The Chief Joseph Hatchery Program

Okanogan River Adult Fish Pilot Weir

2020 Summary of Methods & Results

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BACKGROUND

The Okanogan adult fish pilot weir (herein referred to as the 'weir') was in its ninth year of design modifications and testing in 2020. Continued operation and improvements to the weir are a central part of CCT's strategy for the successful implementation of the CJHP summer/fall Chinook Salmon (*Oncorhynchus tshawytscha*) programs. Pilot weir test results are essential for updating key assumptions, operations and design of the weir.

Objectives for the pilot weir in 2020 included:

1. Install the weir in early July and operate until late September under allowable flow conditions (<3,000 cfs.) and temperature (<22.5 °C);
2. Document environmental effects of the weir through collection of physical and chemical data in the vicinity of the weir;
3. Test weir trapping operations and the Whooshh™ fish transport system including live Chinook capture, handling and release;
4. Direct observations and fish counts for estimating species composition, abundance, health, and timing to inform management decisions and future program operations;
5. Collect NOR and/or HOR brood stock at the weir and transport safely to the CJH;
6. Test the weir configuration, including the location of the trap box, to meet the program's biological and brood-take goals
7. Test fish entrainment through the trap entrance chute and into the trap box

METHODS

The lower Okanogan fish weir was installed approximately 1.5 km downstream of Malott, WA (48°16'21.54 N; 119°43'31.98 W) in approximately the same location as previous years. Weir installation began on August 17th at a river flow of 1,900 cfs. and was completed with the underwater video system on August 21st. An aluminum trap was installed near the center of the channel at the downstream end of the deep pool in the thalweg of the channel. The trap was 3 m wide, 6 m long and 3 m high (Figure 1). A fifteen-foot aluminum accelerator chute was installed at the downstream trap gate. The wings of the weir stretched out from either side of the chute towards the river banks, angling downstream in a slight V configuration. The wings consisted of steel tripods with aluminum rails that supported the 3 m long Acrylonitrile butadiene styrene (ABS) pickets. Each panel was zip-tied to the adjacent panel for strength and stability. Gravel bags were placed between panels when needed to fill gaps that exceeded the target picket spacing. Picket spacing ranged from 2.5 to 5.1 cm (1 to 2 inch) in 1.2 cm. (half-inch) increments (Figure 2). Pickets were manually forced into the river substrate upon deployment and then as needed to prevent fish passage under the weir.

The river-right wing consisted entirely of 2.5 cm. picket spacing (Figure 2). A 3 m gap between the last panel and the right shoreline remained to allow for portage of small vessels around the weir. This was a very shallow gravelly area and under most flow conditions it did not appear to be a viable path for adult salmon passage. However, a set up floating panels that were attached to the substrate extended from the last panel to the river-right shore to limit escapement via this route. The river left wing had variable picket spacing to accommodate non-Chinook fish passage through the pickets. The primary objective of the wider picket spacing was to allow sockeye (*O. nerka*) to pass through the weir and reduce the number of sockeye that would enter the trap. River left was selected for this spacing to better accommodate observation/data collection regarding successful passage of smaller fish through the panels.

Figure 1. Lower Okanogan adult fish pilot weir, 2020. Photo taken in late- August..

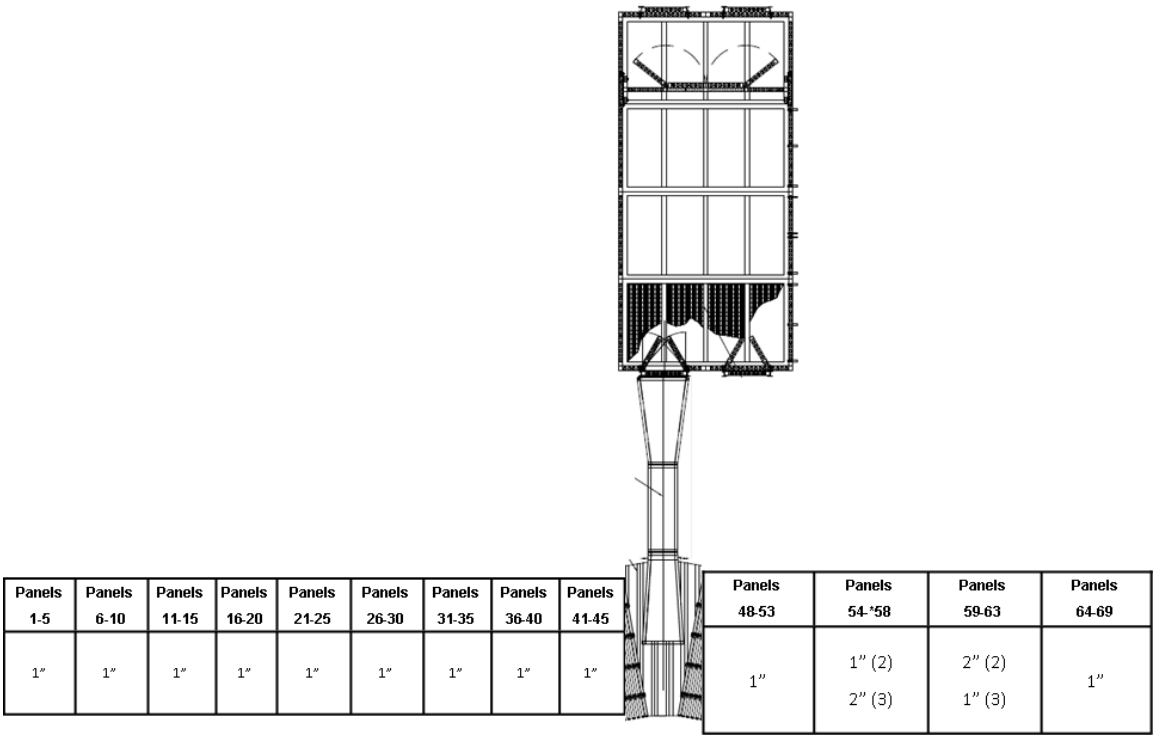

Figure 2. Conceptual diagram of picket (ABS pipe) spacing within each panel (or set of 5 panels) at the Lower Okanogan. A 15 ft. entrance chute was installed at the lower trap gate in 2020.

Physical and chemical data were collected in the vicinity of the weir including the water depth (ft..) inside the trap, water velocity (ft./sec.) upstream, downstream and in the weir trap, dissolved Oxygen (mg./L), total dissolved solids (TDS)(ppm.), turbidity (NTU), temperature (°C), discharge (cfs.) and head differential (cm.). Temperature and discharge were taken from the online data for the USGS gauge at Malott (http://waterdata.usgs.gov/wa/nwis/uv?site_no=12447200). When river temperature exceeded 22.5° C, trapping operations ceased and weir pickets on panels adjacent to the trap on both sides were raised to allow for unrestricted fish passage.

Five minute tower observations were conducted at least two times a day, in the morning (0600-0800) and early afternoon (1200-1400) and an estimate of the number fish observed was recorded. Ten minute bank observations were conducted about 0.8 river km. downstream of the weir, around two pools, at least twice a day, in the morning and afternoon. An estimate of the number of fish observed below the weir was recorded. Algae and debris were cleared off of the weir at least once per day generally during mid-day (1100-1300). Dead fish on the upstream side of the weir were enumerated, identified to species and the presence and extent of injuries were noted. The tail was cut off of each mortality before they were tossed downstream of the weir so that they would not be double counted during surveys.

Weir efficiency, a measure of the proportion of total spawning escapement encountered by the weir, was calculated by the equation;

$$X = \frac{W_T}{T}$$

where X was weir efficiency, W_T was the number of adult summer/fall Chinook encountered in the weir trap including released fish, and T was the total summer/fall Chinook spawning escapement for the Okanogan River Basin.

Weir effectiveness was a measure of the proportion of the adult hatchery Okanogan summer/fall Chinook run encountered in the weir trap, becoming available for removal from the population as a form of adult fish management. It was calculated by the equation;

$$Y = \frac{W_H}{W_H + HOS}$$

where Y is weir effectiveness, W_H is the number of adult hatchery origin fish encountered in the weir trap, and HOS is the total number of hatchery origin spawners.

Trapping operations were conducted under allowable temperature (≤22.5° C) and head differential (<10 cm.) conditions for the season. Trapping operations began on August 27 and continued until September 24. When fish entered the trap during an active trapping session, the downstream fyke was closed and fish were identified and either released or collected for brood.

Eighty-four natural-origin Chinook were collected from the weir trap from August 31 –September 22 and transported to a 2,500 gallon hatchery truck via a rubber boot. The fish were then transported approximately 32 km to Chief Joseph Hatchery where they were held in the brood stock raceways until spawning in October. The Whoooshh™ fish transport system was not deployed in 2020 staffing was limited to effectively operate the system during the season.

RESULTS

The Okanogan River (at Malott) discharge was above normal in 2020, which delayed deployment of the weir until August 17 when the river flow went below 2,000 cfs (Figure 3). Discharge continued to drop throughout the season and was approximately 1,000 cfs by the time the weir was removed for the season on September 24.

Migration of sockeye and summer/fall Chinook is generally affected by a thermal barrier that is caused by warm water temperatures (≥~22 °C) in the lower Okanogan River. The thermal barrier is dynamic within and between years, but it generally sets up in mid-July and breaks down in late August. In some years, the Okanogan River will temporarily cool off due to a combination of interrelated weather factors including rainstorms, cool weather, cloud cover and/or wildfire smoke. This 'break' in the thermal barrier can allow a portion of the fish holding in the Columbia River to enter the Okanogan

and migrate up to thermal refuge in the Similkameen River or Lake Osoyoos. In 2020, temperatures were similar to the median daily temperatures from the last 13 years (Figure 4). Daily mean temperature was above 22.5 °C from July 21 to August 24. Daily mean temperature dropped below 22.5 °C on August 25th and stayed below this mark until the end of the season.

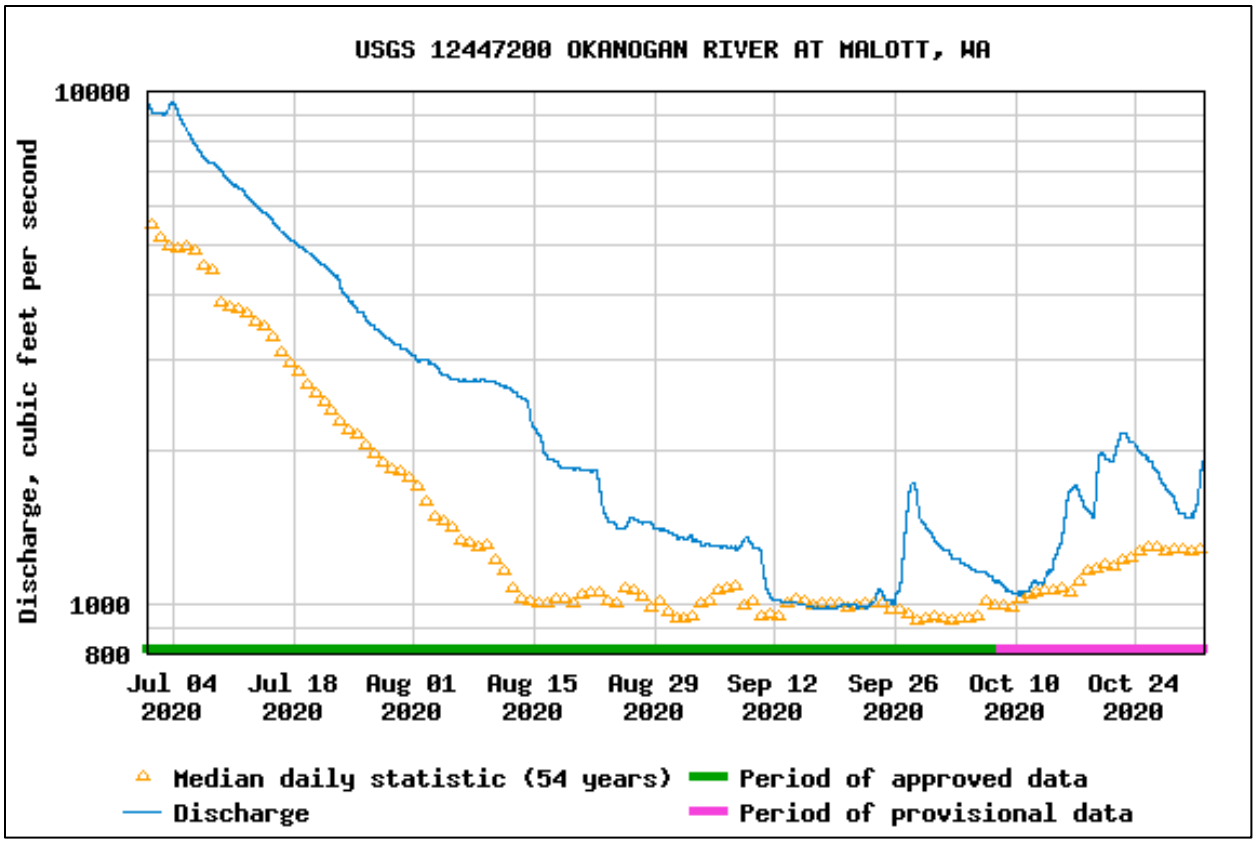

Figure 3. Discharge of the Okanogan River between July 1 and October 31, 2020. This figure was copied directly from the USGS website (http://nwis.waterdata.usgs.gov/wa).

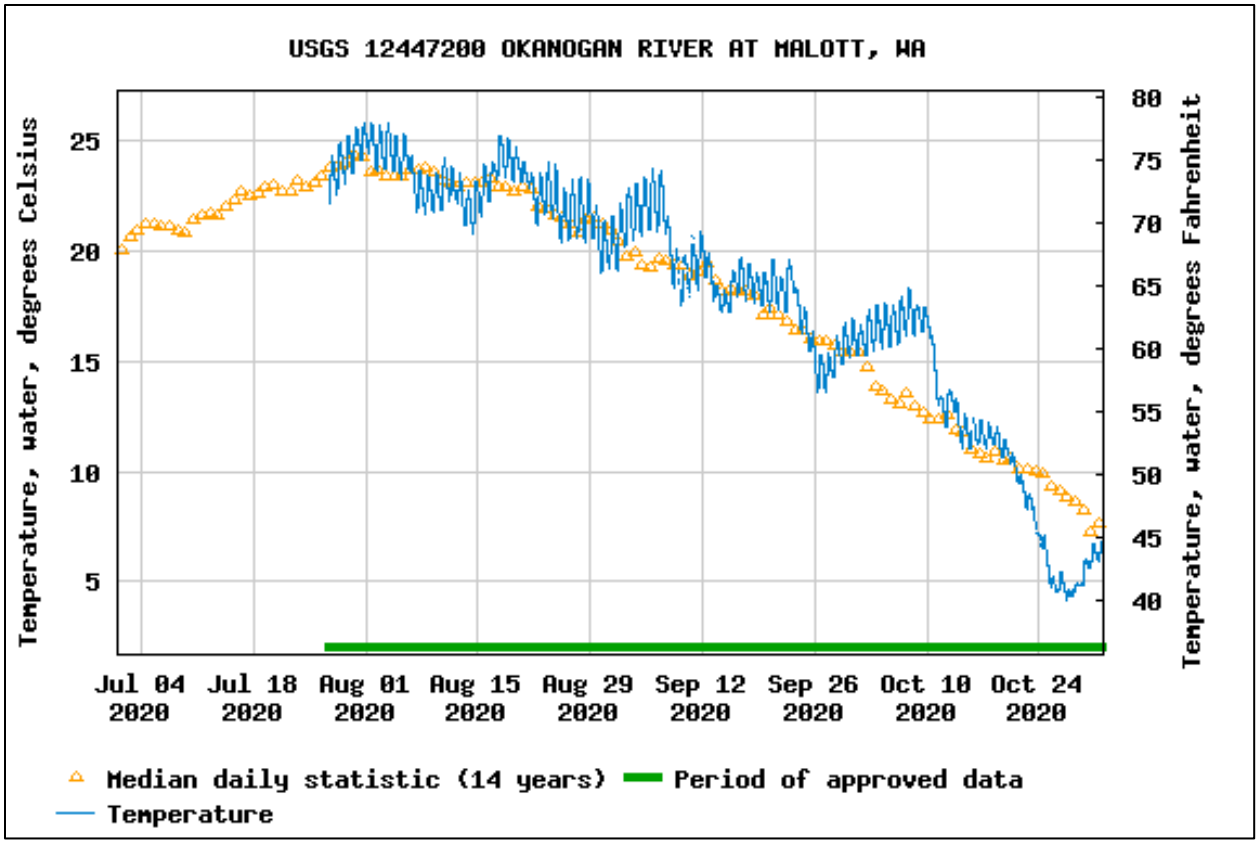

Figure 4. Temperature of the Okanogan River between July 1 and October 31, 2020. This figure was copied directly from the USGS website (http://nwis.waterdata.usgs.gov/wa).

Dissolved Oxygen varied from 6.9 to 8.3 mg. /L, total dissolved solids varied from 129-180 ppm and turbidity varied from 0.7 and 2.1 NTUs (Table 1). The head differential was measured only when pickets were down and ranged from 1.0-4.0 cm. The maximum water velocity measured was 3.4 ft. /sec. (Table 2).

Table 1. Water quality data at or near the lower Okanogan weir in 2020. Temperature and discharge were taken from the USGS gage at Malott. Minimum depth allowed for trap depth is 6 inches and optimal dissolved oxygen levels for adult Chinook should not drop below 6 mg/L.

Date	Trap Depth (ft)	Dissolved Oxygen (mg/L)	Total Dissolved Solids (ppm)	Turbidity (NTU)	Mean Temperature (◦C)	Mean Discharge (cfs)
8/24	1.7	7.80	180	1.2	23	1,430
8/25	1.7	7.80	134	1.4	22	1,470
8/26	1.7	7.85	132	2.1	22	1,470
8/27	1.7	7.74	133	1.3	22	1,450
8/28	1.7	8.01	135	2.0	22	1,440
9/2	1.6	7.89	139	1.3	22	1,330
9/3	1.6	7.00	133	1.5	22	1,300
9/4	1.6	6.93	136	1.1	22	1,300
9/5	1.6	7.05	139	1.1	22	1,290
9/9	1.5	7.98	133	0.8	19	1,290
9/10	1.5	8.23	132	0.8	19	1,190
9/11	1.4	7.36	134	1.6	20	1,030
9/14	1.3	7.98	129	0.7	18	1,010
9/15	1.5	7.46	134	1.2	18	997
9/17	1.4	8.30	138	0.8	19	982
9/18	1.4	7.65	136	0.8	19	984
9/21	1.4	7.41	131	0.8	18	993
9/22	1.4	7.75	135	0.8	19	989
9/23	1.4	7.25	137	1.1	18	1020
Min	1.3	6.9	129	0.7	18	982
Max	1.7	8.3	180	2.1	23	1,470

Table 2. Water velocity upstream (US) and downstream (DS) of the weir and in the trap. Velocity should not exceed 3.5 ft. /sec. Measurements are in ft. /sec.

Date	River Left US	US Center	River Right US	River Left DS	DS Center	River Right DS	Trap Velocity
8/24	1.8	1.9	2.7	2.6	2.3	3.4	1.0
8/25	1.8	1.9	2.7	2.5	2.3	2.7	1.3
8/26	1.9	1.9	2.5	3.0	2.0	2.8	1.0
8/27	1.6	1.6	2.5	2.4	2.5	3.1	1.2
8/28	1.6	1.5	1.9	2.7	2.5	3.1	1.1
8/31	2.4	1.8	2.0	2.8	2.9	2.9	1.1
9/2	1.4	1.4	2.9	3.0	2.3	2.5	1.2
9/3	1.7	1.4	2.8	3.2	2.3	2.3	1.2
9/4	1.3	1.2	2.1	2.6	2.6	2.4	1.1
9/5	1.8	1.4	2.5	2.3	2.1	2.3	1.4
9/10	2.0	1.4	1.7	2.7	2.2	2.0	1.1
9/11	1.3	1.4	1.5	2.9	2.3	2.1	1.0
9/14	1.7	1.5	2.3	2.1	1.9	2.5	1.0
9/15	1.7	1.4	1.8	2.3	2.4	3.2	1.5
9/17	1.4	1.5	1.5	2.4	3.0	2.0	0.9
9/18	1.1	1.4	1.6	2.3	2.2	3.0	1.0
9/21	1.2	1.2	1.6	2.0	2.2	2.6	0.8
9/22	1.3	1.2	2.1	2.0	2.4	2.6	0.9
9/23	1.5	1.3	1.3	2.1	2.2	2.5	0.8
Min	1.3	1.2	1.5	2.1	1.9	2.0	0.9
Max	2.4	1.9	2.9	3.2	3.0	3.4	1.5

One hundred and forty-five dead fish were removed from the weir between August 28 and September 24. The majority of the mortalities (67) were sockeye and 23 of the mortalities were Chinook. All mortalities were impinged on the upstream side of weir indicating that they had most likely died upstream and floated down onto the weir.

Tower observations showed that about half the fish were milling in the center section of the river, just below the trap with the rest being equally split between the river right and river left sections (looking downstream). Estimates were highest during the last weekend of August when mean daily river temperatures dropped below 22.5 °C. Bank observations showed that the number fish observed holding in the lower pool, 0.8 km below the weir, increased about one week after the thermal barrier breakdown in late August (Figure 5). Trapping operations were conducted from August 27-September 24 when river temperature was ≤ 22.5 °C. The total fish trapped at the weir in 2020 was 931 with 93% of them being Chinook salmon (Figure 6). Seventy-two percent of the Chinook trapped were released back into the river (Figure 7). Twenty-seven steelhead were trapped in 2020.

Eighty-four natural-origin Chinook were transported to the hatchery and held in the brood stock ponds concurrently with the fish taken for brood stock from the purse seine. Adult Chinook were transported from the weir trap to the hatchery brood truck via a rubber boot. We were unable to assess the pre-spawn mortality of the weir brood because they were mixed with the rest of the integrated brood when they were transported to the hatchery. Past efforts have not indicated a problem with survival of brood fish collected at the weir. If we need to assess pre-spawn mortality in future years, we will need to mark these fish before they are transported to the hatchery or before they are mixed with the other brood at the hatchery.

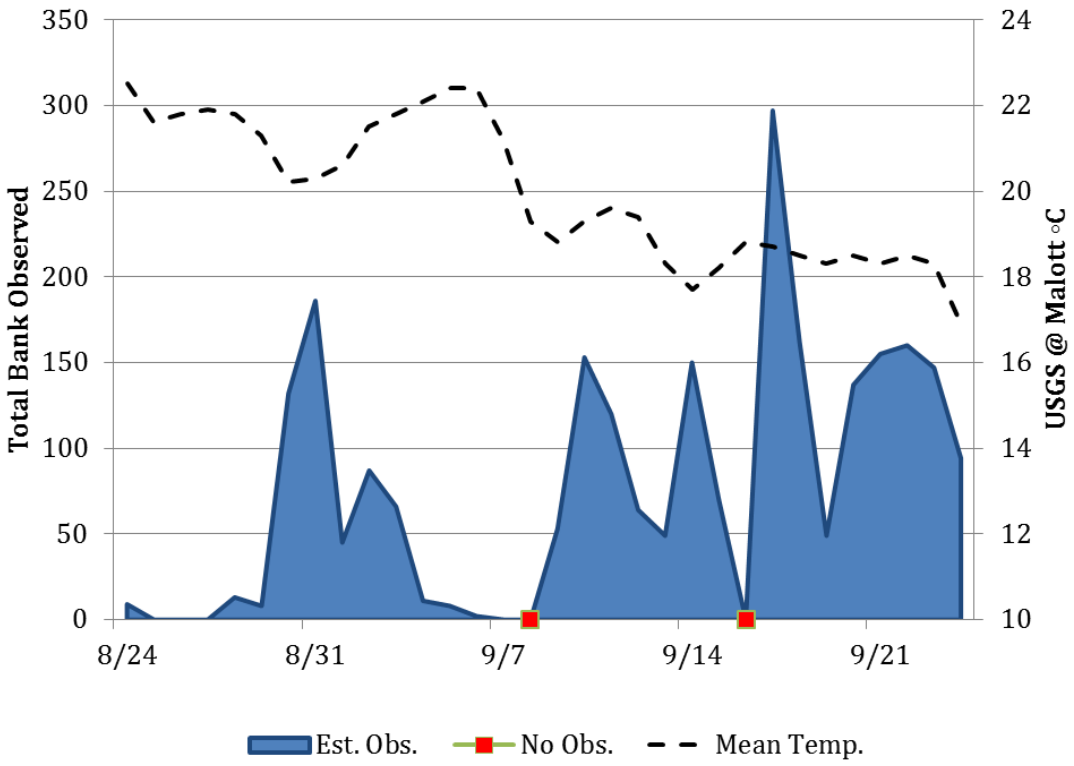

Figure 5. Estimate of Chinook observed from the bank at the lower pool, 0.8 km downstream of the weir.

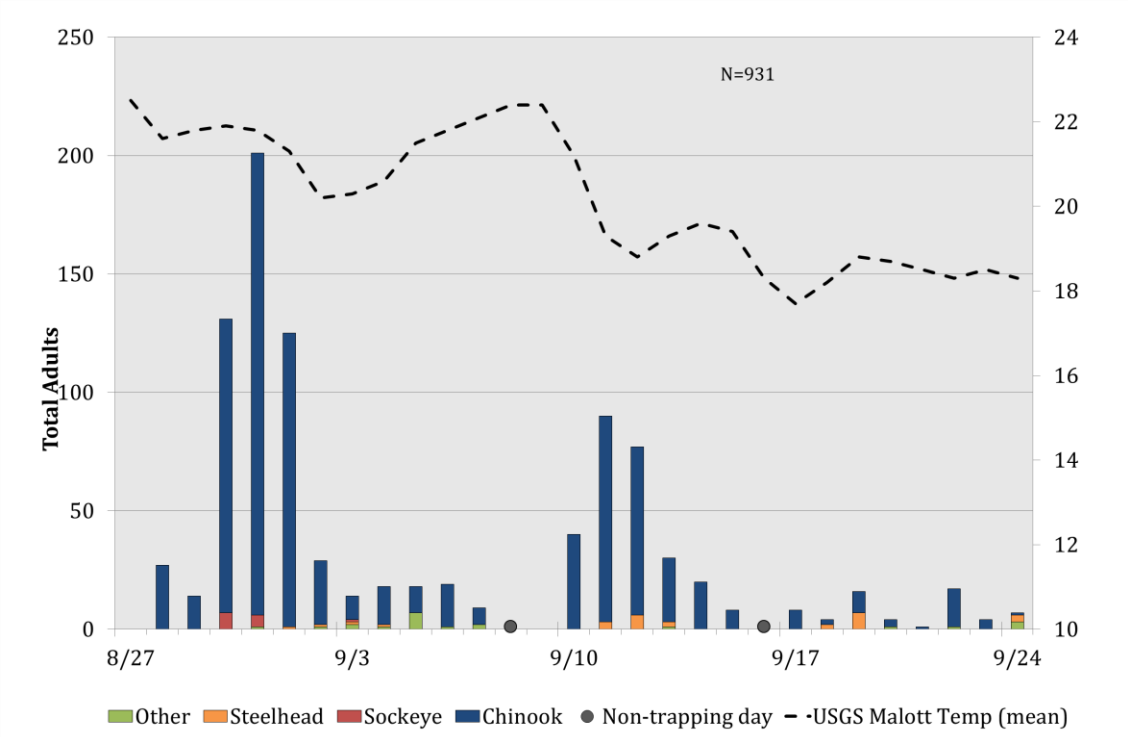

Figure 6. Total number of fish trapped at the Okanogan weir in 2020.

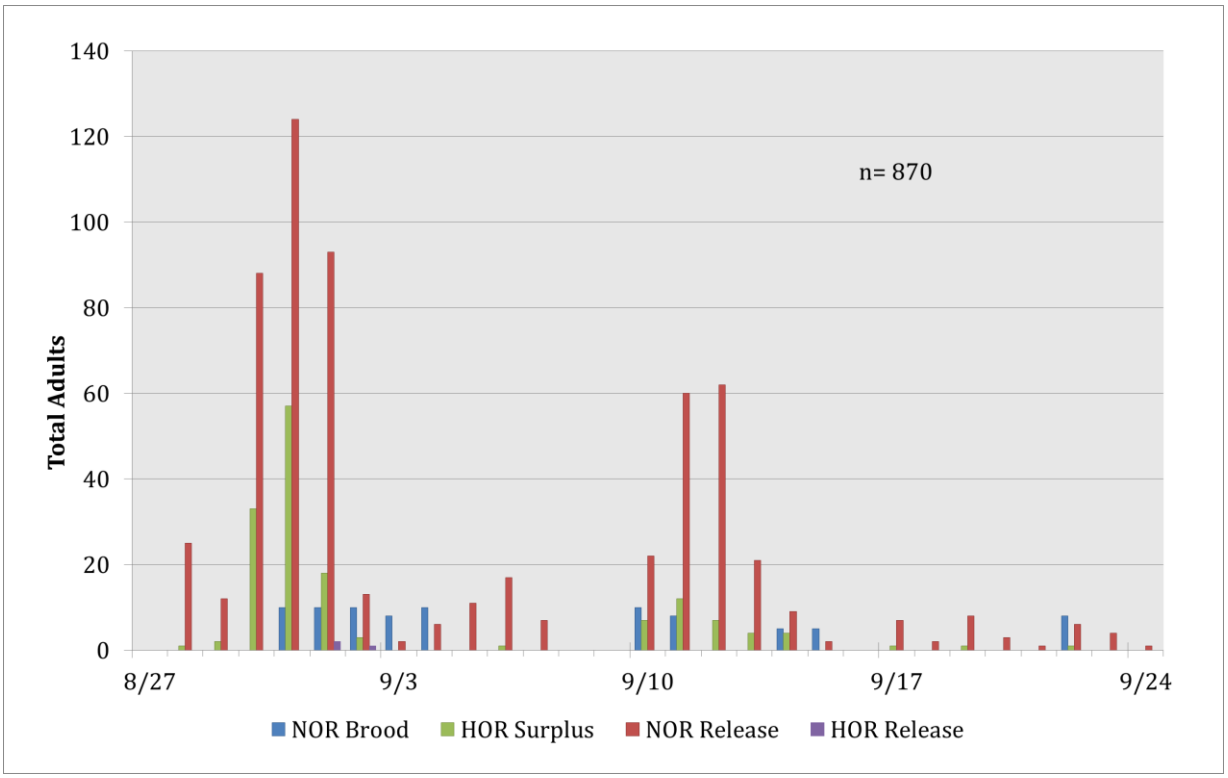

Figure 9. Final destination of Chinook adults captured in the weir trap during trapping operations in 2020.

In 2020, 0.065 (6.5%) of total spawning escapement was detected in the trap (i.e., weir efficiency) (Table 3). The potential weir effectiveness (after removing all of the HOR encountered) was 0.043 (4.3%).

Table 3. The number of hatchery and natural origin Chinook Salmon encountered at the lower Okanogan weir in 2020. Weir efficiency and effectiveness were metrics for evaluating the potential for the weir to contribute to the CJHP population management goals in the future.

Survey Year	Number of Days Trapped	Chinook Adults Encountered in the Weir Trap		Chinook Spawning Escapement Estimates[c,d]		Weir Metrics	
		Natural Origin (NOR)	Hatchery Origin (HOR)	Natural Origin (NOS)	Hatchery Origin (HOS)	Weir Efficiency[a]	Weir Effectiveness[b]
2013	23	73	18	5,627	2,567	0.010	0.007
2014	34	2,006	318	10,407	1,756	0.147	0.140
2015	34	36	19	10,439	3,297	0.004	0.005
2016	30	135	34	8,700	1,905	0.014	0.016
2017	24	344	103	5,429	1,139	0.058	0.075
2018	38	32	16	3,266	1,594	0.009	0.009
2019	5	119	24	2,604	2,849	0.023	0.008
2020	27	709	161	7,957	3,062	0.066	0.045

[a] Estimates for weir efficiency are adjusted for prespawn mortality and include Chinook adults that are harvested, released, and collected for brood.

[b] Estimates for weir effectiveness are adjusted for prespawn mortality and include Chinook adults that are harvested or removed for pHOS management.

[c] Estimates do not include Chinook Zosel Dam counts through 2017, the last year of the project

[d] NOS and HOS estimates determined by 'reach-weighted' pHOS calculations

Discussion

Discharge conditions on the Okanogan River in 2020 were quite a bit higher than those in previous years, restricting installation of the weir until mid- August, which was a month later than 2019. Temperatures on the Okanogan River were fairly normal, compared to the 13 year median. Temperature was not a factor for trapping operations once it began on August 27th. Tower observations were relatively low for the majority of the season outside of the last week in August. Observations of fish from the bank of the downstream pool increased after the water temperature stayed below 20 °C in mid- September. In September, fish observations 0.8 km. below the weir, at the lower pool, were higher than observations at the weir. When river temperature was lower and gage height was less than

4 feet, Chinook were more likely to mill in deeper pools. In previous years tower observations were much higher in September, so it's reasonable that there were more fish milling in the lower pool than there were milling around the weir in September. Continued monitoring of Chinook passage through the weir with respect to temperatures should continue in order to better refine weir operations and future expectations for weir effectiveness.

The number of Chinook handled at the weir (n = 870) was more than the average (n=468). Configuration of the weir was similar to that in 2019 with the trap installed downstream, on the edge of the thalweg, and below the deep pool. The fish entrance chute was included with the trap gate again to test whether it would increase entrainment to the trap box. We evaluated the water conditions as it relates to discharge and stage height and think that we should continue to install the trap at the same location as 2020 to continue testing it with the chute.

None of the water quality parameters monitored were at a level that would cause concern regarding an environmental effect of the weir on water quality. The number (23) of dead fish at the weir was similar to other years with similar run sizes. There were no fish impinged between pickets (head upstream) in 2020.

There were thirteen sockeye trapped in 2020. When pickets were down and the trap was operating, there were no observations of jack or small adult Chinook escaping through the 2" weir panels, but we did observe several sockeye pass through the panels during the day. We will continue to use the 2-inch weir panels again next year to increase the efficiency of Chinook trapping without causing too many sockeye to also use the trap.

There was no way to know exactly how many fish escaped past the weir before it was installed or how many fish swam through while the pickets were up or jumped over the sealing aprons after it was installed. The potential weir effectiveness measure of 4.3% was the third highest to date. Although the barrier broke down in late August, this did not affect fish management objectives in 2020. With a higher adult return, CCT was able to collect their full brood stock quota (84) at the weir and remove about 4% of the hatchery-origin returns. In the future, with larger returns of hatchery fish due to CJH releases we anticipate a much higher pHOS at the weir resulting in higher weir effectiveness. Continuing these evaluations in future years will be critical to determining the long-term viability of the weir as a fish management tool for summer/fall Chinook.

In 2020 CCT F&W staff were able to safely and successfully deploy, operate, and monitor the weir and add to the multi-year evaluation of the weir as a fish management tool for the CJH program. The program experience a larger run than the previous two years which allowed the program to successfully collect brood stock for the hatchery's integrated program and remove a portion of the hatchery-origin returns to manage pHOS. The weir's importance to successful management of the Okanogan summer/fall Chinook population should continue in the coming years with larger hatchery returns resulting

from the increased production at CJH. Experiencing a broad range of environmental conditions spanning the extremely high summer flows of 2012 to the very low and warm flows in 2015 or high algal densities in 2019, is important for understanding the range of challenges and resulting weir effectiveness that can be expected through time.