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Mainstem Klamath River Fall Chinook Salmon Redd Survey 2009

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

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Abstract. This report is a summary of the 2009 fall Chinook salmon (*Oncorhynchus tshawytscha*) redd survey on the mainstem Klamath River, and is the seventeenth such summary provided by the Arcata Fish and Wildlife Office. The survey was conducted over an eight week period (October 14 to December 4, 2009), covering 111.9 river kilometers (rkm) between Ash Creek (rkm 285.7) and Indian Creek (rkm 173.8). A total of 1,840 fall Chinook salmon redds were counted in 2009, which was the second highest count for this section of river since surveys began in 1993. The highest count of 2,539 redds was made in 2002. The 2009 count was 109% greater than the average from the previous sixteen years ($\bar{x} = 881$). Redd densities within approximately 10-rkm sections were highest between China Creek (rkm 191.9) and Ottley Gulch (rkm 183.7; 41.3 redds/rkm) and lowest between Shasta River (rkm 288.5) and Humbug Creek (rkm 279.7; 4.3 redds/rkm).

Introduction

The Klamath River drains approximately 14,000 km² in Oregon and 26,000 km² 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 km², borders the lower 68 km of the Klamath River (Figure 1). The Hupa Valley Tribe Reservation (365 km²) is 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 river kilometers (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 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 tshawytscha*), coho salmon (*O. kisutch*), and steelhead (*O. mykiss*), which contribute to economically and culturally important subsistence, sport, and commercial

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 in the drainage may exceed 200,000 angler days annually (Leidy and Leidy 1984). During the 1980's, the 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).

As in other river systems of the Pacific Northwest, Chinook salmon of the Klamath River Basin are susceptible to habitat degradation and over-exploitation, as reflected by declining runs in recent decades (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 habitats in the basin (Ayers Associates 1999; Flint and Flint 2008).

On October 27, 1986, the United States Congress enacted PL 99-552, the Klamath River Fish and Wildlife Restoration Act. This 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), functioning under the guidance of the Klamath River Fishery Management Council (USFWS 1991). The U.S. Fish and Wildlife Service (USFWS) was funded through the KRBCARP to identify fall Chinook salmon spawning areas, spawn timing, and collect information necessary to estimate the number of natural fall Chinook salmon spawning in the mainstem Klamath River between IGD and the confluence of Indian Creek (rkm 173.8; Figure 1). In 1993, the USFWS started conducting fall Chinook salmon redd surveys to estimate escapement within this section of the mainstem Klamath River. In 2001, the USFWS began estimating escapement between IGD and the Shasta River confluence using carcass-mark recapture methods, but the mainstem river downstream of this area is still surveyed by counting redds. This report summarizes the 2009 redd surveys between Ash Creek (rkm 285.7) and Indian Creek. The Klamath River Technical Advisory Team (KRTAT 2010) uses this information to assess basin wide spawning escapement and in generating stock projections used for harvest management.

Methods

Survey Reaches

The survey area was divided into six reaches based on accessibility and distance a single crew could survey in a day (Table 1; Figure 2). Reach 1 (Iron Gate Dam to Ash Creek) was not surveyed in 2009 because a carcass-mark recapture estimator is now used to derive the number of fall Chinook salmon that spawn in this reach. Carcass-mark recapture provides more accurate escapement estimates in such higher density spawning areas. This was the fourth year (2005, 2007 to 2009) since 1993 that this reach was not included in the redd survey.

The section of river in Reach 1 between Deliverance Camp (rkm 287.5) and Ash Creek was not surveyed because past surveys revealed a lack of available spawning habitat.

Survey Procedures

Weekly visual redd counts were conducted on five mainstem reaches between Ash Creek and Indian Creek. Two crews, each consisting of an oarsman and observer, aided by polarized glasses, conducted surveys by cataraft. To sufficiently cover redd areas, boats maneuvered in a zigzag pattern across the channel while moving downstream. Side and split channels were surveyed by foot or floated on alternating weeks. Crews were assigned the same survey reaches throughout the sampling period with the belief that increased familiarity of redd locations would facilitate more accurate counting of redds.

Data Collection

Redd Data

Flagging was used to mark redd locations. Flagging was attached to vegetation on the riverbank nearest to the observed redd(s). A different flag color was used each week to distinguish redd counts on subsequent surveys. Date, number of old and new redds per site, location in channel, and redd site number were recorded on flags. Reach, flag location, global positioning system coordinates, number of old and new redds, location in channel (left or right bank, mid-channel, side channel, split channel, or pool tail-out), distance from bank, and age of redd were recorded on data forms. Estimated redd ages were coded as 1, 2, or 3 where: “1” was fresh with bright substrate, little or no periphyton, and well-developed mounds; “2” was believed to be two to four weeks old with slightly flattened mounds and dulled substrate due to periphyton growth; “3” was believed to be older than four weeks, identifiable only by the presence of a pit and/or mound. The brightness of substrate on age code “3” was typically not distinguishable from that of surrounding substrate. Only completed redds including both a pit and mound were included in daily counts. Test redds (redds without a completed pit and mound) were not included in this report.

Water Quality

Water temperature was recorded by a PacifiCorp owned and operated Yellow Springs Instrument (YSI®) 6600 V2 or 6900 Multiprobe Datasondes (Sonde®) located approximately 100 m upstream of the Iron Gate Hatchery Bridge (rkm 309.9). Data recorded at 30-minute intervals throughout the survey period were used to calculate mean daily water temperatures. A Secchi disc was used to measure water visibility during each survey.

Discharge

Mean daily river flow was obtained from the U.S. Geological Survey Gauging Station 11516530 (41° 55' 41" N, 122°26'35" W, NAD 27; <http://waterdata.usgs.gov/ca/nwis/current/?type=flow>), located in the Klamath River just downstream of IGD.

Data Analysis

Redd Densities

Redd densities were determined to examine the spatial distribution of redds in the area of study. Redd densities were calculated for the five survey reaches as well as for fourteen approximately 10-rkm sections. The latter analysis was completed to provide improved spatial resolution of redd locations for future evaluations.

Adult and Jack Expansions

The total number of redds counted in this survey were used to estimate adult and jack (two-year-old male) fall Chinook salmon abundance between Ash Creek and Indian Creek (CDFG 2010). Adult numbers were estimated by multiplying the total redd count by two. This estimate assumes each redd represents one male and female adult salmon. The adult age breaks and jack apportionment for the mainstem Klamath River from IGD to Indian Creek was derived from scales and fork length data collected during carcass surveys in Reach 1 (KRTAT 2010).

Results and Discussion

Survey Reaches

A total of 1,840 Chinook salmon redds were counted between Ash Creek and Indian Creek in 2009. This count was 109% greater than the previous sixteen year average ($\bar{x} = 881$) for the five reaches surveyed. Weekly redd counts and percent frequency for survey years 1993 to 2009 are summarized in Table 2. Peak redd counts occurred November 3 to 5 for reaches 2, 4, and 6, and October 27 to 29 for reaches 3 and 5. Combined redd counts for the five reaches surveyed in 2009 were the second highest recorded in the seventeen year history of the project (Figure 3), with the 2002 count ($n = 2,539$) being highest. Redd densities by reach in 2009 are presented in Figure 4. The highest number of Chinook salmon redds/rkm was in Reach 6 (39.5 redds/rkm) and the lowest was in Reach 2 (8.4 redds/rkm; Figure 4). Spatial distributions of redds was slightly different from previous survey years in that the lowest densities were in Reach 2 instead of Reach 5 (10.3 redds/rkm). Spatial distribution of redds for all reaches surveyed are shown in Figures 5 to 9.

10-rkm Section Redd Densities

The highest density of redds was between China Creek and Ottley Gulch (41.3 redds/rkm), which was 165% greater than the preceding 16 year average ($\bar{x} = 15.6$ redds/rkm) for this reach. In 2009, the lowest redd density (4.3 redds/rkm) was observed between Shasta River and Humbug Creek (rkm 279.7; Table 3; Figure 5). Three 10-rkm sections (Walker Creek [rkm 217] to Portuguese Creek [rkm 207.7], China Creek [rkm 191.9] to Ottley Gulch [rkm 183.7], and Ottley Gulch to Indian Creek) had higher densities than any previous survey year (Table 3).

Water Quality

Mean daily water temperatures decreased from 14.2 to 6.8°C during this survey (October 14 to December 4, 2009; Figure 10). Vertical Secchi disc readings ranged from 0.6 to 2.4 m ($\bar{x} = 1.9$ m) during this survey. Visibility generally decreased with higher river discharge, cloud cover, and precipitation.

Discharge

Discharge during the 2009 survey period ranged from 1,290 to 1,330 ft³/s (Figure 10). Over the last 17 years, average daily discharge for the redd survey time period has ranged from 901 ft³/s in 2002 to 1,642 in 1999.

Suction Dredge Mining

Recreational suction dredge mining was present, but inactive, throughout the survey from Ash Creek to Happy Camp. Two redds were observed on a suction dredge tailing between Seiad and China Point. Redds constructed on dredge tailings are more unstable in high flows than those constructed on naturally deposited substrate (Harvey and Lisle 1999).

Adult Jack Expansion

We estimated that 3,680 adult and 135 jack fall Chinook salmon spawned in the mainstem Klamath River in the redd survey area (Reaches 2 to 6; Table 4). Carcass-mark recapture methods estimated that 4,267 adult and 160 jack fall Chinook salmon spawned between IGD and the Shasta River (Reach 1).

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

Reach Number	Upper Boundary		Lower Boundary		Reach Length
	Location	rkm	Location	rkm	rkm
1 ^a	Iron Gate Dam	310.3	Ash Creek ^b	285.7	24.6
2	Ash Creek	285.7	Beaver Creek	261.9	23.8
3	Beaver Creek	261.9	Blue Heron	234.3	27.6
4	Blue Heron	234.3	Seiad Bar	213.6	20.7
5	Seiad Bar	213.6	China Point	192.4	21.2
6	China Point	192.4	Indian Creek	173.8	18.6

^a Redd counts are no longer used to estimate fall Chinook salmon spawners in this reach.

^b The section of river between Deliverance Camp (rkm 287.5) and Ash Creek was not surveyed because past surveys revealed a lack of available spawning habitat in this area.

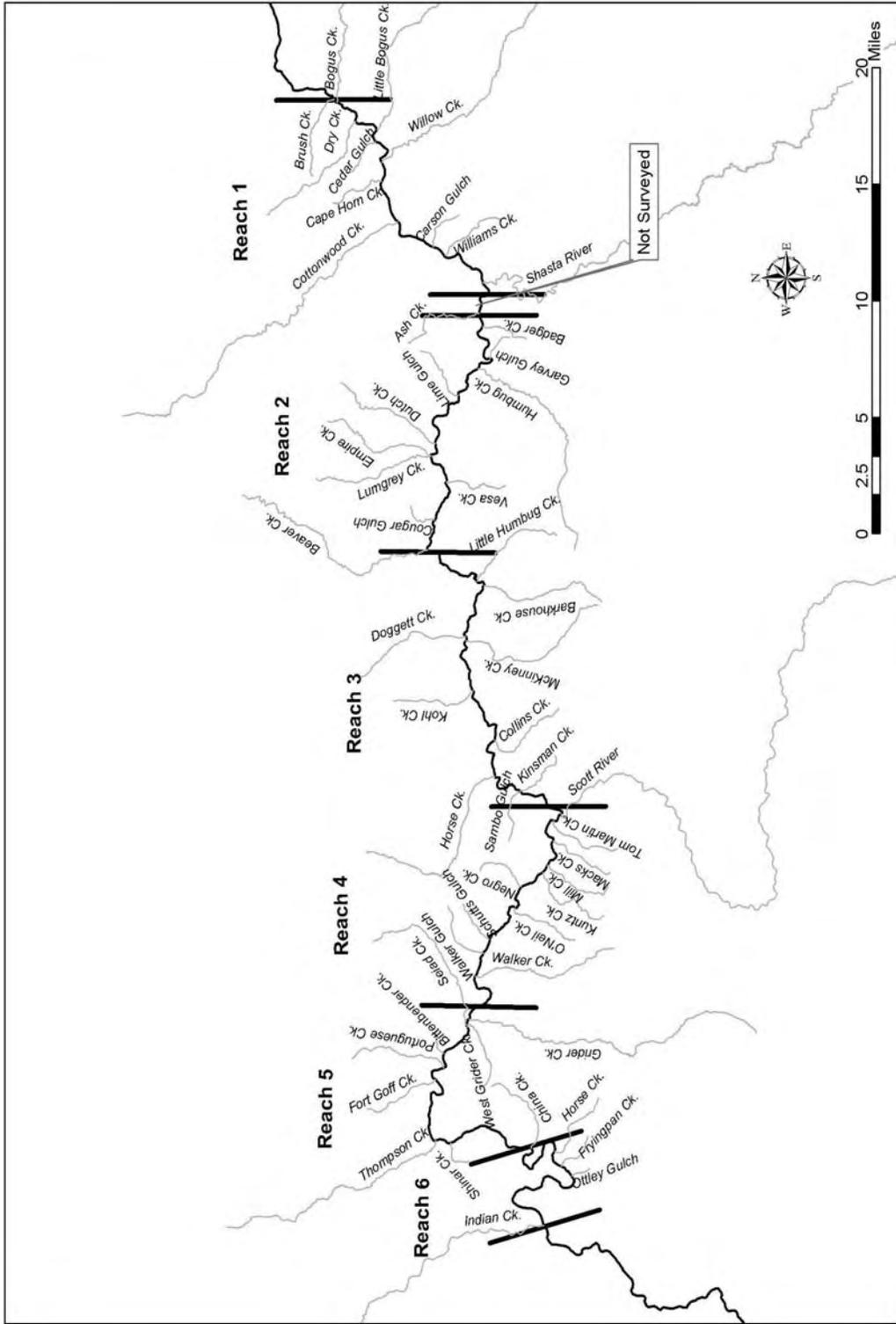


Figure 2. Mainstem Klamath River fall Chinook salmon redd survey reaches (1 to 6).

Table 2. Weekly summary and percent frequency of mainstem Klamath River fall Chinook salmon redd counts for Reaches 1 to 6, 1993 to 2009 (Ns = No Survey, R1 = Iron Gate Dam to Ash Creek, R2 = Ash Creek to Beaver Creek, R3 = Beaver Creek to Blue Heron, R4 = Blue Heron to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek).

Year	Survey dates	Reach						Total
		R1	R2	R3	R4	R5	R6	
1993	Oct 25 to 29	15	13	30	18	16	81	173
	Nov 1 to 5	67	24	4	1	15	5	116
	Nov 8 to 12	5	1	18	7	0	1	32
	Nov 15 to 18	0	0	4	5	0	0	9
	Total	87	38	56	31	31	87	330
	Frequency	26.4%	11.5%	17.0%	9.4%	9.4%	26.4%	
1994	Oct 17 to 21	89	28	48	Ns	Ns	98	263
	Oct 24 to 28	278	59	77	113	98	124	749
	Oct 31 to Nov 4	375	20	46	42	16	33	532
	Nov 7 to 11	86	Ns	Ns	Ns	Ns	Ns	86
	Nov 14 to 18	3	2	7	4	5	5	26
	Total	831	109	178	159	119	260	1,656
	Frequency	50.2%	6.6%	10.7%	9.6%	7.2%	15.7%	
1995	Oct 16 to 20	138	12	70	26	30	139	415
	Oct 23 to 27	598	82	199	94	91	169	1,233
	Oct 30 to Nov 3	727	58	78	35	57	112	1,067
	Nov 6 to 10	277	26	49	13	25	50	440
	Nov 13 to 17	Ns	Ns	Ns	Ns	Ns	Ns	0
	Nov 20 to 24	Ns	Ns	Ns	Ns	Ns	Ns	0
	Nov 27 to Dec 1	39	9	14	4	12	3	81
	Total	1,779	187	410	172	215	473	3,236
Frequency	55.0%	5.8%	12.7%	5.3%	6.6%	14.6%		
1996	Oct 21 to 25	290	31	96	10	118	39	584
	Oct 28 to Nov 1	291	29	25	22	42	92	501
	Nov 4 to 8	83	4	24	8	33	59	211
	Nov 11 to 15	40	0	6	0	7	23	76
	Total	704	64	151	40	200	213	1,372
	Frequency	51.3%	4.7%	11.0%	2.9%	14.6%	15.5%	
1997	Oct 16	272	Ns	Ns	Ns	Ns	Ns	272
	Oct 20 to 24	252	37	69	89	29	136	612
	Oct 27 to 31	424	18	76	52	22	76	668
	Nov 3 to 7	70	7	13	16	8	27	141
	Nov 10 to 14	2	14	4	5	3	18	46
	Total	1,020	76	162	162	62	257	1,739
	Frequency	58.7%	4.4%	9.3%	9.3%	3.6%	14.8%	
1998	Oct 14 to 15	89	Ns	Ns	Ns	Ns	Ns	89
	Oct 19 to 23	180	45	67	15	20	45	372
	Oct 26 to 30	368	11	12	14	7	39	451
	Nov 2 to 6	226	22	33	10	9	28	328
	Nov 9 to 12	135	3	11	3	2	2	156
	Nov 15 to 19	12	1	3	0	1	2	19
	Total	1,010	82	126	42	39	116	1,415
Frequency	71.4%	5.8%	8.9%	3.0%	2.8%	8.2%		

Table 2. (Continued). Weekly summary and percent frequency of mainstem Klamath River fall Chinook salmon redd counts for Reaches 1 to 6, 1993 to 2009 (Ns = No Survey, R1 = Iron Gate Dam to Ash Creek, R2 = Ash Creek to Beaver Creek, R3 = Beaver Creek to Blue Heron, R4 = Blue Heron to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek).

Year	Survey dates	Reach						Total
		R1	R2	R3	R4	R5	R6	
1999	Oct 13 to 15	98	3	Ns	Ns	Ns	Ns	101
	Oct 18 to 22	200	27	31	17	23	39	337
	Oct 25 to 27	304	23	20	Ns	Ns	Ns	347
	Nov 1 to 5	83	12	9	8	8	19	139
	Nov 8 to 12	37	2	2	1	5	11	58
	Nov 15 to 19	1	2	0	2	2	0	7
	Total	723	69	62	28	38	69	989
	Frequency	73.1%	7.0%	6.3%	2.8%	3.8%	7.0%	
2000	Oct 16 to 20	327	92	69	25	10	19	542
	Oct 23 to 27	146	62	34	52	10	53	357
	Oct 30 to Nov 3	254	42	69	54	20	86	525
	Nov 6 to 10	57	12	15	21	2	16	123
	Nov 13 to 17	4	0	9	12	0	6	30
	Nov 20 to 22	1	Ns	Ns	Ns	Ns	Ns	1
	Total	788	208	196	164	42	180	1,578
	Frequency	49.9%	13.2%	12.4%	10.4%	2.7%	11.4%	
2001	Oct 15 to 19	92	24	28	21	2	23	190
	Oct 22 to 26	168	102	128	59	40	82	579
	Oct 29 to Nov 2	323	97	170	102	55	139	886
	Nov 5 to 9	155	10	40	12	31	29	277
	Nov 12 to 16	75	31	49	22	9	Ns	186
	Nov 19 to 23	Ns	Ns	Ns	Ns	Ns	Ns	0
	Nov 26 to 30	17	Ns	Ns	Ns	Ns	Ns	17
	Dec 3 to 7	Ns	Ns	12	Ns	Ns	5	17
	Dec 10 to 14	Ns	5	8	4	3	Ns	20
	Total	830	269	435	220	140	278	2,172
Frequency	38.2%	12.4%	20.0%	10.1%	6.4%	12.8%		
2002	Oct 10	8	Ns	Ns	Ns	Ns	Ns	8
	Oct 15 to 18	124	90	120	71	61	146	612
	Oct 21 to 25	885	198	340	186	141	181	1,931
	Oct 29 to Nov 1	549	112	148	90	69	66	1,034
	Nov 4 to 8	335	90	62	38	20	21	566
	Nov 12 to 15	136	56	39	46	14	65	356
	Nov 19 to 22	76	20	10	10	5	15	136
	Nov 26 to 29	Ns	Ns	Ns	Ns	Ns	Ns	0
	Dec 2 to 6	0	0	7	0	1	1	9
	Total	2,113	566	726	441	311	495	4,652
Frequency	45.4%	12.2%	15.6%	9.5%	6.7%	10.6%		
2003	Oct 14 to 17	0	Ns	38	22	19	48	127
	Oct 20 to 24	563	194	228	178	77	150	1,390
	Oct 27 to 31	553	73	103	18	119	99	965
	Nov 4 to 7	310	33	97	61	50	74	625
	Nov 12 to 15	44	43	14	11	15	48	175
	Nov 19 to 22	2	0	4	2	5	7	20
	Total	1,472	343	484	292	285	426	3,302
	Frequency	44.6%	10.4%	14.7%	8.8%	8.6%	12.9%	

Table 2. (Continued). Weekly summary and percent frequency of mainstem Klamath River fall Chinook salmon redd counts for Reaches 1 to 6, 1993 to 2009 (Ns = No Survey, R1 = Iron Gate Dam to Ash Creek, R2 = Ash Creek to Beaver Creek, R3 = Beaver Creek to Blue Heron, R4 = Blue Heron to Seiad Bar, R5 = Seiad Bar to China Point, R6 = China Point to Indian Creek).

Year	Survey dates	Reach						Total
		R1	R2	R3	R4	R5	R6	
2004	Oct 11 to 15	Ns	0	6	1	3	0	10
	Oct 18 to 22	Ns	57	45	27	17	11	157
	Oct 25 to 29	Ns	22	37	9	17	25	110
	Nov 1 to 5	513	36	27	14	7	10	607
	Nov 8 to 12	Ns	2	10	4	4	3	23
	Nov 29 to Dec 3	Ns	0	9	0	0	0	9
	Total	513	117	134	55	48	49	916
Frequency	56.0%	12.8%	14.6%	6.0%	5.2%	5.3%		
2005	Oct 18 to 20	Ns	12	14	3	3	27	59
	Oct 25 to 27	Ns	10	17	15	17	37	96
	Nov 1 to 3	Ns	9	8	8	7	20	52
	Nov 8 to 10	Ns	Ns	Ns	Ns	Ns	Ns	0
	Nov 15 to 17	Ns	8	1	20	1	31	61
	Total	-	39	40	46	28	115	268 *
	Frequency*	-	14.6%	14.9%	17.2%	10.4%	42.9%	
2006	Oct 16 to 20	109	21	41	66	31	155	423
	Oct 23 to 27	167	17	30	61	21	55	351
	Oct 30 to Nov 3	96	10	33	12	Ns	6	157
	Nov 6 to 10	66	3	9	7	19	110	214
	Nov 13 to 15	15	6	4	Ns	Ns	Ns	25
	Nov 20 to 24	Ns	Ns	Ns	Ns	Ns	Ns	0
	Nov 29	Ns	Ns	Ns	Ns	Ns	16	16
	Total	453	57	117	146	71	342	1,186
Frequency	38.2%	4.8%	9.9%	12.3%	6.0%	28.8%		
2007	Oct 16 to 18	Ns	24	17	36	5	42	124
	Oct 23 to 25	Ns	12	53	15	25	67	172
	Oct 30 to Nov 1	Ns	25	32	47	21	90	215
	Nov 5 to 8	Ns	27	24	37	8	72	168
	Nov 14 to 16	Ns	1	7	3	5	9	25
	Nov 21 to 23	Ns	Ns	Ns	Ns	Ns	Ns	0
	Nov 28 to 29	Ns	Ns	3	Ns	1	4	8
	Total	-	89	136	138	65	284	712 *
Frequency*	-	12.5%	19.1%	19.4%	9.1%	39.9%		
2008	Oct 15 to 17	Ns	3	24	13	12	12	64
	Oct 21 to 23	Ns	61	24	63	10	60	218
	Oct 28 to 30	Ns	30	39	49	36	129	283
	Nov 4 to 6	Ns	42	33	23	19	108	225
	Nov 11 to 13	Ns	6	4	19	14	31	74
	Nov 18 to 20	Ns	5	5	3	1	14	28
	Nov 25 to 27	Ns						
	Dec 2 to 4	Ns	0	6	0	0	0	6
	Total	-	147	135	170	92	354	898 *
Frequency*	-	16.4%	15.0%	18.9%	10.2%	39.4%		
2009	Oct 14 to 16	Ns	21	61	42	33	127	284
	Oct 20 to 22	Ns	64	103	71	53	247	538
	Oct 27 to 29	Ns	30	108	92	69	130	429
	Nov 3 to 5	Ns	69	48	110	37	183	447
	Nov 10 to 12	Ns	17	14	23	20	31	105
	Nov 17 to 19	Ns	0	11	4	6	15	36
	Nov 24 to 26	Ns	Ns	Ns	Ns	Ns	Ns	0
	Dec. 2 to 4	Ns	0	0	0	0	1	1
	Total	-	201	345	342	218	734	1,840 *
Frequency*	-	10.9%	18.8%	18.6%	11.8%	39.9%		

* Reach 1 was not surveyed.

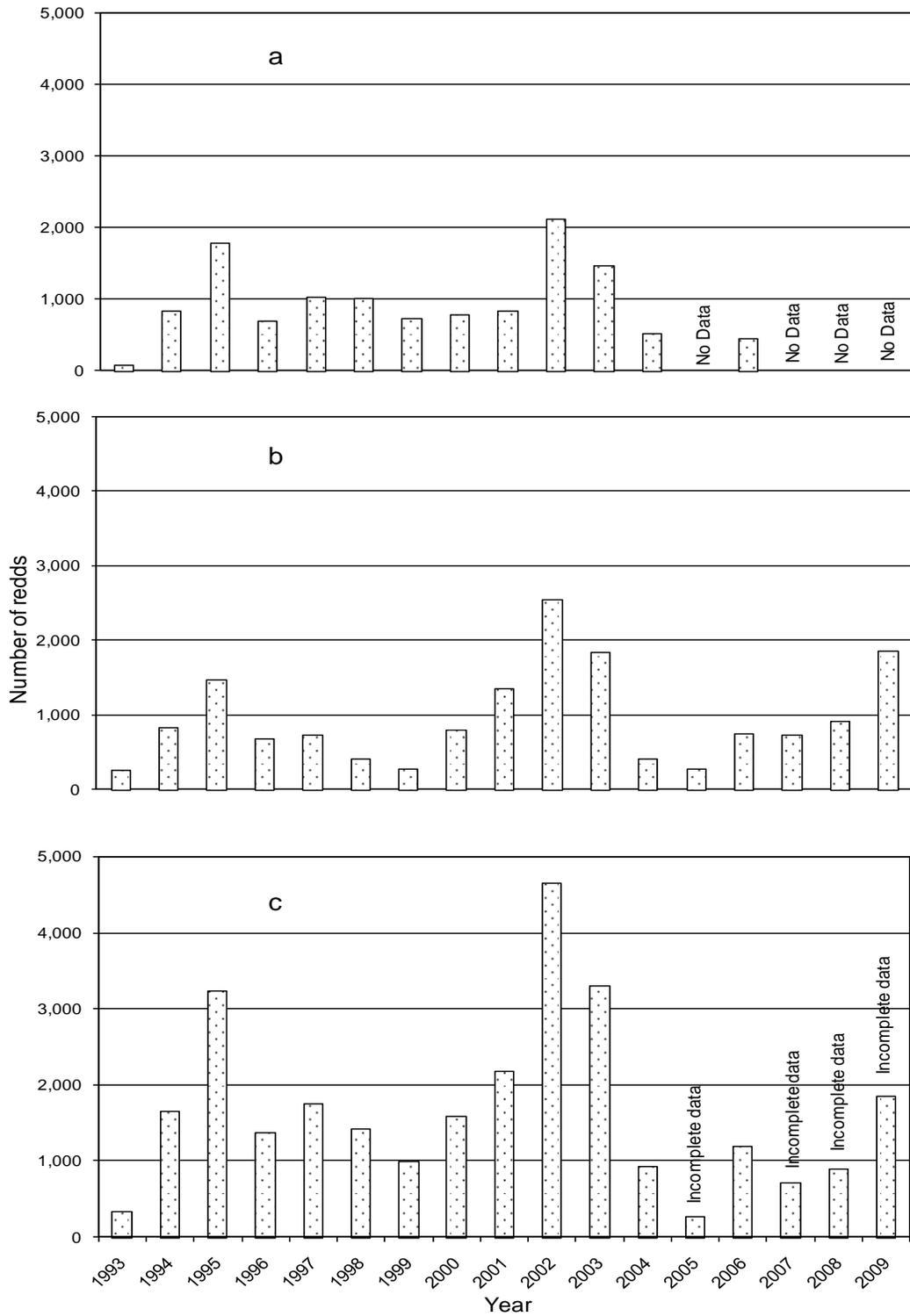


Figure 3. Mainstem Klamath River fall Chinook salmon redd counts 1993 to 2009 for a) Reach 1; b) Reaches 2 to 6; c) all reaches combined. Reach 1 was not surveyed in 2005 and 2007 through 2009.

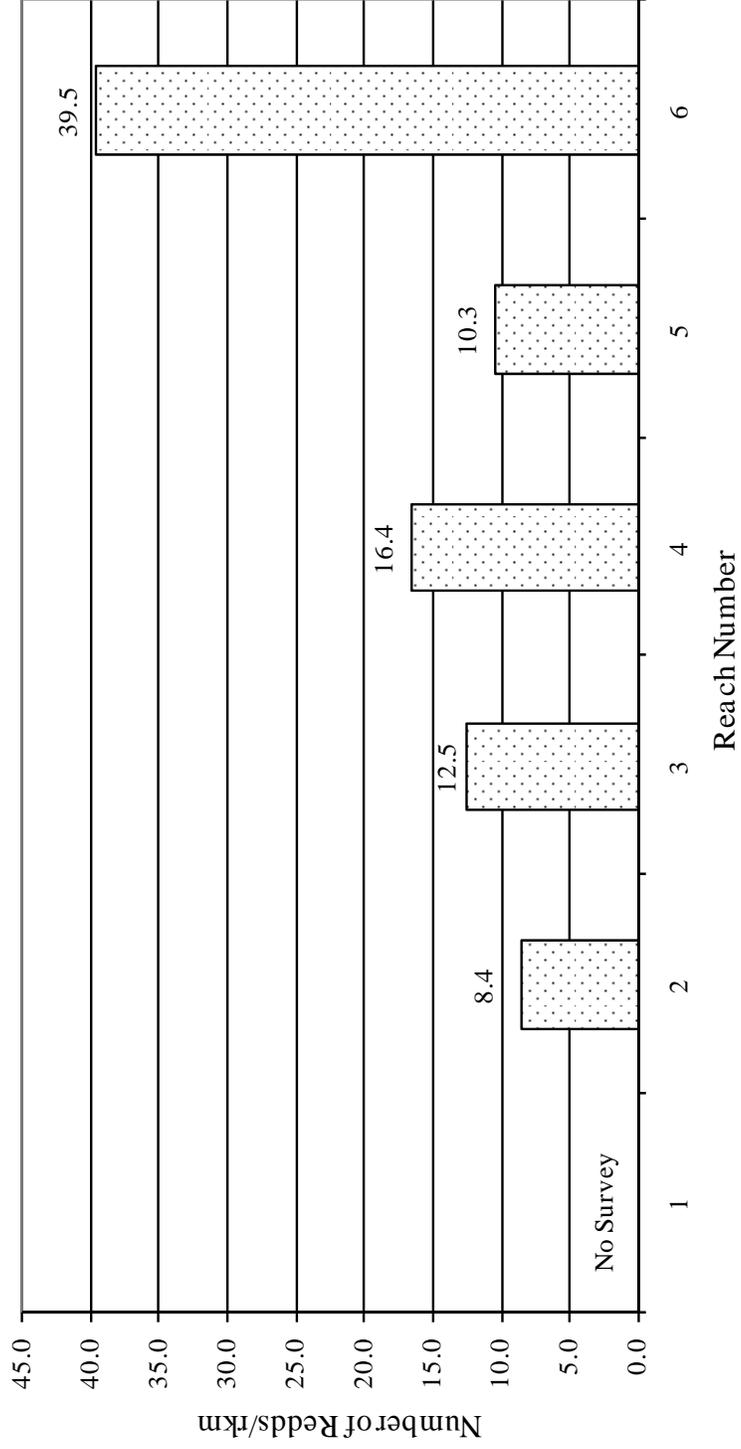


Figure 4. Mainstem Klamath River fall Chinook salmon redd density (redds/rkm) by reach, 2009.

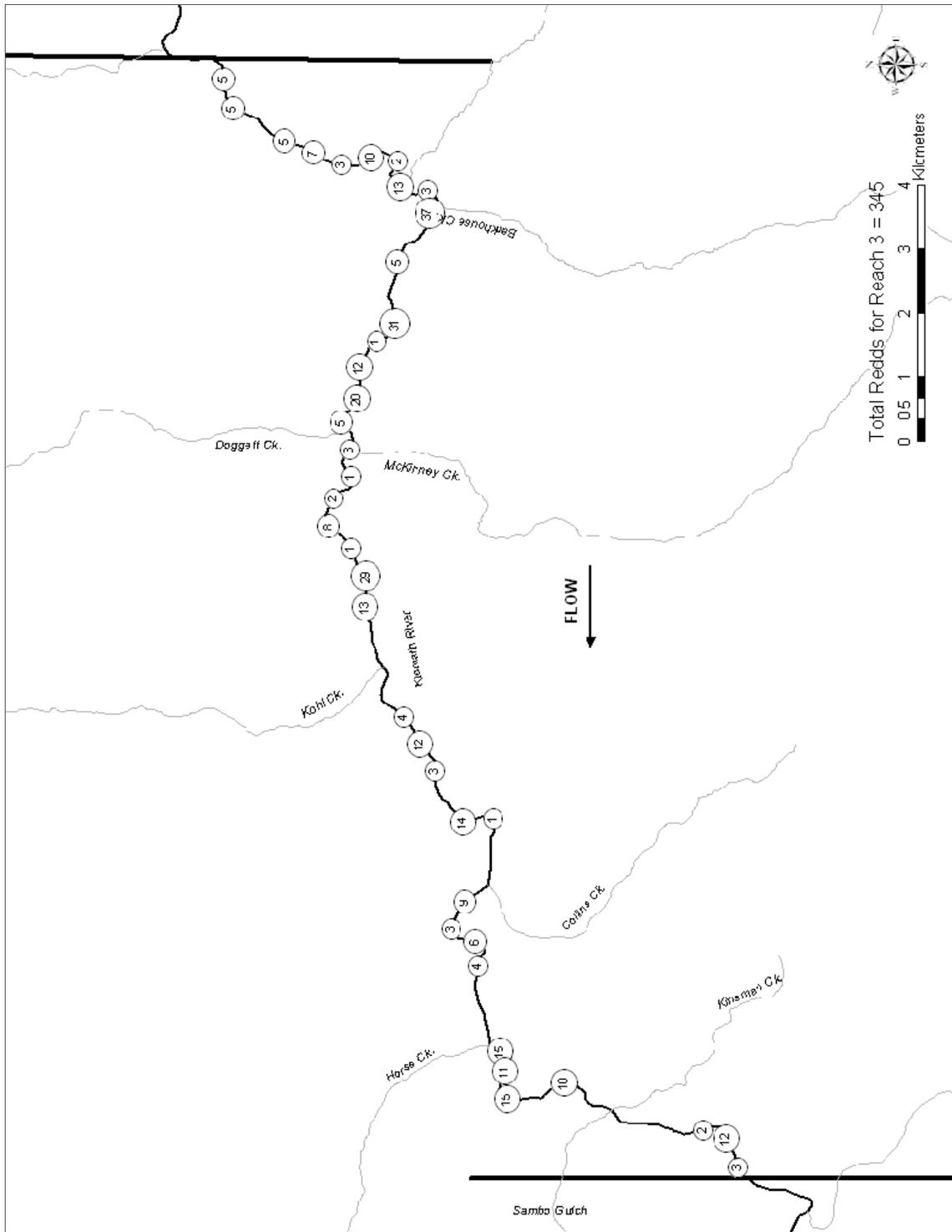


Figure 6. Redd distribution map for Reach 3, Beaver Creek to Blue Heron, mainstem Klamath River, 2009.

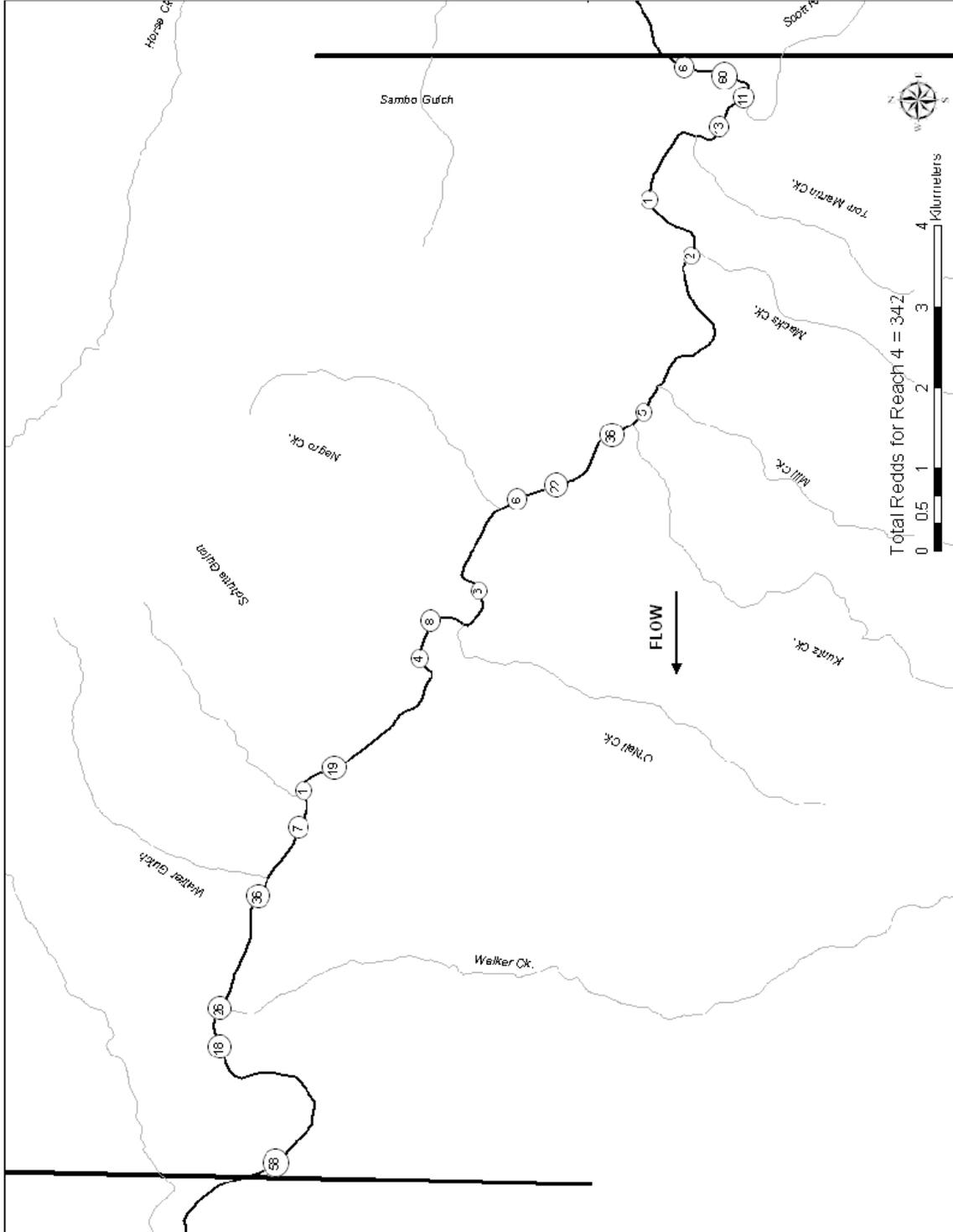


Figure 7. Redd distribution map for Reach 4, Blue Heron to Seiad Bar, mainstem Klamath River, 2009.

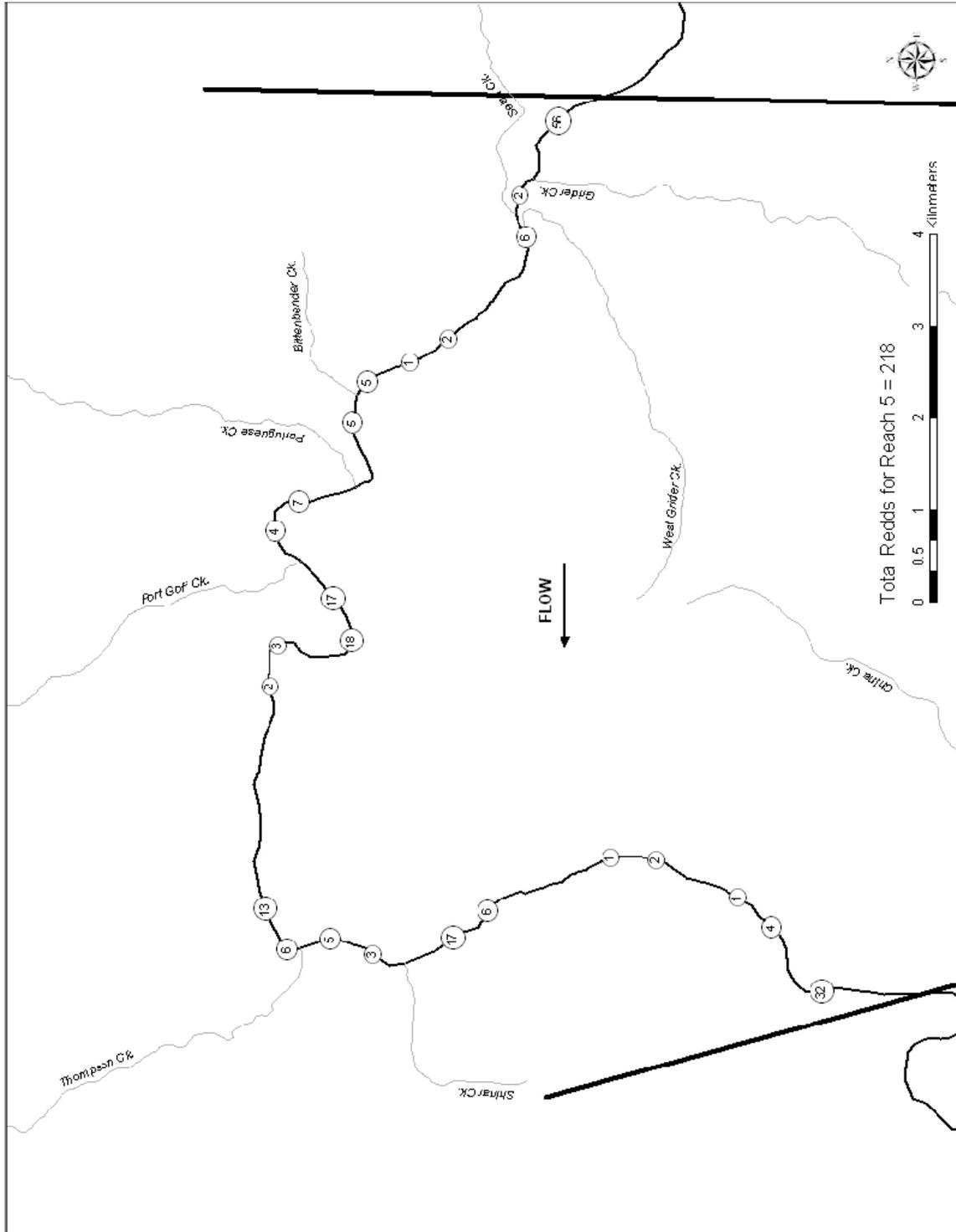


Figure 8. Redd distribution map for Reach 5, Seiad Bar to China Point, mainstem Klamath River, 2009.

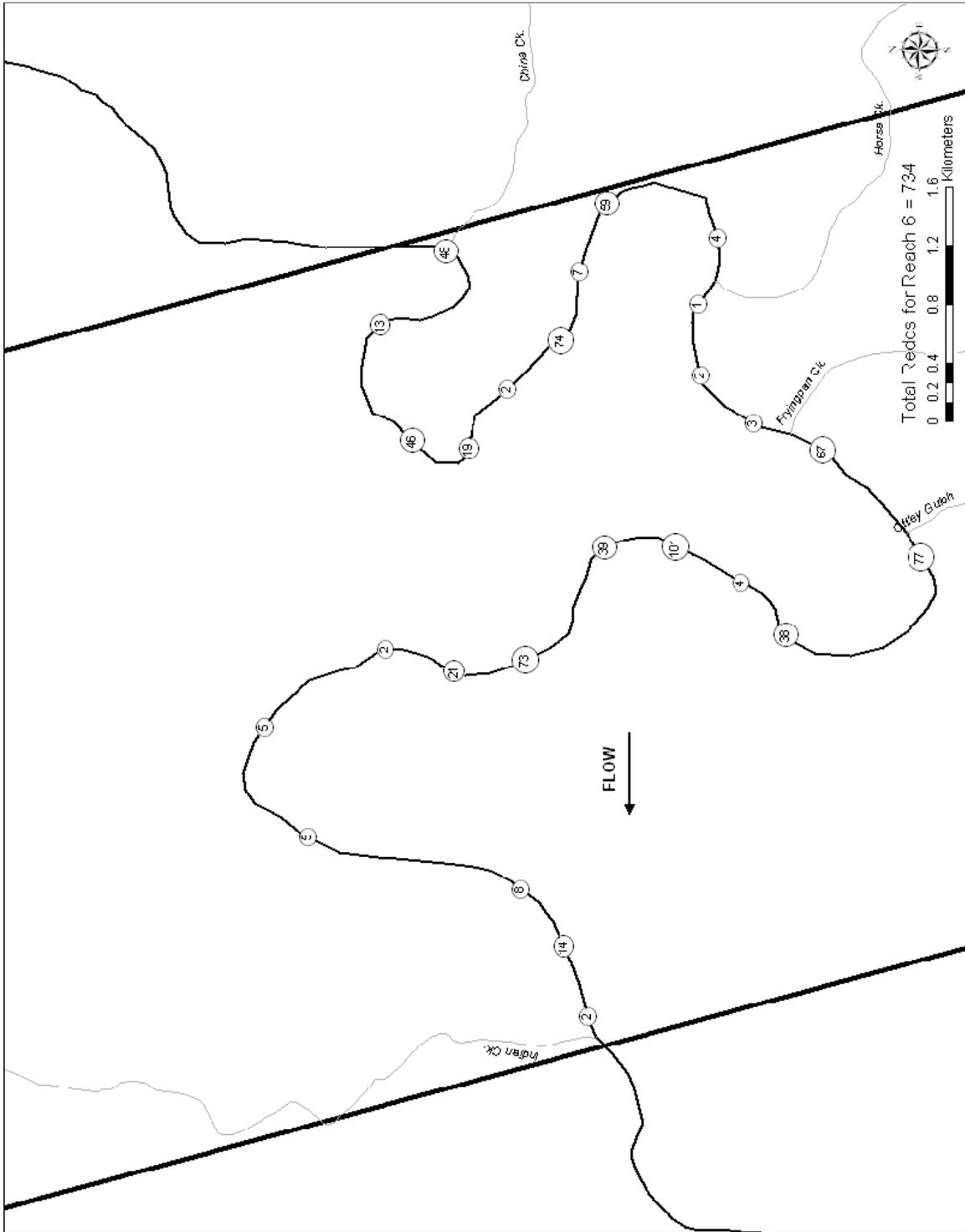


Figure 9. Redd distribution map for Reach 6, China Point to Indian Creek, mainstem Klamath River, 2009.

Table 3. Fall Chinook salmon redds per river kilometer (rkm) for 10 river kilometer (approximate) sections on the mainstem Klamath River, 1993 to 2009 ("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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
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	
Portuguese Creek (207.6) to 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	
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	
China Creek (191.9) to Otley 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	
Otley 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	

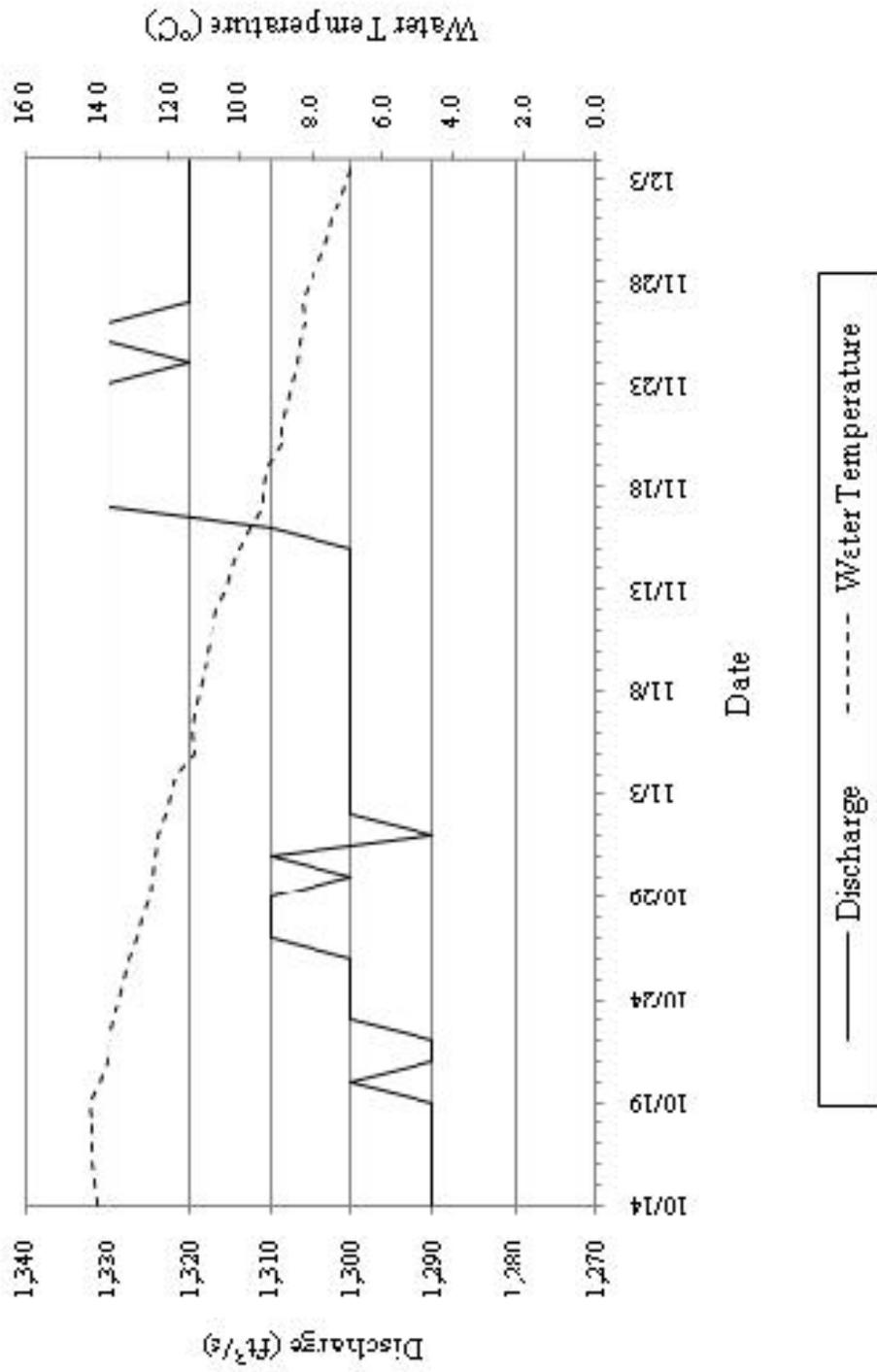


Figure 10. Water temperatures (°C) at river kilometer 309.9 and discharge (ft³/s) from Iron Gate Dam at USGS gage number 11516530 (October 14 to December 4, 2009).

Table 4. Natural fall Chinook salmon spawning escapement and adult and jack expansion, Klamath River, 2009 (modified from CDFG 2010).

Natural Spawning Area	Jacks	Adults	Totals
Mainstem Klamath River			
Iron Gate Dam to Ash Creek ^a	160	4,267	4,427
Ash Creek to Indian Creek ^b	135	3,680	3,815
Bogus Creek Basin	471	5,455	5,926
Shasta River Basin	151	6,145	6,296
Scott River Basin	44	2,167	2,211
Salmon River Basin	516	2,204	2,720
Misc. Klamath Tributaries upstream of Yurok Reservation	175	3,094	3,269
Yurok Reservation Tributaries	296	733	1,029
Total Natural Klamath Spawners	1,948	27,745	29,693
Mainstem Trinity River			
Misc. Trinity Tributaries	70	190	260
Hoopla Reservation Tributaries	113	308	421
Total Natural Trinity Spawners	6,165	16,846	23,011
Grand Total Natural Spawners	8,113	44,591	52,704

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

^b USFWS redd survey.

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