Pacific States Marine Fisheries Commission

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Results of regional spawning ground surveys and estimates of salmonid redd abundance in the South Fork Eel River, Humboldt County, California, 2017-2018.

Prepared by:

Jonathan Guczek[1], Sharon Powers[1], Kori Roberts[1], Scott Monday[2]

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[1] Pacific States Marine Fisheries Commission

[2] Corresponding author. California Department of Fish and Wildlife, Scott.Monday@wildlife.ca.gov

ABSTRACT

The South Fork Eel River Adult Salmonid Redd Abundance Monitoring Project conducted 249 spawning ground surveys upon 37 spatially balanced and randomly selected reaches in the South Fork Eel River Watershed between November 6th, 2017 and February 15th, 2018. Each reach was surveyed an average of 6.7 times, and the average interval between surveys over all reaches was 16.8 days. During the 2017-2018 survey season, crews observed 144 live coho salmon, 114 live Chinook salmon, 8 live steelhead, and 15 unidentified salmonids. Surveyors encountered 11 coho salmon carcasses, 30 Chinook salmon carcasses and 1 unidentified salmonid carcass. A total of 356 redds were detected, and 49 of those redds were observed to be associated with a specific salmonid species digging or guarding the redd. The remaining 307 redds were predicted to species using a k-Nearest Neighbors model. The number of redds were estimated in each sample reach using flagged and re-observed redds in a mark-recapture model then expanded to estimate the number of total redds constructed across the entire South Fork Eel River reach sample frame. Redd abundance estimates for the 2017-2018 spawning season in the South Fork Eel River sample frame area, including 95% confidence intervals, were 1,633 (793, 2473) coho salmon redds, 867 (454, 1279)* Chinook salmon redds, and 5 (1, 15)* steelhead trout redds.

* The South Fork Eel River Adult Salmonid Redd Abundance Monitoring Project does not survey the entire spatial extent of potential Chinook and steelhead trout spawning areas and does not survey the entire time period of potential steelhead spawning in the S.F. Eel River. The project's sample frame of potential reaches and annual survey start and end dates are specifically designed to cover the spatial and temporal extent of S.F. Eel River coho spawning. Chinook and steelhead redd abundance estimates provided in this report are not derived from a survey design intended to estimate the total S.F. Eel redd abundance for these species.

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1 INTRODUCTION

1.1 BACKGROUND

Coho salmon (*Oncorhynchus kisutch*) in the Southern Oregon/Northern California Coast (SONCC) Evolutionarily Significant Unit (ESU) were listed as threatened under the Federal Endangered Species Act in 1997 (62 FR 24588); and their listing was reaffirmed in 2005 (70 FR 37160). The SONNC coho salmon ESU was also listed as threatened under the California Endangered Species Act in 2002 (CDFG 2002). Both the California Department of Fish and Wildlife (CDFW) and the National Marine Fisheries Service (NMFS) have developed recovery plans for coho salmon outlining recovery goals, prioritizing recovery actions, and offering criteria that must be met in order to delist the species (CDFW 2004, NMFS 2014). Long-term population monitoring is an essential component of these recovery plans, as metrics are needed to assess recovery actions and track the species' progress towards recovery.

The 2011 CDFW "*Fish Bulletin 180 California Coastal Salmonid Monitoring Plan*" (CMP) established the approach for monitoring ESA/CESA listed anadromous salmonid population(s) status and trend in California. In the CMP's Northern California area, annual adult salmonid population abundance (status) is monitored using extensive spawning ground surveys (SGS) to estimate total redd abundance within a survey area/sample frame. This report summarized the 2017-18 implementation of the extensive SGS in the coho salmon portion of the South Fork Eel River.

Historically, the South Fork Eel River was the most productive major tributary of the Eel River Basin for anadromous salmonids, supporting runs of coho salmon, Chinook salmon (*O. tshawytscha*), and steelhead/rainbow trout (*O. mykiss*). In 1947, a high of 25,289 returning adult coho salmon were counted at the Benbow Dam (Taylor, 1978). However, Pacific salmon runs in South Fork Eel River have markedly declined since the mid-twentieth century. In 1994, a status review of South Fork Eel River coho salmon estimated the returning population at approximately 1,320 adults (Brown et al. 1994).

South Fork Eel River coho salmon are considered a core population under the federal SONCC Coho Recovery Plan and as such constitute an important demographic for long-term SONCC coho salmon ESU monitoring needs (NMFS 2014). The South Fork Eel River Adult Salmonid Redd Abundance Monitoring Project was initiated by the Pacific States Marine Fisheries Commission (PSMFC), in partnership with CDFW, in 2010 as a long-term effort to provide estimates of adult coho salmon redd abundance in the South Fork Eel River Watershed. This report presents the results of the 2017-2018 spawning survey season, the eighth year of the project. Previous annual reports for spawning years 2010/11 through 2016/17 are available in the CDFW Document Library: https://nrm.dfg.ca.gov/documents/.

1.2 STUDY AREA

The South Fork Eel River flows through Humboldt and Mendocino counties and is a significant tributary within California's third largest watershed (see Figure 1). The South Fork Eel River's confluence with the Eel River is located approximately three miles north of Weott, CA and approximately 40 river miles upstream from the Eel River's confluence with the Pacific Ocean, near Loleta, CA. The South Fork Eel River Basin is the second largest sub-basin in the Eel River Watershed and covers approximately 690 square miles, 19% of the Eel River Basin. The South Fork Eel River is approximately 100 miles long and the basin contains a total of 683 miles of perennial blue line streams according to the USGS 7.5 Minute U.S. Geological Survey (USGS) Quadrangle maps (CDFW 2014). The predominant land uses throughout the basin are timber harvest, livestock grazing, and dispersed rural development. In 1998, the South Fork Eel River was listed as an impaired water body by the federal Environmental Protection Agency due to high levels of sedimentation and high water temperature (CDFW 2014).

Figure 1. Map of the South Fork Eel River Watershed and its location within the Eel River Watershed.

2 METHODS

2.1 SAMPLE FRAME

A sample frame of potential survey reaches was created for South Fork Eel River using five parameters: (1) documented salmonid distributions, (2) stream gradient and stream size where salmonid distributions are unknown, (3) fish passage barrier data, (4) expert knowledge of salmonid distribution and migration barriers, and (5) field reconnaissance (Garwood and Ricker 2011). This data was compiled within a Geographic Information System (GIS) to develop species-specific (coho, Chinook and steelhead) spawning distributions (sample frames).

This South Fork Eel extensive SGS is conducted upon a coho-specific sample frame of 198 sample/survey reaches (Figures 2-4). Each sample reach is one to three kilometers long with start and end points located at tributary mouths, and upstream extents delineated at known barriers to anadromy or at locations where diminishing upstream channel width, gradient or watershed area precludes coho spawning. All reaches were assigned numeric identification, known as the location code. Beginning with the lower most reach, ordering progressed upstream to the top of the main-stem. The next reach in the ordering sequence was the lower most tributary to the main-stem. Ordering progressed up this tributary until its end, continuing to the lower most tributary of the tributary and so on. This sequence of ordering continued through the dendritic pattern of the watershed. Short reaches, less than one kilometer long (sub-reaches) are surveyed together with the main reach that they flow into, and all data collected in sub-reaches are combined with that of their associated main reach (Garwood and Ricker 2011).

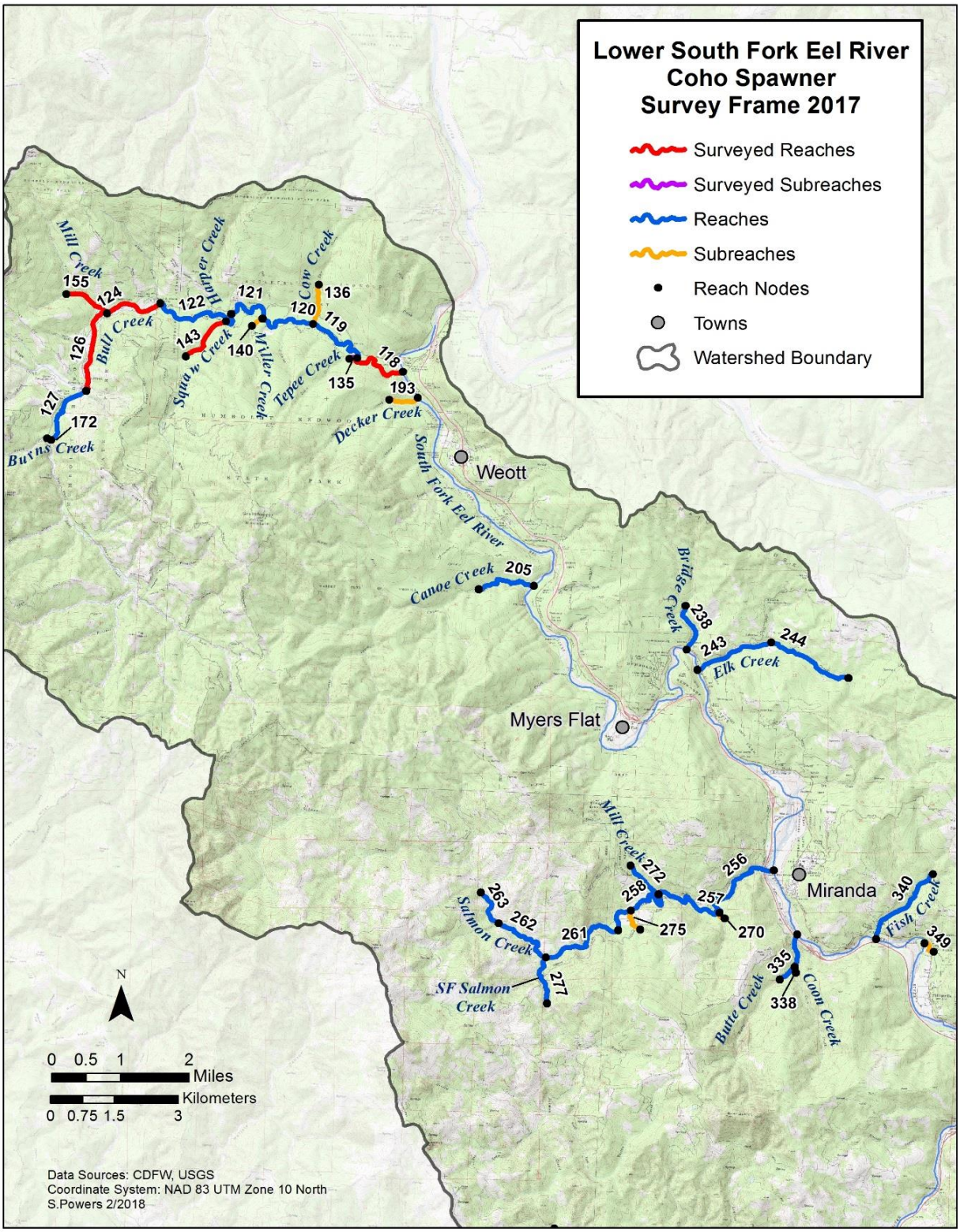

Figure 2. Map of the lower South Fork Eel River coho-specific spawner survey frame. Reaches surveyed during the 2017-2018 spawner survey season are red; associated subreaches are purple. Unsurveyed sample frame reaches are blue; associated sub-reaches are yellow. Each reach is labelled with its numeric location code.

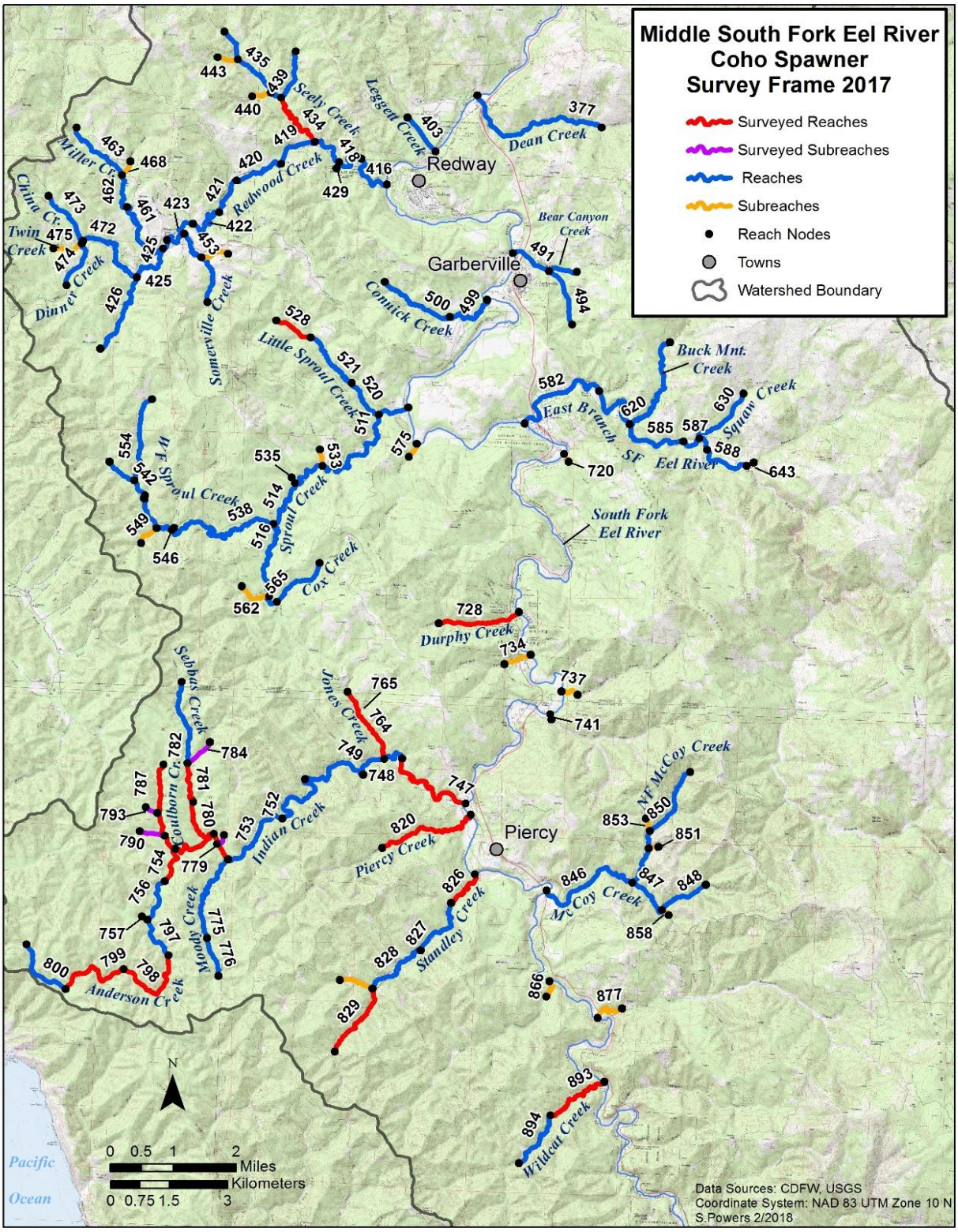

Figure 3. Map of the middle South Fork Eel River coho-specific spawner survey frame. Reaches surveyed during the 2017-2018 spawner survey season are red; associated subreaches are purple. Unsurveyed sample frame reaches are blue; associated sub-reaches are yellow. Each reach is labelled with its numeric location code.

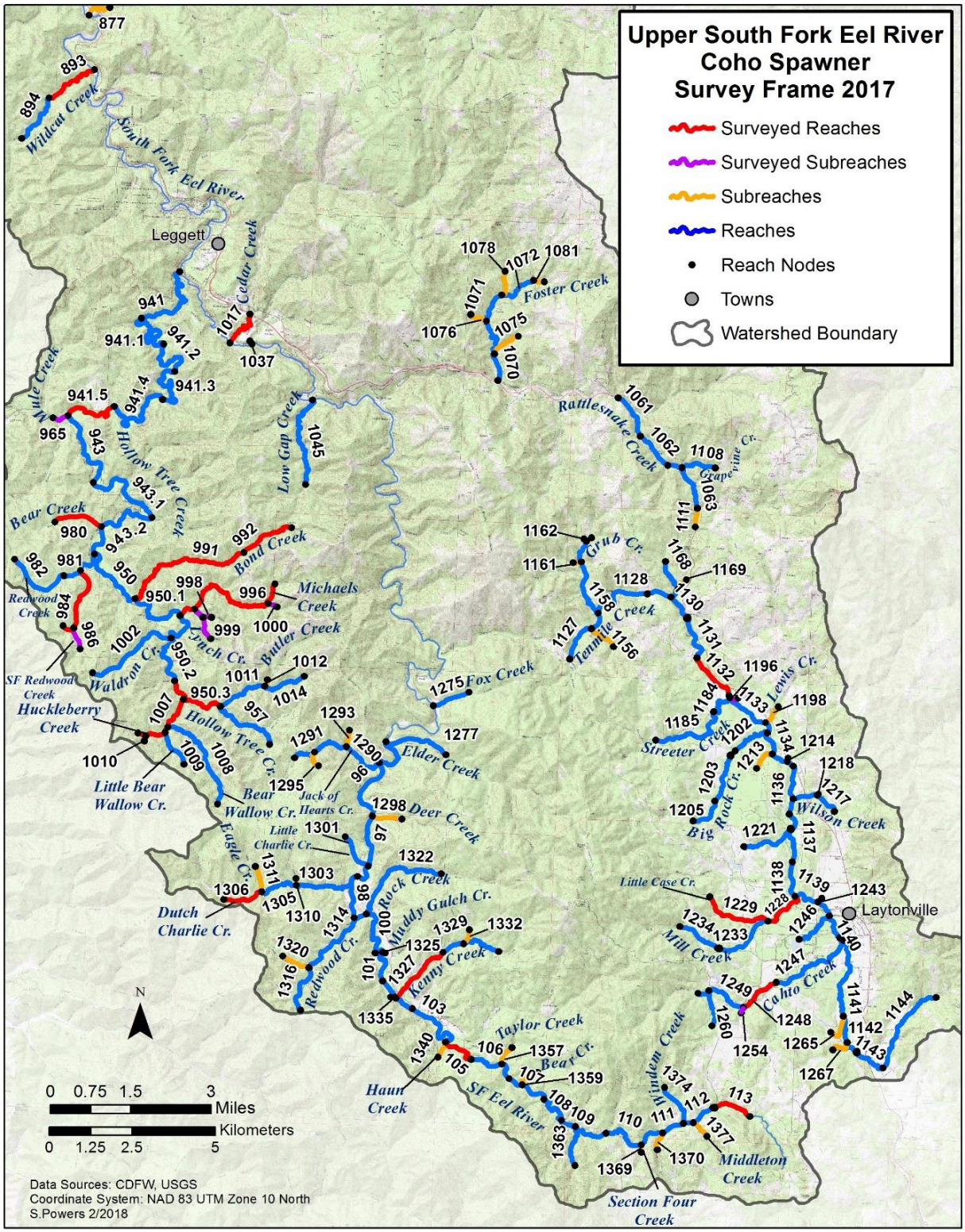

Figure 4. Map of the upper South Fork Eel River coho-specific spawner survey frame. Reaches surveyed during the 2017-2018 spawner survey season are red; associated subreaches are purple. Unsurveyed sample frame reaches are blue; associated sub-reaches are yellow. Each reach is labelled with its numeric location code.

2.2 SAMPLE REACH SELECTION

A Generalized Random Tessellation Stratified (GRTS) sample routine (McDonald 2003) was used to select a randomized and spatially balanced sample. The entire sample frame was used in the draw, and the resulting sample order (GRTS Order) was assigned to a 3 panel design where panel 1 reaches are sampled every year, panel 2 visited every three years and the remainder reaches surveyed every 12 years (Figure 5). On an annual basis, and during the 2017/18 survey, spawning ground surveys are conducted upon 37 of the 198 total sample frame reaches. This scheme resulted in 180 reaches of the total 198 sample frame reaches are included in the rotating panel. The remaining 18 reaches are maintained as a set of reserve reaches that can be substituted in the annual sample when the panel defined reach cannot be surveyed due to a lack of landowner access permission, road closures, or other issues. The rotating panel was developed and incorporated to the S.F. Eel River Monitoring Project in 2017.

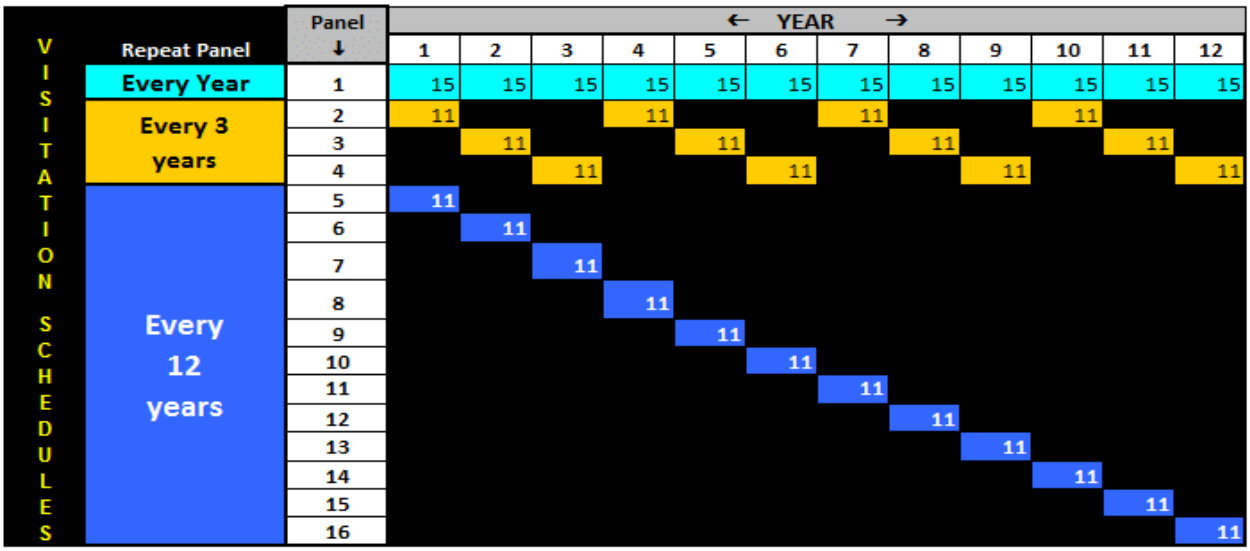

Figure 5. South Fork Eel River Monitoring Project Sample Reach Rotating Panel

Table 1. List of Reaches in Panel 1 to be visited annually.

Stream Name	Drainage	Location Code
South Fork Eel River	Eel River	113
Bull Creek	South Fork Eel River (lower)	126
Dean Creek	South Fork Eel River(middle)	377
Sproul Creek	South Fork Eel River (middle)	511
Sproul Creek	South Fork Eel River (middle)	514
East Branch South Fork Eel River	South Fork Eel River (middle)	582
Anderson Creek	Indian Creek	798
Hollow Tree Creek	South Fork Eel River (upper)	950.3
Foster Creek	Rattlesnake Creek	1070
Tenmile Creek	South Fork Eel River	1144
Tributary to Tenmile Creek	Tenmile Creek	1168
Big Rock Creek	Tenmile Creek	1202
Little Case Creek	Tenmile Creek	1228
Tributary to Cahto Creek	Tenmile Creek	1260
Dutch Charlie Creek	South Fork Eel River	1306

2.3 REACH SURVEY PROTOCOL

Spawning ground surveys were conducted following the methods outlined in Gallagher (et al. 2014). The surveys were conducted during the coho and Chinook salmon spawning season (roughly mid-November to late February/early March during an average rainfall year) by a two-person team, either by foot in smaller streams, or by inflatable kayak in larger streams. Each reach is intended to be surveyed once every 7 to 14 days, or as weather, flow, and turbidity conditions allow.

Live fish and carcasses were identified to species and sex if possible and X-Y coordinates were acquired with a handheld Global Positioning System (GPS) unit. Carcasses were assigned a condition code ranging from 1 to 5 based on freshness, measured to fork length if possible, and marked as "captured" with a uniquely numbered jaw tag. If a carcass was recovered with a jaw tag on a subsequent survey it was considered "re-captured".

Redds were attributed a species if an identifiable fish was observed actively digging or guarding the redd. If no fish was observed on the redd, its species was left as unidentified. The location of all newly observed redds was geo-referenced by acquiring X-Y coordinates with a GPS unit and marked with flagging labelled with that redd's unique record number. All new redds encountered were assigned an age of (1) new since last survey. On subsequent surveys, encountered flags were matched with their associated redds, which were then re-assigned a new age of (2) still visible and measurable, (3) visible, but not measurable, (4) not visible, or (5) unknown due to poor visibility. If a new redd was unattended or an old redd was not previously measured, physical measurements were taken, including length and width of pot and tail spill, substrate size of pot and tail spill, and depth of the pot relative to the surrounding substrate.

2.4 ESTIMATION OF TOTAL REDD ABUNDANCE WITHIN SURVEY FRAME

2.4.1 ASSIGNING SPECIES TO REDDS

Only redds directly associated with a live fish building or guarding them were considered unambiguously known to species. In order to assign a species to the redds labelled in the field as "unidentified species," a k-Nearest Neighbor (kNN) model was used to predict which species (coho, Chinook, or steelhead) was most likely to have constructed the redd (Ricker et al. 2013). Both known species redds and live fish observations were used as known elements in the training set of data in the kNN model. The standardized z-scores of X and Y coordinates, and julian date of observation were used as feature attributes and each redd was classified by the majority vote of the three nearest neighbors (known redds and live fish) in Euclidean distance. Leave-one-out-cross-validation (LOOCV) of the known redds in the survey was then used to evaluate the performance of the kNN model. All calculations were performed using the program R with the "class" package (Venables and Ripley 2002) and the "caret" package (Kuhn 2013). Only known species fish and redds from the current survey year were chosen for use in the training data available to make predictions.

2.4.2 ESTIMATION OF WITHIN-REACH ABUNDANCE

High stream discharge and time between repeated surveys may scour or flatten redds and therefore obscure them from potential counting (Jones, 2012). To account for the unseen fraction of redds deposited then subsequently obscured from view between repeated surveys, the total number of redds constructed within a survey reach was estimated using a flag-based mark-recapture model (Ricker et al. 2014). The total count of individually observed and flagged redds for a given reach is divided by the square root of the seasonally pooled redd survival rate. Redd survival is calculated as the fraction of re-observed and still identifiable flagged redds ("recaptures" assigned age 2 or 3) to the total number of flagged redds available to for potential re-observation ("marked"). Taking the square root of this fraction assumes the deposition of redds occurs at the midpoint between survey intervals (see below) (Schwarz et al. 1993). Bootstrap resampling from an assumed binomial distribution was used to represent the uncertainty of the pooled seasonal redd survival term in the estimator of total number of redds within the reach. The variance of the estimated total number of redds within a reach is calculated as the variance of the resultant bootstrap distribution (Manly 1997, Ricker et al. 2014). Additional assumptions applied to this model are:

1. Surveyors correctly identify all redds and no redds are missed during each survey.
2. Once a redd has been classified as "not visible" it does not become visible at a later occasion.
3. All redd flags are re-observed, identifiable, and recorded.
4. All marked redds have the same probability of survival, regardless of species or age and across all occasions.
5. New redds are constructed at the mid-point between survey intervals

2.4.3 ESTIMATION OF TOTAL REDD ABUNDANCE

A Simple Random Sample estimator is used to expand the number of redds in the sample reaches to an estimated total over the entire sample frame. The estimated total is calculated as the product of the total number of reaches in the sample frame and the mean number of redds of the sample reaches. The total variance is the sum of the within reach variance of the sample reaches and the between sample reach variance (Adams et al. 2011).

Table 2. Survey frequency by reach. Reaches are listed by stream name and location code (location codes listed in parentheses are subreaches). Mean indicates the average number of days between surveys; Max is the maximum number of days between surveys; and N is the total number of surveys. Totals represents the averages for each category. Subreaches with a different number of surveys and mean days between surveys from the main reach are indicated with parentheses.

Location Code	Stream Name	Mean (Days)	Max (Days)	N (Surveys)
105	South Fork Eel River	7.7	21	10
113	South Fork Eel River	16.3	15	7
118(135)	Bull Creek	12.3	33	9
124	Bull Creek	9.0	27	8
126	Bull Creek	13.8	27	7
143	Squaw Creek	15.9	29	9
155	Mill Creek	18.2	34	6
434	Seely Creek	16.8	38	7
528	Tributary to Little Sproul Creek	16.7	25	5
728	Durphy Creek	13.1	22	8
747	Indian Creek	12.7	28	8
754(779)	Indian Creek	20.0	36	5
764	Jones Creek	16.8	27	7
780	Sebbas Creek	15.6	16	6
781(784)	Sebbas Creek	19.5	35	5
787(790,793)	Coulborn Creek	21.0	29	5
798	Anderson Creek	14.2	27	6
799	Anderson Creek	25.0	36	3
820	Piercy Creek	18.8	28	6
826	Standley Creek	30.0	56	4
829	Standley Creek	17.0	21	5
893	Wildcat Creek	21.5	44	5
941.5(965)	Hollow Tree Creek	14.0	35	8
950.3	Hollow Tree Creek	13.0	35	8
980	Bear Creek	22.8	41	5
984(986)	South Fork Redwood Creek	23.0	22	5
991	Bond Creek	24.7	43	5
992	Bond Creek	24.7	43	5
996(998,999,1000)	Michaels Creek	23.0	36	5
1007(1010)	Huckleberry Creek	15.1	20	7
1017	Cedar Creek	12.1	22	8
1132(1196)	Tenmile Creek	11.0	14	10
1228	Little Case Creek	9.3	36	10
1229	Little Case Creek	12.4	36	9
1248(1254)	Cahto Creek	13.6	13	8
1306	Dutch Charlie Creek	14.0	22	8
1327	Kenny Creek	16.2	26	7
	All Reaches	16.8	30.2	6.7

3 RESULTS

3.1 SAMPLE FRAME CHANGES AND STATUS

Field reconnaissance of the South Fork Eel River sampling frame is now considered complete with appropriate updates transferred to the state-wide CMP Geo database in Sacramento and the luLocation table of the CMP Aquatic Survey's Survey Management Switchboard. Sample frame updates included changes to reach lengths, start/stop locations, and total number of reaches. Reach additions resulted from the splitting of reaches on Hollow Tree Creek (Location Codes 943, 950) into multiple shorter reaches that better fit field protocols and reach length criteria for the CMP. Primary main reaches in the South Fork Eel River headwaters region above Dutch Charlie Creek were removed from the sample frame for the 2011-12 survey season then added back in for the 2012 and future years after physical access for survey crews was deemed available and reasonable using boating survey methods. The lower most reach in Rattlesnake Creek above the canyon (Location Code 1060) was removed in 2011 due to inaccessibility and surveyor safety concerns. There were additional instances of shortening reaches at the terminus at the upstream extents of distribution. Smaller sub-reaches were added and or subtracted, but the manipulation of sub-reaches did not change the total number of main reaches in the sample frame. In 2015, the South Fork Eel coho salmon sampling frame was considered finalized and remains generally static for the continuation of the project into future years. Potential of barrier removal is one factor that might result in subtle changes to various reaches in the future. For example, a 2017 culvert replacement project on lower Cedar Creek and subsequent fish observations above the modified culvert will result in an official extension of reach 1017 on Cedar Creek. The current finalized coho salmon sample frame consists of 198 main survey reaches (Figures 2, 3, and 4). This finalization has resulted in the implementation of a fixed, rotating panel design. The various panels out of the sample frame were created prior to the beginning of the season.

3.2 SURVEY STATISTICS

Survey crews conducted a total of 249 spawning ground surveys upon the 37 designated reaches between November 6th, 2017 and February 15th, 2018. Each reach was visited between 3 and 10 times over the survey season. The average number of visits per reach was 6.7. The average interval between surveys over all reaches was 16.8 days (Table 2). Figure 6 presents the discharge measured at the South Fork Eel River USGS gauging station near Miranda, CA relative to the number of surveys completed per day over the survey season.

3.3 FISH OBSERVATIONS

A total of 144 coho salmon, 114 Chinook salmon, 8 steelhead trout and 15 unidentified fish were observed over the survey period. Eleven coho salmon carcasses, 30 Chinook salmon carcasses and one unidentified carcass were counted. Peak coho observations occurred from the week ending on January 13th to the week ending on January 20th. Peak Chinook observations occurred

from the week ending on December 1st to the week ending on December 9th (Figure 7). Table 3 summarizes live fish observations by location code. Table 4 summarizes observations of live fish and carcasses by survey week.

3.4 REDD OBSERVATIONS

Surveyors identified 31 known coho salmon redds, 17 known Chinook redds, and one known steelhead redd (Tables 3 and 4, Figures 7-9). Cross validation of the 49 known redds resulted in the kNN model correctly assigning all known redds to the respective species. Three hundred and eight redds were not field identified to species and kNN predictions of species likely to have constructed them were made.

3.5 TOTAL REDD ABUNDANCE

Sufficient flag marking and re-observation data was available to apply the within-reach estimation model in ten sample reaches where known or predicted coho salmon redds were observed. Aggregate counts of individual known and predicted redds by species were used in the remaining 27 reaches where no reach level expansion due to small sample sizes was available. The total redd abundance estimate for coho salmon for the 2017-2018 South Fork Eel River spawning season, with 95% confidence intervals, is 1,633 (793, 2,473). The total redd abundance estimates for Chinook salmon and steelhead trout are 867 (454, 1,279)* and 5 (1, 15)*, respectively (Table 5).

* The South Fork Eel River Adult Salmonid Redd Abundance Monitoring Project does not survey the entire spatial extent of potential Chinook and Steelhead spawning areas and does not survey the entire time period of potential steelhead spawning in the S.F. Eel River. The project's sample frame of potential reaches and annual survey start and end dates are specifically designed to cover the spatial and temporal extent of S.F. Eel River Coho spawning. Chinook and steelhead redd abundance estimates provided in this report are not derived from a survey design intended to estimate the total S.F. Eel redd abundance for these species.

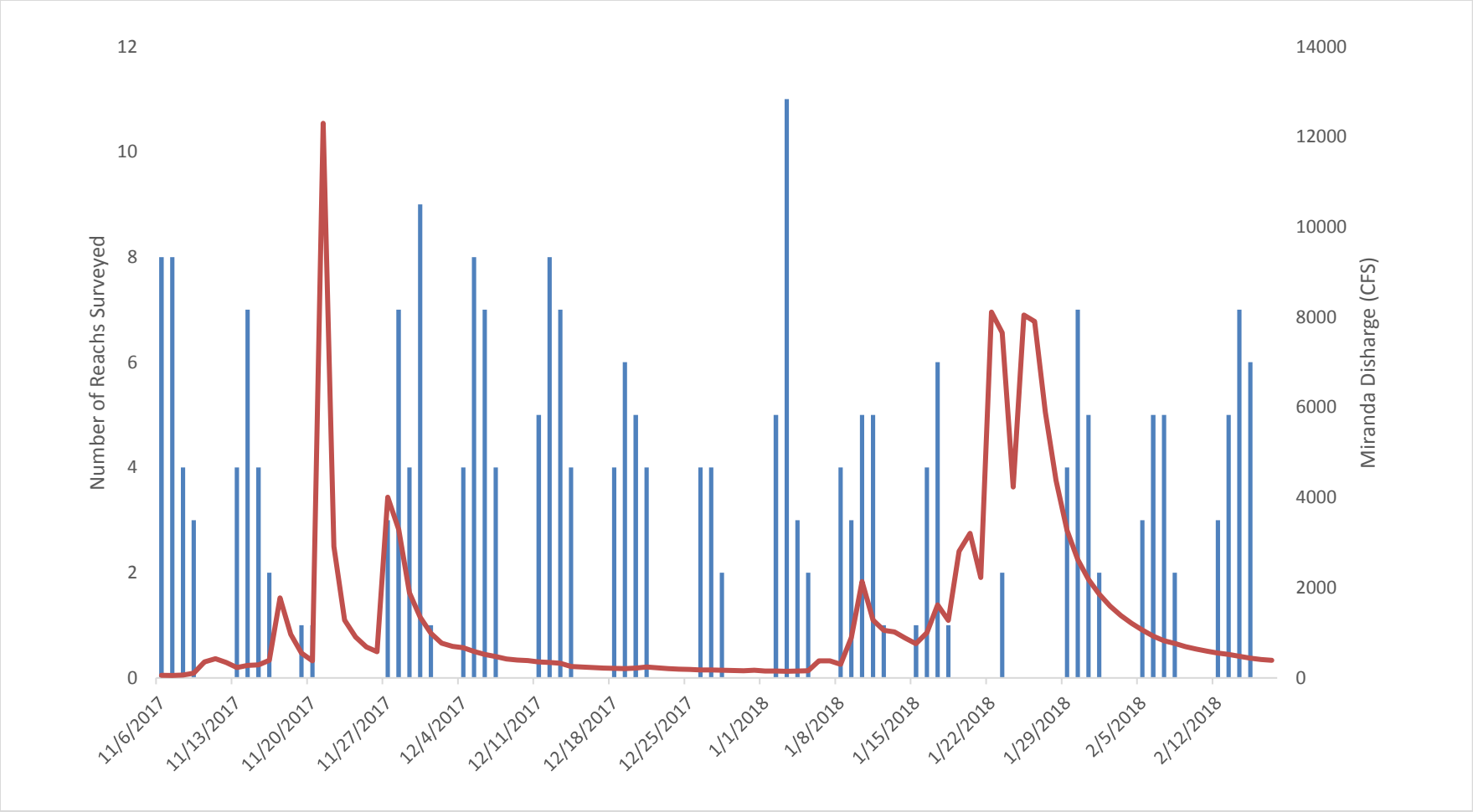

Figure 6. Discharge of the South Fork Eel River near Miranda compared to number of surveys conducted each day over the survey period, November 6, 2017 to February 15, 2018. Discharge (in cubic feet per second, cfs) as recorded at midnight on each day is presented on the primary y-axis (red line); the number of reaches surveyed per day is presented on the secondary y-axis (blue lines).

Table 3. Counts of observed live fish and redds by location code.

Location Code	Live Chinook	Known Chinook Redds	Live Coho	Known Coho Redds	Live Steelhead	Known Steelhead Redds	Live Unidentified	Unidentified Redds
105 S.F Eel River	0	0	6	2	0	0	0	1
113 S.F Eel River	2	1	0	0	0	0	0	3
118 Bull Creek	0	0	0	0	0	0	0	2
135 Subreach to 118	0	0	0	0	0	0	0	0
124 Bull Creek	1	0	0	0	0	0	0	0
126 Bull Creek	4	0	0	0	0	0	0	16
143 Squaw Creek	0	0	3	0	1	0	1	0
155 Mill Creek	0	0	0	0	0	0	0	0
434 Seely Creek	0	0	1	0	0	0	0	1
528 Trib to Little Sproul	0	0	0	0	2	1	0	1
728 Durphy Creek	0	0	0	0	0	0	0	0
747 Indian Creek	17	3	0	0	0	0	0	18
754 Indian Creek	11	3	0	0	0	0	0	26
779 Subreach to 754	0	0	0	0	0	0	0	0
764 Jones Creek	0	0	0	0	0	0	0	0
780 Sebbas Creek	0	0	1	0	0	0	0	2
781 Sebbas Creek	0	0	20	4	0	0	0	17
784 Subreach to 781	0	0	0	0	0	0	0	0
787 Coulborn Creek	0	0	14	2	0	0	7	6
790 Subreach to 787	0	0	3	2	0	0	0	3
793 Subreach to 787	0	0	0	0	0	0	0	0
798 Anderson Creek	6	0	19	7	0	0	1	33
799 Anderson Creek	0	0	2	1	0	0	0	3
820 Piercy Creek	0	0	4	0	0	0	0	0
826 Standley Creek	0	0	0	0	0	0	0	2
829 Standley Creek	0	0	0	0	0	0	0	0
893 Wildcat Creek	0	0	0	0	0	0	0	2
941.5 Hollow Tree Creek	7	0	6	0	0	0	0	27
965 Subreach to 941.5	0	0	0	0	0	0	0	3
950.3 Hollow Tree Creek	1	0	12	1	1	0	1	23
980 Bear Creek	0	0	0	0	0	0	0	0
984 S.F Redwood Creek	0	0	0	0	0	0	0	5
986 Subreach to 984	0	0	0	0	0	0	0	0
991 Bond Creek	0	0	1	1	0	0	0	12
992 Bond Cr eek	0	0	0	0	0	0	0	0
996 Michaels Creek	2	0	2	0	0	0	0	21
998 Subreach to 996	0	0	0	0	0	0	0	0
999 Subreach to 998	0	0	0	0	0	0	0	0
1000 Subreach to 996	0	0	0	0	0	0	0	0
1007 Huckleberry Creek	0	0	21	3	2	0	0	9
1010 Subreach to 1007	0	0	0	0	0	0	0	0
1017 Cedar Creek	32	5	0	0	1	0	1	17
1132 Tenmile Creek	22	5	0	0	0	0	1	10
1196 Subreach to 1132	0	0	0	0	0	0	0	0
1228 Little Case Creek	9	1	2	0	0	0	0	9
1229 Little Case Creek	0	0	0	0	0	0	0	0
1248 Cahto Creek	0	0	0	0	0	0	0	6
1254 Subreach to 1248	0	0	0	0	0	0	0	1
1306 Dutch Charlie Creek	0	0	25	8	1	0	2	23
1327 Kenny Creek	0	0	2	0	0	0	1	5
Total:	114	17	144	31	8	0	15	307

Table 4. Counts of observed live fish, carcasses and redds by week over the survey season, November 6, 2017 to February 15, 2018.

Last Day of Week	Live Chinook	Live Coho	Live Steelhead	Live Unidentified	Chinook carcasses	Coho carcasses	Steelhead carcasses	Unidentified carcasses	Known Chinook Redds	Known coho Redds	Known Steelhead Redds	Unidentified Redds
11-Nov	0	0	0	0	0	0	0	0	0	0	0	0
18-Nov	0	0	0	0	0	0	0	0	0	0	0	0
25-Nov	1	0	0	0	0	0	0	0	0	0	0	3
2-Dec	57	0	0	0	0	0	0	0	9	0	0	26
9-Dec	26	0	0	0	11	0	0	0	6	0	0	20
16-Dec	13	0	0	0	10	0	0	0	2	0	0	46
23-Dec	6	0	0	1	3	0	0	0	0	0	0	12
30-Dec	3	0	0	0	1	0	0	0	0	0	0	4
6-Jan	3	0	0	1	0	0	0	1	0	0	0	18
13-Jan	2	81	3	10	1	1	0	0	0	18	0	51
20-Jan	3	29	0	2	1	0	0	0	0	8	0	56
27-Jan	0	0	2	0	0	0	0	0	0	0	1	1
3-Feb	0	31	2	1	2	8	0	0	0	5	0	25
10-Feb	0	2	1	0	1	1	0	0	0	0	0	22
17-Feb	0	1	0	0	0	1	0	0	0	0	0	23
Total:	114	144	8	15	30	11	0	1	17	31	1	307

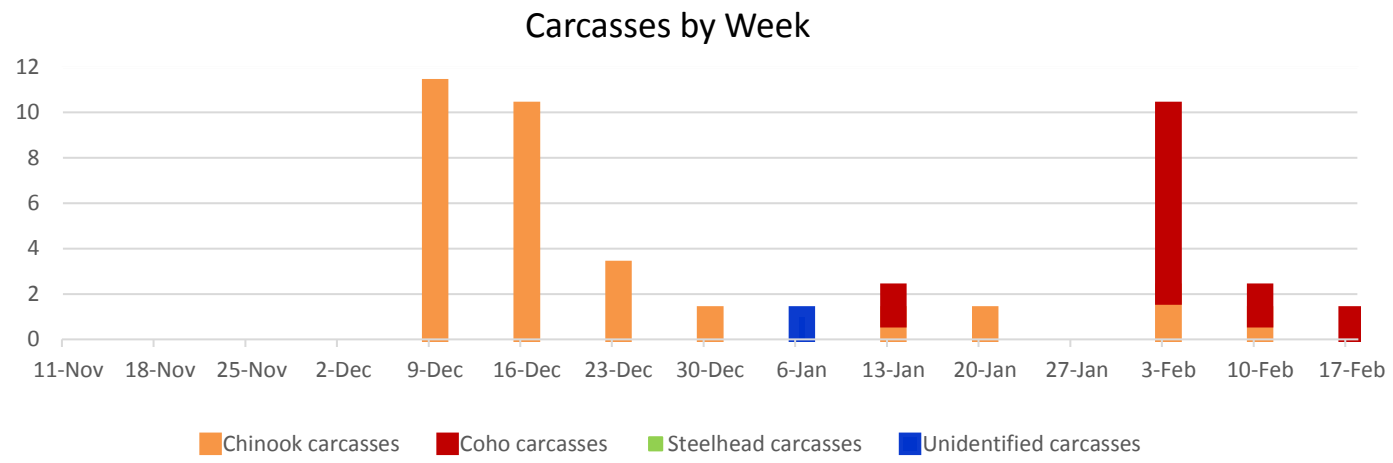

Figure 7. Stacked barplot of observed carcasses by week over the survey season, November 6, 2017 to February 17, 2018

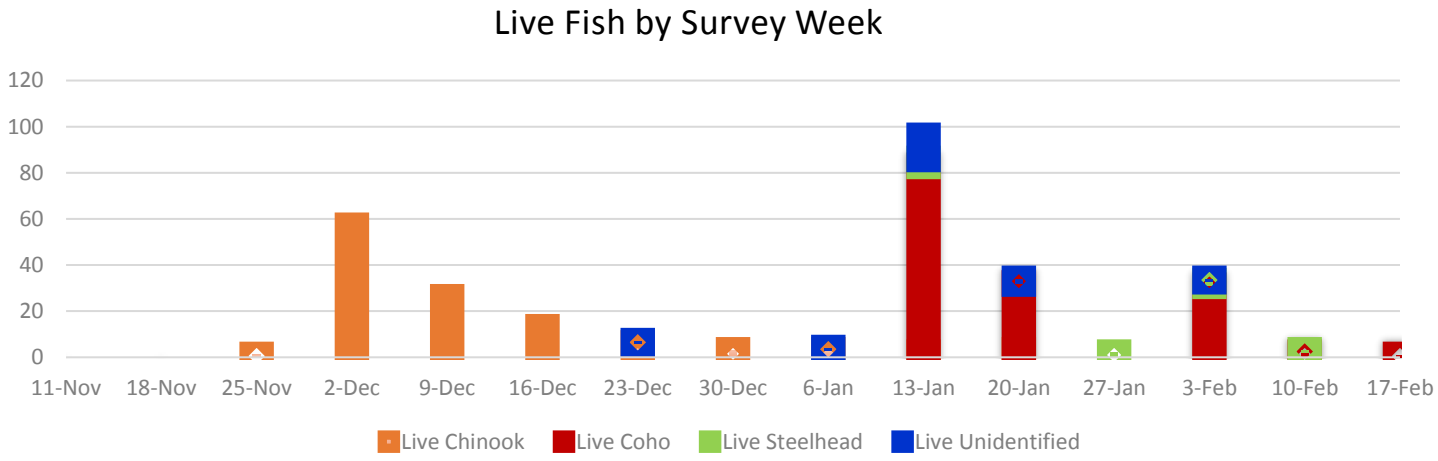

Figure 8. Stacked barplot of observed live fish by week over the survey season, November 6, 2017 to February 17, 2018

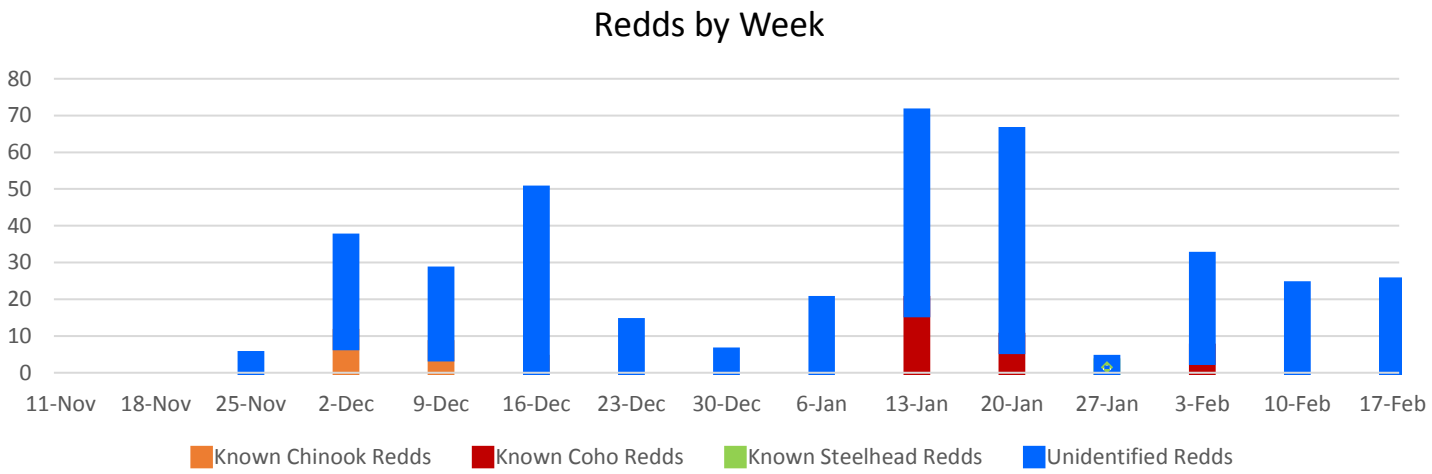

Figure 9. Stacked barplot of observed redds by week over the survey season, November 6, 2017 to February 17, 2018

Table 5. Estimated total redd abundance by species with 95% confidence intervals

	Chinook*	Coho	Steelhead*
Estimated number of redds	867	1,633	5
95% Confidence Intervals	454, 1,279	793, 2,473	1, 15

* The South Fork Eel River Adult Salmonid Redd Abundance Monitoring Project does not survey the entire spatial extent of potential Chinook and steelhead spawning areas and does not survey the entire time period of potential steelhead spawning in the S.F. Eel River. The project's sample frame of potential reaches and annual survey start and end dates are specifically designed to cover the spatial and temporal extent of S.F. Eel River coho spawning. Chinook and steelhead redd abundance estimates provided in this report are not derived from a survey design intended to estimate the total S.F. Eel redd abundance for these species.

4 DISCUSSION

The South Fork Eel River Adult Redd Salmonid Abundance Monitoring Project was initiated in 2010 as a long-term effort to provide estimates of adult coho salmon redd abundance in the South Fork Eel River Watershed over time. As the primary focus of this project is coho salmon, spawning ground surveys are conducted over the spatial extent and time period deemed ideal for coho data capture. Estimates of total redd construction for Chinook salmon and steelhead presented herein are likely underestimates because the spatial extent of Chinook salmon and steelhead spawning habitats are greater than the spatial extent of the coho salmon sampling frame, and because the duration of the steelhead spawning run extends beyond the coho spawning run. The estimates of total redd abundance for Chinook salmon and steelhead presented in this report are representative only of those occurring within the coho-specific sampling frame and within the observation period, November 6th, 2017 to February 15th, 2018.

The South Fork Eel River is a large and complex system. As such, survey intervals and the number of visits per reach are more influenced by the unique discharge and turbidity characteristics of the individual reaches than by conditions basin wide. For example, Hollow Tree Creek and Indian Creek have low turbidity rates during storm events and tend to present a trend of dynamic behavior with the quick rise and fall of stream flows, making it easier to conduct surveys within three to five days after a significant rain event. Bull Creek is a very high turbidity stream and can take weeks before conditions are clear enough to survey. Consequently, some reaches within the sample frame will be more heavily sampled during a season.

4.1 CHINOOK OBSERVATIONS

The 2017-2018 spawning ground survey season began the week of November 6th, 2017. No observations occurred during the first two weeks of the survey season most likely due to the lack

of significant precipitation which would have limited upstream access to the SF Eel River. The first significant rain event of the season in the Eel River Watershed occurred mid-November. This event allowed Chinook salmon to distribute throughout the South Fork Eel River Watershed. The USGS streamflow gauge located on the South Fork Eel River at Miranda, registered a peak flow of 10,000 cubic feet per second (CFS) on November 21, 2017. Crews were able to complete surveys throughout the month of November despite the increase in flows. The first observations of adult spawning Chinook salmon and their redds occurred November 19 in Indian Creek and Cedar Creek. The peak observations of live Chinook occurred November 27 to November 30 with 57 fish counted. This suggests a response to a coinciding rain event that week. Peak redd counts occurred the following two weeks as flows receded.

In the 2017-2018 season, an additional section of Cedar Creek was added to the sample frame upstream of the U.S. Highway 101 stream crossing in response to a California Department of Transportation (Caltrans) passage remediation project at the crossing. In 2017 Caltrans implemented a fish passage improvement project at the outlet of the crossing under Highway 101 in order to improve passage for all life stages of salmonids and lamprey. Twelve of the first 14 Chinook salmon observed in Cedar Creek were located upstream of the Highway 101 crossing.

4.2 COHO OBSERVATIONS

The first live observations of coho of the season occurred during the week ending January 13, 2018 following the second substantial flow event of the season on January 10. Peak observations of coho salmon occurred this week as well, with peak redd observations occurring the following week. This flow event registered 2,138 cfs on the Miranda Gauge located on the South Fork Eel River. Coho were recorded on 17 of the 37 main reaches and one sub-reach. The majority of live coho salmon observations occurred in Dutch Charlie Creek, the Hollow Tree Creek drainage (Hollow Tree Creek and Huckleberry Creek), and the Indian Creek drainage (Coulborn Creek, Anderson Creek and Sebbas Creek).

CDFW, National Oceanic and Atmospheric Administration (NOAA), and numerous stakeholders are currently conducting a salmonid habitat restoration planning effort, referred to as Salmon Habitat Restoration Priorities (SHaRP), in the South Fork Eel River (Weeder, J and Renger, A 2018). SHaRP data analysis identified seven South Fork Eel River sub-basins as priority locations to develop detailed site specific restoration plans, and prior years spawning data from the South Fork Eel River Adult Salmonid Redd Abundance Monitoring Project was used to identify sub-basins of significant biological importance to coho, chinook, and steelhead. The spawning biological importance of Hollow Tree Creek, Indian Creek, and Elder Creek sub-basins was further confirmed by high spawning densities identified during the 2017/18 spawner survey.

Survey coverage throughout the coho salmon run was very high because of favorable conditions that included low turbidity and moderate flows. These favorable survey conditions aligned with a high amount of spawning activity resulting in extensive live fish observations. The average

number of reaches surveyed and total number of surveys completed were the highest of all eight survey seasons. The return survey interval was the lowest of all years (see tables 2 & 6). The total of 144 live coho salmon observed is second to only the 2011-2012 survey season. The number of redds confirmed to be linked to coho was the third highest of all survey seasons.

Table 6. Summary of the prior seven years of South Fork Eel River Coho Population Monitoring Project redd estimates and 95% confidence intervals. *The estimated number of salmonids redds for survey years 2010-2011 through 2014-2015 were adjusted in the 2015-2016 annual report following new data analysis techniques. The estimates presented in this table are the most current and should be used for future analysis.

Survey Year	Number of reaches surveyed	Total Number of Surveys	Average Survey Interval	Average number of surveys per reach	Estimated number of coho redds	Estimated number of Chinook redds*	Estimated number of steelhead redds*
2010-2011	31	151	21	5	1284 (159, 2543)	1829 (679, 2980)	288 (35, 255)
2011-2012	40	204	22	5	1873 (1253, 2493)	68 (15, 148)	379 (58, 818)
2012-2013	40	229	16	6	1340 (658, 2022)	855 (293, 1418)	761 (471, 1051)
2013-2014	39	247	27	6	939 (304, 1574)	223 (40, 423)	1055 (359, 1751)
2014-2015	40	248	19	6	2069 (1342, 2795)	781 (310, 1253)	967 (541, 1393)
2015-2016	40	190	26	5	416 (117, 715)	418 (76, 892)	1125 (686, 1563)
2016-2017	40	227	20	6	465 (98, 831)	1458 (923, 1992)	54 (9, 111)
2017-2018	37	249	16.8	6.7	1,633 (793, 2,473)	867 (454, 1,279)	5 (1, 15)

* The South Fork Eel River Adult Salmonid Redd Abundance Monitoring Project does not survey the entire spatial extent of potential Chinook and Steelhead spawning areas and does not survey the entire time period of potential steelhead spawning in the S.F. Eel River. The project's sample frame of potential reaches and annual survey start and end dates are specifically designed to cover the spatial and temporal extent of S.F. Eel River Coho spawning. Chinook and steelhead redd abundance estimates provided in this report are not derived from a survey design intended to estimate the total S.F. Eel redd abundance for these species.

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