2012-2013 CEDAR RIVER SOCKEYE HATCHERY ANNUAL REPORT

Eric Shoblom

Washington Department of Fish and Wildlife
Olympia, Washington 98501

April 2013

Funded by:
Seattle Public Utilities

Table of Contents

List of Tables and Figures:

Introduction

Since 1991 the Washington Department of Fish and Wildlife (WDFW) has operated the Cedar River Sockeye Hatchery at Landsburg, Washington at river mile (RM) 22 on the Cedar River. The program was started in response to a decline in naturally spawning sockeye salmon in the Cedar River watershed. In addition to the goal of stabilizing declining populations, the program was designed to provide an opportunity to evaluate culture methods that are unique to sockeye culture and test their effectiveness.

WDFW began a supplementation program in the main tributary of Lake Washington, the Cedar River. In 1991, after a few years of minimal success with an egg box program on the Cedar River, the WDFW began operation of an interim hatchery at the Landsburg Drinking Water Diversion Dam near Ravensdale, Washington. After almost 20 years in the interim hatchery, operations were moved to a newly-constructed, permanent facility during the 2011-2012 season. The permanent facility is located just below the Landsburg dam on the north side of the Cedar River.

The new hatchery facility has the capacity to incubate, rear, and release up to 34 million fry and provides the flexibility to adjust operations in accordance with the implementation of the Cedar River Sockeye Hatchery Adaptive Management Plan (AMP). The AMP addresses key concerns about the impacts and capability of the Cedar River sockeye program by utilizing experts in pertinent fields like fish health and hatchery reform to guide hatchery operations. The new hatchery has systems designed to limit stress on the fish, produce hatchery fish more similar to their wild cohorts, and further reduce the risk of pathogen transfer between fish and eggs. The new hatchery is also significantly less vulnerable to component failure from freezing, tree falls, flooding, and exposure to the elements. Additionally, the new components allow staff to more easily monitor key operational functions. Finally, the hatchery is safer for the fish and staff, has more reliable core systems, and is vastly more comfortable, functional, and efficient.

WDFW collects broodstock at a floating resistance-board weir and trap near the Renton Community Center (RM 1.8). As available and necessary, broodstock are also collected at the fish ladder at the Landsburg dam.

Program Goals

The overall goals of the Cedar River Hatchery program are to enhance the Lake Washington sockeye population to levels allowing for sport and tribal fishing opportunities; to afford scientists the opportunity to study and learn about sockeye salmon and their life cycle; and to avoid negatively impacting naturally produced sockeye or other species in the Cedar River watershed.

Specific goals are to collect, hold, and spawn enough adult sockeye broodstock to achieve a maximum green egg take of 37,700,00 eggs and release a maximum of 34,000,000 fry after a normal egg to fry loss of approximately 10%. Additionally, the hatchery serves to ensure stable

sockeye fry production in years when floods impact the survival of natural production in the river.

Facility Description

The Cedar River Hatchery has a 14,000 square foot hatchery building housing 138 kitoi incubators, 47 fiberglass starter troughs, staff offices, chemical storage, lab, shop, parts, mechanical, and maintenance rooms. Also on site are 4 concrete adult raceways with electric crowders, a covered outside spawning area, an inside fertilization/disinfection shed, a 3-bay garage and a large carport housing a trailer for standby personnel at the trap. The hatchery pump intake assemblies supply surface spring water for all incubation and rearing and are located across the river from the facility. Before the spring water reaches incubation, it is sent through heat exchangers that slow down the development of the eggs and fry attempting to mimic the river conditions that naturally produced fry are exposed to**.** Rearing troughs are equipped with three outlets: a main drain, an offline settling drain for cleaning or a 3" fry transfer line. There are two 3 bedroom, 2 bath residences onsite for hatchery standby personnel.

Methods and Results

To achieve the program goals, adults were collected at the floating resistance-board weir and trap located in Renton, Washington (RM 1.8). Adults were then hauled by truck to the adult raceways at the new hatchery. When adults were ready to be spawned, gametes were collected at the adult pond area. The eggs were then fertilized, rinsed, and water-hardened in the fertilization room adjacent to the adult raceways. From there, eggs were transported to the incubation room and put down in incubators.

At strategic times during incubation, chilled spring water was substituted for ambient temperature spring water to provide distinguishing thermal marks on the otolith bones of all of the hatchery fish. Tempered spring water (spring water conditioned to mimic river water temperature) was also used to slow development of eggs and fry. Once the fry swam up and were ready to be ponded, they were allowed to volitionally migrate to one of the 47, 19-foot by 3-foot starter troughs. This volitional migration was allowed to progress over 9 days before the remainder of the fry were manually removed from the incubator and placed into the trough. All fry were fed for at least 14 days and then either released at the hatchery or hauled by truck and released in the middle river (RM 13.5) or at the mouth of the Cedar River (RM 0.1). The release location and number of fry released at each location was predetermined by the Cedar River Hatchery Adaptive Management Work Group (AMWG). The AMWG is an advisory body that helps guide the hatchery program.

Adult sockeye counts through the fish ladder at the Ballard Locks conducted by the WDFW and Muckleshoot Indian Tribe indicated that the 2012 run exceeded pre-season estimates. While the preseason estimate was 45,871, the total count during the normal counting period

(6/18/2012 - 8/5/2012) was 145,815. Locks data can be viewed here (http://wdfw.wa.gov/fish/sockeye/counts.htm).

Trap and Weir Operations

On September 6, 2012 WDFW and SPU installed the resistance board weir at Renton in approximately three hours. Low flows, good weather, and the ease of access to the river promoted this quick install. The trap was placed approximately 24 feet from the edge of the driveway on the south bank of the river. Technicians also painted the aluminum "V" entrance to the trap black and provided shade cover over the bulkhead entrance to the trap in an effort to improve recruitment of Chinook and coho.

Although 145,815 sockeye were estimated to have returned to Lake Washington, of those, WDFW estimates that 97,000 reached the Cedar River.

Trapped sockeye were sorted by sex from the trap into three aluminum live boxes for in stream holding until they were placed into rubber carrying boots, and loaded into the tanker trucks to be hauled to the adult holding ponds at the Cedar River Hatchery.

Technicians operated the tip gate to accommodate unimpeded upstream passage of Chinook according to the protocols for weir operation (Appendix 2). However, stronger Chinook returns this season resulted in lengthy tip gate openings (see summary table below and Appendix 3) . As a result, large portions of the sockeye return were able to bypass the trap. Trap efficiency for this season reached 12.9%.

Hatchery technicians monitored fish activity during daylight hours at the trap, weir, and stretch of river above and below the weir regularly and passed any Chinook, coho, or other non-target species upstream out of the trap as soon as possible. During weir operations, 12 Chinook and 13 coho were passed upstream through the trap. All other Chinook and coho traveled unimpeded through the tip gate.

Last season a row of gravel bags were placed below the weir panels as close to the substrate rail as possible to minimize the risk of Chinook and sockeye getting stuck/pinched below the weir. This season, staff added a second tier of gravel bags that further reduced risks.

In addition to the 10,766 sockeye trapped and hauled from the weir, 1,334 sockeye were transported to the hatchery from the fish ladder at the Landsburg dam.

A late October storm prompted staff to remove the weir early. The weir was entirely submerged and fishing ceased on October 27th. By October 28th, the Cedar River had subsided enough (to approx. 600 cfs) for staff to safely pull some panels from the weir. By October 29th, the Cedar River had surpassed 1,000 cfs. After a lull in the storm and in cooperation with SPU dam operators, WDFW and SPU staff removed the trap and weir by hand from the river

beginning October 28th and finished on November 2nd as diminishing flows permitted (Fig. 1). The substrate rail and substrate cable were left in place.

Cedar River Trap Summary

Fishing Activities

	Sockeye		Chinook		Coho	Trout
	Male	Female	Male	Female	Unsexed	Unsexed
Hauled to Hatchery	5,312	5,454	0	0	0	0
Passed upstream	1,823	7	6	6	13	3
Viewed thru Tip Gate	N/A	N/A	177		N/A	N/A

Trap Configurations

	2011		2012	
	Hours	%	Hours	%
From Install to Initial Removal	1368	100.0%	1224	100.0%
Trap Fishing	1362	99.6%	1224	100.0%
Tip Gate Open	508	37.3%	499.5	40.8%
Deep End Panels Fishing	1279	93.9%	1132	92.5%

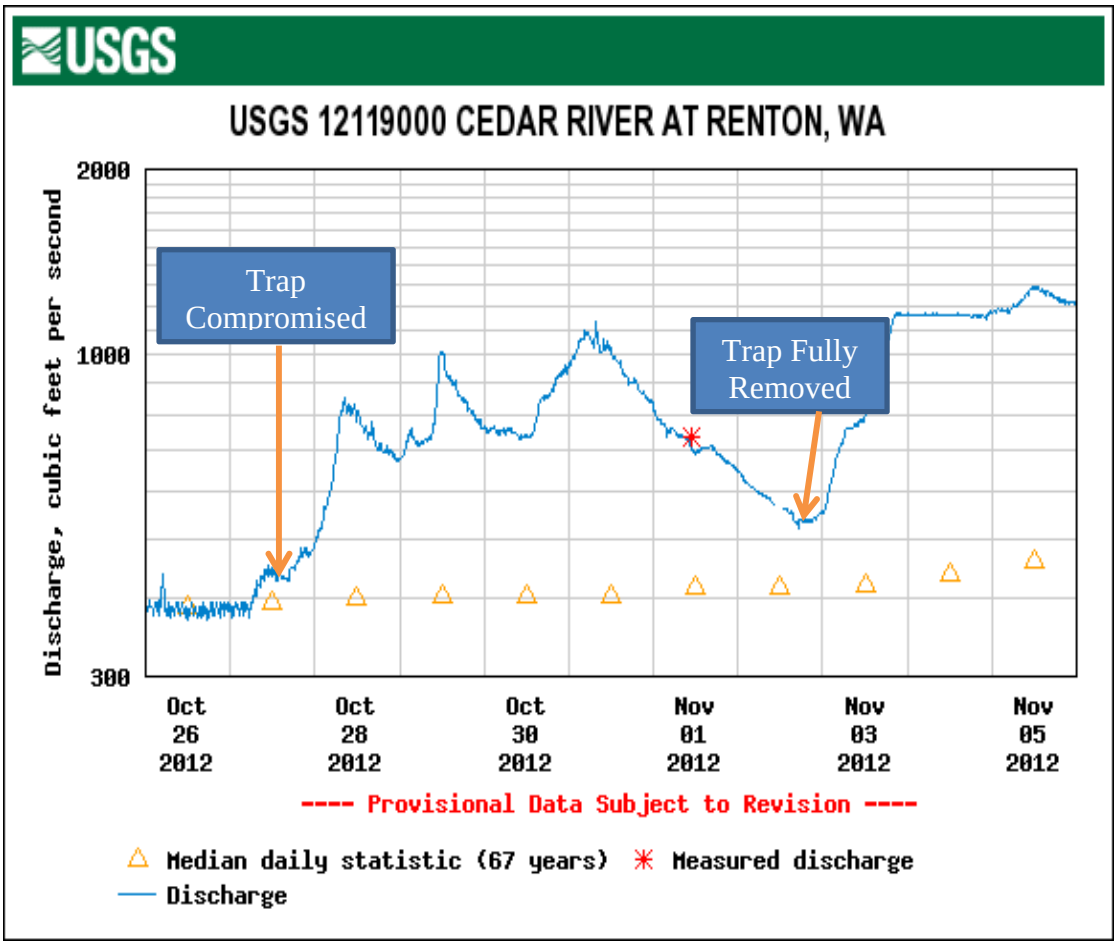

Figure 1: Trap removal began on October 28th and was completed November 2nd.

Spawning Operations

The 2012-2013 spawning season began on September 18 and ended on November 21. Broodstock were delivered via tanker truck to one of four 6 foot wide, 65 foot long adult raceways through an aluminum flume adjacent to the raceways. Maximum loadings of 1,000 fish per raceway with 450 gallons of river water per minute per raceway were found to be suitable. Female raceways were kept to 800 adults with 550-600 gpm.

Adult holding mortality in the 2011 season was extremely high (26.5%) (Table 4.)and prompted several preventative measures for 2012. Densities were lowered to 800 females and 1,000 males per pond. Flows were increased to 550-600 gpm. Sprinklers misted the raceways. The male pond was covered with a blue tarp. One block of salt was added to each raceway in the morning and evening for a few weeks during peak densities. Adults were sorted and spawned three days a week, versus 2 in 2011. This was an effort to reduce holding densities and duration. Any adult mortalities in 2012 were rigorously studied for abnormalities, pathogens, etc. These practices resulted in a reduced holding mortality this season, 7.2%. No virus was detected in the early part of the run but eventually, 23% of the sampled females tested positive for IHN.

Flexibility afforded by the adult raceways and mechanical crowders allowed for management of pond loadings and spawning schedules that minimized the number of times each fish was handled and ensured that the earlier arrival fish were spawned sooner than more recently collected fish. Green females were sorted by their relative ripeness. Females that were very green (not ripe) were placed in a pond with other very green females and were left alone for at least one week to decrease handling stress. Females that were close to being ripe would be placed in a pond that would be sorted on the next spawn day. Male sockeye were confined to a single pond and therefore were not rotated as efficiently. Each spawn, the male pond would be crowded and ripe fish would be spawned and green fish would be returned behind the crowder.

A variance from the 1:1 spawning ratio protocol occurred for 120 females late in the season, as female pond populations started to outnumber male pond populations. For these fish, the spawning matrix was adjusted to either a 3:2 or 2:1 ratio depending on pond populations on a given spawn day.

On spawn days, fish were crowded in their ponds, females were checked for ripeness, and ripe fish were killed using a pneumatic fish stunner. Dead fish were placed on an electric conveyor that lifted them from the lower pond level to a perforated collection table in the spawning area. Females were dipped in a solution of 1:100 iodaphor and placed on a table for 10 minutes in an effort to disinfect their exterior. Males were not disinfected, as sperm contact with iodaphor results in mortality), but were wiped down with paper towels. Gametes were collected in stainless steel bowls, combined with approximately one tablespoon of spring water, stirred to aid fertilization, and passed through the roll-up window into the fertilization room.

After sitting for 5 minutes to ensure total fertilization, fertilized eggs were rinsed and immersed in a solution of 1:100 iodaphor for one hour to ensure proper IHNV disinfection. After one hour, eggs from females were combined into a disinfected bucket and transported to the hatchery. Used stainless steel bowls were washed and thermally disinfected with hot water in a commercial dish washer and then set to air dry. Fertilized, disinfected eggs were put down for incubation in kitois. Eggs were then supplied with regulated pathogen free spring water for the entire duration of their incubation and rearing.

This season marks the largest egg take in the history of the Cedar River Program. Since the program's inception in 1991, the largest egg take was 12 years ago in 2000 at 18.55 million. Before this season, the 21 year average was 9.39 million. This year, 5,694 spawned females produced a final egg take of 20,030,447 with a higher than average fecundity of 3,515.

On spawn days, WDFW hatchery and biological staff worked with SPU staff to obtain 2,128 otoliths and 160 fecundity samples. Ovarian fluid, kidney and spleen, samples were also taken. There were 203 ovarian fluid, and 69 kidney/spleen samples taken. Of the 203 females, 47 of the ovarian fluid samples tested positive for IHN virus (Thomas, 2012-2013).

Incubation and Picking Operations

Previous seasons' operations have revealed that the exceptional quality and temperature of the spring water permit minimal chemical treatments to kitois. From the day after entering the hatchery until hatch, eggs were treated with formalin for 15 minutes per day, 3 days/week at 1:600 ppm to control fungus growth. The minimal treatment regime once again proved successful and fungus was rarely found.

The otolith bones of the eggs and alevins received thermal marks by delivering chilled water to their incubators for prescribed periods of time. To accomplish this, ambient spring water was cooled at least 4 degrees Celsius by a chiller and heat exchangers in the headworks before delivery to the incubators. When an incubator was scheduled to be chilled, the ambient temperature spring water supply to that incubator was replaced by the chilled water for the number of hours prescribed by the chilling schedule provided by the WDFW otolith lab. When the mark was complete, chilled water was discontinued and ambient temperature spring water was returned to the incubator.

During periods of incubation when thermal marks were not being applied, and average river water temperatures were colder than the 48 degree ambient spring water, tempered spring water was used to slow down egg and fry development. One of the goals of the Cedar River Hatchery Adaptive Management Plan is to sync the development and release timing of hatchery fry with that of naturally produced fry. This goal is reflected in the design and operation of the tempered spring water system which uses the colder river water to cool down spring water. Thermal mark periods occur immediately after shocking and picking the eggs and shortly after hatching. To enhance the visibility of each marking period, one week of static temperature

water (ambient spring water) is applied before and after the marking period. Throughout the season, the varying water supplies for each incubator were recorded to establish accurate Temperature Units (T.U.'s). Typically, incubators were on Ambient Spring Water for about 92 days, Chilled Water for 12 days and Tempered Spring Water for roughly 48 days. Each take spent approximately 150 days total at the hatchery before release. The average T.U. (Fahrenheit) for shocking was 640, hatching was 1150, and ponding was 2,050. By release, the fry had accumulated 2,114 T.U.'s on average.

When the eggs reached the eyed stage they were siphoned out of their incubators and physically shocked (bumped) to help distinguish healthy eggs from dead ones. 24 hours after they were shocked they were picked by a Jensorter egg picker initially and secondarily by hand. Once the eggs were picked they were put back into their original incubator between 3, approximately 2" thick layers of plastic saddle substrate. During the picking operation, eggs were sampled to determine size and weighed to establish accurate populations and rates of loss. The rate of loss for the 2012-2013 season was 5.3% (Table 1).

Table 1, 2012 - 2013 Egg Activity Summary

Take Date	Take #	# Females	Green Eggs	Live Eggs	Dead Eggs	% Loss	Adj Total	Over Short(-)	New Fecundity
9/18/13	1	231	739,200	791,780	51,034	6.1%	842,814	103,614	3649
9/21/12	2	195	624,000	665,629	42,137	6.1%	707,766	83,766	3630
9/24/12	3	231	739,200	828,446	35,042	4.0%	863,488	124,288	3738
9/26/12	4	227	726,400	816,068	42,381	4.9%	858,449	132,049	3782
9/28/12	5	254	812,800	862,303	71,719	7.2%	934,022	121,222	3677
10/1/12	6	154	492,800	531,650	26,410	4.7%	558,060	65,260	3624
10/3/12	7	358	1,145,600	1,265,565	57,059	4.4%	1,322,624	177,024	3694
10/5/12	8	197	630,400	685,113	24,864	3.6%	709,977	79,577	3604
10/8/12	9	452	1,446,400	1,523,142	71,491	4.5%	1,594,633	148,233	3528
10/10/12	10	299	956,800	995,970	42,927	4.1%	1,038,897	82,097	3475
10/12/12	11	415	1,328,000	1,243,844	221,705*	15.9%	1,465,549	137,549	3531
10/15/12	12	373	1,193,600	1,250,850	46,975	3.6%	1,297,825	104,225	3479
10/17/12	13	134	428,800	455,444	18,064	7.2%	473,508	44,708	3534
10/19/12	14	495	1,584,000	1,652,136	62,808	3.7%	1,714,944	130,944	3465
10/22/12	15	310	992,000	1,018,908	31,603	3.1%	1,050,511	58,511	3389
10/24/12	16	252	806,400	826,823	32,146	3.8%	858,969	52,569	3409
10/26/12	17	309	988,800	986,971	33,064	3.3%	1,020,035	31,235	3301
10/29/12	18	217	694,400	722,924	25,116	3.5%	748,040	53,640	3447
11/2/12	19	376	1,203,200	1,223,211	54,807	4.2%	1,294,323	91,123	3442
11/5/12	20	107	342,400	310,927	28,611	8.5%	339,538	-2,862	3173
11/9/12	21	57	182,400	174,962	9,327	5.1%	184,289	1,889	3233
11/14/12	22	35	112,000	107,000	3,745	3.4%	110,745	-1,255	3164
11/21/12	23	14	44800	39,556	1,885	4.5%	41,441	-3,359	2960
TOTALS / AVERAGES:		**5,692**	**18,214,400**	**18,979,222**	**1,034,920**	**5.3%**	**20,030,447**	**1,816,047**	**3515**

*181,831 eggs lost when a formalin emitter failed

Approximately 181,000 eggs (78% of the kitoi) were lost when a formalin emitter popped out of its tube and allowed the uncontrolled flow of formalin to burn the eggs. The installation of a modified formalin delivery system this summer will prohibit future occurrences.

Rearing and Release Operations

Ponding

When a substantial amount of fry (a few thousand) began to swim up from the substrate, the outlet screen was removed from the kitoi to allow volitional migration through the incubator drain hose and into the adjacent fiberglass rearing trough.

Heavier densities within the hatchery forced a reduction in the duration of volitional migration this season. Incubators were allowed to volitionally migrate for 9 days before any remaining fry were manually removed from their incubator to their rearing trough. This strategy was less than the 12-14 day migration in the previous season. No adverse impacts were observed as a result of this modification.

Rearing

One to three days after screen removal, fish were introduced to light passes of feed hourly until the remainder of the incubator was placed into the trough. Fish were fed Rangen Soft Moist Starter hourly during the normal workday, seven days per week with a ration of 3-4% body weight for 14 or more days (Table 2).

Due to the various maturation rates of fry, some troughs were still occupied as new kitois attempted outmigration. In these cases, hatchery staff used halogen lights on many kitois to deter the fry from pushing out over the top of the incubator.

Outmigrating fry were sampled to determine their baseline size when they were ponded and averaged of 2,678 fish per pound (fpp). Fry were sampled once more the day of their release and averaged 1,882 fpp. Average growth of the fry was 795 ffp or 30%. Mortality incurred between picking and releasing or “rearing mortality” was exceptionally low at 1.1%.

Table 2, 2012 – 2013 Season Rearing Summary

Take Date	Take #	Mortality Est. %	Mortality #	Ponded Population	Hatch Date	Swim-out Date	Ponding Date	Ponded FPP	Days Fed	Lbs Fed
9/18/12	**1**	1.0%	7,918	783,862	26-Nov	8-Jan	18-Jan	2650	17	163.18
9/21/12	**2**	2.7%	18,513	647,116	28-Nov	17-Jan	25-Jan	2528	13	126.91
9/24/12	**3**	1.0%	8,284	820,162	2-Dec	20-Jan	30-Jan	2592	13	133.59
9/26/12	**4**	1.0%	8,161	807,907	3-Dec	22-Jan	1-Feb	2547	16	163.95
9/28/12	**5**	1.4%	9,578	852,725	6-Dec	23-Jan	4-Feb	2681	15	199.2
10/1/12	**6**	1.0%	5,317	526,334	11-Dec	30-Jan	8-Feb	2613	16	113.8
10/3/12	**7**	1.0%	12,656	1,252,909	10-Dec	3-Feb	11-Feb	2693	15	260.35
10/5/12	**8**	1.0%	6,851	678,262	20-Dec	31-Jan	19-Feb	2536	11	168.86
10/8/12	**9**	1.0%	15,231	1,507,911	21-Dec	5-Feb	19-Feb	2563	15	308.6
10/10/12	**10**	1.0%	9,960	986,010	24-Dec	6-Feb	20-Feb	2617	14	179.7
10/12/12	**11**	1.0%	12,438	1,231,406	24-Dec	12-Feb	23-Feb	2632	16	199.3
10/15/12	**12**	1.0%	12,509	1,238,342	27-Dec	12-Feb	27-Feb	2645	15	190.16
10/17/12	**13**	1.0%	4,554	450,890	27-Dec	12-Feb	27-Feb	2637	16	118.4
10/19/12	**14**	1.0%	16,521	1,635,615	31-Dec	17-Feb	28-Feb	2737	17	398.6
10/22/12	**15**	1.0%	10,189	1,008,719	2-Jan	13-Feb	5-Mar	2780	17	234
10/24/12	**16**	1.0%	8,268	818,555	7-Jan	23-Feb	8-Mar	2969	18	158.3
10/26/12	**17**	1.0%	9,870	977,101	10-Jan	24-Feb	8-Mar	2786	17	183.8
10/29/12	**18**	1.0%	7,229	715,695	14-Jan	4-Mar	14-Mar	2771	15	145.4
11/2/12	**19**	1.0%	12,232	1,210,979	15-Jan	4-Mar	18-Mar	2779	17	313.7
11/5/12	**20**	1.0%	3,109	307,818	16-Jan	9-Mar	19-Mar	2763	20	114.6
11/9/12	**21**	1.0%	1,750	173,212	22-Jan	14-Mar	25-Mar	2667	21	65
11/14/12	**22**	1.0%	1,070	105,930	30-Jan	20-Mar	29-Mar	2829	17	28.1
11/21/12	**23**	1.0%	396	39,160	7-Feb	27-Mar	8-Apr	2571	22	26
TOTALS / AVERAGES:		**1.1%**	**202,604**	**18,776,618**	**12-Jan**	**13-Feb**	**25-Feb**	**2678**	**16.2**	**3,993.5**

Releases

Upon release, fry were sent through a 4" PVC fry transfer line to the either the planting truck or directly into the Cedar River at the hatchery site (RM 24). Trucked fish were released either at the mouth of the Cedar River (RM 0.1) in the Cedar Trails Park, or at the Trestle (RM 13.5) (Appendix 4). The numbers of fry, locations, and schedule for releases were developed by WDFW with input from the AMWG and TWG. 29% of the fry were released at the ,hatchery/upper site, 29% were released at the Trestle/middle site, and 42% were released at Cedar Trails Park at the mouth of the river (See Table 3). This strategy was employed to simulate wide spatial distribution throughout the river of adult recruits from fry released in the middle and upper river. Overall mortality from the green egg stage to released fry was 6.26%, resulting in a planted fry total of 18,776,618.

Studies analyzing release strategies for different locations and timing are achieved through fry trap operations (Kiyohara, 2013) and otolith analysis. In order to identify the different release groups, brood year, and origin, a complex pattern of chill marks is required (See Appendix 5). Mark patterns pre-determined the location and timing of each individual release group months in advance of their actual release. All releases above the mouth were at least 3 days apart from

each other in order to differentiate each release from one another as they entered the fry trap down river.

Emerging fry that were ready to migrate but did not have a vacant trough to do so would charge the screens, overflow the incubator and spill onto the floor or out the drain. It was common to lose thousands of fry overnight from such occurrences. As stated before, staff utilized large halogen lights over the anxious kitoi's and successfully prevented further loss.

Water usage was carefully monitored this year as flow requirements peaked with availability. Fortunately, abundant spring water this season provided ample supply to the pump assemblies. However, it was determined that the heat exchanger for the tempered water supply restricted the flow and limited the availability to the supply troughs. Maximum achieved flow into the hatchery was roughly 1,140 gpm measured in March. All available water was used during most of the season. As the wet season progressed and more water became available, new fry were emerging and supply demands fortunately mirrored the availability. That being said, troughs that had increasing densities due to longer holding times would have received slightly more flow had it been available.

Table3, 2013 Fry Releases by Timing and Location

	Landsburg	**Trestle**	**Mouth**	**Totals**
Early	2,270,031	1,606,627	2,492,618	6,369,277
Middle	2,019,422	1,580,930	2,350,012	5,950,363
Late	1,212,408	2,224,752	3,019,818	6,456,978
Totals	5,501,862	5,412,309	7,862,447	18,776,618
Percent	**29.3%**	**28.8%**	**41.9%**	

Calcein Marking

In-river survival of fry released in the upper and middle river, and delayed outmigration rates were investigated with groups of fry marked with Calcein Green dye.

Calcein is a bright green dye that produces a distinct, iridescent mark on the calcium in fin rays and bones. The mark is not visible under normal light, but shows up clearly when the fish are illuminated with a bright blue light and viewed through a special lens.

Because Calcein dye is not yet approved for use on animals, an Investigational New Animal Drug (INAD) permit from the Aquatic Animal Drug Approval Partnership Program, administered by the U.S. Fish and Wildlife Service, was required. The INAD process included a thorough application process, adherence to certain study protocols, strict monitoring of drug inventory and disposal, and thorough reporting on the results of use of the dye.

Fry to be marked were crowded to one end of their ponds and kept separate from marked fry by intermediate trough screens. Approximately 7,000 fry at a time were dip-netted from the unmarked section of the trough, placed in a 4 gallon bath of 2% saline solution for 6 minutes,

placed in a 4 gallon bath of 5% calcein solution for 6 minutes, and then dumped into the marked portion of the trough. On days when fry were marked, they were not fed to minimize stress. The saline solution was exchanged regularly to further minimize stress on the fish.

Calcein dye was used to mark six troughs of fry from two upper river (Landsburg) release groups and three troughs from one middle river release group. All totaled, 2,272,635 fry were marked for this study. Fry were captured at the fry trap in the lower river on the nights of release and the two following nights were evaluated and enumerated in an attempt to assess survival and delayed migration rates.

In addition to the above Calcein studies, 7 groups of 2,000 were marked and released on separate nights to evaluate collection efficiency of the lower river fry trap.

See the Cedar River's juvenile salmon production evaluation (Kiyohara, 2013) for additional methods, results and conclusions regarding the Calcein trials.

Disease

When fry were planted, 30 fish from each rearing vessel were collected and sent to the WDFW fish health lab for analysis. This season, no regulated viral pathogens were detected and the program was fortunate to avoid an IHN outbreak (Thomas, 2012-2013).

Discussion and Conclusions

This is the second season of operation for the new Cedar River Hatchery and from the announcement of 145K adults at the locks to the bountiful spawning season that collected over 20 million eggs, this season has been marked with many good fortunes and successes. Decreased adult mortality, zero IHN outbreaks and a year of abundant spring water were also fortunate. Additionally, physical and operational adjustments at the weir resulted in better adult trapping results. Finally, various Calcien marked release groups provided valuable information regarding collection efficiency's and sampling challenges. Alternatives should be sought to improve adult collection efficiency and resolve the water and space shortages at the hatchery or they will continue to limit the quality and quantity of fry produced.

Adult Trapping and Weir Management

Chart 1, Eggs Taken vs. Cedar River Escapement

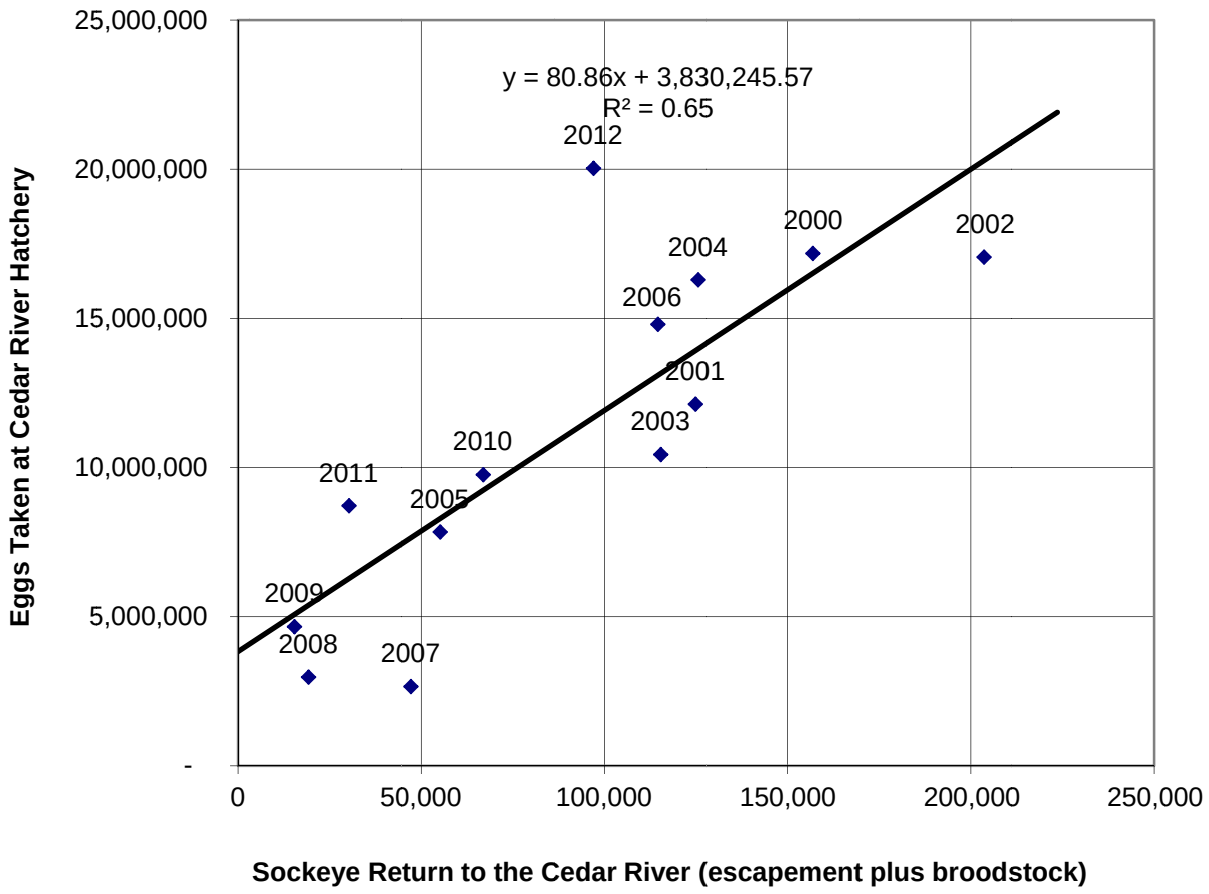

Chart 1 shows the consistent improvement in adult collection indicating a capture efficiency of 12.99%. Collection efficiency refers to the percentage of adults collected vs. what is assumed to have recruited to the Cedar River. More broodstock were collected and eggs taken proportionately to Cedar's escapement than in previous years. Although improved, sockeye trapping conditions weren't ideal. This season, the Cedar River Chinook return was larger than many previous years. A robust Chinook return equates to an increase in Chinook presence at the weir which translates to extended tip gate openings. As a result, many sockeye evaded the trap as they moved upstream through the tip gate.

Achieving adequate lift on the resistance board weir in swifter currents continues to be a challenge. Inflatable pontoons were attached immediately behind the resistance boards to achieve greater lift in higher flows. These floats worked sufficiently in slightly higher than normal flows but were ineffective beyond 500 cfs. Efforts to improve lift and high flow performance are ongoing.

Spawning and Incubation

Table 4 shows that the prespawn mortality rate was low this year. Adult ponds were covered, pond loadings were managed conservatively, and the flexibility afforded by the new adult holding and spawning facility was utilized to decrease the number of times fish were crowded, sorted, or handled. Pond flows were increased from 350-450gpm to 550-600gpm. In addition, adults were held for shorter durations as the hatchery increased the spawning days from 2 to 3 per week. Tests conducted by fish health specialists and hatchery technicians throughout the season found no significant IHN levels, parasites or pathogens (Thomas, 2012-2013).

Table 4, 2005-2012 Adult Prespawn Mortality

Year	Eggs Taken	Male Mortality	Female Mortality	Total Mortality Rate	Female Mortality Rate
2005	7,835,000	407	116	10.68%	2.37%
2006	14,794,000	341	358	7.56%	3.87%
2007	2,496,000	365	92	29.29%	5.90%
2008	2,971,000	241	31	14.65%	1.67%
2009	5,162,325	175	19	6.01%	0.59%
2010	9,560,190	454	86	9.04%	1.44%
2011	9,015,000	1067	703	26.45%	10.51%
2012	20,030,477	661	211	7.2%	3.6%

Female sockeye are generally more sensitive to handling and extended holding times. In order to lower densities and decrease handling of female broodstock, females occupied 3 of the 4 available raceways. The remaining pond was used exclusively for males. This tactic prevented staff from being able to completely sort through the males on any given day, thus resulting in the extended holding and repeated handling of some males.

This season, males outnumbered females returning to the adult trap and Landsburg Fish Passage Facility. However, male holding capacity was limited and densities were pushed to their limits. A higher mortality rate in the male ponds was observed. Some contributing factors may include higher densities, increased physical activity and aggression, and extended holding. Additional adult holding would tremendously benefit this program.

Many changes were incorporated into this year's broodstock holding strategy.
It is difficult to say which changes, if any, are responsible for the decreased mortality. However, all measures, with the exception of salt, will be implemented again next season. Salt applied at two blocks per day was expensive and did not show any sign of significant benefit. This season, two of the four ponds were covered with a tarp. Males seemed to be less active once covered and will therefore be covered again next season. The increase in flows will also be repeated if the water is available. Spawning three days a week is much more labor intensive than two days

of spawning, and creates additional operational challenges later in the season. With less time in between takes, it becomes much more difficult to pick the dead eggs in time before another take is ready. Likewise, removing saddles and brushing screens is much more difficult when multiple takes require the same attention simultaneously. The fewer the days between takes, the greater the possibility that their release dates may overlap as well. However, removing ripe females as soon as possible reduces the amount of eggs they lose during holding, increasing fecundity, and decreases their holding time. Clearly these benefits outweigh the challenges that multiple spawns create. Spawning four days a week will most likely be necessary to reach an egg take above 30 million. Operationally, the challenges will be intense and the program should plan accordingly.

Egg loss for the 2012-2013 season was relatively low (Table 5). Lower egg loss could be attributed to shorter adult holding time, slightly lighter incubator loadings, careful handling of eggs and meticulous management of incubator water flows.

Table 5, 2003-2012 Egg loss

Season	Total Eggs Taken	Loss
2003-2004	11,487,100	17.26%
2004-2005	16,682,000	8.99%
2005-2006	7,513,600	8.27%
2006-2007	13,465,000	8.37%
2007-2008	2,870,300	6.62%
2008-2009	2,971,400	4.75%
2009-2010	5,162,395	7.04%
2010-2011	9,560,190	5.29%
2011-2012	9,015,000	6.06%
2012-2013	20,030,447	5.3%

In September of 2012, an inline river water strainer assembly was installed to limit the fine river debris that previously clogged the condenser water heat exchanger. The new strainers removed a vast majority of debris. The exchanger worked well this season and simply needed to be backflushed by hatchery personnel every week as debris large enough to clog the exchanger was still passing the strainer. At this writing, staff are currently experimenting with different strainer materials in order attain the balance between sufficient flow and proper filtration.

Rearing and Releases

As stated above, one of the goals of the AMP is to synchronize the release timing of hatchery fry with the outmigration of naturally produced sockeye in the river. This has been measured by calculating the median migration dates, the date at which half of the fry have migrated. In order to better align the hatchery fry with their naturally produced counterparts, their median

release date needs to shift forward. Table 6 illustrates a relatively successful shift of the median release dates thus far. This shift can be attributed to the delayed development resulting from the use of cooler tempered spring water and having the capacity to feed all production for a minimum of 14 days. The delay could also be attributed to the slower growth associated with the increase from 8 to 24 hour chill events.

Table 6, Median Fry Plant Date

Year	Median Plant Date
2004-2005	22-Feb
2005-2006	23-Feb
2006-2007	16-Feb
2007-2008	06-Mar
2008-2009	06-Mar
2009-2010	04-Mar
2010-2011	18-Feb
2011-2012	08-Mar
Average	**26-Feb**
2012-2013	**11-Mar**

Appendices

Appendix 1, 2012-2013 Operations Plan

General Production Schedule	May	Actual
Broodstock collection	Sep. 7 - Nov. 15	Sept. 6 - Oct. 26
Spawning	Sep. 17 - Nov. 30	Sep. 17 - Nov. 21
Egg picking	Nov. 12 - Jan. 10	Oct 30 - Jan. 4
Ponding, rearing, release	Jan. 18 - Apr. 19	Jan. 18 - Apr. 30

Adult Return	May	July	December
Preseason Forecast	45,871		
Locks Estimate		150K - 180K	
Live Counts			145,815

Broodstock Collection Goal	May	July	December (actual)
Number of Adults	5,500 - 6,250	9,600 - 12,700	12,100

Broodstock Collection Schedule	May	July	December (actual)*
Sept. 11	276	540	**480**
Sept. 18	399	780	**1642**
Sept. 25	547	1070	**847**
Oct. 2	650	1271	**2277**
Oct. 9	668	1306	**2013**
Oct. 16	625	1222	**2431**
Oct. 23	568	1111	**1414**
Oct. 30	505	988	**857**
Nov. 6	453	886	**57**
Nov. 13	372	727	**81**
Nov. 20	309	604	
Nov. 27	253	495	
TOTALS	5625	11000	**12100**

*Includes 1334 adults collected at Landsburg

Egg Take Goal	May	July	December (actual)
Number of Eggs	8,000,000-10,000,000	13,000,000-15,000,000	20,030,447

Rearing Plan	May	July	December (actual)
Duration	2 weeks	2 weeks	2 weeks

Release Location	May	July	December (actual)
Hatchery	**33%**	**30%**	**29%**
Trestle	**33%**	**30%**	**29%**
Mouth	**34%**	**40%**	**42%**

Appendix 2, Trap and Weir Protocols

2012 Field Season Operational Guidelines for the Cedar River Weir and Fish Trap

These guidelines are based on the framework that was established for the 1999 field season in response to concerns regarding weir impacts to Chinook salmon. The guidelines are based on years of successful implementation during the 1999-2011 brood collection years. It is recognized that the Cedar River Anadromous Fish Committee and the Sockeye Hatchery Adaptive Management Work Group will have the opportunity to recommend changes to these guidelines if conditions change during the season. Such adaptive management will be documented and communicated through the committee chair. Since the implementation of this protocol and the adaptive management approach, the operation of the weir has been successful in avoiding impacts to Chinook salmon. Careful monitoring of fish behavior at the new weir will be necessary to be responsive to changing conditions and fish behavior. The number of Chinook salmon passing the weir and entering the trap in relation to the number of sockeye salmon entering the trap will dictate how the trap and weir will be operated.

GOALS

The weir and fish trap in the Cedar River are maintained and operated to collect sockeye broodstock. However, an additional goal of equal importance is to minimize the risks of adverse effects to upstream migrating adult Chinook salmon. These protocols are intended to satisfy both goals.

Due to ESA issues involving Chinook salmon in the Cedar River, the weir will be operated to avoid adverse impacts to adult Chinook salmon. There are two potential impacts that we will seek to avoid: 1) having Chinook spawn within 25 meters below the weir such that the eventual removal of the weir could impact those redds, and 2) significantly delaying (defined as more than 24 hours) the upstream migration of Chinook. It is recognized that operating the weir to avoid impacts to Chinook limits our ability to meet the objective of collecting sockeye broodstock.

Hatchery personnel and biological staff will communicate and work together to monitor Chinook activity in the area adjacent to the weir.

- Monitoring and documenting Chinook responses to the weir is very important.
- An open weir is defined as the condition that exists when fish have unrestricted access through one or more openings in the weir or trap.
- There will be no restrictions on fishing (closed weir) if there are no Chinook observed downstream of the weir for a 24-hour period, outside of the peak Chinook spawning period, however during the typical peak Chinook spawning period (typically September 25 through October 10) as determined by redd surveys and live counts, the weir will be opened for a 12-hour period following three consecutive days of fishing (no openings in the weir for passing fish) regardless of Chinook being observed.
- If Chinook are observed holding in the area immediately downstream of the weir, and there is a need to collect sockeye adults, then the weir will be opened to allow Chinook to move upstream. The duration of the opening will be in response to the observed behavior of the Chinook, with the goal of keeping any potential delay of Chinook to less than 24 hours. This may be accomplished by opening the weir at night.
- If field biologists or field technicians see more than 10 Chinook holding between the weir (trigger) and the Renton Library below the weir, they will discuss the situation with the hatchery manager and jointly determine a course of action (i.e., opening the weir).
- The weir is to be fished only when sockeye adults need to be collected.
- <u>If there are more Chinook in the trap than sockeye trap pickets will be pulled.</u>
- <u>Chinook that enter the trap will be passed upstream as quickly as possible.</u>
- <u>If the number of Chinook in the trap exceeds what can be removed in 30 minutes, trap pickets will be pulled to pass Chinook.</u>

If a Chinook female unavoidably constructs a redd within 25 meters of the weir, then the redd is to be immediately marked and a discussion will take place. This discussion will include, but is not limited to, the following types of actions: no action, early weir removal, staged weir removal, and modification of weir operations. Discussion will include at least these people or their designee: Paul Faulds and Michele Koehler (SPU), Hatchery Manager, Larry Fisher, Aaron Bosworth (WDFW), Eric Warner (MIT), Randy McIntosh (NMFS) and Hans Berge (KC).

PROPOSED SCHEDULE FOR BROODSTOCK COLLECTION

The following target numbers to be collected are based upon a large run size, assuming an average fecundity of 3,200, and a 1:1 male to female spawning ratio. The 2012 preseason forecast for sockeye returns entering Lake Washington is 45,871. Weekly targets for gamete collection are based upon the average run timing curve. It is agreed that between- week adjustments to accommodate actual returns will be appropriate.

Week Beginning	Percentage of Eggs	Cumulative Number of Eggs	Cumulative Number of Adults	Weekly Adult Goal
Sept. 9	4.90%	1,847,300	1,155	1,155
Sept. 16	12.00%	4,524,000	2,828	1,673
Sept. 23	21.70%	8,180,900	5,113	2,286
Sept. 30	33.30%	12,554,100	7,846	2,733
Oct. 7	45.20%	17,040,400	10,650	2,804
Oct. 14	56.30%	21,225,100	13,266	2,615
Oct. 21	66.40%	25,032,800	15,646	2,380
Oct. 28	75.40%	28,425,800	17,766	2,121
Nov. 4	83.40%	31,441,800	19,651	1,885
Nov. 11	90.00%	33,930,000	21,206	1,555
Nov. 18	95.50%	36,003,500	22,502	1,296
Nov. 25	100.00%	37,700,000	23,563	1,060

MONITORING

The following monitoring activities associated with the weir are to be conducted by hatchery personnel:

- Observe and enumerate Chinook and sockeye from the library to the weir three times daily; it is recognized that at times of high flow or turbidity, accurate observation and enumeration may be compromised. The observation times are as follows: once between 7 AM and 9 AM, once between 11 AM and 1 PM, and once between 3 PM and 5 PM. For sockeye, total estimated numbers are to be recorded.
- Record the number and sex of Chinook that are collected in the fish trap and passed upstream; notice and record any tags or marks observed on the fish. Provide data to the co managers.
- Record the number and sex (where possible) of all other species passed upstream. All Atlantic salmon will be killed and sampled by WDFW staff.
- Count and flag any Chinook redd within 25 m of the weir.
- Chinook carcasses that float onto the weir will be retrieved (placed on the bank) as workload allows. Carcass sampling will be coordinated with WDFW float crews.
- Request routine updates on redd surveys and live counts to validate monitoring results.

Field biologists and hatchery staff will communicate and discuss activities that are observed at the weir as they occur. All biologists and technicians will identify themselves and their respective agencies while making weir observations. Field biologists and hatchery staff will communicate and share information and observations via email. Responsible persons for coordinating this are Hatchery Manager and Aaron Bosworth. The email group this information includes Paul Faulds and Michele Koehler, Eric Warner, and the Cedar River Adaptive Management Work Group.

Appendix 3, **TRAP DATA 2012 SEASON**

Trap Configuration (Hours Set/Fishing)				Fish Activity At the Weir							
Date	Trap Fishing	Tip Gate open	Deep End Panels Fishing	Sockeye Hauled (Trap)	SO PASSED F	SO PASSED M	CO PASSED	CK PASSED F	CK PASSED M	TROUT PASSED	CK VIEWED THRU TIP
6-Sep	24	0.0	24				0				0
7-Sep	24	0.0	24	80			0	1			0
8-Sep	24	3.5	24	113			0				5
9-Sep	24	3.0	24	76			0		1		7
10-Sep	24	25.0	24	61			0				2
11-Sep	24	5.5	24	150			0				3
12-Sep	24	6.0	24	297		1	0				4
13-Sep	24	12.5	24	130		1	0		1		5
14-Sep	24	10.0	24	104	1		0				0
15-Sep	24	5.0	24	257			0	1			2
16-Sep	24	6.5	24	241			0				7
17-Sep	24	4.0	24	200			0	1			0
18-Sep	24	4.0	24	138	1	40	0				5
19-Sep	24	24.0	24	110		2	0				0
20-Sep	24	24.0	24	76			0				0
21-Sep	24	11.0	24	78			0	1			2
22-Sep	24	12.0	24	179		25	0	1			0
23-Sep	24	11.0	24	44			0		1		0
24-Sep	24	20.5	24	34		104	0				3
25-Sep	24	20.0	24	130			0				8
26-Sep	24	12.0	24	332		0					8
27-Sep	24	10.0	24	383		2					3
28-Sep	24	17.0	24	330		2	1				13
29-Sep	24	11.0	24	195		0			1		16
30-Sep	24	12.0	24	320		2	6		1		8
1-Oct	24	13.0	24	399		0	2		1		0
2-Oct	24	22.0	24	181		0		1			0
3-Oct	24	13.0	24	202		1					0
4-Oct	24	16.0	24	401	2	90					1
5-Oct	24	12.0	24	330	2	90					1
6-Oct	24	11.5	24	155		80					2
7-Oct	24	13.0	24	154		40					0
8-Oct	24	15.0	24	200		2	2				7
9-Oct	24	13.0	24	400		20					8
10-Oct	24	10.0	24	330		0					16
11-Oct	24	12.0	24	400		0					6
12-Oct	24	12.0	24	306	1	227	1			1	8
13-Oct	24	11.5	24	590		200					7
14-Oct	24	16.0	24	348		35					5
15-Oct	24	8.0	22	272		60					3
16-Oct	24	3.0	16	79		155					6
17-Oct	24	16.0	19	51		150					6
18-Oct	24	3.0	16	70		175					
19-Oct	24	1.0	15	193		175					
20-Oct	24	0.0	12	177		20					
21-Oct	24	0.0	14	193		2				1	
22-Oct	24	0.0	24	346		8					
23-Oct	24	0.0	16	161		5	1				
24-Oct	24	3.5	16	333		5					
25-Oct	24	0.0	15	226		104				1	
26-Oct	24	5.5	11	150							
TOTALS:	**1,224**	**499.5**	**1,132**	**10,705**	**7**	**1,823**	**13**	**6**	**6**	**3**	**177**

Appendix 4, Release Summary

2012-2013 Release Summary

	Spawn Date	Spawn #	Release Number	Ponding Date	Actual Days Fed	Release Date	Release Location
EARLY	9/18/12	1	783,862	18-Jan	17	2/4	Hatchery
	9/21/12	2	647,116	25-Jan	13	2/7	Mouth
	9/24/12	3	820,162	30-Jan	13	2/12	Trestle
	9/26/12	4	807,907	1-Feb	16	2/17	Hatchery
	9/28/12	5	852,725	4-Feb	15	2/19	Mouth
	10/1/12	6	786,466	8-Feb	16	2/24	Trestle
	10/3/12	7	992,777	11-Feb	15	2/26	Mouth
	10/5/12	8	678,262	19-Feb	12	3/3	Hatchery
MIDDLE	10/8/12	9	781,080	19-Feb	16	3/7	Hatchery
	10/8/12	9	726,830	19-Feb	13	3/4	Mouth
	10/10/12	10	986,010	20-Feb	14	3/6	Mouth
	10/12/12	11	594,235	26-Dec	21	3/10	Trestle
	10/12/12	11	637,171	23-Feb	21	3/10	Mouth
	10/15/12	12	1,238,342	27-Jun	20	3/14	Hatchery
	10/17/12	13	450,890	9-Jul	16	3/17	Trestle
	10/19/12	14	535,806	28-Feb	17	3/17	
LATE	10/19/12	14	1,099,809	28-Feb	18	3/18	Mouth
	10/22/12	15	551,166	4-Mar	18	3/22	Mouth
	10/22/12	15	457,553	4-Mar	17	3/21	Hatchery
	10/24/12	16	818,555	5-Mar	19	3/24	Mouth
	10/26/12	17	977,101	8-Mar	17	3/25	Trestle
	10/29/12	18	715,695	14-Mar	15	3/29	Hatchery
	11/2/12	19	968,508	18-Mar	16	4/3	Trestle
	11/2/12	19	242,471	18-Mar	21	4/8	Mouth
	11/5/12	20	307,816	19-Mar	20	4/8	Mouth
	11/9/12	21	173,212	25-Mar	21	4/15	Trestle
	11/14/12	22	105,930	29-Mar	17	4/15	
	11/21/12	23	39,160	8-Apr	22	4/30	Hatchery

Appendix 5,

Thermal Mark Induction Summary
Cedar River Sockeye Brood Year 2012

							Symbol	
Kitoi	**# Green Eggs**	**Egg Take Date**	**Release Date**	**Run Timing**	**Release Location**	**# Fry Released**	**Intended Pattern**	**Observed Pattern**
2	272,993	9/18/12	2/14/13	early	upriver	253,539	| ||| | | | | | |	| ||| | | | | | |
4	265,619	9/18	2/14	early	upriver	262,963	| ||| | | | | | |	| ||| | || | | | | |* **
8	286,672	9/18	2/14	early	downriver***	267,360	| ||| | || || ||	| ||| | | ||| ||*
10	263,405	9/21	2/7	early	downriver	232,995	| ||| | || || ||	| ||| | || || ||
14	284,524	9/21	2/7	early	downriver	268,535	| ||| | || || ||	| ||| | | || || ||*
16	159,837	9/21	2/7	early	downriver	145,586	| ||| | || || ||	| ||| | || || ||
20	291,478	9/24	2/12	early	midriver	273,047	| ||| | | ||| |	| ||| | | || |
22	280,356	9/24	2/12	early	midriver	268,430	| ||| | | ||| |	| ||| | | || |
26	291,654	9/24	2/12	early	midriver	278,685	| ||| | | ||| |	| ||| | | || |
28	288,666	9/26	2/17	early	upriver	271,238	| ||| | | | | | |	| || | | | | |*
32	283,224	9/26	2/17	early	upriver	263,694	| ||| | | | | | |	| ||| | | | | |
34	286,559	9/26	2/17	early	upriver	272,975	| ||| | | | | | |	| ||| | | | | |
38	261,606	9/28	2/19	early	downriver	244,734	| ||| | || || ||	| ||| | || || ||
40	289,603	9/28	2/19	early	downriver	275,020	| ||| | || || ||	| ||| | | | || ||
44	283,300	9/28	2/19	early	downriver	240,709	| ||| | || || ||	| ||| | | | || ||
46	99,513	9/28	2/19	early	downriver	92,261	| ||| | || || ||	| ||| | | | | | ||*
50	271,650	10/1	2/24	early	midriver	268,934	| ||| | | ||| |	| ||| | | ||| |
52	275,595	10/1	2/24	early	midriver	257,400	| ||| | | ||| |	| ||| | | ||| |
56	273,058	10/3	2/24	early	midriver	260,132	| ||| | | ||| |	| ||| | | ||| |
58	290,808	10/3	2/24	early	downriver	279,288	| ||| | || || ||	| ||| | | || ||*
62	259,311	10/3	2/26	early	downriver	243,420	| ||| | || || ||	| ||| | | || ||*
64	285,248	10/3	2/26	early	downriver	269,429	| ||| | || || ||	| ||| | | || ||*
68	214,199	10/3	2/26	early	downriver	200,640	| ||| | || || ||	| ||| | | || ||*
72	288,204	10/5	3/3	early	upriver	275,522	| ||| | | | | | |	| ||| | | | |*
74	270,145	10/5	3/3	early	upriver	258,765	| ||| | | | | | |	| ||| | | | |*
78	151,628	10/5	3/3	early	upriver	143,975	| ||| | | | | | |	| ||| | | | |*
80	288,414	10/8	3/7	middle	upriver	276,324	| ||| | | | ||| | |	| ||| | | | ||| | |
84	261,943	10/8	3/7	middle	upriver	236,557	| ||| | | | ||| | |	| ||| | | | ||| | |
86	278,424	10/8	3/7	middle	upriver	268,200	| ||| | | | ||| | |	| ||| | | | ||| | |
90	250,992	10/8	3/4	middle	downriver	236,010	| ||| | || | | ||	| ||| | || | | ||
92	278,124	10/8	3/4	middle	downriver	266,433	| ||| | || | | ||	| ||| | || | | ||
96	236,736	10/8	3/4	middle	downriver	224,387	| ||| | || | | ||	| ||| | || | | ||
98	266,553	10/10	3/6	middle	downriver	251,696	| ||| | || | | ||	| ||| | || | | ||
102	275,516	10/10	3/6	middle	downriver	260,519	| ||| | || | | ||	| ||| | || | | |*
104	239,942	10/10	3/6	middle	downriver	227,066	| ||| | || | | ||	| ||| | || | | ||
108	256,886	10/10	3/6	middle	downriver	246,729	| ||| | || | | ||	| ||| | || | | ||
110	285,697	10/12	3/6	middle	midriver	278,225	| ||| | | | | | ||	| ||| | | | | | ||
114	273,328	10/12	3/10	middle	midriver	265,200	| ||| | | | | | ||	| ||| | | | | | ||
116	233,154	10/12	3/10	middle	midriver	50,810	| ||| | | | | | ||	| ||| | | | | | ||
120	275,721	10/12	3/10	middle	downriver	260,161	| ||| | || | | ||	| ||| | || | | ||
122	280,611	10/12	3/11	middle	downriver	266,950	| ||| | || | | ||	| ||| | || | | ||
126	117,038	10/12	3/11	middle	downriver	110,060	| ||| | || | | ||	| || | || | | ||*
128	269,520	10/15	3/11	middle	upriver	258,783	| ||| | | | ||| | |	| ||| | | | ||| | |
132	257,959	10/15	3/14	middle	upriver	248,071	| ||| | | | ||| | |	| ||| | | | ||| | |
134	260,148	10/15	3/14	middle	upriver	243,540	| ||| | | | ||| | |	| ||| | | | ||| | |

<table>
<tr><td>136</td><td>270,072</td><td>10/15</td><td>3/14</td><td>middle</td><td>upriver</td><td>254,553</td><td>| ||| | | | ||| | |</td><td>| | | | | | ||| | |*</td></tr>
<tr><td>138</td><td>240,084</td><td>10/15</td><td>3/14</td><td>middle</td><td>upriver</td><td>233,394</td><td>| ||| | | | ||| | |</td><td>| | | | | | ||| |*</td></tr>
<tr><td>6</td><td>286,479</td><td>10/17</td><td>3/14</td><td>middle</td><td>midriver</td><td>270,449</td><td>| ||| | | | | | |
||</td><td>| ||| | | | | | | ||</td></tr>
<tr><td>5</td><td>187,029</td><td>10/17</td><td>3/17</td><td>middle</td><td>midriver</td><td>180,440</td><td>| ||| | | | | | |
||</td><td>| ||| | | | | | | ||</td></tr>
<tr><td>12</td><td>267,918</td><td>10/19</td><td>3/17</td><td>middle</td><td>midriver</td><td>255,069</td><td>| ||| | | | | | |
||</td><td>||| | | | | | | ||*</td></tr>
<tr><td>11</td><td>299,997</td><td>10/19</td><td>3/17</td><td>middle</td><td>midriver</td><td>280,737</td><td>| ||| | | | | | |
||</td><td>||| | | | | | | ||*</td></tr>
<tr><td>18</td><td>285,013</td><td>10/19</td><td>3/17</td><td>late</td><td>downriver</td><td>274,614</td><td>| ||| | | | || | ||</td><td>||| | | | || | ||*</td></tr>
<tr><td>17</td><td>286,476</td><td>10/19</td><td>3/18</td><td>late</td><td>downriver</td><td>274,614</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>24</td><td>297,672</td><td>10/19</td><td>3/18</td><td>late</td><td>downriver</td><td>286,495</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>23</td><td>277,868</td><td>10/19</td><td>3/18</td><td>late</td><td>downriver</td><td>264,085</td><td>| ||| | | | || | ||</td><td>||| | | | || | ||*</td></tr>
<tr><td>30</td><td>289,715</td><td>10/22</td><td>3/22</td><td>late</td><td>downriver</td><td>280,153</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>29</td><td>281,606</td><td>10/22</td><td>3/22</td><td>late</td><td>downriver</td><td>271,013</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>36</td><td>293,998</td><td>10/22</td><td>3/21</td><td>late</td><td>upriver</td><td>281,160</td><td>| ||| | ||| |||</td><td>| ||| | ||| |||</td></tr>
<tr><td>35</td><td>185,192</td><td>10/22</td><td>3/21</td><td>late</td><td>upriver</td><td>176,393</td><td>| ||| | ||| |||</td><td>| ||| | ||| |||</td></tr>
<tr><td>42</td><td>299,490</td><td>10/24</td><td>3/24</td><td>late</td><td>downriver</td><td>287,971</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>41</td><td>284,175</td><td>10/24</td><td>3/24</td><td>late</td><td>downriver</td><td>273,438</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>48</td><td>275,304</td><td>10/24</td><td>3/24</td><td>late</td><td>downriver</td><td>257,146</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>47</td><td>259,175</td><td>10/26</td><td>3/25</td><td>late</td><td>downriver</td><td>251,039</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>54</td><td>280,932</td><td>10/26</td><td>3/25</td><td>late</td><td>midriver</td><td>270,133</td><td>| ||| | |||||||</td><td>| ||| | |||||||</td></tr>
<tr><td>53</td><td>282,922</td><td>10/26</td><td>3/25</td><td>late</td><td>midriver</td><td>268,317</td><td>| ||| | |||||||</td><td>| ||| | |||||||</td></tr>
<tr><td>60</td><td>197,006</td><td>10/26</td><td>3/25</td><td>late</td><td>midriver</td><td>187,612</td><td>| ||| | |||||||</td><td>| ||| | |||||||</td></tr>
<tr><td>66</td><td>286,817</td><td>10/29</td><td>3/29</td><td>late</td><td>upriver</td><td>273,932</td><td>| ||| | ||| |||</td><td>| ||| | ||| ||*</td></tr>
<tr><td>65</td><td>294,977</td><td>10/29</td><td>3/29</td><td>late</td><td>upriver</td><td>284,515</td><td>| ||| | ||| |||</td><td>| ||| | ||| ||*</td></tr>
<tr><td>70</td><td>166,246</td><td>10/29</td><td>3/29</td><td>late</td><td>upriver</td><td>157,248</td><td>| ||| | ||| |||</td><td>| ||| | ||| |||</td></tr>
<tr><td>76</td><td>273,763</td><td>11/2</td><td>3/29</td><td>late</td><td>midriver</td><td>239,111</td><td>| ||| | |||||||</td><td>| ||| | |||||||</td></tr>
<tr><td>75</td><td>301,160</td><td>11/2</td><td>3/29</td><td>late</td><td>midriver</td><td>237,971</td><td>| ||| | |||||||</td><td>| ||| | |||||||</td></tr>
<tr><td>82</td><td>279,216</td><td>11/2</td><td>4/3</td><td>late</td><td>midriver</td><td>237,004</td><td>| ||| | |||||||</td><td>| ||| | |||||||</td></tr>
<tr><td>81</td><td>299,592</td><td>11/2</td><td>4/3</td><td>late</td><td>midriver</td><td>254,422</td><td>| ||| | |||||||</td><td>| ||| | |||||||</td></tr>
<tr><td>88</td><td>140,592</td><td>11/2</td><td>4/3</td><td>late</td><td>downriver</td><td>242,471</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | ||</td></tr>
<tr><td>94</td><td>154,328</td><td>11/5</td><td>4/8</td><td>late</td><td>downriver</td><td>138,606</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | |</td></tr>
<tr><td>93</td><td>185,210</td><td>11/5</td><td>4/8</td><td>late</td><td>downriver</td><td>169,212</td><td>| ||| | | | || | ||</td><td>| ||| | | | || | |</td></tr>
<tr><td>100</td><td>184,289</td><td>11/5</td><td>4/8</td><td>late</td><td>midriver</td><td>173,212</td><td>| ||| | |||||||</td><td>| | | | |||||||*</td></tr>
<tr><td>106</td><td>110,745</td><td>11/14</td><td>4/15</td><td>late</td><td>midriver</td><td>105,930</td><td>| ||| | |||||||</td><td>| ||| | |||||||</td></tr>
<tr><td>112</td><td>41,441</td><td>11/21</td><td>4/30</td><td>late</td><td>upriver</td><td>39,160</td><td>| ||| | ||| |||</td><td>| ||| | | ||| |||*</td></tr>
</table>

* = errant pattern

** = reference voucher not collected, observed pattern based on personal communication

*** = hatchery reports early upriver release

References

Thomas, J. 2012-2013. Monitoring Sockeye Salmon Health in the Cedar River and Lake Washington. Washington Department of Fish and Wildlife, Olympia, Washington

Kiyohara, K. 2013. Evaluation of Juvenile Salmon Production in 2012 from the Cedar River and Bear Creek, FPA 13-02. Washington Department of Fish and Wildlife, Olympia, Washington.