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## Summary of Abundance and Biological Data Collected During Juvenile Salmonid Monitoring on the Mainstem Klamath River Below Iron Gate Dam, California, 2014

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*Abstract.*— This report summarizes results from the 2014 season of juvenile salmonid outmigrant monitoring on the mainstem Klamath River below Iron Gate Dam. Trapping occurred at three locations: below the confluence with Bogus Creek (river km 308), where Interstate 5 crosses the Klamath River (river km 294), and near the Kinsmen Creek confluence upstream of the confluence with the Scott River (river km 238). Both frame nets and rotary screw traps were used to sample juvenile salmonids and other fishes. Traps were operated beginning in mid- to late February and continued through mid-May or early June. Juvenile salmonids were enumerated daily when traps were operating and subsamples of salmonids were measured for length and weight. Non-salmonid fishes were also enumerated. Mark-recapture studies were conducted periodically at each trap site throughout the season to estimate trap efficiency. The efficiency estimates were combined with the catch data to estimate weekly and seasonal outmigration abundance of natural-origin age-0 juvenile Chinook Salmon at each trap site using a Bayesian time-stratified spline population estimation method. For the periods that traps were operated, abundance estimates of natural-origin age-0 Chinook Salmon were approximately 2.5 million at the Bogus trap site, 2.9 million at the I-5 trap site, and 5.3 million at the Kinsman trap site.

## Introduction

The Klamath River Basin (Figure 1) historically supported large runs of Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*O. mykiss*) and smaller runs of Coho Salmon (*O. kisutch*) (U.S. Fish and Wildlife Service 1960, 1983, Klamath River Basin Fisheries Task Force 1991). These species contribute to economically and culturally important subsistence, sport, and commercial fisheries. A drastic decline of anadromous fishes during the past century and a half has occurred in the Klamath River Basin as a result of a variety of flow- and non-flow-related factors (West Coast Chinook Salmon Biological Review Team 1997; Hardy and Addley 2001). These factors include water storage and transfer, disease, changed genetic integrity from hatchery origin fish straying into natural spawning areas, overharvest, and land-use practices causing habitat loss and degradation.

The U.S. Fish and Wildlife Service (USFWS), in collaboration with the Karuk Tribe and the U.S. Geological Survey (USGS), began trapping juvenile salmonids on the Klamath River between Iron Gate Dam and the Scott River confluence in 2000 to collect outmigration timing data and relative weekly numbers for the calibration of a young-of-the-year (age-0) Chinook Salmon production model, SALMOD (Bartholow et al. 2002). Beginning in 2006, the objectives of this ongoing monitoring project were directed towards generating estimates of production (Gough et al. 2015) and disease monitoring (Nichols and True 2007; Nichols et al. 2008, 2009; True et al. 2010, 2011, 2013; Bolick et al. 2012, 2013). Additionally, these data are used to develop and calibrate a new salmon production model, Stream Salmonid Simulator ( $S^3$ ). Data from this project will also be useful for assessing the status and trends of salmonid populations in the Klamath River. Data collected by this project from 2000 through 2013 are summarized in Gough et al. (2015). This report summarizes data collected during the 2014 trapping season.

## Study Area

Monitoring was conducted at three sites on the mainstem Klamath River (Figure 1) between Iron Gate Dam [river kilometer (rkm) 309.65] and the Scott River confluence (rkm 232.95). The upstream-most site (rkm 307.75) was downstream of the Bogus Creek confluence on Blue Heron RV Park property (Bogus site). The middle site (rkm 293.55) was downstream of the Carson Creek confluence and upstream of where Interstate 5 crosses the Klamath River (I-5 site). The downstream-most site (rkm 237.55) was just upstream of the Kinsman Creek confluence (Kinsman site).

## Methods

### River Conditions

River discharge and water temperature were monitored throughout the outmigrant trapping season. The USGS gauging station below Iron Gate Dam (# 11516530) was used to represent discharge at the Bogus and I-5 trap sites as there are minimal accretions from tributaries between



the gauging station and these sites. Discharge at the Kinsman trap site was estimated by subtracting the discharge of the Scott River near Fort Jones (USGS gauging station 11511950) from the discharge of the Klamath River near Seiad Valley (USGS gauging station 11520500). We monitored water temperatures at each trap site using digital water temperature probes. For details on the probes used and specific protocols see Magnuson (2014).

### **Trap Design and Operation**

At least one of two types of sampling methods, rotary screw traps (RSTs) and frame nets (3 m by 1.5 m opening), were used at the trap sites. Frame nets were placed closer to the bank in shallower, slower moving water compared to RST placement, and more efficiently captured younger and smaller age-0 salmonids along stream margins earlier in the season (late winter to early spring). RSTs were set further from the bank in faster, deeper water and more efficiently captured older and larger age-0 and age-1 salmonids later in the season (late spring to early summer). Frame nets were placed near the bank at a location such that water velocity was ideally between 1.0 and 1.2 m/s at the center of the net and water depth was between 0.3 and 1.0 m. RSTs were placed further from the bank such that the cone would ideally spin between five and seven revolutions/min.

In 2014 one frame net was operated at the Bogus trap site, one frame net and two 2.4 m (8 ft) diameter RSTs were operated at the I-5 trap site, and one 1.5 m (5 ft) diameter RST was operated at the Kinsman trap site. All frame nets and RSTs were deployed in mid- to late February. A RST was not operated at the Bogus site because few larger, late-season juvenile Chinook Salmon pass by this location due to its proximity to Iron Gate Dam. A frame net was not operated at the Kinsman site because the RST situated at the entrance of a side channel efficiently caught fish entering the side channel. Also, most of the river at the Kinsman site was either too fast or too deep to effectively use a frame net. The Bogus frame net and I-5 RSTs were operated until mid-May, when Iron Gate Hatchery (IGH) began its annual release of age-0 Chinook Salmon. The Kinsman RST was operated until early June, and then for a single day in late June to collect hatchery-origin juvenile Chinook Salmon for disease sampling. Aquatic vegetation and other debris repeatedly flawed sets of the I-5 frame net, so this frame net was only operated during three weeks of the season.

All traps were typically operated four consecutive nights each week throughout the sampling period. Traps were set Monday afternoon and checked once per day Tuesday through Friday. The following information was recorded for each trap on each day: date, site, trap type, crew members, air and water temperatures, trap check time, trap reset time, trap depth, and center velocity. Rotation rates at the times of sets and checks of RSTs were also measured as a count of complete cone revolutions in a minimum of 180 seconds. Air temperature was taken in the shade close to the river's edge. Water temperature was taken at the surface in the shade and in moving water. Trap depth of RSTs is the submerged depth of the cone. Trap depth of frame nets is the water depth at the midpoint of the frame entrance. Center velocity is the water velocity at 60% of the trap depth. If a trap was relocated, RST rotations, depth, and velocity were re-measured.

All captured fish were identified and enumerated. A maximum daily biosample for each trap type at each trap site of 30 fish from each salmonid species and 10 fish from each non-salmonid species were measured and examined, including up to 10 lamprey ammocetes from each genus and 10 eyed lamprey from each species. The following data were recorded from all salmonids in the biosample: development stage (sac fry, fry, parr, or smolt), fork length (FL), weight, presence/absence of a hatchery mark, presence of any external abnormalities, and abdomen condition. Gill color (red, pale/pink, white, or tan) and condition (normal, eroded, or fungal) were recorded for salmonids  $\geq 45$  mm FL. Salmonid gills were later classified as healthy if they were red in color and were free of fungus and erosion. Gills were classified as unhealthy if they were pale/white/tan in color, fungal, or eroded. The following data were recorded for non-salmonids in the biosample: species, development stage [lampreys only (ammocete, eyed juvenile, or adult)], FL or total length (for species with pointed or round tails), and presence of any external abnormalities.

### **Chinook Salmon Production Estimates**

Weekly and season totals of natural-origin age-0 Chinook Salmon outmigrating past a trap site were estimated using a Bayesian time-stratified spline population estimation method (Bonner et al. 2009). This method requires the following weekly data: total age-0 Chinook Salmon with adipose fins, total adipose fin-clipped age-0 Chinook Salmon (and associated hatchery clip rate), trapping effort (sample fraction, described below) and mark-recapture numbers. The numbers of age-0 Chinook Salmon with and without adipose fins were summarized from the weekly trapping data and fin-clip rates were reported by IGH.

Trapping effort, here termed sample fraction ( $s$ ), was calculated for each trap site in each week of the trapping season by summing the number of days ( $d$ ) each  $i^{\text{th}}$  trap at a site was operated within a week and then dividing by the number of days in a week (seven) multiplied by the number of traps ( $t$ ) operated at the site within a week:

$$s = \frac{\sum_{i=1}^n (d_i)}{7t}$$

For example, at a site where two RSTs were each operated four days and one frame net was operated two days during a week, the sample fraction would be 0.476.

Mark-recapture trap efficiency tests for age-0 Chinook Salmon were conducted at the three trap sites throughout the trapping season. Hatchery-produced age-0 Chinook Salmon provided by IGH were used for this process. Test fish were marked with Bismarck Brown stain (Rawson 1984) and released approximately 0.5 to 0.8 km upstream of the trap site to be tested. At least three habitat units, including at least one riffle, were between the release site and the trap site to allow the fish enough time and space to distribute across the river channel similarly to a natural population passing the trap site. Two or three recapture days were available after the release of

marked fish. The number of marked fish released and the number of marked fish recaptured for each efficiency test were used as inputs to the population estimation method.

Mark-recapture efficiency tests could not be conducted for Coho Salmon or Steelhead due to the limited catch of these species, so production estimates were not generated. Catch and fork length data are presented to indicate the presence and size distribution of these species at the trap sites.

## Results and Discussion

### River Conditions

Discharge below Iron Gate Dam, pertinent to the Bogus and I-5 sites, was relatively stable during the trapping season, never exceeding 55 m<sup>3</sup>/s (Figure 2). An exception occurred in late May when discharge rose abruptly for a few days. Discharge at the Kinsman trap site was higher and more variable than at Iron Gate Dam (Figure 2). Peak discharge occurred in mid-March at the Kinsman trap site. Water temperature generally increased throughout the trapping season at all three trap sites (Figure 2), although there was day-to-day variation as well. In general, temperatures at the Kinsman site were more variable than temperatures at the Bogus and I-5 sites (Figure 2).

### Salmonid Abundance and Biological Data

#### *Chinook Salmon*

Four efficiency tests were conducted at the Bogus and Kinsman trap sites and three efficiency tests were conducted at the I-5 trap site in 2014 (Table 1). Release groups ranged in size from 3,549 to 5,181. Seasonal abundance estimates of natural-origin age-0 Chinook Salmon were 2.5 million at the Bogus trap site, 2.9 million at the I-5 trap site, and 5.3 million at the Kinsman trap site. Weekly estimates of natural-origin age-0 Chinook Salmon outmigrating past the three trap sites are presented in Figure 3 and Table 1. Peak age-0 Chinook Salmon outmigration occurred during calendar week 13 (late March) at the Bogus trap site, week 16 (mid-April) at the I-5 trap site, and week 12 (mid-March) at the Kinsman trap site (Figure 3, Table 1). Sampling appeared to encompass the majority of the outmigration period at the Bogus and I-5 sites, although the beginning of the outmigration period may have been missed at the Kinsman site (Figure 3).

Weekly raw catch information for juvenile Chinook Salmon is presented in Appendix A. A small number of natural-origin age-1 Chinook Salmon were observed at the three trap sites (Appendix A): one at the Bogus trap site, four at the I-5 trap site, and two at the Kinsman trap site. No known hatchery-origin juvenile Chinook Salmon were observed at the Bogus or I-5 trap sites due to the termination of sampling before the hatchery release, but a small number were observed at the Kinsman trap site during the final weeks of sampling.

No natural-origin age-0 Chinook Salmon exhibited distended abdomens (an indication of infection with the parasite *Ceratonova shasta*) at the Bogus and I-5 trap sites (Table 2). At the Kinsman trap site no fish with distended abdomens were observed through week 18 (late April),

but during weeks 19-21 between 10-20% of fish had distended abdomens. At the Bogus and I-5 trap sites a small number of examined Chinook Salmon had unhealthy gills, 2.7% and 1.3%, respectively (Table 2). At the Kinsman trap site 15.4% of examined fish had unhealthy gills. Most of the fish with unhealthy gills were observed during the final weeks of the trapping season. Abdomen and gill condition are useful real-time indicators of fish health and disease prevalence. However, infection can only be definitively determined through genetic analysis and histological examination of juvenile salmonids (e.g., True et al. 2013).

Natural-origin age-0 Chinook Salmon fork lengths were relatively stable throughout most of the trapping season at the Bogus and I-5 trap sites, then increased during the end of sampling (Figure 4, Figure 5, Figure 6, Appendix B, Appendix C, Appendix D). Age-0 Chinook Salmon fork lengths gradually increased throughout the trapping season at the Kinsman trap site (Figure 7, Appendix E). Length-weight data for Chinook Salmon are presented in Figure 8.

### *Coho Salmon*

Catches of natural-origin age-0 Coho Salmon commenced in mid-March at the Bogus and I-5 sites and late March at the Kinsman site and continued through the remainder of the trapping season (Appendix A). Peak age-0 Coho Salmon catches occurred during calendar week 15 (early April) at the Bogus site, week 16 (mid-April) at the I-5 site, and week 17 (late April) at the Kinsman site. Natural-origin age-1 Coho Salmon were observed in low numbers: 1 at the Bogus trap site, 7 at the I-5 trap site, and 49 at the Kinsman trap site (Appendix A). Iron Gate Hatchery releases yearling (age-1) Coho Salmon, 100% marked with a left maxillary clip, annually from mid-March to early April. In 2014, this release occurred on March 17 (calendar week 12). Hatchery-origin Coho Salmon were captured at each trap site, primarily at the Bogus and I-5 sites directly following the release, but over a longer period of time at the Kinsman site. All catch data for Coho Salmon should be interpreted cautiously as these numbers are raw catches not adjusted for effort or trap efficiency and do not encompass the entire outmigration period.

Natural-origin age-0 Coho Salmon fork lengths were stable or increased little throughout the trapping season until the final weeks of sampling when fork lengths increased (Figure 4, Figure 5, Figure 6, Figure 7, Appendix B, Appendix C, Appendix D, Appendix E). No consistent trends in fork lengths for age-1 natural-origin or hatchery-origin Coho Salmon were evident, potentially due to small sample sizes. Length-weight data for Coho Salmon are presented in Figure 8.

### *Steelhead*

Catches of natural-origin age-0 Steelhead commenced in mid-April at the Bogus and I-5 trap sites and in late April at the Kinsman trap site and continued through the remainder of the trapping season (Appendix A). Peak age-0 Steelhead catches occurred during calendar week 18 (late April) at the Bogus and Kinsman trap sites and during week 17 at the I-5 trap site. Natural-origin age-1+ Steelhead were caught throughout the trapping season in low numbers at the Bogus and I-5 trap sites, and in slightly higher numbers at the Kinsman trap site (Appendix A). There

were no obvious peak weeks in age-1+ Steelhead catches at any of the sites. All catch data for Steelhead should be interpreted cautiously as these numbers are raw catches not adjusted for effort or trap efficiency and do not encompass the entire outmigration period.

Age-0 Steelhead fork lengths increased little throughout the season (Figure 4, Figure 5, Figure 6, Figure 7, Appendix F, Appendix G, Appendix H, Appendix I). Low sample sizes preclude identifying any trend in fork lengths at the Bogus and I-5 sites for age-1+ natural-origin Steelhead. Fork lengths of age-1+ natural-origin Steelhead at Kinsman were variable but there was a noticeable increase after week 15. Length-weight data for Steelhead are presented in Figure 8.

### **Other Species**

While these sampling efforts were designed to target juvenile salmonids, a variety of fishes were captured in the frame nets and RSTs. Non-target fishes captured at the Bogus site were predominately non-native species including bullhead (*Ameiurus* spp.), crappie (*Pomoxis* spp.), Golden Shiner (*Notemigonus crysoleucas*), sunfish (*Lepomis* spp.), and Yellow Perch (*Perca flavescens*) (Table 3). The most common non-target fishes captured at the I-5 site included native species, lamprey (*Entosphenus* spp.), Marbled Sculpin (*Cottus klamathensis*), Speckled Dace (*Rhinichthys osculus*), and suckers (*Catostomus* spp.), and non-native species, bullhead (*Ameiurus* spp.), Golden Shiner (*N. crysoleucas*), and Yellow Perch (*P. flavescens*) (Table 3). The most-common non-target fishes captured at the Kinsman site included native species, lamprey (*Entosphenus* spp.), Speckled Dace (*R. osculus*), and suckers (*Catostomus* spp.), and non-native bullhead (*Ameiurus* spp.) (Table 3).

Table 1. Mainstem Klamath River weekly age-0 juvenile Chinook Salmon outmigrant abundance estimates and mark-recapture information, 2014. (table continued on following page)

Trap site	Week	Week starting	Raw catch	Marks released	Marks recovered	Sample fraction	Mean population estimate	SD of population estimate	0.025 bound	0.975 bound	
Bogus	8	2/17/2014	65	0	--	0.4286	10,102	6,056	4,014	24,555	
	9	2/24/2014	252	0	--	0.4286	42,709	17,480	20,474	86,631	
	10	3/4/2014	2,006	0	--	0.5714	161,948	52,417	80,849	283,398	
	11	3/10/2014	3,071	0	--	0.5714	284,469	84,832	152,254	484,682	
	12	3/17/2014	2,365	0	--	0.5714	324,700	107,122	163,984	574,538	
	13	3/24/2014	5,825	4,903	103	0.5714	487,556	45,859	403,968	586,170	
	14	3/31/2014	5,749	0	--	0.5714	475,208	126,745	281,046	783,534	
	15	4/7/2014	4,332	4,793	124	0.5714	305,220	26,544	257,470	361,887	
	16	4/14/2014	1,512	0	--	0.5714	198,784	59,724	105,787	335,027	
	17	4/21/2014	2,074	4,840	128	0.5714	140,908	12,131	119,011	166,656	
	18	4/28/2014	306	0	--	0.4286	49,910	15,504	25,886	84,064	
	19	5/5/2014	139	4,948	60	0.5714	17,701	2,436	13,487	22,983	
	20	5/12/2014	4	0	--	0.4286	1,222	869	350	3,492	
	Total						2,519,930	291,666	2,029,004	3,167,300	
	I-5	9	2/24/2014	27	0	--	0.1429	28,880	20,891	12,603	62,549
		10	3/4/2014	242	0	--	0.5714	61,304	26,487	30,988	115,343
		11	3/10/2014	308	0	--	0.2857	127,342	44,084	66,319	226,155
		12	3/17/2014	451	0	--	0.5714	159,393	55,553	82,248	292,855
		13	3/24/2014	1,394	0	--	0.5714	304,285	84,393	175,629	506,062
		14	3/31/2014	1,097	5,011	27	0.5714	349,879	61,113	247,552	485,875
15		4/7/2014	2,468	0	--	0.5714	518,794	128,391	308,763	812,822	
16		4/14/2014	3,572	4,740	56	0.5714	556,740	73,963	430,289	718,228	
17		4/21/2014	2,095	0	--	0.5714	438,364	113,006	255,166	697,076	
18		4/28/2014	622	0	--	0.4286	234,000	74,981	128,430	409,299	
19		5/5/2014	424	0	--	0.5714	107,733	49,988	54,881	199,813	
20	5/12/2014	72	3,549	4	0.4286	29,819	58,305	11,682	65,527		
Total						2,929,842	469,991	2,179,448	3,950,966		
Kinsman	9	2/24/2014	225	0	--	0.2857	470,506	495,075	106,443	1,841,270	
	10	3/4/2014	2,100	0	--	0.5714	681,908	349,047	243,338	1,562,681	
	11	3/10/2014	0	0	--	0.0000	698,129	496,899	202,934	1,930,733	
	12	3/17/2014	4,538	0	--	0.5714	872,758	458,480	310,287	1,924,631	
	13	3/24/2014	3,594	0	--	0.5714	727,637	354,424	273,569	1,527,866	
	14	3/31/2014	949	0	--	0.5714	388,901	134,752	191,219	709,448	
	15	4/7/2014	1,051	5,181	40	0.4286	344,288	59,447	249,281	483,943	
	16	4/14/2014	740	0	--	0.4286	298,553	100,778	148,059	540,573	
17	4/21/2014	1,217	0	--	0.5714	282,339	116,672	129,330	558,856		

<b>Trap site</b>	<b>Week</b>	<b>Week starting</b>	<b>Raw catch</b>	<b>Marks released</b>	<b>Marks recovered</b>	<b>Sample fraction</b>	<b>Mean population estimate</b>	<b>SD of population estimate</b>	<b>0.025 bound</b>	<b>0.975 bound</b>
	18	4/28/2014	449	0	--	0.4286	179,401	61,140	92,188	323,524
	19	5/5/2014	183	4,974	19	0.4286	109,143	21,119	75,124	157,624
	20	5/12/2014	146	4,878	23	0.5714	62,747	12,780	41,472	91,464
	21	5/19/2014	114	4,929	20	0.4286	61,039	11,745	42,162	88,070
	22	5/26/2014	161	0	--	0.2857	55,723	27,058	22,348	117,966
	23	6/2/2014	18	0	--	0.2857	18,021	9,618	6,700	42,685
	Total						5,271,066	1,518,485	3,029,887	8,696,107

Table 2. Mainstem Klamath River weekly natural-origin age-0 Chinook Salmon health information, 2014. A distended abdomen is an indication of potential infection with the parasite *Ceratonova shasta*. These data are also collected for juvenile Coho Salmon and Steelhead but are not reported here.

Trap site	Week	Sample dates	Gill condition			Abdomen condition		
			Number examined	Number unhealthy	Percent unhealthy	Number examined	Number distended	Percent distended
Bogus	8	2/19-2/21	0	0	--	38	0	0.0%
	9	2/26-2/28	0	0	--	30	0	0.0%
	10	3/4-3/7	0	0	--	90	0	0.0%
	11	3/11-3/14	0	0	--	90	0	0.0%
	12	3/18-3/21	0	0	--	90	0	0.0%
	13	3/25-3/28	0	0	--	90	0	0.0%
	14	4/1-4/4	0	0	--	90	0	0.0%
	15	4/8-4/11	0	0	--	90	0	0.0%
	16	4/15-4/18	1	0	0.0%	90	0	0.0%
	17	4/22-4/25	0	0	--	90	0	0.0%
	18	4/29-5/1	11	0	0.0%	90	0	0.0%
	19	5/6-5/9	25	1	4.0%	74	0	0.0%
	20	5/13-5/15	0	0	--	2	0	0.0%
	Total		37	1	2.7%	954	0	0.0%
I-5	8	2/20-2/20	0	0	--	3	0	0.0%
	10	3/4-3/7	0	0	--	90	0	0.0%
	11	3/11-3/14	0	0	--	29	0	0.0%
	12	3/18-3/21	4	1	25.0%	90	0	0.0%
	13	3/25-3/28	3	0	0.0%	150	0	0.0%
	14	4/1-4/4	11	1	9.1%	180	0	0.0%
	15	4/8-4/11	11	0	0.0%	90	0	0.0%
	16	4/15-4/18	13	0	0.0%	90	0	0.0%
	17	4/22-4/25	19	0	0.0%	90	0	0.0%
	18	4/29-5/1	27	0	0.0%	90	0	0.0%
	19	5/6-5/9	54	0	0.0%	91	0	0.0%
	20	5/13-5/15	11	0	0.0%	22	0	0.0%
		Total		153	2	1.3%	1,015	0
Kinsman	9	2/27-2/28	0	0	--	30	0	0.0%
	10	3/4-3/7	5	0	0.0%	90	0	0.0%
	11	3/11-3/14	12	3	25.0%	60	0	0.0%
	12	3/18-3/21	25	1	4.0%	90	0	0.0%
	13	3/25-3/28	20	0	0.0%	90	0	0.0%
	14	4/1-4/4	12	0	0.0%	90	0	0.0%
	15	4/9-4/11	27	0	0.0%	60	0	0.0%
	16	4/15-4/18	37	0	0.0%	59	0	0.0%
	17	4/22-4/25	46	0	0.0%	90	0	0.0%
	18	4/29-5/1	53	8	15.1%	90	0	0.0%
	19	5/6-5/9	40	15	37.5%	60	6	10.0%
	20	5/13-5/16	49	23	46.9%	76	15	19.7%
	21	5/20-5/22	37	6	16.2%	56	9	16.1%
	Total		363	56	15.4%	941	30	3.2%



Table 3. Catch totals of non-target fish species captured in the mainstem Klamath River at the three trap sites (all traps within a site combined), 2014.

Common name	Scientific name	Trap site		
		Bogus	I-5	Kinsman
Ammocete ( <i>Entosphenus</i> )	<i>Entosphenus</i> spp.	2	3	32
Bullhead <sup>a</sup>	<i>Ameiurus</i> spp.	14	40	59
Crappie <sup>a</sup>	<i>Pomoxis</i> spp.	10	4	0
Fathead Minnow <sup>a</sup>	<i>Pimphales promelas</i>	0	1	0
Golden Shiner <sup>a</sup>	<i>Notemigonus crysoleucas</i>	34	16	5
Klamath River Lamprey	<i>Entosphenus similis</i>	8	20	136
Marbled Sculpin	<i>Cottus klamathensis</i>	9	13	8
Pacific Lamprey	<i>Entosphenus tridentatus</i>	2	0	3
Prickly Sculpin	<i>Cottus asper</i>	0	0	3
Speckled Dace	<i>Rhinichthys osculus</i>	13	49	239
Sucker spp.	<i>Catostomus</i> spp.	3	12	27
Sunfish <sup>a</sup>	<i>Lepomis</i> spp.	17	3	0
Yellow Perch <sup>a</sup>	<i>Perca flavescens</i>	130	20	2

<sup>a</sup> non-native

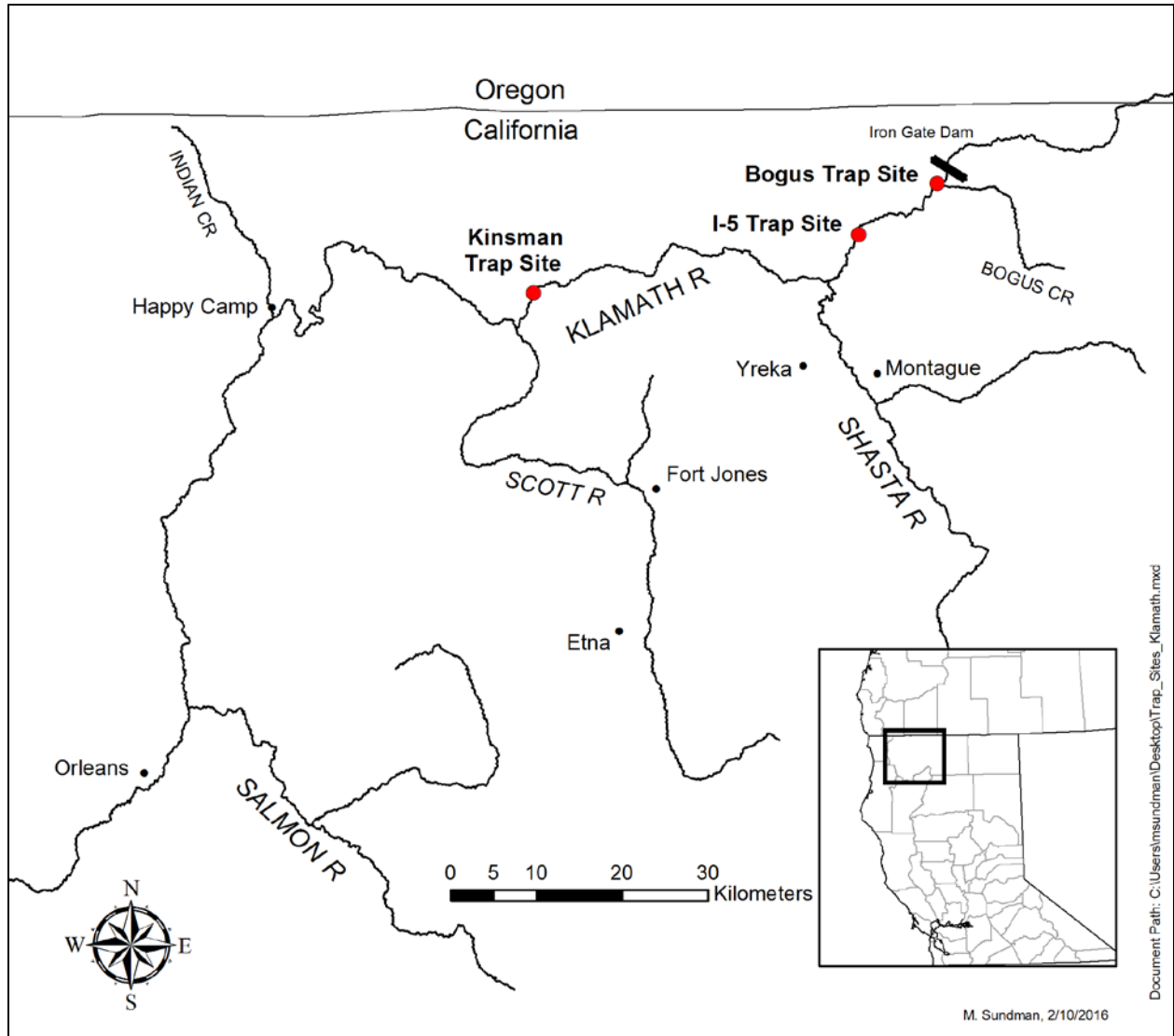


Figure 1. The Klamath River basin with trap sites identified.

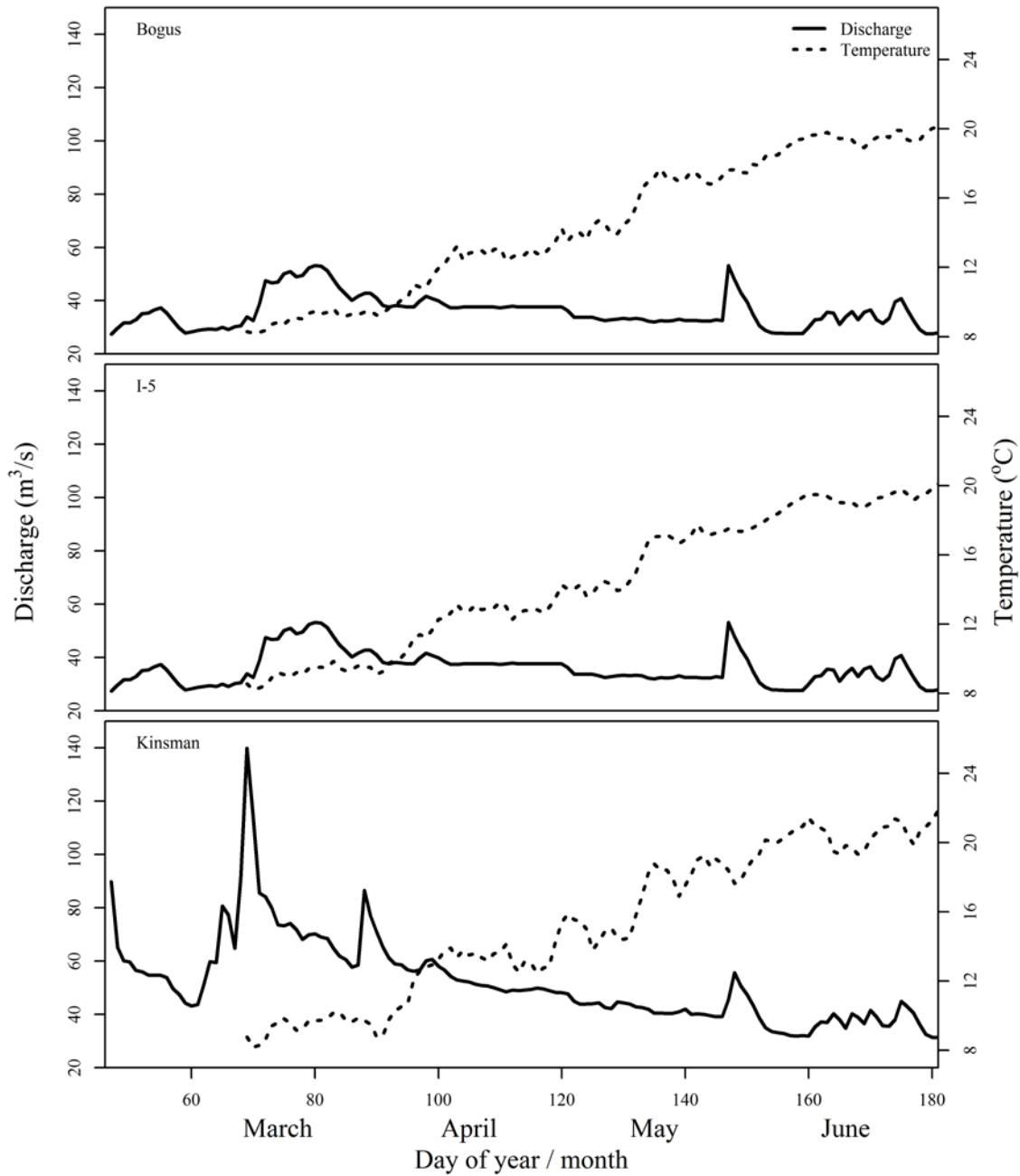


Figure 2. Klamath River mean daily discharge (m<sup>3</sup>/s) and mean daily temperature (°C) at the three trap sites for mid-February through the end of June, 2014.

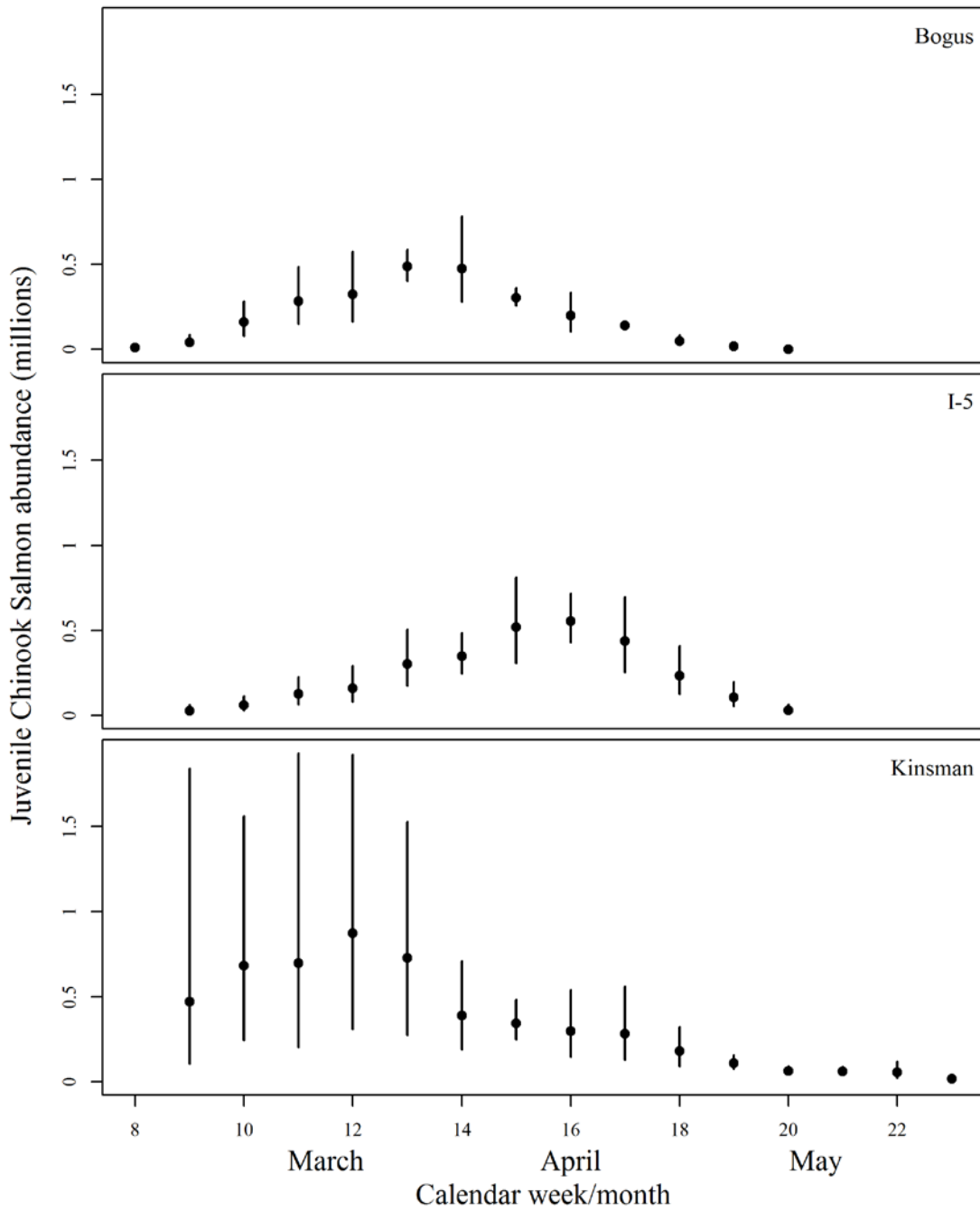


Figure 3. Weekly mean, lower (2.5% credible interval), and upper (97.5% credible interval) bound estimates for natural-origin, age-0 juvenile Chinook Salmon outmigrant abundance at the three trap sites, 2014. Trapping did not occur after week 20 at the Bogus and I-5 sites.

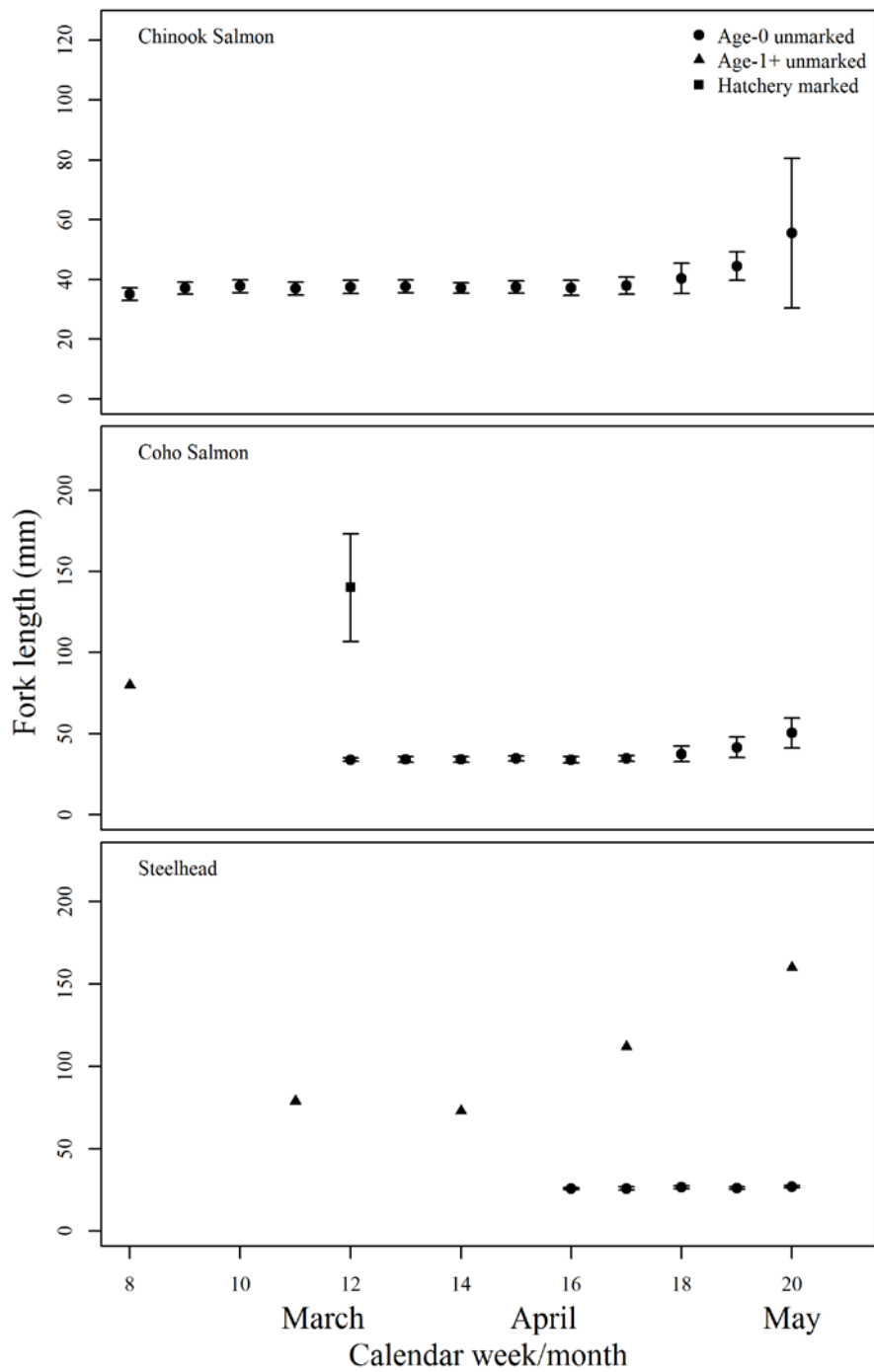


Figure 4. Weekly fork lengths (mean  $\pm$  one standard deviation) of unmarked age-0, unmarked age-1+, and hatchery-marked Chinook Salmon, Coho Salmon, and Steelhead captured at the Klamath River Bogus frame net, 2014.

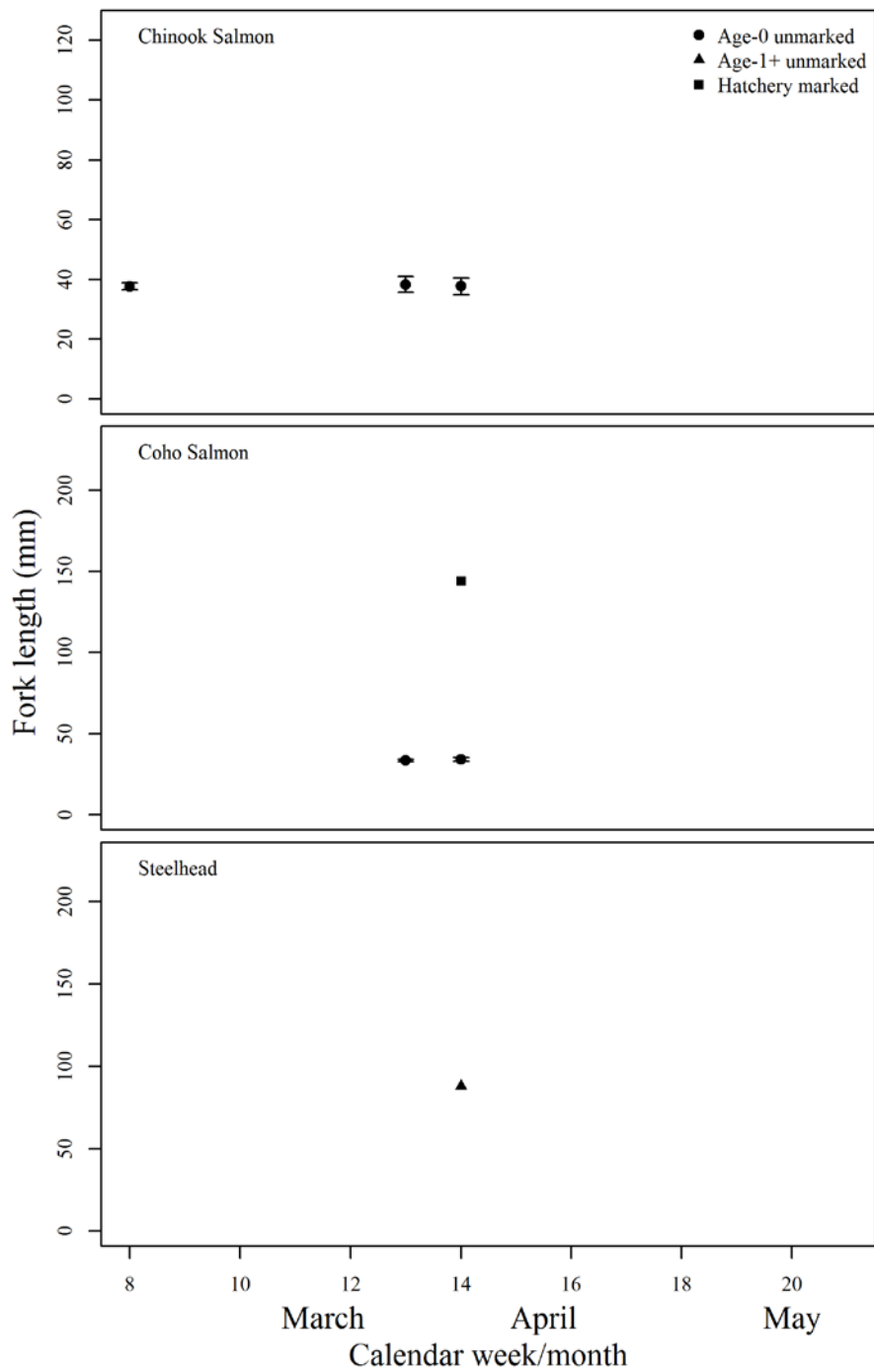


Figure 5. Weekly fork lengths (mean  $\pm$  one standard deviation) of unmarked age-0, unmarked age-1+, and hatchery-marked Chinook Salmon, Coho Salmon, and Steelhead captured at the Klamath River I-5 frame net, 2014. Note: the I-5 frame net was only operated during calendar weeks 8, 13, and 14 in 2014.

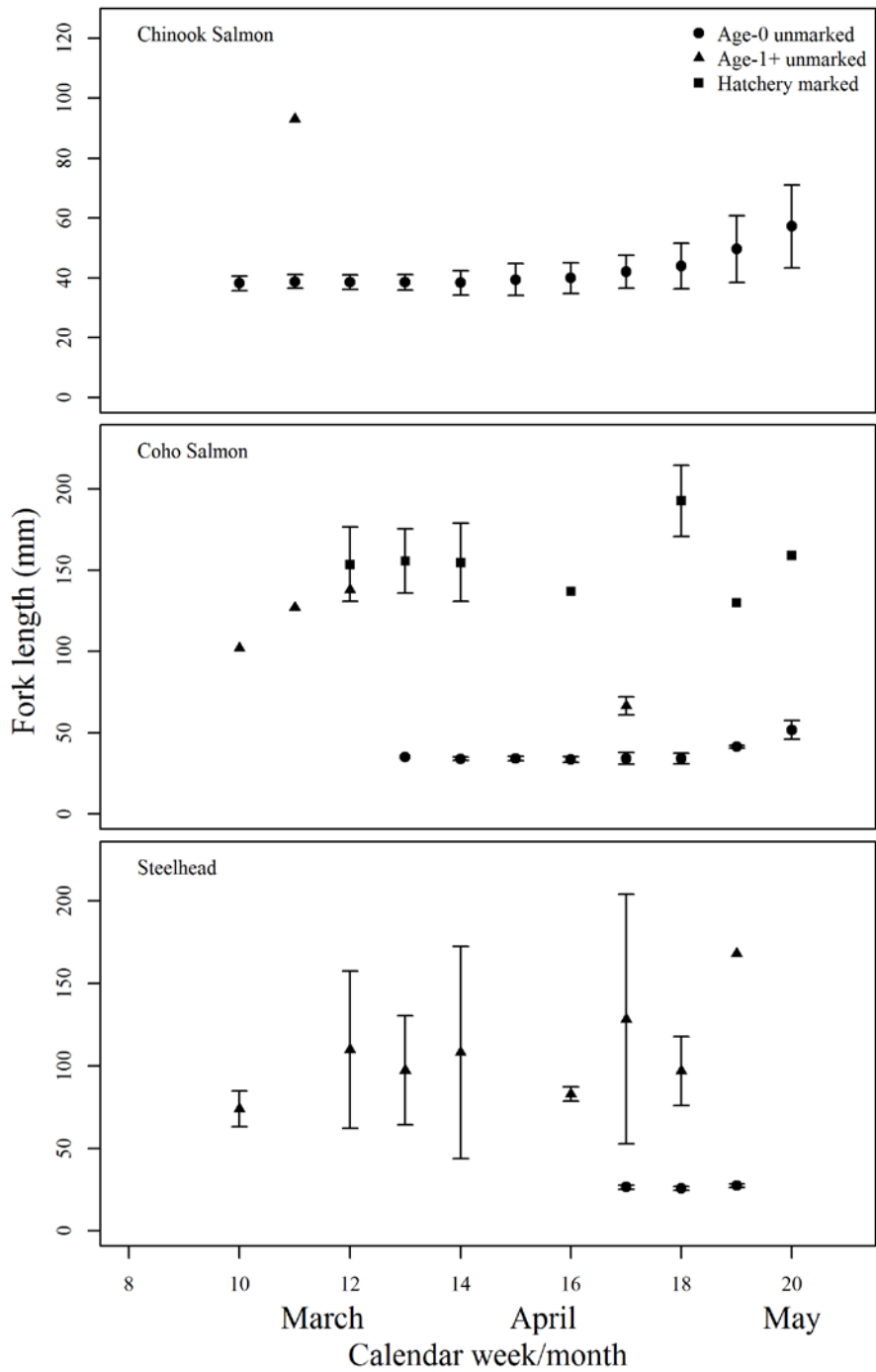


Figure 6. Weekly fork lengths (mean  $\pm$  one standard deviation) of unmarked age-0, unmarked age-1+, and hatchery-marked Chinook Salmon, Coho Salmon, and Steelhead captured at the Klamath River I-5 RST, 2014.

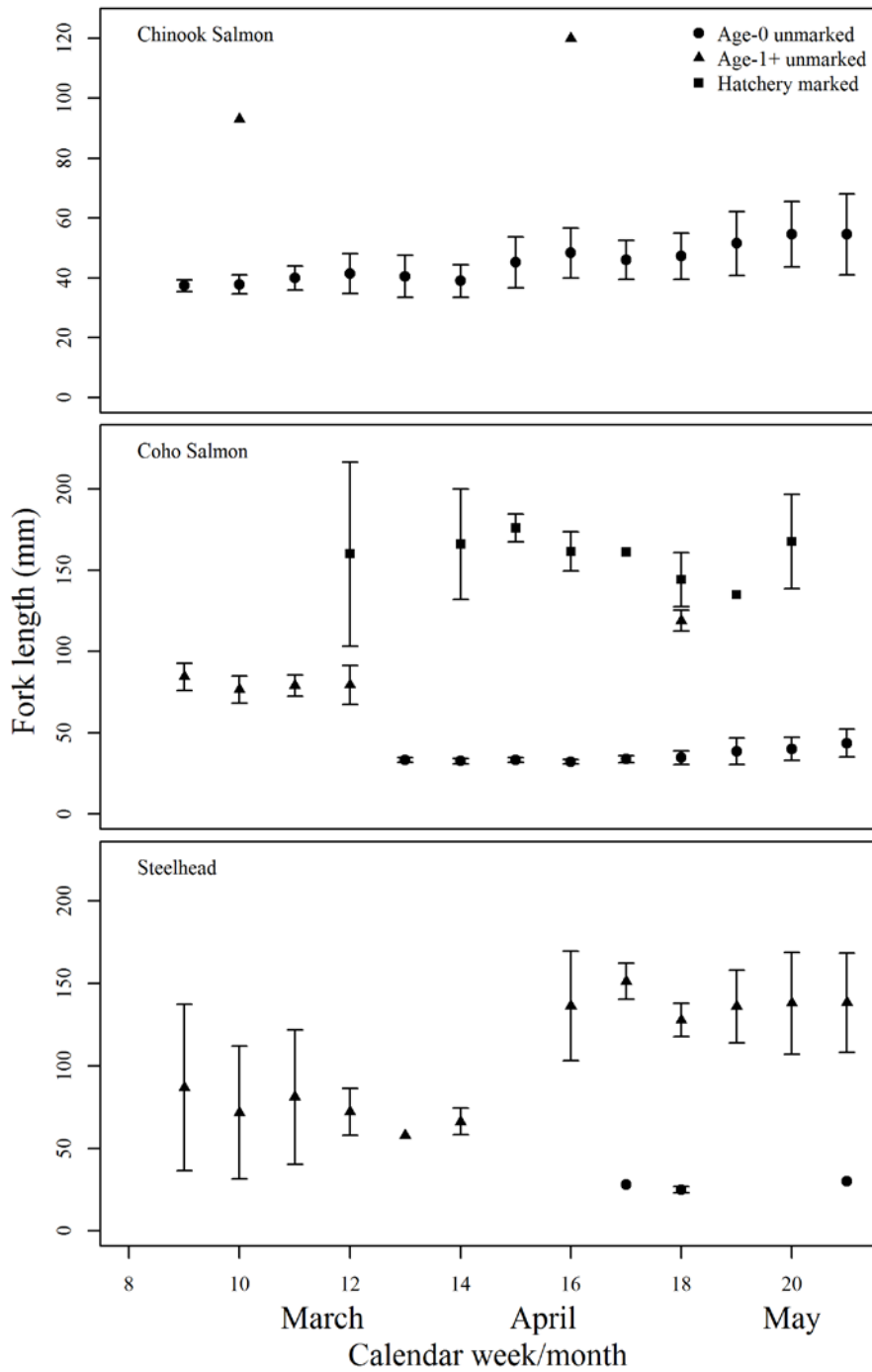


Figure 7. Weekly fork lengths (mean  $\pm$  one standard deviation) of unmarked age-0, unmarked age-1+, and hatchery-marked Chinook Salmon, Coho Salmon, and Steelhead captured at the Klamath River Kinsman RST, 2014.



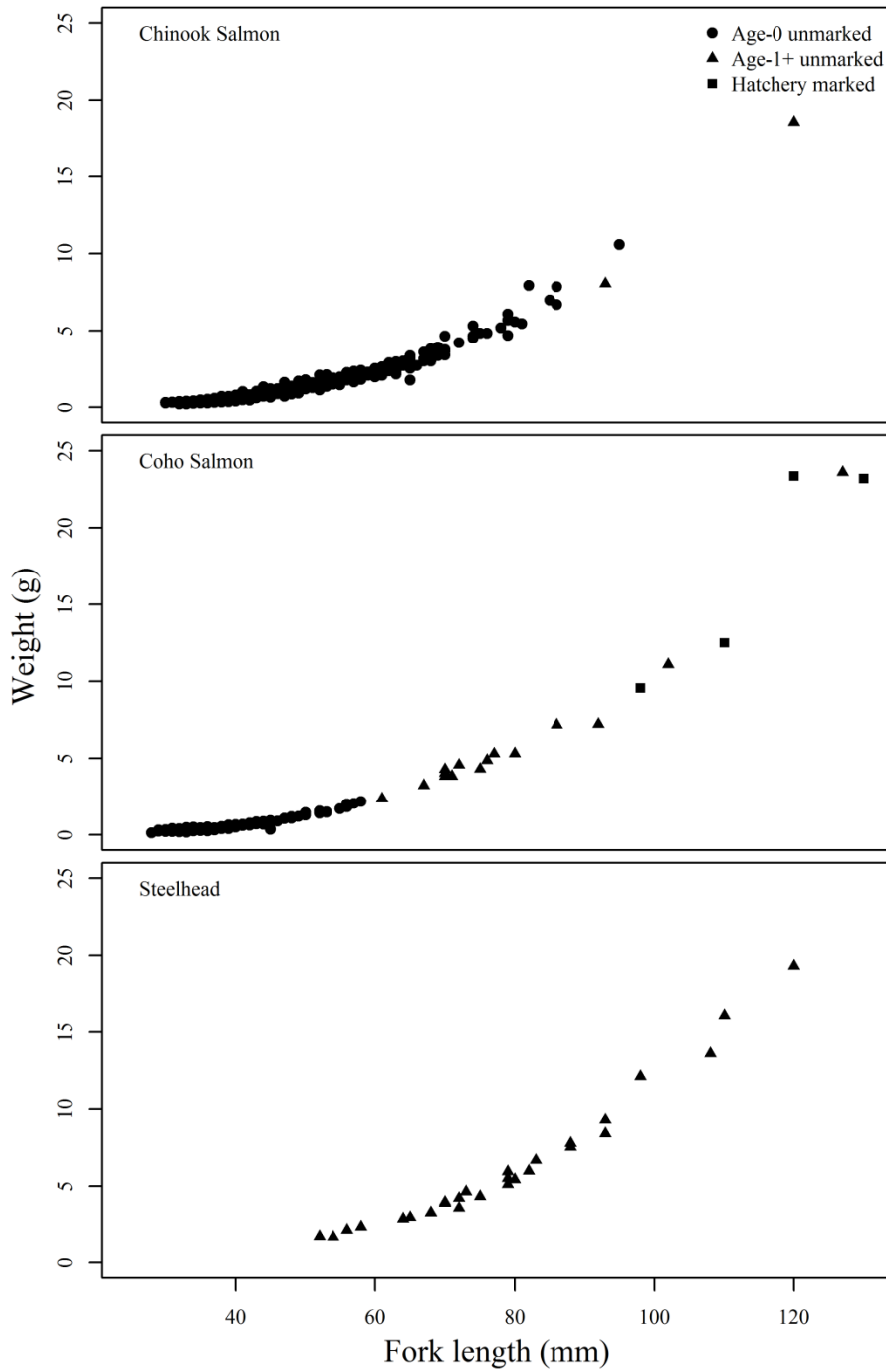


Figure 8. Weight plotted against fork length for individual juvenile Chinook Salmon, Coho Salmon, and Steelhead, all trap sites combined, 2014.

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## **Appendices**

Appendix A. Mainstem Klamath River weekly juvenile salmonid outmigrant trap catch summary, 2014. (appendix continued on following page)

Trap	Calendar week	Sample dates	Trap days	Mean Q (ft <sup>3</sup> /s)	Water temperature (C)			Chinook Salmon			Coho Salmon			Steelhead		
					Min	Max	Mean	Age-0		Age-1+	Age-0		Age-1+	Age-0	Age-1+	
								No clip	AD clip	No clip	No clip	No clip	LM clip	No clip	No clip	
Bogus Frame	8	2/19-2/21	3	1,130	--	--	--	65	0	0	0	1	0	0	0	
	9	2/26-2/28	3	1,149	--	--	--	252	0	0	0	0	0	0	0	
	10	3/4-3/7	4	1,040	--	--	--	2,006	0	0	0	0	0	0	0	
	11	3/11-3/14	4	1,399	7.6	9.3	8.4	3,071	0	0	3	0	0	0	1	
	12	3/18-3/21	4	1,807	7.9	10.2	9.1	2,365	0	0	24	0	7	0	0	
	13	3/25-3/28	4	1,569	8.5	10.0	9.3	5,825	0	0	170	0	0	0	0	
	14	4/1-4/4	4	1,380	9.0	10.8	9.7	5,749	0	0	586	0	0	0	1	
	15	4/8-4/11	4	1,391	10.1	14.5	11.6	4,332	0	0	1,108	0	0	0	0	
	16	4/15-4/18	4	1,329	11.8	14.2	12.9	1,512	0	0	875	0	0	5	0	
	17	4/22-4/25	4	1,330	10.2	13.6	12.8	2,074	0	0	472	0	0	200	2	
	18	4/29-5/1	3	1,283	12.3	15.5	13.6	306	0	1	54	0	0	412	1	
	19	5/6-5/9	4	1,173	12.7	15.6	14.2	139	0	0	28	0	0	70	0	
	20	5/13-5/15	3	1,154	13.9	18.8	16.5	4	0	0	2	0	0	8	1	
	I-5 Frame	8	2/20-2/20	1	1,130	--	--	--	3	0	0	0	0	0	0	0
		13	3/26-3/28	3	1,569	8.4	11.4	9.5	296	0	0	29	0	0	0	0
		14	4/1-4/3	2	1,380	8.4	11.5	9.7	202	0	0	30	0	1	0	0
	I-5 RST	9	2/28-2/28	2	1,149	--	--	--	27	0	0	0	0	0	0	2
		10	3/4-3/7	8	1,040	--	--	--	242	0	0	0	1	0	0	5
		11	3/11-3/14	4	1,399	6.8	11.0	8.6	308	0	2	0	1	0	0	0
		12	3/18-3/21	8	1,807	7.9	11.0	9.3	451	0	1	1	1	173	0	4
13		3/25-3/28	8	1,569	8.4	11.4	9.5	1,394	0	1	5	0	12	0	5	
14		4/1-4/4	8	1,380	8.4	11.5	9.7	1,097	0	0	13	0	4	0	5	
15		4/8-4/11	8	1,391	10.2	13.9	11.8	2,468	0	0	41	0	0	0	0	
16		4/15-4/18	8	1,329	11.7	14.7	12.9	3,572	0	0	193	0	1	4	2	
17		4/22-4/25	8	1,330	11.2	14.6	12.8	2,095	0	0	91	4	1	42	4	
18		4/29-5/1	6	1,283	12.0	16.0	13.7	622	0	0	21	0	2	38	3	
19		5/6-5/9	8	1,173	12.8	15.6	14.1	424	0	0	7	0	2	7	1	
20	5/13-5/15	6	1,154	13.4	18.3	16.2	72	0	0	7	0	1	0	1		
Kinsman RST	9	2/27-2/28	2	1,149	--	--	--	225	0	0	0	12	0	0	5	
	10	3/4-3/7	4	1,040	--	--	--	2,100	0	1	0	16	0	0	22	
	12	3/18-3/21	4	1,807	8.6	10.4	9.6	4,538	0	0	0	6	2	0	6	

Trap	Calendar week	Sample dates	Trap days	Mean Q (ft <sup>3</sup> /s)	Water temperature (C)			Chinook Salmon			Coho Salmon			Steelhead		
					Min	Max	Mean	Age-0		Age-1+	Age-0		Age-1+		Age-0	Age-1+
								No clip	AD clip	No clip	No clip	No clip	LM clip	No clip	No clip	
	13	3/25-3/28	4	1,569	9.2	10.8	9.9	3,594	0	0	97	1	0	0	3	
	14	4/1-4/4	4	1,380	8.2	11.6	9.8	949	0	0	35	0	4	0	3	
	15	4/9-4/11	3	1,391	10.9	15.0	13.1	1,051	0	0	30	0	4	0	1	
	16	4/15-4/18	3	1,329	12.1	15.1	13.5	740	0	1	127	6	5	0	6	
	17	4/22-4/25	4	1,330	11.7	15.1	13.1	1,217	0	0	145	2	2	1	10	
	18	4/29-5/1	3	1,283	11.5	17.5	14.6	449	0	0	29	4	7	8	14	
	19	5/6-5/9	3	1,173	12.9	16.7	14.6	183	0	0	23	0	1	1	15	
	20	5/13-5/16	4	1,154	12.7	20.3	17.3	146	0	0	23	1	4	0	21	
	21	5/20-5/22	3	1,150	15.8	21.0	18.2	114	0	0	35	0	0	1	20	
	22	5/29-5/30	2	1,433	16.5	20.7	18.5	161	8	0	15	1	0	0	22	
	23	6/3-6/4	2	1,001	17.5	23.0	20.2	18	0	0	7	0	1	1	3	
	26	6/24-6/24	1	1,209	18.9	23.0	20.8	26	7	0	2	0	0	3	6	

Appendix B. Klamath River at Bogus site (frame net) weekly unmarked and hatchery-marked Chinook and Coho salmon fork lengths (mm), 2014.

Calendar week	Sample dates	Unmarked Chinook Salmon					Unmarked Coho Salmon					Marked Coho Salmon														
		Age-0		Age-1+			Age-0		Age-1+			Age-0		Age-1+												
		n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd
8	2/19-2/21	39	35.1	29	40	2.1	0	--	--	--	--	0	--	--	--	--	1	80.0	80	80	0.0	0	--	--	--	--
9	2/26-2/28	30	37.1	32	40	2.0	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--
10	3/4-3/7	90	37.7	32	42	2.2	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--
11	3/11-3/14	90	36.9	31	42	2.1	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--
12	3/18-3/21	90	37.5	32	43	2.2	0	--	--	--	--	10	34.0	32	35	1.1	0	--	--	--	--	6	140.0	98	172	33.1
13	3/25-3/28	90	37.7	33	43	2.1	0	--	--	--	--	85	34.2	29	38	1.8	0	--	--	--	--	0	--	--	--	--
14	4/1-4/4	90	37.2	33	42	1.8	0	--	--	--	--	89	34.3	30	40	1.7	0	--	--	--	--	0	--	--	--	--
15	4/8-4/11	90	37.5	33	45	2.1	0	--	--	--	--	90	34.8	30	38	1.4	0	--	--	--	--	0	--	--	--	--
16	4/15-4/18	90	37.1	32	48	2.5	0	--	--	--	--	90	34.1	28	38	2.0	0	--	--	--	--	0	--	--	--	--
17	4/22-4/25	90	38.0	34	53	2.9	0	--	--	--	--	90	34.8	32	41	1.7	0	--	--	--	--	0	--	--	--	--
18	4/29-5/1	90	40.3	33	62	5.1	0	--	--	--	--	54	37.6	32	52	4.8	0	--	--	--	--	0	--	--	--	--
19	5/6-5/9	74	44.4	34	60	4.8	0	--	--	--	--	26	41.6	32	55	6.3	0	--	--	--	--	0	--	--	--	--
20	5/13-5/15	4	55.5	42	93	25.0	0	--	--	--	--	2	50.5	44	57	9.2	0	--	--	--	--	0	--	--	--	--

## Appendix C. Klamath River at I-5 site (frame net) weekly unmarked and hatchery-marked Chinook and Coho salmon fork lengths (mm), 2014.

Calendar week	Sample dates	Unmarked Chinook Salmon										Unmarked Coho Salmon										Marked Coho Salmon				
		Age-0					Age-1+					Age-0					Age-1+					Age-1+				
		n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd
8	2/20-2/20	3	37.7	37	39	1.2	0	--	--	--	--	0	--	--	--	--	--	--	--	--	--	0	--	--	--	--
13	3/26-3/28	60	38.3	34	48	2.7	0	--	--	--	--	16	33.6	33	35	0.7	0	0.0	--	--	0.0	0	--	--	--	--
14	4/1-4/3	90	37.7	33	46	2.8	0	--	--	--	--	44	34.2	32	37	1.2	0	0.0	--	--	0.0	1	144.0	144	144	0.0

## Appendix D. Klamath River at I-5 site (RST) weekly unmarked and hatchery-marked Chinook and Coho salmon fork lengths (mm), 2014.

Calendar week	Sample dates	Unmarked Chinook Salmon										Unmarked Coho Salmon										Marked Coho Salmon				
		Age-0					Age-1+					Age-0					Age-1+					Age-1+				
		n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd
9	2/28-2/28	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--	0	--	--	--	--
10	3/4-3/7	90	38.2	30	43	2.5	0	--	--	--	--	0	--	--	--	--	1	102.0	102	102	0.0	0	--	--	--	--
11	3/11-3/14	29	38.8	34	43	2.4	1	93.0	93	93	0.0	0	--	--	--	--	1	127.0	127	127	0.0	0	--	--	--	--
12	3/18-3/21	90	38.6	35	46	2.4	0	--	--	--	--	0	--	--	--	--	1	138.0	138	138	0.0	89	153.5	104	225	22.9
13	3/25-3/28	90	38.5	31	48	2.6	0	--	--	--	--	1	35.0	35	35	0.0	0	--	--	--	--	11	155.7	125	190	19.7
14	4/1-4/4	90	38.4	27	53	4.1	0	--	--	--	--	5	34.0	33	35	1.0	0	--	--	--	--	4	154.8	130	180	24.0
15	4/8-4/11	90	39.4	33	57	5.3	0	--	--	--	--	24	34.3	32	37	1.4	0	--	--	--	--	0	--	--	--	--
16	4/15-4/18	90	40.0	34	58	5.1	0	--	--	--	--	85	33.8	30	45	1.8	0	--	--	--	--	1	137.0	137	137	0.0
17	4/22-4/25	90	42.0	33	59	5.5	0	--	--	--	--	59	34.3	31	57	3.7	3	66.7	61	72	5.5	0	--	--	--	--
18	4/29-5/1	90	43.9	34	68	7.6	0	--	--	--	--	19	34.1	31	45	3.2	0	--	--	--	--	2	192.5	177	208	21.9
19	5/6-5/9	90	49.6	35	95	11.2	0	--	--	--	--	2	41.5	41	42	0.7	0	--	--	--	--	1	130.0	130	130	0.0
20	5/13-5/15	65	57.2	37	95	13.9	0	--	--	--	--	7	51.9	41	58	5.6	0	--	--	--	--	1	159.0	159	159	0.0



Appendix E. Klamath River at Kinsman site (RST) weekly unmarked and hatchery-marked Chinook and Coho salmon fork lengths (mm), 2014.

Calendar week	Sample dates	Unmarked Chinook Salmon										Unmarked Coho Salmon										Marked Coho Salmon				
		Age-0					Age-1+					Age-0					Age-1+					Age-1+				
		n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd	n	mean	min	max	sd
9	2/27-2/28	30	37.4	33	41	2.0	0	--	--	--	0	--	--	--	--	6	84.5	75	97	8.5	0	--	--	--	--	
10	3/4-3/7	90	37.8	33	50	3.2	1	93.0	93	93	0.0	0	--	--	--	14	76.6	65	92	8.2	0	--	--	--	--	
11	3/11-3/14	60	40.0	33	49	4.0	0	--	--	--	0	--	--	--	5	79.0	74	90	6.4	0	--	--	--	--	--	
12	3/18-3/21	90	41.4	31	64	6.6	0	--	--	--	0	--	--	--	4	79.5	70	97	12.0	2	160.0	120	200	56.6		
13	3/25-3/28	90	40.5	30	58	7.0	0	--	--	--	56	33.3	30	38	1.5	0	--	--	--	0	--	--	--	--	--	
14	4/1-4/4	90	39.0	32	60	5.5	0	--	--	--	22	32.6	31	36	1.6	0	--	--	--	2	166.0	142	190	33.9		
15	4/9-4/11	60	45.2	33	73	8.5	0	--	--	--	16	33.4	31	36	1.4	0	--	--	--	2	176.0	170	182	8.5		
16	4/15-4/18	59	48.4	35	65	8.4	1	120.0	120	120	0.0	43	32.3	29	35	1.3	0	--	--	2	161.5	153	170	12.0		
17	4/22-4/25	90	46.0	37	65	6.5	0	--	--	--	84	33.8	30	44	2.2	0	--	--	--	1	161.0	161	161	0.0		
18	4/29-5/1	89	47.2	33	67	7.7	0	--	--	--	29	34.7	30	50	4.3	4	119.0	110	125	6.4	7	144.3	125	165	16.6	
19	5/6-5/9	60	51.5	36	77	10.7	0	--	--	--	18	38.6	30	56	8.2	0	--	--	--	1	135.0	135	135	0.0		
20	5/13-5/16	76	54.6	37	81	10.9	0	--	--	--	14	40.2	33	57	7.1	0	--	--	--	3	167.7	140	198	29.1		
21	5/20-5/22	56	54.5	34	86	13.5	0	--	--	--	25	43.7	32	58	8.6	0	--	--	--	0	--	--	--	--		
22	5/29-5/30	0	--	--	--	--	0	--	--	--	0	--	--	--	--	0	--	--	--	0	--	--	--	--		
23	6/3-6/4	0	--	--	--	--	0	--	--	--	0	--	--	--	--	0	--	--	--	0	--	--	--	--		
26	6/24-6/24	0	--	--	--	--	0	--	--	--	0	--	--	--	--	0	--	--	--	0	--	--	--	--		

Appendix F. Klamath River at Bogus site (frame net) weekly unmarked Steelhead fork lengths (mm), 2014.

Calendar week	Sample dates	Unmarked Steelhead									
		Age-0					Age-1+				
		n	mean	min	max	sd	n	mean	min	max	sd
8	2/19-2/21	0	--	--	--	--	0	--	--	--	--
9	2/26-2/28	0	--	--	--	--	0	--	--	--	--
10	3/4-3/7	0	--	--	--	--	0	--	--	--	--
11	3/11-3/14	0	--	--	--	--	1	79.0	79	79	0.0
12	3/18-3/21	0	--	--	--	--	0	--	--	--	--
13	3/25-3/28	0	--	--	--	--	0	--	--	--	--
14	4/1-4/4	0	--	--	--	--	1	73.0	73	73	0.0
15	4/8-4/11	0	--	--	--	--	0	--	--	--	--
16	4/15-4/18	3	25.7	25	26	0.6	0	--	--	--	--
17	4/22-4/25	85	25.9	23	29	1.0	1	112.0	112	112	0.0
18	4/29-5/1	90	26.6	25	28	0.8	0	--	--	--	--
19	5/6-5/9	41	26.1	25	27	0.7	0	--	--	--	--
20	5/13-5/15	8	27.0	26	28	0.8	1	160.0	160	160	0.0

## Appendix G. Klamath River at I-5 site (frame net) weekly unmarked Steelhead fork lengths (mm), 2014.

Calendar week	Sample dates	Unmarked Steelhead									
		Age-0					Age-1+				
		n	mean	min	max	sd	n	mean	min	max	sd
14	4/1-4/3	0	0.0	--	--	0.0	1	88.0	88	88	0.0

## Appendix H. Klamath River at I-5 site (RST) weekly unmarked Steelhead fork lengths (mm), 2014.

Calendar week	Sample dates	Unmarked Steelhead									
		Age-0					Age-1+				
		n	mean	min	max	sd	n	mean	min	max	sd
9	2/28-2/28	0	--	--	--	--	0	--	--	--	--
10	3/4-3/7	0	--	--	--	--	4	74.0	64	88	10.9
11	3/11-3/14	0	--	--	--	--	0	--	--	--	--
12	3/18-3/21	0	--	--	--	--	4	110.0	68	157	47.6
13	3/25-3/28	0	--	--	--	--	5	97.4	68	154	33.0
14	4/1-4/4	0	--	--	--	--	5	108.2	72	222	64.2
15	4/8-4/11	0	--	--	--	--	0	--	--	--	--
16	4/15-4/18	0	--	--	--	--	2	83.0	80	86	4.2
17	4/22-4/25	29	26.5	24	30	1.3	2	128.5	75	182	75.7
18	4/29-5/1	37	25.8	24	30	1.2	3	97.0	79	120	21.0
19	5/6-5/9	6	27.3	26	29	1.0	1	168.0	168	168	0.0
20	5/13-5/15	0	--	--	--	--	0	--	--	--	--

## Appendix I. Klamath River at Kinsman site (RST) weekly unmarked Steelhead fork lengths (mm), 2014.

Calendar week	Sample dates	Unmarked Steelhead									
		Age-0					Age-1+				
		n	mean	min	max	sd	n	mean	min	max	sd
9	2/27-2/28	0	--	--	--	--	4	87.0	49	160	50.5
10	3/4-3/7	0	--	--	--	--	13	71.8	45	175	40.3
11	3/11-3/14	0	--	--	--	--	7	81.1	54	168	40.6
12	3/18-3/21	0	--	--	--	--	3	72.3	56	82	14.2
13	3/25-3/28	0	--	--	--	--	1	58.0	58	58	0.0
14	4/1-4/4	0	--	--	--	--	3	66.3	59	75	8.1
15	4/9-4/11	0	--	--	--	--	0	--	--	--	--
16	4/15-4/18	0	--	--	--	--	3	136.3	100	165	33.2
17	4/22-4/25	1	28.0	28	28	0.0	4	151.5	142	162	11.0
18	4/29-5/1	8	25.0	22	28	1.9	14	127.9	111	142	10.2
19	5/6-5/9	0	--	--	--	--	11	136.2	108	180	22.0
20	5/13-5/16	0	--	--	--	--	17	138.1	98	210	30.8
21	5/20-5/22	1	30.0	30	30	0.0	11	138.4	83	190	30.1
22	5/29-5/30	0	--	--	--	--	0	--	--	--	--
23	6/3-6/4	0	--	--	--	--	0	--	--	--	--
26	6/24-6/24	0	--	--	--	--	0	--	--	--	--