Report

2014 Egg Survival and Emergence in Reaches 1A and 1B in the San Joaquin River Restoration Area

2014 Mid-Year Technical Report

SAN JOAQUIN RIVER RESTORATION PROGRAM

July 2014

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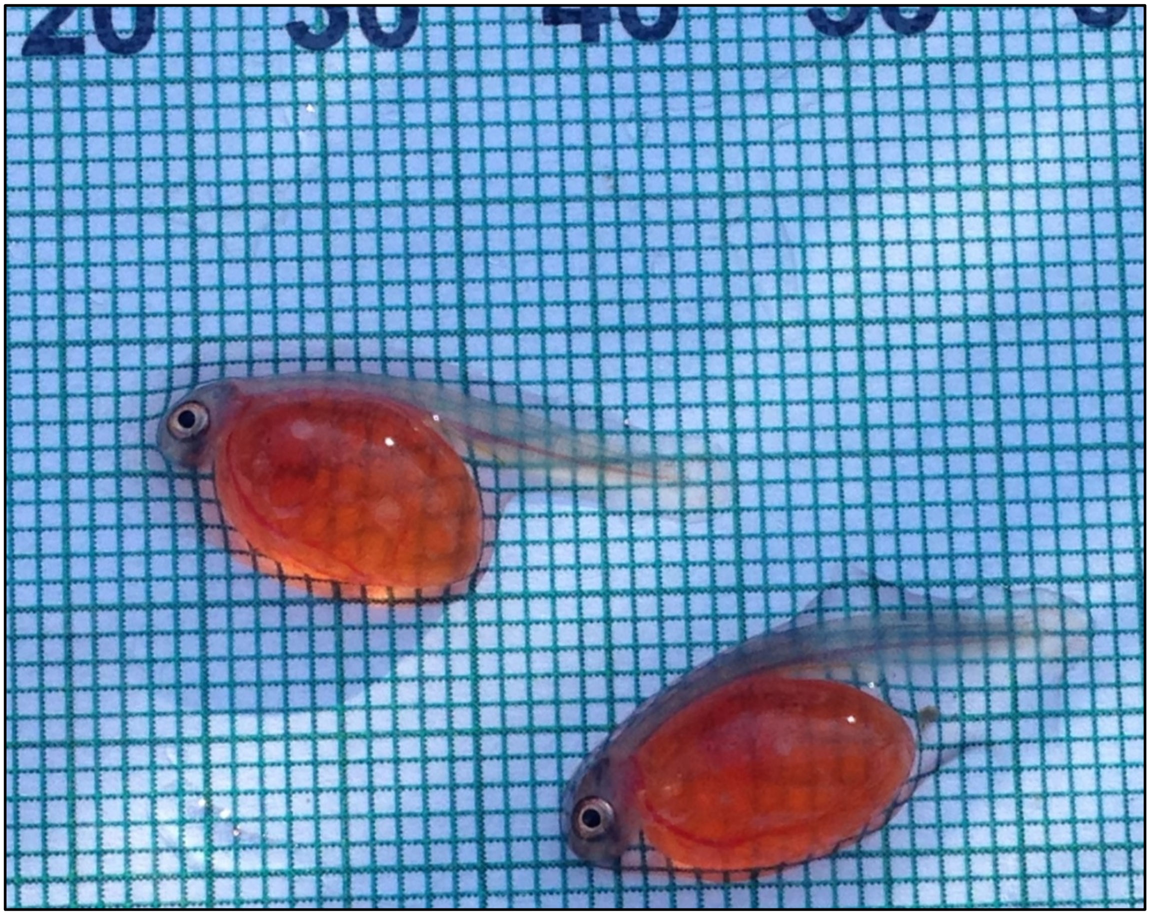

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Abbreviations and Acronyms

ABS	acrylonitrile butadiene styrene
ATU	accumulated thermal unit
CDFW	California Department of Fish and Wildlife (
cm	centimeter
mm	millimeter
PVC	polyvinyl chloride
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
SJRRP	San Joaquin River Restoration Program
SR-99	State Route 99

1.0 Egg Survival and Emergence in Reaches 1A and 1B in the San Joaquin River Restoration Area

1.1 Background

The Restoration Goal of the San Joaquin River Restoration Program (SJRRP) includes the return of viable, long-term and sustainable populations of naturally-producing spring and fall-run Chinook salmon. To realize restoration of the Lower San Joaquin River salmon populations, successful completion of the freshwater portion of the lifecycle must occur. While it has been hypothesized that an appropriate spawning and incubation matrix is available, the last salmon to successfully spawn in the lower river was over 5 decades ago (McBain and Trush 2002). Therefore, the suitability of the available habitat must be fully evaluated. Specific variables that contribute to suitability for incubation and emergence include hyporheic temperature, permeability, dissolved oxygen and the sediment size composition and sedimentation rate that contribute to the values of those variables.

In 2011 and 2012 egg survival studies were conducted in Reach 1a in an effort to assess egg survival in existing spawning habitat along a longitudinal gradient from Friant Dam to Highway 41. The egg survival information has been accompanied by sediment size class analysis, fine sediment accumulation, and hyporheic water quality measurements to evaluate how these variables impact survival estimates. This study was conducted using eyed eggs from the Feather River Fish Hatchery. In 2012, the SJRRP began a program to trap and haul adult Chinook salmon from upstream of the Hills Ferry Barrier near the Merced River confluence to Highway 99 (Reach 1b) to assess spawning site selection, movement patterns, and to conduct streamside spawning studies. The 2013 egg survival and emergence study goal is to pair the trap and haul program to make more assessments based on natural spawning success in reaches 1a and 1b. It will provide the next step in gaining information in the survivability and condition of embryos developing in the available spawning habitat by utilizing both artificial egg placement, as well as capping naturally placed redds resulting from the adult transport study using fall run Chinook salmon trapped in Reach 5. Fry emergence has successfully been studied in other rivers (Field-Dodgson 1983, Rubin 1995, Bernier-Bourgault 2005). Egg survival estimates, as have been calculated in 2011 and 2012, only describe the first step in successful reproduction for salmonids in the San Joaquin River. Assessments of alevin emergence are also important. Egg survival studies in encapsulated artificial egg tubes cannot be used to evaluate the ability of alevin to escape the hyporheic environment and emerge successfully. Given the high sand content in the system as noted in many of the background documents and ongoing studies, evaluating successful emergence is the next step in determining life cycle completion for the spawning/incubation/emergence life stages of salmon in the San Joaquin River.

In 2011 and 2012 we conducted egg survival studies along with sediment transport and physical habitat characterization using egg tubes and eyed eggs from a hatchery source. We have 2 years of data and would like to start investigating other limiting factors related to spawning habitat quality, so are recommending investigating emergence success, and condition/health at emergence of naturally spawned embryos as well as artificial placements.

Egg survival from 2011 experiments was variable both within and between sites. In 2011 survival ranged from 13 percent to 50 percent. Highest average survival by site was at the uppermost site and lowest was in the middle of the study reach. In 2012 survival was similar and ranged from 20 percent to 54 percent, with lowest and highest values at the same sites. The site with the highest survival also had the largest substrate composition, but substrate may be too large for salmon to mobilize during redd construction. The site with the lowest survival was also correlated with a high sand content. These data have helped clarify the role of fine sediment in egg survival. However, it remains unknown how current habitat conditions effect emergence from natural redds and resulting alevin success.

The goal of this study is to evaluate the survival to emergence, as well as the overall condition at and timing of emergence for alevins from naturally placed fall run Chinook salmon redds as well as artificial placements in the San Joaquin River. This information has been identified important for describing the overall suitability of spawning gravel by the Spawning Habitat Suitability Small Interdisciplinary Group.

Objectives:

1. Develop empirical counts of emerging alevin from natural and artificial redds in the Restoration Area.

2. Develop emergence timing data and compare to known degree-day relationships for Chinook salmon.

3. Asses condition of emerging alevins and compare among sites.

4. Relate emergence timing and condition to environmental parameters at each spawning area.

1.2 Methods

This emergence study was conducted in conjunction with the trap and haul operations and redd and carcass survey. U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and California Department of Fish and Wildlife (CDFW) transported fall-run Chinook salmon (*Oncorhynchus tswaytscha*) from Reach 5 to reach 1A and released them near the State Route 99 (SR-99) bridge. Salmon transport operations were conducted October 1 through December 15, 2013 while redd and carcass surveys were conducted weekly from October 12, 2013 to January 3, 2014.

Redd Cap Site Selection—A redd cap site was selected only if the redd was distinct and the emergence trap would be able to cover all the egg pockets. Sites were also selected based on redd distribution throughout the reach and calculated accumulated thermal units (ATU) so traps could be monitored simultaneously. Five emergence traps were in place from December 16, 2013 until April 14, 2014 between river miles 267 and 256. Figure 1 shows relative location of emergence traps to previous egg survival study sites. All spawning activity and redd measurements were collected during the weekly spawning and carcass survey study.

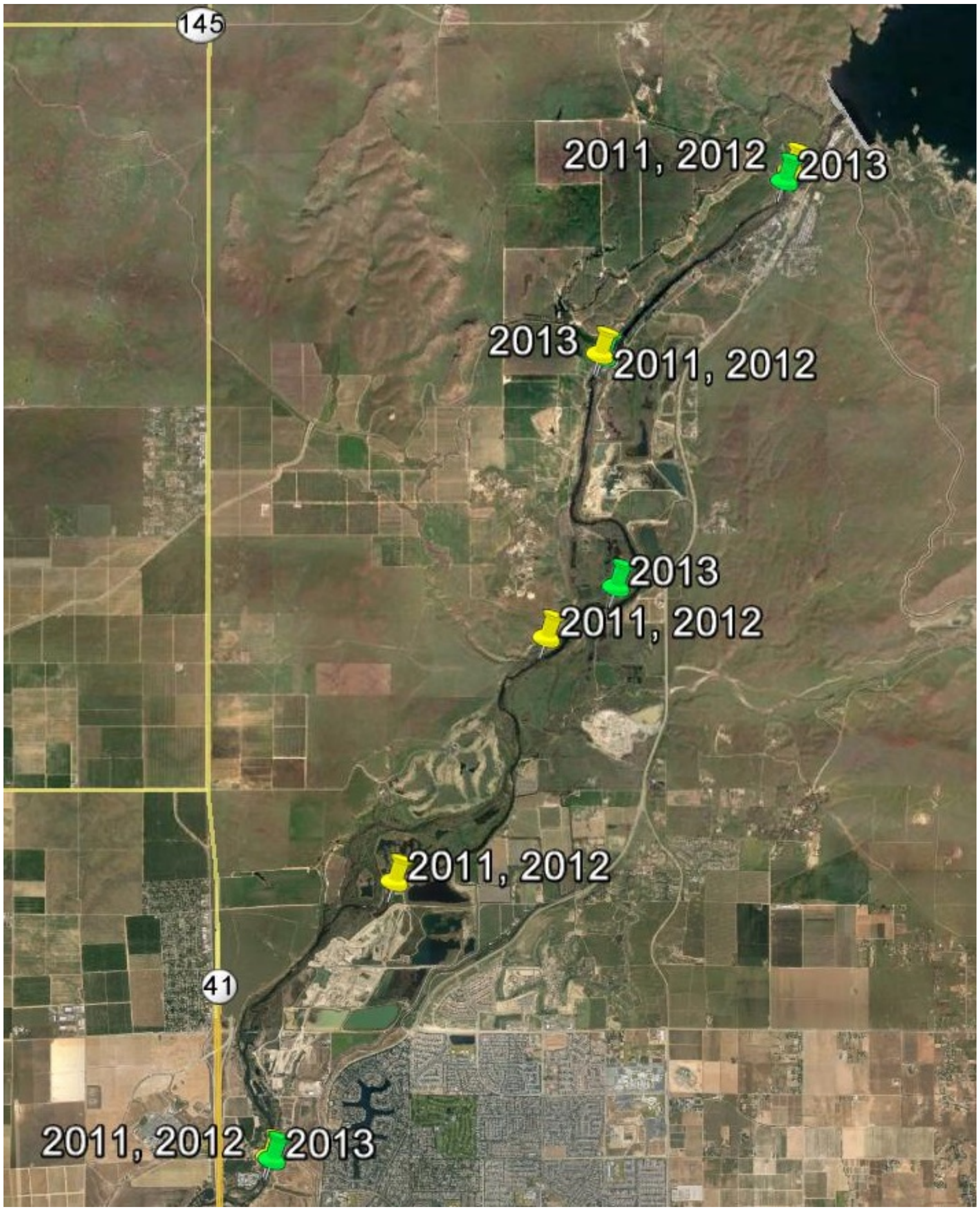

Figure 1. Map of Egg Study Sites from 2011-2012 (yellow) and Egg Tube and Redd Cap Sites for 2013 (green)

Redd Cap Construction—The emergence traps that were used in this study were the same traps used during the Lower Tuolumne Don Pedro Project Fisheries Study Report (TID/MID 1991). The frame was constructed in two parts from 5/8-inch square steel bar and 1/8 x 1 inch flat steel bar and reinforced with 3/8 inch round steel bar in order to maintain its shape (TID/MID 1991). The top of the frame has small pegs of steel with holes welded on to anchor the cover. The frames were also painted with two coats of rust resistant paint.

The caudal end which acted as a one way live-well was assembled using a 1-gallon wide mouth polyethylene bottle and a 15 cm diameter funnel. The bottom of the bottle was cut out and the funnel was attached with silicone. Holes were cut into both sides of the bottle and 1/8 inch polypropylene mesh was attached with silicone to create a vent to allow water to escape and prevent fish mortality from current. A sock constructed of Dacron sailcloth extended from the opening of the back to the holding bottle and was attached using a hemmed drawstring which grabs the lip of the funnel (TID/MID 1991).

The cover of the trap consisted of 1/8-inch nylon mesh which covered the entire trap and a 12-inch Dacron sailcloth border which was buried straight down in the gravel to minimize lateral escapement of juvenile Chinook salmon (TID/MID 1991). Grommets were sewn into the cover to align with welded pegs. The emergence trap measured eight feet long and six feet at its widest point; covering 30.5 square feet (TID/MID 1991).

Redd Cap Assembly and Installation—The emergence traps were installed one week before earliest redd calculated ATUs. Redd Caps were assembled on the bank. The two piece frames were bolted together and the canvas top was laid on top and aligned with the pegs. Washers and cotter pins anchored the canvas to the frame. Velcro was used in addition to washers and cotter pins to hold the sock in place and minimize escapement from the trap. The trap was then carried over to the redd and place where a majority of the egg pockets were thought to be. Rebar measuring 3/8 inch thick by 30 inch long was pounded around the frame aligned with grommet holes and synched down with washers and hose clamps to anchor the frame. A trench was excavated around the frame at a depth of twelve inches or until the substrate became too armored and digging could no longer continue. The canvas skirt was then buried and backfilled with excavated materials and the holding bottle was attached (Figure 2).

Figure 2. Emergence Trap Installed

Egg Tube Construction—The egg tubes that were used are a modified version of the Bernier-Bourgault (2005) incubator. The original incubator was designed to accommodate brook trout eggs which are incubated at depths of 1–10 centimeters (cm) (Devries 1997) compared to Chinook salmon at 20–60 cm (Allen 1986). The new incubator was modified with a longer basket to be buried deeper into the gravel and widened to accommodate larger spawning gravel. The top half, referred to as the fly trap cap, was designed so it could be easily removed while in place. The fly trap consists of a 7.62 cm Schedule 40 polyvinyl chloride (PVC) female pipe thread cap, a 7.62 x 10.16 cm Schedule 80 PVC nipple, a 6.1cm female DWV PVC adapter and a 7.5 cm diameter funnel which was attached with all-purpose PVC cement. The funnel was place upside down to act as a one way channel once chinook had emerged. Both the PVC cap and nipple had holes drilled to allow water to pass through. The basket design included a 3 x 10 cm acrylonitrile butadiene styrene (ABS) cap-socket for the base, a 30.48 x 9.75 x 0.31 cm roll of kwik mesh that was rolled together and attached with zip ties. The inside was lined with wire screen as an additional precaution to keep juveniles from squeezing through the basket holes. The ABS cap-socket and lower fly trap female double walled corrugated PVC adapter were affixed to the basket using zip ties. Once assembled, the fly trap can easily be screwed on and off of the female adapter PVC and cap removed. Weighted Plexiglas covers were made to slip over top of the basket when monitoring to reduce the chance of fish escaping (Figure3).

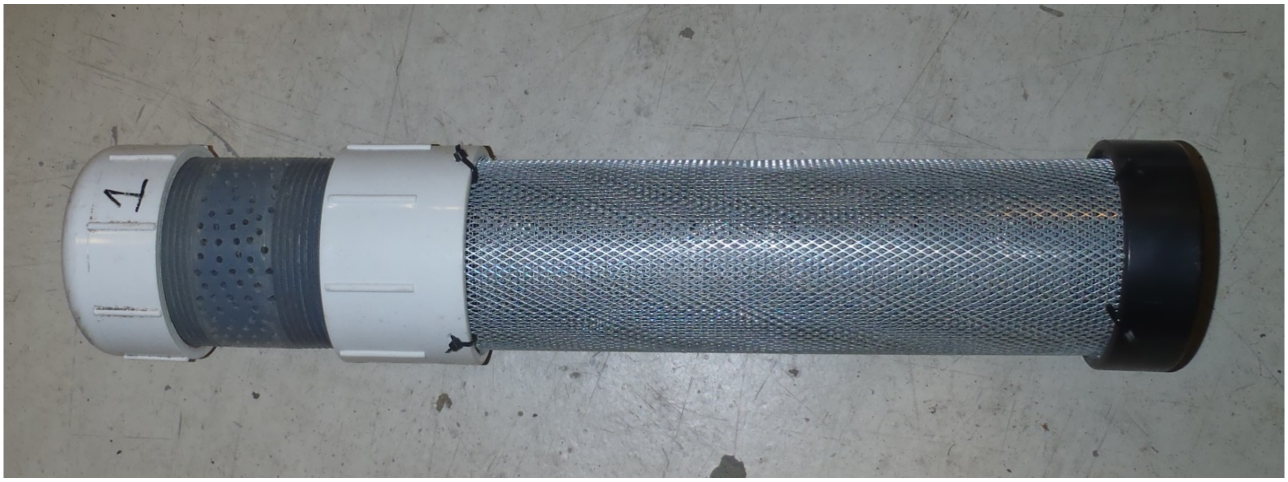

Figure 3. Assembled Egg Tube

Egg Tube Site Selection, Assembly, and Installation—The egg tube site was determined by the location of the redd. The egg tubes were installed two weeks prior to the emergence trap covers in order to have simultaneous emergence. Each site had four egg tubes, two tubes of eyed eggs and two of green eggs. All eggs used were from streamside spawned fish. The eyed eggs were from fish spawned on November 17, 2013 and all green eggs were from fish spawned on December 2, 2013. Eggs were sorted the morning of tube installation at the DFG spawning trailer. Eggs were separated into groups of 100 and marked so eyed and green eggs could be easily distinguished. Eggs were transported in a Styrofoam egg cooler with non-chlorinated ice on the top layer keeping eggs moist and cool. Once at the site the eggs were placed into a bucket with river water while the egg tube site was prepared.

Tubes were installed on December 3 and 4, 2013 and retrieved between February 11, 2014 and March 25, 2014. They were placed parallel to the emergence trap location in a diamond shape formation. In the center of the egg tube formation the BOR installed a piezometer to measure permeability and monitor water quality at all sites. Each tube hole was dug out individually with a bottomless bucket and McLeod if needed to loosen or remove larger and embedded substrate. Alternating layers of natural substrate from the spawning riffle and eggs were placed inside the egg tubes up to the top of the basket. The fly trap was screwed onto the basket and the tube was placed in a bucket of river water and carried over to the excavated hole. The tube was placed inside of the empty bottomless bucket, which was preventing the hole from collapsing, and hand filled the inside of the bucket surrounding the tube with excavated materials. Once filled, the bucket was slowly removed from the substrate while the tube was held in place to keep from rising up. If needed more substrate was piled around the edges of the egg tubes. These steps were repeated for all tube installations.

Monitoring—Redd caps and egg tubes were checked and cleaned two to four times a week. Traps were check more often during peak emergence. All debris was removed from rebar and the cover was scrubbed with a soft brush. The sock was then pinched off and lightly shaken to move any salmon in the sock down to the holding bottle. The holding bottle was then lifted vertically and the draw string loosened to detach the jar. Contents were emptied into a bucket and the sock was re-attached. Captured fish were identified to species and a subsample of up to twenty fish per species were measured to the nearest millimeter (mm) (FL). It was noted if a yolk sac was present or if mortality was observed.

Egg tubes were unscrewed from the basket. Before removing the fly trap a large dip net was set directly behind the tube in case fish escape when the cover is being attached. Once the cover is in place the top of the fly trap is unscrewed and visually inspected. Contents were then emptied into a bucket and the fly trap screwed back into place. The dip net was checked and any chinook present were added to the bucket. Captured fish were identified to species and a subsample of up to twenty fish per species were measured to the nearest mm (FL). It was noted if a yolk sac was present or if mortality was observed.

1.3 Results

Emergence Traps—Chinook salmon were captured beginning the week of January 19 (redd 5) and ending the week of March 16, 2014 (redds 5, 8, 15). For each redd, the number of Chinook salmon caught by week is shown in Figures 4-8. Redd 14 had a total emergence of 276 fry, redd 15 892 fry, redd 5 333 fry, redd 8 5,160 fry and no emergence was observed at redd 7. Most Chinook salmon fry emerged between 32 and 39 mm FL (Figure 9).

Egg Tubes—Egg tube survival amongst the four sites varied within and between sites. Survival ranged from 0-68 percent for eyed and green egg tubes. Emergence success was significantly different in eyed versus green egg tubes. Survival ranged from 13-68 percent for eyed and 0-14 percent for green eggs (Table 1).

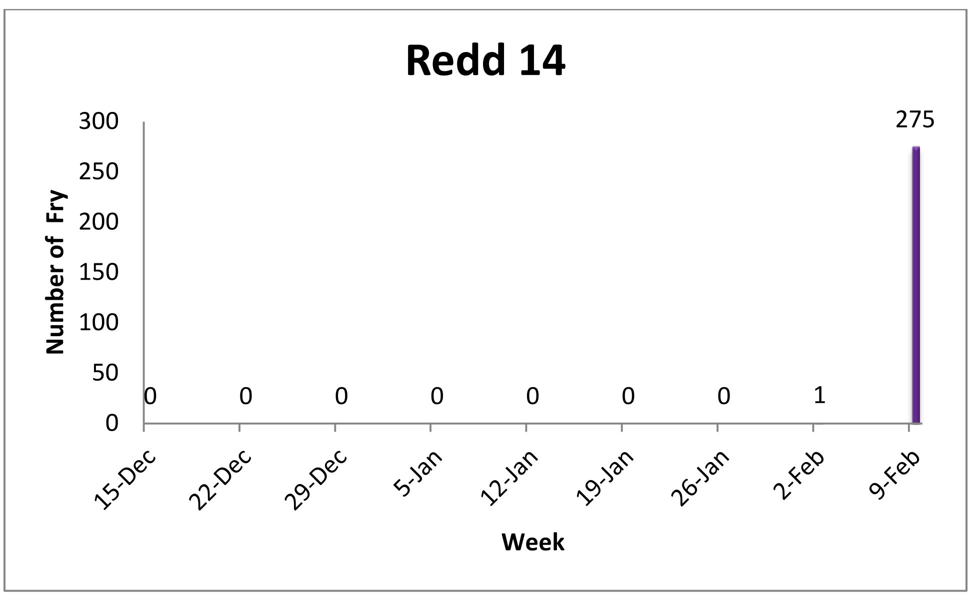

Figure 4. Numbers of Emerged Fry from Redd 14 by Week

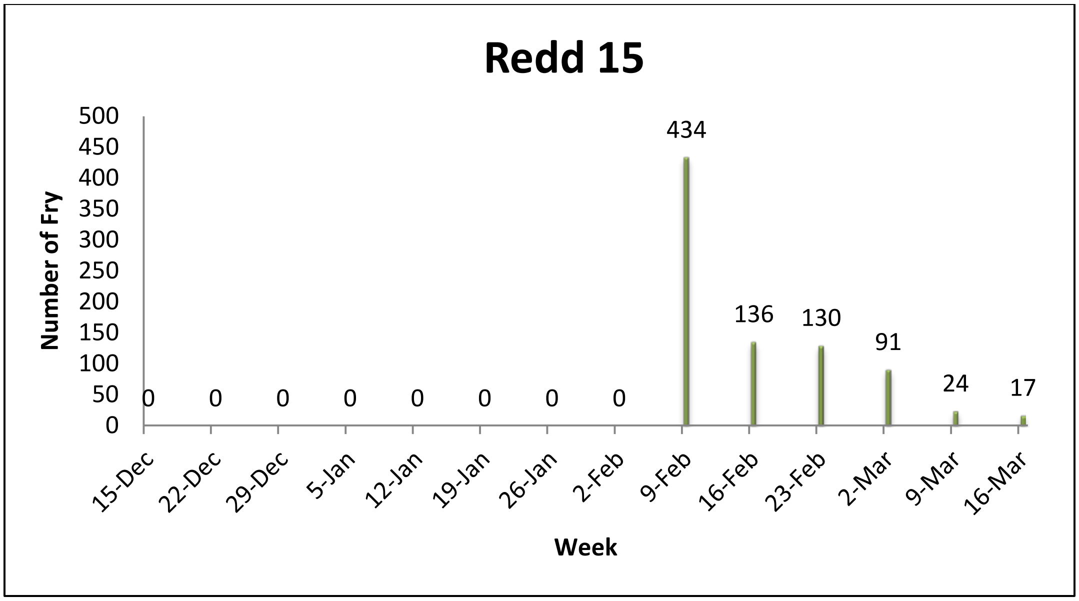

Figure 5. Numbers of Emerged Fry from Redd 15 by Week

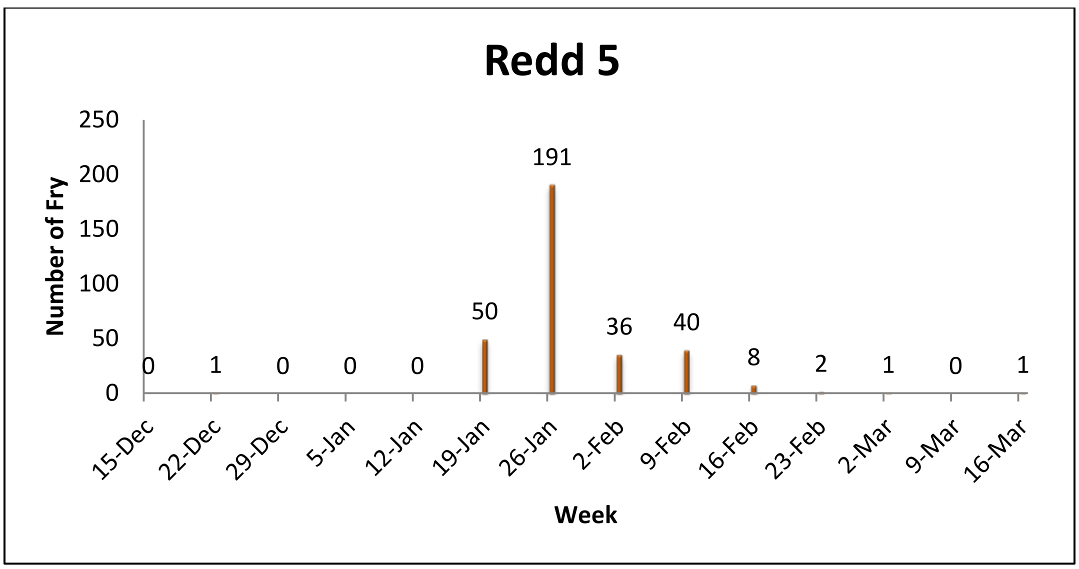

Figure 6. Numbers of Emerged Fry from Redd 5 by Week

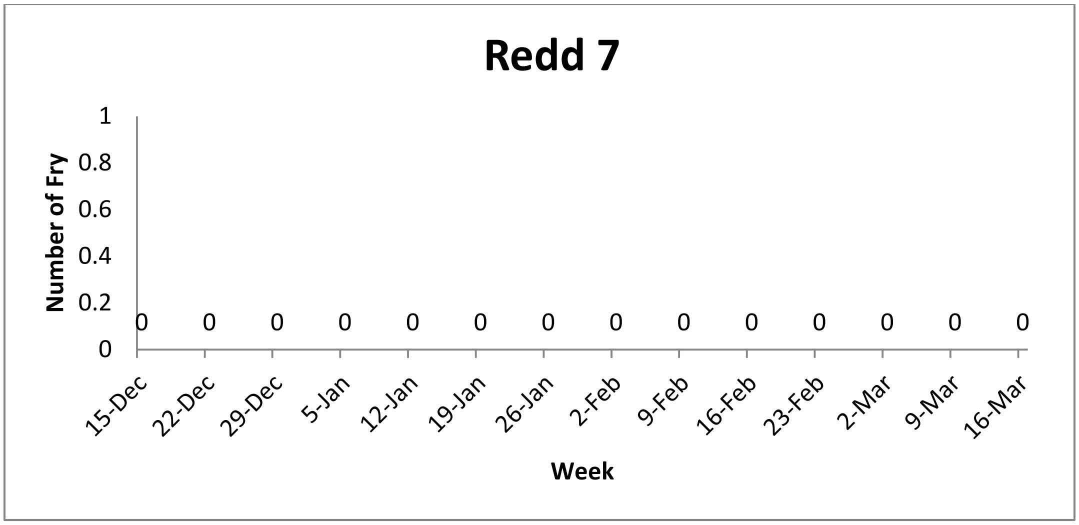

Figure 7. Numbers of Emerged Fry from Redd 7 by Week

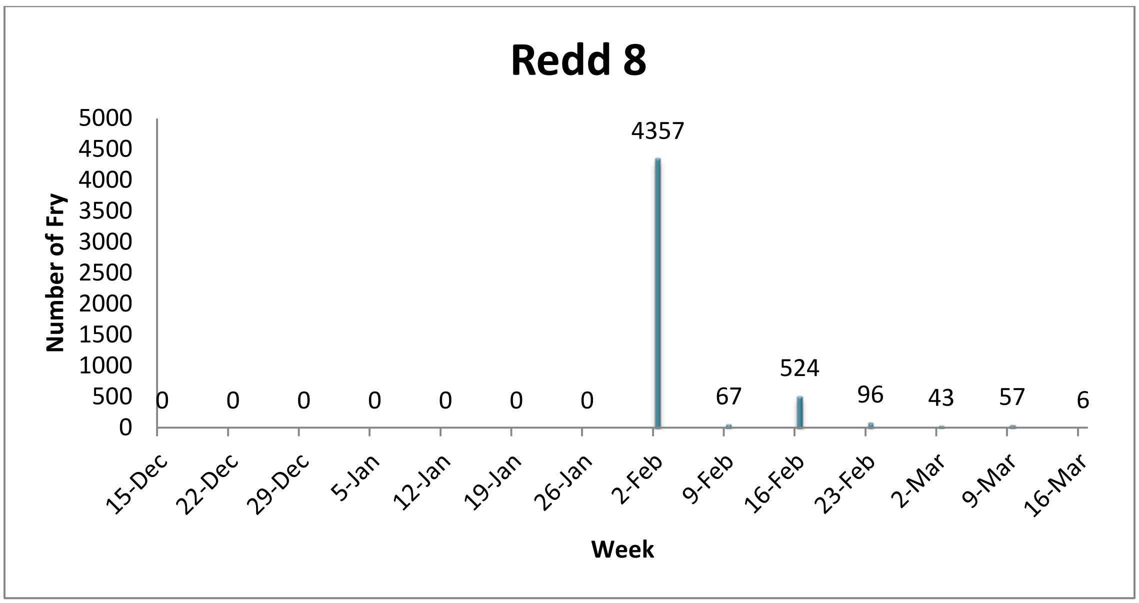

Figure 8. Numbers of Emerged Fry from Redd 8 by Week

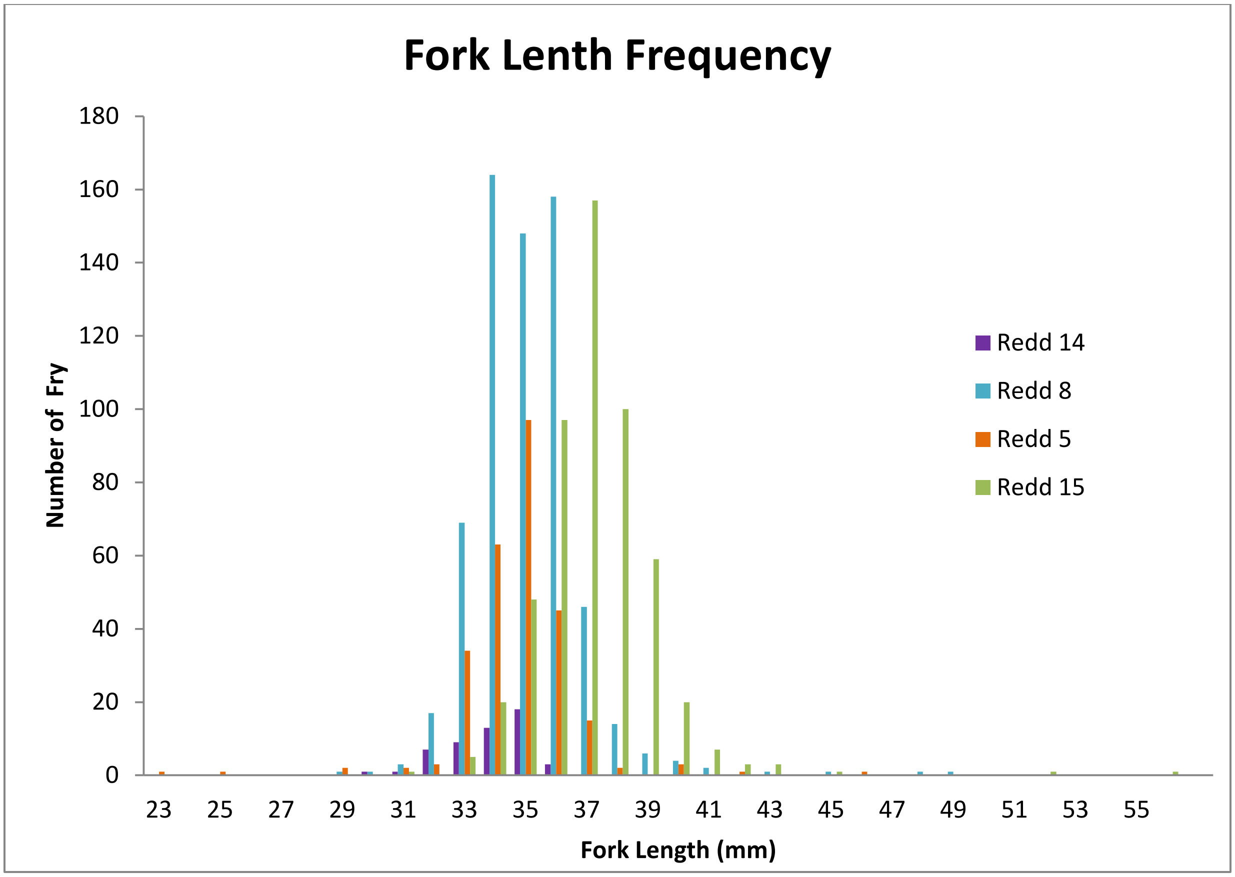

Figure 9. Fork Length Frequencies of Chinook Salmon Collected from all Redd Cap Sites

Table 1. Survival Estimates of all Egg Tube Studies from 2011-2013

	Predicted	**2011**	**2012**	**2013**	**2013**	**2013**
Location	Survival			Eyed	Green	Paired Redd
Rd 206	90%	50%	54%	26.5%	0%	**14**
Lost Lake	63%	36%	36%	68%	14%	**15**
Ball Ranch	N/A	-----	-----	47%	1.5%	**5**
Highway 41	0%	35%	36%	13%	2.5%	**7,8**

1.4 Discussion

To be completed for December Annual Technical Report.

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