U.S. Fish & Wildlife Service

Arcata Fisheries Data Series Report DS 2013-26

Mainstem Klamath River Fall Chinook Salmon Redd Survey, 2010

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September 2013

Funding for this study was provided by the Klamath River Fish Habitat Assessment Program of the Arcata Fish and Wildlife Office.

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Key words: Chinook salmon, Klamath River, redd, escapement, spawning survey.

The correct citation for this report is:

Magneson, M. D. and K. Wright. 2013. Mainstem Klamath River Fall Chinook Salmon Redd Survey, 2010. U. S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Data Series Report Number DS 2013-26, Arcata, California.

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Abstract. This report summarizes the 2010 fall Chinook salmon *Oncorhynchus tshawytscha* redd survey on the mainstem Klamath River, and is the eighteenth such summary provided by the Arcata Fish and Wildlife Office. The survey was conducted over an 8-week period (October 13 to December 2, 2010), covering 114.7 river kilometers (rkm) of the mainstem Klamath River located between the Shasta River (rkm 288.5) and Indian Creek (rkm 173.8). A total of 646 fall Chinook salmon redds were counted in 2010, which was the sixth lowest count for this section of river since annual surveys began in 1993. Redd counts over the previous 17-year history of this survey ranged from 243 in 1993 to 2,539 in 2002. The 2010 count was 31% less than the prior 17-year mean ($\bar{x}$ = 938). Redd densities within approximately 10-rkm sections were highest between Ottley Gulch (rkm 183.7) and Indian Creek (16.9 redds/rkm) and lowest between Shasta River (rkm 288.5) and Humbug Creek (rkm 279.7; 0.6 redds/rkm).

Introduction

The Klamath River drains approximately 14,000 km^2 in Oregon and 26,000 km^2 in California. The majority of the watershed in California is within the boundaries of the Six Rivers, Klamath, and Shasta–Trinity National Forests. The Yurok Tribe Reservation, comprising about 219 km^2, borders the lower 68 rkms of the Klamath River (Figure 1). The Hupa Valley Tribe Reservation (365 km^2) is primarily located upstream of the confluence of the Klamath and Trinity Rivers. The Karuk Tribe's ancestral territory extends along the Klamath River from Bluff Creek to southern Oregon. The largest tributaries in the basin include the Trinity, Salmon, Scott, and Shasta rivers. Iron Gate Dam (IGD), located 310.3 rkm upstream of the river mouth, is a barrier to upstream passage of anadromous salmonids. Iron Gate Hatchery, located near the base of IGD, was constructed in 1966 to mitigate for losses in natural fish production that resulted from dam construction (USFWS 1991).

The Klamath River Basin historically supported large runs of Chinook salmon *Oncorhynchus tshawytcha*, coho salmon *O. kisutch*, and steelhead *O. mykiss* that contribute to economically and culturally important subsistence, sport, and commercial

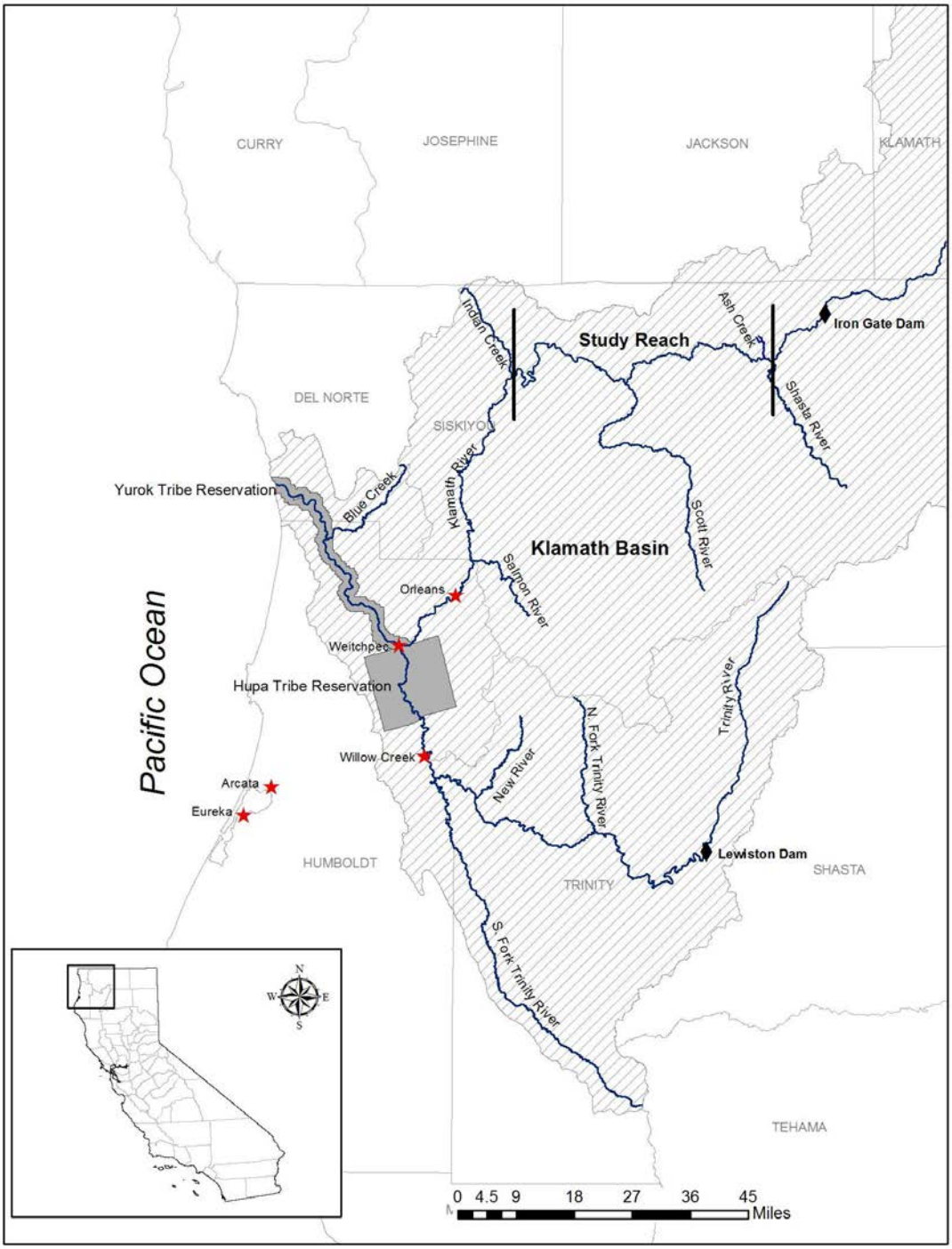

Figure 1. Bracketed area depicting the study area of the Klamath River redd survey, extending downstream on the mainstem Klamath River from the Shasta River confluence to the Indian Creek confluence in northern California.

fisheries (Leidy and Leidy 1984). Generations of Native Americans have fished in the drainage, with catches of salmon, steelhead, lamprey, and sturgeon historically providing the mainstay for the tribes. Sport fishing for salmon and steelhead is also popular in the drainage and may exceed 200,000 angler days annually (Leidy and Leidy 1984). During the 1980's, Klamath River stocks accounted for up to 30% of commercial Chinook salmon landings in northern California and southern Oregon, averaging about 450,000 Chinook salmon per year (PFMC 1988).

Chinook salmon populations in the Klamath River Basin have declined from historical levels, in part due to habitat degradation and over-exploitation that has been common to many river systems in the Pacific Northwest (USFWS 1991). Expanded logging and fishing operations, construction of roads and dams, agricultural use, mining, and other forms of anthropogenic development have led to increased concern about the depletion of anadromous salmonid populations and their associated habitats in the basin (Ayres Associates 1999; Flint and Flint 2008).

On October 27, 1986, the United States Congress enacted Public Law 99-552, the Klamath River Fish and Wildlife Restoration Act. Functioning under the guidance of the Klamath River Fishery Management Council (USFWS 1991), the act 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). The U.S. Fish and Wildlife Service (Service) was funded through the KRBCARP to identify fall Chinook salmon spawning areas and spawn timing and to collect information necessary to estimate the number of fall Chinook salmon spawning in the mainstem Klamath River (in-river spawners) between IGD and the confluence of Indian Creek (rkm 173.8; Figure 1). In 1993, the Service started conducting fall Chinook salmon redd surveys to estimate escapement within this section of the mainstem Klamath River. In 2001, the Service added carcass mark-recapture methods to better estimate escapement in the more densely used spawning area between IGD and the Shasta River confluence (rkm 288.5; Gough and Williamson 2012). During years when both carcass and redd surveys were conducted in this stretch of the river (2001 to 2004, 2006), the ratio of the successfully spawned female escapement estimate to observed redds ranged from 3.3:1 (2002) to 4.8:1 (2003), demonstrating that carcass mark-recapture is a more accurate estimator of escapement in this section of river. Below the Shasta River there are not enough carcasses found to conduct a mark-recapture survey. However the negative downstream decay of the successfully spawned females–redd ratio within the carcass study area suggests that redd surveys in the less-densely used spawning area below the Shasta River confluence provide sufficient redd counts (Gough and Williamson 2012). This report summarizes the 2010 redd surveys in the mainstem Klamath River between the Shasta River and Indian Creek. The Klamath River Technical Team (KRTT) uses this information to assess basin-wide spawning escapement and to generate stock projections for harvest management (KRTT 2011).

Methods

Survey Reaches

The survey area is divided into six reaches based on accessibility and distance that a single crew can survey in a day (Figure 2; Table 1). Reach 1 (IGD to Shasta River) was not surveyed in 2010 because a carcass mark-recapture estimator is now used to derive the number of fall Chinook salmon that spawn in this reach. This was the fifth year (2005, 2007 to 2010) since 1993 that this reach was not included in the redd survey. The upper 2.8 rkm in Reach 2, from the Shasta River to Ash Creek, was not surveyed because past efforts revealed little to no spawning activity in this section of the river. We assumed no redds were constructed in this short stretch in 2010.

Data Collection

Redd Data

Weekly visual redd counts were conducted on the five mainstem reaches from the Shasta River to Indian Creek. Two crews, each consisting of a rower and observer, aided by polarized glasses, surveyed the river by cataraft. Rafts were oared downstream and maneuvered in a zigzag pattern over spawning areas in order to sufficiently census redds. Side and split channels were surveyed by foot or floated on alternating weeks. Crews were assigned the same survey reaches throughout the sampling period under the assumption that increased familiarity with spawning areas facilitated more accurate redd counts (Table 1).

Flagging was used to mark redd locations. Flags were attached to vegetation on the riverbank just downstream of the last observed redd within a habitat unit. A different flag color was used each week to distinguish redd counts on subsequent surveys. Each flag was labeled with the following information: date, surveyors, location (nearest 0.05 rkm), number of old and new redds, and location in channel. Reach, flag location, GPS coordinates, numbers of old and new redds, location in channel, distance from bank, and age(s) of redd(s) were recorded on data forms. Estimated redd age was recorded using a scale of 1 to 3 where:

- redd age 1 = less than two weeks old, characterized by bright substrate, little or no periphyton, and a well-developed mound,
- redd age 2 = two to four weeks old, characterized by a slightly flattened mound and dulled substrate due to periphyton growth, and
- redd age 3 = older than four weeks, identifiable only by the presence of a pit and/or mound. The brightness of the substrate on age code ‘3’ was typically not distinguishable from that of the surrounding substrate.

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.

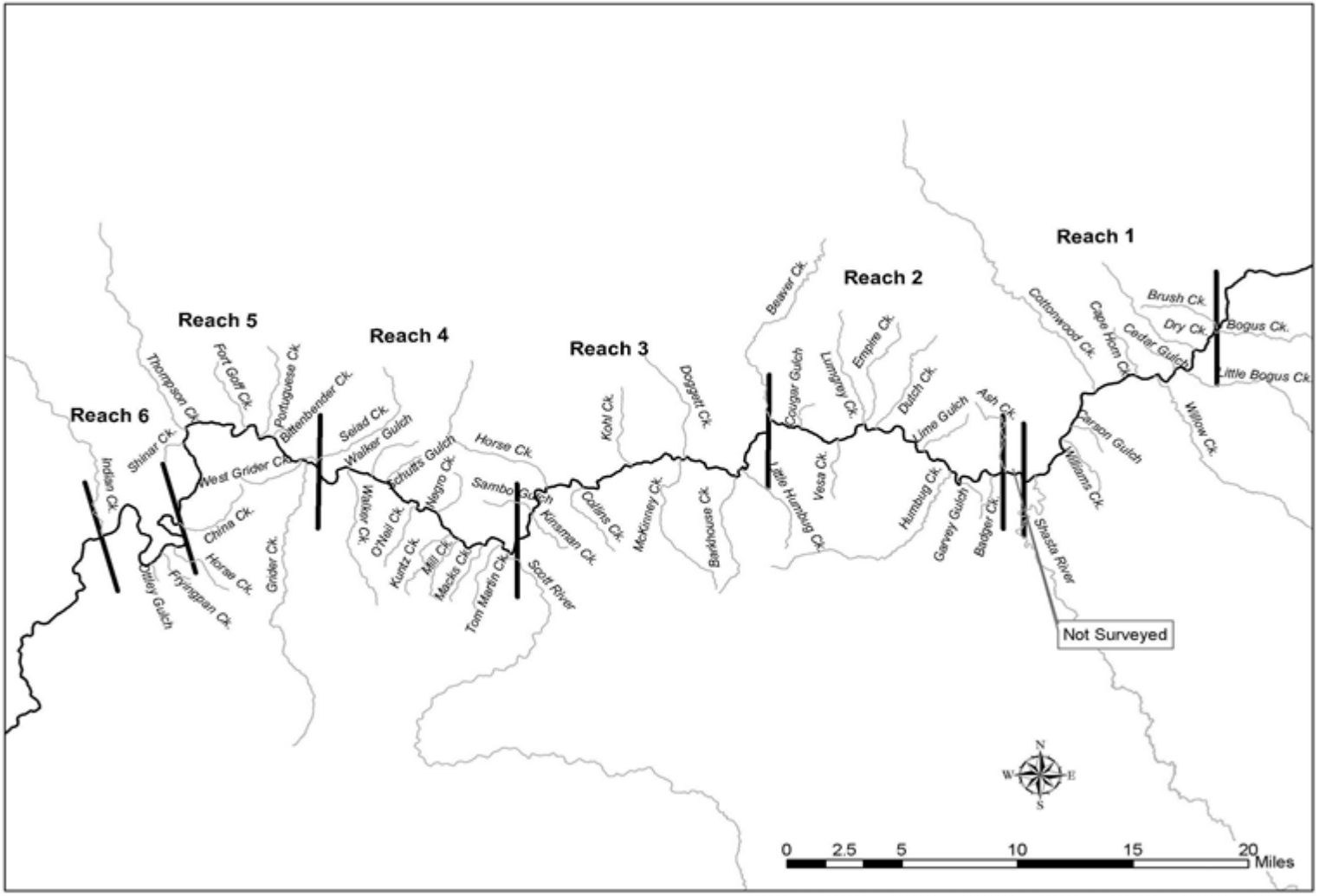

Figure 2. Mainstem Klamath River fall Chinook salmon redd survey reaches (1 to 6). Note: Redd surveys were not conducted in Reach 1 (Iron Gate Dam to Shasta River) The 2.8-rkm section between the Shasta River and Ash Creek was also not surveyed because past surveys revealed a lack of spawning activity in this stretch of river.

Table 1. Location and length of mainstem Klamath River fall Chinook salmon redd survey study reaches.

Reach	Upper boundary		Lower boundary		Reach length
number	Location	rkm	Location	rkm	(rkm)
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[c]	Blue Heron	234.3	Seiad Bar	213.6	20.7
5[d]	Seiad Bar	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 the 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 spawning activity in this area.

[d] Surveyed by USFWS crew.

[e] Reach 6 was split at Gordons Ferry (rkm 185.0) and surveyed by Karuk Tribe and USFWS crews.

Water Quality

Water temperature was recorded using an Onset® HOBO Water Temp Pro v2 Model Number U22-001 placed below the bridge at the Iron Gate Hatchery (rkm 309.9) and downstream of Seiad Valley by the USGS gauging station (11520500; rkm 206.8). Temperatures were recorded at 1-hr intervals throughout the survey period. Secchi disk depth was taken each survey as a measure of water visibility.

Discharge

Mean daily river flow was obtained from the U.S. Geological Survey Gauging Station 11516530, located in the Klamath River just downstream of IGD, and 11520500, in the Klamath River downstream of Seiad Valley, California.

Data Analyses

Adult and Jack Escapement Estimates

The total number of single-counted redds in this survey was used to estimate adult and jack (age-2 males) fall Chinook salmon escapement that spawned 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 2012) 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 by

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

where P_{age2} is the jack proportion based on scale readings from the carcass survey.

Redd Densities

Redd densities were calculated at both the reach and 10-rkm spatial distribution levels. The latter analysis provides an improved spatial resolution of redd distribution.

Results and Discussion

Adult and Jack Escapement

We observed 646 Chinook salmon redds in 2010, representing 1,292 adults in the mainstem Klamath River between the Shasta River and Indian Creek confluences (Reaches 2 to 6; Table 2). Applying the surrogate jack proportion of 6.76% from the IGD–Shasta River carcass survey, jack escapement was estimated to be 94. Carcass-mark recapture methods and carcass scale ages produced estimates of 2,392 adult and 180 jack fall Chinook salmon that spawned between IGD and the Shasta River (Reach 1; KRTT 2011). The 2010 redd count was 31% less than the previous 17-year mean ($\bar{x}$ = 938) for the five reaches surveyed. The combined redd count for the five reaches surveyed in 2010 was the sixth lowest recorded in the 18-year history of this project, with the highest count occurring in 2002 (n = 2,539) and the lowest in 1993 (n = 243; Table 3; Figure 3).

Redd counts stratified by survey week and reach for survey years 1993 to 2010 are summarized in Table 3. Peak redd counts occurred during calendar week 43 for Reaches 2, 3, 5, and 6 and Calendar Week 44 for Reach 4 in 2010. Redd densities by reach in 2010 are presented in Figure 4. The highest concentration of Chinook salmon redds/rkm was in Reach 6 (15.8 redds/rkm) and the lowest was in Reach 3 (2.1 redds/rkm). The spatial distribution of redds was slightly different from most previous years' surveys in that the lowest densities were in Reach 3 instead of Reach 5 (2.9 redds/rkm). The spatial distributions of redds in each reach are shown in Figures 5 to 9.

Table 2. Estimates of in-river fall Chinook salmon spawning escapement in the mainstem Klamath River, 2010 (data compiled from CDFG 2011).

Natural Spawning Area	Jacks	Adults	Totals
Mainstem Klamath River			
Iron Gate Dam to Ash Creek[a]	180	2,392	2,572
Ash Creek to Indian Creek[b]	95	1,292	1,387
Bogus Creek Basin	291	3,179	3,470
Shasta River Basin	87	1,259	1,346
Scott River Basin	394	2,113	2,507
Salmon River Basin	356	2,478	2,834
Misc. Klamath Tributaries upstream of Yurok Reservation	274	1,663	1,937
Yurok Reservation Tributaries	134	790	924
Total Natural Klamath Spawners	**1,811**	**15,166**	**16,977**
Mainstem Trinity River	9,779	21,579	31,358
Misc. Trinity Tributaries	69	152	221
Hoopa Reservation Tributaries	147	324	471
Total Natural Trinity Spawners	**9,995**	**22,055**	**32,050**
Grand Total Natural Spawners	**11,806**	**37,221**	**49,027**

[a] USFWS carcass-mark recapture survey. Shasta River (rkm 288.4) to Ash Creek (rkm 285.7) not surveyed.

[b] USFWS redd survey.

10-rkm Section Redd Densities

In 2010, only the 10-rkm section between Ottley Gulch (rkm 183.7) and Indian Creek (16.9 redds/rkm) had a higher redd density than the preceding 17-year average ($\bar{x}$ =11.8 redds/rkm) for that section. The lowest redd density (0.6 redds/rkm) was observed between the Shasta River and Humbug Creek (rkm 279.7), which was also the lowest density within this section since these surveys began in 1993 (Table 4). The second lowest 2010 redd density (1.0 redd/rkm) was observed between Kohl (rkm 248.0) and Kinsman creeks (rkm 237.0), and was the lowest recorded density (tied with 2005) within this section since surveys began.

Table 3. Weekly reach summary of mainstem Klamath River fall Chinook salmon redd counts, 1993 to 2010 (Ns = No Survey, R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek, 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).

	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%	
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%	
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%	
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%	
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%	

Table 3 (continued). Weekly reach summary of mainstem Klamath River fall Chinook salmon redd counts, 1993 to 2010 (Ns = No Survey, R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek, 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).

	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%	
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%	
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	788	208	196	164	42	180	**1,578**
		Percent of Total	49.9%	13.2%	12.4%	10.4%	2.7%	11.4%	
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%	
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%	

Table 3 (continued). Weekly reach summary of mainstem Klamath River fall Chinook salmon redd counts, 1993 to 2010 (Ns = No Survey, R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek, 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).

	Calendar		Reach						
Year	**Week**	**Survey dates**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**Total**
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%	
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
	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%	
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%	
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%	
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%	

[a] Reach 1 was not surveyed.

Table 3 (continued). Weekly reach summary of mainstem Klamath River fall Chinook salmon redd counts, 1993 to 2010 (Ns = No Survey, R1 = Iron Gate Dam to Shasta River, R2 = Shasta River to Beaver Creek, 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).

	Calendar		Reach						
Year	**Week**	**Survey dates**	**R1**	**R2**	**R3**	**R4**	**R5**	**R6**	**Total**
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%	
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%	
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%	

[a] Reach 1 was not surveyed.

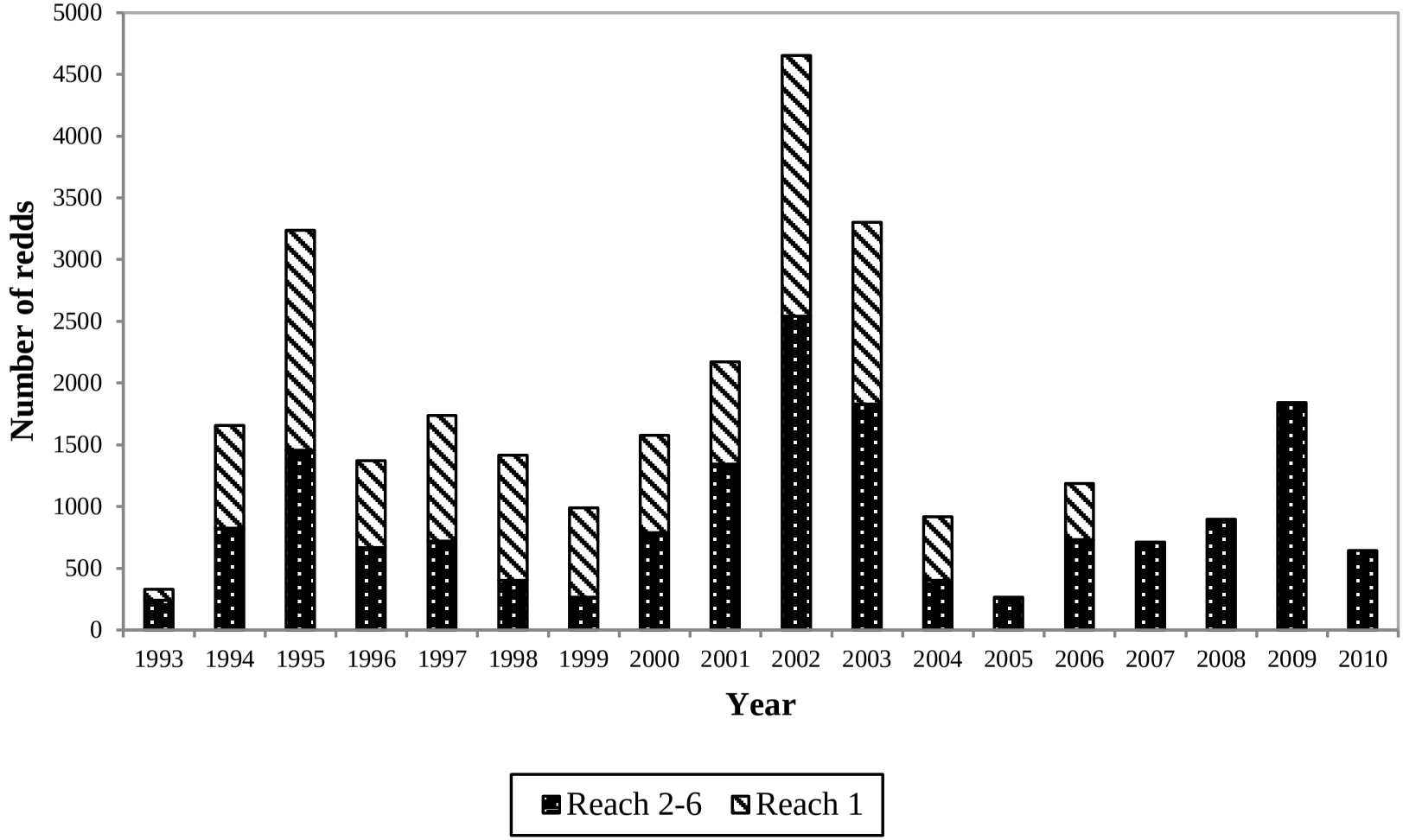

Figure 3. Mainstem Klamath River fall Chinook salmon redd counts 1993 to 2010. Reach 1 was not surveyed in 2005 and 2007 through 2010.

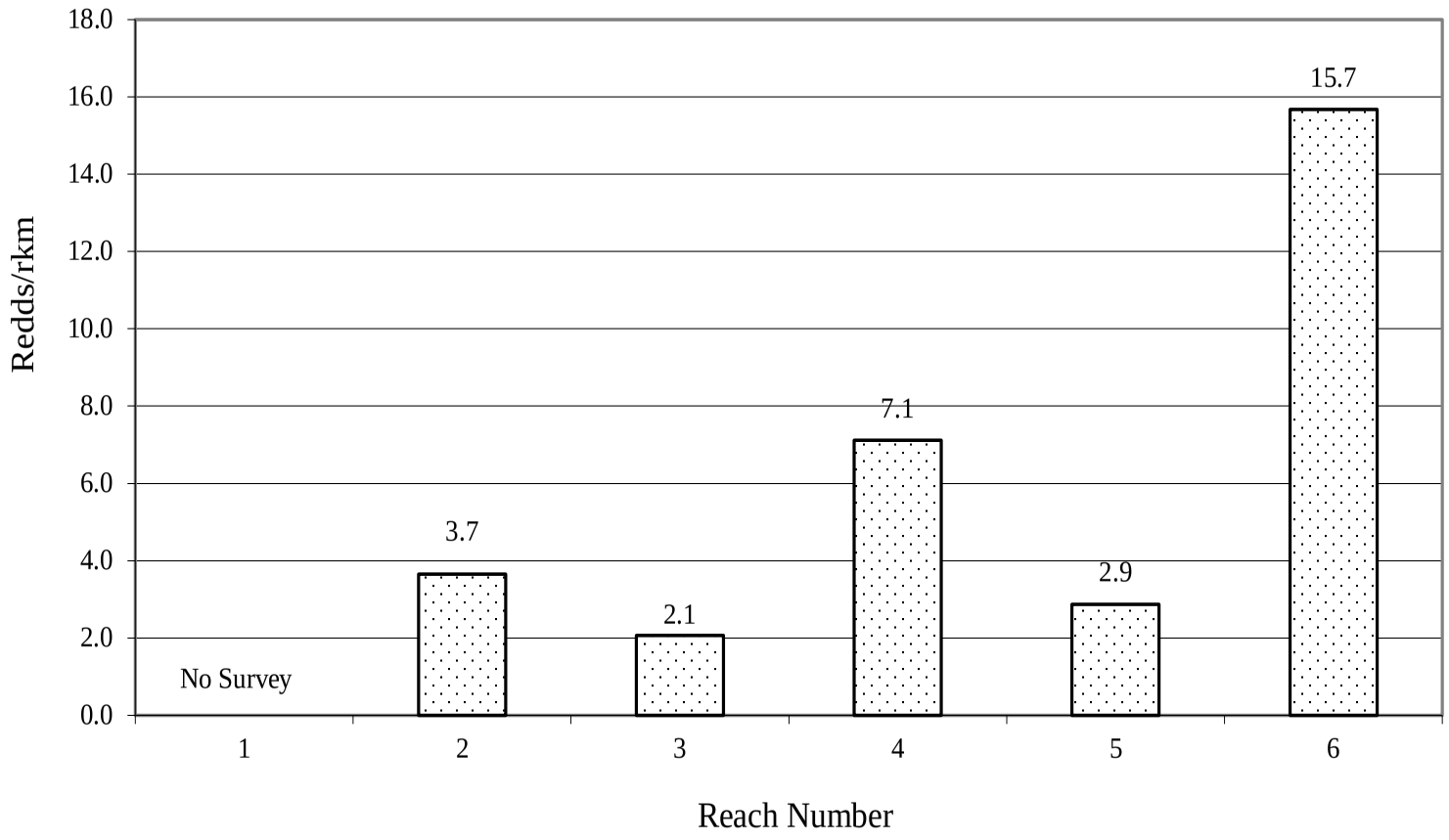

Figure 4. Mainstem Klamath River fall Chinook salmon redd density (redds/rkm) by reach, 2010.

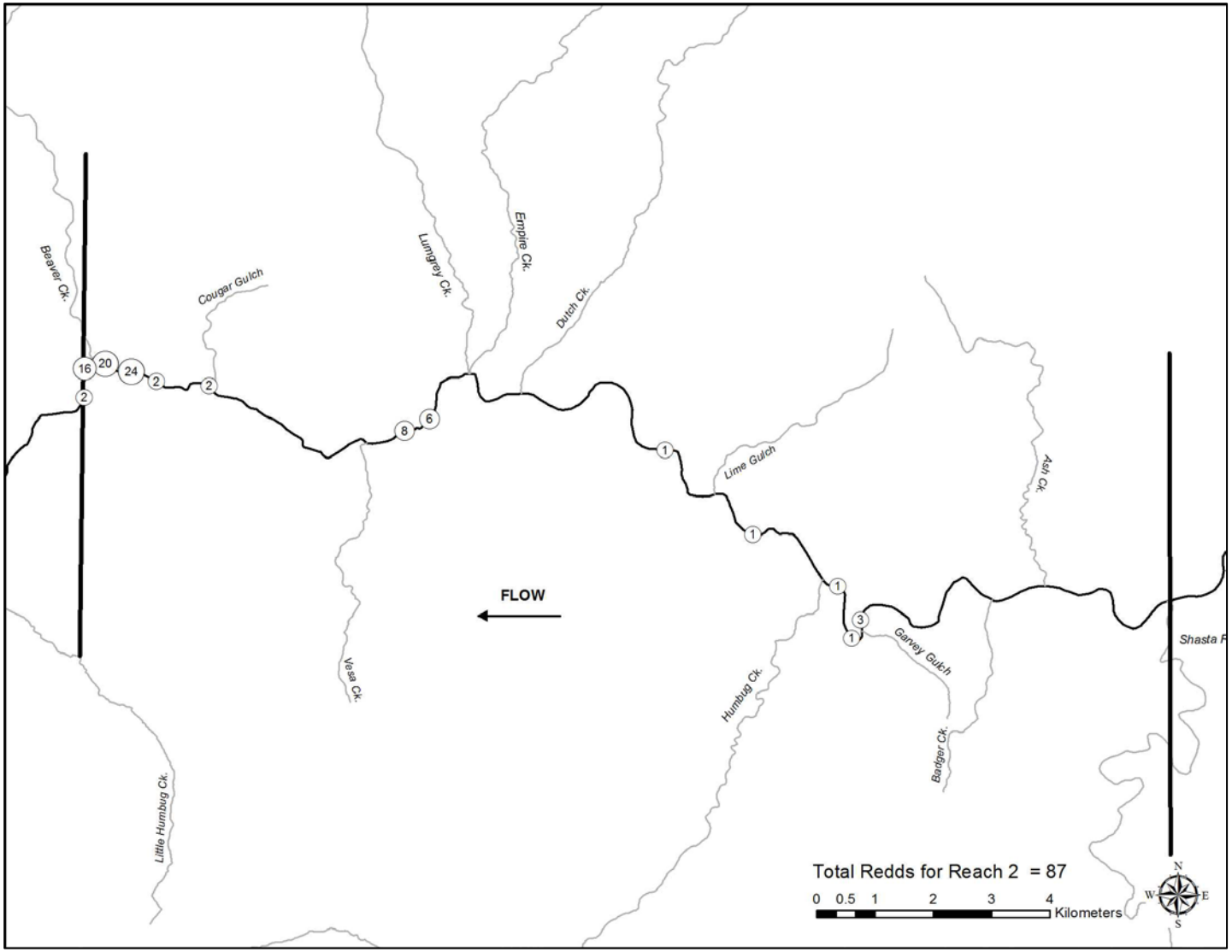

Figure 5. Redd distribution map for Reach 2 (Shasta River to Beaver Creek), mainstem Klamath River, 2010.

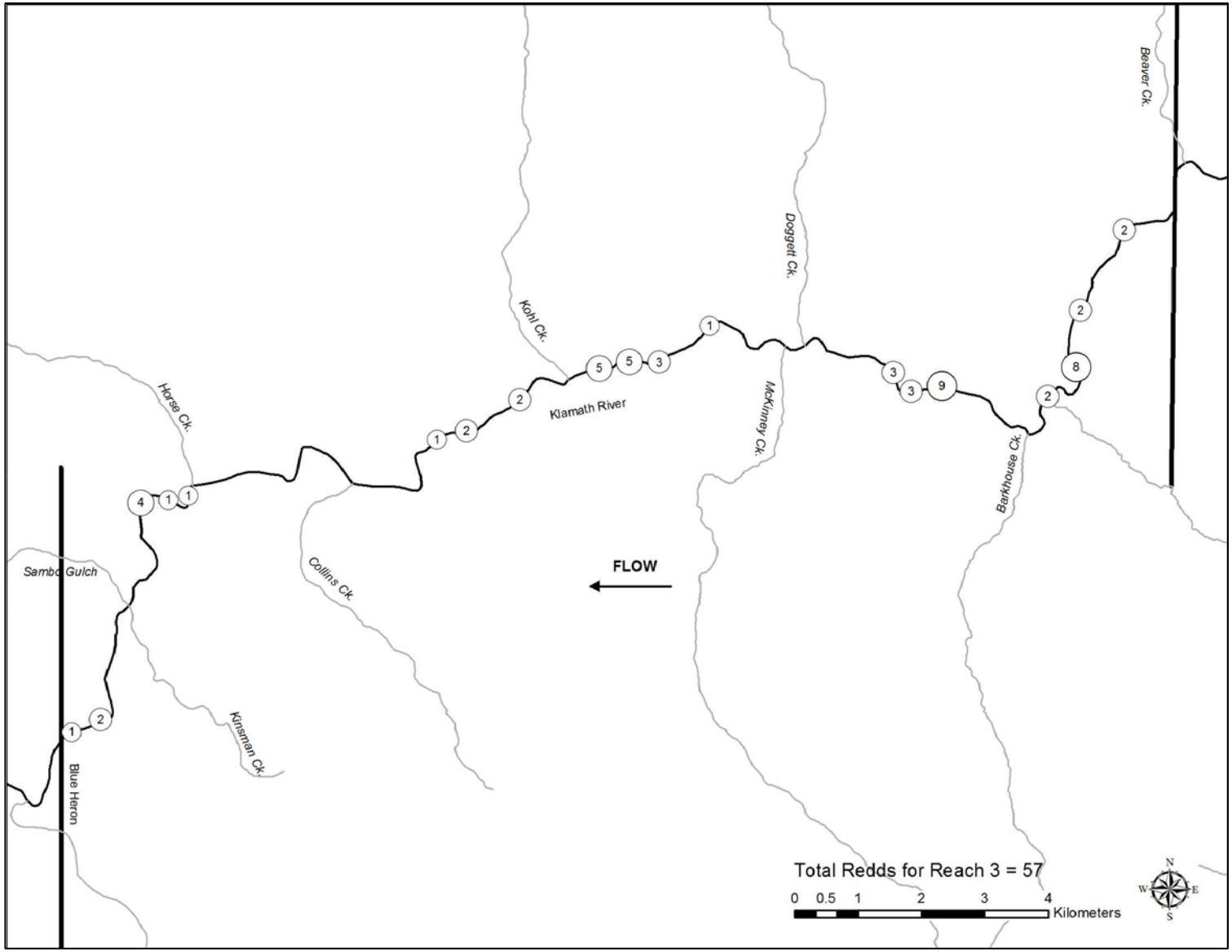

Figure 6. Redd distribution map for Reach 3 (Beaver Creek to Blue Heron river access), mainstem Klamath River, 2010.

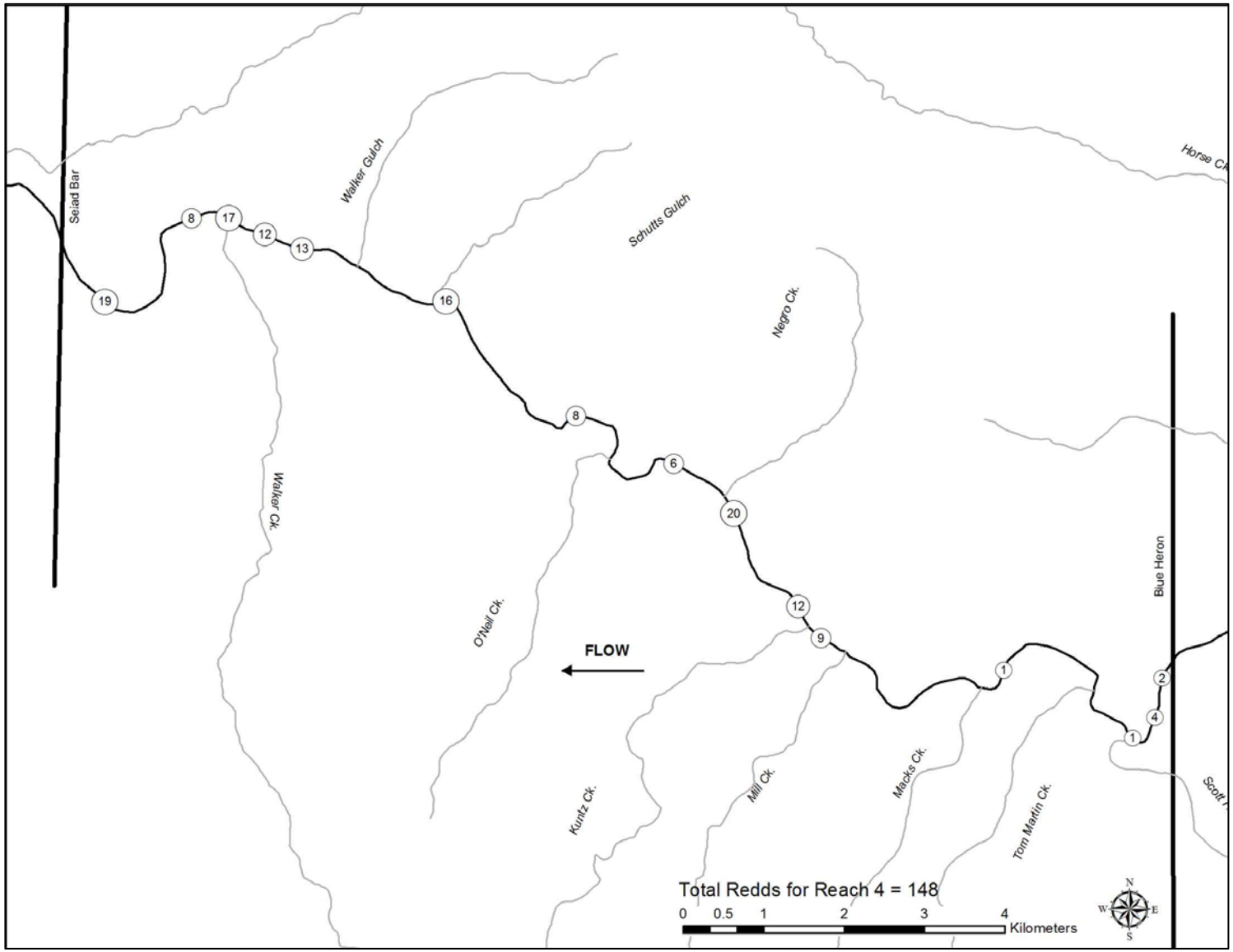

Figure 7. Redd distribution map for Reach 4 (Blue Heron to Seiad Bar), mainstem Klamath River, 2010.

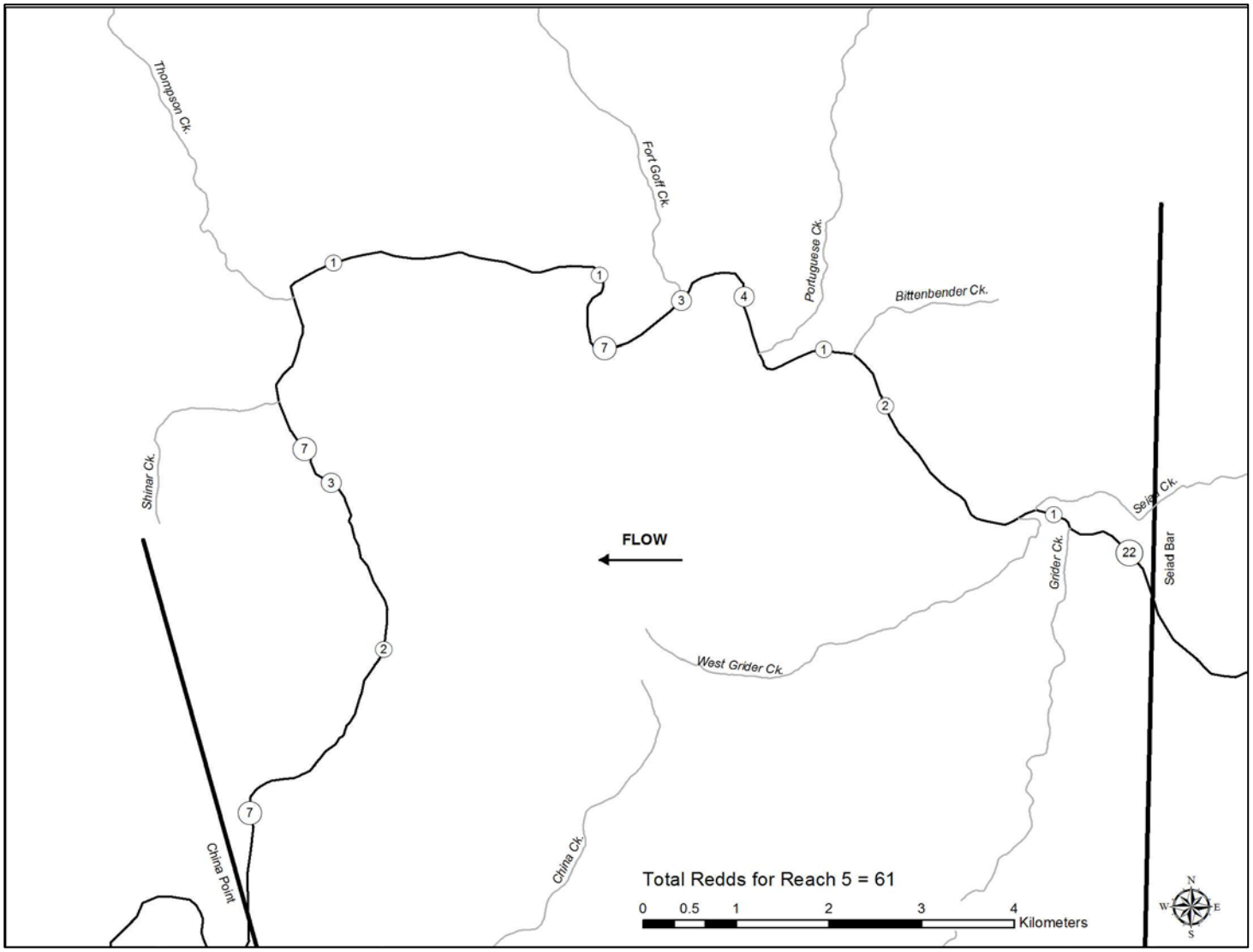

Figure 8. Redd distribution map for Reach 5 (Seiad Bar to China Point), mainstem Klamath River, 2010.

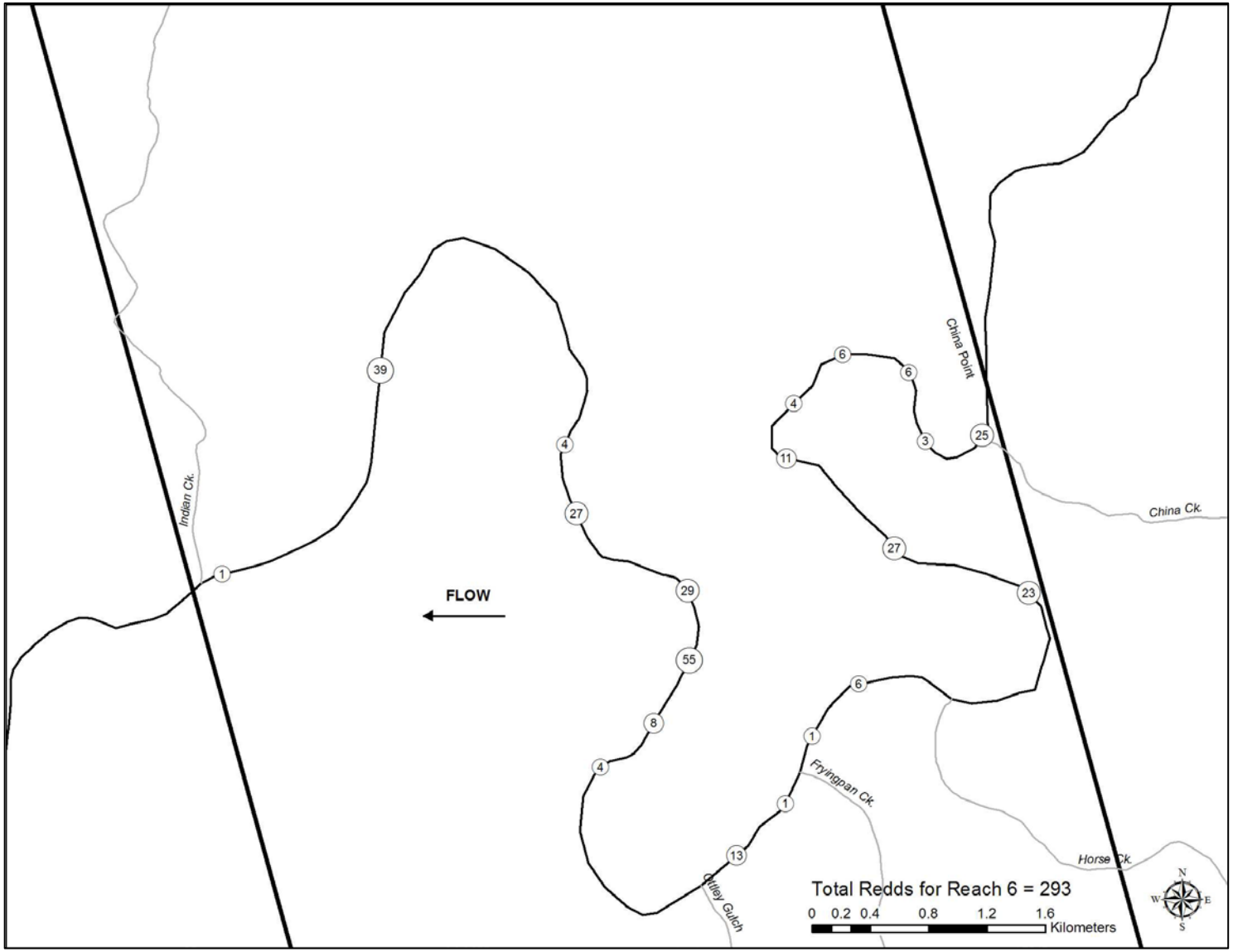

Figure 9. Redd distribution map for Reach 6 (China Point to Indian Creek), mainstem Klamath River, 2010.

Table 4. Fall Chinook salmon redd density by 10 river km (approximate) sections on the mainstem Klamath River, 1993 to 2010 ("Ns" = No survey).

Tributary Reach	Reach Length (rkm)	Year																	
		1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
Iron Gate Dam (309.8) to Cape Horn Creek (300.6)	9.2	8.7	69.9	137.8	61.0	85.0	84.7	65.4	64.2	61.0	161.4	106.8	43.7	Ns	43.2	Ns	Ns	Ns	Ns
Cape Horn Creek (300.6) to Shasta River (288.5)	12.2	0.6	14.9	41.3	12.0	20.2	18.7	9.5	16.1	22.0	51.4	40.0	8.9	Ns	4.6	Ns	Ns	Ns	Ns
Shasta River (288.4) to Humbug Creek (279.7)	8.8	1.0	1.8	7.2	1.3	2.2	4.8	3.8	10.5	8.9	18.1	11.6	5.9	1.8	1.8	1.1	2.4	4.3	0.6
Humbug Creek (279.7) to Vesa Creek (268.3)	11.4	1.6	3.0	3.2	1.3	2.8	1.9	2.5	4.8	5.6	15.4	10.8	2.9	0.8	1.6	3.5	5.0	4.8	1.4
Vesa Creek (268.3) to Little Humbug Creek (257.5)	10.9	1.7	10.5	15.4	6.1	5.3	3.9	2.7	10.9	20.5	33.0	19.4	5.7	1.6	3.2	5.5	8.1	13.5	7.3
Little Humbug Creek (257.4) to Kohl Creek (248.0)	9.5	2.7	6.1	16.8	4.7	7.9	4.5	0.9	8.4	16.4	28.7	20.8	6.9	2.4	5.5	5.9	5.9	19.2	3.1
Kohl Creek to (248.0) Kinsman Creek (237.1)	11.0	2.4	4.0	14.5	5.3	3.6	5.5	3.0	5.2	13.2	22.6	14.2	3.2	1.0	4.0	4.5	4.3	9.7	1.0
Kinsman Creek (237.0) to Kuntz Creek (227.3)	9.8	0.8	6.8	3.9	3.4	1.6	0.6	1.2	3.4	9.3	20.1	10.2	1.4	1.2	1.9	4.2	6.0	11.9	2.0
Kuntz Creek (227.3) to Walker Creek (217.0)	10.3	2.0	8.8	12.0	2.3	14.6	3.5	1.8	10.5	15.0	29.8	21.7	4.1	2.8	10.6	9.9	9.7	16.1	10.1
Walker Creek (217.0) to Portuguese Creek (207.7)	9.4	2.7	9.0	13.4	8.0	1.9	1.4	2.2	4.1	8.1	12.1	10.7	2.6	1.9	3.8	3.6	4.4	16.3	5.6
Portuguese Creek to (207.6) Shinar Creek (199.1)	8.6	0.5	4.1	8.1	5.0	2.9	2.3	1.9	2.4	5.8	19.0	18.0	2.7	0.7	3.0	2.8	4.3	9.1	1.9
Shinar Creek (199.1) to China Creek (192.0)	7.2	3.1	10.6	19.9	11.4	4.3	0.8	0.4	0.8	4.3	9.4	7.8	0.8	1.9	8.3	4.2	7.6	15.4	6.1
China Creek (191.9) to Ottley Gulch (183.7)	8.3	4.9	14.0	23.4	17.7	13.6	8.1	4.3	14.3	25.9	27.8	27.8	3.1	10.1	17.3	19.0	17.5	41.3	12.2
Ottley Gulch (183.7) to Indian Creek (173.9)	9.9	2.4	9.1	18.9	6.7	13.4	4.9	3.1	6.2	6.4	24.5	17.8	2.2	2.9	17.6	10.9	19.4	34.6	16.9

Water Quality

Mainstem Klamath River mean daily water temperature decreased from 16.0 to 7.5ºC at the Iron Gate Hatchery Bridge (Figure 10) and from 15.0 to 6.6 °C near Seiad Valley (Figure 11) over the survey period (October 13 to December 2, 2010). Secchi disk depth readings ranged from 0.6 to 2.4 m ($\bar{x}$ = 1.6 m) during these surveys. The lowest Secchi disk reading was recorded on October 28 and the highest on October 14. Water visibility was generally lower during periods of higher river discharge, cloud cover, and precipitation.

Discharge

Discharge during the 2010 survey period in the mainstem Klamath River ranged from 1,030 to 1,360 ft^3/s below IGD (Figure 10) and 1,270 to 2,540 ft^3/s near Seiad Valley (Figure 11). Overall, daily mean discharge was 1,223 ft^3/s below IGD and 1,878 ft^3/s near Seiad Valley.

Suction Dredge Mining

A statewide ban on recreational suction dredge mining was imposed August 6, 2009. Recreational suction dredge mining was not observed; however, one new redd was observed on what appeared to be a remnant suction dredge tailing at rkm 209.5 (Reach 5). This tailing was presumably created before the ban. Redds constructed on dredge tailings tend to be more unstable in high flows than those constructed on naturally-deposited substrate (Harvey and Lisle 1999).

Acknowledgements

The Arcata Fish and Wildlife Office wishes to acknowledge the Karuk Tribe of California, Department of Natural Resources, for providing support and the following personnel for conducting surveys: Ken Brink, Sonny Mitchell, Mike Polmateer (crew leader), and Ron Reed. Surveys were conducted by AFWO personnel, Ernest Chen, Graham McNamee (volunteer), Oliver Miano, and Amanda Piscitelli. We would finally like to thank Wally Johnson for allowing us river access through his property at Seiad.

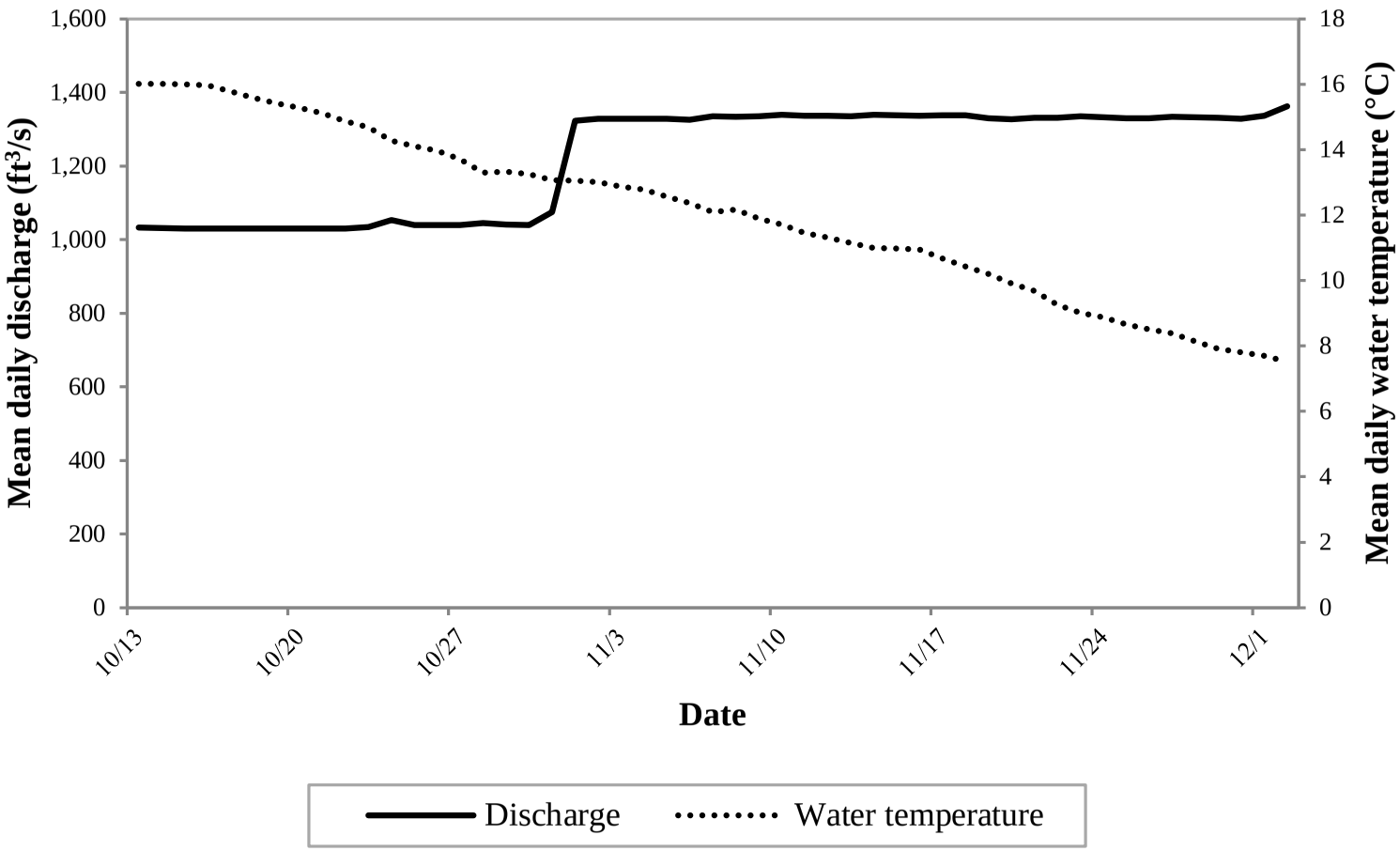

Figure 10. Water temperatures (°C) at river kilometer 309.9 and discharge (ft^3/s) below Iron Gate Dam at USGS Gage 11516530, October 13 to December 2, 2010.

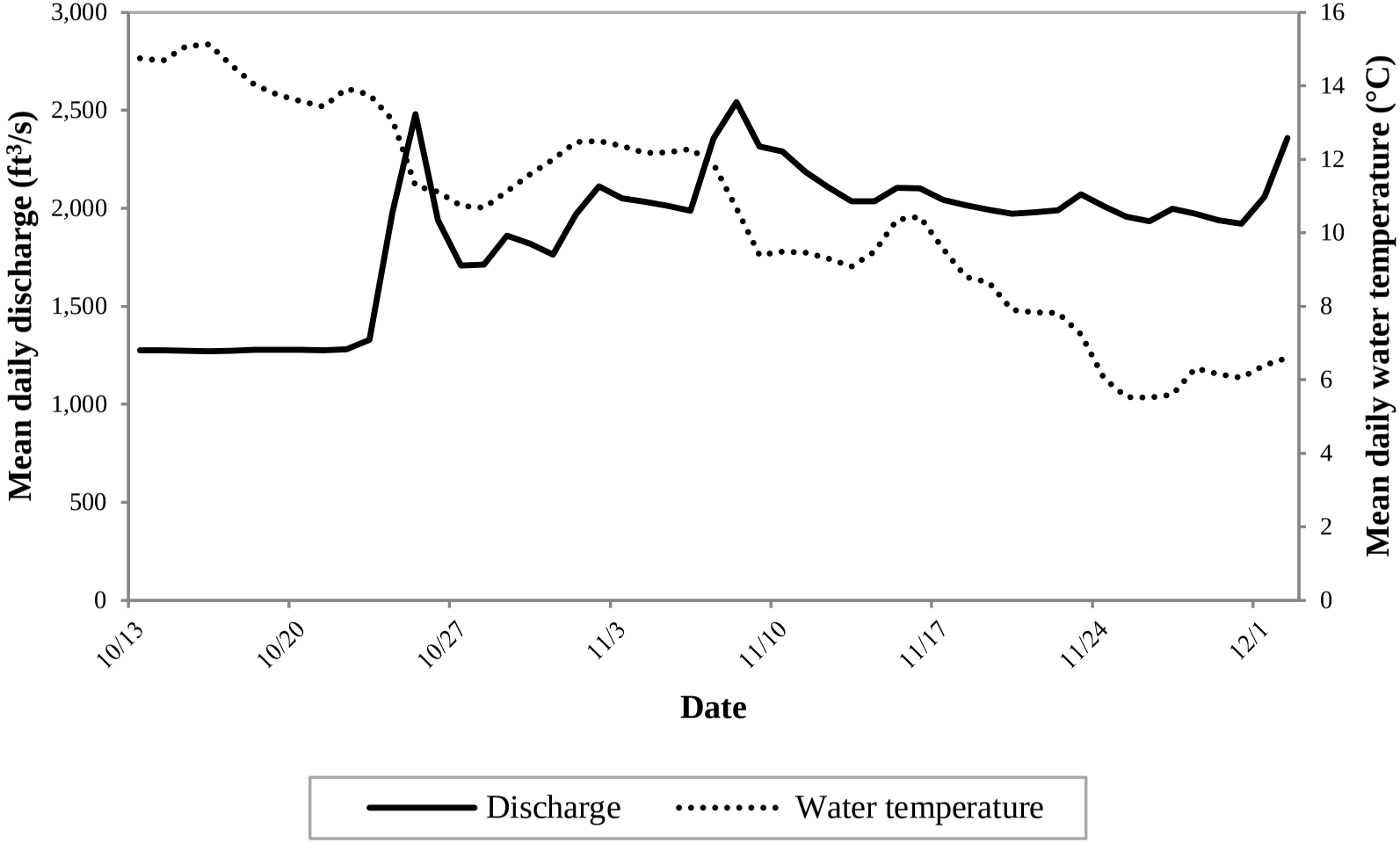

Figure 11. Water temperatures (°C) at river kilometer 206.8 and discharge (ft^3/s) near Seiad Valley at USGS Gage 11520500, October 13 to December 2, 2010.

Literature Cited

Ayres Associates. 1999. Geomorphic and sediment evaluation of the Klamath River, California, below Iron Gate Dam. Prepared for U.S. Fish and Wildlife Service, Yreka, California, by Ayres Associates, Fort Collins, Colorado.

CDFG (California Department of Fish and Game). 2011. Klamath River basin fall Chinook salmon spawner escapement, in-river harvest and run-size estimates, 1978–2010. Available from W. Sinnen, CDFG, 5341 Ericson Way, Arcata, California 95521.

Flint, L.E., and A.L. Flint. 2008. A basin-scale approach to estimating stream temperatures of tributaries to the Lower Klamath River, California. Journal of Environmental Quality 37:57–68.

Gough, S.A., and S.C. Williamson. 2012. Fall Chinook salmon run characteristics and escapement for the mainstem Klamath River, 2001–2010. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata Fisheries Technical Report Number TR 2012-14, Arcata, California.

Harvey, B.C., and T.E. Lisle. 1999. Scour of Chinook salmon redds on suction dredge tailings. North American Journal of Fisheries Management 19:613–617.

KRTT (Klamath River Technical Team). 2011. Klamath River fall Chinook salmon age-specific escapement, river harvest, and run size estimates, 2010 run. Available from the Pacific Fishery Management Council, 7700 NE Ambassador Place, Suite 101, Portland, Oregon 97220-1384.

Leidy, R.A., and G.R. Leidy. 1984. Life stage periodicities of anadromous salmonids in the Klamath River Basin, northwestern California. U.S. Fish and Wildlife Service, Division of Ecological Services, Sacramento, California.

PFMC (Pacific Fishery Management Council). 1988. Review of 1988 ocean salmon fisheries. Portland, Oregon.

USFWS (United States Fish and Wildlife Service). 1991. Annual report: Klamath River fisheries assessment program, 1989. Coastal California Fishery Resource Office, Arcata, California.