The Chief Joseph Hatchery Program

Okanogan River Adult Fish Pilot Weir

2015 Summary of Methods & Results

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Funding Source:	Bonneville Power Administration (current), Grant County Public Utility District (6/2011 – 4/30/2013)
Agreement No.	430-3128 – Amendment No. 3
BPA Project No.	2003-023-00
Revised:	25 January, 2016

BACKGROUND

The Okanogan adult fish pilot weir (herein referred to as the 'weir') was in its fourth year of design modifications and testing in 2015. 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 2015 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 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 broodstock at the weir and transport safely to the CJH;

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 July 15th at a river flow of 1,250 cfs and was complete with the underwater video system on July 23rd. An aluminum trap was installed near the center of the channel at the upstream 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). The wings of the weir stretched out from either side of the trap 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. Sand bags were placed between panels when needed to fill gaps that exceeded the target picket spacing. Picket spacing ranged from 2.5 to 7.6 cm (1 to 3 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.

Figure 1. Lower Okanogan adult fish pilot weir, 2015. Photo taken in late August, one week after start of the Okanogan Complex wildfire.

The river-right wing consisted entirely of 2.5 cm picket spacing. 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 block net was set up 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. In past years CCT has observed jack and even adult Chinook passing through the 7.6 cm picket spacing panels. To reduce the escapement of smaller hatchery Chinook, CCT wanted to partially block the 7.6 cm panels once the majority of sockeye had passed the weir. After consultation with the Technical Oversight Group (TOG), aluminum grating was placed on the 7.6 cm picket spacings on August 28th.

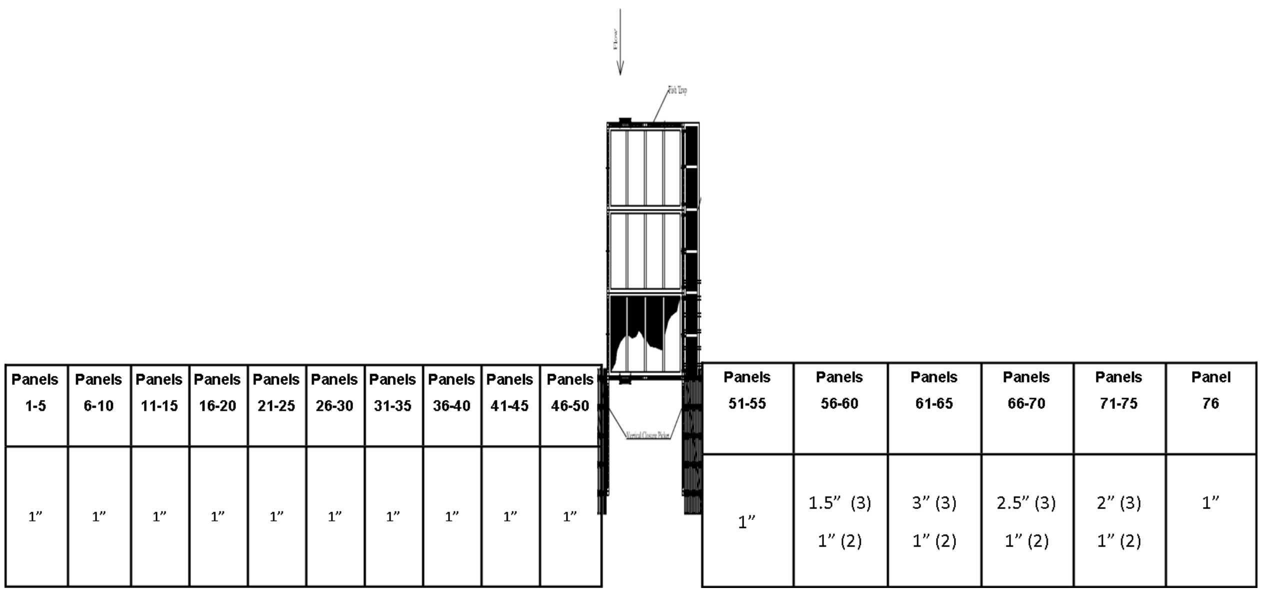

Figure 2. Conceptual diagram of picket (ABS pipe) spacing within each panel (or set of 5 panels) at the Lower Okanogan adult fish pilot weir in 2015.

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 (July 27-August 26) 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 three times a day, in the morning (0600-0800), early afternoon (1200-1400) and evening (1700-1900) 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 (July 22-August 20, August 25-September 24), generally in the morning (0800-1000). 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 boat 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 during daylight hours, generally 0600-2000, under allowable temperature conditions (≤22.5° C) from July 27 to September 24. Trapping operations were ceased from August 20 to 26 due to a ban on fieldwork and safety concerns related to the forest fires. When fish entered the trap during an active trapping session, the downstream gate was closed and fish were identified and either released, surplussed or collected for brood. Nineteen natural origin Chinook were collected from the weir trap from September 11 to September 20, transported to shore via a fish boot (rubber tire inner tube) and immediately taken to a 2,500 gallon hatchery truck. The fish were then transported approximately 32 km to Chief Joseph Hatchery where they were held in the broodstock raceways until spawning in mid-October.

RESULTS

The Okanogan River (at Malott) discharge was below normal in 2015 and was below 800 cfs for the trapping season. Staff were able to safely enter the river and begin installation on July 15 when discharge was 1,250 cfs (

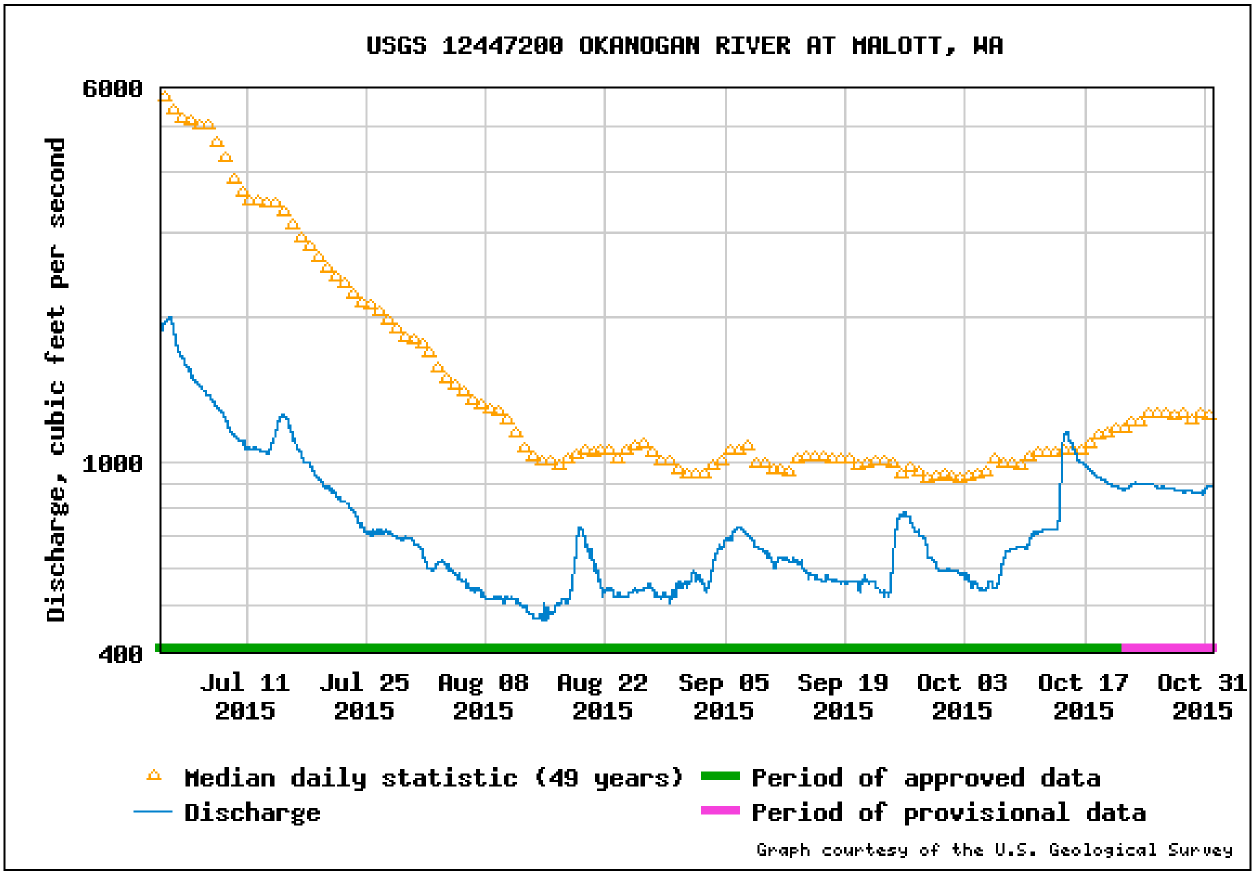

Figure 3). Discharge continued to drop rapidly throughout the installation period until August 15 when levels stabilized between 500-700 cfs for the rest of the season.

Migration of Sockeye and summer 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 generally it 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 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 2015, temperatures were similar to, though occasionally higher than the median daily temperatures from the last 49 years (Figure 4). Temperature was above 22.5 °C on July 1 when flow was 1,930 cfs. Temperatures stayed above 22.5 °C until July 25. From July 26 to July 28 temperature varied between 20.5 °C and 24.5 °C and then stayed above 22.5 °C on July 29 for one week. Temperature varied again between 24.7°C and 20.9 °C from August 5-7 and then stayed above 22.5 °C on August 8 for several weeks. As of August 21, temperatures stayed below 22.5 °C for the rest of the season.

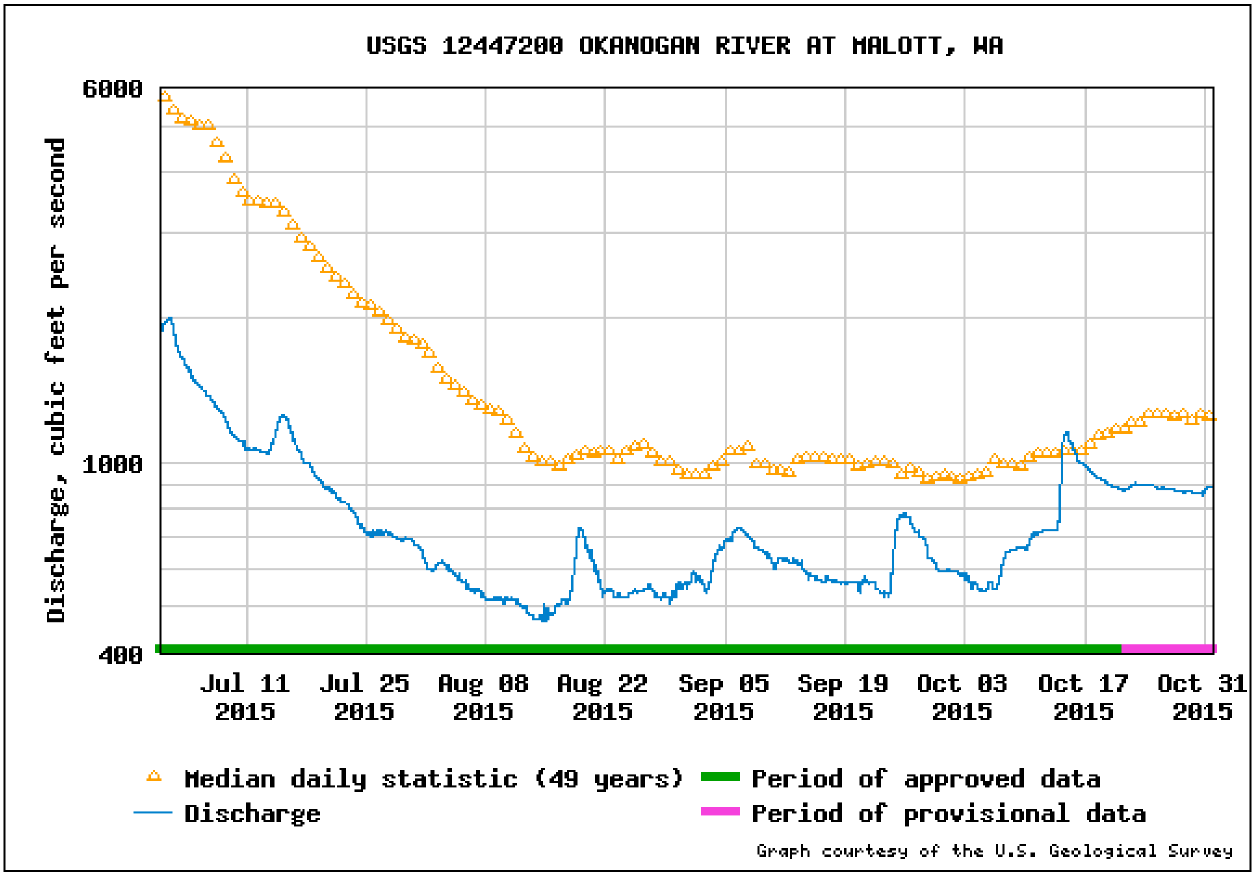

Figure 3. Discharge of the Okanogan River between July 1 and October 31, 2015. This figure was copied directly from the USGS website (http://nwis.waterdata.usgs.gov/wa).

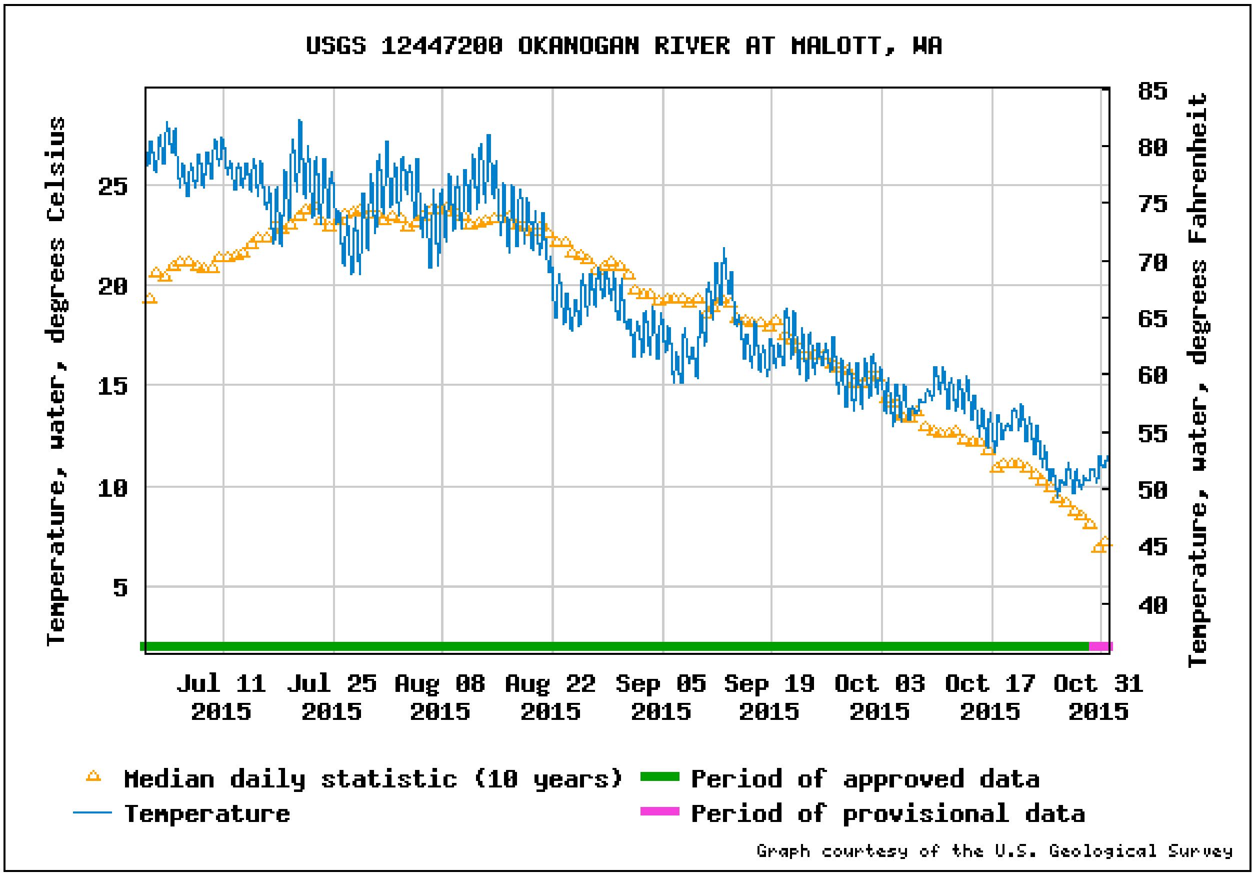

Figure 4. Temperature of the Okanogan River between July 1 and October 31, 2015. This figure was copied directly from the USGS website (http://nwis.waterdata.usgs.gov/wa).

Dissolved Oxygen varied from 5.5 to 10.2 mg/L, total dissolved solids varied from 119-160 ppm and turbidity varied from 0.7 and 2.1 NTUs (Table 1). The head differential ranged from 0-4 cm across the weir panels (Table 2). The maximum water velocity measured was 2.5 ft./sec. (Table 3).

Table 1. Water quality data at or near the lower Okanogan weir in 2015. Temperature and discharge were taken from the USGS gauge at Malott.

Date	Trap Depth (ft.)	Dissolved Oxygen (mg/L)	Total Dissolved Solids (ppm)	Turbidity (NTU)
7/27	2.2	8.2	139	0.9
7/28	2.2	9.0	135	0.9
7/29	2.2	8.3	139	0.9
7/30	2.1	8.7	134	0.8
7/31	2.1	8.7	140	1.1
8/3	0.6	9.4	147	1.2
8/4	2.1	6.0	146	1.1
8/5	2.0	10.2	127	1.2
8/6	2.0	10.2	143	1.1
8/7	0.6	9.6	129	1.2
8/10	2.0	8.4	154	1.5
8/11	0.6	9.4	152	1.5
8/12	2.0	7.2	160	1.4
8/13	0.6	6.5	160	1.2
8/14	2.0	5.7	160	1.3
8/17	2.0	7.6	158	1.3
8/18	2.1	7.7	154	1.8
8/19	2.2	7.5	150	1.2
8/20	0.6	7.9	148	1.4
8/27	2.0	9.7	144	1.1
8/28	2.0	6.1	138	0.8
8/29	2.0	6.0	141	1.3
8/30	2.1	6.2	140	1.1
8/31	2.1	6.0	140	1.5
9/1	2.1	6.2	134	1.1
9/2	2.1	5.6	131	0.8
9/3	2.1	6.2	137	1.2
9/4	0.8	6.1	130	1.0
9/5	2.2	5.5	133	0.8
9/6	2.2	5.7	123	1.2
9/7	2.2	9.9	122	0.9
9/8	2.2	8.1	119	2.1
9/9	2.2	8.5	120	0.8
9/10	2.2	8.3	124	0.7
9/11	2.2	7.7	128	0.7
9/12	0.7	7.8	131	0.8
9/13	2.1	7.8	131	0.8
9/14	2.1	6.8	130	0.8

Date	Trap Depth (ft.)	Dissolved Oxygen (mg/L)	Total Dissolved Solids (ppm)	Turbidity (NTU)
9/15	2.1	6.6	127	0.9
9/16	2.1	6.8	125	0.9
9/17	2.1	6.8	124	1.4
9/18	2.1	7.6	126	0.8
9/19	2.1	6.9	128	1.1
9/20	2.1	7.1	131	1.2
9/21	2.1	7.1	134	0.9
9/22	2.1	6.6	131	1.1
9/23	2.1	6.7	130	0.9
9/24	2.1	6.9	129	1.1
Min	0.6	5.5	119	0.7
Max	2.2	10.2	160	2.1

Table 2. Head differential across the different picket spacings. If differential exceeded 10 cm, pickets were cleaned immediately. Measurements are in cm. Daily mean gage height is included in feet. Gage height is copied directly from the USGS website (http://nwis.waterdata.usgs.gov/wa).

Date	1.0" Picket Spacing (cm)	1.5 Picket Spacing (cm)	2.0" Picket Spacing (cm)	2.5" Picket Spacing (cm)	3.0" Picket Spacing (cm)	Gage Height (ft.).
07/23	4.0	3.0	1.0	4.0	3.0	2.90
07/24	2.0	1.5	1.5	1.5	1.5	2.84
07/27	2.0	1.5	1.5	1.5	1.5	2.82
07/28	1.5	1.5	0.5	0.5	1.5	2.80
07/29	1.5	0.5	0.5	0.5	0.5	2.79
07/30	1.5	0.5	1.5	1.5	1.5	2.78
07/31	1.5	0.5	0.5	0.5	0.5	2.74
08/03	1.5	0.5	0.5	0.5	0.5	2.69
08/04	0.5	0.5	0.5	0.5	0.5	2.65
08/05	1.0	0.5	0.5	0.0	0.0	2.63
08/06	1.5	0.5	0.5	0.5	0.5	2.60
08/07	1.5	0.5	0.5	0.5	0.5	2.59
08/10	1.5	0.5	0.5	0.5	0.5	2.57
08/11	1.0	0.0	0.0	0.0	0.5	2.57
08/12	0.5	0.5	0.5	0.5	0.5	2.54
08/13	0.5	0.5	0.0	0.0	0.0	2.52
08/14	1.0	0.5	0.5	0.5	0.5	2.52
08/17	1.5	0.5	0.5	0.5	0.5	2.57
08/18	1.5	0.5	0.5	0.5	0.5	2.74
08/19	1.5	0.5	0.5	0.5	0.5	2.79
08/20	1.5	0.5	0.5	0.5	0.5	2.70
08/28	1.5	0.5	0.5	0.5	0.5	2.58
08/29	1.5	0.5	0.5	0.5	0.5	2.58
08/30	1.5	0.5	0.5	0.5	0.5	2.61
08/31	1.5	0.5	0.5	0.5	0.5	2.62
09/01	1.5	0.5	0.5	0.5	0.5	2.65
09/02	1.5	0.5	0.5	0.5	0.5	2.62
09/03	1.5	0.5	0.5	0.5	0.5	2.68
09/04	1.5	0.5	0.5	0.5	0.5	2.76
09/05	1.5	0.5	0.5	0.5	0.5	2.79
09/06	1.5	0.5	0.5	0.5	0.5	2.84
09/07	1.5	0.5	0.5	0.5	0.5	2.81
09/08	1.5	0.5	0.5	0.5	0.5	2.77
09/09	1.5	0.5	0.5	0.5	0.5	2.74
09/10	1.5	0.5	0.5	0.5	0.5	2.70
09/11	1.5	0.5	0.5	0.5	0.5	2.71
09/12	1.5	0.5	0.5	0.5	0.5	2.71

Date	1.0" Picket Spacing (cm)	1.5 Picket Spacing (cm)	2.0" Picket Spacing (cm)	2.5" Picket Spacing (cm)	3.0" Picket Spacing (cm)	Gage Height (ft.).
09/13	1.5	0.5	0.5	0.5	0.5	2.70
09/14	1.5	0.5	0.5	0.5	0.5	2.66
09/15	1.5	0.5	0.5	0.5	0.5	2.65
09/16	1.5	0.5	0.5	0.5	0.5	2.64
09/17	1.5	0.5	0.5	0.5	0.5	2.64
09/18	1.5	0.5	0.5	0.5	0.5	2.63
09/19	1.5	0.5	0.5	0.5	0.5	2.63
09/20	1.5	0.5	0.5	0.5	0.5	2.62
09/21	1.5	0.5	0.5	0.5	0.5	2.63
09/22	1.5	0.5	0.5	0.5	0.5	2.62
09/23	1.5	0.5	0.5	0.5	0.5	2.59
09/24	1.5	0.5	0.5	0.5	0.5	2.70
Min	0.5	0.0	0.0	0.0	0.0	2.52
Max	4.0	3.0	1.5	4.0	3.0	2.84

Table 3. 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	Center US	River Right US	River Left DS	Center DS	River Right DS	Trap Velocity
7/23	2.5	1.3	1.4	2.1	1.6	1.9	1.3
7/24	2.1	1.4	1.4	2.0	0.2	1.9	1.0
7/27	1.9	1.2	1.8	1.5	1.4	2.2	0.8
7/28	0.2	0.2	0.1	1.3	0.8	1.3	0.6
7/29	1.4	1.1	1.9	1.7	1.8	2.0	0.7
7/30	2.1	1.2	1.5	2.0	1.6	1.9	0.7
7/31	1.8	1.4	1.7	1.9	1.5	1.8	0.9
8/3	2.1	0.9	1.7	2.2	1.6	1.9	0.8
8/4	2.0	1.0	1.3	2.0	1.5	2.0	1.0
8/5	1.9	1.2	1.6	1.6	1.3	1.8	1.0
8/6	1.5	1.2	1.5	1.5	1.6	1.9	0.9
8/7	1.8	0.8	1.6	1.4	0.9	1.8	0.6
8/10	1.7	1.3	1.6	1.6	1.2	2.1	0.4
8/11	1.7	1.2	1.5	1.5	1.8	1.7	0.5
8/12	1.6	1.3	1.7	1.7	1.3	1.9	0.5
8/13	1.7	0.9	1.5	1.6	1.8	1.9	0.7
8/14	1.6	1.2	1.5	1.6	1.5	1.9	0.5
8/17	1.6	1.3	1.6	1.6	1.4	1.9	0.4
8/18	1.6	1.2	1.5	1.9	2.1	2.3	0.5
8/19	1.8	1.0	1.4	1.6	1.8	2.1	0.5
8/20	1.9	0.6	1.6	1.7	1.4	1.5	0.5
8/28	2.0	1.8	1.8	1.5	1.2	1.7	1.0
8/29	1.7	1.2	1.3	1.4	0.9	1.1	1.0
8/30	1.9	1.2	1.8	1.5	1.0	1.5	0.6
8/31	1.4	1.1	1.2	1.3	1.3	1.4	0.6
9/1	1.5	1.2	1.7	1.6	1.8	1.5	0.6
9/2	1.9	1.4	1.5	1.4	1.4	2.2	0.6
9/3	1.5	1.2	2.0	1.6	2.0	1.6	0.7
9/4	1.9	1.1	1.2	1.5	0.7	2.3	0.7
9/5	1.6	1.3	1.7	1.9	0.8	1.8	0.7
9/6	1.8	1.2	1.5	1.7	0.7	1.8	0.8
9/7	1.6	1.6	1.6	1.6	0.6	1.9	0.7
9/8	1.5	1.5	1.4	1.8	0.6	1.8	0.7
9/9	1.6	1.2	1.3	1.7	0.7	1.8	0.7
9/10	1.2	1.0	1.6	1.3	0.6	2.1	0.7

Date	River Left US	US Center	River Right US	River Left DS	DS Center	River Right DS	Trap Velocity
9/11	1.1	1.1	1.4	1.4	0.6	2.3	0.7
9/12	1.8	0.5	1.2	1.2	0.8	1.9	0.7
9/13	1.5	1.1	1.4	1.6	0.7	2.0	0.7
9/14	1.2	1.1	1.4	1.7	0.6	2.2	0.7
9/15	1.5	1.1	1.4	1.3	0.7	1.9	0.7
9/16	1.1	1.1	1.6	1.5	0.6	2.2	0.7
9/17	1.5	1.2	1.4	1.5	0.6	2.0	0.7
9/18	1.7	1.2	1.4	1.3	0.5	1.7	0.7
9/19	1.6	1.3	1.1	1.4	0.7	1.6	0.6
9/20	1.6	1.3	1.5	1.4	0.8	1.7	0.7
9/21	1.1	1.2	1.6	1.6	0.6	1.9	0.7
9/22	1.6	1.3	1.5	1.6	0.7	2.1	0.7
9/23	1.5	1.2	1.4	1.8	0.7	1.9	0.7
9/24	1.5	1.2	1.5	1.7	0.8	2.1	0.7
Min	0.2	0.2	0.1	1.2	0.2	1.1	0.4
Max	2.5	1.8	2.0	2.2	2.1	2.3	1.3

Two hundred and sixty-three dead fish were removed from the weir between July 20 and September 18 (

Table 4). Sockeye and Chinook Salmon were the most commonly encountered species. There were no Steelhead mortalities removed from the weir in 2015. All fish were impinged on the upstream side of weir indicating that they had most likely died upstream and floated down onto the weir. The majority of the Chinook carcasses were observed a month before Chinook were encountered in the trap. (Figure 5). The higher mortality observed on August 3-7 was not due to Chinook being handled in the trap because the trap was not in operation at that time (Figure 5). There were also no observations of fish caught between pickets in a head upstream direction, which would have indicated that a fish got stuck and died while trying to push through the pickets.

Table 4. Date and species of fish mortalities observed at the lower Okanogan fish weir in 2015. All fish mortalities were considered "wash downs" and collected on the upstream panels of the weir**.**

Date	Bridgelip Sucker	Carp	Chinook	Mountain Whitefish	Smallmouth Bass	Sockeye	Unknown Sucker
7/20						17	
7/21						13	
7/22			1			38	
7/23			1			17	
7/24			3			7	
7/27			4			7	
7/28			1				
7/29							
7/30						2	
7/31							1
8/3			10			7	
8/4			9				
8/5			22			1	
8/6			10			3	
8/7			21			3	
8/8			3			1	
8/10	2		6		1		
8/11			2			1	
8/12			1				
8/13			1			1	
8/14	1						
8/17			2				
8/18							
8/19	1		1				
8/20			1				
8/21			1				
8/22							
8/23							
8/24							
8/25							
8/26							
8/27						2	
8/28	1						
8/29						3	
8/30							
8/31		1					2
9/1		1	1				1
9/2						1	
9/3							
9/4			1				
9/5						4	

Date	Bridgelip Sucker	Carp	Chinook	Mountain Whitefish	Smallmouth Bass	Sockeye	Unknown Sucker
9/6			2	1		3	
9/7							
9/8			7			13	
9/9						2	
9/10						1	
9/11			3			2	
9/12						1	
9/13							
9/14							
9/15							
9/16							
9/17							1
9/18							1
Total	**5**	**2**	**114**	**1**	**1**	**134**	**6**

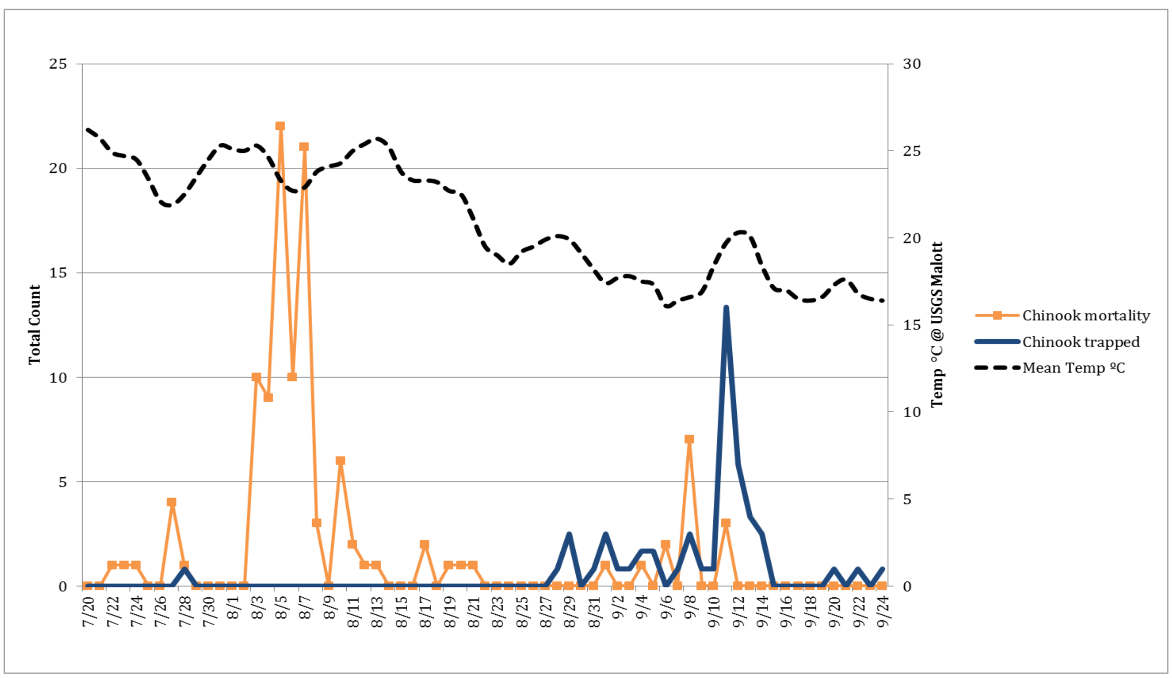

Figure 5. Total number of Chinook trapped and total number of Chinook carcasses collected off the weir panels. The majority of the Chinook carcasses occurred a month before most Chinook were encountered in the trap.

Tower observations showed that most fish were milling in the river right (looking downstream) to center of channel. Estimates were highest during the last week of July and August when river temperatures were below 22.5 °C. Bank observations showed that the number fish observed holding in the lower pool, 0.8 km below the weir, was higher (~95%) after the thermal barrier breakdown. Trapping operations were conducted intermittently from July 27 to 29, August 6, 7, 19, 20 and August 27 to September 24 when river temperature was ≤ 22.5 °C. The total fish trapped at the weir in 2015 was 67 with 81% of them being Chinook Salmon (Figure). A third of the Chinook trapped were released back into the river (Figure). Three Steelhead were trapped between 8/29-8/31 and released within 30 minutes of observation. The TOG was notified when Steelhead were trapped, including the total number, origin and condition after release. To reduce handling of fish, trap attendants opened the gate of the crowder and the upstream gate of the trap to allow for complete passage. Fish that were passed upstream were classified as having a vigorous condition, swimming away unharmed. Nineteen natural origin Chinook were transported to the hatchery and held in the broodstock ponds concurrently with the fish taken for broodstock from the purse seine and hatchery ladder. Adult Chinook were transported from the weir trap to the hatchery brood truck with a rubber boot. None of the weir collected fish died at the hatchery as of the second spawn in early October.

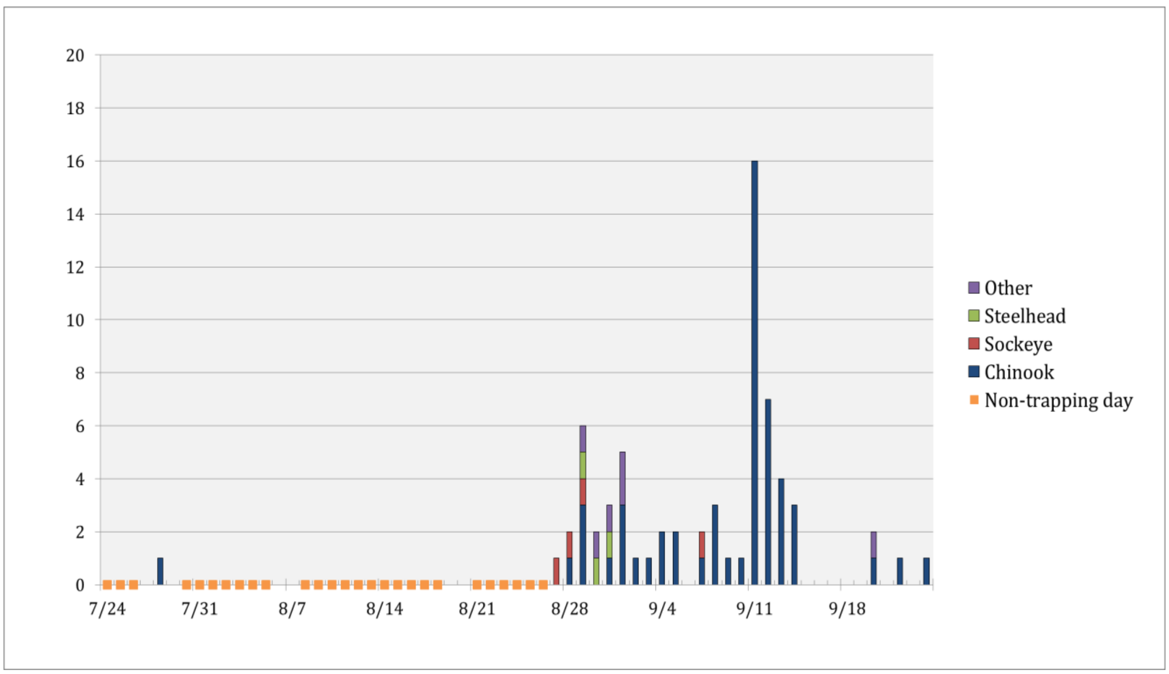

Figure 6. Total number of fish trapped at the Okanogan weir in 2015.

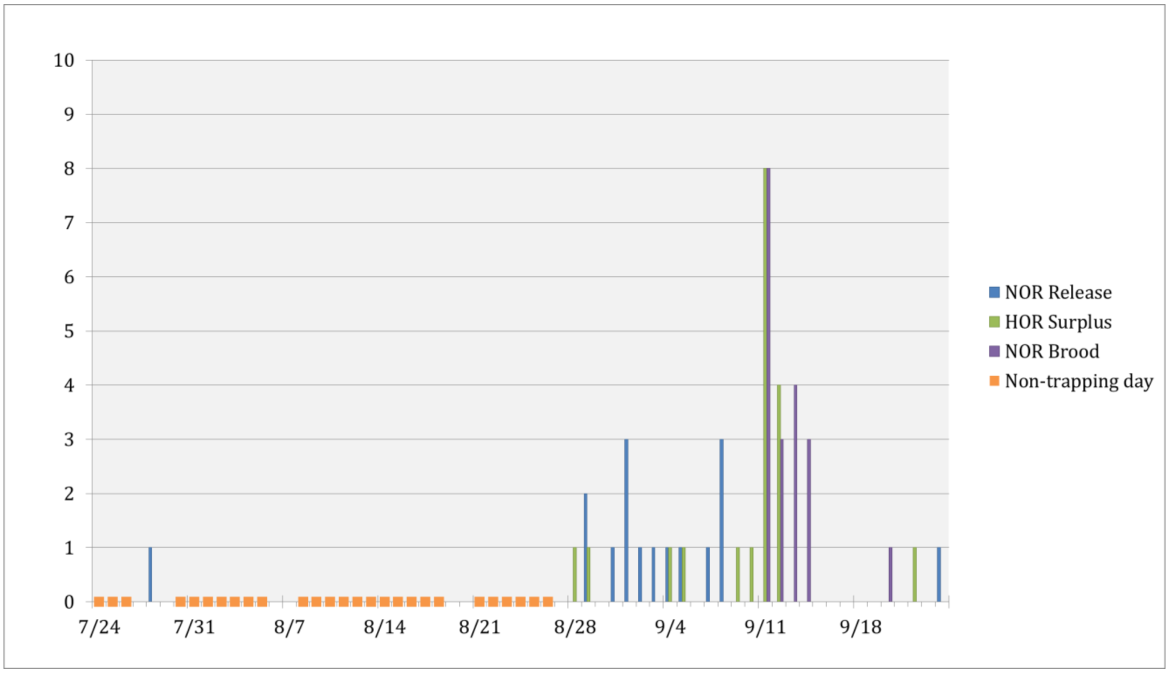

Figure 7. Final destination of Chinook adults captured in the weir trap during trapping operations in 2015.

In 2015, 0.004 of total spawning escapement was detected in the trap (i.e., weir efficiency) (Table 5). The potential weir effectiveness (if we had been removing all of the HOR encountered) was 0.006.

Table 5. The number of hatchery and natural origin Chinook Salmon encountered at the lower Okanogan weir in 2015. 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 summer/fall Chinook carcasses					
	Chinook Adults Encountered in the Weir Trap		Chinook Spawning Escapement Estimates[c]		Weir Metrics	
	Natural Origin (NOR)	Hatchery Origin (HOR)	Natural Origin (NOS)	Hatchery Origin (HOS)	Weir Efficiency[a]	Weir Effectiveness[b]
2013	67	17	5,909	2,285	0.009	0.006
2014	1,947	269	10,602	1,561	0.141	0.134
2015	35	19	11,064	2,684	0.004	0.006

[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.

Discussion

Discharge conditions on the Okanogan River in 2015 were low, allowing for installation and operation of the weir in mid-July, which was 3-4 weeks earlier than previous years. Temperatures on the Okanogan River were fairly high in July and most of August which limited Chinook movement and trapping operations. Temperature slowly dropped below 22.5 °C in late August. During this time trapping operations were suspended for one week due to the hazardous working conditions created by the Okanogan Complex wildfires. After reviewing the number of adult Chinook pit tagged at Bonneville and their detections at the Wells Adult Ladder and the Lower Okanogan Pit Array, we suspect that the mode of fish passage occurred during this trapping suspension, within a week after the mean daily temperature dropped below 22.0 °C. Tower and bank fish observations were generally higher after the thermal barrier broke on August 20. During this time, 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 3 feet, Chinook were more likely to mill in deeper pools. 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.

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 (263) of dead fish at the weir was higher in 2015 than previous years. This was due primarily to the very warm water conditions in 2015 and because the weir was installed much earlier in 2015. Mortality was highest during non-trapping periods in July and early August, indicating that trap operation and handling were not the cause of mortality. We do not believe that dead 'wash ups' were a good indicator of weir effects. A fish kill upstream that had nothing to do with the weir could cause many fish to wash up on the upstream side of the weir. Conversely, any adverse effects of the weir would not have been detected if fish carcasses were stranded on shore or taken by scavengers before washing up on the weir. However, behavioral observations and the lack of fish impinged between pickets (head upstream) were good indicators that this weir configuration and picket spacing were not a major cause of direct mortality. No data were collected to assess indirect mortality.

Weir trapping and fish handling commenced when temperatures were sufficient. Natural-origin Chinook were successfully trapped and released into the river. Natural-origin broodstock were successfully collected and there was 100% survival to spawning. There were few observations of Sockeye at the weir and only four were trapped in 2015. Unfortunately, this did not allow for confirmation of the observations made in 2014 of large numbers of Sockeye (and Chinook) swimming through the 2.5 and 3.0 inch picket spacing. Most sockeye passed the weir when the pickets were pulled adjacent to the trap (i.e., non-trapping configuration) and therefore did not need to pass through the trap or the 2.5-3.0 inch picket spacing. It is also possible that more sockeye moved more at night in 2015 which would have precluded observations of movement through the weir. A few jack and small adult Chinook escaped through the 3.0 weir panels that were intended to allow Sockeye passage. We recommend testing a weir configuration that does not include the 3.0 inch weir panels to increase the efficiency of Chinook trapping without causing too many Sockeye to also use the trap. Based on 2014 observations the 2.5" picket spacing was adequate to allow passage of sockeye when the weir was in trapping configuration.

There was no way to know how many fish escaped past the weir before it was installed or how many fish swam through, around or jumped over the wings after it was installed. The number of Chinook handled at the weir (n = 54) was considerably less than previous years (2014 = 2,324; 2013 = 91). The potential weir effectiveness measure of .70% was low because there was not a thermal barrier break with cool enough temperatures to allow trapping and subsequently the mode of fish passed the weir during a period of suspended trapping operations due to fires. Thus, despite the early deployment of the weir was not an effective tool for pHOS management in 2015. Fortunately, this did not hinder fish management objectives in 2015 because pHOS was already low and only 14% of the Chinook trapped were hatchery origin. 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 Chinook.

The broodstock collection protocol at the weir was to get 15% (n = 85) of the integrated program from the later arriving fish (in September, post thermal barrier). The weir failed to meet its broodstock collection objective through the trap post thermal barrier breakdown was relatively low, collecting only 19 fish. The 100% survival rate provided confidence that the weir can be used for broodstock collection in the future. We recommend a continued risk-averse approach to broodstock collection at the weir in 2016, particularly if natural origin broodstock are collected. The effects on survival and egg viability due to prolonged prespawn holding in the Columbia River and late migration into the relatively warm Okanogan have not been evaluated.

Although the weir was not very successful at trapping Chinook in 2015, 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 weir's importance to the Okanogan summer/fall Chinook population will increase 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 is important for understanding the range of challenges and resulting weir effectiveness that can be expected through time.