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Mainstem Klamath River Fall Chinook Salmon Redd Survey 2014–2016

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Mainstem Klamath River Fall Chinook Salmon Redd Survey 2014–2016

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Abstract.— This report summarizes the 2014, 2015, and 2016 fall Chinook Salmon *Oncorhynchus tshawytscha* redd surveys on the mainstem Klamath River. Each year the surveys were conducted over a 9-week period (from early October to early December), covering 114.7 km between the Shasta River (rkm 288.4) and Indian Creek (rkm 173.8) confluences. Redd numbers over the previous 21-year history of this survey ranged from 243 (in 1993) to 3,390 (in 2012). In 2014 we observed 3,456 fall Chinook Salmon redds, which was the highest count for this section of river since annual surveys began in 1993. The 2014 count was 3.2 times more than the previous 21-year mean (1,084). In 2015 we observed 2,492 fall Chinook Salmon redds, which was 2.1 times more than the previous 22-year mean (1,192). In 2016 we observed 1,097 fall Chinook Salmon redds, which was 0.88 times less than the previous 23-year mean (1,248). The downstream-most reach (Reach 6) had the highest redd density in all three years, which is consistent with 14 of the prior 20 years.

Introduction

The Klamath River Basin historically supported large runs of Chinook Salmon *Oncorhynchus tshawytscha*, Coho Salmon *O. kisutch*, and steelhead *O. mykiss* that contribute to economically and culturally important subsistence, sport, and commercial fisheries (Leidy and Leidy 1984; DOI et al. 2013). Populations of Chinook Salmon in the Klamath River Basin have dramatically declined over the past century as a result of various factors including logging, overfishing, construction of roads and dams, water storage, agricultural use, mining, infectious disease and changes in ocean conditions (West Coast Chinook Salmon Biological Review Team 1997; Ayres Associates 1999; Heard et al. 2007; Moyle et al. 2008, 2011; Thorsteinson et al. 2011; DOI et al. 2013).

In response to concerns over declining salmon (USFWS 1991; Heard et al. 2007; Moyle et al. 2008, 2011), the United States Congress enacted the Klamath River Fish and Wildlife Restoration Act (Public Law 99-552) in 1986. Known as the "Klamath Act", this legislation authorized the Secretary of the Interior to restore anadromous fish populations to optimum levels in the Klamath River Basin through the creation of the Klamath River Basin Conservation Area Restoration Program (KRBCARP). As part of the fishery resource monitoring program implemented under KRBCARP, the U.S. Fish and Wildlife Service (USFWS) implemented redd surveys in 1993 to identify the distribution, abundance, and timing of fall Chinook Salmon spawning in the mainstem Klamath River between Iron Gate Dam (IGD) and the confluence with Indian Creek [river kilometer (rkm) 310.3 and 173.8, respectively; Figure 1]. In 2001, the USFWS added carcass mark-recapture methods to more accurately estimate escapement in the more densely used spawning area located between IGD and the Shasta River confluence (rkm 288.4; Gough and Williamson 2012). During the five years when both carcass and redd surveys were conducted in this stretch of the river (2001–2004, 2006), the estimated ratio of the successfully spawned female carcass to observed redds ranged from 3.3:1 (2002) to 4.8:1 (2003). The higher estimates for carcass, versus redd-based methods, were attributed to observer error in densely used spawning areas due to superimposition of redds, indicating that carcass mark-recapture is a more accurate estimator of escapement in this area (Gough and Williamson 2012). However, a downstream decline of the successfully spawned female carcasses–redd ratio within the study area suggest that redd surveys in the less densely used spawning area below the Shasta River confluence provides a sufficient escapement estimate. Carcass surveys continue to be employed between IGD and the Shasta River while redd surveys are employed from the Shasta River to Indian Creek (Gough and Som 2015).

This report summarizes the 2014, 2015, and 2016 fall Chinook Salmon redd surveys, a collaboration between the Karuk Tribe Department of Natural Resources and the Arcata Fish and Wildlife Office, in the mainstem Klamath River between the Shasta River and Indian Creek. In addition to providing data on spawning abundance and distribution of fall Chinook Salmon, information generated by this survey is a component of the Klamath Basin fall Chinook Salmon in-river run assessment (KRTT 2015a–2017a) that is used to generate stock projections for harvest and escapement management (KRTT 2015b–2017b; PFMC 2015–2017).

Methods

Survey Area

The mainstem Klamath River from IGD to Indian Creek was divided into six reaches based on accessibility and distance that a single crew could survey in a day (Figure 2; Table 1). Since 2006, Reach 1 (IGD–Shasta River) has not been surveyed for redds because a carcass mark-recapture survey is conducted to estimate the number of fall Chinook Salmon that spawn in this reach (Gough and Som 2015). The upper 2.7 km in Reach 2, from the Shasta River to Ash Creek, was not surveyed because past surveys revealed little to no spawning activity in this section of the river. For this report we assumed no redds were constructed in this short stretch of the river.

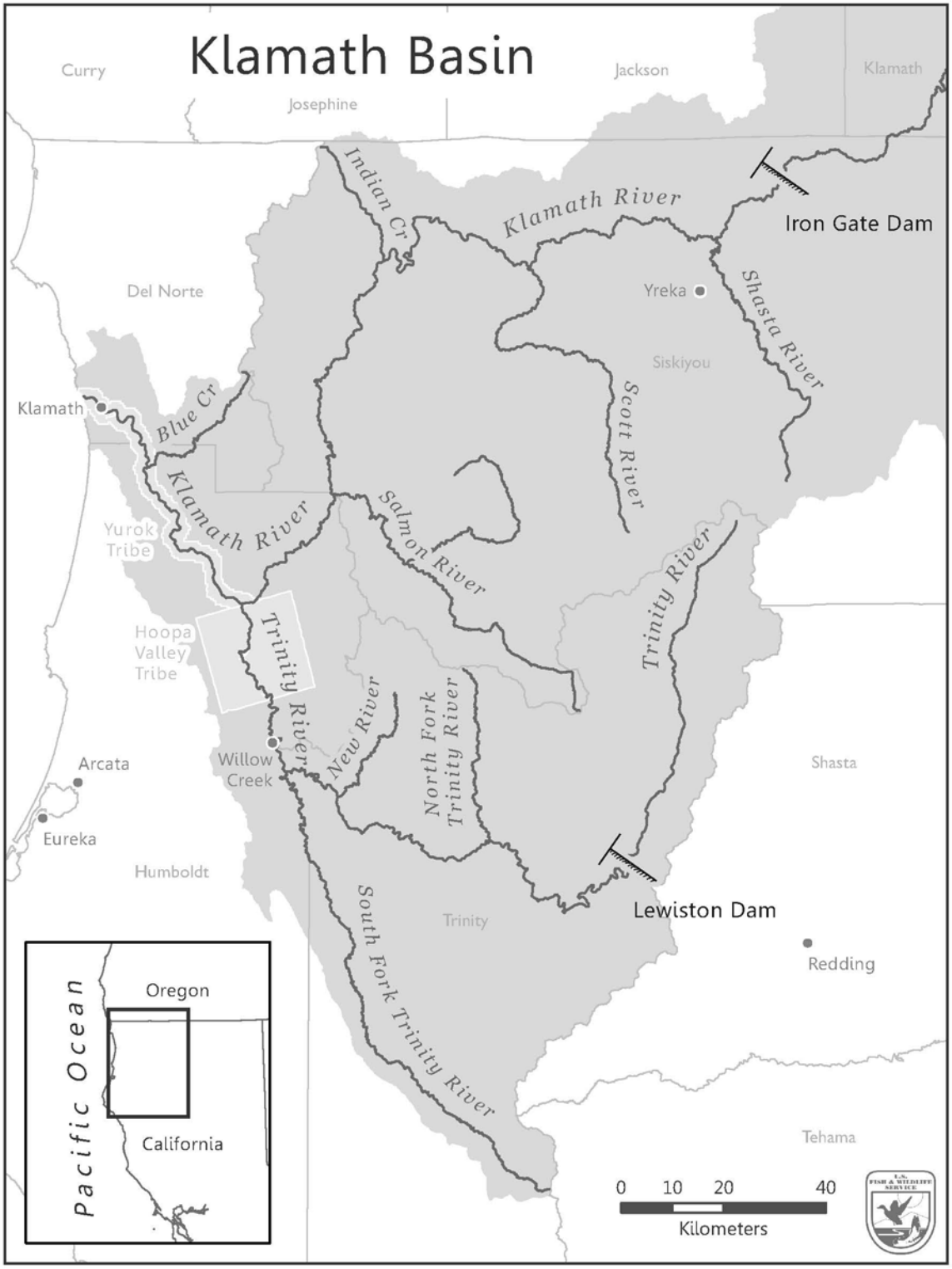

Figure 1. Klamath River Basin, northern California. The mainstem Klamath River redd survey extends from the Shasta River to Indian Creek.

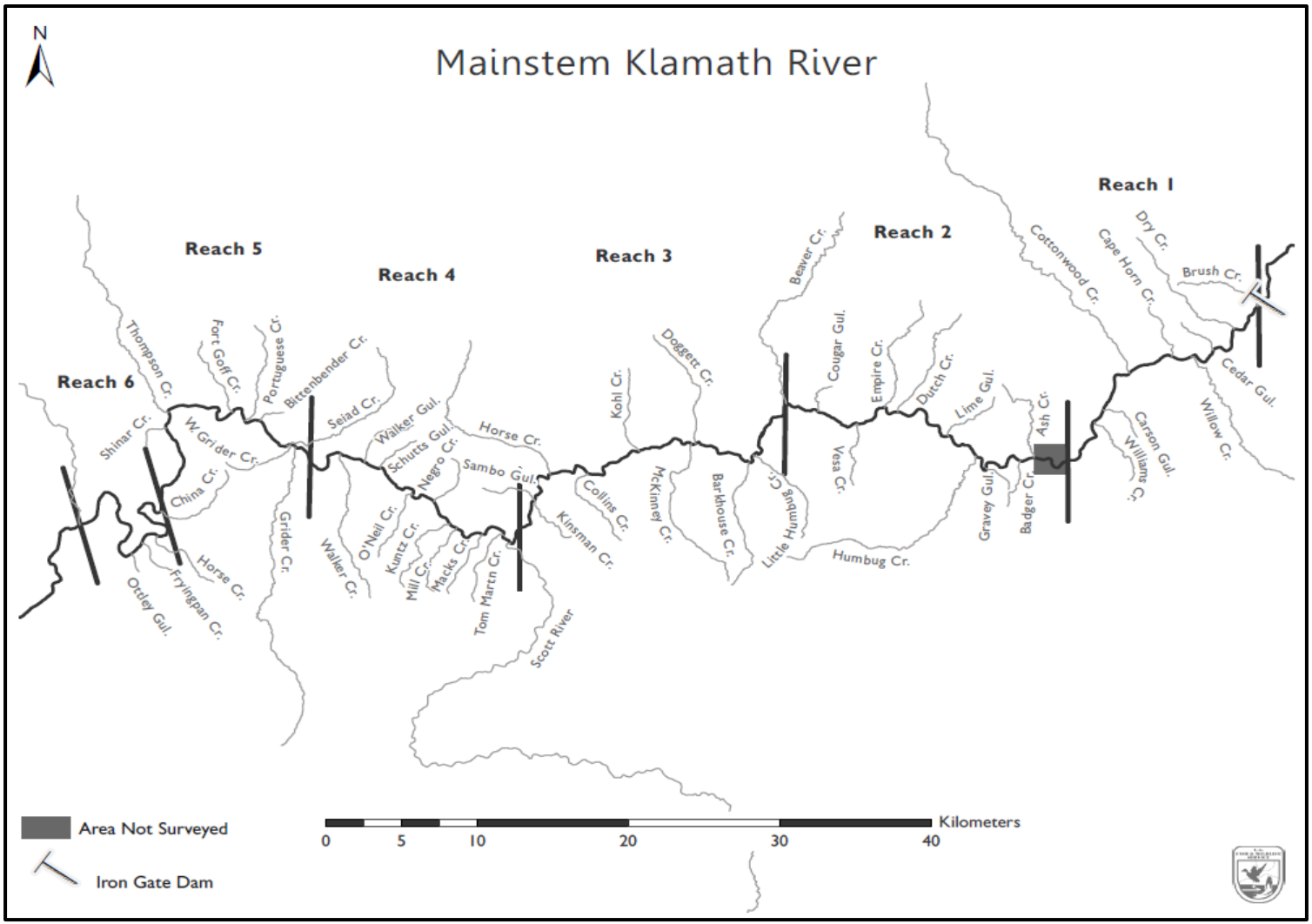

Figure 2. Mainstem Klamath River fall Chinook Salmon redd survey reaches. *Note*: Escapement is now estimated from carcass mark-recapture survey data in Reach 1 (Iron Gate Dam–Shasta River). The 2.7-km section between the Shasta River and Ash Creek was not surveyed because past surveys revealed a lack of spawning activity in this stretch of river.

Table 1. Location and length of mainstem Klamath River fall Chinook Salmon redd survey Reaches.

	Upper boundary		Lower boundary		Reach length
Reach	**Location**	**rkm**	**Location**	**rkm**	**(km)**
1[a]	Iron Gate Dam	310.3	Shasta River	288.4	21.9
2[b]	Shasta River[c]	288.4	Beaver Creek	261.9	26.5
3[d]	Beaver Creek	261.9	Blue Heron	234.3	27.6
4[b]	Blue Heron	234.3	Seiad Bar	213.6	20.7
5[d]	Seiad Bar[f]	213.6	China Point	192.4	21.2
6[e]	China Point	192.4	Indian Creek	173.8	18.6

a. Reach 1 not surveyed for redds (escapement in this reach estimated from carcass mark-recapture surveys by USFWS and the Yurok Tribe).
b. Surveyed by Karuk Tribe crew.
c. The section of river between Shasta River and Ash Creek (rkm 285.7) was not surveyed because past surveys revealed little to no evidence of spawning activity in this area.
d. Surveyed by USFWS crew.
e. Reach 6 was split at Gordon's Ferry (rkm 185.0) and surveyed by Karuk Tribe and USFWS crews.
f. In 2016 access to Seiad Bar was restricted. The survey reach boundary was moved to Sluice Box (rkm 211.0). Survey length of Reaches 4 and 5 changed to 23.3 km and 18.6 km respectively, but for purposes of this report are summarized using the established reach designations.

Data Collection

River Discharge and Water Clarity

Mean daily river discharge was obtained from USGS gaging stations 11516530, located in the Klamath River just downstream of IGD, and 11520500, located in the Klamath River near Seiad Valley.

Secchi disk depth was measured each survey week in Reach 5 as an indicator of water clarity, which can influence the observability of redds.

Redd Data

Weekly visual redd surveys were conducted on the five mainstem reaches from Ash Creek to Indian Creek (Table 1). Two crews, each consisting of a rower and observer, aided by polarized sunglasses, surveyed the river by cataraft. Catarafts were rowed downstream and maneuvered in a zigzag pattern over spawning areas to count redds. Side and split channels were surveyed by foot or floated on alternating weeks. Crews surveyed the same reaches each week for consistency and familiarity with the river and to promote more accurate redd counts.

A GPS waypoint was taken at each lone redd or redd aggregation when observed for the first time during the season. The GPS waypoint, river kilometer, numbers of old and new redds, location of redd(s) in the channel, distance of redd(s) from bank, habitat type, and estimated age(s) of redd(s) were recorded on a data sheet each time a new redd or aggregation containing new redds was encountered.

Only completed redds, identified by a pit and mound, were counted. Test redds (i.e., those without a completed pit and mound) were not included in the count. Only new redds (i.e., those observed for the first time) were summed across the survey weeks to produce the total redd count for the season.

Data Analysis

Adult and Jack Escapement Estimates

The total number of new redds in this survey was used to estimate the number of adult and jack (age-2 fish) fall Chinook Salmon spawners in the mainstem Klamath River between the Shasta River and Indian Creek. Assuming each redd represents one male and one female adult salmon, adult escapement (N_{adult}) was estimated by multiplying the total redd count (R) by two:

$$\hat{N}_{adult} = 2R .$$

The age composition of mainstem Chinook Salmon from the IGD–Shasta River carcass survey (KRTT 2015, 2016a, 2017) was used as a surrogate for apportioning escapement by age class in the mainstem Klamath River below the Shasta River. Jack (age-2 fish) escapement (N_{jack}) was estimated in the following equation where P_{age2} is the jack proportion based on scale readings from the carcass survey:

$$\hat{N}_{jack} = \frac{\hat{N}_{adult}}{\left(1 - P_{age2}\right)} - \hat{N}_{adult} .$$

Results and Discussion

River Discharge and Water Clarity

In 2014, mean daily discharge in the mainstem Klamath River during the survey period ranged from 953 to 1,691 ft^3/s below IGD ($\bar{x}$ = 1,136 ft^3/s) and from 1,260 to 2,270 ft^3/s ($\bar{x}$ = 1,613 ft^3/s) near Seiad Valley (Figure 3). Secchi disk depth readings ranged from 1.2 to 1.8 m ($\bar{x}$ = 1.5 m) during these surveys (Figure 3). The shallowest Secchi depths were measured on October 29, November 19, and December 3 (1.2 m), while the deepest were measured November 5 and November 12 (1.8 m). Fairly stable discharge conditions throughout the survey period, with some small changes in regime, did not impact the survey.

In 2015, mean daily discharge in the mainstem Klamath River during the survey period ranged from 913 to 1,090 ft^3/s below IGD ($\bar{x}$ = 1,010 ft^3/s) and from 1,153 to 1,357 ft^3/s ($\bar{x}$ = 1,244 ft^3/s) near Seiad Valley (Figure 4). Secchi disk depth readings ranged from 0.9 to 1.2 m ($\bar{x}$ = 1.2 m) during these surveys (Figure 4). The shallowest Secchi depth was

measured on November 18 (0.9 m), while the deepest were measured on October 21, October 28, November 4, and November 11 (1.2 m). Stable flows and relatively high water clarity provided suitable conditions for the redd surveys throughout the sampling period.

In 2016, mean daily discharge in the mainstem Klamath River during the survey period ranged from 946 to 2,550 ft^3/s below IGD ($\bar{x}$ = 1,014 ft^3/s) and from 1,220 to 4,650 ft^3/s ($\bar{x}$ = 2,373 ft^3/s) near Seiad Valley (Figure 5). Secchi disk depth readings ranged from 1.5 to 3.0 m ($\bar{x}$ = 2.2 m) during the survey period (Figure 5). The shallowest Secchi depth was recorded on November 16 (1.5 m) and the deepest was measured November 9 (3.0 m). During the survey period there were two notable discharge events on October 31 and November 10. These discharge events decreased water clarity, but likely had minimal effect on the total redd count for the survey period. Due to the short duration of events and the nature of the redd survey protocol, redds constructed during these periods were likely observed and recorded when water clarity improved the following week.

Redd Counts and Escapement Estimates

We observed 3,456 redds in 2014, which represent 6,912 adult fall Chinook Salmon in the mainstem Klamath River between the Shasta River and Indian Creek confluences (Reaches 2–6; Appendix A; Figure 6). Applying the surrogate jack proportion of 7.6% from the IGD–Shasta River carcass survey, jack escapement was estimated to be 569 (KRTT 2015). Peak redd counts in 2014 occurred during Calendar Week (CW) 44 for Reaches 2 and 6, and CW 43 for Reaches 3, 4, and 5 (Appendix A). The highest concentration of redds was in Reach 6 (57.3 redds/km) and the lowest was in Reach 2 (11.8 redds/km; Appendix A).

We observed 2,492 redds in 2015, which represent 4,984 adult fall Chinook Salmon in the mainstem Klamath River between the Shasta River and Indian Creek confluences (Reaches 2–6; Appendix A; Figure 6). Applying the surrogate jack proportion of 3.4% from the IGD–Shasta River carcass survey, jack escapement was estimated to be 175 (KRTT 2016a). Peak redd counts in 2015 occurred during CW 43 for Reaches 2, 4, and 6, CW 44 for Reach 3, and CW 42 for Reach 5 (Appendix A). The highest concentration of redds was in Reach 6 (43.0 redds/km) and the lowest was in Reach 2 (11.2 redds/km; Appendix A).

We observed 1,097 redds in 2016, which represent 2,194 adult fall Chinook Salmon in the mainstem Klamath River between the Shasta River and Indian Creek confluences (Appendix A; Figure 6). Applying the surrogate jack proportion of 5.2% from the IGD–Shasta River carcass survey, jack escapement was estimated to be 121 (KRTT 2017). Peak redd counts in 2016 occurred during CW 42 for Reach 6, CW 43 for Reaches 2 and 5, CW 44 for Reach 3, and CW 45 for Reach 4 (Appendix A). The highest concentration of redds was in Reach 6 (23.9 redds/km) and the lowest was in Reach 2 (4.7 redds/km; Appendix A).

The 2014 redd count was the largest number of observed redds for this section of river since annual surveys began in 1993 and was 3.2 times more than the previous 21-year mean (1,084; Figure 6; Figure 7; Appendix A). Redd numbers from this survey ranged from 243 (in 1993) to 3,390 (in 2012) prior to 2014. The 2015 redd count was 2.1 times more than the previous 22-year mean (1,192) and the 2016 count was 0.88 times less than the previous 23-year mean (1,248).

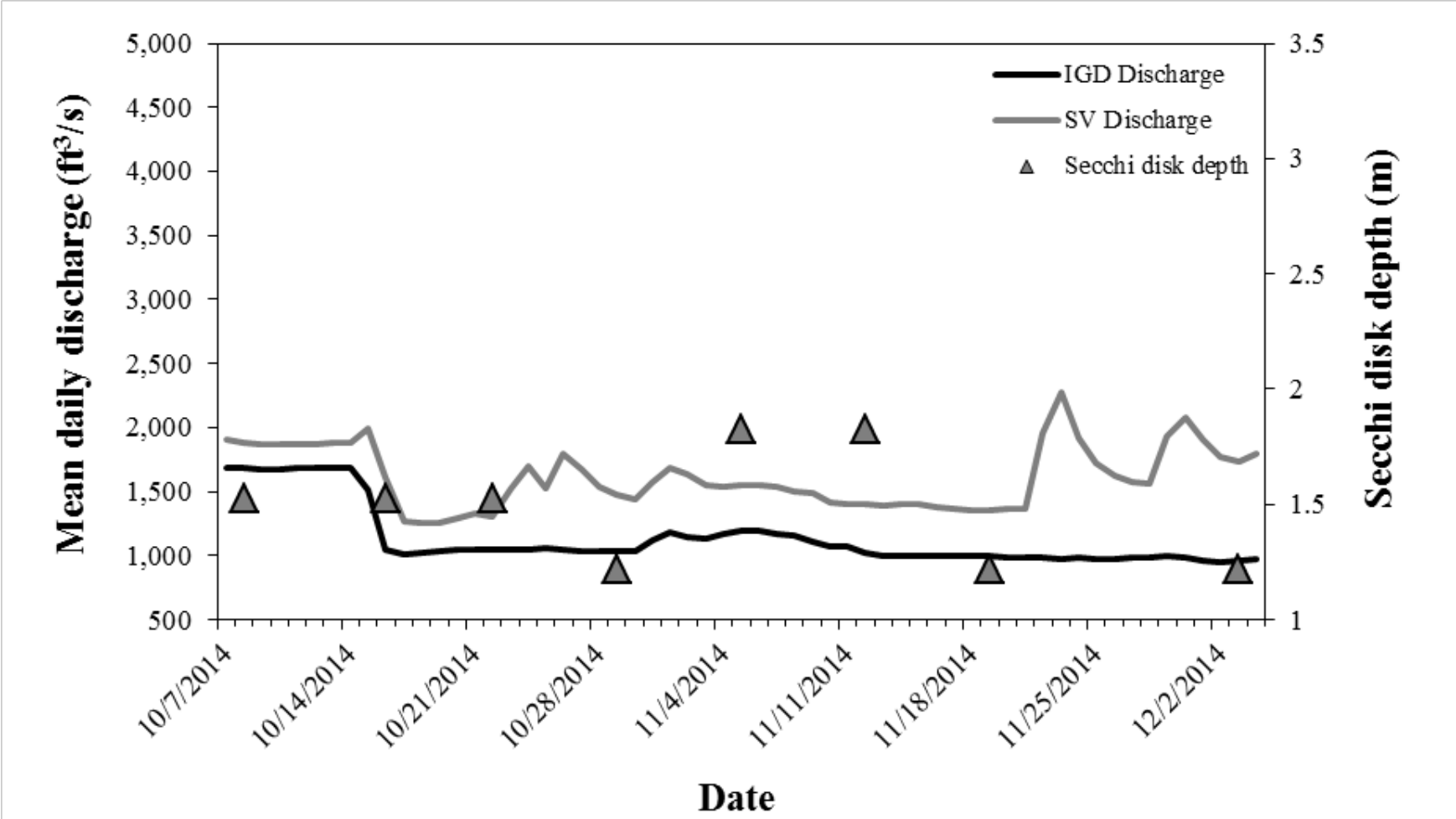

Figure 3. Mean daily discharge below Iron Gate Dam (USGS gaging station 11516530) and near Seiad Valley (USGS gaging station 11520500) from October 7 to December 4, 2014, and Secchi depth readings taken each survey week in Reach 5.

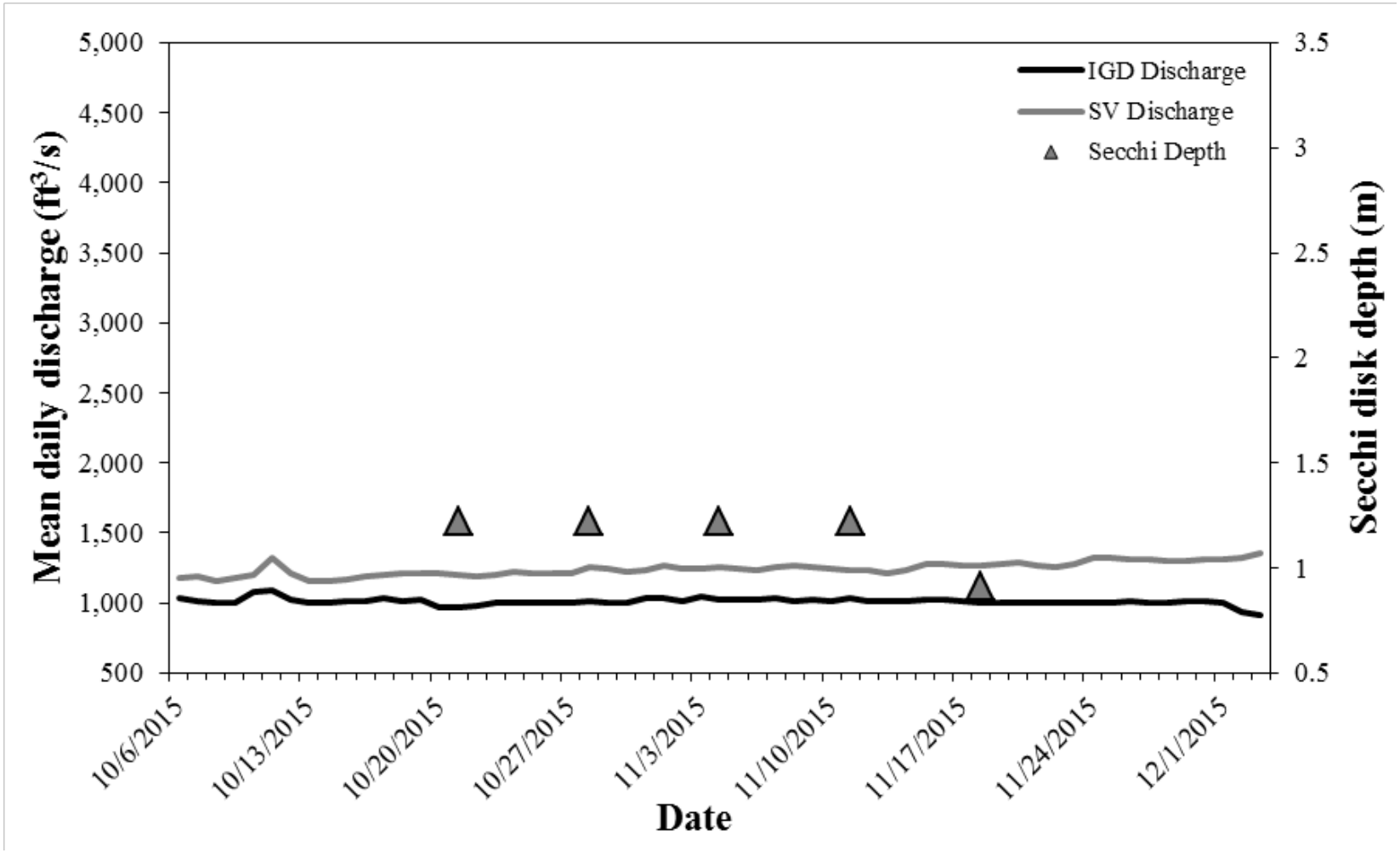

Figure 4. Mean daily discharge below Iron Gate Dam (USGS gaging station 11516530) and near Seiad Valley (USGS Gaging station 11520500) from October 6 to December 3, 2015, and Secchi depth readings taken each survey week in Reach 5.

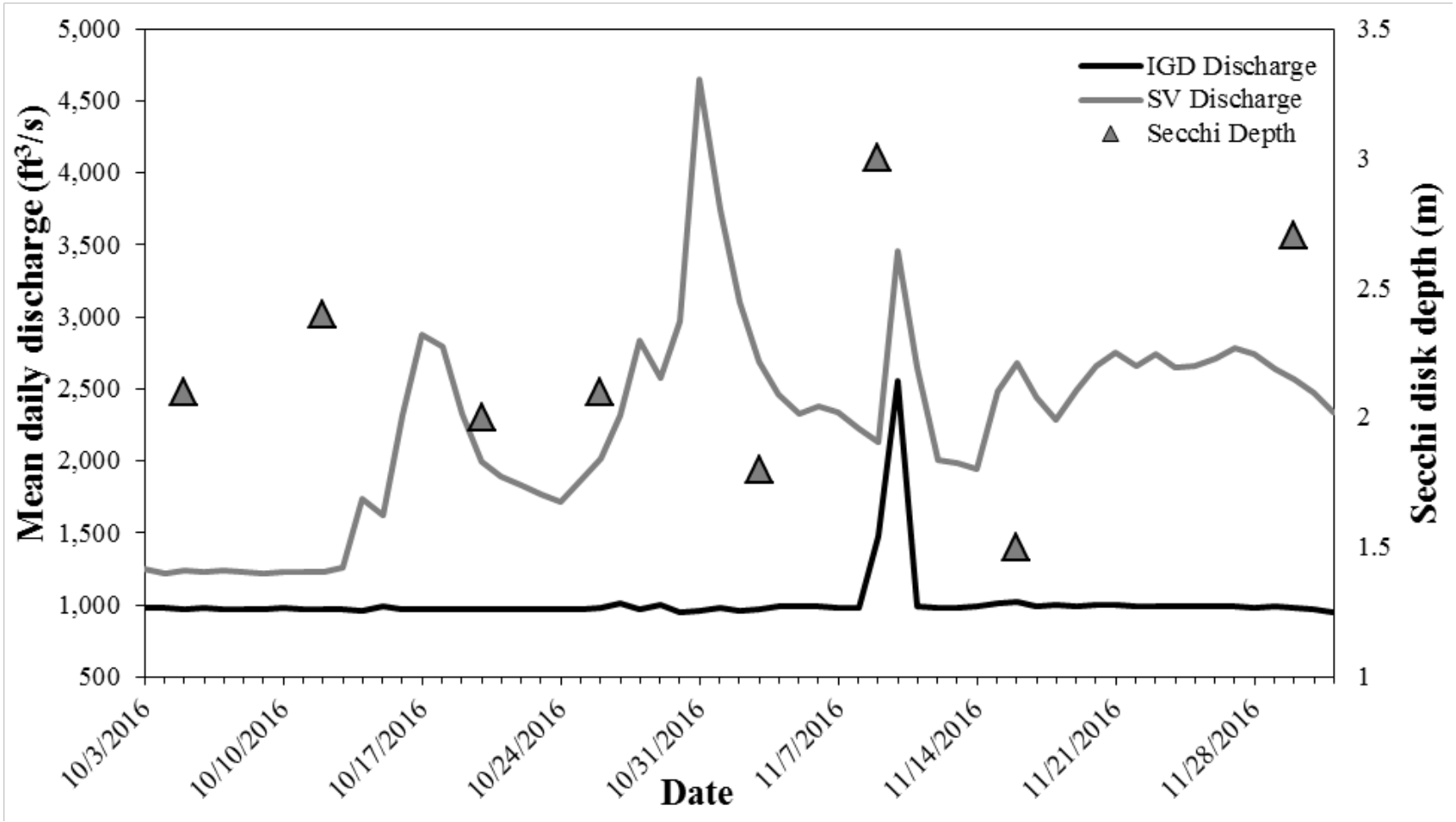

Figure 5. Mean daily discharge below Iron Gate Dam (USGS gaging station 11516530) and near Seiad Valley (USGS Gaging station 11520500) from October 3 to December 1, 2016, and Secchi depth readings taken each survey week in Reach 5.

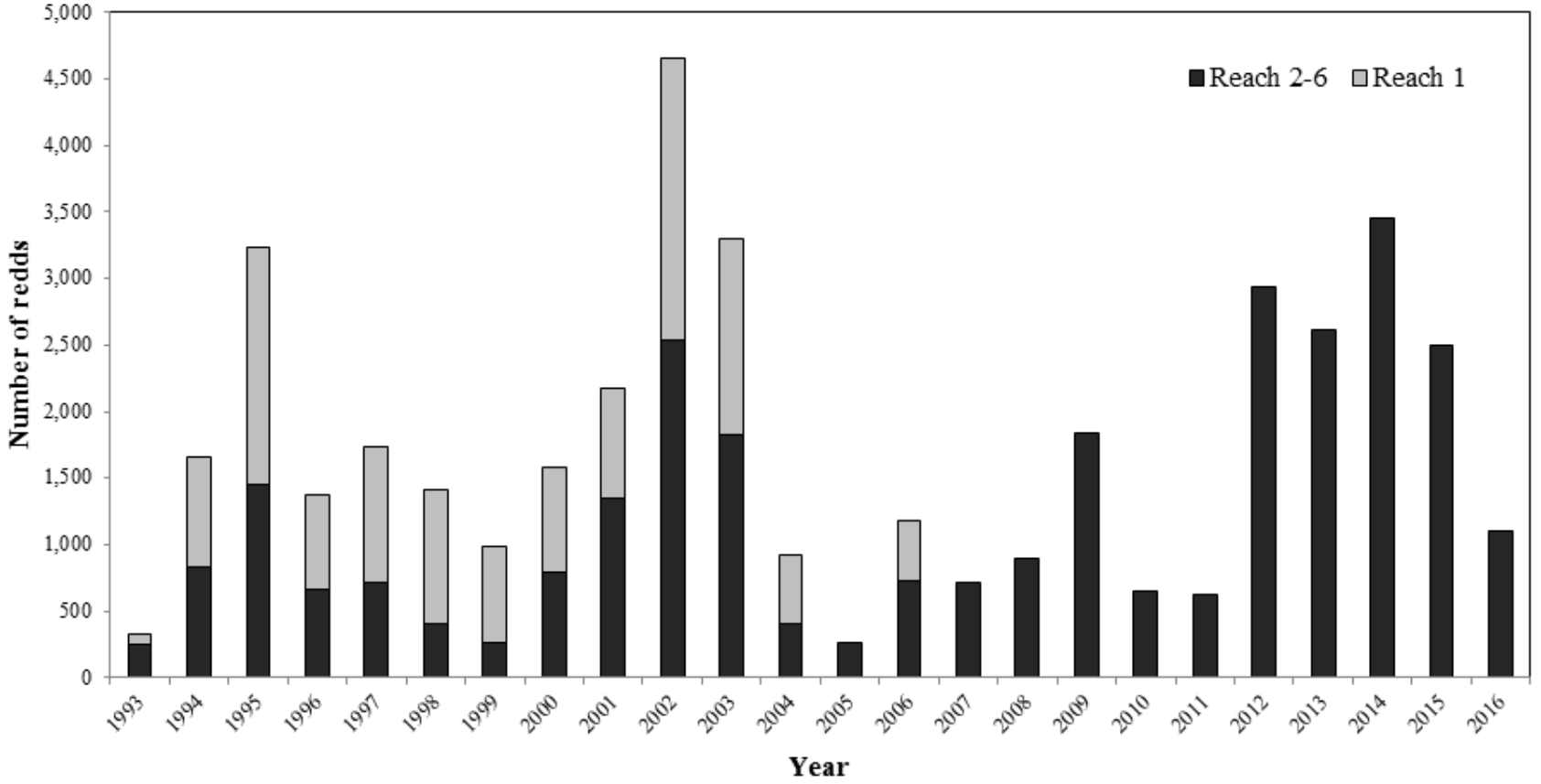

Figure 6. Mainstem Klamath River fall Chinook Salmon redd counts, 1993–2016. Reach 1 was surveyed from 1993 to 2004 and in 2006.

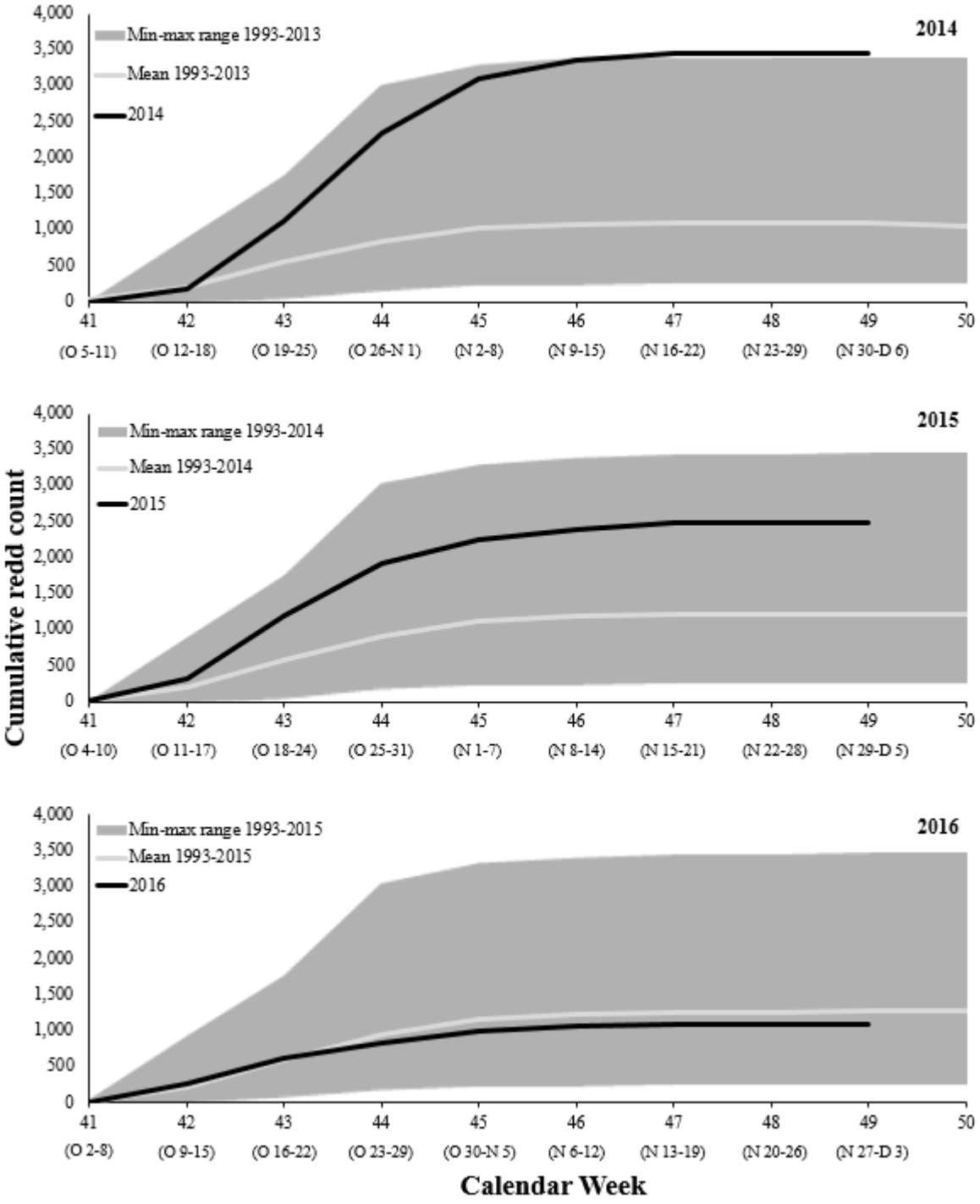

Figure 7. Cumulative Chinook Salmon redd counts by Calendar Week, 2014–2016, compared to previous years' surveys respective mean and range.

Peak counts of new redds occurred during CW 44 in 2014 and in CW 43 during the 2015 and 2016 surveys (Figure 7; Appendix A). In past years' surveys, peak counts of new redds in Reaches 2–6 typically occurred in CW 43 or 44 (mid- to late October; Appendix A).

Redd Density and Distribution

Like the majority of previous years (1993–1997 and 2005–2013, excluding Reach 1 when surveyed), redd density was highest in Reach 6 in 2014, 2015, and 2016 (Appendix A). In particular, the single largest aggregation of redds in each of the yearly surveys covered by this report was in Reach 6 between rkm 188 and 189 (Appendix B, Appendix C, Appendix D). This aggregation was associated with a large low-gradient riffle. Reach 6 has had the highest redd density for 14 of the past 20 years of this survey, excluding Reach 1 when surveyed, which historically had higher redd densities than all other reaches (Appendix A).

The spatial distribution of redds was similar for all three years. In Reaches 2, 4, and 5, redds were unevenly distributed in small patches with several large aggregations. In Reach 3, redds were more evenly distributed. In Reach 6 large aggregations of redds were interspersed with stretches containing few or no redds (Appendix B, Appendix C, Appendix D). This spatial distribution was generally consistent across all previous years where spatial distribution data was available (1999–2013; Grove et al. 2006; Grove and Magneson 2006a-c; Magneson 2006, 2008, 2013; Magneson et al. 2008; Magneson and Wright 2010, 2013; Wright and Magneson 2010; Magneson and Colombano 2014a, 2014b).

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Appendix A. Weekly summary of mainstem Klamath River fall Chinook Salmon redd counts, 1993–2016. R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek (note: the 2.7-km section from the Shasta River to Ash Creek was not surveyed and was assumed to have no redds), R3 = Beaver Creek to Blue Heron river access, R4 = Blue Heron river access to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek; Ns = no survey

	Calendar		Reach						
Year	**week**	**Survey dates**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**Total**
1993	44	Oct 25 to 29	15	13	30	18	16	81	173
	45	Nov 1 to 5	67	24	4	1	15	5	116
	46	Nov 8 to 12	5	1	18	7	0	1	32
	47	Nov 15 to 18	0	0	4	5	0	0	9
		Reach Total	87	38	56	31	31	87	**330**
		Percent of Total	26.4%	11.5%	17.0%	9.4%	9.4%	26.4%	
		Redd Density	4.0/km	1.4/km	2.0/km	1.5/km	1.5/km	4.7/km	
1994	43	Oct 17 to 21	89	28	48	Ns	Ns	98	263
	44	Oct 24 to 28	278	59	77	113	98	124	749
	45	Oct 31 to Nov 4	375	20	46	42	16	33	532
	46	Nov 7 to 11	86	Ns	Ns	Ns	Ns	Ns	86
	47	Nov 14 to 18	3	2	7	4	5	5	26
		Reach Total	831	109	178	159	119	260	**1,656**
		Percent of Total	50.2%	6.6%	10.7%	9.6%	7.2%	15.7%	
		Redd Density	37.9/km	4.1/km	6.4/km	7.7/km	5.6/km	14.0/km	
1995	42	Oct 16 to 20	138	12	70	26	30	139	415
	43	Oct 23 to 27	598	82	199	94	91	169	1,233
	44	Oct 30 to Nov 3	727	58	78	35	57	112	1,067
	45	Nov 6 to 10	277	26	49	13	25	50	440
	46	Nov 13 to 17	Ns	Ns	Ns	Ns	Ns	Ns	0
	47	Nov 20 to 24	Ns	Ns	Ns	Ns	Ns	Ns	0
	48	Nov 27 to Dec 1	39	9	14	4	12	3	81
		Reach Total	1,779	187	410	172	215	473	**3,236**
		Percent of Total	55.0%	5.8%	12.7%	5.3%	6.6%	14.6%	
		Redd Density	81.2/km	7.1/km	14.9/km	8.3/km	10.1/km	25.4/km	
1996	43	Oct 21 to 25	290	31	96	10	118	39	584
	44	Oct 28 to Nov 1	291	29	25	22	42	92	501
	45	Nov 4 to 8	83	4	24	8	33	59	211
	46	Nov 11 to 15	40	0	6	0	7	23	76
		Reach Total	704	64	151	40	200	213	**1,372**
		Percent of Total	51.3%	4.7%	11.0%	2.9%	14.6%	15.5%	
		Redd Density	32.1/km	2.4/km	5.5/km	1.9/km	9.4/km	11.5/km	
1997	42	Oct 16	272	Ns	Ns	Ns	Ns	Ns	272
	43	Oct 20 to 24	252	37	69	89	29	136	612
	44	Oct 27 to 31	424	18	76	52	22	76	668
	45	Nov 3 to 7	70	7	13	16	8	27	141
	46	Nov 10 to 14	2	14	4	5	3	18	46
		Reach Total	1,020	76	162	162	62	257	**1,739**
		Percent of Total	58.7%	4.4%	9.3%	9.3%	3.6%	14.8%	
		Redd Density	46.6/km	2.9/km	5.9/km	7.8/km	2.9/km	13.8/km	

Appendix A (continued). Weekly summary of mainstem Klamath River fall Chinook Salmon redd counts, 1993–2016. R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek (note: the 2.7-km section from the Shasta River to Ash Creek was not surveyed and was assumed to have no redds), R3 = Beaver Creek to Blue Heron river access, R4 = Blue Heron river access to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek; Ns = no survey.

	Calendar		Reach						
Year	**week**	**Survey dates**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**Total**
1998	42	Oct 14 to 15	89	Ns	Ns	Ns	Ns	Ns	89
	43	Oct 19 to 23	180	45	67	15	20	45	372
	44	Oct 26 to 30	368	11	12	14	7	39	451
	45	Nov 2 to 6	226	22	33	10	9	28	328
	46	Nov 9 to 12	135	3	11	3	2	2	156
	47	Nov 15 to 19	12	1	3	0	1	2	19
		Reach Total	1,010	82	126	42	39	116	**1,415**
		Percent of Total	71.4%	5.8%	8.9%	3.0%	2.8%	8.2%	
		Redd Density	46.1/km	3.1/km	4.6/km	2.0/km	1.8/km	6.2/km	
1999	42	Oct 13 to 15	98	3	Ns	Ns	Ns	Ns	101
	43	Oct 18 to 22	200	27	31	17	23	39	337
	44	Oct 25 to 27	304	23	20	Ns	Ns	Ns	347
	45	Nov 1 to 5	83	12	9	8	8	19	139
	46	Nov 8 to 12	37	2	2	1	5	11	58
	47	Nov 15 to 19	1	2	0	2	2	0	7
		Reach Total	723	69	62	28	38	69	**989**
		Percent of Total	73.1%	7.0%	6.3%	2.8%	3.8%	7.0%	
		Redd Density	33.0/km	2.6/km	2.2/km	1.4/km	1.8/km	3.7/km	
2000	43	Oct 16 to 20	327	92	69	25	10	19	542
	44	Oct 23 to 27	146	62	34	52	10	53	357
	45	Oct 30 to Nov 3	254	42	69	54	20	86	525
	46	Nov 6 to 10	57	12	15	21	2	16	123
	47	Nov 13 to 17	4	0	9	12	0	6	30
	48	Nov 20 to 22	1	Ns	Ns	Ns	Ns	Ns	1
		Reach Total	789	208	196	164	42	180	**1,579**
		Percent of Total	50.0%	13.2%	12.4%	10.4%	2.7%	11.4%	
		Redd Density	36.0/km	7.8/km	7.1/km	7.9/km	2.0/km	9.7/km	
2001	42	Oct 15 to 19	92	24	28	21	2	23	190
	43	Oct 22 to 26	168	102	128	59	40	82	579
	44	Oct 29 to Nov 2	323	97	170	102	55	139	886
	45	Nov 5 to 9	155	10	40	12	31	29	277
	46	Nov 12 to 16	75	31	49	22	9	Ns	186
	47	Nov 19 to 23	Ns	Ns	Ns	Ns	Ns	Ns	0
	48	Nov 26 to 30	17	Ns	Ns	Ns	Ns	Ns	17
	49	Dec 3 to 7	Ns	Ns	12	Ns	Ns	5	17
	50	Dec 10 to 14	Ns	5	8	4	3	Ns	20
		Reach Total	830	269	435	220	140	278	**2,172**
		Percent of Total	38.2%	12.4%	20.0%	10.1%	6.4%	12.8%	
		Redd Density	37.9/km	10.2/km	15.8/km	10.6/km	6.6/km	14.9/km	

Appendix A (continued). Weekly summary of mainstem Klamath River fall Chinook Salmon redd counts, 1993–2016. R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek (note: the 2.7-km section from the Shasta River to Ash Creek was not surveyed and was assumed to have no redds), R3 = Beaver Creek to Blue Heron river access, R4 = Blue Heron river access to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek; Ns = no survey.

	Calendar		Reach						
Year	week	Survey dates	R1	R2	R3	R4	R5	R6	Total
2002	41	Oct 10	8	Ns	Ns	Ns	Ns	Ns	8
	42	Oct 15 to 18	124	90	120	71	61	146	612
	43	Oct 21 to 25	885	198	340	186	141	181	1,931
	44	Oct 29 to Nov 1	549	112	148	90	69	66	1,034
	45	Nov 4 to 8	335	90	62	38	20	21	566
	46	Nov 12 to 15	136	56	39	46	14	65	356
	47	Nov 19 to 22	76	20	10	10	5	15	136
	48	Nov 26 to 29	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Dec 2 to 6	0	0	7	0	1	1	9
		Reach Total	2,113	566	726	441	311	495	**4,652**
		Percent of Total	45.4%	12.2%	15.6%	9.5%	6.7%	10.6%	
		Redd Density	96.5/km	21.4/km	26.3/km	21.3/km	14.7/km	26.6/km	
2003	42	Oct 14 to 17	0	Ns	38	22	19	48	127
	43	Oct 20 to 24	563	194	228	178	77	150	1,390
	44	Oct 27 to 31	553	73	103	18	119	99	965
	45	Nov 4 to 7	310	33	97	61	50	74	625
	46	Nov 12 to 15	44	43	14	11	15	48	175
	47	Nov 19 to 22	2	0	4	2	5	7	20
		Reach Total	1,472	343	484	292	285	426	**3,302**
		Percent of Total	44.6%	10.4%	14.7%	8.8%	8.6%	12.9%	
		Redd Density	67.2/km	12.9/km	17.5/km	14.1/km	13.4%	22.9/km	
2004	42	Oct 11 to 15	Ns	0	6	1	3	0	10
	43	Oct 18 to 22	Ns	57	45	27	17	11	157
	44	Oct 25 to 29	Ns	22	37	9	17	25	110
	45	Nov 1 to 5	513	36	27	14	7	10	607
	46	Nov 8 to 12	Ns	2	10	4	4	3	23
	47	Nov 15 to 19	Ns	Ns	Ns	Ns	Ns	Ns	0
	48	Nov 22 to 26	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Nov 29 to Dec 3	Ns	0	9	0	0	0	9
		Reach Total	513	117	134	55	48	49	**916**
		Percent of Total	56.0%	12.8%	14.6%	6.0%	5.2%	5.3%	
		Redd Density	23.4/km	4.4/km	4.9/km	2.7/km	2.3/km	2.6/km	
2005	43	Oct 18 to 20	Ns	12	14	3	3	27	59
	44	Oct 25 to 27	Ns	10	17	15	17	37	96
	45	Nov 1 to 3	Ns	9	8	8	7	20	52
	46	Nov 8 to 10	Ns	Ns	Ns	Ns	Ns	Ns	0
	47	Nov 15 to 17	Ns	8	1	20	1	31	61
		Reach Total	-	39	40	46	28	115	**268** [a]
		Percent of Total[a]	-	14.6%	14.9%	17.2%	10.4%	42.9%	
		Redd Density	-	1.5/km	1.4/km	2.2/km	1.3/km	6.2/km	

[a] Reach 1 was not surveyed.

Appendix A (continued). Weekly summary of mainstem Klamath River fall Chinook Salmon redd counts, 1993–2016. R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek (note: the 2.7-km section from the Shasta River to Ash Creek was not surveyed and was assumed to have no redds), R3 = Beaver Creek to Blue Heron river access, R4 = Blue Heron river access to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek; Ns = no survey.

	Calendar		Reach						
Year	week	Survey dates	R1	R2	R3	R4	R5	R6	Total
2006	42	Oct 16 to 20	109	21	41	66	31	155	423
	43	Oct 23 to 27	167	17	30	61	21	55	351
	44	Oct 30 to Nov 3	96	10	33	12	Ns	6	157
	45	Nov 6 to 10	66	3	9	7	19	110	214
	46	Nov 13 to 15	15	6	4	Ns	Ns	Ns	25
	47	Nov 20 to 24	Ns	Ns	Ns	Ns	Ns	Ns	0
	48	Nov 29	Ns	Ns	Ns	Ns	Ns	16	16
		Reach Total	453	57	117	146	71	342	**1,186**
		Percent of Total	38.2%	4.8%	9.9%	12.3%	6.0%	28.8%	
		Redd Density	20.7/km	2.2/km	4.2/km	7.1/km	3.3/km	18.4/km	
2007	42	Oct 16 to 18	Ns	24	17	36	5	42	124
	43	Oct 23 to 25	Ns	12	53	15	25	67	172
	44	Oct 30 to Nov 1	Ns	25	32	47	21	90	215
	45	Nov 5 to 8	Ns	27	24	37	8	72	168
	46	Nov 14 to 16	Ns	1	7	3	5	9	25
	47	Nov 21 to 23	Ns	Ns	Ns	Ns	Ns	Ns	0
	48	Nov 28 to 29	Ns	Ns	3	Ns	1	4	8
		Reach Total	-	89	136	138	65	284	**712** [a]
		Percent of Total[a]	-	12.5%	19.1%	19.4%	9.1%	39.9%	
		Redd Density	-	3.4/km	4.9/km	6.7/km	3.1/km	15.3/km	
2008	42	Oct 15 to 17	Ns	3	24	13	12	12	64
	43	Oct 21 to 23	Ns	61	24	63	10	60	218
	44	Oct 28 to 30	Ns	30	39	49	36	129	283
	45	Nov 4 to 6	Ns	42	33	23	19	108	225
	46	Nov 11 to 13	Ns	6	4	19	14	31	74
	47	Nov 18 to 20	Ns	5	5	3	1	14	28
	48	Nov 25 to 27	Ns	Ns	Ns	Ns	Ns	Ns	Ns
	49	Dec 2 to 4	Ns	0	6	0	0	0	6
		Reach Total	-	147	135	170	92	354	**898** [a]
		Percent of Total[a]	-	16.4%	15.0%	18.9%	10.2%	39.4%	
		Redd Density	-	5.5/km	4.9/km	8.2/km	4.3/km	19.0/km	
2009	42	Oct 14 to 16	Ns	21	61	42	33	127	284
	43	Oct 20 to 22	Ns	64	103	71	53	247	538
	44	Oct 27 to 29	Ns	30	108	92	69	130	429
	45	Nov 3 to 5	Ns	69	48	110	37	183	447
	46	Nov 10 to 12	Ns	17	14	23	20	31	105
	47	Nov 17 to 19	Ns	0	11	4	6	15	36
	48	Nov 24 to 26	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Dec 2 to 4	Ns	0	0	0	0	1	1
		Reach Total	-	201	345	342	218	734	**1,840** [a]
		Percent of Total[a]	-	10.9%	18.8%	18.6%	11.8%	39.9%	
		Redd Density	-	7.6/km	12.5/km	16.5/km	10.3/km	39.5/km	

[a] Reach 1 was not surveyed.

[b]The count for this reach was estimated.

Appendix A (continued). Weekly summary of mainstem Klamath River fall Chinook Salmon redd counts, 1993–2016. R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek (note: the 2.7-km section from the Shasta River to Ash Creek was not surveyed and was assumed to have no redds), R3 = Beaver Creek to Blue Heron river access, R4 = Blue Heron river access to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek; Ns = no survey.

	Calendar		Reach						
Year	week	Survey dates	R1	R2	R3	R4	R5	R6	Total
2010	42	Oct 13 to 15	Ns	0	1	17	6	16	40
	43	Oct 19 to 21	Ns	37	19	36	19	99	210
	44	Oct 26 to 28	Ns	34	18	39	12	44	147
	45	Nov 2 to 4	Ns	14	3	30	5	67	119
	46	Nov 10 to 12	Ns	2	12	15	9	56	94
	47	Nov 16 to 18	Ns	0	0	11	6	10	27
	48	Nov 23 to 25	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Nov 30 to Dec 2	Ns	0	4	0	4	1	9
		Reach Total	-	87	57	148	61	293	**646** [a]
		Percent of Total[a]	-	13.5%	8.8%	22.9%	9.4%	45.4%	
		Redd Density	-	3.3/km	2.1/km	7.1/km	2.9/km	15.8/km	
2011	42	Oct 12 to 14	Ns	0	5	4	0	7	16
	43	Oct 18 to 20	Ns	2	4	17	14	97	134
	44	Oct 25 to 27	Ns	20	20	29	43	89	201
	45	Nov 1 to 3	Ns	1	22	14	10	80	127
	46	Nov 8 to 10	Ns	11	31	0	16	32	90
	47	Nov 15 to 17	Ns	0	18	8	5	23	54
	48	Nov 22 to 24	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Nov 29 to Dec 1	Ns	0	5	0	4	0	9
		Reach Total	-	34	105	72	92	328	**631** [a]
		Percent of Total[a]	-	5.4%	16.6%	11.4%	14.6%	52.0%	
		Redd Density	-	1.3/km	3.8/km	3.5/km	4.3/km	17.6/km	
2012	41	Oct 10 to 12	Ns	0	0	5	0	27	32
	42	Oct 16 to 18	Ns	20	6	222	87	540	875
	43	Oct 22 to 25	Ns	96	320	Ns	Ns	440	856
	44	Oct 30 to Nov 1	Ns	83	162	458[b]	364	195	804
	45	Nov 6 to 8	Ns	28	43	113	21	76	281
	46	Nov 14 to 16	Ns	3	16	8	18	31	76
	47	Nov 21 to 23	Ns	Ns	Ns	Ns	Ns	Ns	0
	48	Nov 27 to 28	Ns	Ns	8	Ns	0	Ns	8
		Reach Total	-	230	555	348	490	1,309	**2,932** [a]
		Percent of Total[a]	-	7.8%	18.9%	11.9%	16.7%	44.6%	
		Redd Density	-	8.7/km	20.1/km	16.8/km	23.1/km	70.4/km	
2013	43	Oct 22 to 24	Ns	58	358	197	269	549	1,431
	44	Oct 29 to 31	Ns	139	98	137	69	196	639
	45	Nov 5 to 7	Ns	39	71	107	49	126	392
	46	Nov 12 to 14	Ns	4	29	19	14	18	84
	47	Nov 19 to 22	Ns	13	17	8	5	11	54
	48	Nov 26 to 28	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Dec 3 to 5	Ns	0	9	0	0	2	11
		Reach Total	-	253	582	468	406	902	**2,611** [a]
		Percent of Total[a]	-	9.7%	22.3%	17.9%	15.5%	34.5%	
		Redd Density	-	9.5/km	21.1/km	22.6/km	19.2/km	48.5/km	

[a] Reach 1 was not surveyed.

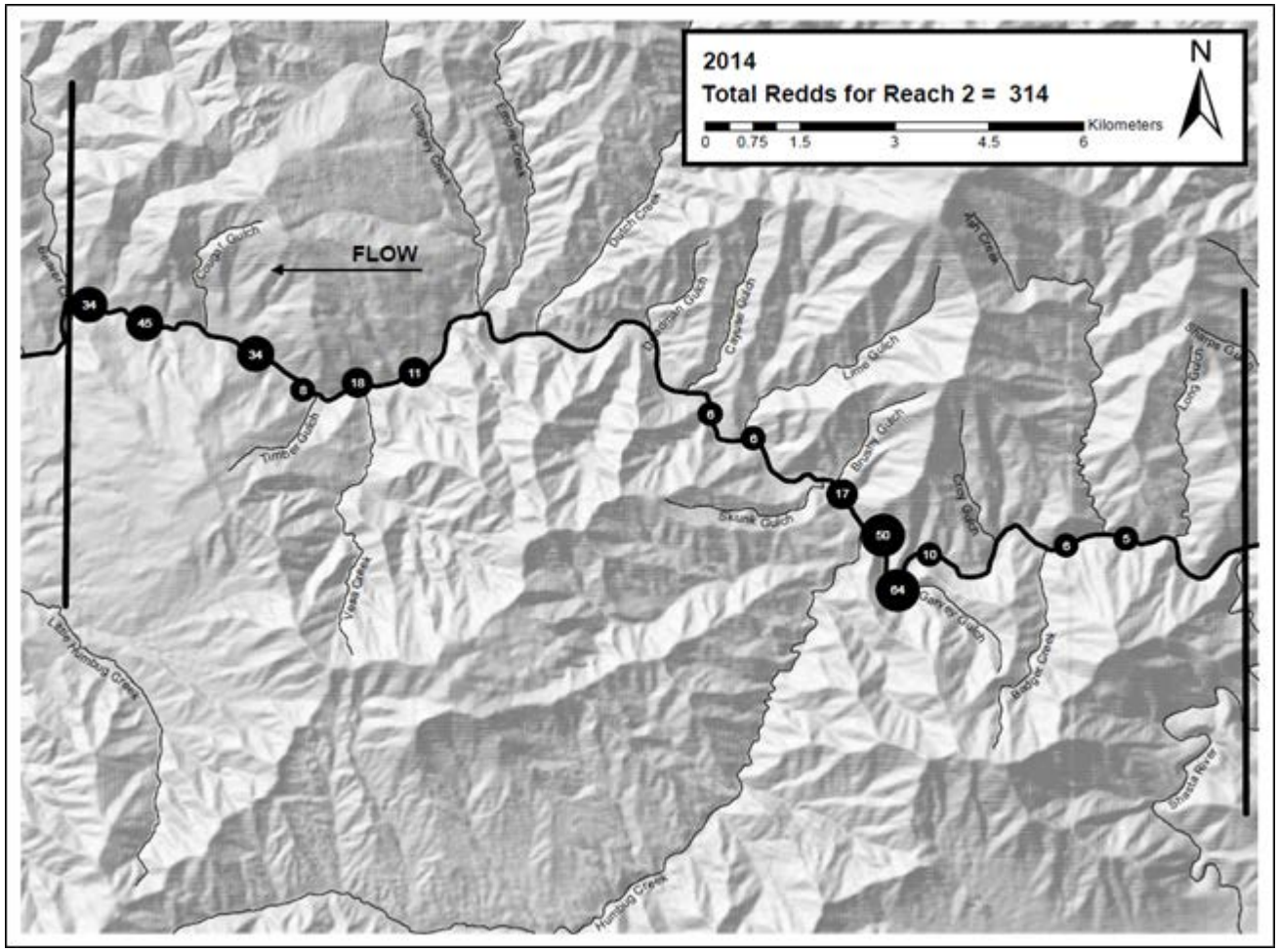
[b] The count for this reach was estimated.

Appendix A (continued). Weekly summary of mainstem Klamath River fall Chinook Salmon redd counts, 1993–2016. R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek (note: the 2.7-km section from the Shasta River to Ash Creek was not surveyed and was assumed to have no redds), R3 = Beaver Creek to Blue Heron river access, R4 = Blue Heron river access to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek; Ns = no survey.

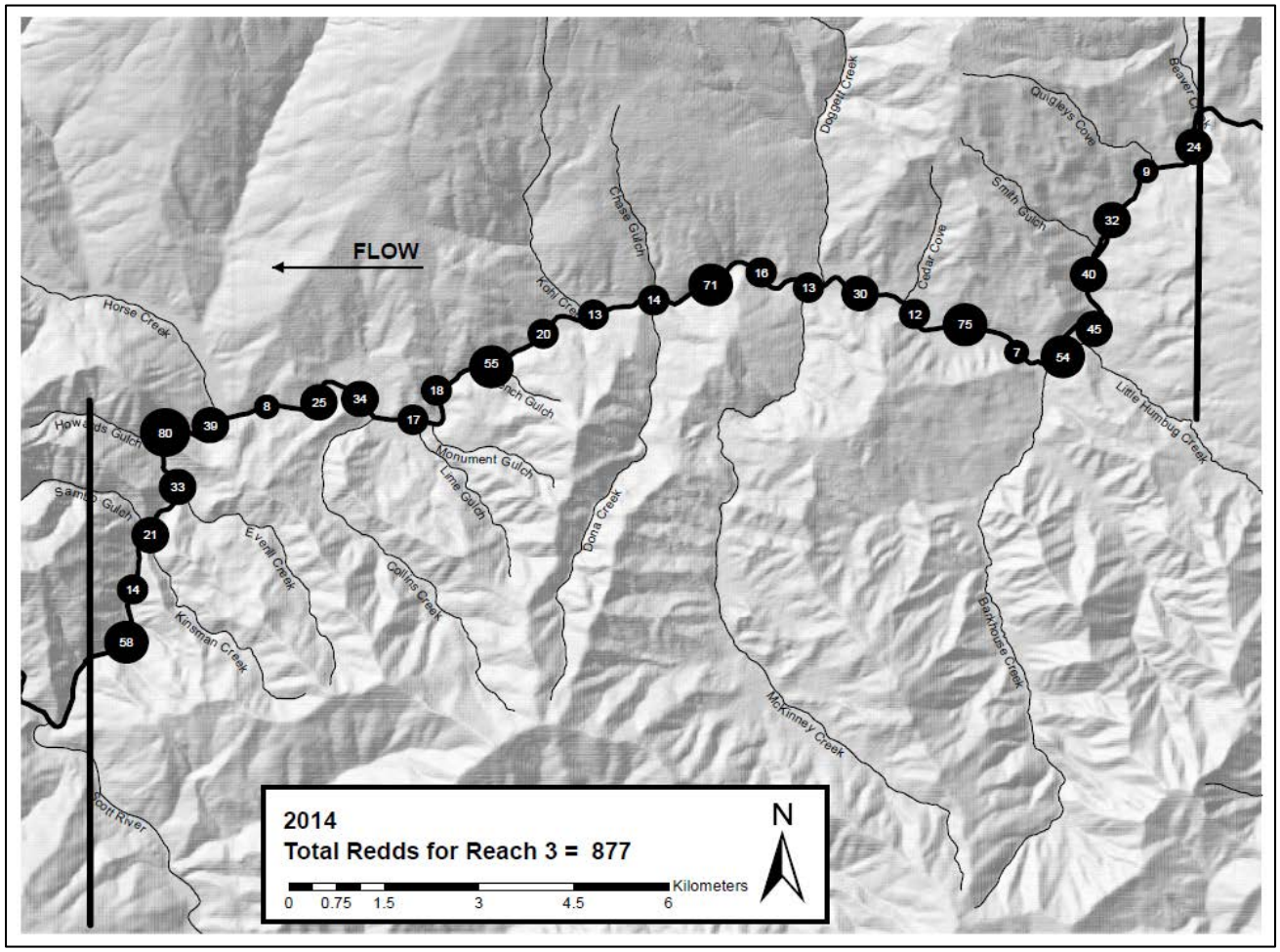
	Calendar		Reach						
Year	week	Survey dates	R1	R2	R3	R4	R5	R6	Total
2014	41	Oct 7 to 9	Ns	0	0	0	1	0	1
	42	Oct 15 to 17	Ns	23	1	5	19	121	169
	43	Oct 21 to 23	Ns	63	338	190	301	68	960
	44	Oct 28 to 30	Ns	104	261	178	124	554	1221
	45	Nov 4 to 7	Ns	87	229	149	71	198	734
	46	Nov 11 to 13	Ns	31	42	85	24	77	259
	47	Nov 18 to 20	Ns	6	5	45	5	37	98
	48	Nov 25 to 27	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Dec 2 to 4	Ns	0	1	0	3	10	14
		Reach Total	-	314	877	652	548	1,065	**3,456** [a]
		Percent of Total[a]	-	9.1%	25.4%	18.9%	15.9%	30.8%	
		Redd Density	-	11.8/km	31.8/km	31.5/km	25.8/km	57.3/km	
2015	41	Oct 6 to 8	Ns	0	4	4	1	10	19
	42	Oct 14 to 16	Ns	22	45	11	59	155	292
	43	Oct 20 to 22	Ns	142	103	301	58	279	883
	44	Oct 27 to 29	Ns	54	131	298	52	189	724
	45	Nov 3 to 5	Ns	30	101	74	38	95	338
	46	Nov 10 to 12	Ns	32	13	37	19	27	128
	47	Nov 17 to 19	Ns	18	21	9	12	42	102
	48	Nov 24 to 26	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Dec 1 to 3	Ns	0	3	0	1	2	6
		Reach Total	-	298	421	734	240	799	**2,492** [a]
		Percent of Total[a]	-	12.0%	16.9%	29.5%	9.6%	32.1%	
		Redd Density	-	11.2/km	15.3/km	35.5/km	11.3/km	43.0/km	
2016	41	Oct 4 to 6	Ns	0	0	0	0	4	4
	42	Oct 11 to 13	Ns	13	28	14	28	172	255
	43	Oct 19 to 21	Ns	56	55	27	99	132	369
	44	Oct 25 to 27	Ns	5	60	29	55	59	208
	45	Nov 2 to 4	Ns	30	18	52	29	42	171
	46	Nov 8 to 10	Ns	6	12	2	24	23	67
	47	Nov 15 to 17	Ns	2	0	0	6	14	22
	48	Nov 21 to 23	Ns	Ns	Ns	Ns	Ns	Ns	0
	49	Nov 29 to Dec 1	Ns	0	0	0	0	1	1
		Reach Total	-	112	173	124	241	447	**1,097** [a]
		Percent of Total[a]	-	10.2%	15.8%	11.3%	22.0%	40.7%	
		Redd Density	-	4.7/km	6.3/km	6.0/km	11.4/km	23.9/km	

[a] Reach 1 was not surveyed.

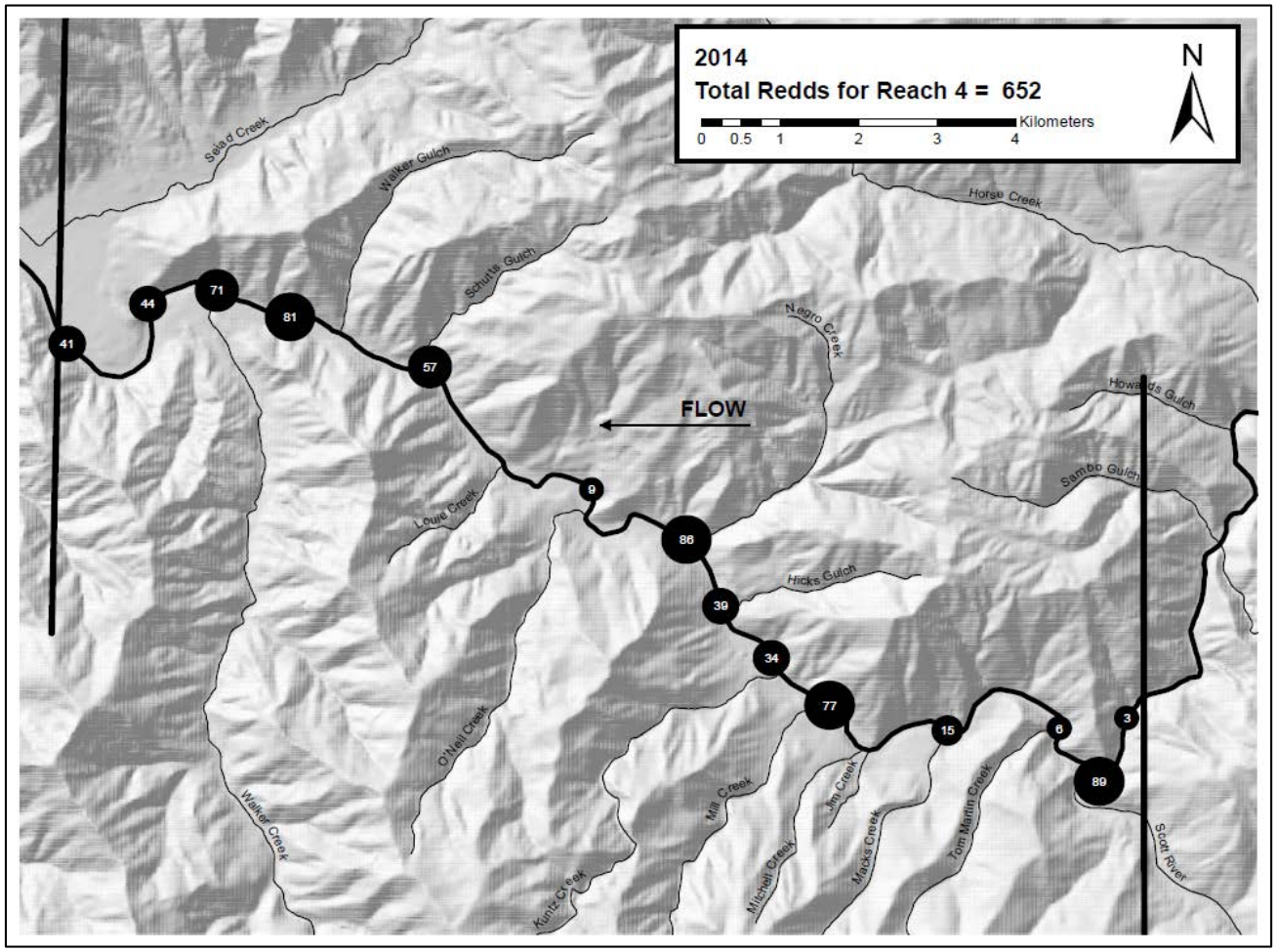
[b]The count for this reach was estimated.



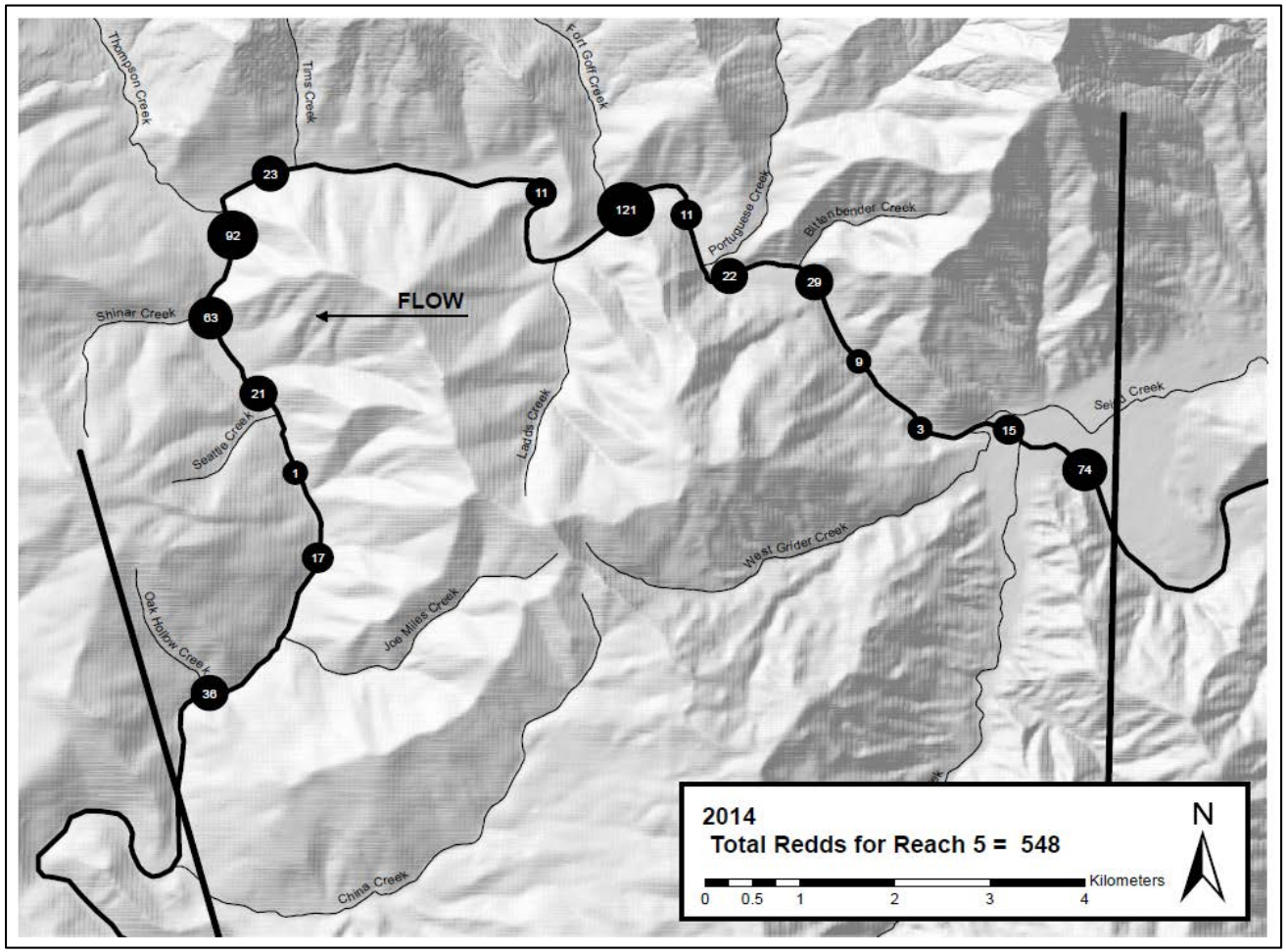
Appendix B. Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2014. Redds are binned to the nearest whole rkm.



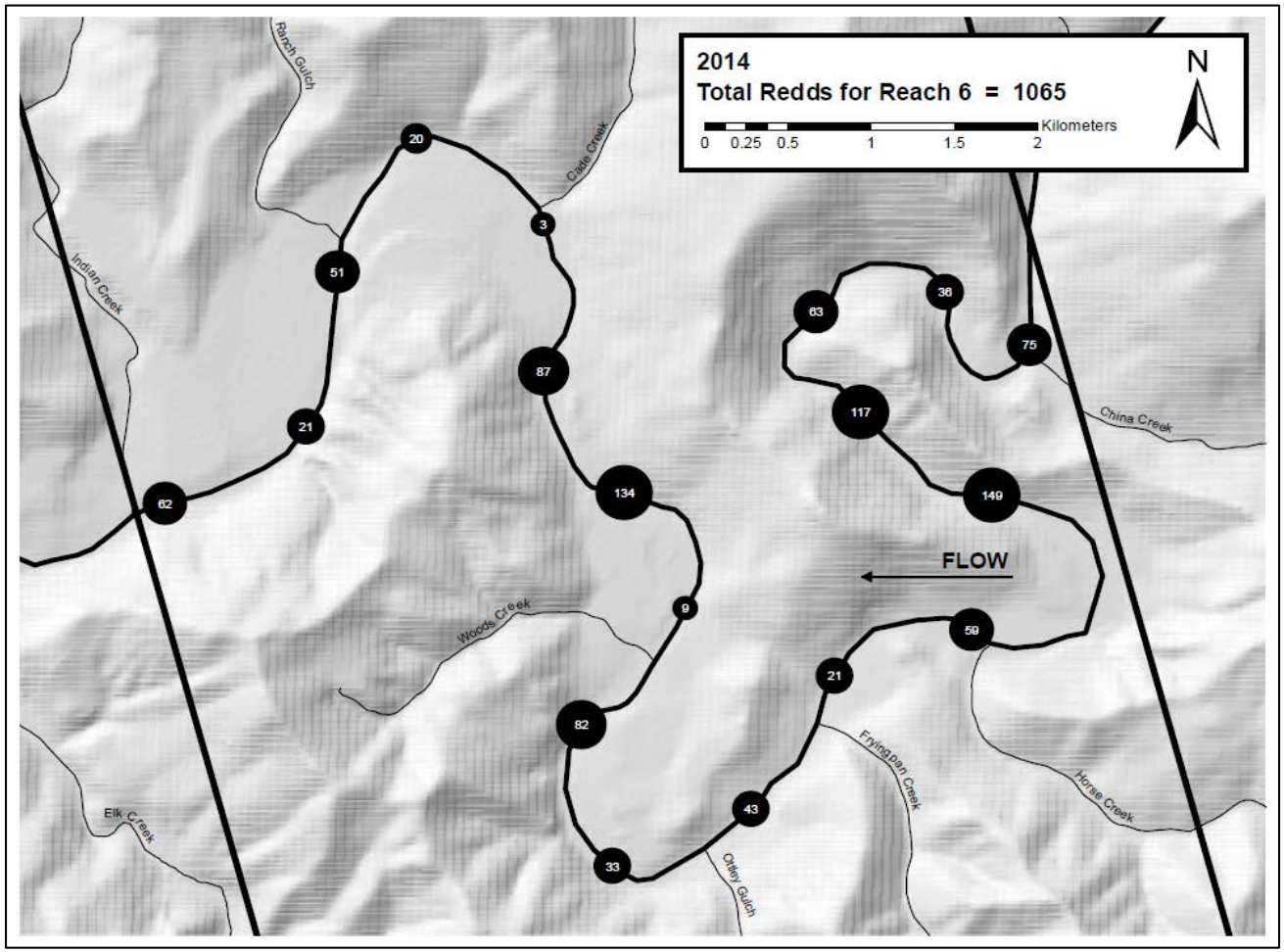
Appendix B (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2014. Redds are binned to the nearest whole rkm.



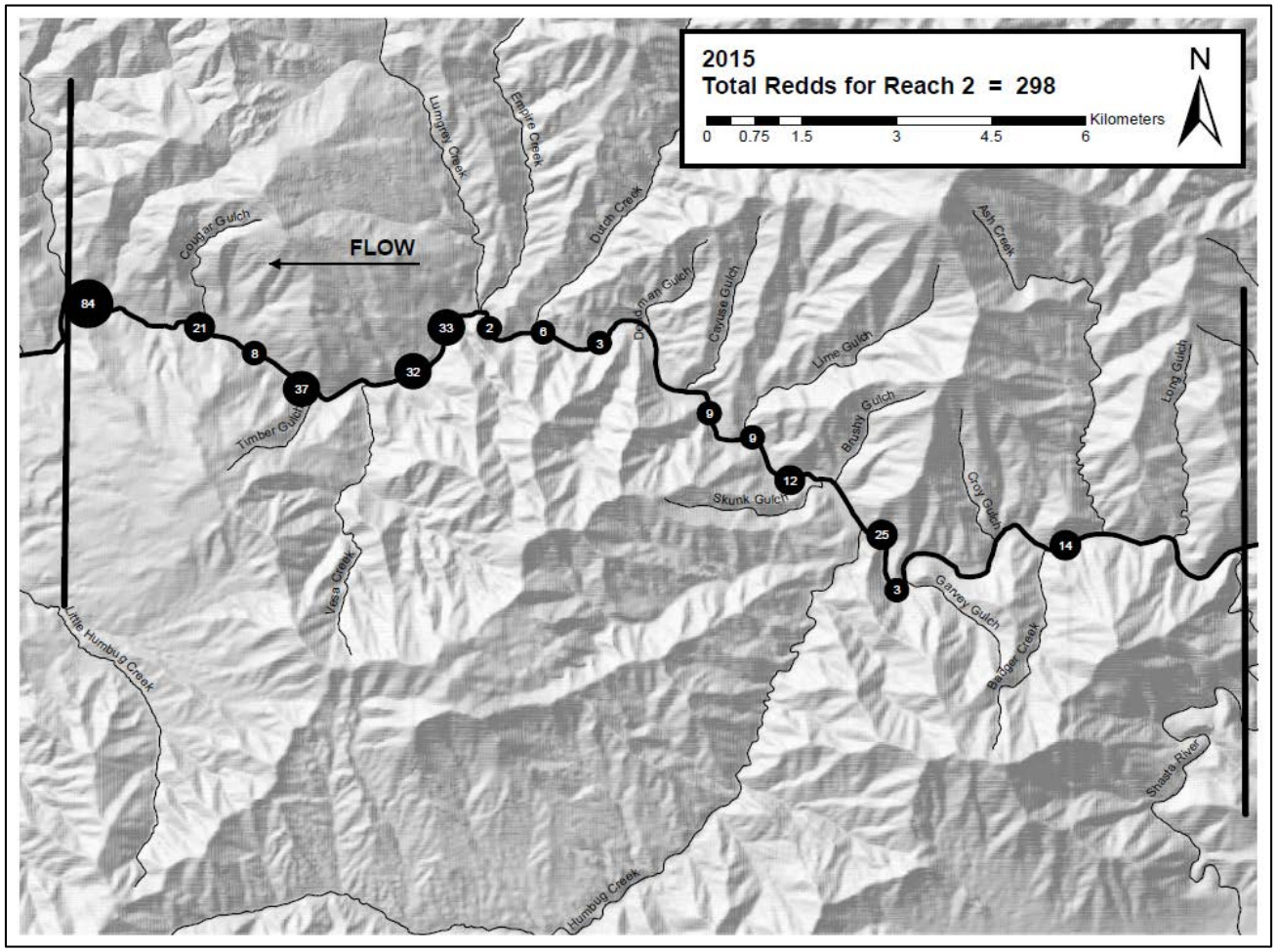
Appendix B (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2014. Redds are binned to the nearest whole rkm.



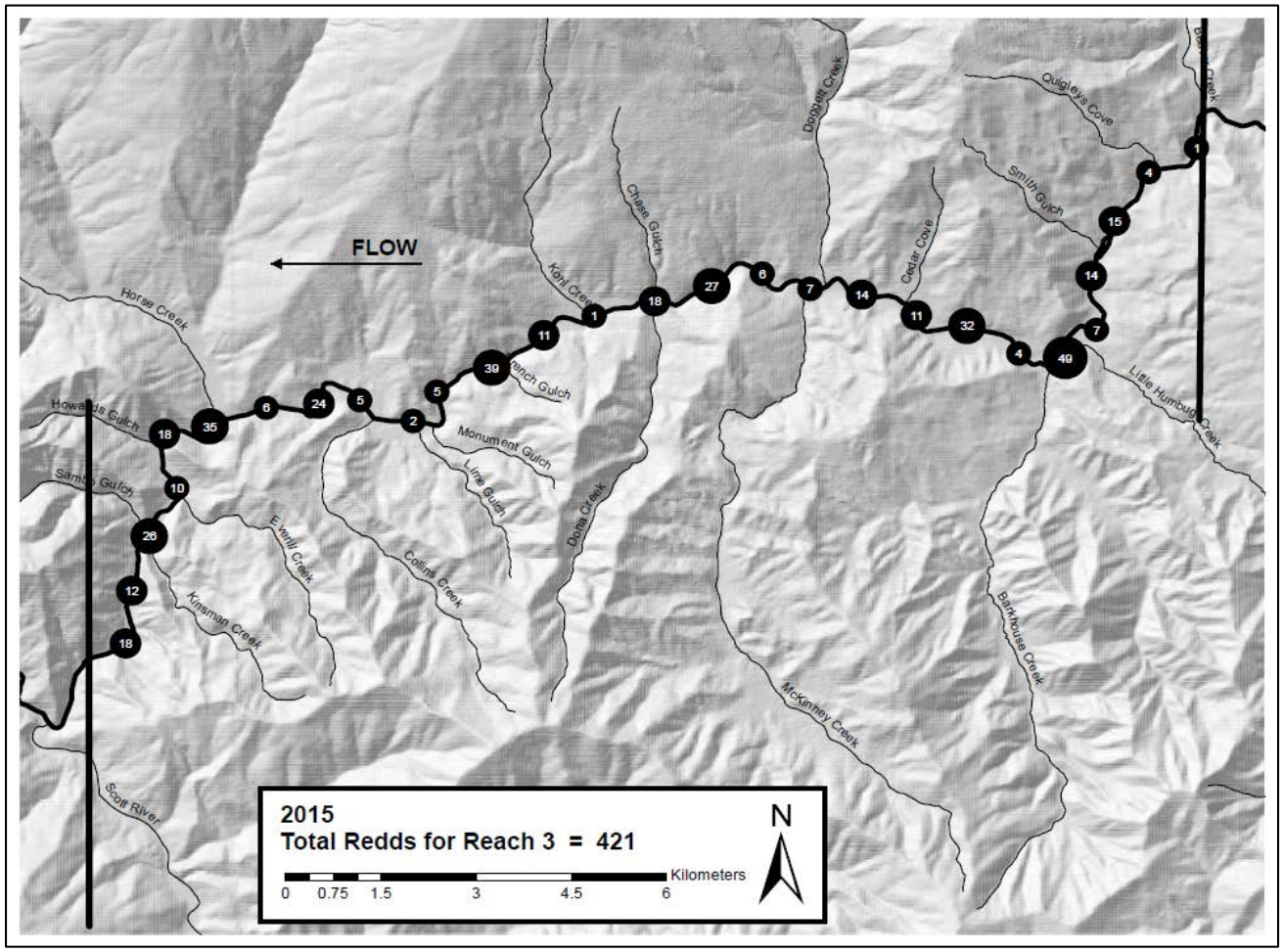
Appendix B (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2014. Redds are binned to the nearest whole rkm.



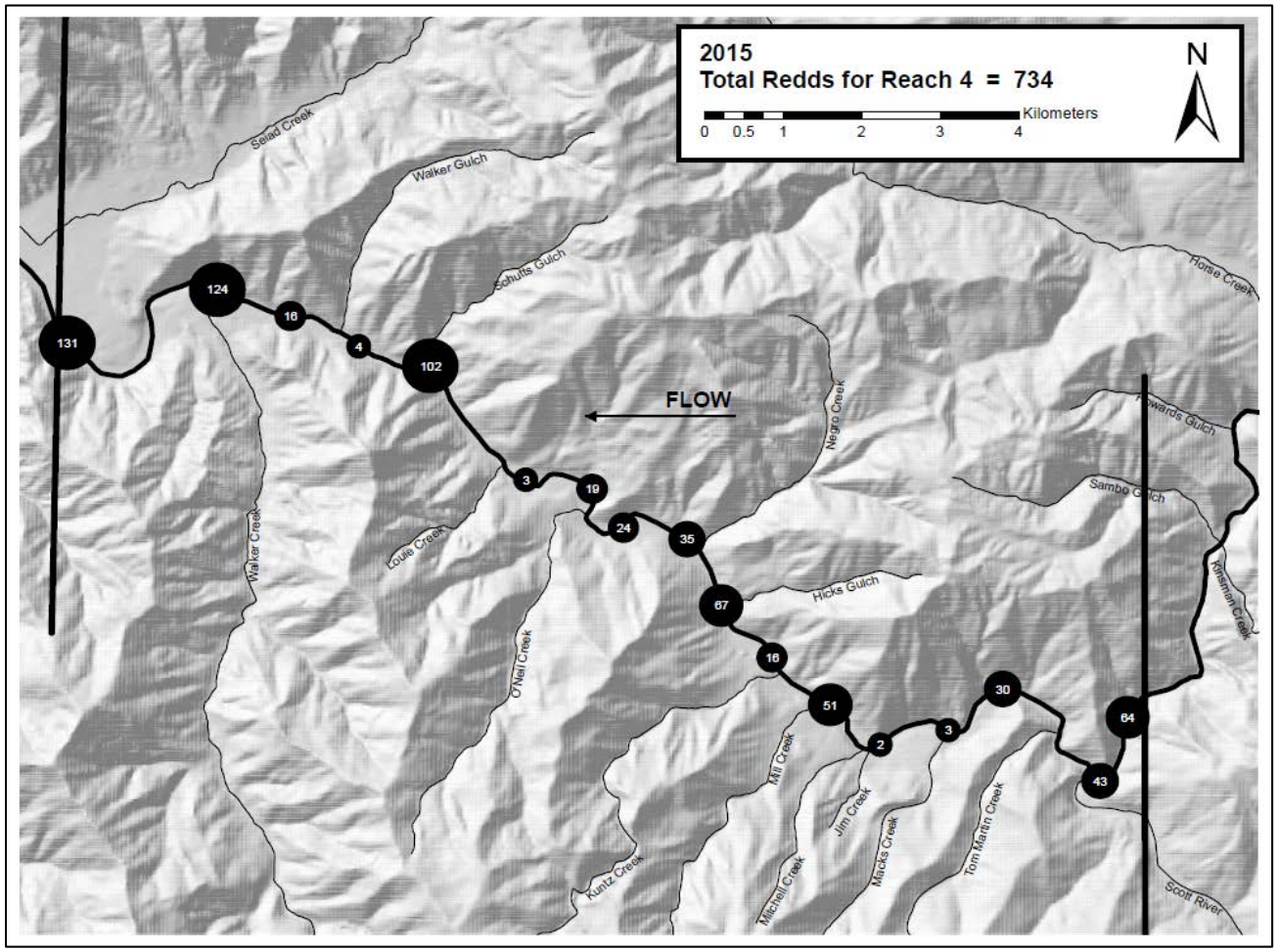
Appendix B (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2014. Redds are binned to the nearest whole rkm.



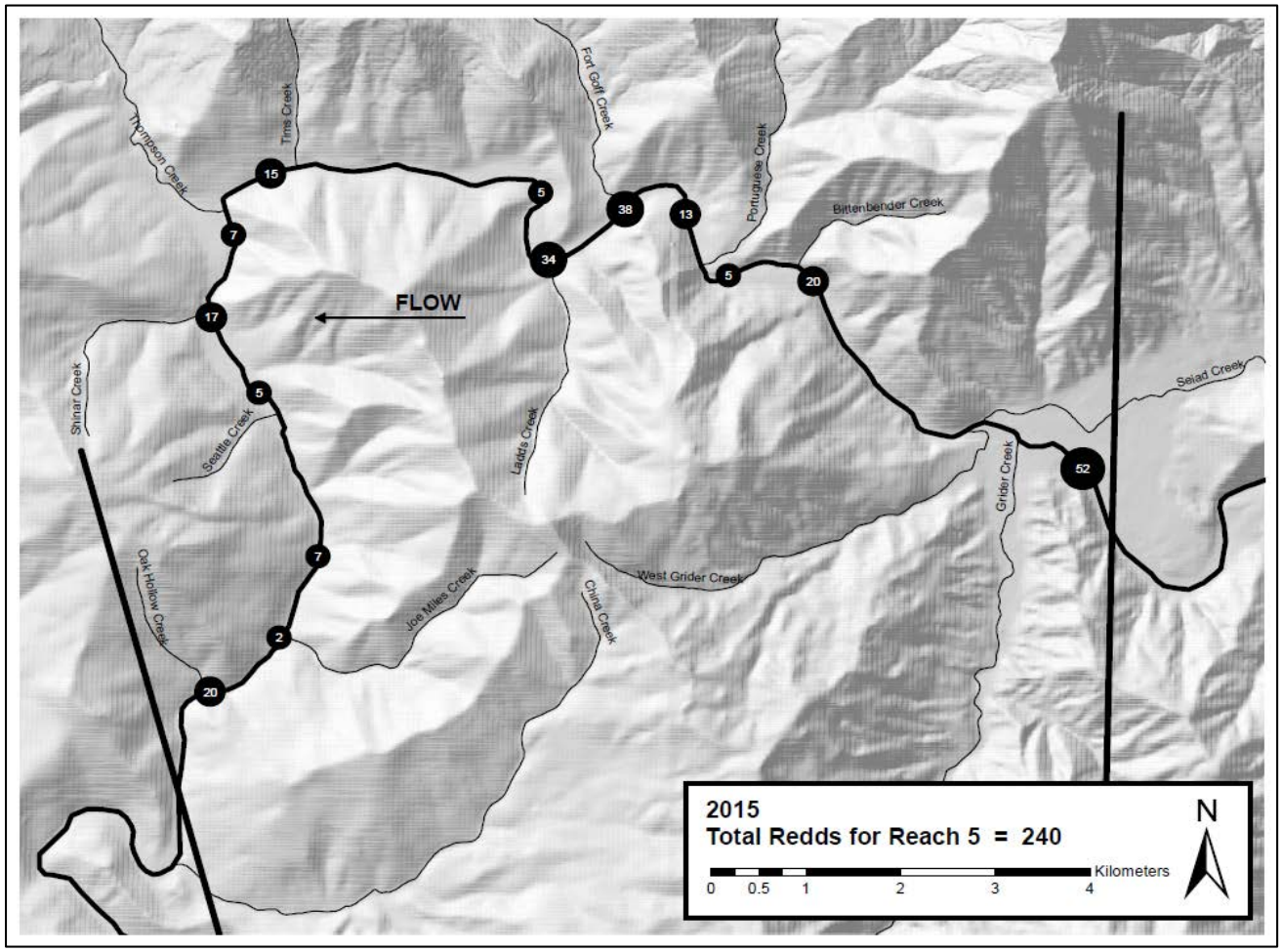
Appendix C. Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2015. Redds are binned to the nearest whole rkm.



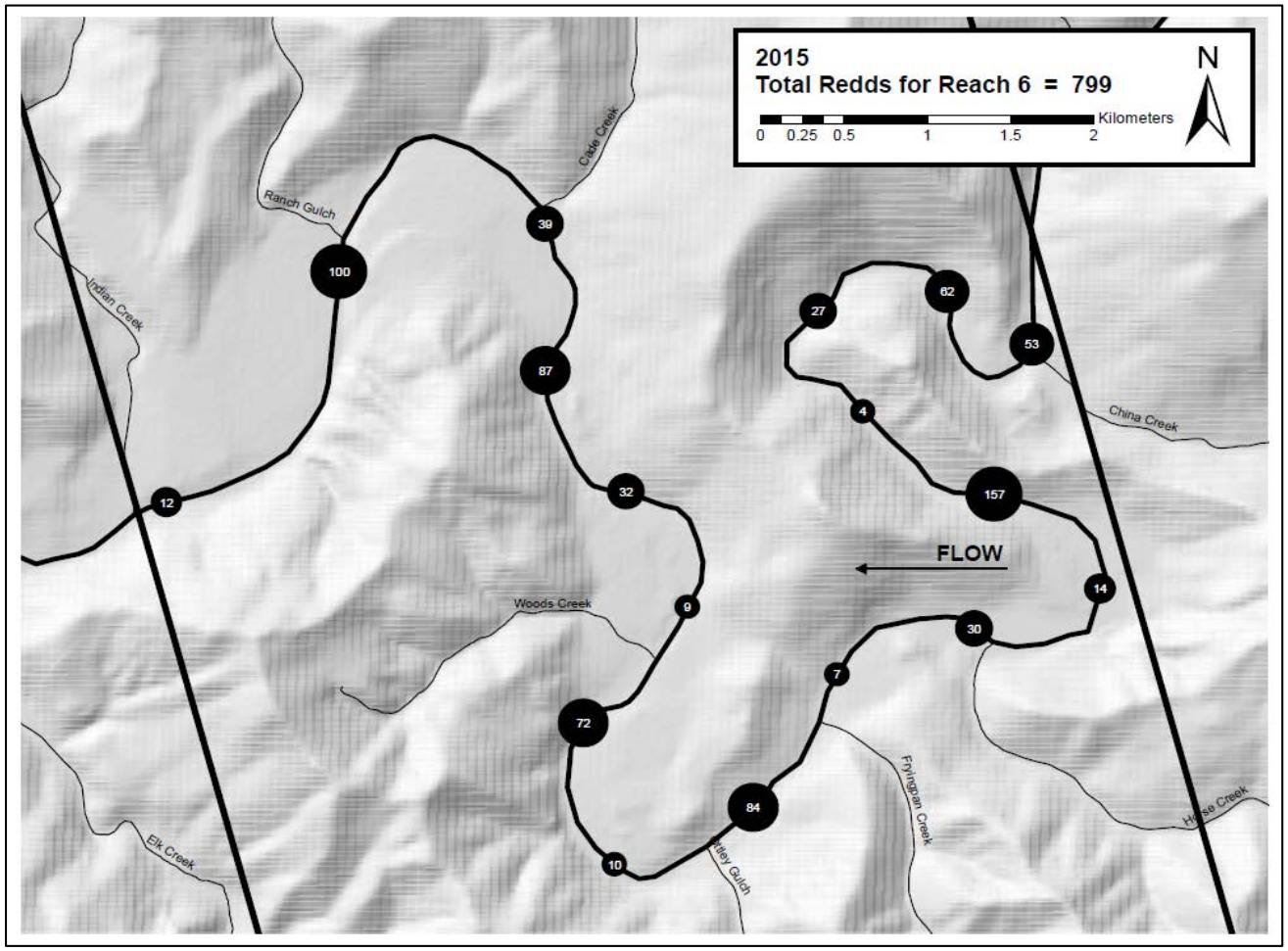
Appendix C (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2015. Redds are binned to the nearest whole rkm.



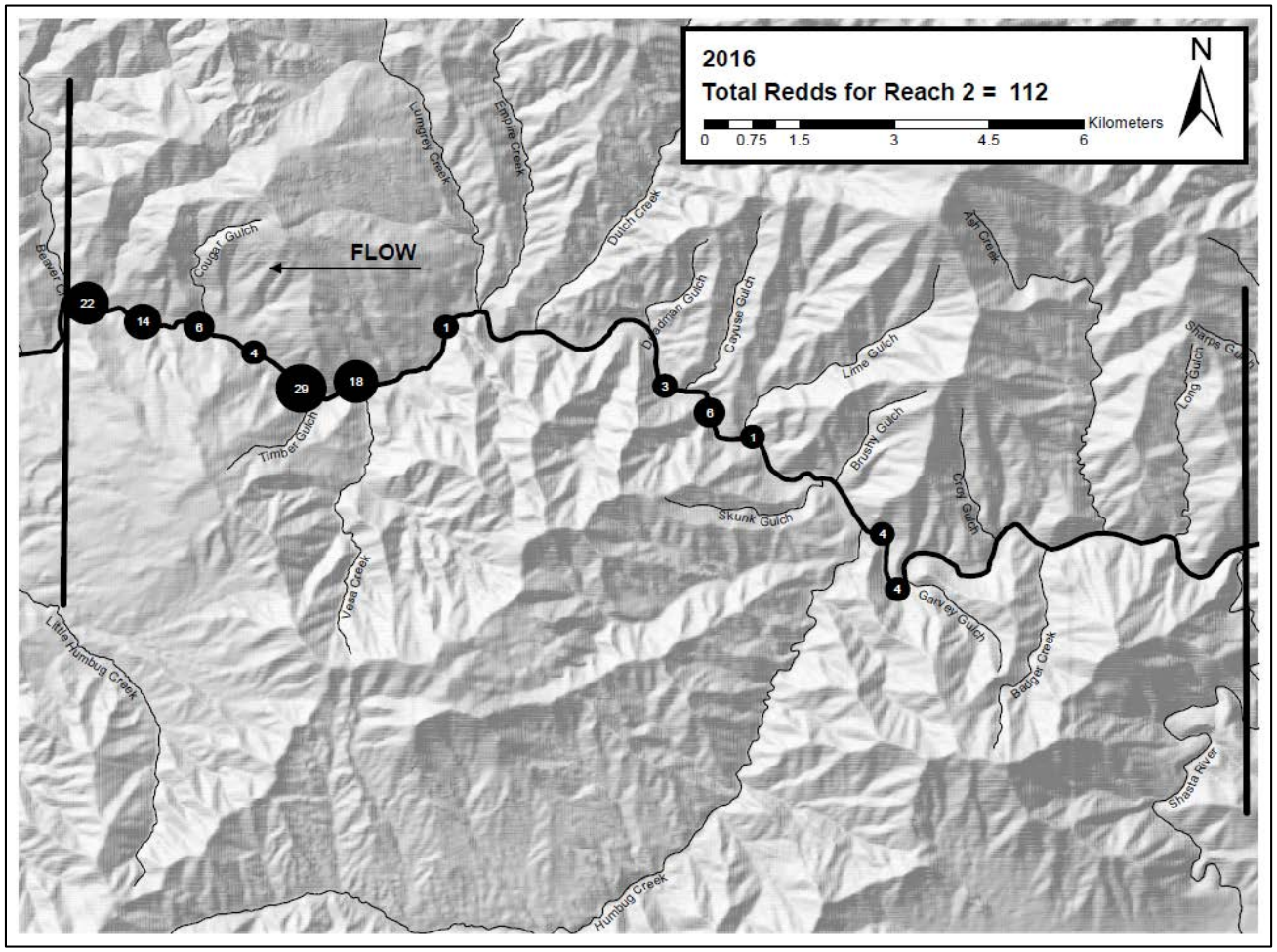
Appendix C (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2015. Redds are binned to the nearest whole rkm.



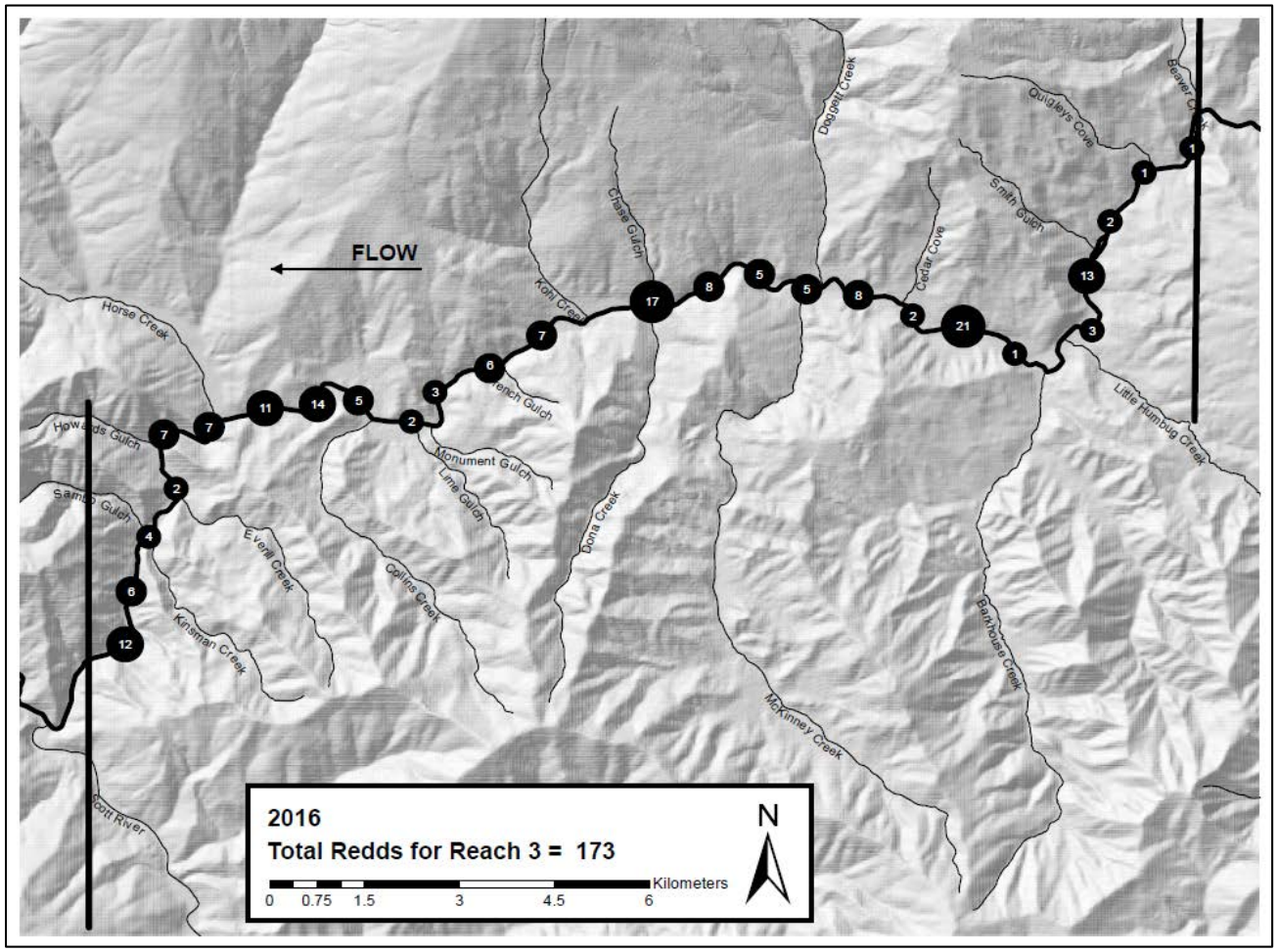
Appendix C (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2015. Redds are binned to the nearest whole rkm.



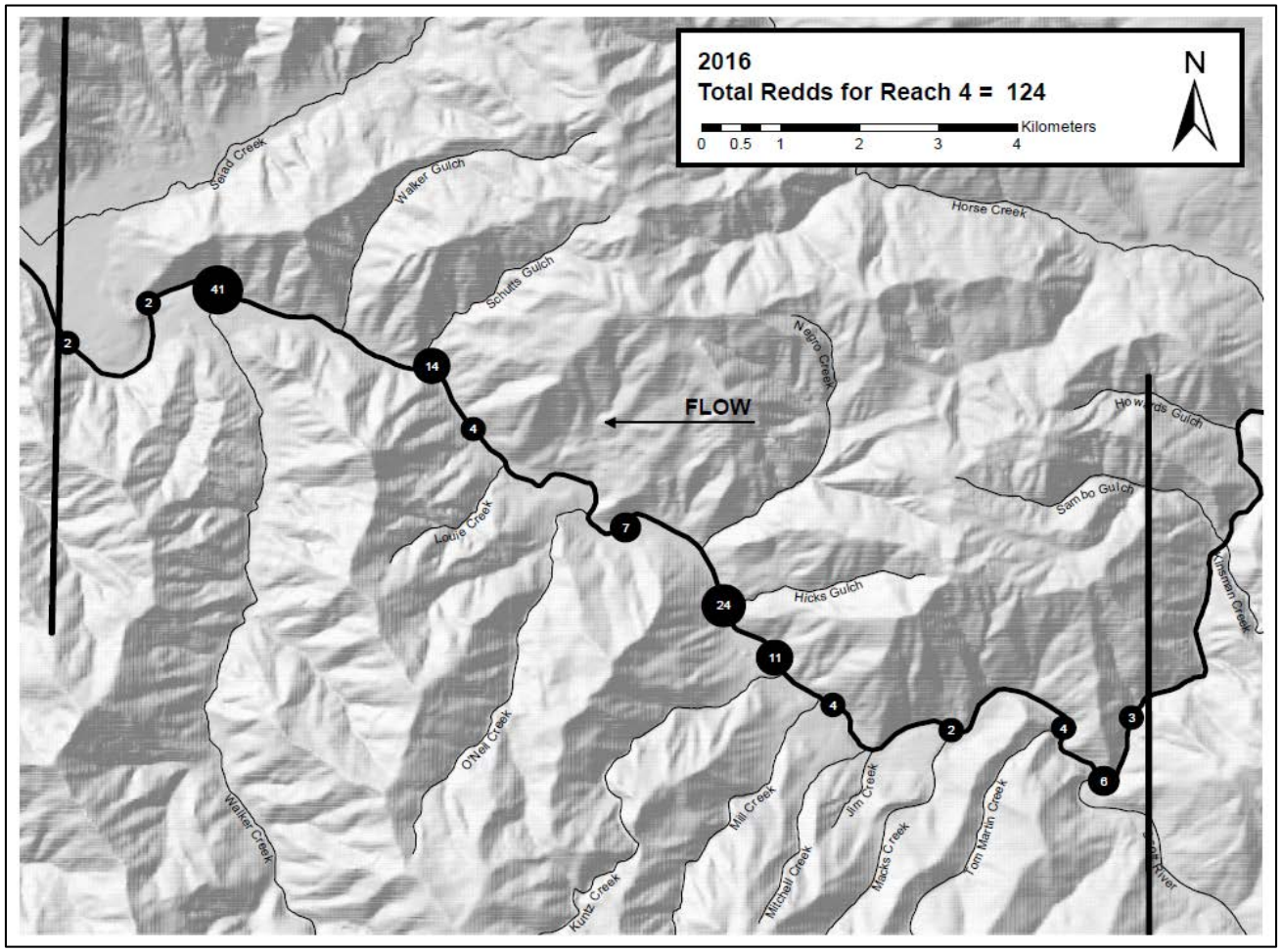
Appendix C (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2015. Redds are binned to the nearest whole rkm.



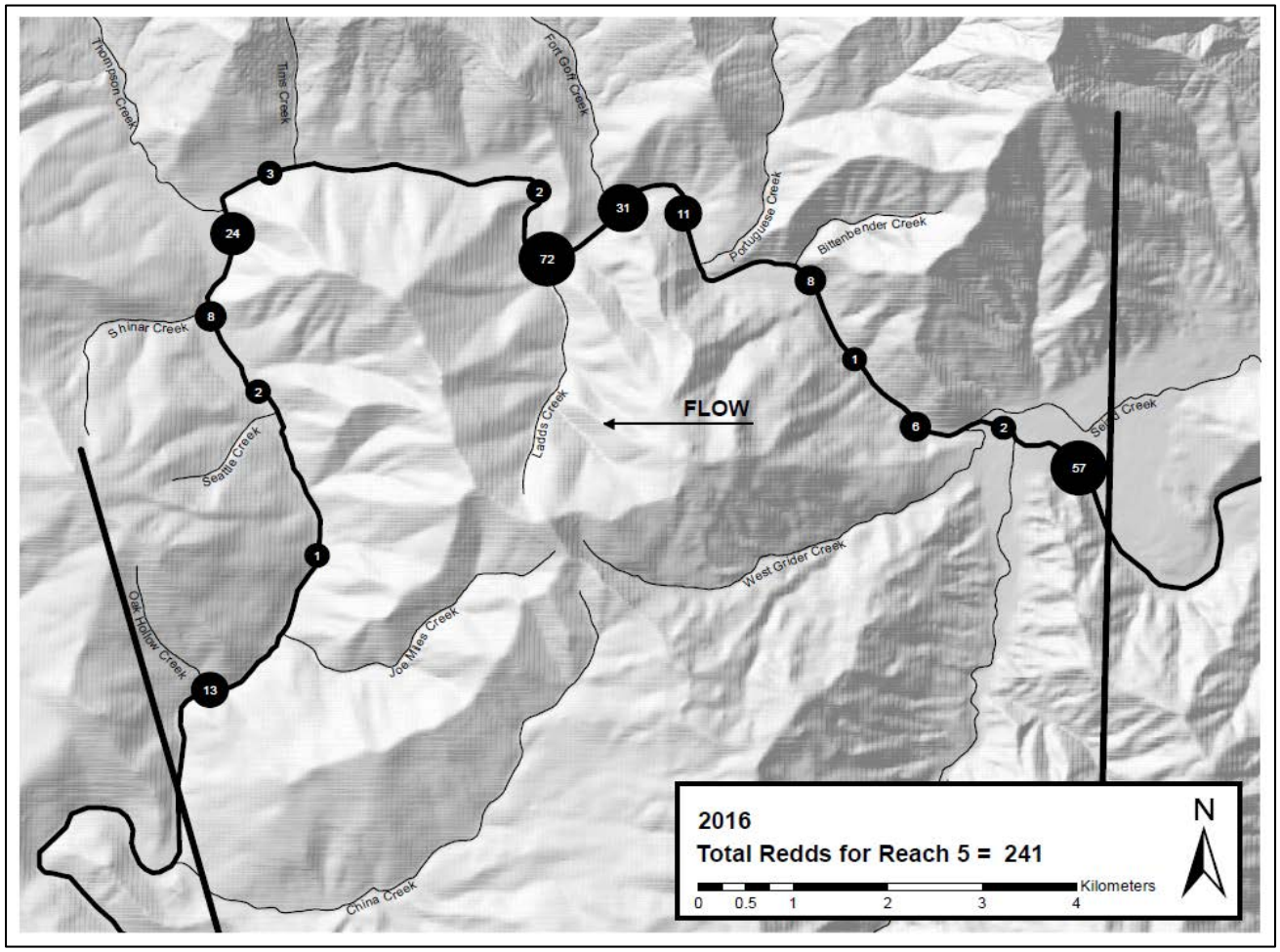
Appendix D. Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2016. Redds are binned to the nearest whole rkm.



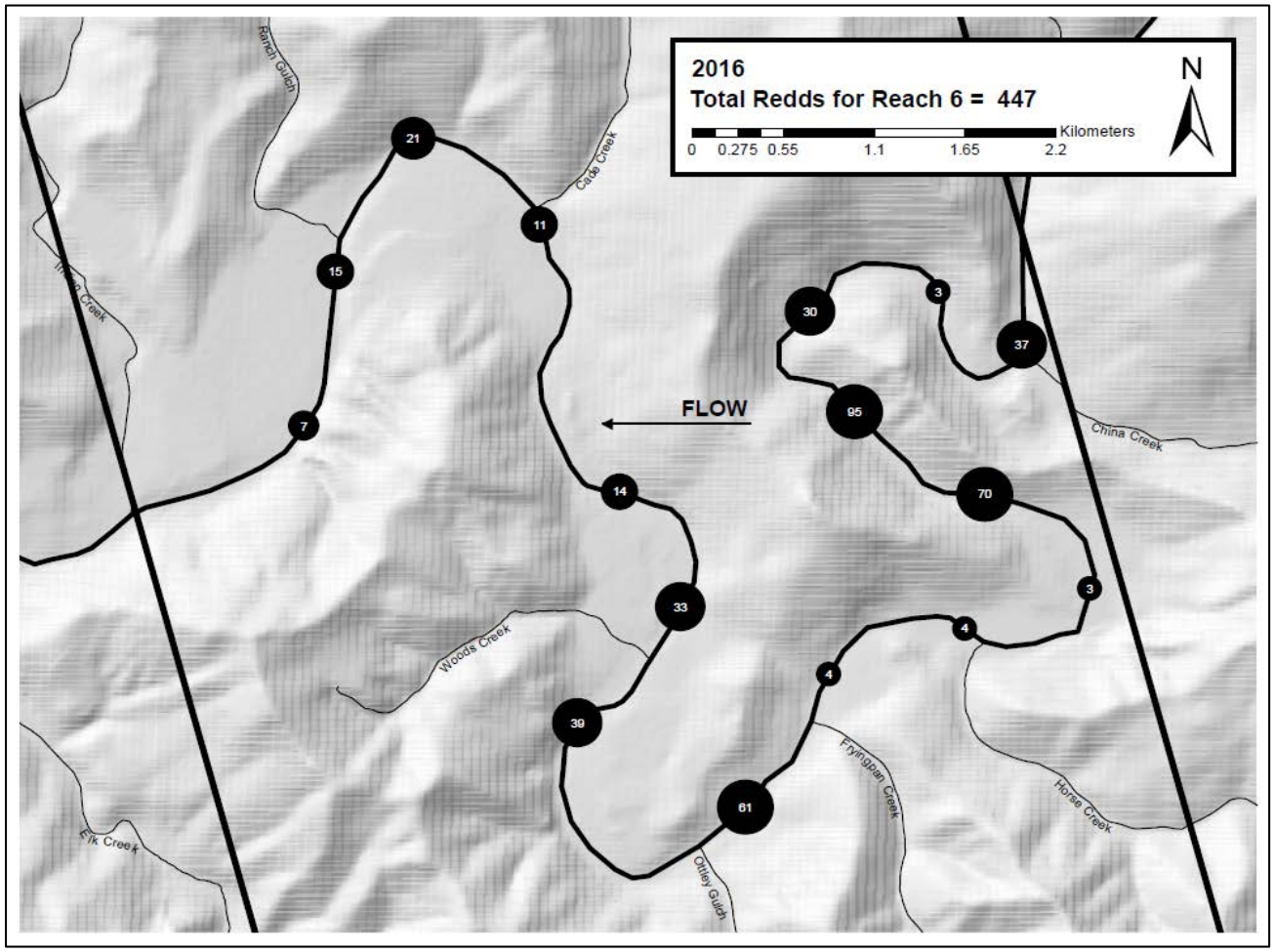
Appendix D (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2016. Redds are binned to the nearest whole rkm.



Appendix D (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2016. Redds are binned to the nearest whole rkm.



Appendix D (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2016. Redds are binned to the nearest whole rkm.



Appendix D (continued). Redd count distribution in the mainstem Klamath River within survey reaches 2–6 (shown separately) located between the Shasta River and Indian Creek, 2016. Redds are binned to the nearest whole rkm.