Shasta River Brood Year 2013

Juvenile Coho Salmon PIT Tagging Study

August 29, 2016

California Department of Fish and Wildlife

Prepared by Yreka Fisheries

EXECUTIVE SUMMARY

This report summarizes passive integrated transponder (PIT) tag data collected on brood year 2013 (BY2013) juvenile coho in the Shasta River (the progeny of adult coho that spawned in 2013). The key findings of this study were:

1. Overall known survival of the 647 BY2013 PIT tagged coho, from the time they were tagged in the upper Shasta River in 2014, to outmigration into the Klamath River in the spring of 2015 was 22%.
2. Four percent (n=27) of the BY2013 coho PIT tagged in the upper Shasta River outmigrated between May 26 and June 26 in 2014. Based on their size and appearance, we consider these fish to be age-0 smolts.
3. During residency in the Shasta River, overall seasonal survival of PIT tagged juvenile coho in the upper Shasta River was similar from season to season, ranging from 61% in the summer to 72% in the winter.
4. Known summer survival of 144 PIT tagged juvenile coho relocated from Parks Creek to Kettle Spring (67%) was similar to known summer survival of 49 tagged coho that were naturally occurring in Kettle Spring (71%). This was higher than known summer survival of 22 coho tagged and released in Parks Creek without being relocated (9%), likely due to habitat conditions.
5. Known survival of age-1 smolts encountered in February 2015 (or later) and then again at RKM 1 as they outmigrated to the Klamath River was 67%. This is lower than smolt survival to outmigration documented in the BY2010 study (77%) and the BY2012 study (91%).

TABLE OF CONTENTS

List of Figures

List of Tables

I. INTRODUCTION

The California Department of Fish and Wildlife (CDFW) has been using passive integrated transponder (PIT) tags to monitor juvenile coho (*Oncorhynchus kisutch*) movements and survival in the Shasta River since 2008. Individually marking salmonids and tracking their movements using stationary PIT tag antenna stations has proven to be a useful tool for gathering data that can inform fisheries managers. This report presents data collected on 647 PIT tagged brood year 2013 (BY2013) juvenile coho, which is a sample of the progeny of an estimated 134 returning adults and jacks that spawned in the Shasta River in the fall of 2013. BY2013 coho emerged from redds in the spring of 2014 and out-migrated as age-1 smolts in the spring of 2015.

A balance was sought to represent the data with enough resolution to detect patterns and trends, yet simple enough that the findings could be used to reasonably identify potential management actions and future monitoring needs. In addition to general findings on fish movement and survival throughout the watershed, three specific topics were evaluated (each described more thoroughly below):

1. A relocation effort that occurred in June 2014 during which juvenile coho were moved from Parks Creek to Kettle Spring due to the lack of flow and high water temperatures.
2. Movements and survival of juvenile coho in Big Springs Creek.
3. Age-1 smolt outmigration timing and survival.

We used the Shasta River Brood Year 2012 Juvenile Coho Salmon PIT Tagging Study (Adams and Bean, 2016) as a template for this document so that the results between the two cohorts may easily be compared. We have placed all the photos referenced in this document in Appendix J.

1. Parks Creek Relocation Effort

From November 20, 2013 to January 29, 2014, an estimated 31 coho redds were documented in Parks Creek (a tributary to the Shasta River) between the Duke's Ranch to .48 miles upstream of Slough Road (Reach 24) (M. Knechtle pers. comm.) and a combined total of 47 redds were documented in the upper Shasta River watershed above HWY A-12 (Reaches 22, 23, and 24) (Knechtle and Chesney 2014). Shasta River Reach 24 is approximately 3.81 river miles long and includes the confluence with Bridge Field Creek. Bridge Field Creek delivers cold water from several springs including Black Meadow Spring and Bridge Field Spring (map -Appendix A). All of the coho redds observed in 2013/2014 were documented downstream of the Bridge Field Creek confluence. Due to irrigation practices and the drought in 2014, it was anticipated that fry from these redds would be at risk to mortality due to low flows and high stream temperatures (Appendix B). In years past, CDFW documented coho spawning upstream of the confluence of Bridge Field Creek (Olswang 2007, Olswang 2012) and in 1995, CDFW documented Chinook salmon spawning in the Bridge Field Creek channel (Appendix C).

On May 20 2014, CDFW conducted a dive survey in Bridge Field Creek, near the confluence with Parks Creek, upstream of the location where most of coho redds were observed. During the survey, approximately 40 age-0 coho and 20 age-0 steelhead were observed in the creek (Figure 1, May 20, 2014 Field Note – Appendix D). On June 13, 2014, CDFW observed that the flow in Parks Creek below

the confluence with Bridge Field Creek was reduced compared to the previous site visit. Visibility was poor and no coho were observed in locations where dive surveys were conducted during the May 20, 2014 survey. A total of 12 juvenile coho were seined from the deeper pools in Parks Creek downstream of the confluence of Bridge Field Creek and PIT tagged (Appendix D). On June 17, 2014, CDFW returned to the site to check on the status of juvenile coho salmon. Dive surveys were conducted throughout the vicinity. No age-0 coho were observed in Bridge Field Creek and were only present in low numbers downstream of the confluence with Parks Creek. However, juvenile coho salmon were observed throughout Parks Creek in the reach above the confluence with Bridge Field Creek (Appendix D).

In order to reduce juvenile coho mortality, CDFW implemented a coho rescue effort on Parks Creek on June 20 and 23, 2014 (Appendix D). Water temperatures had increased and flows decreased when water was diverted for irrigation. A total of 286 coho were captured upstream of the confluence of Bridge Field Creek and Parks Creek and relocated to a creek with cold spring inflow (Kettle Springs) on the property. Based on an agreement with the landowner, Kettle Springs was to remain free flowing (i.e., not diverted for irrigation purposes) after the relocation in order to maximize the potential for survival of the relocated and naturally occurring juvenile coho that were utilizing the habitat in Kettle Springs Creek. In order to evaluate the effectiveness of this effort, a sample of the relocated coho were PIT tagged and their survival and movements are presented in this report.

2. Big Springs Creek

The springs feeding Big Springs Creek are the largest source of spring water (>80 cfs) in the Shasta River watershed. Big Springs Creek itself has the potential to provide approximately three kilometers of cold water summer rearing habitat for juvenile coho, and its favorable thermal input could extend down the Shasta River past its confluence. However, irrigation withdraws, tailwater inputs, and cattle grazing in the stream have compromised the salmonid habitat in Big Springs Creek. Recent cattle exclusion fencing and alternative water management practices have improved conditions in Big Springs Creek for salmonids. Despite favorable summer stream temperature conditions existing throughout much of Big Springs Creek, previous studies suggest that juvenile coho primarily utilize two discrete locations for summer rearing; the outfall pool directly downstream of Big Springs Lake, and the reach immediately downstream of the water wheel structure.

Little Springs Creek is a tributary of Big Springs Creek that is approximately 2.4 kilometers long and is fed by a spring complex that discharges at a rate of approximately 7 cfs. Juvenile coho were first documented in Little Springs Creek during the BY2012 study. In order to maximize coho production in Big Springs Creek and Little Springs Creek, an understanding of how coho currently utilize habitat there is necessary. In this study, we investigated juvenile coho movements and survival within Big Springs Creek and Little Springs Creek.

3. Smolt Outmigration

Smolt outmigration is an important segment of coho life history since fish must pass through the entire river system downstream of their rearing locations. Outmigrant trapping and PIT tag detection data has shown that the timing of age-1 coho smolt outmigration in the Shasta River coincides with the onset of

the irrigation season. For the mainstem Shasta River and Big Springs Creek the irrigation season is from April 1 to September 30 with the exception of riparian water right holders which are not regulated. For the two main tributaries of the Shasta River, Parks Creek and Little Shasta River, the irrigation period is March 1 to November 1 (Shasta River Adjudication 1932). It is important to understand smolt migration timing and identify potential impacts of water management so that survival of outmigrating coho smolts may be maximized during this critical period.

II. STUDY SITE

The Shasta River is located in Siskiyou County in northern California, and flows approximately 100 kilometers from its headwaters to the Klamath River (Figure 1). Tributaries fed by precipitation and snow melt flow from the western slopes of the Cascade Range and eastern slopes of the Eddy Mountains into the Shasta River. However, cold water springs provide most of the summer base flow. These springs, located in the upper Shasta River watershed, are charged by glacial melt from Mount Shasta. The spring flow becomes nutrient rich as the water flows through porous volcanic and sedimentary rock. Water from the springs enters the river at a constant temperature of approximately 13° C. As a result of these attributes, primary productivity in the Shasta River is very high and in turn salmonid prey abundance is high and rearing juvenile salmonids experience rapid growth rates.

The gradient is relatively low throughout the Shasta Valley, but increases through the lowest ten kilometers, where the river flows through a canyon before converging with the Klamath River approximately 350 river kilometers from the Pacific Ocean (Photos 1, 2). Dwinnell Dam was constructed in 1928 at Shasta River RKM 65 (65 kilometers upstream from the Klamath River), impounding Lake Shastina (Photo 3) and blocking migration of anadromous fish.

The climate is semi-arid with annual precipitation ranging from about 25-45 cm, the majority of which falls as snow at the higher elevations in winter. Flows are severely impacted by irrigation withdraws, particularly during the summer months. USGS streamflow data collected from October 2013 to July 2015, measured near the Shasta River's confluence with the Klamath River, is shown in Figure 2.

Based on previous radio tagging efforts and redd survey data collected by CDFW, coho spawning currently occurs in two general areas of the Shasta River. These areas are the "canyon" reach located between RKM 0 and RKM 12, and the "upper" Shasta River, located between the confluence of Big Springs Creek (RKM 53) and the first kilometer upstream of Parks Creek (RKM 57), Big Springs Creek, and the valley portion of Parks Creek (Figure 1).

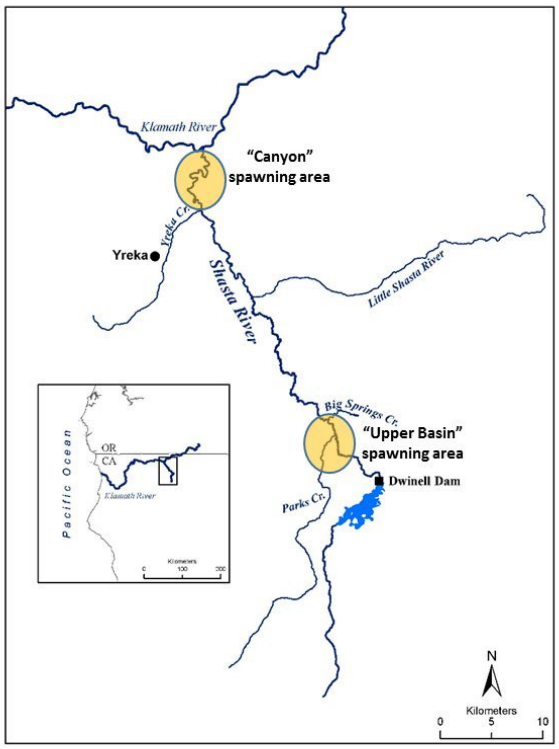


Figure 1. Map of Shasta River showing coho spawning locations.

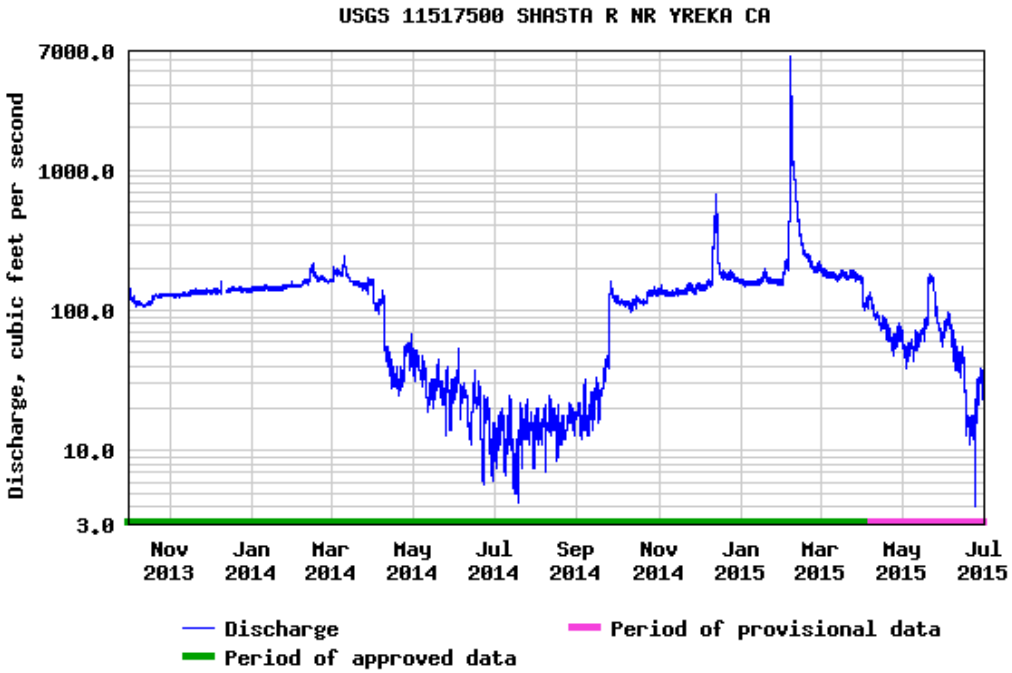


Figure 2. USGS hydrograph from gage station located at Shasta River RKM 0 from October 2013 to July 2015.

III. METHODS

1. Capture/Tagging

Reconnaissance level snorkel surveys were conducted throughout Big Springs Creek and the Shasta River from RKM 51 (Nelson Ranch) to RKM 62 (near Dwinell Dam), Big Springs Creek, Little Springs Creek, and the Kettle Spring outfall. Parks Creek from RKM 7 upstream to Bridge Field Spring was surveyed on May 20, June 13 and 19, 2014, to identify locations where coho were rearing and their relative abundance in order to target capture efforts in key locations. Capture efforts were carried out where coho were observed during these dive surveys. Trapping methods included hand nets used while snorkeling, seine nets, and overnight sets of un-baited minnow traps and fyke nets. In addition to upper Shasta River tagging efforts, some BY2013 coho were tagged at an outmigrant rotary screw trap that CDFW operates near the Shasta River's confluence with the Klamath River (RKM 0) from February through June (Photo 4). Coho captured at this site were scanned for PIT tags and a sample of untagged fish were implanted with PIT tags during their migration out of the Shasta River.

Captured juvenile coho were anesthetized with CO_2 and scanned with a hand-held PIT tag reader to identify previously tagged individuals. PIT tags and 14-gage needles were disinfected with isopropyl alcohol prior to use. An incision was made approximately 10 mm anterior to the base of the left pectoral fin with the needle and the PIT tag was then inserted by hand. Coho 50-59 mm fork length were implanted with 9 mm PIT tags while those 60 mm or larger were implanted with 12 mm tags. Fish were measured for fork length, tagged, sampled for scales, and held in aerated recovery containers before releasing them to their capture location (except for the fish that were captured in Parks Creek and relocated to Kettle Spring Creek).

2. PIT Tag Detection

Eighteen PIT tag detection stations operated in the Shasta River watershed during this study (Figure 3, Appendix E, Photos 5-24). These antenna systems were custom built in collaboration with Mauro Engineering (Mt. Shasta, California). Antennas were made of a wire conductor threaded through PVC pipe for structure and secured to t-posts driven into the river bed. A variety of antenna dimensions were used depending on channel characteristics at a given site. A data logger powered by a solar panel and batteries recorded PIT tag detections onto an SD card along with a date and time stamp. Data was uploaded to a Microsoft Access database for analysis.

Most PIT tag antenna stations were checked on a weekly basis to verify operation, perform any necessary maintenance, and assess detection capability. During each visit antenna station performance was rated on a 0-3 scale based on each antenna's read range and the total portion of the rivers transect over which detection was occurring (Appendix F). This served to qualitatively track detection efficiency at each site throughout the study. All of the PIT tag stations operated fairly consistently throughout the study; however they did experience periods of compromised performance due to high water, damage from rodents, or equipment malfunction (Figure 4). A high flow event in February 2015 resulted in about a week during which most antenna stations were non-operational, either because they were removed or

damaged by high flows and debris. Detection stations in Big Springs Creek and the Shasta River upstream of Parks Creek remained operational through the high flow event, since flows in those locations did not increase significantly. The following stations were only in operation for a short period during the study: RKM 0C, RKM 0A, and Parks RKM 8. The PIT tag antenna equipment at RKM 0C was stolen. That station was not operational from June 28, 2014 through March 20, 2015. The PIT station at RKM 0A was only in operation from October 21 through December 10, 2014, to aid in detection of PIT tagged adults and the PIT station located at Parks RKM 8 was not installed until September 10, 2014.

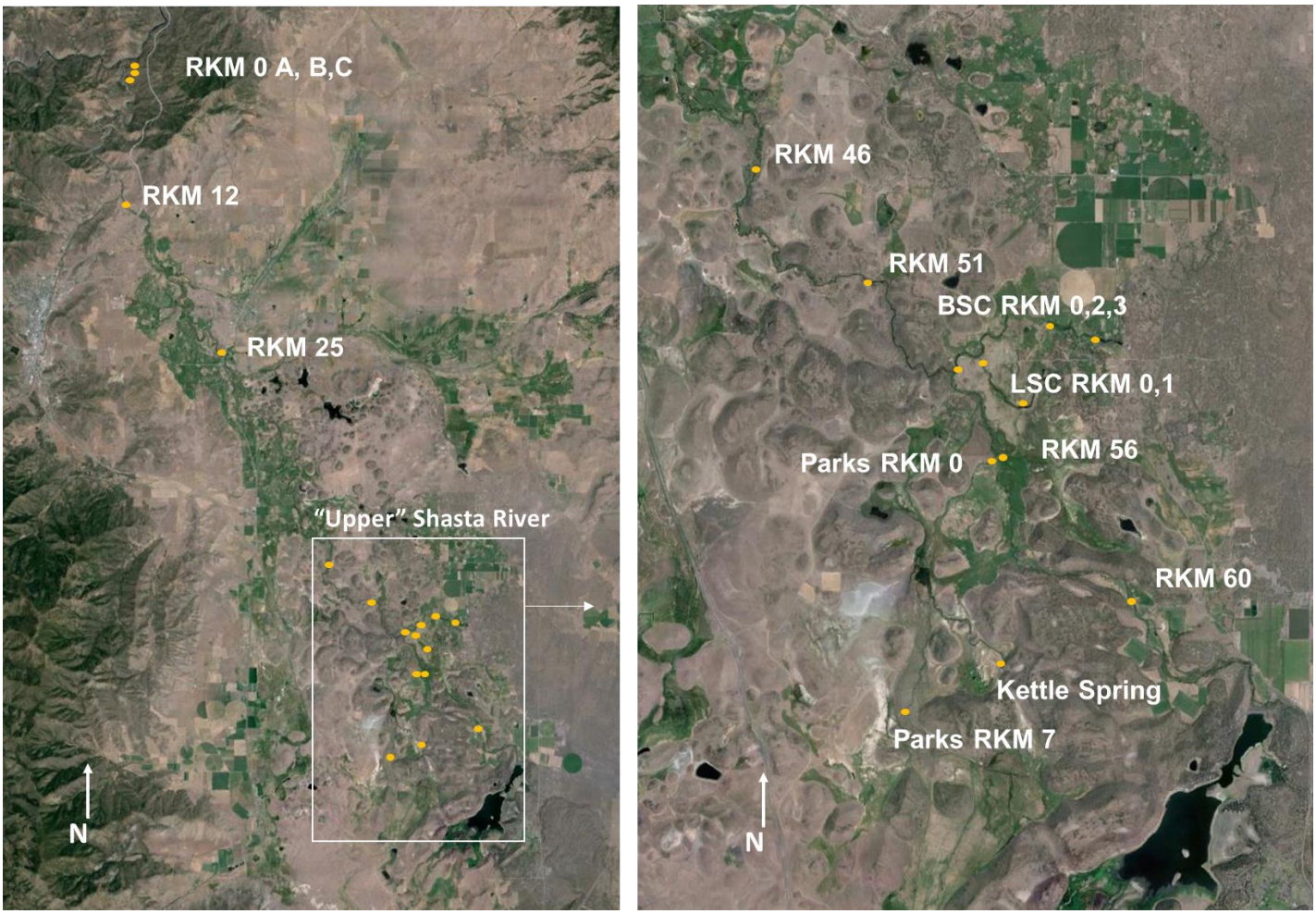


Figure 3. Locations of PIT tag detection stations in the Shasta River watershed during the BY2013 coho study.

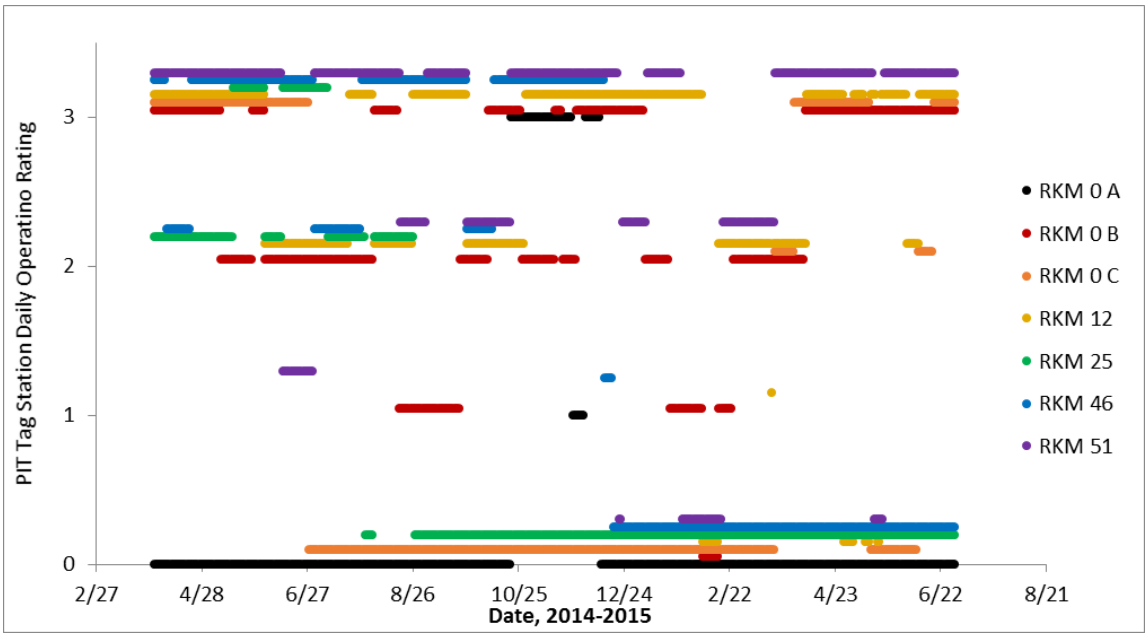


Figure 4. Daily PIT tag antenna station operation for the seven locations downstream of the upper Shasta River tagging locations. Rating scheme based on estimated percentage of river transect covered by a PIT tag detection field: 3=67-100% 2=34-66% 1=1-33 0=0%.

3. Temperature Monitoring

Temperature loggers (HOBO by Onset) were deployed at most PIT tag antenna stations. Temperature loggers were housed in a section of steel or PVC pipe and attached to rebar or t-post anchors with steel cable. Most temperature loggers were cleaned and downloaded on a monthly basis. Stream temperature was recorded at hourly intervals. Temperature plots can be found in Appendix G.

4. Data Analysis

Temporal and spatial categorical schemes were developed to evaluate juvenile coho movement and survival at the watershed scale, similar to that developed in the BY2010 and BY2012 Shasta River coho studies (Adams 2013, Adams and Bean 2016). The spatial categories are defined by dividing the Shasta River into five reaches (Table 1, Figure 5). These reaches are each coded by an individual letter and specific color in this report as: L (green)=Lower section of the upper Shasta River (Nelson Ranch to Big Springs Creek; RKM 51-53), U (orange)=Upper section of the upper Shasta River (Big Springs Creek to Dwinnell Dam; RKM 54-60), B (blue)=Big Springs Creek including Little Springs Creek, P (pink)=Parks Creek (Parks RKM 0-8 including Kettle Spring), and M (red)=the Shasta River from the confluence with the Klamath River upstream to RKM 50 (downstream of L). Each reach includes sites where tagging occurred and PIT tag stations were operated.

The temporal categories are defined by five encounter periods (Figure 6). An “encounter” of an individual can mean either detection at an antenna station or a physical recapture during a trapping effort. The first encounter occasion is the initial tagging effort during which individuals are assigned to

the location where they were tagged (April-July 2014). The second encounter occasion is summer rearing period during which individuals are assigned the location they were last encountered from April-September 2014 (excluding the spring tagging location). Individuals tagged after July are included in the summer rearing encounter period. The third encounter occasion is the winter rearing period during which individuals are assigned the location they were last encountered from October 2014-February 2015. The fourth encounter occasion is smolt departure from the upper Shasta River during which individuals are identified as alive and present in the upper Shasta River at the start of the smolt outmigration period based on their encounter upstream of RKM 12 from March-May 2015. The fifth and final encounter occasion is smolt outmigration from the Shasta River, in which individuals are identified as successfully reaching the Klamath River based on their encounters at RKM 0 or RKM 12 from March-May 2015.

An individual tagged fish is determined to have survived a given temporal category if it was encountered on any proceeding occasion in any location (known survivor). To calculate the total known survival rate from one encounter occasion to the next, the number of known survivors was divided by the total number of individuals known to be alive and present during the given encounter occasion. This calculation is performed for all upper Shasta River tagged coho combined, as well as for each location category individually. The result of these "known survival" calculations is actually a minimum survival estimate, since fish that outmigrated without being encountered are counted as mortalities. Given that relatively few (n=27) upper Shasta River tagged coho were encountered downstream of the upper Shasta River prior to the smolt outmigration period (4% in this study), and the operation of the multiple antenna stations downstream of the upper Shasta River (Figure 4), it is assumed that this "known survival" calculation is close to the true survival rate. It is not likely that many PIT tagged coho outmigrated from the Shasta River without being encountered at least once.

Table 1. Spatial categories defined for movement and survival analyses.

Location Code	Description	Capture Locations	Detection Locations
L	Upper Shasta River Downstream of Big Springs Creek (RKM 51-53)	RKM 51 RKM 53	RKM 51
U	Upper Shasta River Upstream of Big Springs Creek (RKM 54-60)	RKM 55 Spring RKM 57 RKM 55 RKM 56	RKM 56 RKM 60
B	Big Springs Creek and Little Spring Creek	BSC RKM 2 BSC RKM 3	BSC RKM 0 LSC RKM 0 BSC RKM 2 LSC RKM 1 BSC RKM 3
P	Parks Creek RKM 0-8 including Kettle Spring	Kettle Spring Parks RKM 8	Parks RKM 0 Kettle Spring Parks RKM 7 Parks RKM 8
M	Downstream of upper Shasta (RKM 0-48)	RKM 0	RKM 0 A RKM 12 RKM 0 B RKM 25 RKM 0 C RKM 48

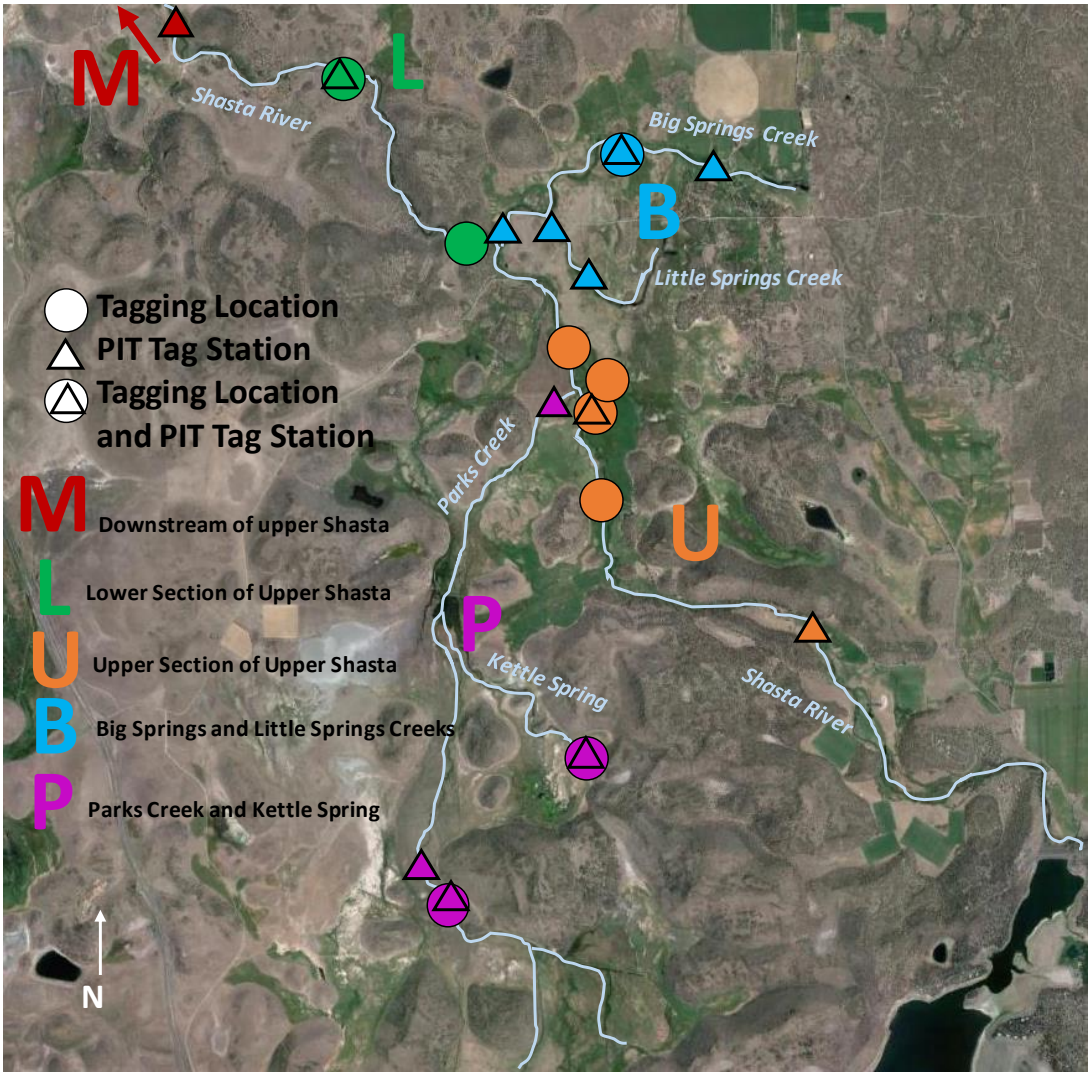


Figure 5. Map of Shasta River spatial categories for BY2013 coho movement and survival analyses.

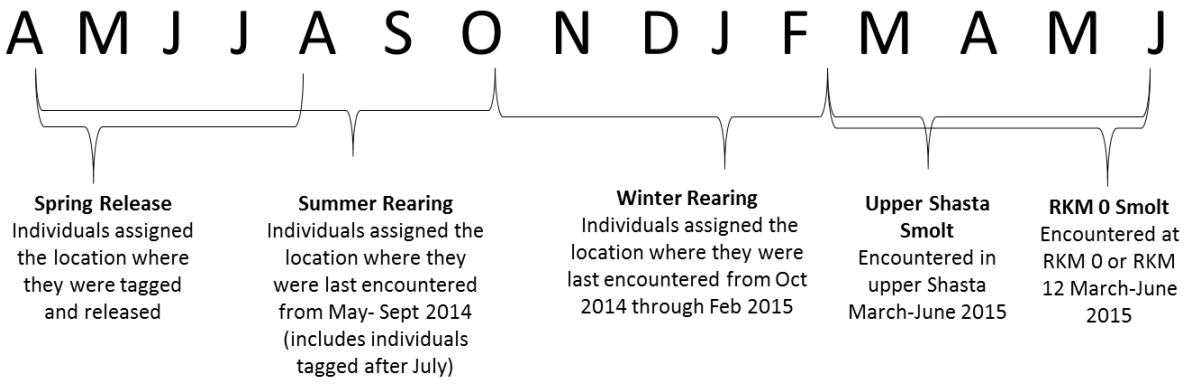


Figure 6. Temporal categories as defined by five encounter occasions from April 2014 to June 2015.

IV. RESULTS

1. Capture/Tagging

A total of 647 age-0 BY2013 coho were tagged in the upper Shasta River (Table 2, Figure 7). The first BY2013 coho observed that were large enough to tag (50mm) were located in the Shasta River near the Parks Creek confluence in early April 2014 (Photo 25). Observations of coho near the Big Springs Creek confluence were minimal, contrary to previous years, and only two coho were captured and tagged at that location. Fifty-nine (59) coho were captured in fyke nets or a rotary screw trap and tagged at RKM 51 (upper Nelson Ranch) in May and June 2014. Forty-four (44) coho were captured and tagged in RKM 55 Spring and in the Shasta River just downstream of the RKM 55 Spring confluence in late April and early May. Several hundred BY2013 coho were observed at RKM 57 (approximately 1-2 kilometers upstream of the Parks Creek confluence) in beaver pond habitat (Photo 26), and 172 were captured and tagged there in July and August. These fish were found concentrated in a dense school along with hundreds of tui chubs, suckers, and speckled dace. No coho were observed in the reach directly downstream of Clear Spring or from RKM 60 to 62 (Hidden Valley Ranch).

BY2013 coho fry were observed in Big Springs Creek upstream of the bridge at BSC RKM 1 on March 18 2014 (Photo 27). A total of 89 BY2013 coho were captured and tagged BSC RKM 2 (downstream of the water wheel structure) in early May. Approximately 50 coho were observed at BSC RKM 3 (the outfall pool from Big Springs Lake) on May 18 2014 (Photo 28) and 28 were captured and tagged there on July 17, 2014. No BY2013 coho were observed during snorkel surveys in Little Springs Creek during the course of this study.

Twenty-two (22) coho were captured, tagged, and released at Parks Creek RKM 8 (between Parks 5 diversion and the slough confluence) on May 20, 2014. Coho were observed at Kettle Spring prior to relocation efforts and 34 were tagged and released there on June 13, 2014. Relocation efforts took place on June 20 and 23, 2014, when aquatic habitat conditions for juvenile coho in Parks Creek were becoming inhospitable (stream disconnected and water temperatures over 20° C) and were anticipated to deteriorate (Photos 29-31). A total of 286 coho were captured in Parks Creek between the slough confluence and the reach adjacent to Bridge Field Spring (Figure 8), 144 of which were PIT tagged. Fish captured in Parks Creek were released in Kettle Spring Creek at the bridge crossing approximately 1 kilometer downstream of the Kettle Spring outfall (Photos 32-34). An additional 15 coho were tagged at the Kettle Spring outfall pool on August 22, 2014 (Photo 35). These fish may have included relocated individuals that were not tagged initially.

BY2013 coho in the upper Shasta River basin showed a great variability in size (Figure 9). Coho captured in Big Springs Creek tended to be larger than those captured in the mainstem Shasta River, with some exceeding 90 mm in May. Coho captured in Kettle Spring were the largest coho tagged in 2014, however, those captured in Parks Creek were the smallest with some measuring less than 60 mm in June.

A total of 1,661 BY2013 coho were captured as age-0 outmigrants between March 5 and June 30, 2014 at the RKM 0 rotary screw trap, of which 733 were measured for fork length (Figure 10) and 477 were implanted with PIT tags. BY2013 coho captured at the RKM rotary screw trap in 2014 fell within two distinct size groups. One group ranged from 40-80 mm and were caught primarily in May, and a second group that ranged from 90-120 mm and were caught primarily in June. Six age-0 BY2013 coho were captured at the RKM 0 trap site that had been tagged in the upper Shasta River, five of which fell within the group of larger coho that oumigrated later in the season. A total of 5,501 age-1 coho smolts were captured at the RKM 0 rotary screw trap between Februry 14 and June 6, 2015, of which 949 were measured and 48 were identified as having been tagged in the upper Shasta River. No age-1 coho were tagged at the RKM 0 rotary screw trap in 2015.

Table 2. PIT tagged BY2013 Shasta River coho by location and date range.

Reach	Location	Total Tagged	Date Range		Gear
L	RKM 51	59	4/8/2014	5/30/2014	Fyke, Rotary Screw Trap
L	RKM 53	2	4/16/2014		Hand Net
U	RKM 55	13	5/12/2014		Hand Net
U	RKM 55 Spring	31	4/23/2014	5/12/2014	Minnow Trap, Hand Net
U	RKM 56	38	4/7/2014	4/25/2014	Fyke, Hand Net
U	RKM 57	172	7/11/2014	8/22/2014	Seine
B	BSC RKM 2	89	4/29/2014	5/30/2014	Seine, Fyke, Minnnow Trap
B	BSC RKM 3	28	7/17/2014		Seine
P	Kettle Spring	49	6/13/2014	8/22/2014	Seine
P	Kettle Spring (From Parks RKM 9)	144	6/20/2014	6/23/2014	Hand Net, Seine, Fyke
P	Parks RKM 8	22	5/20/2014	6/13/2014	hand net, seine
	Total Upper	647			
M	RKM 0 (2014)	477	4/30/2014	6/30/2014	Rotary Screw Trap

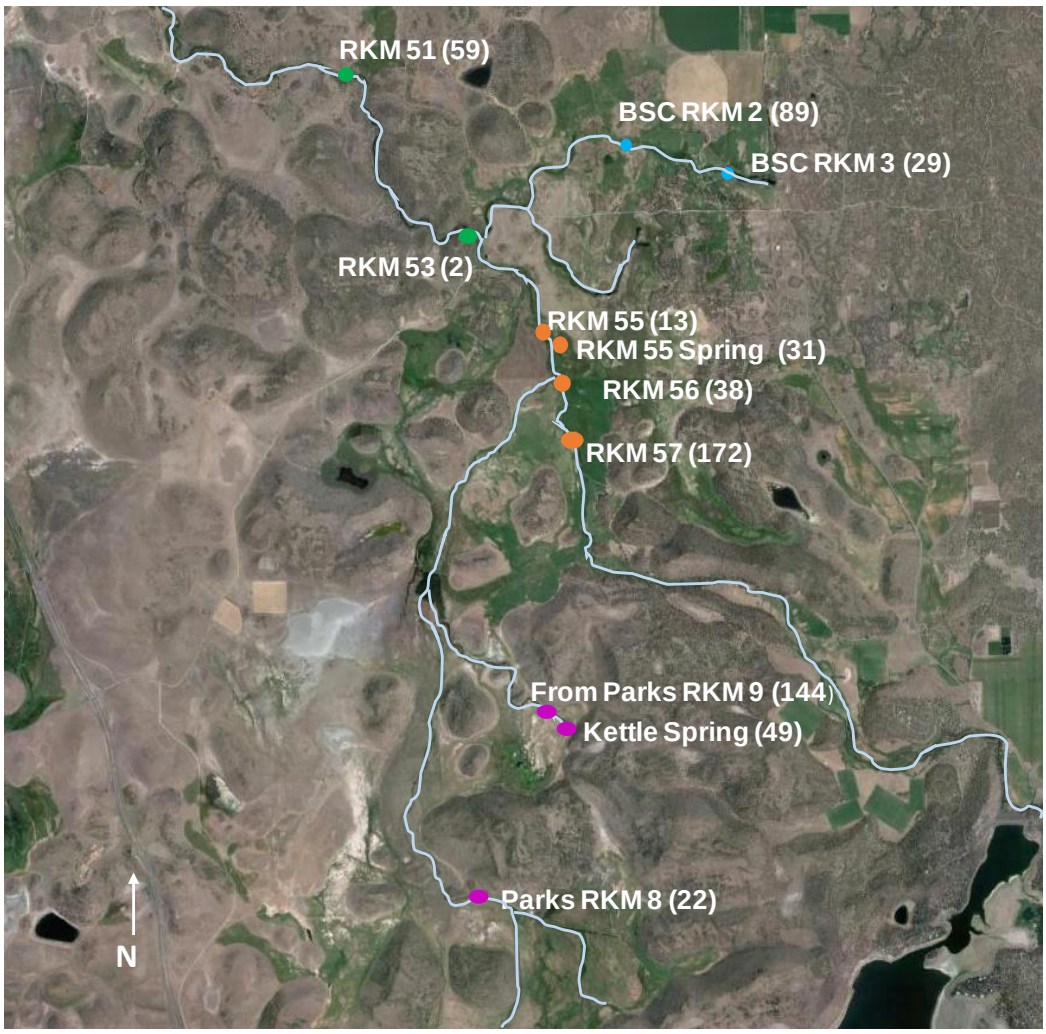


Figure 7. BY2013 coho upper Shasta River tagging locations. Total coho tagged at each site shown in parentheses.

Figure 8. Map of Parks Creek and Kettle Spring showing PIT tag stations, the reach where relocated coho were captured (purple shading), and the site where relocated coho were released (downstream of Kettle Spring).

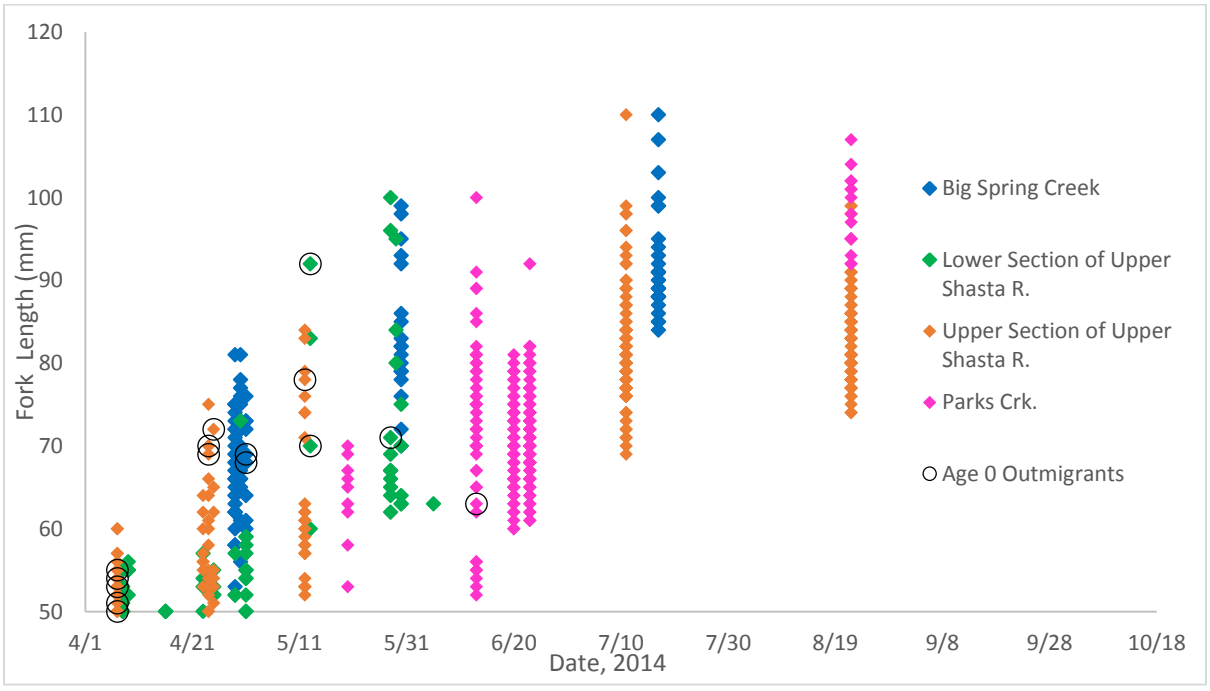


Figure 9. BY2013 coho fork length at date of tagging in the upper Shasta River. N=648. The 27 BY2013 coho that were encountered outmigrating from the upper Shasta River during the spring of 2014 are circled.

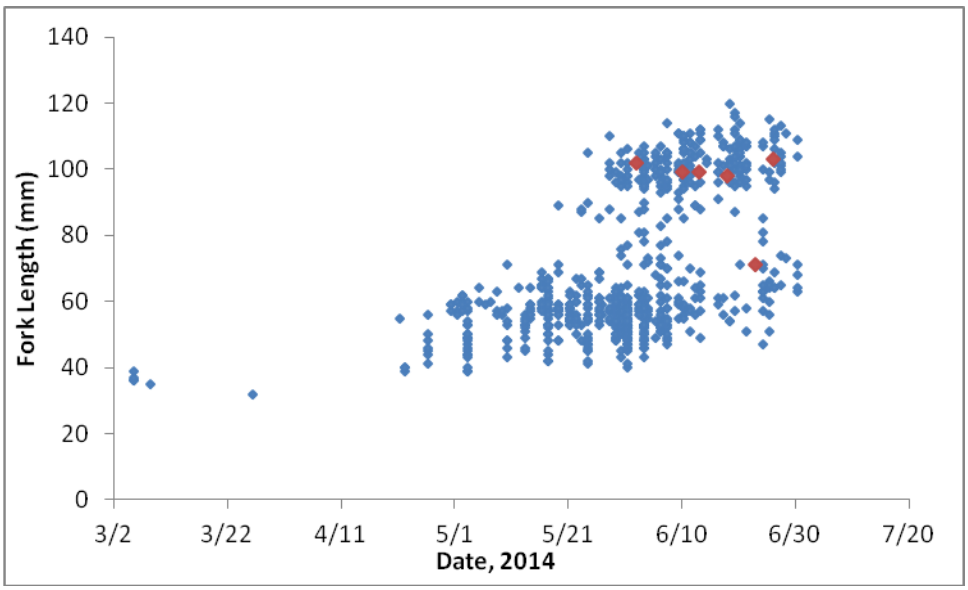


Figure 10. BY2013 coho fork length at date of tagging at the RKM 0 rotary screw trap in the Shasta River. Recaptured individuals that were previously tagged in the upper Shasta River are indicated in red.

2. Movement and Survival

The frequency of PIT tag detections at all upper Shasta PIT tag antenna stations combined was highest in June and July 2014 (Figure 11). Most of the early summer detections occurred in locations where fish were tagged and released nearby; antenna stations such as BSC RKM 2, BSC RKM 3, and Kettle Spring outfall. Twenty-seven (27) individuals were encountered downstream of the upper Shasta River during May and June. These age-0 outmigrants were some of the largest BY2013 coho tagged in the upper basin (Figure 9). These individuals were also among a group of larger age-0 coho captured at the RKM 0 rotary screw trap (Figure 10).

The frequency of detections declined from July to August but then increased from September through November 2014, as coho were detected moving from their summer rearing location to a different location to rear for the winter. Most of these redistribution detections took place in Parks Creek where coho moved from the Kettle Spring outfall pool downstream to Parks Creek and up Parks Creek past the Parks RKM 7 and Parks RKM 8 stations. Movement and survival of the Parks Creek tag group is analyzed further in section 2.3. Only 4% of the PIT tagged coho moved from one of the four upper Shasta River study reaches to another from October 2014 through February 2015. Overall detection rates were lower during January and February, likely because fish were relatively stationary in winter rearing locations. No BY2013 coho were detected outmigrating from the upper Shasta River from August 2014 through February 2015. During the spring outmigration period (March-May 2015), 139 PIT tagged age-1 coho were detected as they left the upper Shasta River (RKM 51 or upstream), and 68 of those were later detected at RKM 12 or RKM 0 before they entered the Klamath River. An additional 75 individuals were detected at RKM 12 or RKM 0 that were not detected in the upper Shasta during the March to May 2015 time period. No detections of BY2013 coho occurred after May 2015. See Appendix H for graphs of total individuals detected at each PIT tag antenna station by month.

Of the 620 BY2013 coho tagged in the upper Shasta River that were not detected outmigrating prior to March 2015, 143 (23%) are known to have survived to reach the Klamath River as age-1 smolts in the spring of 2015. The known survival of BY2013 upper Shasta River coho tagged at all locations combined was 69% from the initial spring release to the summer rearing encounter occasion; 61% through the summer rearing occasion, 72% through the winter rearing occasion, and 67% of the tagged smolts known to be alive in the upper basin in March 2015 are known to have survived to reach the Klamath River (Figure 12, Table 3). While overall survival was relatively constant across encounter occasions, it varied between reaches during each encounter occasion (Figure 13). Known survival from the spring tagging occasion to the summer rearing occasion ranged from a low of 51% in the L reach to a high of 85% in Big Springs Creek. Known summer survival ranged from a low of 29% in L reach to a high of 69% in P reach, and known winter survival ranged from a low of 48% in P reach to a high of 70% in U reach.

Movements of tagged BY2013 coho between reaches prior to the smolt outmigration were limited. Less than 10% of any tag group moved to another upper Shasta River reach between any of the encounter occasions (Tables 4, 5). Some individuals from the L, U, and B reaches outmigrated from the upper Shasta River during the summer rearing period (11%, 15%, and 9%, respectively), however none of the coho tagged in Parks Creek were detected outmigrating during the summer rearing occasion. No BY2013 coho were detected outmigrating from the upper Shasta River during the winter rearing occasion.

Of the 75 individuals that were not encountered in the upper Shasta in March 2015 or later but were encountered at RKM 0 in March 2015 or later, 43 were encountered between September 2014 and February 2015 in the upper Shasta River (9 in Big Springs, 16 in Parks Creek, 10 at RKM 56, and 8 at RKM 51.) Seven of the 75 were last encountered in the summer of 2014 in Big Springs or Parks Creek and four were last encountered at RKM 51 in the summer of 2014. Twenty-one of the 75 were tagged at RKM 57 and not encountered anywhere prior to detection during outmigration at RKM 0 in 2015.

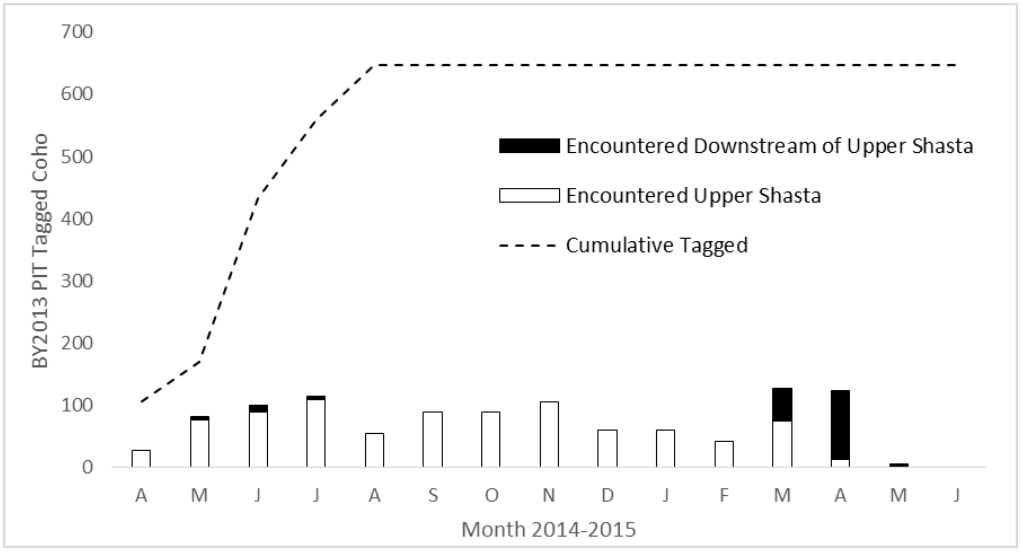


Figure 11. Total tagged BY2013 coho tagged in the upper Shasta River that were detected each month at all upper Shasta antenna stations combined (white) and downstream antenna stations (black) along with the cumulative monthly total tagged (dashed line).

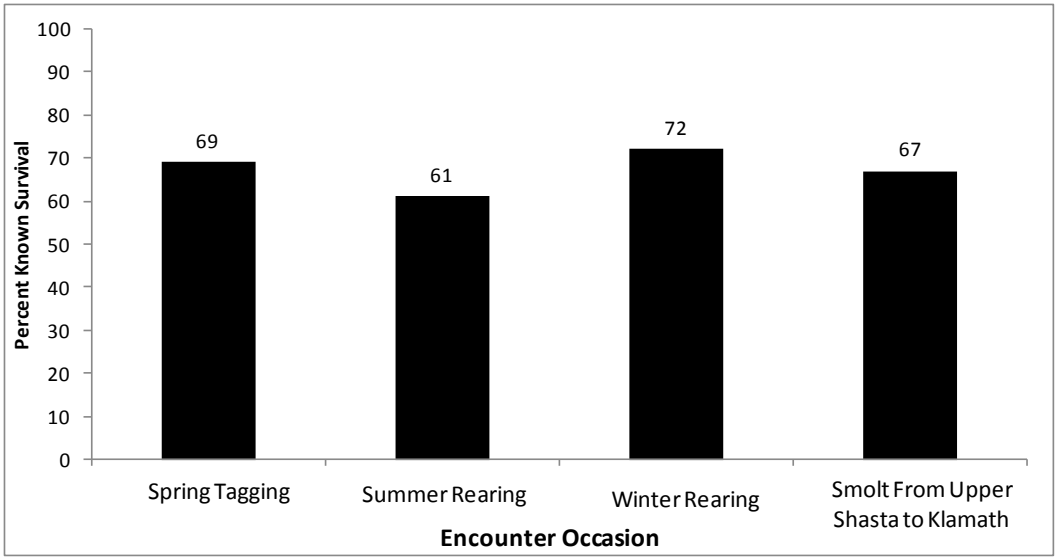


Figure 12. Known survival from each encounter occasion for all upper Shasta tagged BY2013 coho combined.

Table 3. Number of tagged BY2013 coho encountered in each reach of the upper Shasta River during each encounter occasion and the percentage from each reach that are known to have survived to the next encounter occasion. The total in each location represents any individuals encountered in that location during that time period and the known survivors are the individuals that were encountered at any location in any proceeding time period. The total numbers of individuals that moved between sites are shown in tables 4 and 5.

		Spring Release	Summer Rearing	Winter Rearing	Upper Shasta Smolt	RKM 0 Smolt
All upper Shasta locations combined	Total	432	488	297	214	143
	Known Survivors	300	297	214	143	
	% Known Survival	69%	61%	72%	67%	
Upper Shasta downstream of Big Springs Creek (L)	Total	61	14	17		
	Known Survivors	31	4	10		
	% Known Survival	51%	29%	59%		
Upper Shasta upstream of Big Springs Creek (U)	Total	82	213	20		
	Known Survivors	56	99	14		
	% Known Survival	68%	46%	70%		
Big Springs and Little Spring Creek (B)	Total	89	86	51		
	Known Survivors	76	47	29		
	% Known Survival	85%	55%	57%		
Parks Creek and Kettle Spring (P)	Total	200	91	92		
	Known Survivors	137	63	44		
	% Known Survival	69%	69%	48%		
Outmigrated from Upper Shasta	Total		27		139	143
	Known Survivors				68	
	% Known Survival				49%	
Known Alive But Not Encountered	Total		84	117	75	

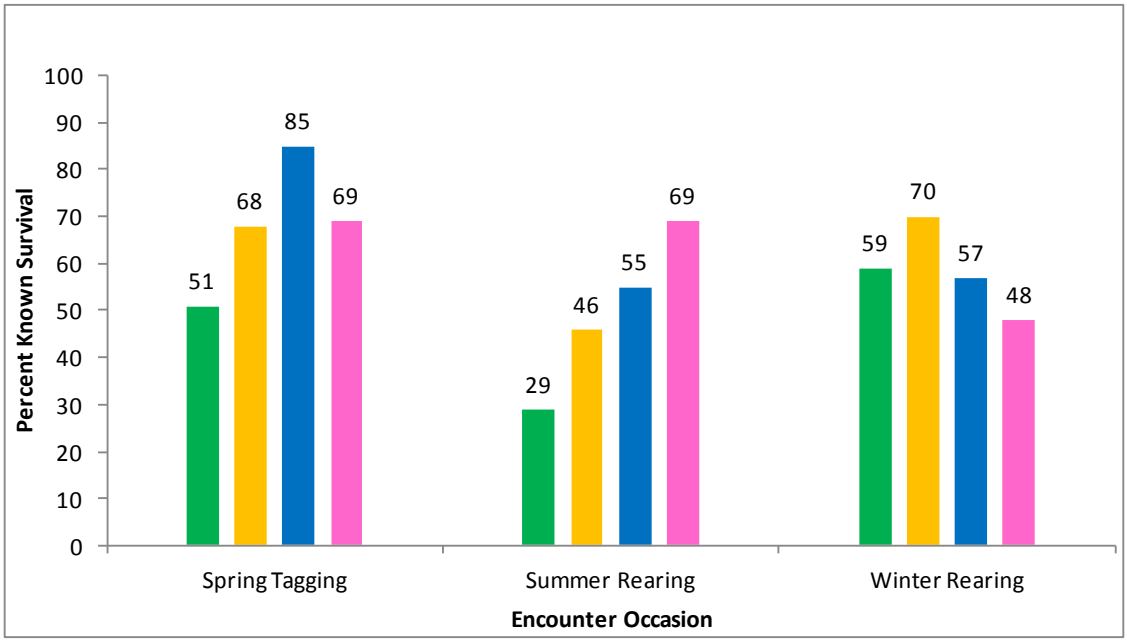


Figure 13. Known survival percentage of BY2013 coho encountered in each of the four upper basin reaches during the spring tagging, summer rearing, and winter rearing encounter occasions.

Table 4. Movements among upper Shasta River locations from the initial spring release location to the summer rearing location.

		Tag Location (April-July 2014)							
		L		U		B		P	
		Total	%	Total	%	Total	%	Total	%
	Total Released	61		82		89		200	
Location Last Encountered During Summer Rearing Period (May-Sept 2014)	L	7	11%	3	4%	4	4%	0	0%
	U	4	7%	29	35%	5	6%	3	2%
	B	5	8%	1	1%	51	57%	1	1%
	P	2	3%	5	6%	2	2%	67	34%
	Outmigrated From Upper Shasta River	7	11%	12	15%	8	9%	0	0%
	Known Alive But Not Encountered	6	10%	6	7%	6	7%	66	33%
	Not Encountered Again	30	49%	26	32%	13	15%	63	32%

Table 5. Movements among upper Shasta River locations from the summer encounter occasion to the winter encounter occasion.

		Summer Rearing Location (April-September 2014)							
		L		U		B		P	
		Total	%	Total	%	Total	%	Total	%
	Total Released	14		213		86		91	
Location Last Encountered During Winter Rearing Period (Oct 2014-February 2015)	L	1	7%	0	0%	3	3%	6	7%
	U	1	7%	2	1%	1	1%	2	2%
	B	0	0%	1	0%	41	48%	1	1%
	P	0	0%	0	0%	1	1%	51	56%
	Outmigrated From Upper Shasta River	0	0%	0	0%	0	0%	0	0%
	Known Alive But Not Encountered	2	14%	94	44%	1	1%	3	3%
	Not Encountered Again	10	71%	114	54%	39	45%	28	31%

3. Parks Creek Relocation Effort

Of the 144 BY2013 coho juveniles that were captured in Parks Creek, tagged, and relocated to Kettle Springs Creek, 96 (67%) are known to have survived until October 2014 (Table 6). Sixty-four (64) were detected at the Kettle Spring outfall pool antenna station by the end of September 2014; 23 of those were first encountered at the outfall pool within two weeks of being tagged and released (Figure 14). One of the tagged and relocated BY2013 individuals outmigrated from Parks Creek during the summer, 48 were not detected by October 1, 2014 but are known to have survived summer based on a later encounter, and 31 were not detected again after their relocation.

Of the 95 tagged and relocated coho known to survive until October and remain in Parks Creek, 63 (66%) are known to have survived to March 2015 or outmigrated from Parks Creek during the winter encounter period. Outmigration from Parks Creek during the winter period (24 individuals) was fairly evenly distributed over time from October 2014 to February 2015. Forty-four (46%) of the 95 individuals were encountered at Parks Creek RKM 7 and/or Parks Creek RKM 8 as they moved upstream toward the location where they were initially captured, including 21 individuals that were encountered at the Kettle Spring outfall during the summer period. These movements up Parks Creek generally took place between October and December 2014.

Of the 22 BY2013 coho tagged at Parks Creek RKM 8, three were encountered again and only two (9%) are known to have survived until October 2014. One was last encountered at the Parks Creek RKM 7 station in the summer, one outmigrated from Parks Creek in the winter, and one outmigrated from Parks Creek in the spring of 2015. Of the 49 BY2013 coho tagged at Kettle Spring outfall (i.e., not relocated), 35 (71%) are known to have survived until October (Table 7). One of the 49 individuals

tagged at Kettle Springs was encountered at Parks RKM 7 during the summer period and five outmigrated from Parks Creek during the summer period. Of the 30 coho tagged at Kettle Springs outfall pool that are known to have survived until October and remained in Parks Creek, 14 (47%) were encountered at Parks RKM 7 and/or Parks RKM 8 during the winter rearing period and 13 (43%) outmigrated from Parks Creek during the winter rearing period.

BY2013 coho captured at Parks RKM 8 (22 individuals) prior to the relocation effort were the smallest fish in the study, given the date of tagging (<60mm on June 13, 2014). Conversely, coho tagged and released at Kettle Spring prior to the relocation effort (34 individuals) were among the largest tagged given the date of tagging (65-90+ mm on June 13, 2014). The coho captured and relocated from Parks Creek generally ranged from 60-80 mm on June 20, and 23, 2014 (Figure 15).

Figure 14. First and last detections of relocated BY2013 coho at Parks RKM 7 and 8 combined (top), Kettle Spring outfall (middle) and Parks Creek RKM 0 or anywhere outside of Parks Creek (bottom) in 2014 and 2015.

Table 6. Seasonal movement and survival of 144 tagged BY2013 coho relocated from Parks Creek RKM 8 to Kettle Spring Creek on June 20 and 23, 2014.

	Summer				Winter			
	Last Encounter June-September 2014		Known Survival to October 2014 or Outmigrated		Last Encounter October 2014-February 2015		Known Survival to March 2015 or Outmigrated	
	Total	%	Total	%	Total	%	Total	%
Total	**144**		**96**	**67%**	**95**		**63**	**66%**
Kettle Spring	64	44%	47	73%	12	13%	5	42%
Parks RKM 7/8	0	0%	0		44	46%	19	43%
Parks RKM 0 or outide Parks	1	1%	1	100%	24	25%	24	100%
Alive but not encountered	48	33%	48	100%	15	16%	15	100%
Not encountered again	31	22%						

Table 7. Seasonal movement and survival of the 49 BY2013 coho tagged at Kettle Spring outfall in 2014.

	Summer				Winter			
	Last Encounter June-September 2014		Known Survival to October 2014 or Outmigrated		Last Encounter October 2014-February 2015		Known Survival to March 2015 or Outmigrated	
	Total	%	Total	%	Total	%	Total	%
Total	**49**		**35**	**71%**	**30**		**21**	**70%**
Kettle Spring	25	51%	18	72%	3	10%	1	33%
Parks RKM 7/8	1	2%	1	100%	14	47%	7	50%
Parks RKM 0 or outide Parks	5	10%	5	100%	13	43%	13	100%
Alive but not encountered	11	22%	11	100%	0	0%		
Not encountered	7	14%						

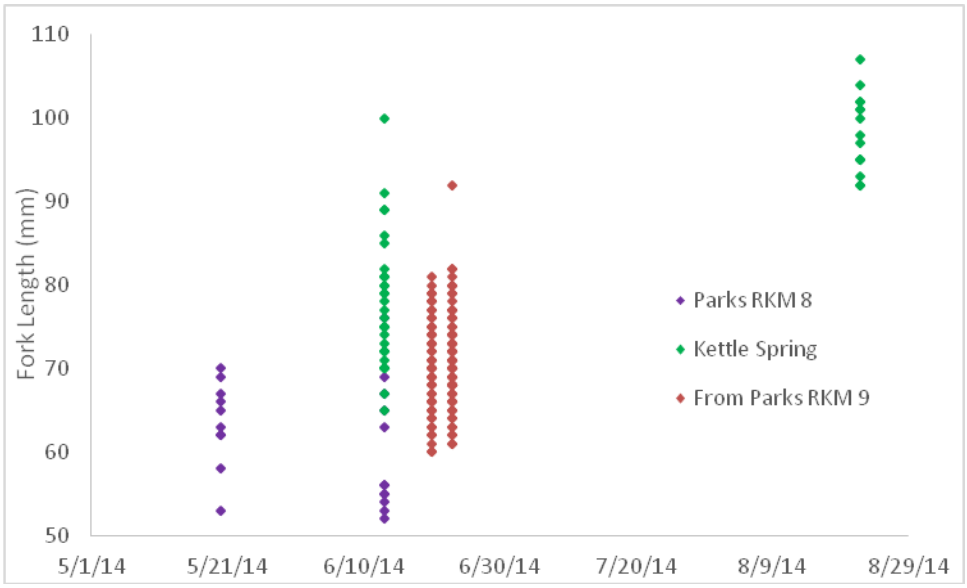


Figure 15. Fork length at date of tagging for BY2013 coho tagged in Parks Creek.

4. Big Springs Creek

A total of 138 BY2013 coho were either tagged or detected in Big Springs Creek (including Little Springs Creek) during the course of this study. Figure 16 shows the locations of PIT tag stations within Big Springs and Little Springs creeks. Known survival of all tagged coho encountered during each occasion in Big Springs Creek and Little Springs Creek combined was 65% during the spring (April-June 2014), 56% during the summer (July-September 2014), and 65% during the winter (October 2014-February 2015) (Tables 8-10). The majority (77%) of BY2013 coho present in Big Springs Creek during the spring period (April-June, 2014) were encountered just downstream of the water wheel structure (BSC RKM 2). Approximatley 10% of the BY2013 coho present in Big Springs Creek in the April-June time period outmigrated from the upper Shasta River during that same time period.

During the summer rearing period (July-September 2014) the majority of encounters of BY2013 coho were evenly distributed between BSC RKM 2 and BSC RKM 3 (36% and 35%, respectivley), which includes the 29 individuals tagged at BSC RKM 3 during that time. Known summer survival at BSC RKM 2 and BSC RKM 3 was 50% and 60%, respectivley. Only three individuals were encountered outmigrating from Big Springs Creek during July-September 2014. During the winter rearing period (October 2014-February 2015) most BY2013 coho were encoutered at BSC RKM 3 (26%). Some individuals moved downstream during the winter period, with seven that were encountered at BSC RKM 0 and ten that were encountered outside of Big Springs Creek during that time. Winter survival in Big Springs Creek ranged from a low of 50% in Little Springs Creek to a high of 69% at BSC RKM 3.

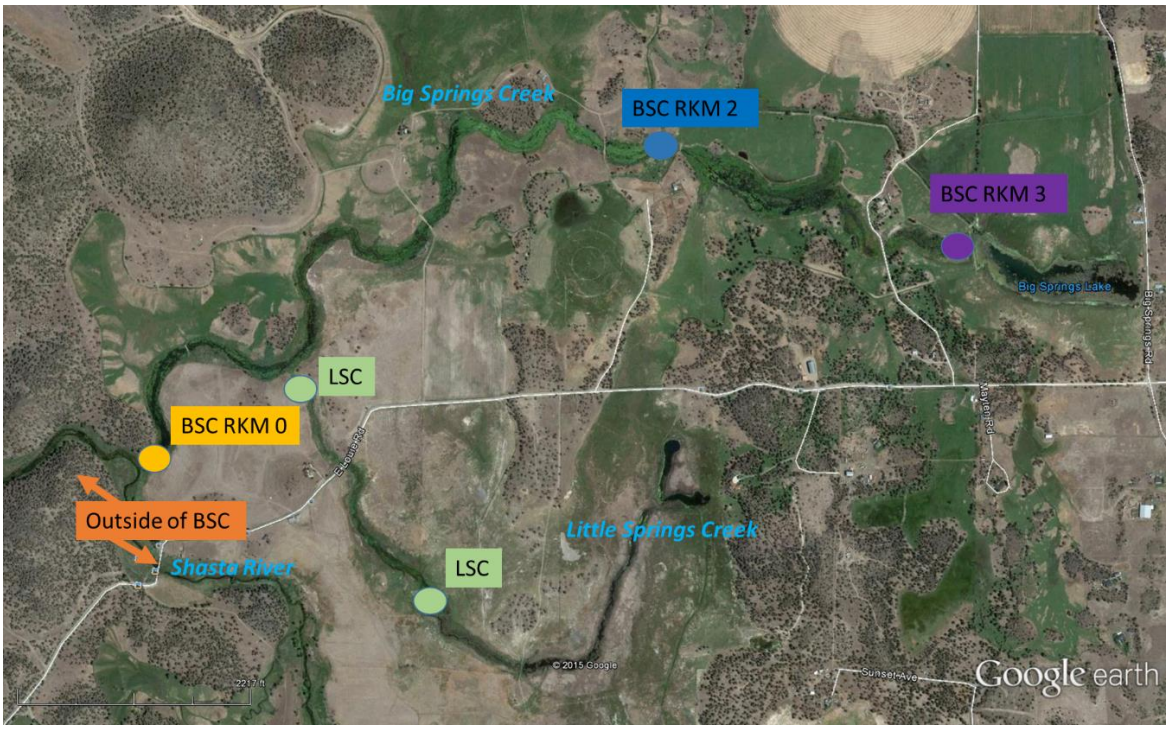


Figure 16. PIT tag antenna stations locations in Big Springs and Little Springs creeks during the BY2013 coho study.

Table 8. Location of last encounter and known survival of tagged BY2013 coho encountered in Big Springs Creek during April-June 2014.

	Last encounter April-June 2014		Known survival to July 2014	
	Total	%	Total	%
Total	79		51	65%
BSC 0	6	8%	1	17%
BSC 2	61	77%	42	69%
BSC 3	9	11%	7	78%
LSC	3	4%	1	33%
Outside of BSC	20			

Table 9. Location of last encounter and known survival of tagged BY2013 coho encountered in Big Springs Creek during July-September 2014.

	Last encounter July-Sep. 2014		Known survival to Oct. 2014	
	Total	%	Total	%
Total	72		40	56%
BSC 0	0	0%		
BSC 2	36	36%	18	50%
BSC 3	35	35%	21	60%
LSC	1	1%	1	100%
Alive But Not Encountered	11			
Outside of BSC	3			

Table 10. Location of last encounter and known survival of tagged BY2013 coho encountered in Big Springs Creek during October 2014-February 2015.

	Last encounter Oct. 2014-Feb. 2015		Known survival to Mar. 2015	
	Total	%	Total	%
Total	52		34	65%
BSC 0	7	7%	4	57%
BSC 2	15	15%	10	67%
BSC 3	26	26%	18	69%
LSC	4	4%	2	50%
Alive But Not Encountered	1			
Outside of BSC	10			

5. Smolt Outmigration

In 2015, a total of 5,501 age-1 coho were captured at the RKM 0 screw trap as they were outmigrating. These fish were caught between February and early June. The majority (74%) were captured within the 20 days following the initial drop in flows due to irrigation withdrawals on April 1, 2015 (Figure 18). A total of 146 PIT tagged age-1 coho from the upper Shasta River were detected at the two antenna stations at RKM 0. Most detections of upper basin tagged coho also occured during the 10 days following the initial draw down in flows (Figure 19).

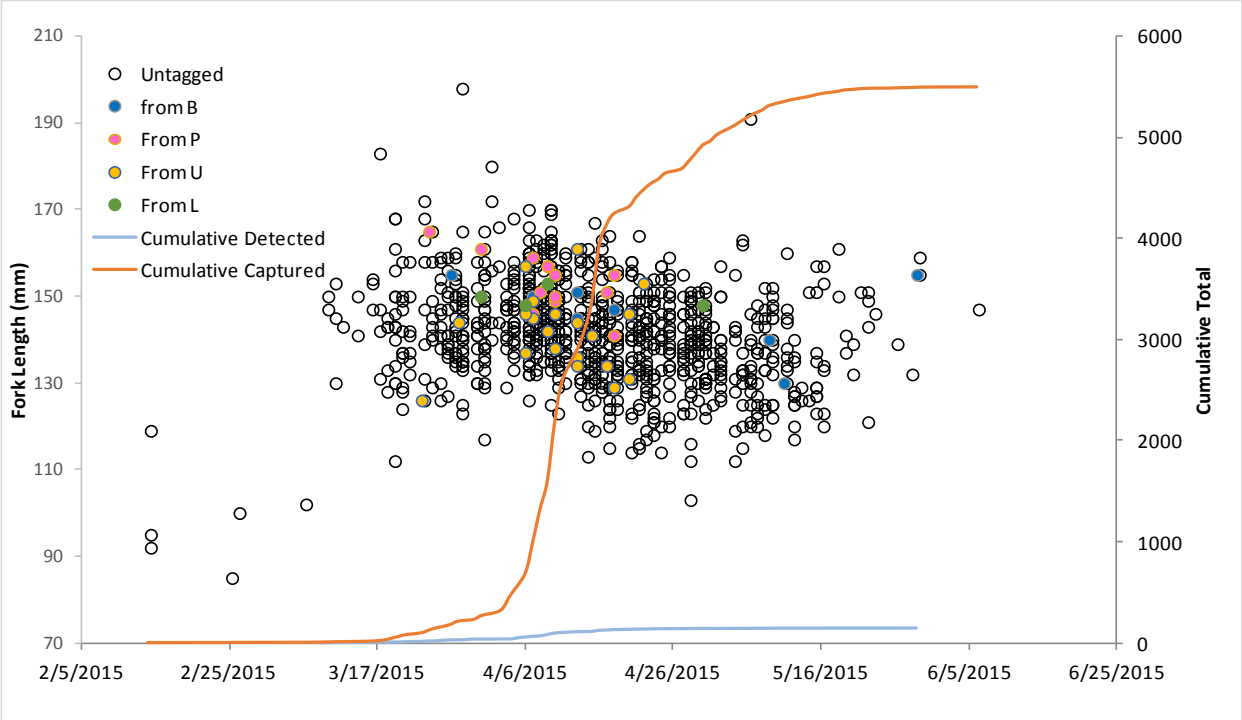


Figure 17. Size and timing of BY2013 Shasta River coho encountered at RKM 0 between February 5 and June 25, 2015. Winter rearing location for PIT tagged fish captured at the RST is indicated by color.

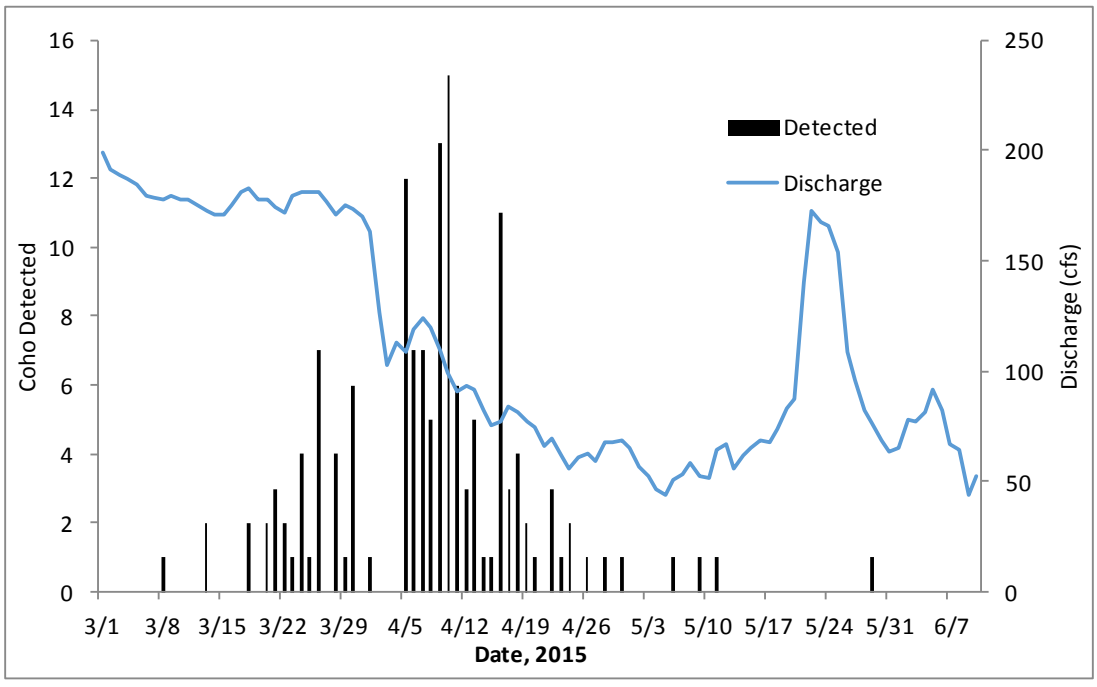


Figure 18. Upper basin tagged BY2013 coho detected daily at RKM 0 in 2015 and flow measured at USGS gage.

V. DISCUSSION

1. Capture/Tagging

While using PIT tags to monitor movements and survival is very informative, it is important to remember that a potentially critical life history segment exists between fry emergence and tagging that is missed by this method. By the time juvenile coho in the upper Shasta River reached the 50-mm minimum fork length required for PIT tag implantation during this study, significant events that effect survival and movement were likely to have already taken place. Smaller fish may be more susceptible to predation or elevated water temperatures than larger fish. Coho tagged at locations upstream of redds and initial rearing locations had obviously made successful upstream migrations prior to being tagged, therefore unsuccessful upstream migrants may be under represented in the sample of tagged fish, simply because they did not survive to reach upstream capture locations.

BY2013 juvenile coho that met the size criteria for PIT tagging were captured earlier in 2014 than in the previous Shasta River PIT tag studies (early April as opposed to early May). This may be due in part to field crew staff becoming more efficient at finding and capturing juvenile coho over time. It may also be due to the fact that the winter was very mild and this may have resulted in accelerated egg development and early season productivity. BY2013 coho also tended to have a wider range in size than in previous studies (both at a given location and between locations). Size differences among different locations could result from a wider range in spawning timing, emergence timing, or growth rates of juveniles. Egg development and emergence timing is dictated in large part by water temperature during the incubation period which varies between spawning locations (CDFW unpublished data). Incubation temperatures may also vary within reaches due to small springs and seeps. The densities of coho observed in summer rearing locations such at the Big Springs outfall pool and in beaver pond habitats on the mainstem Shasta (upstream of Parks Creek) were much higher than observed during previous studies; size differences at a given summer rearing location may have also been due in part to density dependent effects on growth.

Differences in growth rates may be most important with regard to the age-0 outmigrant life history. BY2013 coho that left the upper Shasta River as age-0 fish appeared to have gone through smoltification based on their appearance when observed at the RKM 0 rotary screw trap (silver scales and faint parr marks). The upper Shasta River age-0 outmigrants tended to be from the earliest tag group (tagged at RKM 56 in early April) or from the high end of the size distribution of other tag groups (Figure 9). Age-0 outmigrants from the upper Shasta River also tended to fall within a group of larger coho captured later in the season at the RKM 0 rotary screw trap (Figure 10). In the BY2012 study, juvenile coho large enough to tag were not observed as early in the year and the size range of coho in general was not as broad. Very few age-0 coho outmigrated from the upper Shasta River in the BY2012 study and the group of larger coho captured later in the season observed during this study was not observed during that study.

2. Movement and Survival

Movements between reaches were minimal during this study relative to movements between reaches that were documented during previous studies. Few movements were documented from the spring tagging period to summer rearing locations. This may be due to fish being tagged after upstream migrations to summer rearing habitat had already occurred, or perhaps spawning took place closer to summer rearing locations (such as in Big Springs Creek or the Shasta River upstream of Parks Creek). Age-0 outmigrants were documented moving downstream from each of the upper Shasta reaches during May and June 2014. Production of age-0 outmigrants from the upper basin, regardless of whether it was a result of spawning timing, egg development, or juvenile growth rates, may have important implications to the population growth of Shasta River coho. Survival of age-0 coho that enter the Klamath River is not known. Considering typical conditions in the Klamath River in June, when these fish leave the Shasta River, survival may be poor and this life history could result in a population sink. It is unknown if surviving age-0 smolts return to spawn after the typical 1.5 years at sea, which could result in inter-cohort breeding, essentially weakening one cohort but strengthening another.

Overall, known survival rates of PIT tagged coho in the upper basin decreased relative to the BY2012 study. Detection efficiency for outmigrating coho may have also been reduced, particularly during the high water event in February 2015. However, during previous studies movements were limited in February and detections at antenna stations that remained operational through the high water event were minimal. Therefore, it is still likely that known survival is close to true survival. Overall known survival was more comparable across encounter periods than in previous studies, but known survival across locations in a given encounter period was more variable. Our data do not indicate a particular location or season when survival was extremely low or high (known survival in a given reach during a given encounter period ranged from 48% to 85%).

While overall known survival of PIT tagged BY2013 coho was less than that documented during the BY2012 study (22% versus 33%), overall production of BY2013 coho smolts (based on rotary screw trap estimates) was greater; 1,920 coho smolts were captured at the rotary screw trap in 2015 resulting in a population estimate of 6,279 (95% CI 5510-7048) (Debrick et al 2015) versus 300 coho smolts captured in 2014 resulting in a population estimate of 850 (95%CI 623-1076)(Debrick and Stenhouse 2014). The BY2012 adult run was an estimated 115 coho (Chesney and Knechtle 2013) and the BY2013 adult run was an estimated 134 fish (Knechtle and Chesney 2014.) It's remarkable that the production estimates for two similar sized adult runs had such a large differential, especially in light of the fact that the PIT tagged coho had lower known survival in the high production year. The sex composition of the two brood classes may be the primary cause for the difference (more females result in greater total reproduction).

3. Parks Creek Fish Relocation

Coho have been documented utilizing Parks Creek for spawning since 2004 (Littleton and Pisano 2006), particularly the reach adjacent to Bridge Field Spring. However, aquatic habitat conditions in this reach are affected by multiple diversions, tailwater inputs, and legacy effects of cattle in the stream. During aerial surveys over the Shasta Valley In the fall of 2011 and 2012, CDFW observed push-up dams on

Parks Creek near I5 and Slough Road (see map in Appendix I). These diversions were operating during November and December to provide stockwater in fields adjacent to Parks Creek. This practice, particularly in drought years, contributes to low flow conditions in Parks Creek and can potentially restrict the distribution of suitable coho spawning habitat. The drought and irrigation patterns in 2014 caused conditions to become particularly poor (high water temperatures and low flows) and extreme efforts were taken to minimize juvenile coho mortality in this reach due to concerns about the possibility of cohort extirpation. For coho recovery purposes, it would be beneficial to modify agricultural practices so that flows in this reach are suitable for spawning.

Known survival of relocated BY2013 coho was similar to those fish that were tagged in Kettle Spring, and higher than those that were tagged and released at Parks RKM 8 without being relocated. The relocation effort appears to have increased survival probability for those fish. However, a more important management action for improving chances of survival of coho was providing adequate flow in this reach. In addition to providing habitat for the 286 coho relocated there, it provided habitat for an unknown number of coho that moved there on their own. Releasing coho in Kettle Spring Creek may have had an effect on fish that naturally occurred there, though that interaction has not been documented.

The reach where coho were relocated from contains unique habitat characterized by a narrow channel but many long deep pools and dramatically undercut banks. At least some coho may have survived in the reach without being relocated. Even when Parks Creek became disconnected in this reach, pools over 6 feet deep remained. Some of these deep pools may have groundwater or spring water association, keeping them cool enough to sustain coho. Even fish captured from that reach and trucked to a location approximately 4 kilometers away in June swam back as soon as conditions allowed in October.

Kettle Spring remained free flowing through most of 2014. Kettle Spring Creek may have provided significant summer rearing habitat throughout its length. Snorkel surveys were limited to the outfall pool and the bridge where relocated fish were released. It is unknown if coho were rearing in other locations in Kettle Spring Creek. Considering the very low flow in Parks Creek, Kettle Spring flow may also have provided suitable habitat downstream of its confluence with Parks Creek, perhaps extending downstream towards the Parks Creek confluence with the Shasta River. However, data collection did not occur in these areas during 2014 and therefore, little is known about conditions there. Bridge Field Spring and Black Meadow Spring have the potential to provide cold water summer rearing habitat similar to Kettle Spring if managed for that purpose. Juvenile coho have shown an ability to seek out cold water during the summer and could likely move to these springs if access and continual spring flow to the creek were provided.

Known winter survival was lower than known summer survival in Parks Creek (48% versus 69%). During the high water event in February 2014, Parks Creek was flowing well outside of its banks and left behind large expanses of standing water in the flood plain when flows subsided. Stranding of coho may have occurred as a result. Largemouth bass and sunfish were observed regularly during snorkel surveys and in trap catches in Parks Creek (Photos 36, 37) and these species could be sources of substantial predation on juvenile coho.

4. Big Springs Creek

Consistent with findings of previous studies, BY2013 coho in Big Springs Creek reared primarily in two locations; just downstream of the water wheel structure (BSC RKM 2) and at the outfall pool of Big Springs Lake (BSC RKM 3). Also consistent with previous studies, known survival was surprisingly low (50-70%) across sampling locations and seasons in Big Springs Creek. Predation by rainbow trout, otters, and birds may be elevated because the fish appear to be concentrated in these two locations. This seems particularly likely at the outfall pool during summer when flows are reduced and coho are schooled up in the small pool that remains. However, we never observed predation at either location. It has been assumed that movements into Big Springs Lake through the outfall culvert do not occur due to the water velocities within the culvert. However, PIT tagging studies have shown that coho are able to move through culverts under certain conditions (Little Springs Creek and Kettle Spring) and perhaps coho are able to move into Big Springs Lake, as well (Photos 38, 39). Should this be the case they could then suffer mortality in unscreened diversion ditches or pumps used for irrigation.

No BY2013 coho were observed in Little Springs Creek during snorkel surveys. Some tagged individuals were detected at the antenna stations in Little Springs Creek, but overall use of Little Springs Creek seemed to be reduced from the BY2012 study. The culverts in Little Springs Creek became plugged with debris on multiple occasions in 2014 causing impoundment and warming of the spring water.

5. Smolt Outmigration

The majority of age-1 coho smolts outmigrated from the Shasta River during the first two weeks of April 2015 following the drop in flows brought on by the start of the irrigation season. This is true of both PIT tagged coho from the upper Shasta River as well as for catches of untagged coho at the RKM 0 rotary screw trap; this outmigration timing is consistent with findings from previous studies (Adams 2013, Chesney et al. 2009, Adams and Bean 2016). Known survival of smolts from the upper Shasta River to the Klamath River was reduced in the BY2013 study compared to the BY2012 study (67% vs. 91%).

The number of tagged coho detected at RKM 0 in the spring of 2015 was dwarfed by the number of untagged coho captured at the RKM 0 rotary screw trap (143 versus 1,920). Based on smolt catches at the screw trap, BY2013 may have been one of the most productive cohorts documented since the rotary screw trap operation began (considering the number of adults that spawned in 2013.) If age-0 smolt production is considered as well, success for BY2013 coho was even greater.

VI. POTENTIAL MANAGEMENT ACTIONS

1. The unique spring water resources in the Shasta River should be managed to provide the aquatic habitat required for coho to complete their freshwater lifecycle.
2. Identify the source of sunfish and bass, and reduce or eliminate them from Parks Creek and other areas in the Shasta River.
3. Insure that flows from Kettle Springs remain in the creek throughout the year.
4. Manage Black Meadow and Bridge Field springs to provide summer rearing and spawning habitat.

5. Manage the flows in Parks Creek to allow for suitable spawning conditions between I-5 and the confluence of Bridge Field Creek.

VII. FUTURE MONITORING NEEDS

1. Use a mark-recapture model similar to that developed in the BY2010 study to estimate movement and survival for both BY2012 and BY2013 coho. This approach includes detection probability estimates and would provide confidence intervals around survival estimates which may provide more definitive information on survival than the minimum or "known survival" calculated in this report.
2. Investigate implications of the age-0 smolt life history.
3. Look more closely at water temperature data collected in the upper Shasta River and how it might be correlated with fish movements.
4. Investigate potential movements of coho into Big Springs Lake through the culvert at the outfall pool.
5. Determine if bass and sunfish are preying on juvenile coho in Parks Creek.
6. Monitor temperatures throughout Kettle Spring Creek and Parks Creek.
7. Investigate additional coho rearing habitat outside of the current distribution of PIT tag arrays.

VIII. REFERENCES

Adams, C, C. 2013. Survival and Movement of Juvenile Coho Salmon (*Oncorhynchus kisutch*) in the Shasta River, California. Master's Thesis. Humboldt State University, Arcata, California.

Adams, C.C. and Bean, C.E. 2016. Shasta River Brood Year 2012 Juvenile Coho Salmon PIT Tagging Study. California Department of Fish and Wildlife, Yreka Fisheries.

Chesney, D. and M. Knechtle. 2013. Shasta River Fish Counting Facility, Chinook and Coho Salmon Observations in 2012, Siskiyou County, CA. Unpublished Report. Klamath River Project. Department of Fish and Wildlife. 27 pages.

Chesney, W.R., C.C. Adams, W.B. Crombie, H.D. Langendorf, S.A. Stenhouse, and K.M. Kirkby. 2009. Shasta River juvenile Coho habitat and migration study. Report prepared by California Department of Fish and Game for U.S. Bureau of Reclamation, Klamath Area Office.

Davids Engineering, Inc. 2011. Shasta Springs Ranch Irrigation Efficiency Study. A Cooperative Investigation Undertaken by the California Department of Fish and Wildlife and Emmerson Investments. Davis California

Debrick. A., S. Stenhouse, W. Chesney. 2015. Report Shasta and Scott River Juvenile Outmigrant Study, 2015. Grant Number P0710307. Anadromous Fisheries Resource Assessment and Monitoring Program. Yreka Fisheries. California Department of Fish and Wildlife. 95 pages.

Debrick, A. and S. Stenhouse. 2014 Final Report, Shasta and Scott River Juvenile Salmonid Outmigrant Study, 2014. Grant Number P0710307. Anadromous Fisheries Resource Assessment and Monitoring Program. Yreka Fisheries. California Department of Fish and Wildlife. 94 pages.

Knechtle, M. and D. Chesney. 2014. 2013 Shasta River Salmon Studies, Final Report. California Department of Fish and Wildlife. Northern Region. Klamath River Project. 24 pages.

Littleton, B. and M. Pisano. 2006. Shasta River Coho Salmon Radio Telemetry Investigation, 2004. California Department of Fish and Game. Northern California-North Coast Region. 32 pages.

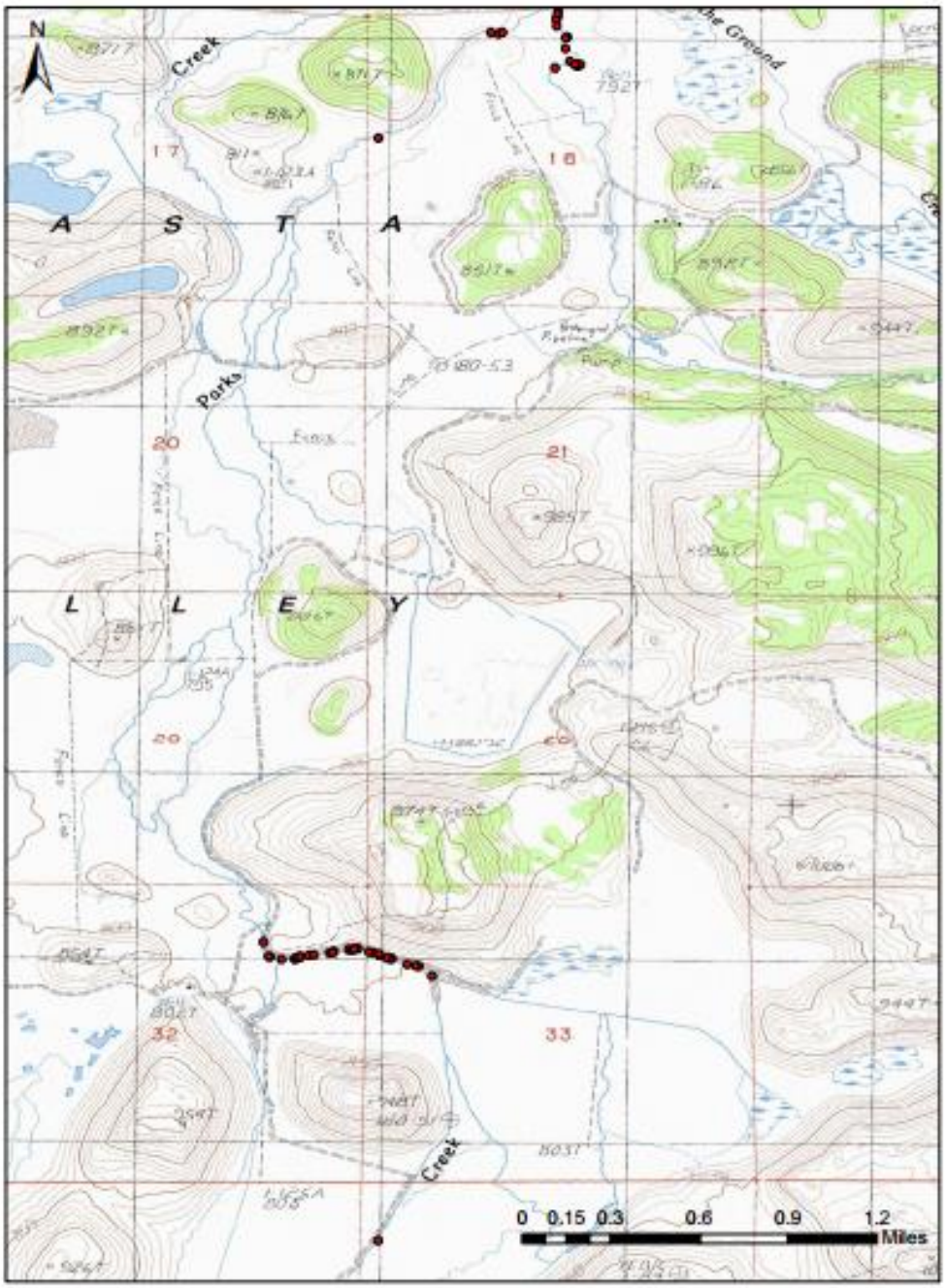
Olswang, M. 2012. Shasta River Coho Radio Tagging Summary (at a glance). 2 pages

Olswang, M. 2007. Shasta River Coho Salmon Radio-telemetry Investigation. Summary Report. California Department of Fish and Game, Northern Region. 6 pages.

Shasta River Adjudication Proceeding: Judgment and Decree in the Matter of the Determination of the Relative Rights, Based Upon Prior Appropriation, of the Various Claimants to the Waters of Shasta River and Its Tributaries, in Siskiyou County, California, Issue 7035. 1932. California State Print Office. 316 pages.

Stenhouse, S., C. Bean, W. Chesney, and M. Pisano. 2012. Water temperature thresholds for coho salmon in a spring-fed river, Siskiyou County, California. California Fish and Game. 98(1):19-37

Appendix A. 2013 Shasta River observed redds, Reaches 22, 23, and 24



Appendix B. Shasta River/Parks Creek Drought Initiative Individual Agreement (NOAA) and Memorandum of Understanding by and between Emmerson Investments and the California Department of Fish and Wildlife

Shasta River/Parks Creek Drought Initiative Individual Agreement (Drought Agreement)

Goals of the Voluntary Drought Initiative

NOAA's National Marine Fisheries Service (NMFS) and the California Department of Fish and Wildlife (CDFW) are among the Federal and State agencies that recognize the severe constraints the 2014 drought is likely to have on agriculture and fish in California. The California Voluntary Drought Initiative (Drought Initiative) expresses our intention to work with water users in high priority areas throughout the State who acknowledge the unprecedented conditions in order to reduce the negative effects of the drought on salmon and steelhead.

NMFS is charged by Congress to protect species through the Endangered Species Act (ESA). The ESA provides for formal agreements with individuals and organizations pursuing activities, such as agriculture, that allow them to be conducted while protecting fish and their habitat. These processes generally take time to implement and may simply be impractical for severe drought-related water use this year.

Governor Brown proclaimed a drought state of emergency on January 17, 2014 directing State officials to take all necessary actions to prepare for water shortfalls and instructed the State Water Resources Control Board (SWRCB) to notify water right holders that they may be directed to cease or reduce water diversions from streams and rivers later this season due to low water conditions. On April 25, 2014, Governor Brown issued an Executive Order directing state agencies to, in part, work with landowners in priority watersheds to protect certain species and maximize the beneficial uses of scarce water supplies, including employment of voluntary agreements to secure instream flows, relocate members of those species, or take other measures.

To address the urgency created by the drought, NMFS and CDFW have developed the Drought Initiative to reduce the effects of the drought on priority salmon and steelhead populations in California during the 2014 drought, while Federal and State drought declarations or designations are in effect. The initiative includes an approach to the application of the ESA's section 9 enforcement standards, as they are related to the withdrawal of water, from salmon and steelhead-bearing stream and rivers. This is a temporary, volunteer initiative that is only being implemented during Federal and State drought declarations or designations, with the goal of supporting agricultural activities while protecting the survival and recovery of ESA and CESA-listed salmon and steelhead and other species of special concern where they co-occur with ESA or CESA-listed populations.

Shasta River and Parks Creek Listed Fish Species and their Recovery Value

Coho salmon in the Shasta River basin are part of the Southern Oregon/Northern California coast (SONCC) coho salmon Evolutionarily Significant Unit, which is listed as threatened under the ESA and the CESA. Preliminary monitoring efforts conducted by the CDFW fisheries staff estimate that 151 adult coho salmon returned to spawn in the Shasta River during the winter of 2013/2014. Spawning ground surveys conducted by the CDFW in collaboration with biological staff from Emmerson Investments Inc., found that 47 salmonid redds were constructed in Parks Creek and the upper Shasta River, upstream of the confluence of Parks Creek (Figure 1). Of these, 30 are located in Parks Creek (Reach 24) downstream of the confluence of Parks Creek and the slough formed by water conveyed from Bridge Field Springs and Black Meadow.

NMFS and CDFW expect most of the 47 observed redds were constructed by coho salmon. Redd construction occurred co-incident with the run timing of returning Shasta River adult coho salmon. Also, dimensions of observed redds are consistent with the size of coho salmon redds.

Coho salmon recovery in the Shasta River watershed is a high priority for NMFS and CDFW. The diversity and complexity of the physical and environmental conditions historically present within the Shasta River basin created unique life history strategies and diverse coho salmon habitat. Historical instream river conditions, fostered by unique cold spring complexes, created ideal rearing habitat for juvenile coho salmon throughout their freshwater residency. Information suggests that coho salmon abundance is severely depressed relative to historical population numbers. Since 2001 minimum adult coho salmon returns to the Shasta River have ranged between 9 and 291 fish, levels well below depensation. Depensation occurs when populations are reduced to such a low level that adult coho may have difficulty finding suitable mates which decreases the probability of achieving successful egg fertilization. In addition, impacts to genetic fitness increase dramatically with the reduced population size. When combined with reductions in habitat quality and quantity that have occurred over time, these low population numbers have led NMFS and CDFW to determine that the Shasta River population is currently at a high risk of extinction.

However, recent habitat and instream flow restoration activities within the upper Shasta basin have greatly improved habitat conditions for anadromous salmonids in recent years. NMFS and CDFW are hopeful that additional habitat restoration efforts like those being considered by the Shasta Watershed Conservation Group, the Montague Water Conservation District, and The Nature Conservancy within the basin will create conditions that will ultimately lead to a viable coho salmon population in the Shasta River. Given the dire water supply conditions that we are faced with this spring and summer, NMFS would like to encourage local landowners to engage in collaborative water conservation actions to enhance the survival and fitness of incubating embryos, emerging fry and juvenile life stages of coho salmon that are present in Parks Creek and the upper Shasta River.

Given the extensive impact of the 2014 drought, NMFS expects that under the most conservative approaches to water management, some coho salmon fry in Parks Creek and Upper Shasta River will perish. To assist local landowners and provide additional guidance for conservation actions

intended to reduce impacts to coho salmon, NMFS has developed the following Emergency 2014 Drought Initiative Individual Agreement.

Benefits for Water Users Who Participate in the Drought Initiative Individual Agreement

ESA Enforcement

Under the Endangered Species Act, NOAA has responsibility to protect and recover listed species including salmon and steelhead in California. The NMFS Office of Law Enforcement, often working with state and other federal agencies, investigates activities or inactivity that may result in the unlawful take of these species, and refers suspected unlawful activity to the Enforcement Section of the NOAA Office of the General Counsel for civil prosecution, or to the Department of Justice for criminal prosecution. Protection of ESA listed salmon and steelhead are a priority for NOAA across their range, and NOAA uses management plans and takes enforcement actions to help ensure the protection and recovery of these species.

At this time, severe and unprecedented drought conditions are affecting parts of California. To help address the concerns those conditions present, NMFS is working with those withdrawing water from California streams and rivers to take into account those needs and at the same time carry out its responsibilities towards ESA listed salmon and steelhead by taking the extraordinary steps outlined in this agreement. NOAA is thus seeking to encourage participation in the Drought Program. To that end, in making decisions about bringing or referring enforcement actions and about appropriate penalties, NOAA will consider participation in the Drought Program an important mitigating factor if a Drought Program participant unintentionally takes ESA listed fish species while withdrawing water or carries out other action that affects fish passage while complying with a Drought Initiative agreement. To obtain this special consideration, a Drought agreement participant must establish that it has implemented one of the specified water mitigation measures described in this agreement and fully complied with the requirements of the attached Drought agreement. NOAA will actively pursue enforcement actions against those who act negligently, recklessly or intentionally in violation of the ESA.

Financial and Technical Assistance

NMFS will endorse efforts by public and private organizations to provide technical and financial assistance for water users who participate in this program. If requested, NMFS will provide recommendations and letters of support to those organizations for targeting financial and technical assistance for improvements to fish passage associated with water deliveries for program participants.

Elements of the 2014 Drought Agreement

To qualify for the benefits of the 2014 Drought Agreement, the water user must implement A, B, C, and D as described below, and as applicable, as determined by NMFS.

Contribute to Protective Flows

A. The water user or a group of water users maintain adequate flows to ensure redds within their property are inundated with moving water until alevins (emerging fry) are no longer

observed downstream of redd locations. Based on our current understanding of emergence timing with in the basin, we anticipate that emergence could end sometime between late April and early May.

B. The water user agrees to maintain adequate flows and instream conditions in Parks Creek from the confluence of the slough formed by water conveyed from Bridge Field Springs and Black Meadow to the confluence of Kettle Springs to ensure coho fry and juveniles have unimpeded passage opportunities to cold water refugia habitats through May 21, 2014.
C. The water user agrees to forego the use of Kettle Springs for diversions through November 1, 2014, this Agreement is for this year and this year only given the urgency and extent of the drought conditions and shall not be interpreted to and does not waive, relinquish, modify, abandon, forfeit, sever or change the Water Rights or any other water rights held by the owner.
D. The water user or a group of water users support fish rescue and relocation efforts by
    I. Adjusting flows in an effort to support NMFS' and CDFW's rescue and relocation of fish. Flow adjustments may require the use of flashboard dams at Bridge Field Springs to reduce flows while rescue operations are underway.
    II. Allowing fish to be relocated to the river adjacent to their property and following III below or allowing fish to be rescued from the river adjacent to their property and relocated elsewhere, and allowing access for such activities and monitoring described in this agreement.
    III. Maintaining over-summering instream flows adequate (as defined by NMFS) for the survival of individuals.

Protecting Saved Water

It is the intent of NMFS' and CDFW's drought initiative to help ensure contributions of willing participants will be honored by downstream water users so that whatever drought measure is chosen, the saved or dedicated water will be prioritized for passage flows and protected from downstream appropriation at least downstream to the confluence of Parks Creek and the Shasta River.

Fish passage Flows in Parks Creek

The objective for providing adequate fish passage flows in Parks Creek is to provide fry and juvenile coho salmon with the opportunity to move into thermal refugia habitats associated with cold water springs. Potential locations where coho salmon may move include habitats near the source of Black Meadow, Bridge Field, and Kettle Spring in the Parks Creek watershed, Clear Springs in the upper Shasta River, Big Springs Creek, Little Springs Creek and other cold water sources (smaller springs or seeps) that may exist. The following are base flow scenarios that agencies believe to be needed for the successful passage of juvenile salmonids to over summering habitat associated with cold water spring sources.

Parks Creek Flow Targets

Base flows- (1) Maintain current flows (approximately 4 cfs) from the slough conveying waters from Bridge Field and other springs, through May 21, 2014 or until mean daily water temperatures begin to exceed lethal levels for coho salmon (24℃, based on Sullivan et al. 2000), necessitating rescue and relocation efforts, . Based on previous studies, we anticipate that juvenile coho will move toward cold water habitats once mean daily water temperatures reach about 20℃. (2) Unimpeded discharge from Kettle Springs to the confluence of Parks Creek until November1, 2014.

Access/Monitoring of Emergence and Fish Passage Success- The applicant has worked closely with NMFS and CDFW representatives to develop the proposed flow requirements described in the agreement to protect in-gravel larvae, fry, and smolts and allow fish to migrate. The applicant and agency representative will continue to coordinate so that flow contributions are monitored, to determine if the intended results of protective measures occur. The applicant grants reasonable access over the property to conduct the monitoring activities described in this agreement.

Monitoring may involve one or more of the following activities:

(1) Up and downstream snorkel surveys, where appropriate to determine where the fish are, and when they will need passage flows.
(2) Use of traps (McBain traps or fyke nets) to monitor abundance and movement. Traps will need to be checked each morning to reduce potential impacts (delay in feeding, predation).
(3) Monitoring of flow and water temperature conditions to allow adequate time to coordinate and assemble equipment necessary to conduct fish rescue operations prior to the point when adverse water quality conditions (high temperatures) might decrease the effectiveness of those operations.

Potential Fish Relocation Areas

The applicant has agreed to work closely with NMFS and CDFW to identify suitable locations where rescued coho salmon could be placed to successfully rear over the summer period. NMFS CDFW and the applicant have determined that the preferred alternative is to relocate coho salmon to the Parks Creek and Kettle Springs Creek confluence where cold water refugia exist. Through this agreement, the applicant has agreed to protect the Kettle Springs Creek cold water refugia. If adequate fish relocation areas are not available at or near the Parks Creek and Kettle Springs Creek, NMFS and CDFW will work with other landowners to identify suitable locations where rescued coho salmon could be relocated. Potential locations include spring sources along the upper Shasta River and in the Big Springs complex.

If you have questions about the program or your eligibility for program benefits, please contact:

2013 Shasta River Observed Redds Reaches 22, 23 and 24

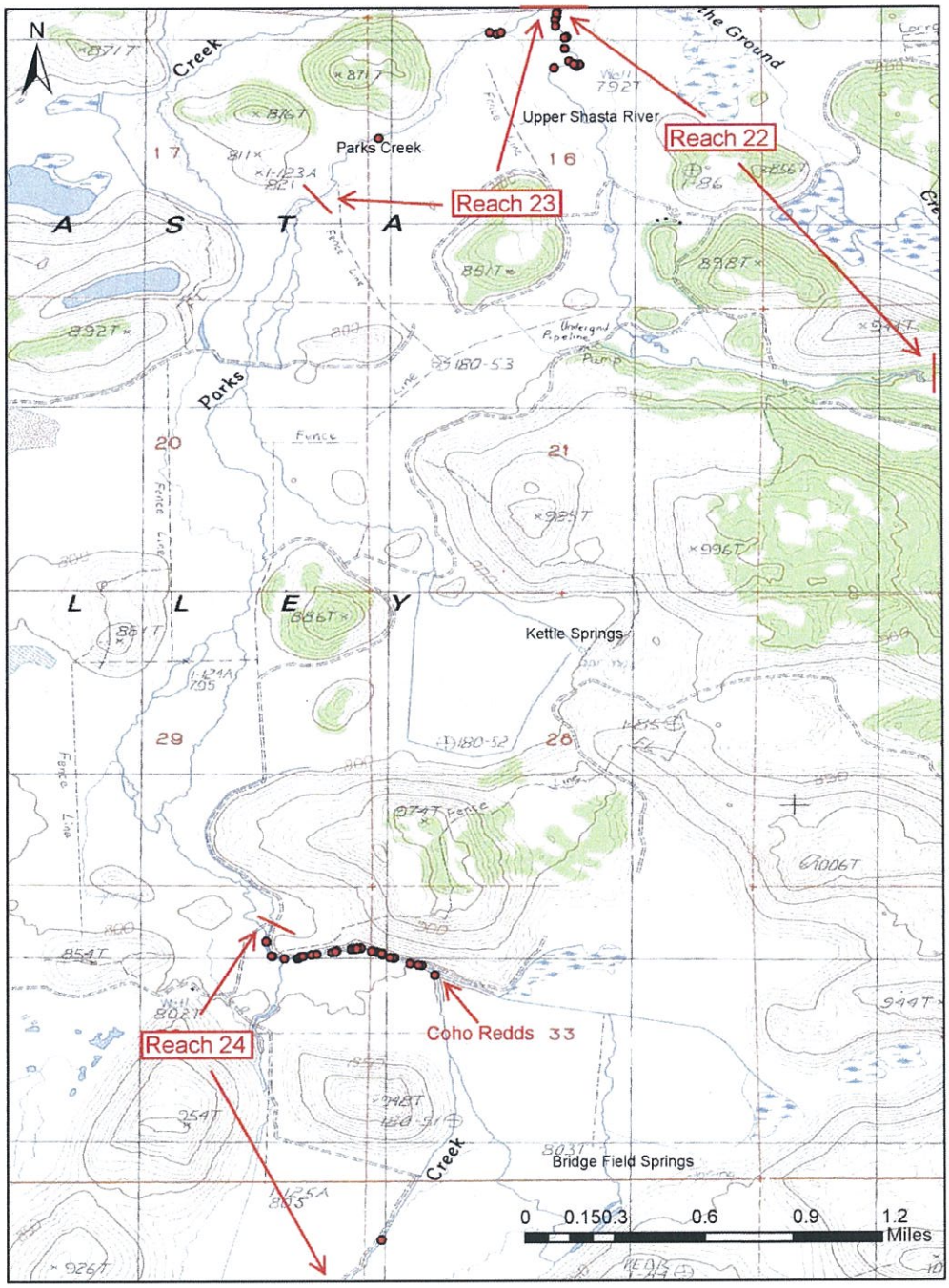


Figure 1. Location of coho salmon spawning redds observed in the upper Shasta River and Parks Creek during the winter of 2013/2014. Data and map were provided by the California Department of Fish and Wildlife in February of 2014.

NMFS Contact:

Jim Simondet
National Marine Fisheries Service
California Coastal Area Office
1655 Heindon Road
Arcata, CA 95519
Email jim.simondet@noaa.gov
(707) 825-5171

Participating Parties

Applicant for the Landowner
Emmerson Investments Inc.

Irma Lagomarsino
Assistant Regional Administrator
National Marine Fisheries Office, West Coast Region, California Coastal Area Office

MEMORANDUM OF UNDERSTANDING

by and between

Emmerson Investments

and

CALIFORNIA DEPARTMENT OF FISH AND WILDLIFE

This California Endangered Species Act Memorandum of Understanding ("CESA MOU") is made and entered into by and between Emmerson Investments, Inc. _____ (Landowner)-and the California Department of Fish and Wildlife (hereinafter called the "CDFW").

The purpose of this CESA MOU is to provide a framework for cooperative activities and studies that involve or address issues of importance to the Shasta River coho salmon (*Oncorhynchus kisutch)*. This CESA MOU provides for take associated with actions taken by the CDFW and the Landowner to provide instream flows, monitor stream conditions and fish abundance, and to potentially rescue and relocate coho salmon as management activities under authority of Section 2081(a) of the California Fish and Game Code.

RECITALS

WHEREAS, the CDFW has jurisdiction over the conservation and protection of fish, wildlife, and native plants and their habitats and holds those resources in trust for the people of California (California Fish and Game Code Section 1802).

WHEREAS, coho salmon are classified as a threatened species by the State of California Fish and Game Commission pursuant to the California Endangered Species Act (CESA, California Fish and Game Code section 2050 et seq.).

WHEREAS, Fish and Game Code section 2080 prohibits the import, export, take, possession, purchase or sale of any species, in whole or in part, that has been listed as threatened or endangered by the California Fish and Game Commission. Take is defined in Fish and Game Code section 86 as 'hunt, pursue, catch, capture, or kill, or attempt to hunt, pursue, catch, capture or kill." However, Fish and Game Code section 2081(a) allows CDFW to authorize take and other acts prohibited by Fish and Game Code section 2080 for scientific, educational, or management purposes. This CESA MOU authorizes a limited level of take of coho salmon for management purposes.

WHEREAS, on January 17, 2014 Governor Brown issued a proclamation declaring the state to be in an emergency due to the ongoing severe drought conditions.

WHEREAS, on April 25, 2014, Governor Brown issued an Executive Order directing the

CDFW to, in part, work with other state and federal agencies and landowners in priority watersheds to protect threatened and endangered species and species of special concern to maximize the beneficial uses of scarce water supplies, including employment of voluntary agreements to secure instream flows, relocate members of those species or take other measures.

WHEREAS conditions on Parks creek and other Shasta River tributaries have been effected by the 2014 drought, and may continue to deteriorate, such that sufficient instream flows to ensure the survival of listed juvenile coho salmon may require the addition of voluntary water inputs to the stream by the landowner. In addition, juvenile fish may need to be relocated to areas with more suitable conditions in the watershed to prevent mortality of those CESA-listed fish. Spawning ground surveys conducted by the CDFW in collaboration with biological staff from Emmerson Investments Inc., found that 47 salmonid redds were constructed in Parks Creek and the upper Shasta River, upstream of the confluence of Parks Creek, with 30 of those redds located in Parks Creek downstream of the confluence of Parks Creek and the slough formed by water conveyed from Bridge Field Springs and Black Meadow springs.

WHEREAS, Landowner owns real property adjacent to Parks Creek in the Shasta River watershed more particularly described as (Real Property) that is located near Bridge Field Springs and Kettle Springs.

WHEREAS, the Real Property is adjacent to the Parks Creek, which has suitable habitat for listed coho salmon. Landowner is willing to participate with the CDFW in providing instream flows and fish rescue and relocation activities, if necessary, by allowing access to the Real Property for the purposes of capturing and removing, or relocating juvenile coho salmon on or to Parks Creek adjacent to the Real Property.

WHEREAS, NOW, THEREFORE, THE PARTIES HERETO AGREE AS FOLLOWS:

1. Methods

CDFW or its agent will carry out all monitoring and fish capture and relocation activities in accordance with standard fishery practices. CDFW, or its agent, will notify Landowner, at least 24 hours in advance, at the telephone number listed below, of all planned monitoring and fish rescue/relocation activities it will carry out on the Real Property. Those activities may include:

Monitoring may involve one or more of the following activities:

(1) Up and downstream snorkel surveys, where appropriate to determine where the fish are, and when they will need passage flows.
(2) Use of traps (McBain traps or fyke nets) to monitor abundance and movement. Traps will need to be checked each morning to reduce potential impacts (delay in feeding, predation).
(3) Once passage flows are implemented, information obtained from PIT tagged fish may help inform when fish have successfully moved into thermal refugia habitats suitable for over summering.
(4) Monitoring of flow and water temperature conditions to allow adequate time to coordinate and assemble equipment necessary to conduct fish rescue operations prior to the point when

adverse water quality conditions (high temperatures) might decrease the effectiveness of those operations.

2. Landowner Commitments Regarding Fish Management Activities on the Real Property

A. Landowner agrees to provide reasonable access to CDFW and its agents, including equipment access, to the Real Property to carry out any of the management activities listed in Section 1 of this CESA MOU for the purposes of:

1) Monitoring habitat conditions, including stream flow and water temperature, and coho salmon abundance, size, and condition prior to any management activities;

2) Capturing and removing coho salmon from and/or relocating fish to suitable habitat, and for monitoring conditions post-relocation; or

B. Landowner agrees to provide reasonable access over the Real Property to allow CDFW and its agents to either capture coho salmon or allow captured coho salmon to be placed in the Shasta River, adjacent to the Real Property. Landowner also grants access to the Real Property to CDFW and its agents to carry out the management activities described in this CESA MOU for the purposes of monitoring habitat conditions, possibly later capturing and removing fish from and/or relocating fish to suitable habitat, and for monitoring conditions post-relocation.

C. Specific Landowner Commitments: The Landowner shall carry out actions as described below:

1) Maintain adequate flows and instream conditions in Parks Creek from the confluence of the slough formed by water conveyed from Bridge Field Springs and Black Meadow to the confluence of Kettle Springs to ensure coho fry and juveniles have unimpeded passage opportunities to cold water refugia habitats through May 21, 2014. This to entail maintaining current flows (approximately 4 cfs) from the slough conveying waters from Bridge Field and other springs, through May 21, 2014 or until mean daily water temperatures begin to exceed lethal levels for coho salmon (24℃, based on Sullivan et al. 2000), necessitating rescue and relocation efforts. Based on previous studies, we anticipate that juvenile coho will move toward cold water habitats once mean daily water temperatures reach about 20℃. Maintain adequate flows to ensure redds within their property are inundated with moving water until alevins (emerging fry) are no longer observed downstream of redd locations. Based on our current understanding of emergence timing within the basin, we anticipate that emergence could end sometime between late April and early May.

2) Maintain unimpeded discharge from Kettle Springs through November 1, 2014, thus forgoing diversion from these springs. This Agreement is for this year and this year only

given the urgency and extent of the drought conditions and shall not be interpreted to and does not waive, relinquish, modify, abandon, forfeit, sever or change the Water Rights or any other water rights held by the owner.

3) Support fish rescue and relocation efforts, if necessary by
    1) Adjusting flows in an effort to support NMFS' and CDFW's rescue and relocation of fish. Flow adjustments may require the use of flashboard dams at Bridgefield Springs to reduce flows while rescue operations are underway.
    2) Allowing fish to be relocated to the river adjacent to their property and following III below or allowing fish to be rescued from the river adjacent to their property and relocated elsewhere, and allowing access for such activities and monitoring described in this agreement.
    3) Maintaining over-summering instream flows adequate (as defined by NMFS) for the survival of individuals.

3. Monitoring

Monitoring by CDFW or its agents may involve one or more of the following activities:

1) Conducting snorkel surveys up and downstream of the location of the coho redds as appropriate to determine where the fish are, and when they will need passage flows.
2) Use of fishery sampling gear and equipment (McBain traps, fyke nets or seines) to monitor abundance and movement.
3) Monitoring of flow and water temperature conditions to allow adequate time to coordinate and assemble equipment necessary to conduct fish rescue operations prior to the point when adverse water quality conditions (high temperatures) might decrease the effectiveness of those operations.

4. Fish Rescue and Relocation

Methods: CDFW or its agent will carry out any necessary fish capture and relocation activities in accordance with standard fishery practices. CDFW, or its agent, will notify Landowner, at least 24 hours in advance, to the telephone number listed below, of all planned monitoring and fish rescue/relocation activities it will carry out on the Real Property. Those activities may include:

1) Monitoring of habitat conditions in the Park creek and salmonid abundance, size, and condition prior to relocation of salmonids at risk, including coho salmon;
2) Upon determination that stream flow and temperature conditions for salmonids, including coho salmon, are deteriorating in the Parks creek watershed, or upon

reasonable projections of same, CDFW will capture and remove juvenile coho, from Parks Creek adjacent to Landowner's Real Property and relocate those salmonids to suitable habitat elsewhere in the watershed;

3) The landowner will work closely with CDFW and NMFS to identify suitable locations where rescued coho salmon could be placed to successfully rear over the summer period. CDFW, NMFS and the landowner have determined that the preferred alternative is to relocate juvenile coho salmon to the Parks Creek and Kettle Springs Creek confluence where cold water refugia exist. Through this MOU, the applicant has agreed to protect the Kettle Springs Creek cold water refugia. If adequate fish relocation areas are not available at or near the Parks Creek and Kettle Springs Creek, CDFW will work with other landowners to identify suitable locations where rescued coho salmon could be relocated.

4) Monitoring stream depth and temperature at relocation site(s) post-relocation to determine if conditions remain adequate to keep salmonids alive and provide for salmonid passage.

5. Authorized Take Level

Coho salmon: Juvenile fish mortalities related to, or occurring in the course of the landowner providing and maintain sufficient instream flows in the specified section of Parks Creek as specified in this MOU, or in the course of fish rescue activities is authorized. The number of coho salmon which may die in the course of fish capture and relocation activities conducted by CDFW is typically small (less than 10%) and is much-reduced from levels of mortality that will potentially occur in absence of carrying out this activity.

6. Federal Endangered Species Act

The Southern Oregon Northern California coho salmon is listed as a threatened species under the federal Endangered Species Act (ESA) of 1973. CDFW has a permit from the National Marine Fisheries Service (NMFS) that allows CDFW, its employees and its designees to perform the rescue activities listed in Section 1 above, should they need to occur. Landowner is not expected or authorized to assist in the handling of coho salmon as a part of any fish rescue effort. Nothing in this CESA MOU authorizes any action pursuant to the federal ESA.

7. Effective Date and Termination

Unless terminated sooner by either party of the CESA MOU by giving thirty (30) days prior written notice of earlier termination, this CESA MOU shall commence on the date of execution and will terminate on December 31, 2014 both days inclusive.

8. Amendments

Amendments to this CESA MOU may be proposed by either party and shall become effective when both parties sign a written modification to this document.

9. **Disclaimer**

The CDFW shall incur no fiscal obligation under this CESA MOU.

10. **Authority**

The undersigned represents that they have the authority to, and do, bind the person or entity on whose behalf and for whom they are signing this CESA MOU.

IN WITNESS WHEREOF, THE PARTIES HERETO HAVE EXECUTED THIS CESA MOU TO BE IN EFFECT AS OF THE DATE LAST WRITTEN BELOW.

EMMERSON INVESTMENTS, INC.

By David J Moschetti

Date: 5/14/2014

Phone Number: (530)378-8000

Street address:

Neil Manji, Regional Manager,
Northern Region

California Department of
Fish and Wildlife
601 Locust Street
Redding CA 96001

Date: 5/14/2014

Neil.Manji@wildlife.ca.gov

Appendix C. Field note prepared by Bill Chesney, October 28, 1995

Field note: 10/28/95

Spawning ground survey on Shasta Springs Ranch

On 10/28/95, California Department of Fish and Game staff Todd Kemp and Bill Chesney conducted spawning ground surveys on the Shasta Springs Ranch in the upper Shasta River watershed. The purpose of the survey was to determine the distribution and number of Chinook salmon spawning on this ranch.

10/28/95, Parks Creek and Bridge Field Springs Creek on the Shasta Springs Ranch

The manager of the ranch, Pete Skala told us that he had observed 2 adult salmon spawning below the culvert flowing from the small free flowing spring just north of the Bridge Field Springs impoundment located at Point 2 in Figure 1 below.

Our survey on 10/28/95 included Bridge Field Springs Creek from the confluence with Parks Creek to outfall culvert (Pont 1 to Point 2 in Figure 1 below). We observed 13 redds and 10 live Chinook in Parks Creek just below the confluence with Bridge Field Springs Creek. We observe 3 redds in Bridge Field Springs Creek directly below the spring outfall at Point 2 and estimated the outflow of this spring at Point 2 in Figure 1 to be 3 cfs.

Photo 1 Outfall of unnamed spring just north of the Bridge Field Spring impoundment.

Photo 2 Chinook redd directly downstream of spring outfall shown in Photo 1.

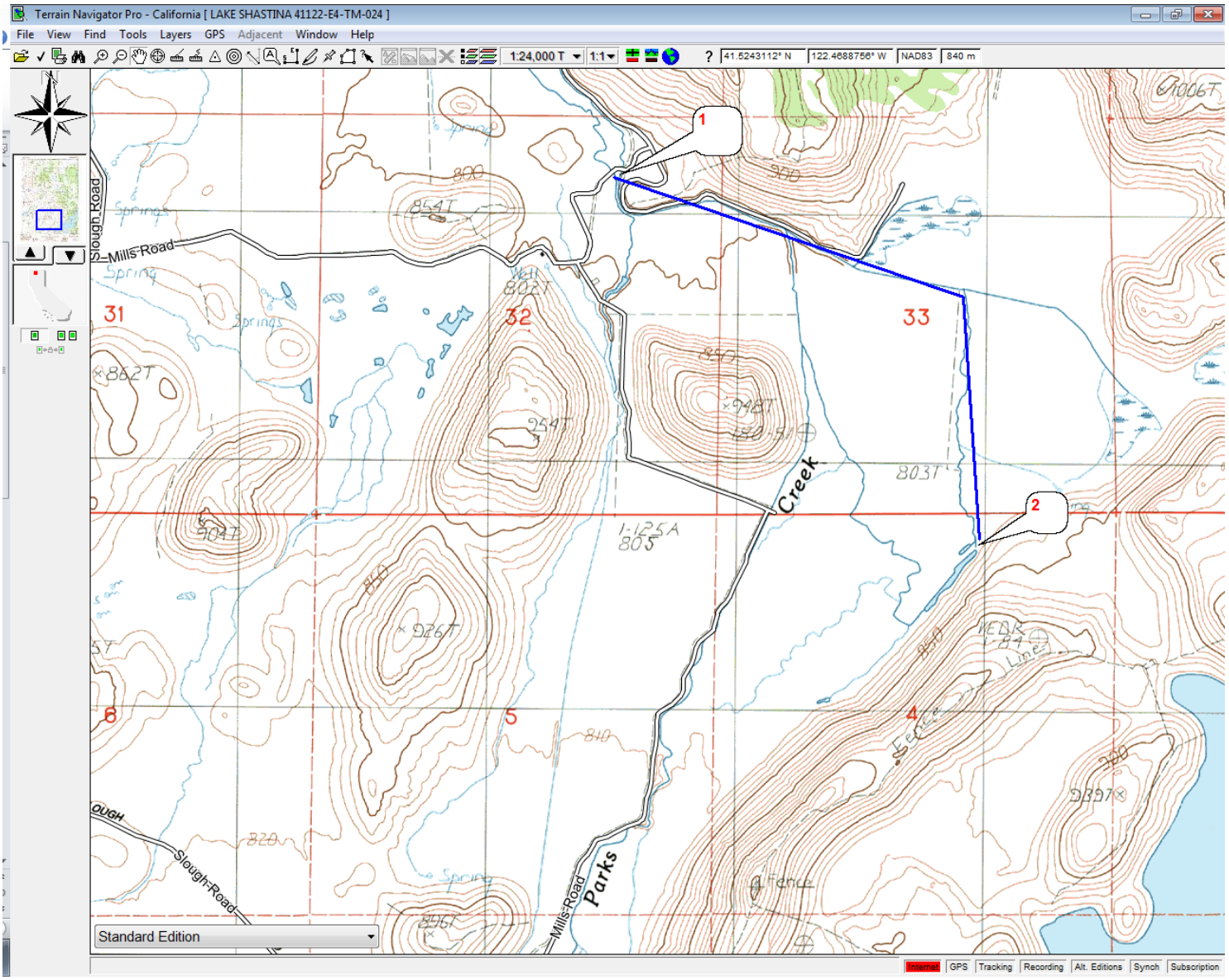

Terrain Navigator Pro - California [LAKE SHASTINA 41122-E4-TM-024]
File View Find Tools Layers GPS Adjacent Window Help
1:24,000 T
1:1
41.5243112° N
122.4688756° W
NAD83
840 m
Slough Road
Mills Road
31
32
33
1
2
Creek
Parks
Mills Road
Slough Road
Standard Edition
Internet
GPS
Tracking
Recording
Alt. Editions
Synch
Subscription

Figure 1

Appendix D. Field notes prepared by Chris Adams to document coho relocation effort on Parks Creek in 2014

Hole in the Ground/Shasta Springs Ranch Field Note, 5-20-14

California Department of Fish and Wildlife, Yreka Fisheries

Field Crew: Chris Adams

Prepared by: Chris Adams

On 5/20/14 Chris Adams and Julie Kelley (accompanied by Pete Scala and Mike Podlech) visited Hole In The Ground and Shasta Springs Ranch to complete the following:

- Service PIT Tag station at Dukes (Parks RKM 7)
- Service PIT Tag station at Kettle Spring
- Snorkel survey Kettle Spring outfall
- Snorkel survey are of concentrated coho redds near "Parks 5" diversion

Kettle Spring

The PIT tag antenna station at Kettle Spring was operating normally. Two tagged fish were detected at this station since the last visit on 3/20/14 (Table 1), including one age-0 coho that was tagged in the Shasta River near the Parks Creek confluence. I snorkeled the impoundment and downstream of the culvert between the impoundment and outfall to the creek. The impoundment was not full, and all flow was going to Kettle Creek. No coho were observed upstream of the culvert. Approximately 10 age-0 coho and 2 age-0 steelhead were observed downstream of the culvert. Thousands of speckled dace and hundreds of tui chubs were observed both downstream and upstream of the culvert.

Table 1. PIT tag detections at the Kettle Spring antenna station between 3/20/14 and 5/20/14.

Tagging Data					Kettle Spring Detection	
PIT	Species	FL (mm)	Location	Date	First	Last
900224000011174	Coho Salmon	70	RKM 56 (Shasta/Parks Conf.)	4/24/14	5/1/14	5/1/14
900236000050306	Steelhead Trout	61	Kettle Spring	7/2/13	7/2/13	4/30/14

Parks Creek

One of the two antennas at the Parks RKM 7 station was operating normally. Some repairs are needed on the second antenna, which will be completed on the next visit. Fourteen PIT tagged fish were detected at the Parks RKM 7 station since the last visit on 3/20/14 (Table 2). The majority of these fish were age-1 salmonids likely moving downstream as smolts after overwintering in Parks Creek upstream of the station. One age-0 coho was detected. This was the same individual that was detected at Kettle Spring two days prior. I conducted a snorkel survey in Parks Creek from the bridge at Dukes upstream to the Parks 5 diversion fish screen. Two age-0 steelhead and several dace were observed in this reach. Visibility was poor. I also surveyed a reach approximately 30 meters long, 150 meters upstream of the Parks 5 point of diversion, in the location where a concentration of redds were observed during the fall 2013 surveys. Approximately 40 age-0 coho and 20 age-0 steelhead were observed in this reach; visibility was poor. Nine age-0 coho (53-70 mm) and five age-0 steelhead (50-56 mm) were captured with a hand net and PIT tagged at this location. Several coho and steelhead were also captured that were too small to tag (43-49mm).

Table 2. PIT tag detections at the Parks Creek RKM 7 antenna station between 3/20/14 and 5/20/14.

Tagging Data					Parks RKM 7 (Dukes) Detection	
PIT	Species	FL (mm)	Location	Date	First	Last
900224000011174	Coho Salmon	70	RKM 56	4/24/14	5/3/14	5/3/14
989001000144258	Steelhead Trout	60	RKM 56	6/25/13	4/3/14	4/30/14
900236000050306	Steelhead Trout	61	Kettle Spring	7/2/13	2/17/14	4/17/14
900236000050392	Coho Salmon	78	Kettle Spring	7/2/13	10/26/13	4/14/14
900236000050375	Steelhead Trout	78	RKM 55	7/1/13	10/22/13	4/9/14
989001000143952	Steelhead Trout	84	BSC RKM 2	7/16/13	10/25/13	4/6/14
900236000050266	Steelhead Trout	62	RKM 56	5/29/13	11/7/13	4/6/14
900236000050329	Coho Salmon	76	Kettle Spring	7/2/13	10/30/13	4/5/14
900236000050525	Sucker	215	RKM 53	8/6/13	11/10/13	4/5/14
989001000144027	Coho Salmon	72	RKM 55 Spring	6/18/13	10/19/13	4/3/14
989001000144260	Steelhead Trout	88	RKM 56	6/24/13	12/14/13	4/3/14
900236000050144	Coho Salmon	64	RKM 53	5/14/13	12/4/13	4/1/14
989001000143953	Coho Salmon	64	RKM 55 Spring	5/29/13	1/23/14	4/1/14
989001000143945	Coho Salmon	67	RKM 55 Spring	5/29/13	11/15/13	3/22/14

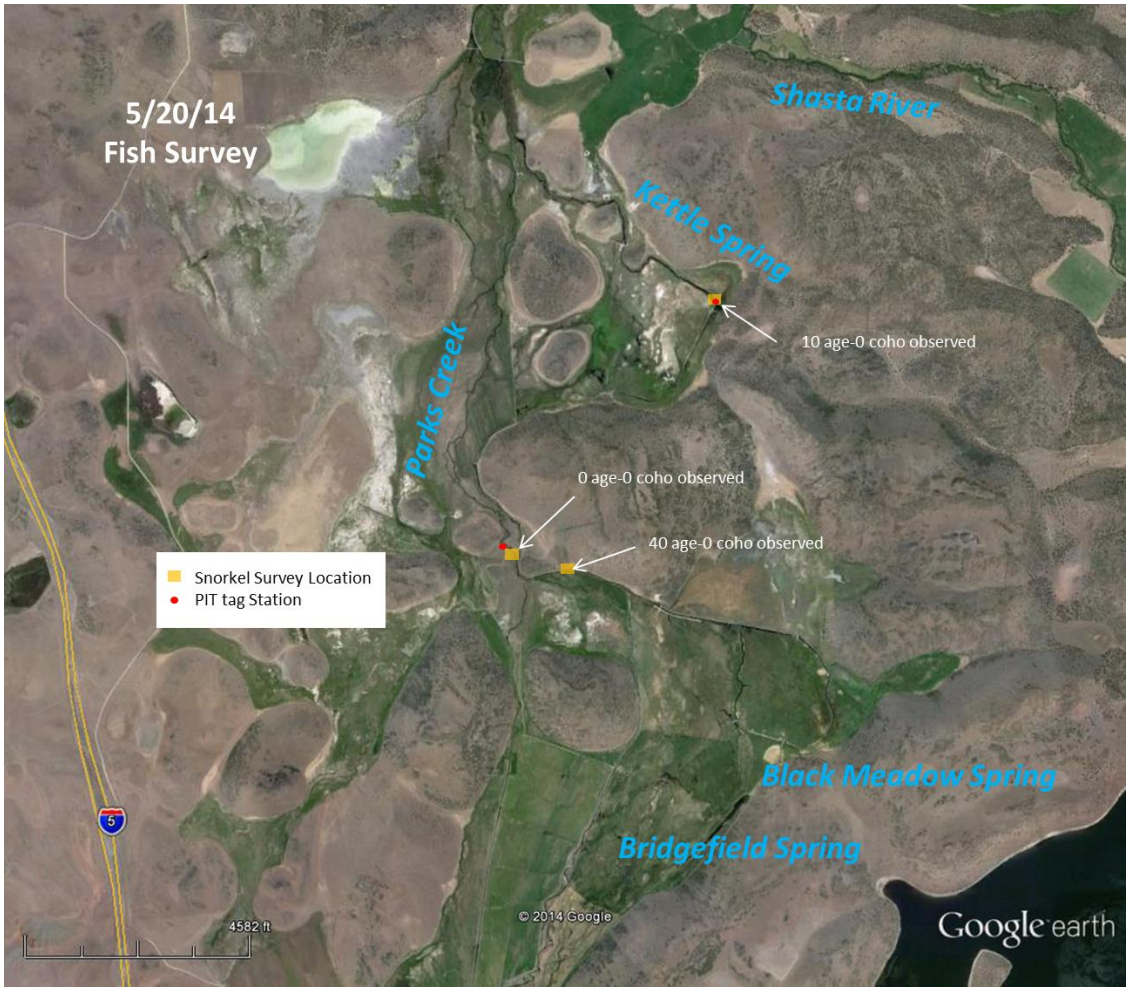


Figure 1. Map of surveyed locations, 5/20/14

Figure 2. Age- 0 coho salmon captured at Parks Creek RKM 8, 5/20/14

Figure 3. Age-0 coho salmon captured and PIT tagged at Parks Creek RKM 8, 5/20/14

Hole in the Ground/Shasta Springs Ranch Field Note, 6-13-14

California Department of Fish and Wildlife, Yreka Fisheries

Field Crew: Chris Adams, Julie Kelley, Berlynna Heres

Prepared by: Chris Adams

On 6/13/14 CDFW staff visited Hole In The Ground and Shasta Springs Ranch to complete the following:

- Service PIT Tag station at Dukes (Parks RKM 7)
- Snorkel survey are of concentrated coho redds near "Parks 5" diversion and PIT tag juvenile coho if present
- Service PIT Tag station at Kettle Spring
- Snorkel survey Kettle Spring outfall and PIT tag juvenile coho if present

Parks Creek

Flows in Parks Creek in the vicinity of the "Parks 5 diversion" were drastically reduced relative to the last visit on 5/20/14. Visibility was poor and no coho were observed in the area where observations were made on 5/20/14. We used a seine to sample the slough-like reaches where water was deeper, but slow moving. Using this method we captured 12 juvenile coho, all which were PIT tagged and released. None of these fish were previously tagged. Some age-1 steelhead, Tui chubs, speckled dace, suckers, turtles, and bullfrog tadpoles were also captured.

At the Parks RKM 7 (Dukes) antenna station, the upstream antenna was not operating; however the downstream antenna was operating normally. The tuning box on the upstream antenna was replaced, and both antennas were operating normally on departure. Detection data will be presented in a separate document.

Kettle Spring

The Kettle Spring impoundment was partially filled. Approximately 200 age-0 coho were observed below the outlet of the impoundment; 34 of these were captured with a hand net and PIT tagged.

The antenna station at Kettle Spring was not operating due to dead batteries. Batteries were replaced and the statin was operating normally on departure.

Figure 1. PIT tag antennas at Parks RKM 7, 6/13/14

Figure 2. Parks Creek upstream of Parks 5 diversion where coho were seined, 6/13/14

Figure 3. Confluence of Parks Creek and Bridgefield/Blackmeadow Slough, 6/13/14

Hole in the Ground/Shasta Springs Ranch Field Note, 6-17-14

California Department of Fish and Wildlife, Yreka Fisheries/ National Marine Fisheries Service

Field Crew: Chris Adams, Gary Curtis, Mark Hampton

Prepared by: Mark Hampton and Chris Adams

Subject: Field Notes, Reconnaissance survey for juvenile coho salmon presence in Parks Creek, Bridge Field and Black Meadow spring creeks and sloughs.

On Tuesday, June 17, Gary Curtis (CDFW), Chris Adams (CDFW), and Mark Hampton (NMFS) conducted pedestrian and snorkel surveys on the Emmerson Investments Inc. Ranch properties to determine the relative abundance and distribution of juvenile coho salmon in Parks Creek and spring fed tributary and slough habitats upstream of the PIT tag array located just downstream of the Duke's road crossing. The survey began at about 9:15 am and ended at about 2:45 pm. The survey was conducted in three general locations, Parks Creek downstream of the Bridge Field slough confluence, Parks Creek upstream of the Bridge Field slough confluence, and in the upper reaches of Bridge Field and Black Meadow spring creeks from just downstream of the confluence of the two creeks upstream to the source of each spring. In addition, the lower reach of Bridge Field slough just above its confluence Park Creek was also surveyed. Please see Figure 1 for a map of the areas surveyed.

Parks Creek, Dukes crossing upstream to Bridge Field slough confluence (Figure 1 and 2)

- Juvenile coho salmon were observed present in low numbers (1 to 3 fish per observation) distributed sporadically throughout this reach where suitable habitats remain.
- Water temperatures during the morning hours when the survey was conducted were approximately 16.6˚C (61.8˚F) at about 9:20 am.
- Flows appeared to be a little higher then was observed on the previous Friday (June 13) by Chris Adams. Although no measurements were conducted, the estimated discharge appeared to be less than 2.0 cfs.
- The water clarity was poor and visibility was limited to about 1 to 1.4 feet during the survey.
- Other species observed included speckled dace, sculpin sp., tui chub, and rainbow trout.

Parks Creek, upstream of the Bridge Field slough confluence (Figure 3)

- The lower section of this reach was surveyed in the morning from about 10:10am to 11:30am? and the upper section was surveyed in the afternoon from about 2:00pm to 2:45pm.
- Water temperature in Parks Creek was 15.5˚C in Parks creek above slough and 13.9˚C in the slough above confluence with Parks Creek. Water temperature measurements were taken at about 10:25 am.
- Water clarity was extremely good and visibility was excellent throughout this reach.

- The lower section of this reach was surveyed in the morning and upper section of this reach was surveyed in the afternoon.
- Juvenile coho salmon were present in pool habitats throughout this reach. The numbers of juvenile coho observed per pool ranged from about 2 to 30? (Chris correct this).
- Other species observed included speckled dace, sculpin sp., tui chub, centrachids (green sunfish?) and rainbow trout.

Black Meadow and Bridge Field Springs (Figure 4 and 5)

- This reached was snorkeled from the pool just downstream of the culvert and road crossing below the confluence of the two spring creeks, upstream to the source of each spring creek.
- The water temperature was 16.5˚C at 12:15 pm in the lower reach of Black Meadow spring creek and 18.5˚C at 12:25 pm in the lower reach of Bridge Field spring creek.
- Water visibility was very good.
- No salmonids were observed in either creek.

Bridge Field slough

- Water clarity was poor and water temperatures near road crossing were between 15.9 and 16.2˚C at about 1:00 pm.
- Snorkel surveys were conducted in the slough just below the road crossing and in an adjacent slough that appears to drain the pasture along the east side of Bridge Field slough.
- No coho salmon were observed in either location.

Figure 1. Parks Creek Below Bridgefield/Blackmeadow Slough

Figure 2. Confluence of Parks Creek and Birdgefield/Blackmeadow Slough 6/17/14

Figure 3. Parks Creek upstream of Birdefield/Blackmeadow slough 6/17/14

Figure 4. Bridgefield Spring below impoundment 6/17/14

Figure 5. Bridgefield impoundment 6/17/14

Hole in the Ground/Shasta Springs Ranch Field Note, 6-20-14 and 6-23-14

California Department of Fish and Wildlife, Yreka Fisheries

Field Crew: Chris Adams, Julie Kelley, Berlynna Heres, Molly Gorman, Stephen Stenhouse, Donn Rehberg

Prepared by: Chris Adams

Due to poor and worsening flow and temperature conditions in Parks Creek, effort was made to capture juvenile coho and relocate them to more suitable habitat in Kettle Spring. On 6/19/14 CDFW staff set 16 minnow traps and 4 fyke nets in Parks Creek pool habitats in the reach adjacent to Bridgefield Spring to the confluence with the Bridgefield/Blackmeadow slough confluence (Figure 1). On 6/20/14 the traps were cleared and an additional seining effort was conducted in the downstream-most pool where substantial numbers of coho were observed. On 6/23/14 CDFW staff returned to capture and relocate additional juvenile coho using seines in the deeper pools where coho had been observed. A total of 286 juvenile coho were captured along with 34 age-0 and age-1 steelhead (table 1). Non-salmonid catch was not tabulated for the seining efforts. All salmonids were transported the road crossing on Kettle Spring Creek; 144 and 8 steelhead were PIT tagged prior to release. Flow in Parks Creek was approximately 1 cfs. Fish were concentrated in several deep pools, some as deep as 2 meters. Temperatures in riffle sections were measured as high as 23 degrees C, however temperatures were relatively cooler (approximately 19 degrees C) at the bottom of the deeper pools. Approximately 100 sunfish were captured in Parks Creek, ranging in size from 30mm young of the year to 200+ mm. Two of the larger sunfish were sacrificed for gut analysis. Both were gravid and contained tow small fish which were unidentifiable (Figure 2). Predation rates on juvenile coho salmon by sunfish may be substantial in Parks Creek.

Table 1. Results of capture efforts for juvenile coho in Parks Creek on 6/20/14.

	coho	rainbow trout (0+,1+)	sunfish	dace	sculpin	Tui chub	sucker
Minnow/ fyke traps 6/20/14	38	7	92	48	10	6	1
Seine 6/20/14	158	10					
Siene 6/23/14	90	17					
Total coho	**286**						

The antenna station at Parks RKM 7 was checked and downloaded on 6/20/14 and the Kettle Spring antenna station was checked and downloaded on 6/23/14. Both stations were operating normally. Detection data will be presented in a separate document.

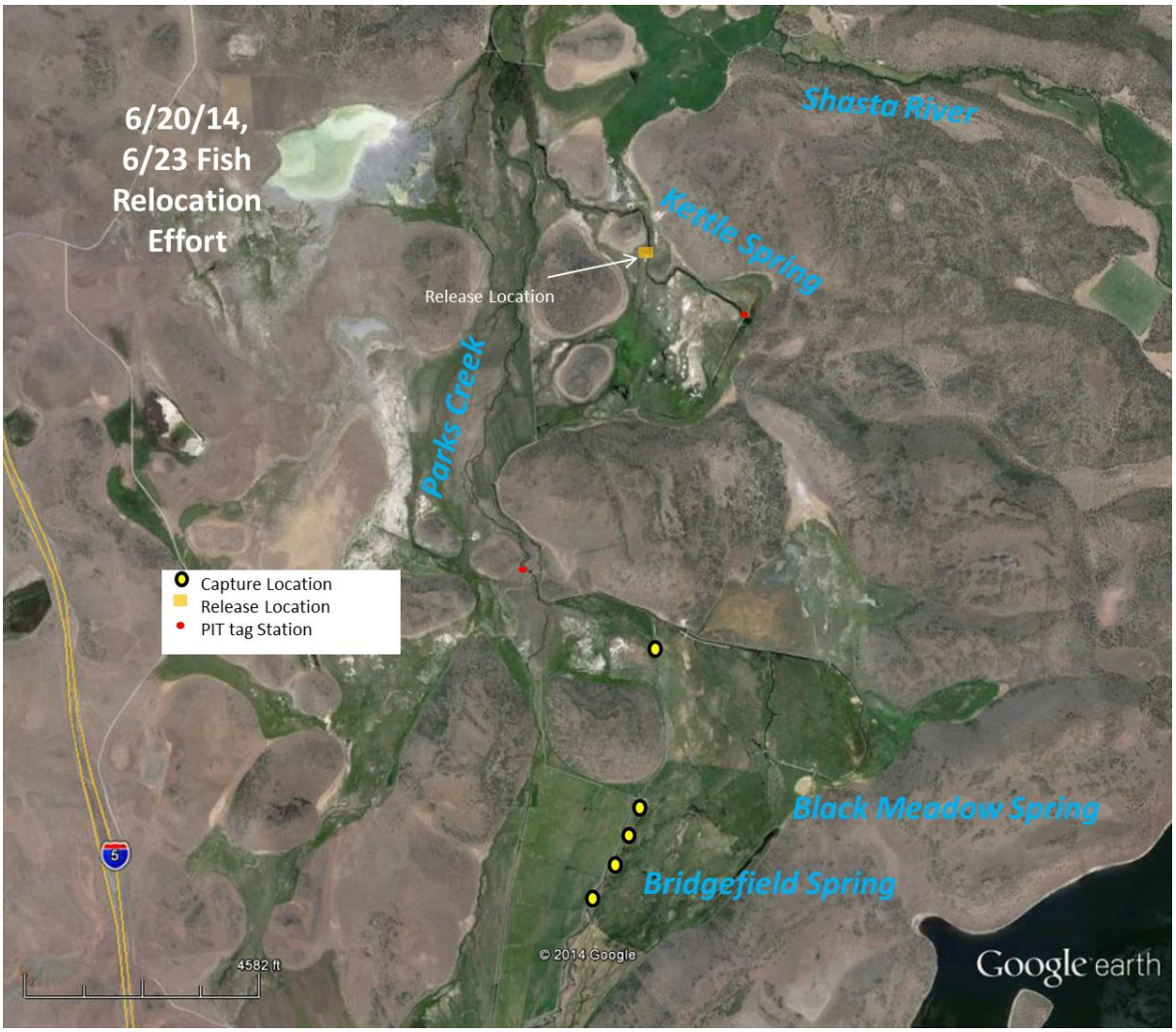


Figure 1. Map of capture and release sites for Parks Creek coho relocation, 6/20/14 and 6/23/14.

Figure 2. Sunfish captured in Parks Creek on 6/20/14.

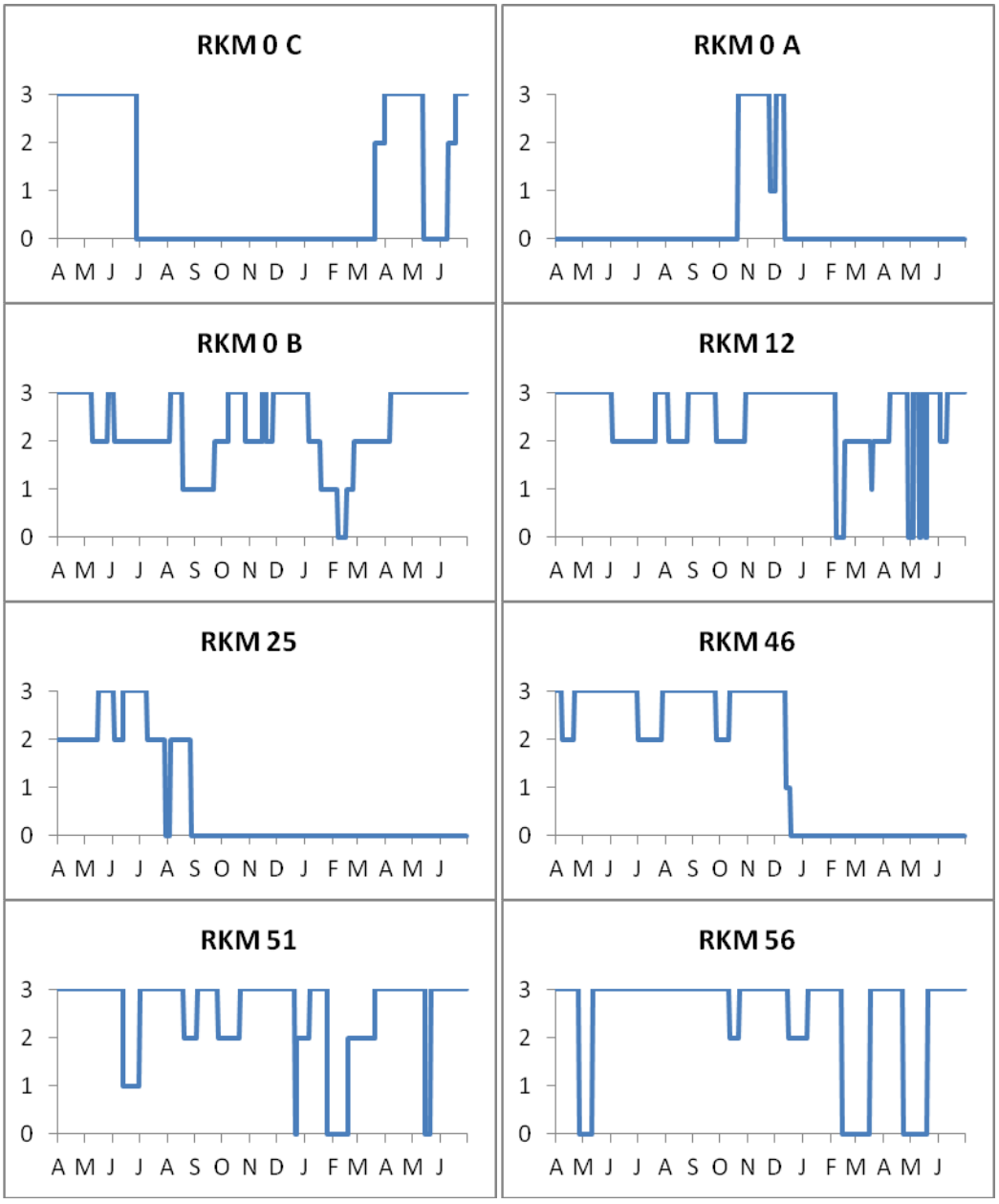
Figure 3. PIT tag antennas at Parks RKM 7, 6/20/14

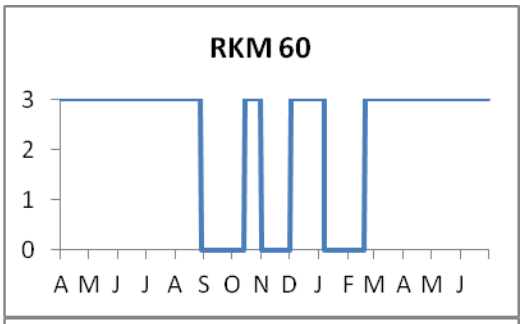
Appendix E. List of PIT tag antenna stations and locations.

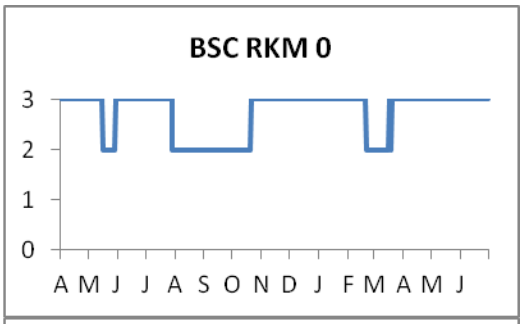
Station Name	Location Description
RKM 0 A	75 meters upstream on Klamath River, downstream rotary screw trap site
RKM 0 B	100 meters upstream from Klamath River, at adult counting weir site
RKM 0 C	300 meters upstream from Klamath River
RKM 12	Shelly Bridge
RKM 25	Meamber Ranch, 200 meters upstream from Montague Grenada Road
RKM 46	Lower Nelson Ranch
RKM 51	Upper Nelson Ranch
RKM 56	Shasta River 50 meters upstream from Parks Creek
RKM 60	Lower Hidden Valley Ranch
BSC RKM 0	Big Springs Creek 50 meters upstream from Shasta River
BSC RKM 2	Water wheel structure (antennas both upstream and downstream of structure)
BSC RKM 3	Outlet of Big Springs Lake (antennas in pool downstream of culvert)
LSC RKM 0	Little Springs Creek 20 meters upstream of Big Springs Creek
LSC RKM 1	Little Springs Creek just downstream of "beaver pond" culvert (second culver downstream of springs)
Parks RKM 0	Parks Creek 20 meters upstream of Shasta River
Parks RKM 7	Parks Creek at Dukes Ranch on Emmerson Investmens Inc. property, 100 meters downstream of "Parks 5" diversion
Parks RKM 8	Parks Creek at Dukes Ranch on Emmerson Investmens Inc. property, 25 meters upstream of "Parks 5" diversion
Kettle Spring	Outlet of Kettle Spring impoundment (antennas in pool downstream of culvert)

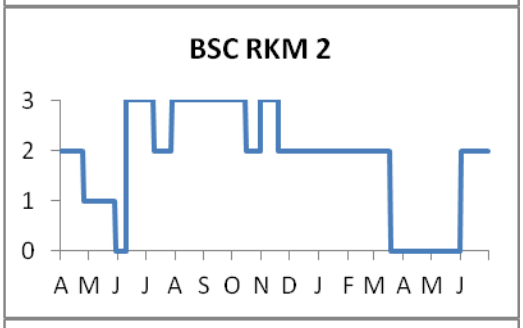
Appendix F. Daily antenna station performance

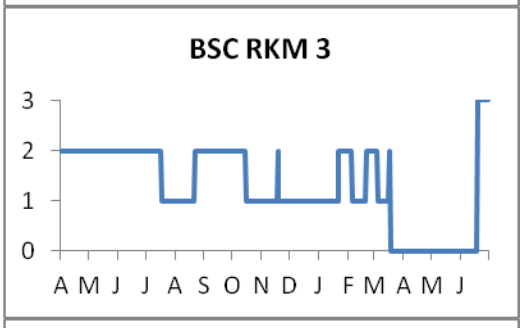
The below graphs illustrate the portion of river transect covered by PIT tag detection field (0=0, 1=1-33%, 2=34-66%, 3=67-100%).

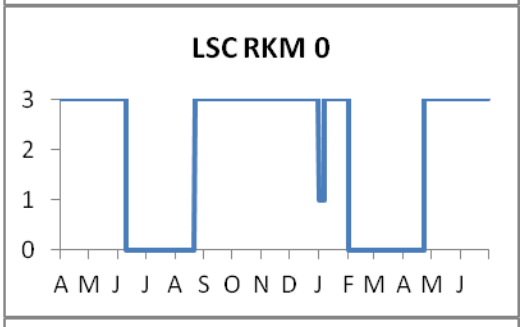


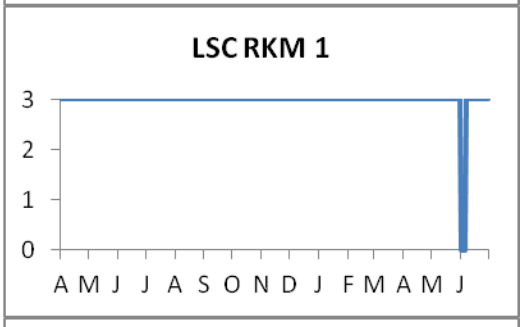

RKM 60
3
2
1
0
A M J J A S O N D J F M A M J

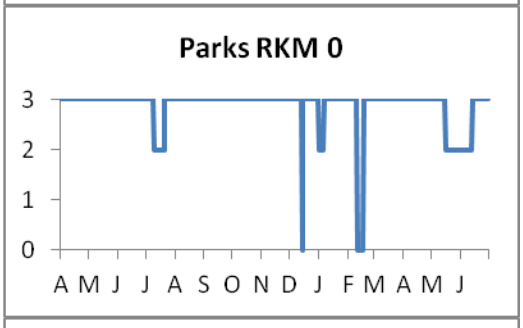

BSC RKM 0
3
2
1
0
A M J J A S O N D J F M A M J

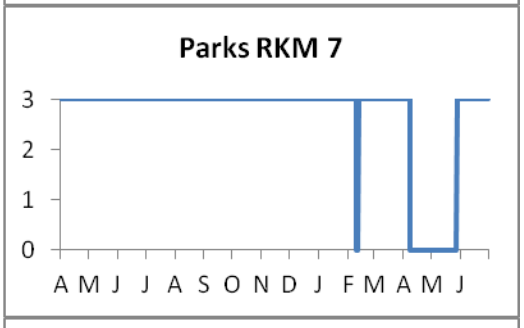

BSC RKM 2
3
2
1
0
A M J J A S O N D J F M A M J

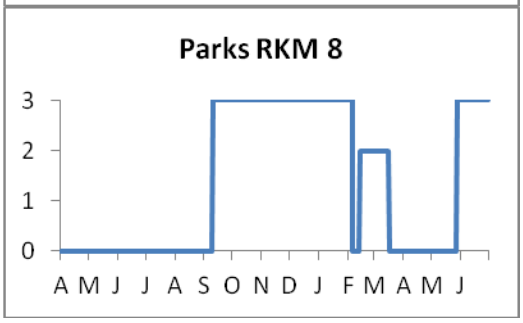

BSC RKM 3
3
2
1
0
A M J J A S O N D J F M A M J

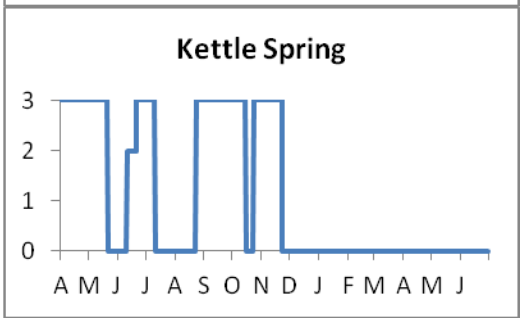

LSC RKM 0
3
2
1
0
A M J J A S O N D J F M A M J


LSC RKM 1
3
2
1
0
A M J J A S O N D J F M A M J

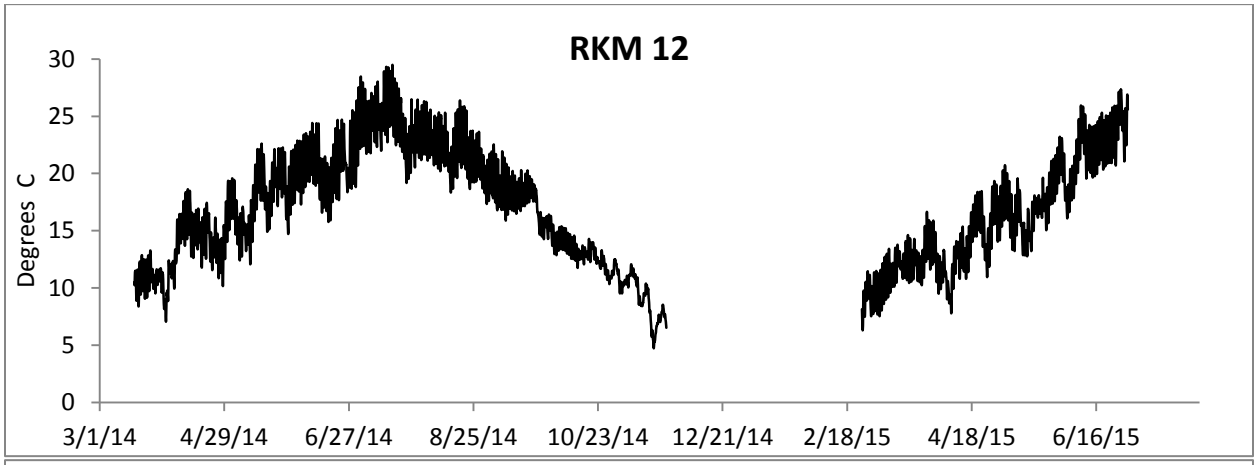

Parks RKM 0
3
2
1
0
A M J J A S O N D J F M A M J

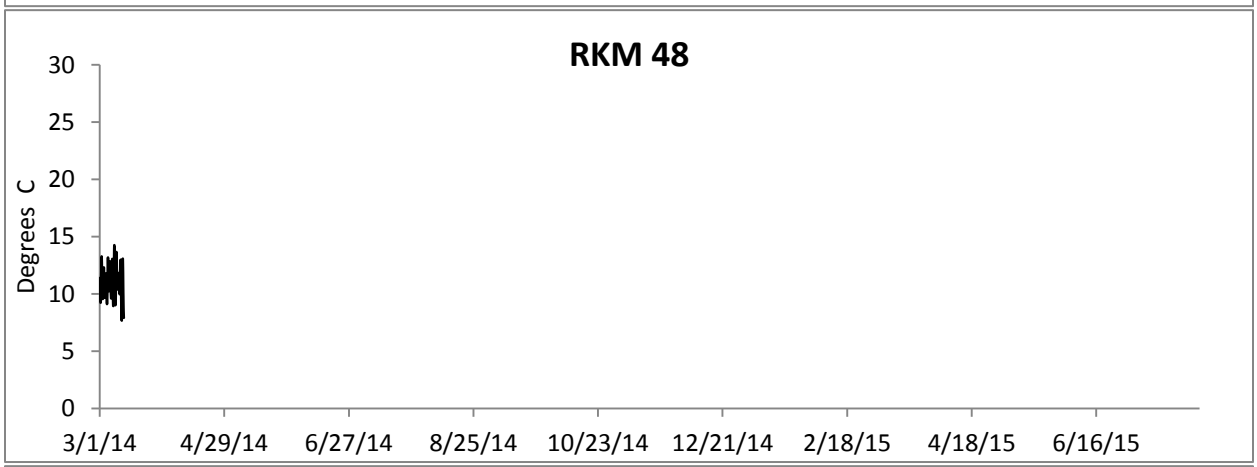

Parks RKM 7
3
2
1
0
A M J J A S O N D J F M A M J

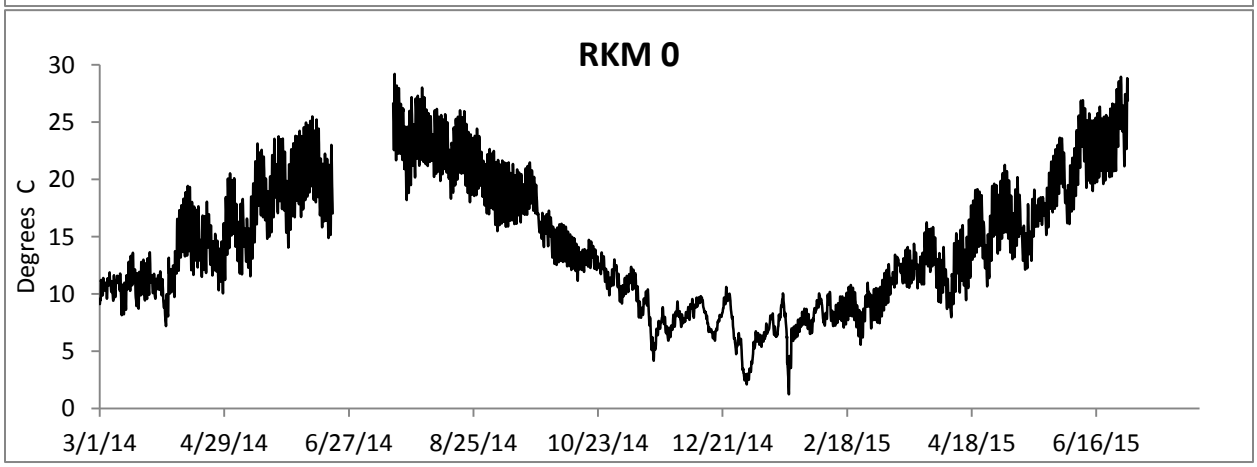

Parks RKM 8
3
2
1
0
A M J J A S O N D J F M A M J

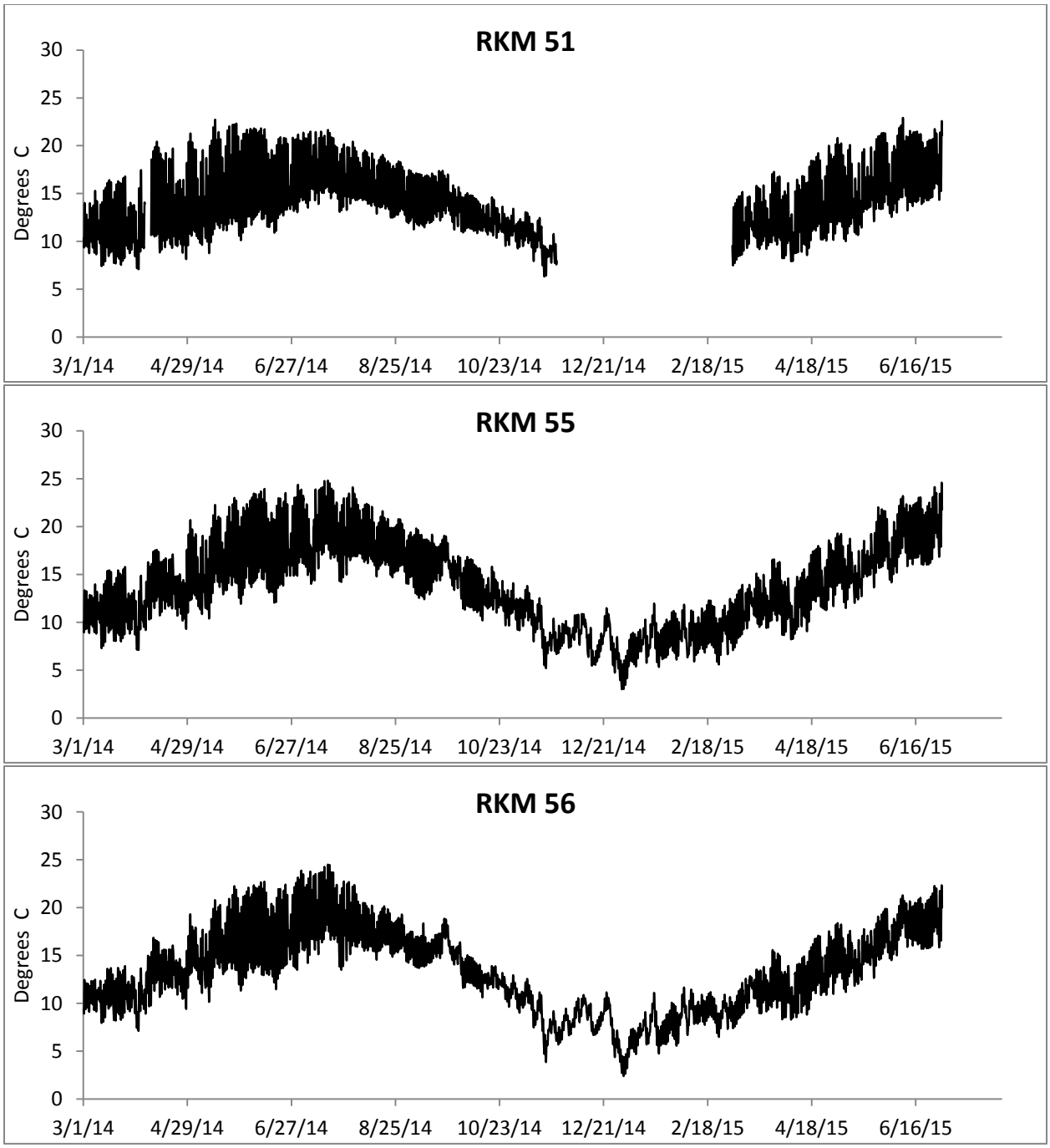

Kettle Spring
3
2
1
0
A M J J A S O N D J F M A M J

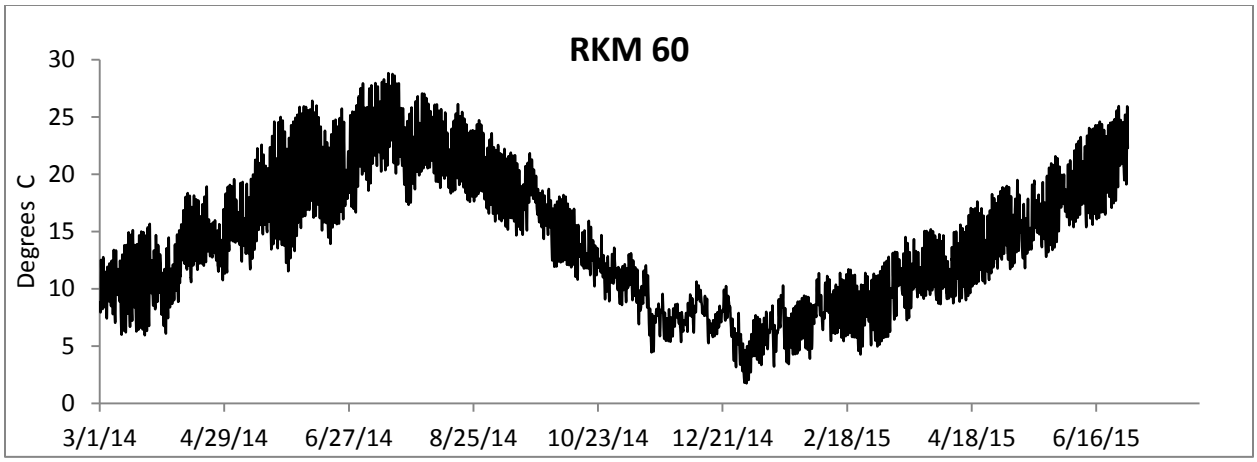
Appendix G. Temperature plots

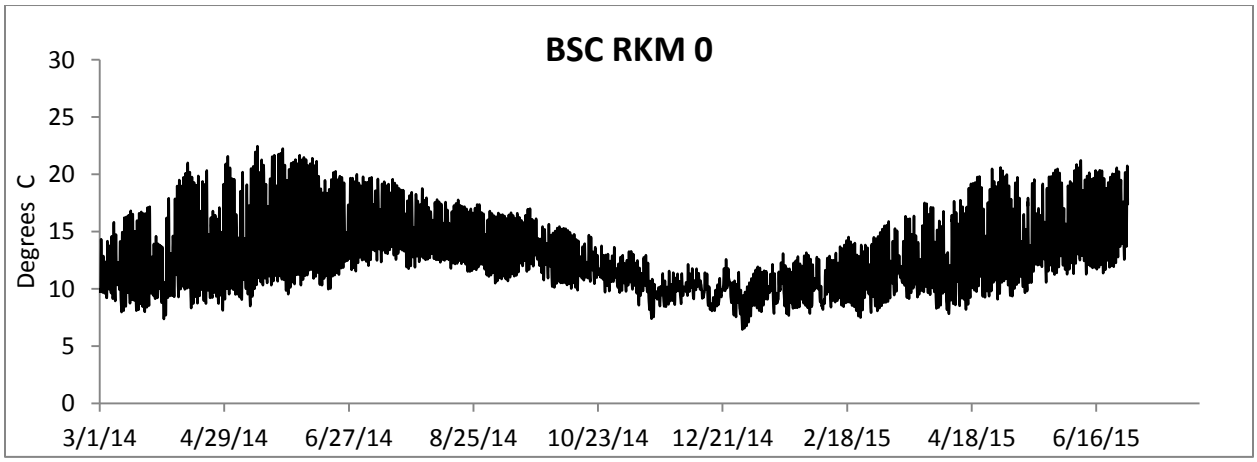


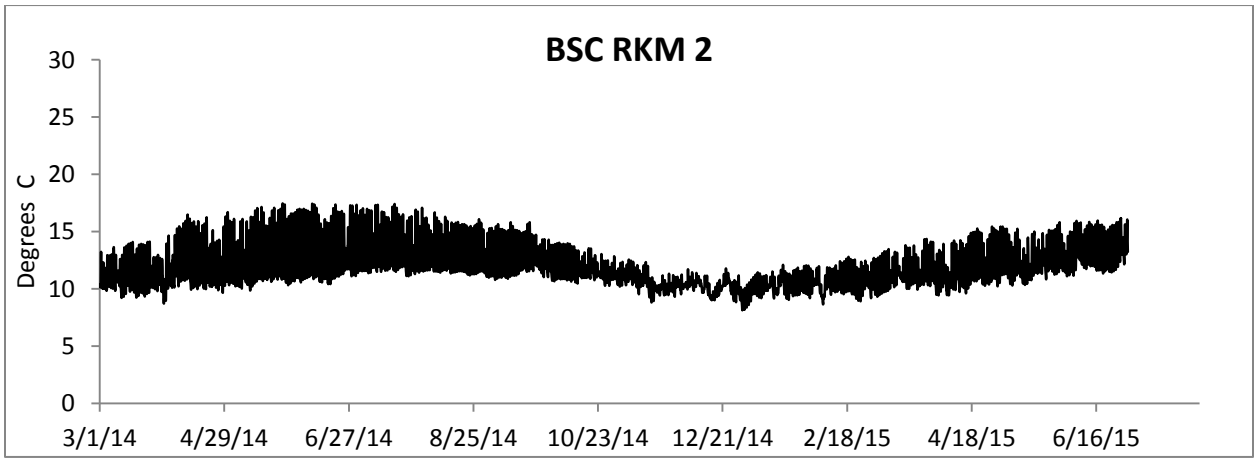


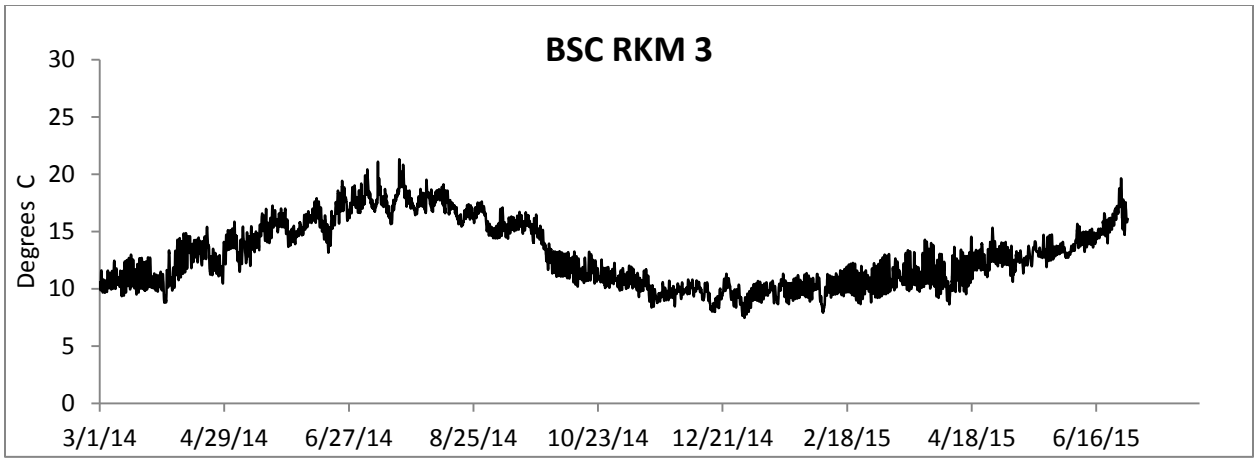


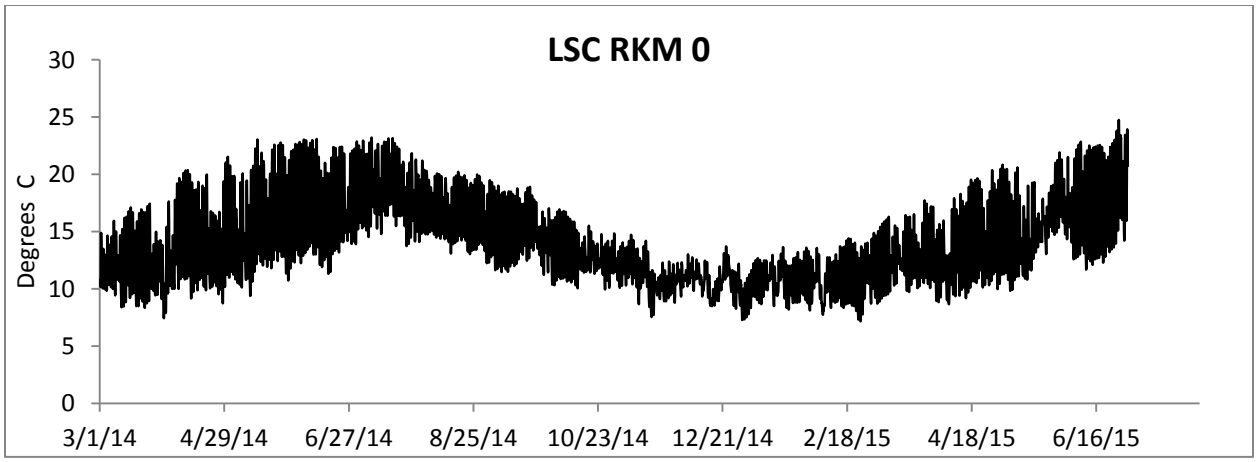

RKM 51
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15
RKM 55
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15
RKM 56
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

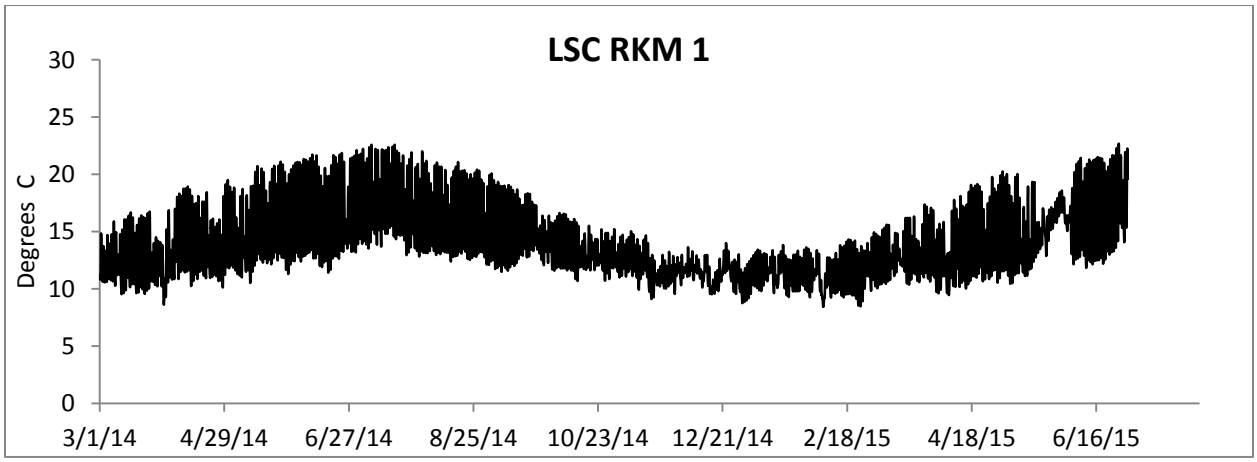

RKM 60
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

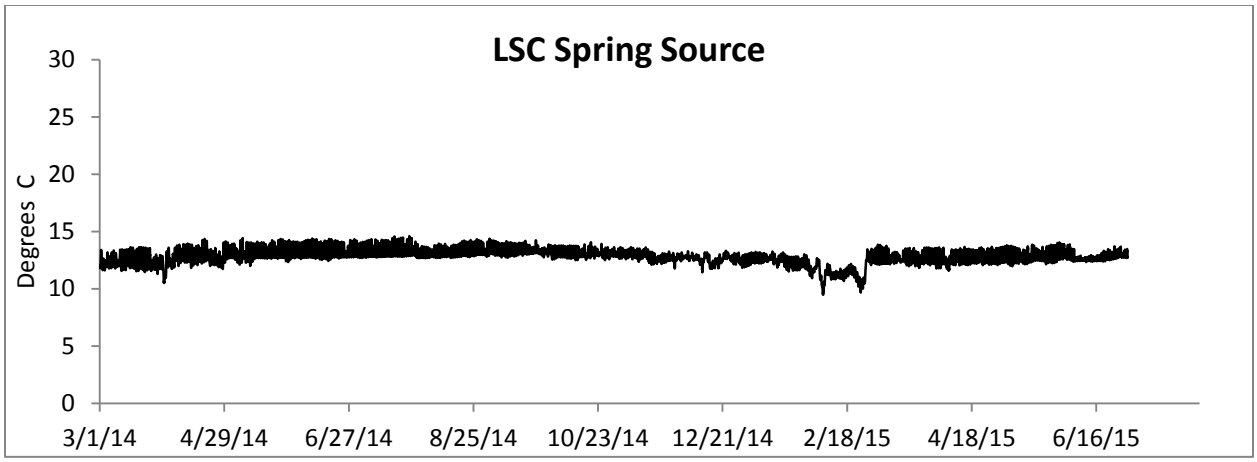

BSC RKM 0
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

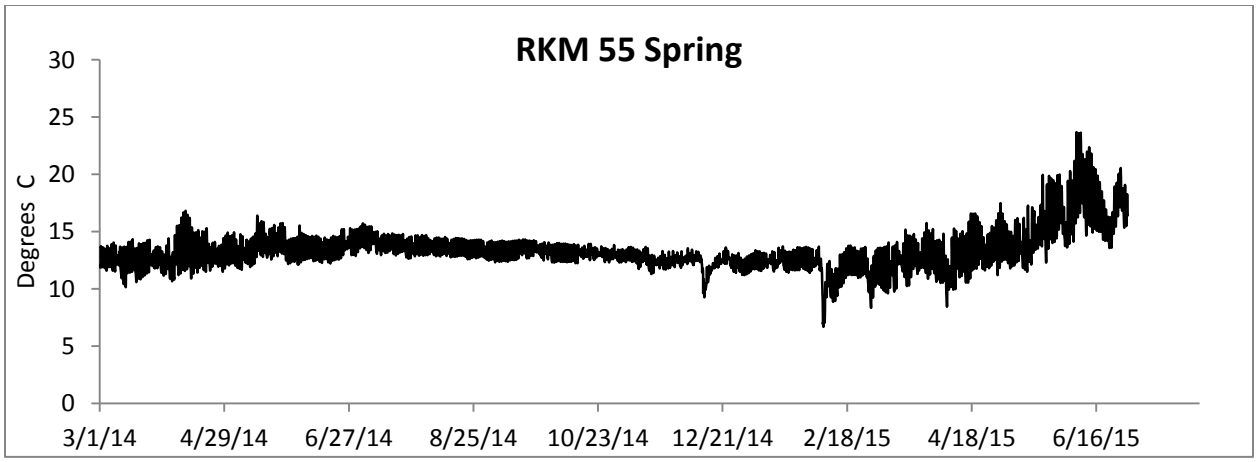

BSC RKM 2
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

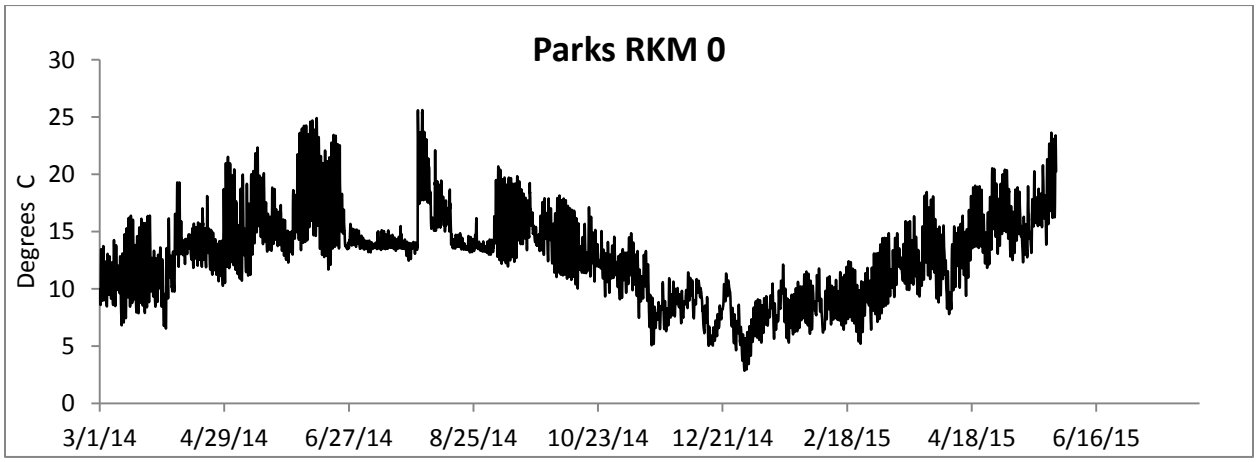

BSC RKM 3
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15


LSC RKM 0
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

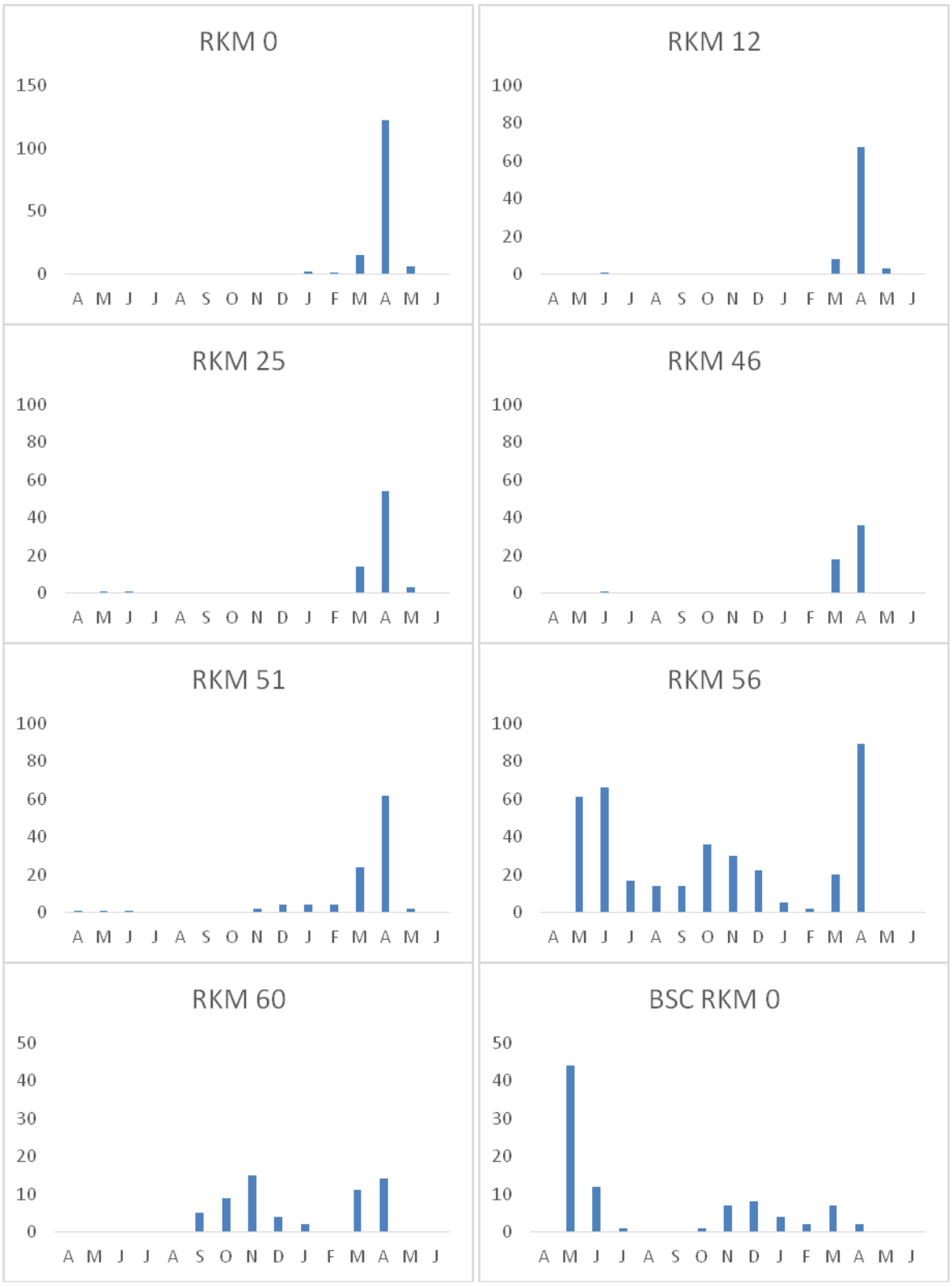

LSC RKM 1
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

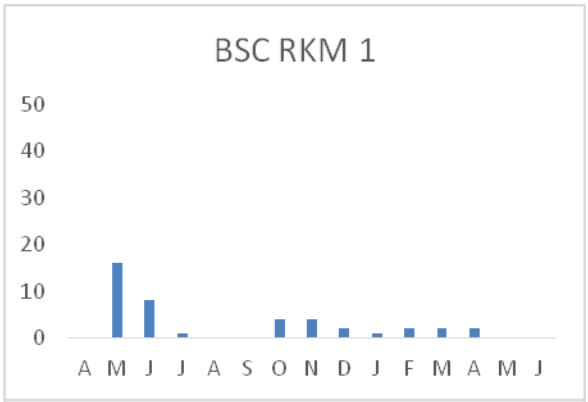

LSC Spring Source
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

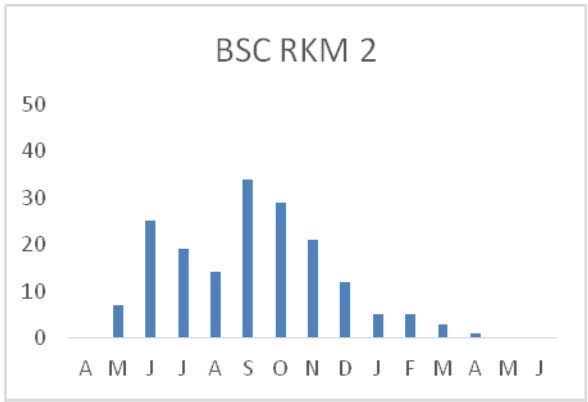

RKM 55 Spring
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

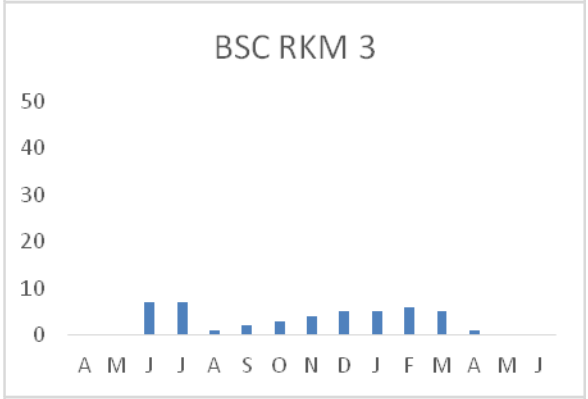

Parks RKM 0
Degrees C
30
25
20
15
10
5
0
3/1/14
4/29/14
6/27/14
8/25/14
10/23/14
12/21/14
2/18/15
4/18/15
6/16/15

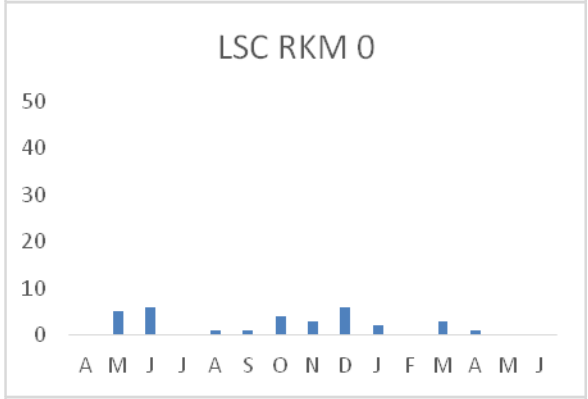
Appendix H. Monthly total detections of BY2013 coho at each PIT tag antenna station

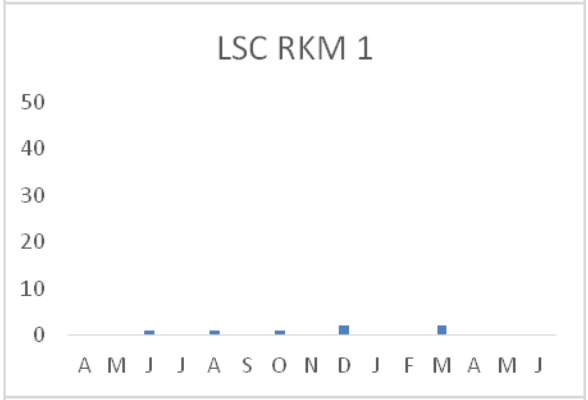


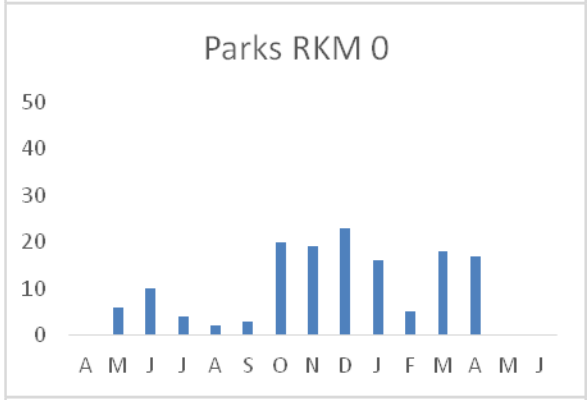

BSC RKM 1
50
40
30
20
10
0
A M J J A S O N D J F M A M J

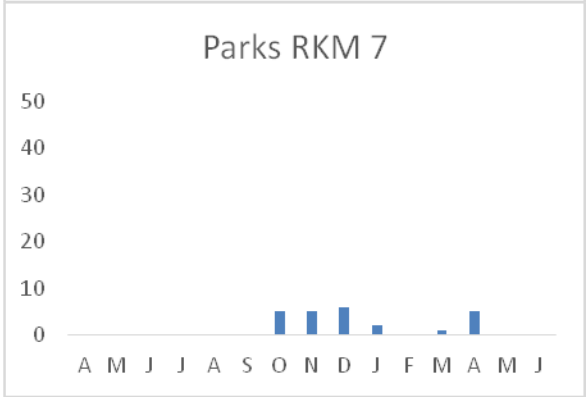

BSC RKM 2
50
40
30
20
10
0
A M J J A S O N D J F M A M J

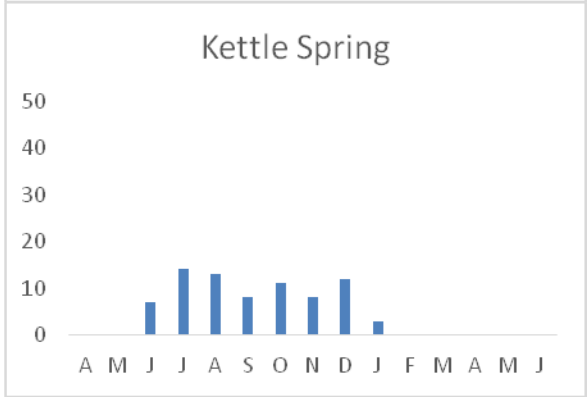

BSC RKM 3
50
40
30
20
10
0
A M J J A S O N D J F M A M J


LSC RKM 0
50
40
30
20
10
0
A M J J A S O N D J F M A M J


LSC RKM 1
50
40
30
20
10
0
A M J J A S O N D J F M A M J


Parks RKM 0
50
40
30
20
10
0
A M J J A S O N D J F M A M J


Parks RKM 7
50
40
30
20
10
0
A M J J A S O N D J F M A M J


Kettle Spring
50
40
30
20
10
0
A M J J A S O N D J F M A M J

Appendix I. Field note prepared by Yreka Fisheries, October 2012

Field note 10/22/12
Subject: Shasta River Coho,
Parks Creek Diversions and impact to spawning habitat.

In 2004, CDFG initiated a multi year study to determine where coho spawn in the Shasta River watershed. Adult coho were captured, radio tagged and released at the weir (RM 0). From this work, we learned that areas of Parks Creek, a tributary to the upper Shasta River at River Mile 32.3, were consistently being utilized by coho for spawning and juvenile rearing habitat (Figure 1). Using Passive Integrated Transponder tags (PIT tags) and a network of antennas, we've learned that the juvenile coho produced from upper Parks Creek, migrate to several cold springs in the upper watershed as water temperatures warm during the spring.

In 2008, Parks Creek was the only location where we observed coho spawning in the upper watershed.

Under present management, flows in Parks Creek are diverted for agricultural purposes. In recent years the diversions have reduced stream flow and limited access and utilization of this spawning habitat by coho (Figure 1). In spite of by pass flows released by Montague Water Conservation District of 6cfs in fall 2011, diversion of surface flow on the Emmerson Property, effectively dewatered portions of Park Creek where coho spawning has been documented (Photo 1). We believe that due to this loss of access and production, we did not see juvenile coho utilizing spring habitat in the Parks Creek watershed in 2012 as we have in previous years.
On 10/18/12 we flew over the Parks Creek watershed to assess current conditions. Two diversions Parks #1 and Parks #4 were observed dewatering the stream in the locations where spawning has been observed (Photos 2 and 3).

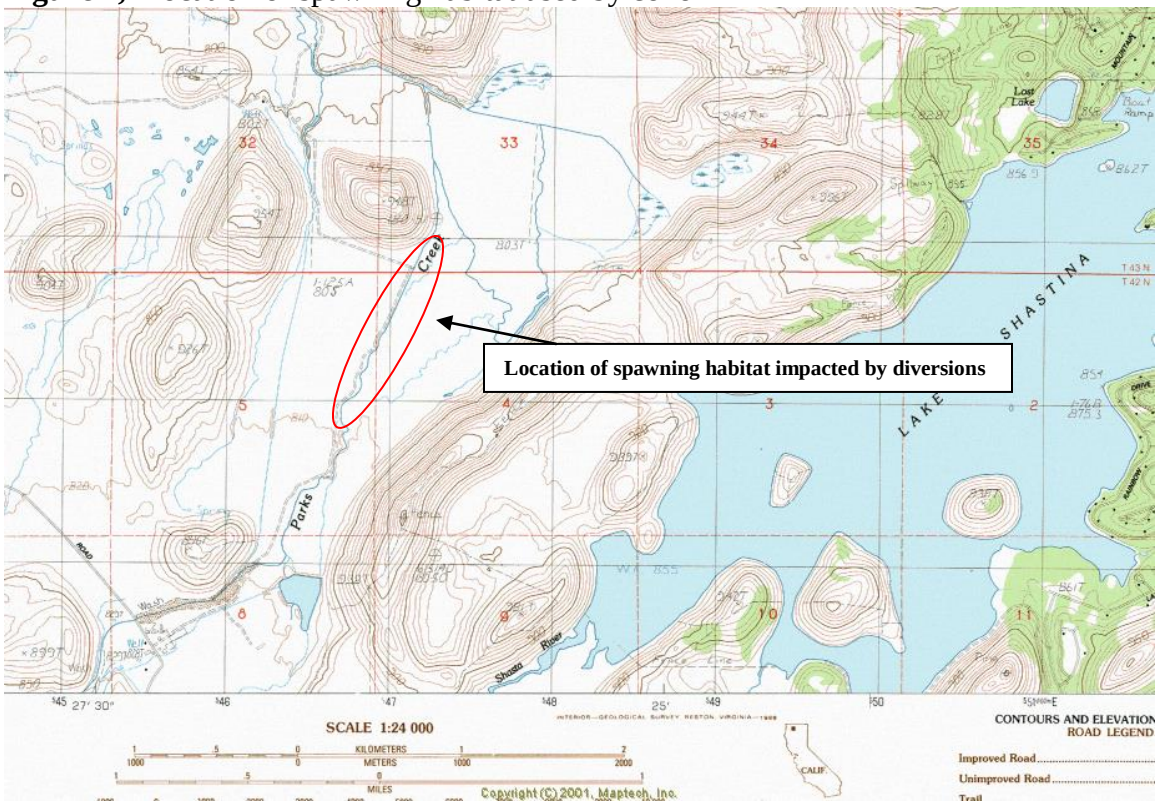
The first coho have already arrived at Iron Gate Hatchery and rain is forecasted throughout this week this increase in flow will encourage upstream migration of adults. With the diversions in place as observed on 10/18/12 we are unlikely to see sufficient flow in the channel for spawning.

Photo 1, Parks Cr Diversion number 2 on 11/30/11

Photo 2, EII Parks Diversion 1, 10-18-12. The circle shows the location of the push up dam, the arrow shows the location of Parks Cr. channel and direction of flow.

Photo 3, Parks Cr.diversion 4 on 10/18/12. The arrow shows the direction of flow

Figure 1, Location of spawning habitat used by coho



Appendix J. Photos

Photo 1. Shasta River canyon from airplane, 9-4-14.

Photo 2. Shasta Valley from airplane, 9-4-14.

Photo 3. Dwinnell dam and Lake Shastina from airplane, 9-4-14.

Photo 4. Rotary screw trap at Shasta RKM 0, 5-18-14.

Photo 5. Shasta RKM 0 B PIT station, 5-8-14.

Photo 6. Shasta RKM 0 PIT station C, 4-14-14.

Photo 7. Shasta RKM 12 PIT station, 6-30-14.

Photo 8. Shasta RKM 25 PIT Station, 5-18-14.

Photo 9. Shasta RKM 48 PIT Station, 3-24-14.

Photo 10. Shasta RKM 51 PIT Station, 3-18-15.

Photo 11. Shasta RKM 56 PIT Station, 5-12-14.

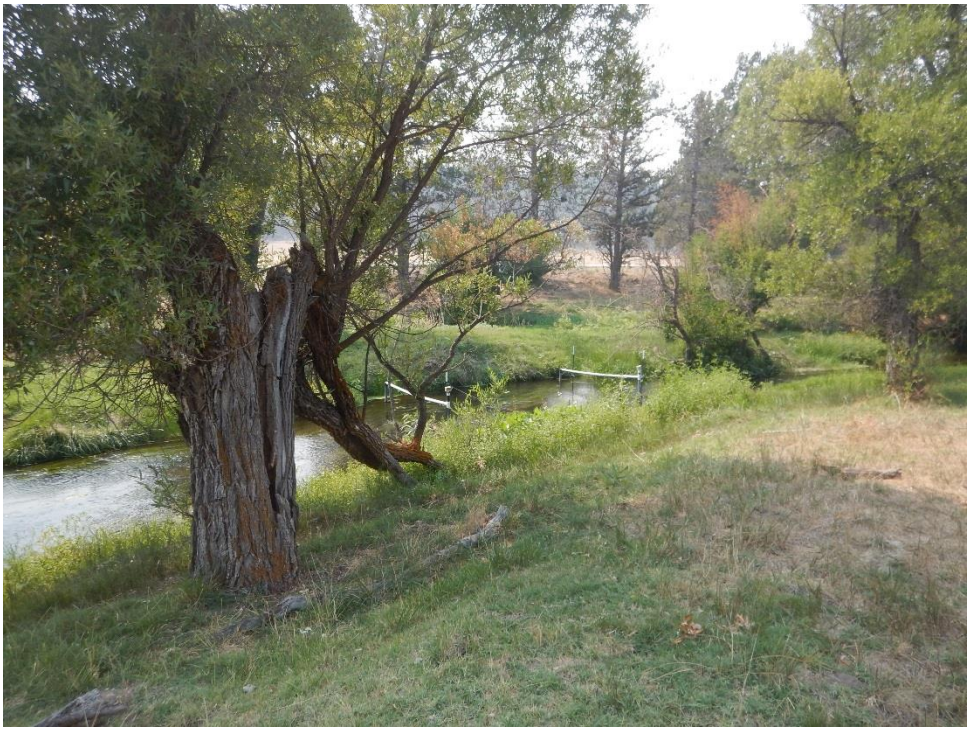


Photo 12. Shasta RKM 60 PIT Station, 8-29-14.

Photo 13. Big Springs Creek RKM 0 PIT Station, 3-24-14.

Photo 14. Big Springs Creek RKM 0 PIT Station, 8-4-14.

Photo 15. Big Springs Creek RKM 2 PIT Station, 8-21-14.

Photo 16. Big Springs Creek RKM 2 PIT Station, 11-18-14.

Photo 17. Big Springs Creek RKM 3 PIT Station, 7-17-14.

Photo 18. Big Springs Creek RKM 3 PIT Station, 11-18-14.

Photo 19. Little Springs Creek RKM 0 PIT Station, 10-10-14.

Photo 20. Little Springs Creek RKM 1 PIT Station, 10-10-14.

Photo 21. Parks Creek RKM 0 PIT Station, 5-12-14.

Photo 22. Parks Creek RKM 7 PIT Station, 6-20-14.

Photo 23. Parks Creek RKM 8 PIT station, 10-23-14.

Photo 24. Kettle Spring PIT station, 7-11-14.

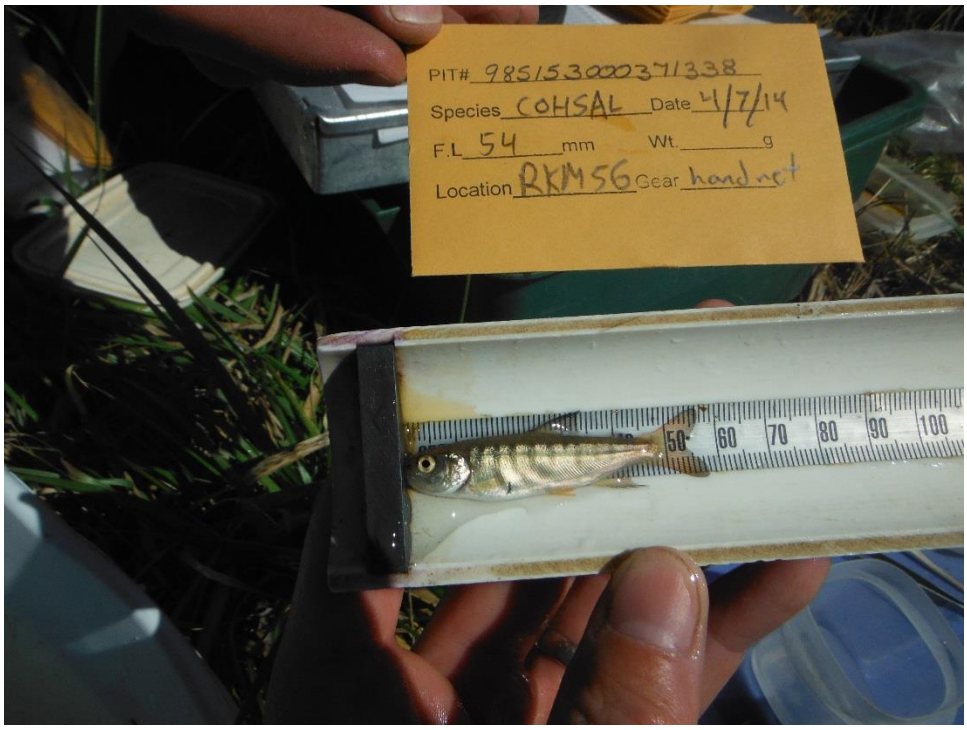


Photo 25. BY2013 coho tagged at Shasta RKM 56, 4-7-14.

Photo 26. Shasta RKM 57 tagging site, 8-22-14.

Photo 27. Coho and Chinook fry in Big Springs Creek (RKM 1.5), 3-18-14.

Photo 28. Coho directly downstream of culvert from Big Springs Lake, 5-18-14.

Photo 29. Parks Creek at Bridge Field Creek confluence, 6-17-14.

Photo 30. Parks Creek upstream of Bridge Field Creek confluence, 6-17-14.

Photo 31. Parks Creek adjacent to Bridge Field Spring, 6-17-14.

Photo 32. Kettle Spring release site for coho reocated from Parks Creek, 6-23-14.

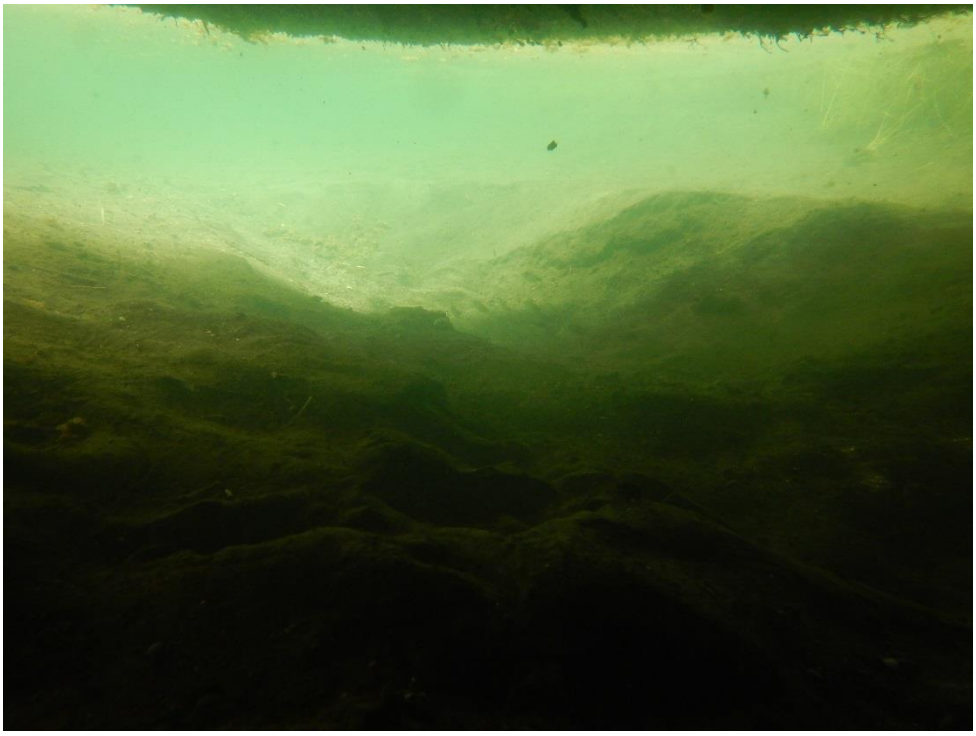


Photo 33. Coho and steelhead under algae mat upstream of the release location at Kettle Creek brigde (middle of frame, close up in photo 34), 8-22-14.

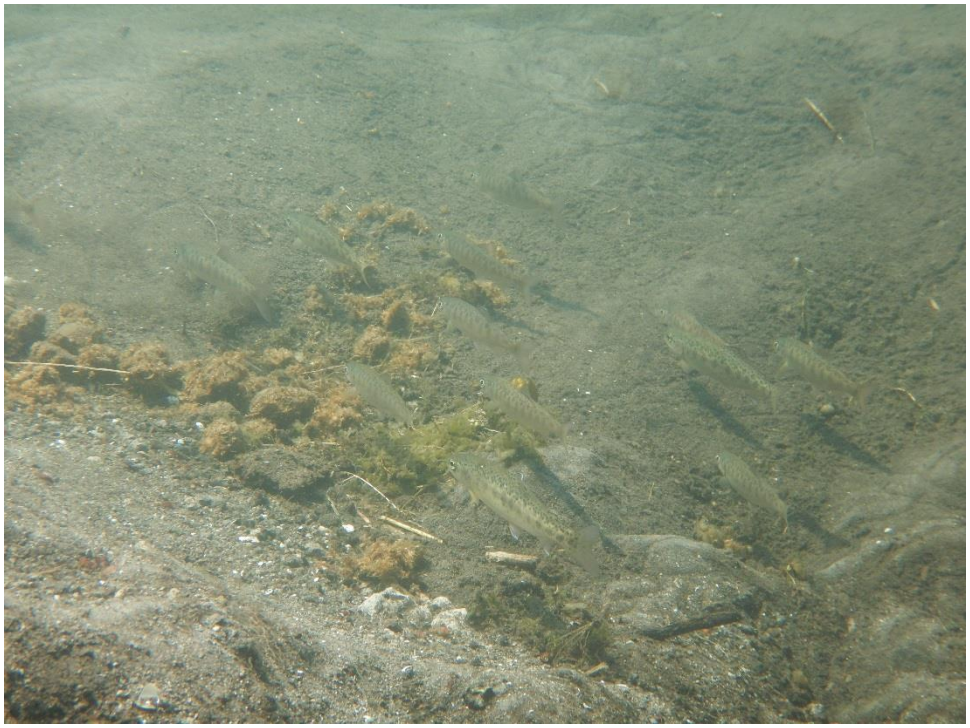


Photo 34. Coho and steelhead under algae mat upstream of the release location at Kettle Creek brigde (close up of middle of frame in photo 33), 8-22-14.

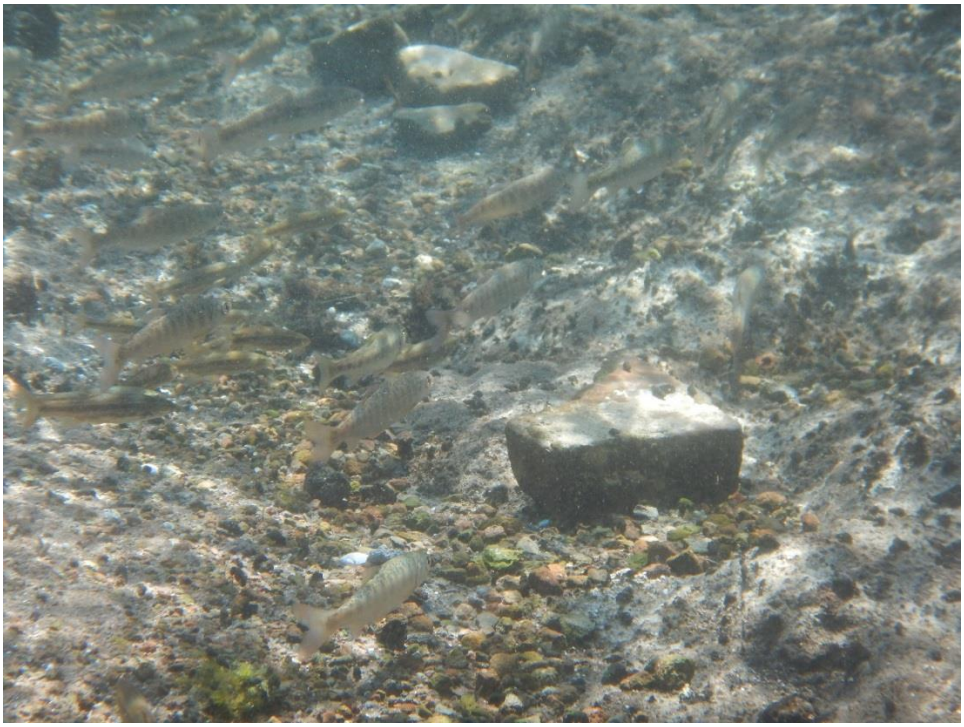


Photo 35. Coho, steelhead, and speckled dace just below culvert at Kettle Spring impoundment, 8-22-14.

Photo 36. Green sunfish observed in Parks Creek, 7-11-14.

Photo 37. Stomach contents (unidentifiable fish) of green sunfish captured in Parks Creek on 6-20-14.

Photo 38. Looking upstream into the culvert from Big Springs Lake, 8-21-14.

Photo 39. Big Springs Lake from airplane, 9-17-14.