approximately double the available habitat for spring Chinook in the Klickitat basin (which begins upstream of the Klickitat Hatchery, rkm 67).

In 1960, the Washington Department of Fish and Wildlife (WDFW) signed a Memorandum of Agreement with the Yakama Nation (YN), the Bureau of Indian Affairs, and the US Fish and Wildlife Service to use Mitchell Act funds to finance a construction project to improve access of anadromous fish (spring Chinook and steelhead) to the upper basin. The Fishway Complex, construction of which took two years, consists of two tunnels (61 m and 260 m, respectively) through which fish may swim to by-pass Falls #4 and #5 and Falls #10 and #11, and a 3-4 m high concrete dam at the upstream end to divert flow into the upper tunnel. Additionally, blasting of Falls #1, #8 and #9 was performed to assist passage; the smaller Falls #2, #3 and #6 were not modified as they were not considered to be barriers.

Unfortunately, the Fishway design did not sufficiently preclude entry of the rock and debris which is mobilized by the heavy spring flows the river experiences each year, and maintenance of the tunnels was inadequate. As a result, the Fishway became completely blocked within a few years of operation, and the upstream dam created an additional blockage for migration via the natural river channel, making the upper basin totally inaccessible to spring Chinook.

YN projects to renovate the Fishway Complex began in 2002. Flow into the two tunnels was blocked, and the accumulated debris removed. The concrete stair-step fish ladder structure within each was demolished and replaced with a vertical slot design that would accumulate debris less readily, maintain suitable entrance velocities and depth, as well as head differences between pools and maximum velocities at the weir slots. Trash racks were modified and a fore bay sluice gate installed in both tunnels. In 2005, renovation was complete and water flow reopened through the Fishway. Within the same year, spring Chinook redds were again observed in the upper basin.

For many years, the Washington Department of Fish and Wildlife operated a segregated spring Chinook program at Klickitat Hatchery. Returns of these fish supported harvest in the lower river, but the naturally spawning population has remained depressed. Management of the hatchery was recently transferred to the YN, and they have changed operations from a segregated to an integrated program, to supplement and rebuild the natural population. At present, however, the juvenile release locations for the supplementation program are all located in the river below Castile Falls. The YN has decided to wait and see if spring Chinook will naturally (re)colonize the newly accessible upper basin, and build up an abundant naturally-spawning population. Annual escapement to the upper basin will be the measure of key importance in monitoring this development.

Since reopening of the Fishway, spawning escapement of spring Chinook to the upper basin has been estimated indirectly by expansion of an annual redd count. The YN performs three successive redd surveys during the spawning season each year, spaced approximately 10 days apart. The surveys cover essentially the totality of the known spawning area within the basin above Castile Falls. The total number of redds observed during these surveys is then multiplied by the expansion factor of 3 fish per redd (Zendt and Bosch 2009) to obtain an estimate of total escapement. While the method of estimating spawning abundance by expansion of annual redd counts is generally recognized to have substantial uncertainty (e.g., Mosey and Truscott 1999, Murdoch and Miller 1999, Dunham et al. 2001, Faurot and Kucera 2005, Gallagher et al. 2007), it is the only method currently feasible for use in the upper basin. However, that fish migrating to the upper basin must pass through the Fishway presents an opportunity to make direct counts. The recently completed Klickitat River Anadromous Fisheries Master Plan (YN 2008) includes plans to install an optical video system to record passage of fish as they pass through a constriction within the upstream outlet of the Fishway. Construction of the counting system is scheduled to begin in 2010, with hopes of having the system operational for the 2011 migration season. In the meantime, we proposed to use an alternative technology for direct counting with which to estimate annual escapement - a Dual-Frequency Identification Sonar (DIDSON; Sound Metrics Corporation, Seattle, Washington, www.soundmetrics.com).

A DIDSON is a multi-beam underwater acoustic video camera. It repetitively emits sets of sound beams and uses its unique patented lens to resolve the reflections of objects passing within its field of view into a two-dimensional image. The standard model of the DIDSON (DIDSON-S) emits an array of 96 beams at high frequency (HF; 1.8 MHz), or 48 beams at low frequency (LF; 1.1 MHz). Operated at HF, the DIDSON has a functional range of 10-12 m, and a range of 24+ m when operated at LF. Placed in a body of water and oriented to transmit horizontally through the water column, it produces a top-down ("bird's-eye") view of the conically-shaped ensonified field. Unlike optical cameras, the camera is able to "see" objects irrespective of light intensity, and in water with up to moderate levels of turbidity. Additionally, field testing for fisheries applications, including salmon escapement estimation in rivers, has shown that the DIDSON has some significant advantages relative to other sonars (Moursund et al. 2003, Johnson et al. 2004, Maxwell and Gove 2004, Faurot and Kucera 2005, Galbreath and Barber 2005, Xie et al. 2005, Kucera and Orme 2006, Burwen et al. 2007, Maxwell 2007, Faulkner and Maxwell 2008, Melegari and Osborne 2008). We proposed to install a DIDSON at the upstream outlet of the Castile Falls Fishway to observe spring Chinook swimming upstream out of the Fishway to access the upper basin. Operated across the entire migration period, we would then be able to obtain a direct count of total escapement.

We report here an estimate of the 2009 spring Chinook escapement to the upper basin of the Klickitat River obtained through use of a DIDSON. Additionally, we comment on logistical issues related to operation of the sonar, and discuss differences in the estimates produced with the DIDSON relative to that based on an expanded redd count.

METHODS

In May 2009, preparations were made to deploy a standard model DIDSON at the upstream outlet of the Castile Falls Fishway. The outlet canal of the Fishway consists of six 3.2 m long openings. Each opening is faced with a heavy metal trash rack. The 15 cm spacing between vertical bars of the trash rack grates permits exit of salmon and steelhead from within the Fishway to the upper basin of the Klickitat River, but blocks entry of most large woody debris. To the outside face of the upper two and lower two trash racks we attached sections of weir fencing, so as to restrict passage of fish through the middle two sections only. Each section of weir fencing consisted of a 3.1 m x 0.8 m aluminum frame, with holes drilled along the lengths at 7 cm intervals, through which lengths of 1.6 cm diameter aluminum conduit were passed (1.8 m for the downstream frames, and 1.2 m for the upstream frames). A 1900 l propane tank was transported to the site to provide fuel to a small gasoline electrical generator, which had been converted for use with propane. Two heavy duty job site storage boxes were installed on top of the Fishway outlet – one to house the generator and tools, and the other the electronic equipment - field computer, external hard drive, etc. (Figure 2).

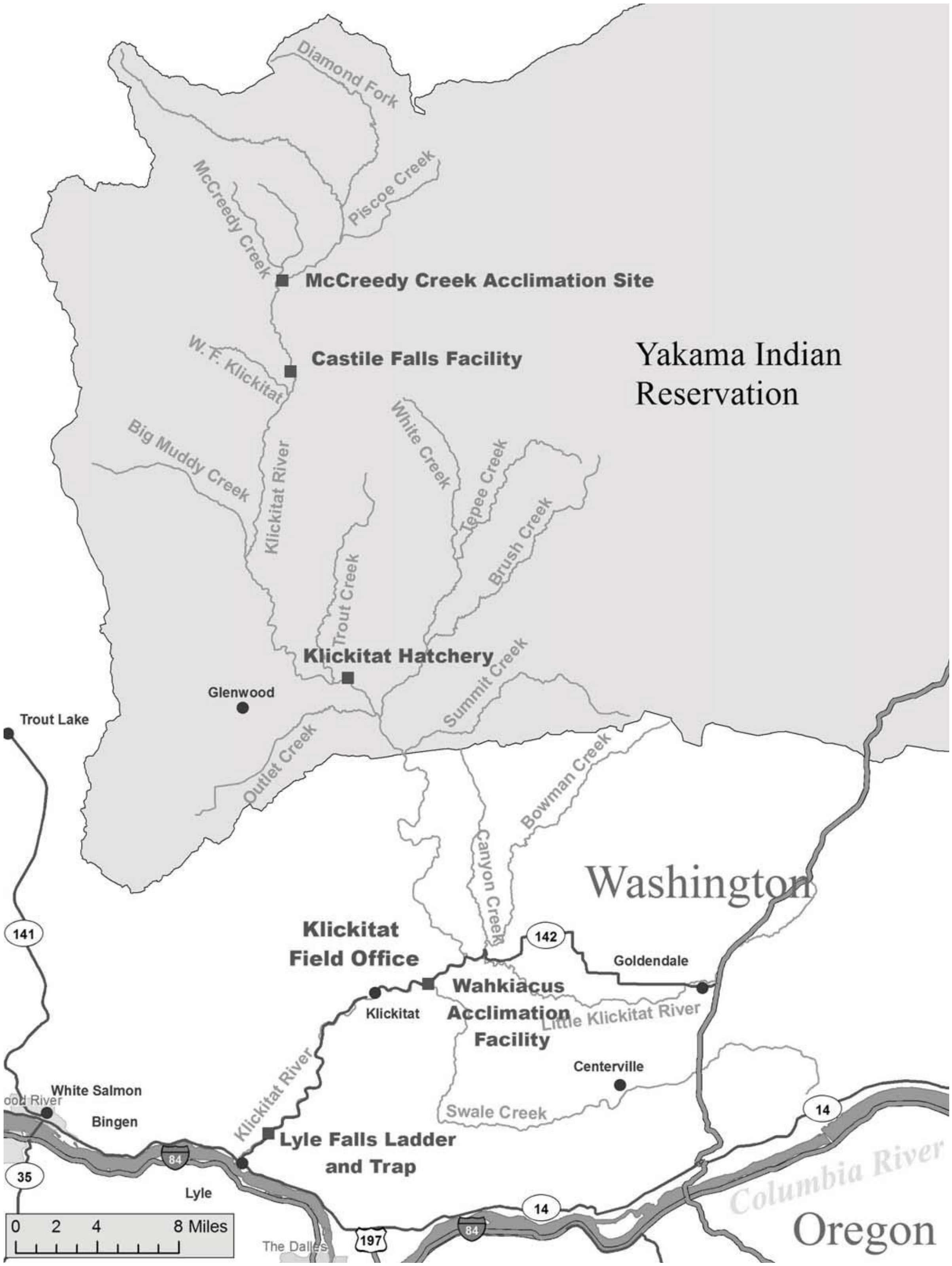

Figure 1. Location of Yakama Nation facilities for the Klickitat River Anadromous Fisheries Project (Figure 1-2, YN 2008).

The DIDSON was installed immediately outside of the Fishway, 3 m upstream of the two unblocked sections and oriented in a downstream direction parallel to the Fishway. The DIDSON was programmed with a 2.6 m Start Length and a 9 m Window Length (Sound Metrics Corporation 2009), such that the entire water column outside the unblocked sections (through which upstream migrating salmon would pass) was within the field of view of the sonar (Figure 2). The DIDSON was programmed to record sequential 1-hour files, at high frequency (1.8 MHz) and 9 frames per second, and operated from May 22 to September 29, 2009. These dates are well before and after, respectively, the period during which we estimated that spring Chinook would be migrating through the Fishway. The site was visited twice per week to confirm proper operation of the sonar. Every second or third visit, the 500 GB external portable hard drive to which the files were being recorded, was switched for a new one, and the recorded files on the former were copied to a larger (2 GB) office-based hard drive for storage and processing.

Processing and reading of the DIDSON video files began in September 2009. Initially, an echogram was created for each DIDSON file. Processing parameters for the echograms included: Minimum Track Size = 400, Minimum cluster Area = 400, and Maximum Cluster Area = 10,000. The value for the Minimum Threshold parameter was varied between 4.1 and 3.2, in accordance with the amount of background “noise” created by turbulence (entrained air bubbles) in the water at the time the file was recorded (Sound Metrics Corporation 2009).

Beginning with the July echograms (when we suspected that upstream migration would begin), each echogram was reviewed by a single reader (Barber). When “tracks” in the echograms occurred (indicative of possible fish passage events), a rectangle around the track was drawn to create a “tape loop” of the raw video. A note was made of the time and direction of movement for each image which appeared to represent passage of a fish of medium to large size (suspected to be a salmon) - as opposed to movement of a smaller sized fish, of floating debris, or of a cloud of air bubbles, etc. In the end, all available files from June 10 to September 10 were read – which provided complete coverage of the period (mid July to mid-August) that passage events were observed (Figure 3).

Each noted passage event was subsequently re-reviewed in the presence of a second reader (Galbreath), and the two readers reached a consensus as to which images would be counted as upstream passage events of a spring Chinook. The hour and date of these counts were recorded in a spreadsheet, and the data were then analyzed to assess trends within days (diurnal), and across dates. The analysis expanded the number of fish observed, to account for gaps in the data caused by interruptions in operation of the DIDSON, to produce an estimate of total escapement. This estimate was then compared to that based on an expansion of the total redd count recorded for 2009.

Figure 2. A) Dam and upstream outlet of Castile Falls Fishway at low water (August 2009). B) At high water (June 2009). C) View downstream at high water. D) DIDSON on stand. E) DIDSON installed adjacent to Fishway. F) Fishway outlet showing weirs, job site storage boxes and DIDSON. G) Field computer and external hard drive.

RESULTS

Escapement Estimation

The fish passage events (with one exception observed on June 16) were confined to the 42 day period from July 12 to August 22 (Appendix), during which 18 fish were observed. Unfortunately, failure of the generator led to loss of 10+ days' worth of files during this period. Distribution of the limited number of observed fish (n=18) and their wide dispersion did not provide sufficient support for a temporal trend, either across hours within days (diurnal trend), or across days within the migration period. Therefore, we estimated total escapement, by considering each hour during the 42 day migration period as a stratum (24 x 42 = 1008), with 758 strata during which 18 events were observed, and 250 strata for which data is missing. To infer the missing escapement, we calculated the probability of a fish passage event per stratum (per hour per day), assuming that escapement is a Poisson random variable and that escapement was uniform over the entire migration period (i.e., fish passage within strata are independent events), due to the lack of apparent temporal trend over hours and days. The maximum likelihood estimate (MLE) of both the mean and the variance of escapement per stratum was 0.0239. Applying the MLE across the missing 254 strata yielded a modal estimate of 6 as the number of unobserved escapement events, with a 95% confidence interval from 2 to 10. This estimate added to the number of observed events (n=18) yields an estimate for total escapement of spring Chinook in 2009 of 24, with a 95% confidence interval from 20 to 28.

DIDSON Operation

Several different events occurred over the season which led to cessation or improper operation of the DIDSON for a shorter or longer duration. In the early part of the season (late May to early June), water flow was high and bore heavy sediment loads (Figure 3). Over this period, sediment progressively accumulated within the DIDSON lens, causing an increasing loss of resolution in the associated video files. As the high flows also presented a danger for a lone person to enter the water to access the DIDSON, the lens was not checked until June 16, at which time it was cleaned, and after which the files recovered their proper level of resolution. Fortunately, this problem occurred prior to the spring Chinook migration period, and thus did not affect our estimation of escapement.

As indicated previously, the propane generator failed (breakage of a copper connector to the propane adapter) in mid July, and it took approximately three weeks to order and attach a new adapter. A gasoline generator was used during a portion of the interim period, although it required refueling every two days, which was more often than we were available to visit the site.

The DIDSON ceased to function on a few other occasions, apparently due to electronic "glitches" of some sort. One of these occurrences (8/26) was identified later as failure of the high frequency circuit board. However, by switching operation of the DIDSON to low frequency we were able to continue operation, albeit with video files of somewhat lower resolution. This circuit board was subsequently replaced by Sound Metrics Corporation.

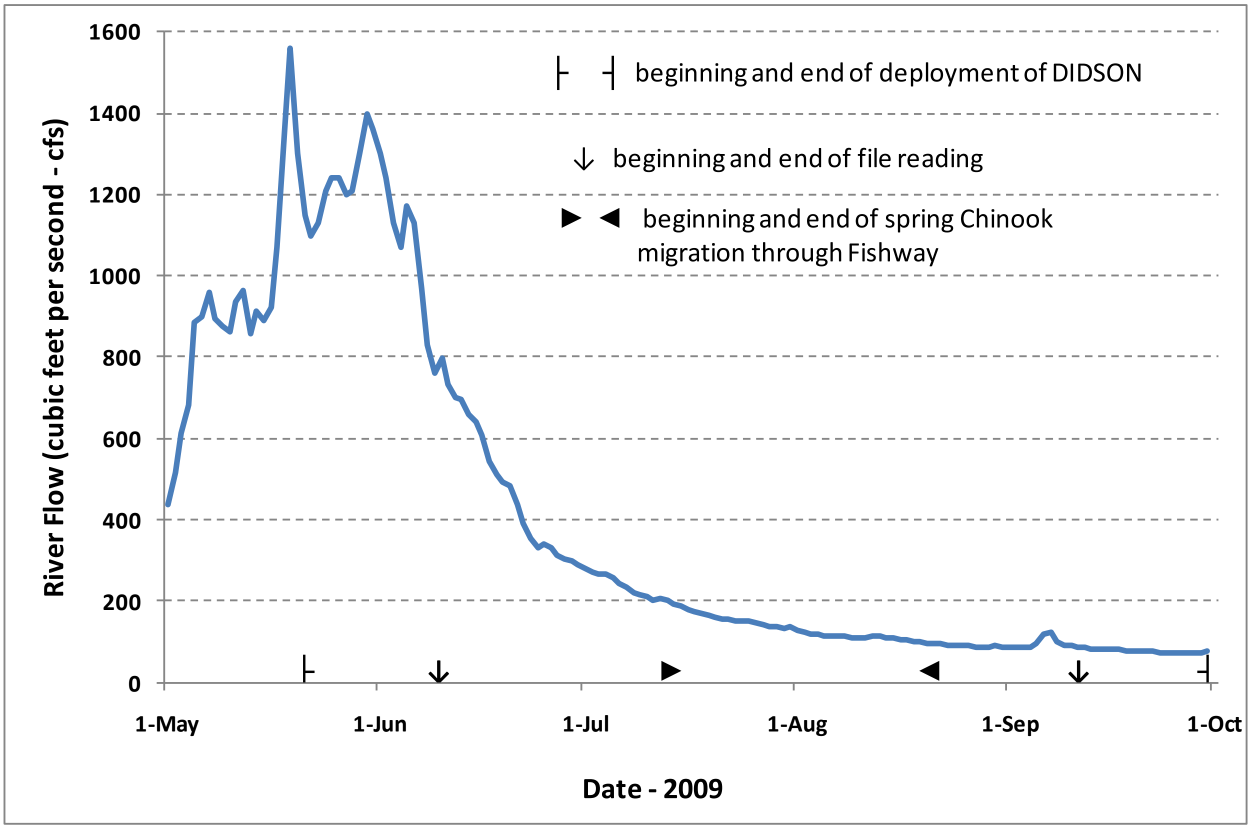

Figure 3. Flow (cfs) recorded at the USGS stream flow gauge number 14107000 (Klickitat River above West Fork near Glenwood, WA), located 1 km upstream of the Castile Falls Fishway Complex (rkm 103). (http://waterdata.usgs.gov/wa/nwis/dv?cb_00060=on&cb_00065=on&format=gif_default&begin_date=2009-1-1&end_date=2009-12-30&site_no=14107000&referred_module=sw)

DISCUSSION

The estimate derived from the DIDSON recordings for the 2009 escapement of spring Chinook to the upper basin of the Klickitat River was 24 ± 4 fish. We feel this to be a conservative estimate. There is a certain amount of subjectivity in assessing whether the size of an image of a swimming fish is sufficiently large to be that of a migrating spring Chinook salmon, versus a "medium-sized" fish that could be a small spring Chinook, i.e., jack or possibly a large resident rainbow trout. In our review of the files, we limited identification of spring Chinook to relatively large images, and therefore may have excluded some jacks from our escapement estimate.

Another issue to using a DIDSON for escapement estimation relates the relatively low resolution (relative to the image from an optical camera) of the pixellated images it provides, which precludes being able to differentiate between species of similar-sized fish. This could have presented us a problem for escapement estimation in the upper basin of the Klickitat, where there both steelhead and spring Chinook are present. However, we expected there to be a relatively distinct temporal separation in their migration through the Fishway. Steelhead migrate into the Klickitat from the Columbia River, beginning in the summer (summer run) through to early winter (winter run). They tend to hold in the lower mainstem Klickitat, before migrating up into their spawning areas for spawning from February to June the following year. In contrast, spring Chinook enter the Klickitat from late April or May, and move progressively upstream, arriving at the Klickitat Hatchery (well downstream of Castile Falls at rkm 67) from mid May to early August. While unsure when fish pass through the Fishway prior to this project, it was know that natural spawning in the upper basin does not occur until late August to mid September. As such, we anticipated that any steelhead migrating to the upper basin for spawning would have passed Castile Falls before June, with spring Chinook migration anticipated no earlier than June. This in fact appeared to be the case in 2009. With one exception, fish passage events in the files we reviewed (beginning June 10) all occurred within the July 12 to August 22 period – a time much later than expected for any steelhead passage, providing us with relatively high assurance that all of these fish were indeed spring Chinook. The one exception was observation on June 16 of a large fish. However, this fish was also moving in a downstream direction and we suspect it was a steelhead kelt migrating downstream following spawning. This observation was excluded for the spring Chinook count.

The 2009 spring Chinook escapement estimate (24 ± 4) produced from the DIDSON recordings was greater than that based on redd counts. Only four redds were observed during the 2009 YN spawning surveys in the upper basin – two on Sept. 1, one on Sept. 8, and one on Sept. 17 (Joseph Zendt, personal communication). Expanded by a 3 fish per redd factor, yields an escapement estimate of 12. Presuming the veracity of the DIDSON estimate - it being based on direct counts - the difference between the DIDSON and the redd count-based estimates may be due to one or more reasons, including:

a) The redd count is underestimated due to observers having not observed existent redds within the areas surveyed, and/or the surveys having been incomplete – that additional spawning area containing redds existed but was not surveyed.
b) The expansion factor (3 fish per redd) is under-estimated due to pre-spawn mortality, from natural causes and/or from fishing/poaching.

Plans are underway to redeploy the DIDSON to provide a spring Chinook escapement estimate of the 2010 run. We intend to follow the same basic procedures used in 2009, with the following exceptions:

a) The DIDSON and computer will be powered by a thermoelectric generator (recently installed on site to provide power to a radio-tracking receiver), which should be of increased reliability relative to the propane adapted internal combustion generator.
b) We will block an additional section of the Fishway (5 instead of 4) so that out-migration is possible through only a single section. This will permit use of a shorter Window Length, and provide improved resolution of the images.
c) The DIDSON will be deployed with a silt exclusion box.

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Appendix – Hourly counts of upstream spring Chinook passage through the Castile Falls Fishway as observed in DIDSON files recorded in 2009. “NA” indicates that a readable file was unavailable.

	June																					July									
Hour	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
3	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	NA	0	0	0	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
9	0	0	0	0	0	0	NA	0	0	0	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
10	0	0	0	0	0	0	NA	0	0	0	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	NA	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	0	NA	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	NA	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
14	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
16	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	**1***	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Σ																															

1* (presumed to be a steelhead kelt)

	July																					August								
Hour	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9
0	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
1	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
2	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	**1**	0	0	0
3	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
4	0	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	NA	NA	NA	**1**	0	NA	0	0	0	0	0	0	0	0	0
5	0	0	0	0	0	0	0	**1**	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
6	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
7	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
8	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	NA	0	0	0	0	0	0
9	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	NA	0	0	0	0	0	0
10	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
11	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
12	0	0	0	0	0	**1**	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
13	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	NA	0	NA	NA	NA	**1**	0	NA	0	0	0	0	0	0	0	0	0
14	0	0	**1**	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	**1**	NA	NA	0	0	NA	0	0	0	0	0	0	0	0	0
15	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	NA	NA	0	0	NA	0	0	**1**	0	0	0	0	0	0
16	0	0	0	0	0	**1**	0	0	NA	NA	NA	NA	NA	0	0	NA	0	0	0	0	NA	0	0	0	0	0	0	0	0	0
17	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0
18	0	**1**	0	0	0	0	0	**1**	NA	NA	NA	NA	NA	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0
19	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0
20	0	0	0	0	**1**	**1**	0	0	NA	NA	NA	NA	NA	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0
21	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	NA	NA	0	0	0	**1**	0	0	0	0	0	0	0	0	0
22	0	0	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0
23	0	0	0	**1**	0	0	0	0	NA	NA	NA	NA	NA	0	0	NA	NA	0	0	0	0	0	0	0	0	0	0	0	0	0
Σ		**1**	**1**	**1**	**1**	**3**		**2**											**2**		**1**			**1**			**1**			

	August																						September									
Hour	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	1	2	3	4	5	6	7	8	9	10
0	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0
1	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0
2	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0
3	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0
4	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0
5	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0
6	0	0	0	0	0	0	0	0	0	0	NA	NA	**1**	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	NA	0	0
7	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	NA	0	0
8	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	NA	0	0
9	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	NA	0	0
10	0	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	NA	0	0
11	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	NA	0	0
12	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	0	0	0
13	0	0	0	0	0	0	0	0	0	0	NA	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	0	0	0
14	0	0	0	0	0	0	0	**1**	0	NA	NA	0	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	NA	NA	NA	0	0	0
15	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	0	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
16	0	0	0	0	0	0	**1**	0	0	NA	NA	0	0	0	0	0	0	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
17	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	0	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
18	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	0	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
19	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
20	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
21	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
22	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
23	0	0	0	0	0	0	0	0	0	NA	NA	0	0	0	0	0	NA	NA	NA	NA	NA	0	0	0	0	0	NA	NA	NA	0	0	0
Σ							**1**	**1**					**1**																			