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Mainstem Trinity River Chinook Salmon Spawning Distribution 2012–2014

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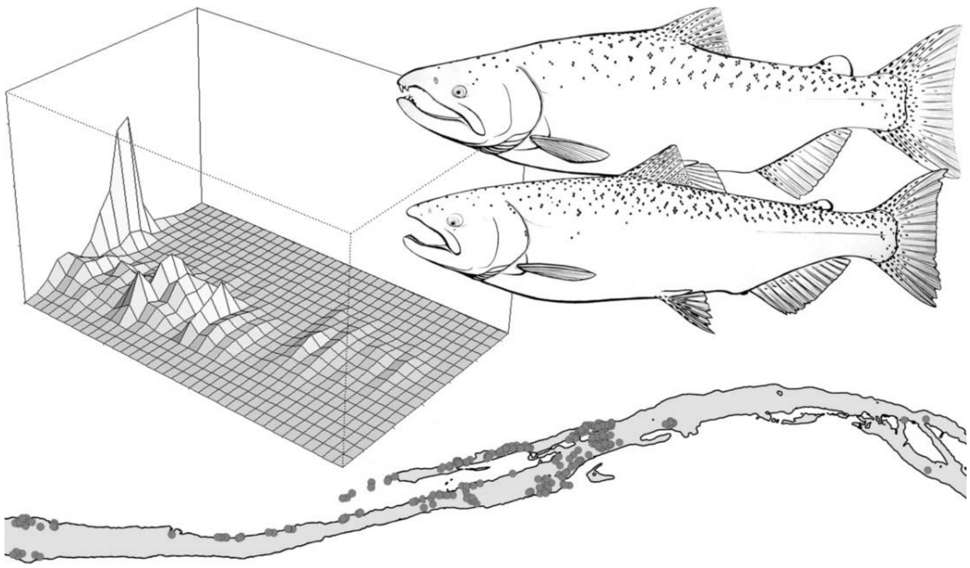

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Abstract.— Salmon redds and carcasses were surveyed on the mainstem Trinity River, from Lewiston Dam to the confluence with the Klamath River, during the 2012–2014 spawning seasons to map spawning distribution, evaluate pre-spawn mortality, and characterize redds by species and spawner origin. We applied generalized additive models to the spatiotemporal distribution of unmarked and hatchery-marked spawned female salmon carcasses to apportion redd counts by natural- and hatchery-origin Chinook Salmon *Oncorhynchus tshawytscha*. The annual estimated numbers of redds constructed by natural-origin Chinook Salmon females were 6,170, 2,682, and 2,733 from 2012 to 2014, respectively. The number of redds constructed by hatchery-origin Chinook Salmon were 1,145, 603, and 909 for the same respective time period. The distribution of redds constructed by hatchery-origin Chinook and Coho salmon were highly skewed toward Lewiston Dam. Since this project began in 2002, the number of redds constructed per year by natural-origin Chinook Salmon has been highly variable with no significant trend, while the number of redds built by hatchery-origin Chinook Salmon has trended downward. We observed an increase in the mean distance from Lewiston Dam of natural-origin Chinook Salmon redds. Between 2002 and 2014, from upstream to downstream, the number of natural-origin Chinook Salmon redds decreased in the Lewiston reach, remained unchanged in the Limekiln, Douglas City, Junction City, and North Fork reaches, increased in the Big Flat and Del Loma reaches, and remained unchanged in the South Fork, Willow Creek, and Hoopa reaches. Within channel restoration sites, spawning distribution responded to physical alterations at the local scale, but the number of redds exhibited inconsistent responses to channel rehabilitation work. Also calculated from carcass data, annual pre-spawn mortality in the survey area ranged between 2.4% and 11.5% from 2009 to 2014.

Introduction

The Trinity River once supported large populations of naturally produced anadromous salmonids, including spring- and fall-run Chinook Salmon *Oncorhynchus tshawytscha* (USFWS and HVT 1999). Prior to the construction of Trinity and Lewiston dams, the spawning of these two races was separated temporally and spatially due to the timing of adult upstream migration of each race and the hydrology of the river. In 1940s, Moffett and Smith (1950) observed Chinook Salmon spawning from the North Fork to the East Fork of the Trinity River. They noted that "almost without exception, Trinity River salmon migrating above the South Fork to spawn in the 72 miles between the North Fork and Ramshorn Creek."

Following construction of Lewiston Dam, spring- and fall-run Chinook Salmon spawning in the mainstem Trinity River exhibited considerable spatial and temporal overlap due to lack of access to historic spawning areas for the spring-run. High redd densities became frequent within the upper-most portions of the river below this barrier, where presumably hatchery-origin salmon and their progeny comingled and spawned with naturally produced fish. Rogers (1972) documented that in 1970 more than 50% of Chinook Salmon spawned in the two miles (3.2 km) below Lewiston Dam and 80% spawned above Douglas City. Redd surveys in the 1980s and 1990s between North Fork Trinity River and Cedar Flat documented variable spawning use in these reaches with redd counts ranging from a low of 187 redds in 1998 to a high of 928 in 1997 (USFWS 1986 and 1987; Quihillalt 1999). Chamberlain et al. (2012) noted that the mean distance from Lewiston Dam of natural-origin Chinook Salmon redds upstream of Cedar Flat increased from 2002 to 2011.

In an effort to restore the fishery resources of the Trinity River, the Secretary of the Interior signed the Trinity River Mainstem Fishery Restoration Record of Decision (ROD) in 2000 (USDOI 2000), establishing the Trinity River Restoration Program (TRRP). The goal of the TRRP is to:

> "…restore and sustain natural production of anadromous fish populations downstream of Lewiston Dam to pre-dam levels, to facilitate dependent tribal, commercial, and sport fisheries' full participation in the benefits of restoration via enhanced harvest opportunities." (TRRP and ESSA 2009)

To achieve this goal, the TRRP implements a suite of actions (flow management, mechanical channel rehabilitation, coarse sediment augmentation, and watershed restoration) to restore riverine habitats and restore some habitat-creating alluvial processes (USFWS and HVT 1999; USDOI 2000). Collectively, these actions are intended to increase and maintain salmonid habitats in the 64-km section of the Trinity River from Lewiston Dam downstream to the North Fork Trinity River ('restoration reach') which was severely degraded due the operation of the Trinity River Division (TRD) of the Central Valley Project. Downstream of the North Fork Trinity River, valley narrowing and accretions of flow and sediment from tributaries attenuate many of the morphological impacts that have occurred in the restoration reach (USFWS and HVT 1999).

The Integrated Assessment Plan (IAP; TRRP and ESSA 2009) sets forth a list of objectives to evaluate the effectiveness of TRRP restoration actions. Salmon spawning surveys are preformed to provide data to address Objective 3, specifically sub-objectives 3.1 and 3.3:

> **Objective 3**: Restore and maintain natural production of anadromous fish populations.
>
> > **Sub-objective 3.1**: Increase spawning, incubation, and emergence success of anadromous spawners.
> >
> > **Sub-objective 3.3**: Minimize impacts of predation and genetic interactions between and among hatchery and natural anadromous fish.

The IAP proposes assessing spawning at three spatial scales: site, reach, and system scales and states, "increased spawner success will likely occur within 3–4 brood cycles following completion of channel rehabilitation and subsequent fluvial and geomorphic evolution."

In this report we detail the results from salmon spawning survey data collected in 2012, 2013, and 2014 on the mainstem Trinity River. Collection of salmon carcasses provides information on pre-spawn mortality, escapement estimates, and reflects the species and origin composition of the spawned salmon. Delineating individual salmon redds provides the location and approximate timing of spawning. When analyzed together, each year's data produces a spatially and temporally explicit set of observed redd locations, with each redd having an associated probability of construction by female natural-origin Chinook Salmon, hatchery-origin Chinook Salmon, natural-origin Coho Salmon *O. kisutch*, and hatchery-origin Coho Salmon. We define 'hatchery-origin' as fish produced and released from Trinity River Hatchery (TRH), and 'natural-origin' as fish that emerge from a redd, regardless of parental origin. These data sets facilitate an array of analyses over a range of spatial and temporal scales, which we use to investigate spawning distribution and abundance. Where applicable, we use the performance measures set forth by the IAP to evaluate changes in spawning as responses to the restoration actions of the TRRP.

Methods

Survey Area and Timing

The Trinity River occupies a watershed area of approximately 7,679 km^2 in Trinity and Humboldt counties of northwestern California. Lewiston Dam, located 182.0 km upstream of the Trinity River's confluence with the Klamath River, is a barrier to fish migration.

TRH, located at the base of Lewiston Dam, is operated to mitigate the loss of Chinook Salmon, Coho Salmon, and steelhead *O. mykiss* production upstream of the dams. TRH releases approximately 4.3 million Chinook Salmon, 500,000 Coho Salmon, and 800,000 steelhead juveniles to the Trinity River, annually.

For the data collection portion of this study, the mainstem Trinity River from Lewiston Dam to its confluence with the Klamath River was delineated into 14 reaches ranging in length between 3.3 and 21.3 km (Figure 1, Table 1). Reach breaks were based on river access locations and channel distances that could be surveyed in a day. Two whitewater sections were not surveyed: the 9.7-km Pigeon Point run (Reach 8) and the 15.6-km section that includes the Burnt Ranch Gorge (Reach 11). Reaches 1–7 were surveyed weekly as conditions permitted. Reaches 9–14 (excluding Reach 11) were surveyed every other week. Annual surveys began in early September and extended into mid-December. This time frame was intended to encompass the majority of Chinook Salmon spawning activity.

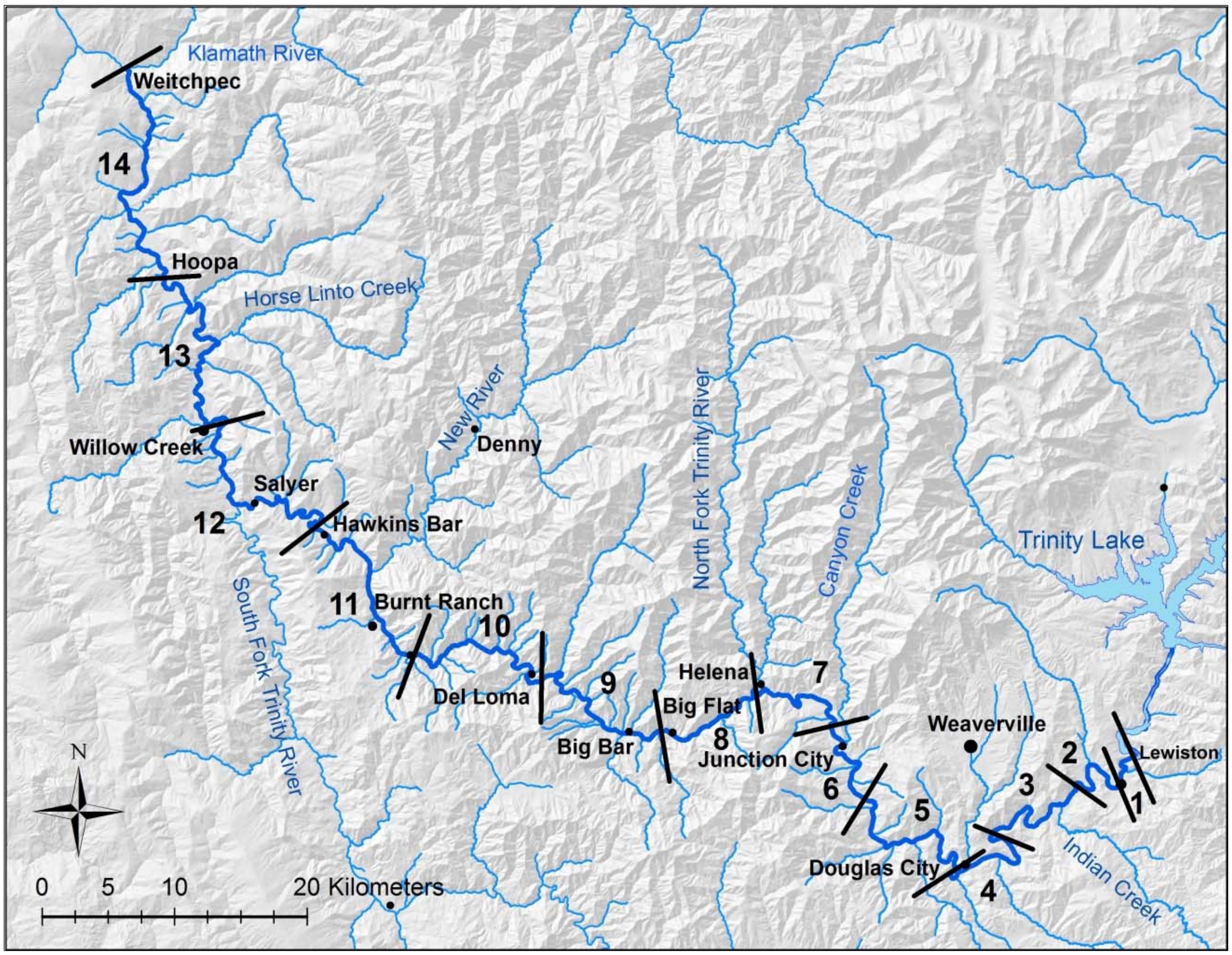


Figure 1. Survey Reaches 1–14 (Lewiston Dam to Weitchpec) on the mainstem Trinity River. Dangerous whitewater conditions precluded surveys in Reaches 8 and 11.

Table 1. Reach boundaries [and river kilometer (rkm)] for the mainstem Trinity River salmon spawning surveys. Agencies involved in data collection include California Department of Fish and Wildlife (CDFW), Shasta–Trinity National Forest (USFS), U.S. Fish and Wildlife Service (USFWS), Yurok Tribal Fisheries Program (YTFP), and Hoopa Valley Tribal Fisheries Department (HVT).

	Boundaries		
Reach	Upstream	Downstream (rkm)	Surveying agency
1	Lewiston Dam (rkm 182.0)	Old Lewiston Bridge (178.7)	USFS, YTFP, CDFW
2	Old Lewiston Bridge	Bucktail River Access (171.6)	CDFW, YTFP
3	Bucktail River Access	Steel Bridge River Access (160.7)	CDFW, YTFP
4	Steel Bridge River Access	Douglas City Campground (150.1)	CDFW, YTFP
5	Douglas City Campground	Round House (135.7)	CDFW, YTFP
6	Round House	Junction City Campground (127.1)	USFWS, HVT
7	Junction City Campground	Pigeon Point Campground [a] (117.4)	USFWS, HVT
8	Pigeon Point Campground [a]	Big Flat River Access (107.6)	NOT SURVEYED
9	Big Flat River Access	Del Loma River Access (93.8)	USFWS, HVT
10	Del Loma River Access	Cedar Flat River Access (79.1)	USFWS, HVT
11	Cedar Flat River Access	Hawkins Bar (63.4)	NOT SURVEYED
12	Hawkins Bar	Camp Kimtu in Willow Creek (42.6)	USFWS, HVT
13	Camp Kimtu in Willow Creek	Roland’s Bar in Hoopa Valley (21.3)	USFWS, HVT
14	Roland’s Bar in Hoopa Valley	Weitchpec (Trinity mouth; 0.0)	USFWS, HVT

[a] Pigeon Point Campground access is 0.8 km downstream of the North Fork Trinity River confluence (rkm 118.2). The primary area where Trinity River Restoration Program actively manages to improve channel morphology and salmon habitat are in Reaches 1–7.

Field Surveys and Data Collection

To locate redds and carcasses in the mainstem Trinity River, survey reaches were navigated by two rafts, one on each side of the river. Each raft's two-person crew included an observer and a rower. High water clarity, shallow-water spawning (Hampton et al. 1997), and generally narrow channel widths (mean < 30 m; HVT et al. 2011) allowed the river bottom in spawning areas to be visible throughout most of the river. In places where channel widths exceeded the limit of visibility, the rower maneuvered the raft in a zigzag pattern to enable observation of the river bottom. Non-navigable side channels were surveyed on foot. Bottoms of pools that were too deep to be visible were assumed to not have any salmon redds.

Observers searched for completed redds that were identifiable by a scoured pit and distinctive mound (Burner 1951). Newly constructed redds were typically distinguishable from the surrounding river bed by the lighter color of freshly overturned substrate (Figure 2). Three weeks or more after construction, redd coloration gradually returned to that of the surrounding substrate following recolonization by periphyton. Coordinates of observed redds were recorded at the upstream edge of each redd mound with a Trimble ProXH GPS receiver (<30 cm accuracy) connected to a tablet computer using Trimble TerraSync software. Data were recorded in Zone 1 [NAD 1983 (Conus)] of the California State Plane Coordinate System. Previously surveyed redds displayed on the field computers allowed surveyors to distinguish new redds from those already surveyed. The distance from Lewiston Dam of each redd was measured by referencing the nearest point along the 2009 river centerline.

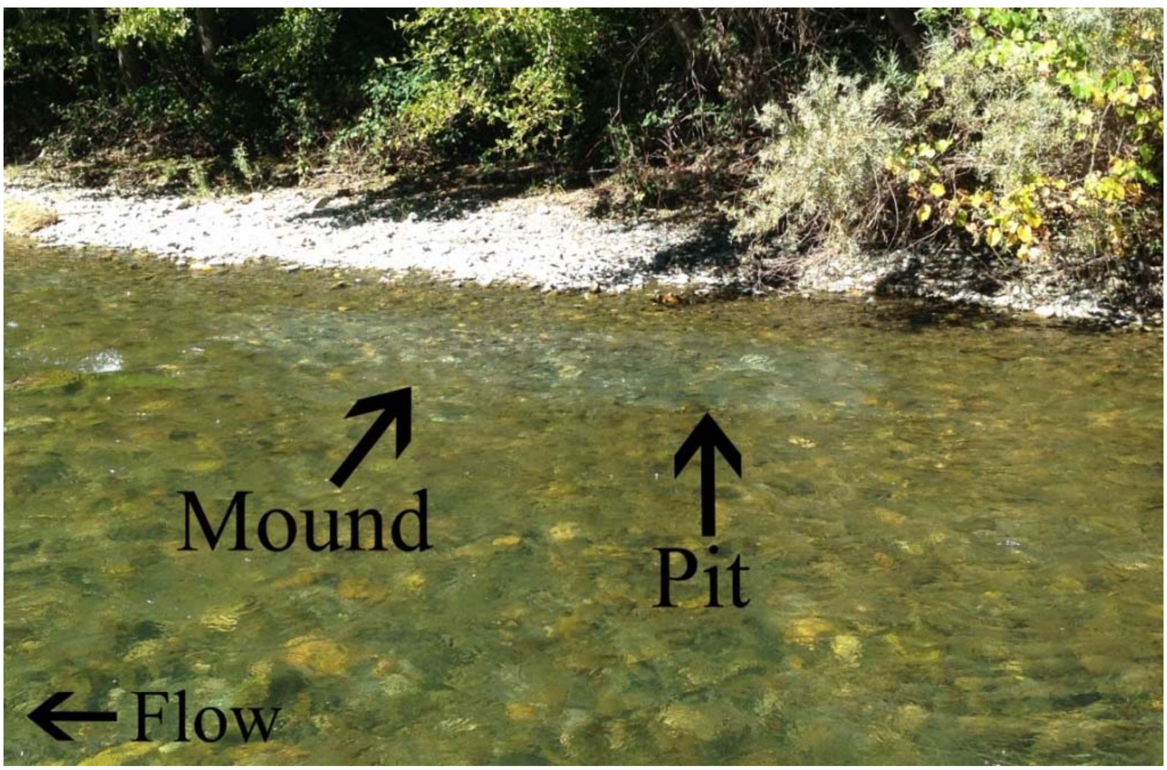


Figure 2. Photograph of a salmon redd in the Trinity River. Recently constructed redds are distinguishable from the surrounding streambed by the bright appearance of freshly overturned substrate that has not yet been recolonized by periphyton.

Salmon carcasses retrieved from the water were measured for fork length and inspected for body condition, species, sex, spawned state (i.e., egg retention; females only), and presence or absence of a hatchery mark and/or weir tag. We cannot differentiate salmon carcasses by run-type, as there are no defining physical characteristics that distinguish spring-run from fall-run Chinook Salmon carcasses. In Reaches 1–2, fresh carcasses were tagged with individually numbered tags and returned to the water (see Carcass Estimation – Reaches 1 and 2 section).

Since Brood Year 2000, approximately 25% of Chinook Salmon produced at the TRH have been dually marked as juveniles by clipping the adipose fin (‘ad-clip’) and inserting a coded-wire tag (CWT). The heads of ad-clipped Chinook Salmon carcasses were removed for later CWT retrieval and recovery of the production multiplier for each individual’s original TRH release group. An annual average production multiplier was calculated by weighting the production multiplier of the recovered CWT group by the number of individuals recovered per group. This number was used to expand the number of ad-clipped female Chinook Salmon carcasses to account for unmarked hatchery-produced fish. All (i.e., target mark rate = 100%) Coho Salmon released from TRH are marked by clipping the right maxillary, which enabled identification of all hatchery-origin Coho Salmon carcasses and dismisses the need for a production multiplier.

After spawning, female salmon guard their redds until they can no longer maintain position and die soon after. Female carcasses are typically recovered relatively close (<1 km) to their redds due to this nest guarding behavior, whereas males may spawn with multiple females and move between those redds (Glock et al. 1980; Cederholm et al. 1989; Riggers et al. 1999; Murdoch et al. 2009a). Males do not exhibit nest-guarding behavior and their carcasses are frequently recovered several kilometers from their spawning location(s) (Murdoch et al. 2009a). This difference in behavior between spawning male and female salmon preclude the use of male carcasses to assign species or origin to redds.

Carcass Estimation – Reaches 1 and 2

A large fall Chinook Salmon run size was predicted to return to the Klamath/Trinity Basin in 2012 (KRTT 2012), meriting the preparation of a sampling routine that would ensure logistic feasibility and completion of surveys. When large numbers of redds and carcasses were predicted to prevent full coverage of survey reaches in a week, a systematic sampling rate (e.g., every third) of carcasses could be employed. During systematic carcass sampling the location of every carcass was recorded, as were the locations of all redds, but only carcasses systematically sampled were examined. Additionally, it was requested that a safer sampling methodology be considered that eliminated the need to physically chop carcasses. This sampling protocol and the associated methods used to estimate carcass abundance are described below.

Carcass abundance estimates were generated via a hierarchical latent variables Bayesian model. This model assumes a latent (unobservable) ecological process interacts with a detection process to produce the observed counts of carcasses (Kery and Schaub 2012). For this survey, the latent process is the true abundance of carcasses. As not all carcasses are observed (imperfect detection), a separate observation process links the unobserved latent process to the observed data.

In essence, annual carcass estimates were generated by first estimating weekly detection probabilities. Next, weekly counts of fresh carcasses (those arriving since the prior survey) were assumed to arise from a binomial process (Kery and Schaub 2012), which allows the estimation of weekly abundances. Finally, weekly estimates were summed to create an annual abundance estimate as a derived parameter (Kery and Schaub 2012).

The exact method for estimating weekly abundances varied by week according to whether or not subsampling was implemented. In weeks where no subsampling was required, the method described in the above paragraph was executed with weekly counts of fresh Chinook Salmon carcasses (C_i, and here after i-th index week) and detection probabilities (p_i) estimated via the count of recovered carcasses (R_i) that had been marked the previous week (M_{i-1}). In weeks where subsampling was employed, the model becomes a bit more complicated to account for subsampling variation in the recaptured carcasses and the relative counts of fresh carcasses among all observable carcasses. Incorporating this extra variation was achieved by adding another binomial component to the model. First, $p_i$was estimated from the mark–recapture experiment (having accounted for the subsampling rate, r_i) which was in turn used to estimate the abundance of all carcasses (A_i). Next, C_i among all sampled carcasses (S_i) was applied to estimate the target probability (t_i; i.e., the proportion of all carcasses that are fresh Chinook carcasses). Finally, the abundance of fresh Chinook Salmon carcasses (N_i) was assumed to be derived from a binomial distribution, and estimated using $\widehat{A_i}$ and $\widehat{t_i}$. The annual estimate of Chinook Salmon carcasses (N) was estimated by summing all weekly estimates:

$$R_i \sim binomial(M_{i-1}, p_i * r_i);\ S_i \sim binomial(A_i, p_i);\ C_i \sim binomial(S_i, t_i);\ \ N_i \sim binomial(A_i, t_i)$$

$$N = \sum_i N_i.$$

The assumptions of this modeling framework include: 1) crews correctly identified fresh Chinook Salmon carcasses among all other carcasses (e.g., decaying carcasses or carcasses of other species, though species distinction only required for fresh carcasses), 2) marked carcasses remained in the study reach for at least one week, and 3) the detection probability of all carcasses was equal within a given week.

Implementing our abundance model in a Bayesian framework and estimating parameters via Markov Chain Monte-Carlo (MCMC) methods allowed us to propagate all sources of estimation uncertainty (over all detection probabilities and weeks) and generate confidence intervals for each annual abundance estimate (Kery and Schaub 2012). A requirement of Bayesian implementation is specifying prior distributions for all estimated parameters. In all cases, we implemented non-informative priors, and commenced with MCMC sampling via JAGS software (Plummer 2003) implemented with R statistical software (R Core Team 2016).

Pre-spawn Mortality

We include pre-spawn mortality analyses going back to 2009 in this report because this metric was not previously reported over this spatial extent (i.e., entire mainstem Trinity River below Lewiston Dam). Prior to 2014, conditions 1 and 2 (‘fresh’) female carcasses were noted as either spawned (i.e., obvious egg loss and caudal fin erosion) or unspawned (i.e., no egg loss and intact caudal fin). Beginning in 2014, fresh carcasses were described as spawned (≤1/3 eggs retained), partially spawned (1/3–2/3 eggs retained), or unspawned (≥2/3 eggs retained). These spawning condition data were used to assess levels of pre-spawn mortality. Female carcasses designated as 'spawned' and 'partially spawned' were considered successful spawners. Unspawned carcasses were considered pre-spawn mortalities. Measurement of pre-spawn mortality is limited to occurrence within the time and space of the surveys. Therefore, pre-spawn mortality in the lower Klamath River of Trinity River-bound fish and pre-spawn mortality of spring-run Chinook Salmon prior to the first survey are not reflected in our data and analyses.

Probability of Redd Construction by Species and Origin and Total Estimation

On the mainstem Trinity River, Chinook and Coho salmon spawning periods temporally overlap and natural- and hatchery-origin salmon spawn in the same locations. Redds are not visually distinguishable by these species and origin types. We used the estimated proportion and spatial distribution of fresh female carcasses of hatchery- and natural-origin Chinook and Coho salmon to infer the probability of redd construction by species and origin. This methodology only accounts for the female component of the spawning population since spawning behavior of males [i.e., spawning with multiple females and sometimes moving several kilometers from original spawning locations (Murdoch et al. 2009b)] precludes the use of the hatchery- and natural-origin data in a similar manner as was done for females. Predictions of the probability and number of Coho Salmon redds are used solely for apportioning those redds that were not built by Chinook Salmon. This report does not provide an estimate for Coho Salmon redds because our survey only covers the early portion of the Coho Salmon spawning period (typically beginning a few weeks after the peak of Chinook Salmon spawning activity and continuing beyond the period of our surveys).

To standardize a time frame across years, we designated September 1 as the first survey day. Generalized Additive Models (GAM) were used with the spatiotemporal distribution of carcasses to estimate the longitudinal gradient in proportional distribution of spawned females by species (Chinook or Coho salmon) and origin (hatchery or natural) along the river channel and over time. Time (survey day) and location (distance from dam) of fresh spawned female carcasses were independent variables in the GAM used to estimate spawning activity by proportions of each species and mark category (presence or absence of hatchery mark). Spline smoothing with three degrees of freedom (df) was used for both independent variables in program R (Wood 2004; R Core Team 2015) and the response (i.e., output) was predicted at daily time steps for the study duration at each redd location. Female salmon by species and mark category (hatchery-marked or unmarked) using carcass data were apportioned by binomial model construction for the GAMs:

$$\hat{p} \sim s(DFD, 3) + s(Survey\ Day, 3),$$

where $\hat{p}$ is the estimated proportion of species/mark category of interest, $s(DFD, 3)$ is the river centerline distance from Lewiston Dam in kilometers (spline smoothed with 3 df), and $s(Survey\ Day, 3)$ is the survey day (spline smoothed with 3 df). The spatial and temporal expression of spawned female salmon carcass data is a function of redd location, number of days from redd construction to death, and distance of post-mortem drift. Therefore, the species and origin of carcasses informs predictions of the species and origin associated with redds within a distance upstream (spatial offset) and a time period (temporal offset).

However, we did not apportion redds by species or origin with spatial offset because a carcass drift study found that over 75% of carcasses are recovered within 0.5 km of their release point (Chamberlain et al. 2012).

Perrin and Irvine's (1990) review of female salmon redd occupancy, post-construction to death, revealed averages of 12.1 days for Chinook Salmon and 11.4 days for Coho Salmon. Our survey intervals were weekly rather than daily, so we applied a temporal lag of two weeks to our carcass data for informing redd composition by species and origin. A 14-day offset was applied to adjust predicted ratios of carcasses from day i to i-14.

A female Chinook Salmon typically constructs a single redd while a female Coho Salmon may construct multiple redds (Laufle et al. 1986; Gallagher and Gallagher 2005; Murdoch et al. 2009b; Gallagher et al. 2010). Based on previous work by Gallagher (2003) in unregulated northern California coastal streams, Duffy (2005) recommends assuming redd construction rates of 1.0 redd per female for Chinook Salmon and 1.25 redds per female for Coho Salmon when estimating escapement with redd counts. For the population estimates, we applied a multiplier to carcass counts to adjust for differential rates of redd construction by Chinook and Coho salmon:

$$\begin{matrix} Chinook\ redd \\ multiplier \end{matrix} = \frac{\hat{p}_{Chinook\ female}}{\hat{p}_{Chinook\ female} + (\hat{p}_{Coho\ female} \times 1.25\ Coho\ redds/female)},$$

where $\hat{p}$ is the proportion estimated from the GAM output.

Cumulative redd counts were arranged by survey day within reach boundaries. Redd counts of zero were assigned just outside of the beginning and end of survey seasons in order to establish estimation boundaries necessary for interpolation. The cumulative number of redds for each survey day was estimated with monotonic cubic Hermite spline interpolation in program R (R Core Team 2015). The number of redds constructed daily was then estimated from interpolated data by subtracting the cumulative redd total for survey day i from survey day i+1.

Season total estimates of redds by species and origin were calculated by summing predicted probabilities of construction for each species/origin category. A bootstrap routine with 1,000 replications was used in program R to predict total redds constructed by species and origin with 2.5 and 97.5 percentiles returned as 95% confidence intervals (Davison and Hinkley 1997, Canty and Ripley 2015, R Core Team 2015).

Redd Abundance and Distribution

For long-term analyses, we combined the data in this report with the preceding ten years (2002–2011) of mainstem Trinity River redd data from Chamberlain et al. (2012). Note that of these previous years, Reaches 12–14 were only surveyed from 2007 to 2011.

System-scale (~100 km) changes in redd abundance and distribution were evaluated with the combined data set from 2002 to 2014. Linear models were used to test for trends in redd abundance. Mean spawning distance from Lewiston Dam for natural- and hatchery-origin Chinook Salmon was evaluated using linear models, using only redds built upstream of Cedar Flat [river kilometer (rkm) 117.9 from Lewiston Dam] and excluded redds from Reach 8 (Pigeon Point).

Changes in the number of redds at the site-scale (~0.2–2 km) were also assessed. We used local-scale boundaries derived from aggregations of 200-m data frame polygons (Buffington et al. 2014) that are approximate to past and future mechanical restoration site boundaries or to generally recognized sections of river. These aggregate polygons were attributed with a corresponding TRRP site name or local informal name (Table 2). Polygons generally encompassed a larger portion of the river than actual TRRP channel restoration sites' boundaries. The entire restoration reach is presented in this grouping scheme, including sections where mechanical channel restoration has not occurred. Annual counts of natural-origin Chinook Salmon redds were summed within each respective section and divided by the total annual natural-origin Chinook Salmon redds surveyed in the restoration reach to give the proportion of the total spawning activity that occurred in restoration areas.

We used ten reach-scale sections (8–22 km) to evaluate trends in natural- and hatchery-origin Chinook Salmon redd abundance from 2002 to 2014. This spatial scale is an intermediate between the system-wide and local scales. Survey Reaches 1–7 were too small for this analysis so we used the reaches defined by HVT et al. (2011) (Figure 3, Table 2). HVT et al. (2011) partitioned the restoration reach into five 'rehabilitation reaches' that were delineated by differences in hydrology and sediment supply characteristics. Downstream of the restoration reach we used survey reach boundaries, since they were of similar size as the rehabilitation reaches. Changes in spawning within these reaches was analyzed using linear regression of both the annual number and proportion (number of redds in reach/sum of redds in all reaches) of natural-origin and hatchery-origin Chinook Salmon redds.

Table 2. List of restoration and non-restoration sites within the Lewiston and Limekiln rehabilitation reaches.

Rehabilitation reaches (from HVT et al. 2011)	TRRP site name	Boundaries (km from Lewiston Dam) Upstream	Downstream	Length (km)	Year of TRRP Mechanical Restoration Construction
Lewiston Reach	Lewiston Hatchery	0.0	1.0	1.0	2006
	Sven Olbertson	1.0	1.6	0.6	2008
	Below Sven Olbertson	1.6	2.0	0.4	
	Deadwood Creek	2.0	2.4	0.4	2008
	Cableway	2.4	3.2	0.8	2008
	Hoadly Gulch	3.2	3.8	0.6	2008
	Sawmill	3.8	5.4	1.6	2009
	Upper Rush Creek	5.4	6.9	1.5	
Limekiln Reach	Lower Rush Creek	6.9	8.2	1.3	
	Dark Gulch	8.2	10.8	2.6	2008
	Bucktail Hole	10.8	11.0	0.2	
	Lowden Ranch	11.0	12.6	1.6	2010
	Trinity House Gulch	12.6	13.2	0.6	2010
	Tom Lang Gulch	13.2	14.6	1.4	
	Below Tom Lang Gulch	14.6	14.8	0.2	
	Poker Bar	14.8	17.0	2.2	
	China Gulch	17.0	18.0	1.0	

Table 2 (continued). List of restoration and non-restoration sites within the Lewiston and Limekiln rehabilitation reaches.

Rehabilitation reaches (from HVT et al. 2011)	TRRP site name	Boundaries (km from Lewiston Dam) Upstream	Downstream	Length (km)	Year of TRRP Mechanical Restoration Construction
Limekiln Reach (continued)	Below China Gulch	18.0	18.6	0.6	
	Limekiln Gulch	18.6	20.2	1.6	
	Below Limekiln Gulch	20.2	21.0	0.8	
	Steel Bridge Road Day Use	21.0	22.0	1.0	
	Below Steel Bridge	22.0	22.8	0.8	
	McIntyre Gulch	22.8	24.2	1.4	
	Vitzthum Gulch	24.2	26.6	2.4	2007
	Indian Creek	26.6	28.4	1.8	2007
Douglas City Reach	Upper Douglas City	28.4	29.2	0.8	
	Douglas City	29.2	30.0	0.8	2013
	Reading Creek	30.0	32.2	2.2	2010
	Upper Steiner Flat	32.2	32.8	0.6	
	Middle Steiner Flat	32.8	33.6	0.8	
	Lower Stein Flat (not built)	33.6	34.6	1.0	
	Lower Steiner Flat (built)	34.6	35.4	0.8	2012
	Lorenz Gulch	35.4	36.8	1.4	2013
	The Canyon 1 (below Lorenz)	36.8	38.9	2.1	
Junction City Reach	The Canyon 2 (below Lorenz)	38.9	41.2	2.3	
	Dutch Creek	41.2	43.6	2.4	
	Evans Bar	43.6	44.8	1.2	
	Below Evans Bar	44.8	45.0	0.2	
	Soldier Creek	45.0	46.0	1.0	
	Chapman Ranch	46.0	47.2	1.2	
	Deep Gulch	47.2	47.8	0.6	
	Sheridan Creek	47.8	49.2	1.4	
	Oregon Gulch	49.2	50.2	1.0	
	Sky Ranch	50.2	51.2	1.0	
	Upper Junction City	51.2	52.2	1.0	2012
	Lower Junction City	52.2	52.8	0.6	2014
North Fork Reach	Below Lower Junction City	52.8	53.0	0.2	
	Hocker flat	53.0	54.8	1.8	2005
	Upper Conner Creek	54.8	55.8	1.0	
	Conner Creek	55.8	57.0	1.2	2006
	Below Conner Creek	57.0	57.4	0.4	
	Wheel Gulch	57.4	58.4	1.0	2011
	Valdor Gulch	58.4	60.4	2.0	2006
	Below Valdor Gulch	60.4	60.6	0.2	
	Elkhorn	60.6	62.0	1.4	2006
	Pear Tree Gulch	62.0	63.2	1.2	2006
	Below Pear Tree	63.2	63.8	0.6	

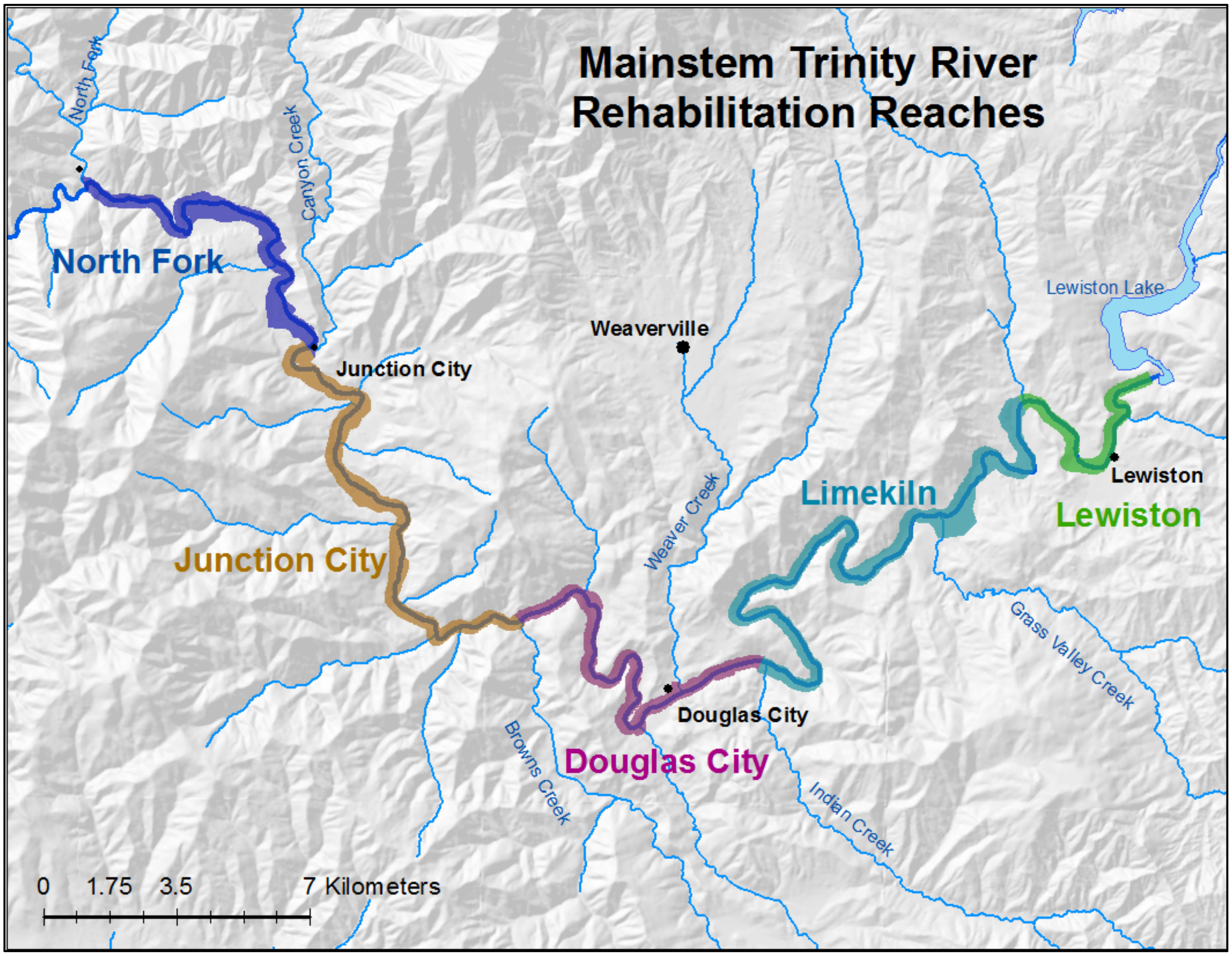


Figure 3. Map of the five rehabilitation reaches in the upper 64 km of the mainstem Trinity River below Lewiston Dam (HVT et al. 2011).

Data presented by Chamberlain et al. (2012) suggests that natural-origin Chinook Salmon redd construction timing changes with distance from Lewiston Dam. To evaluate this possible trend we used survey data from 2012 to 2014. The date of initial observation of each redd was plotted against its distance from Lewiston Dam. Each redd was then weighted by its probability of construction by a natural-origin Chinook Salmon and linear regression was used to examine trends.

Results

Sampling Success

Crews were able to complete most (92%) of the planned weekly (Reaches 1–7) and bi-weekly (Reaches 9–10, 12–14) surveys in the 2012–2014 seasons (Appendix A–Appendix C). Of these years, 2012 had the most missed surveys due to high river flows in mid-November (30 missed of the 135 scheduled surveys). Low to moderate flows in 2013 and 2014 allowed crews to complete most scheduled survey days (10 surveys missed of 133 scheduled in 2013 and 14 missed of 136 scheduled in 2014).

The early portions of the 2012–2014 survey seasons were affected by augmented flows from Lewiston Dam intended to increase flow through the lower Klamath River, each ending in mid-September (Figure 4; USBOR 2015). Following these events, discharge from Lewiston Dam dropped to 12.7 m^3/s (450 ft^3/s) through October 17 and again to 8.5 m^3/s (300 ft^3/s) for the remainder of the survey seasons.

Water visibility was greater than 1.5 m for most (87%) surveys over the three years (Appendix A–Appendix C). Water released from Lewiston Dam was more turbid than usual in 2014, which mostly affected surveys in Reaches 1–4. Crews that surveyed these reaches often reported water visibility less than 1.5 m in September and October and less than 0.9 m in November and December. Redd construction is preferred in water less than 0.9 m deep (Hampton 1988), therefore water clarity was assumed to only adversely affect the late-2014 redd surveys.

Salmon Carcasses

Sampling every observed carcass while completing each day's survey was possible in all reaches throughout 2013 and below Reach 2 in 2012 and 2014. Systematic sampling in Reaches 1 and 2, where mark–recapture methods were used, reduced the number of carcasses handled 2012 and 2014 so that surveys could be completed. The highest systematic sampling rate used was 1:10 (1 fish was fully examined for every 10 carcasses located) during peak carcass abundance in 2012. The numbers of fresh carcasses reported below only include carcasses examined in the field and were not expanded by systematic sampling rates. Only general information and data necessary to the inference modeling is shown. Further detail is provided for fresh spawned female carcasses used in the inference modeling analysis. Borok et al. (2014) reports more comprehensive carcass data from 2012, such as length-frequency distributions and detailed CWT information.

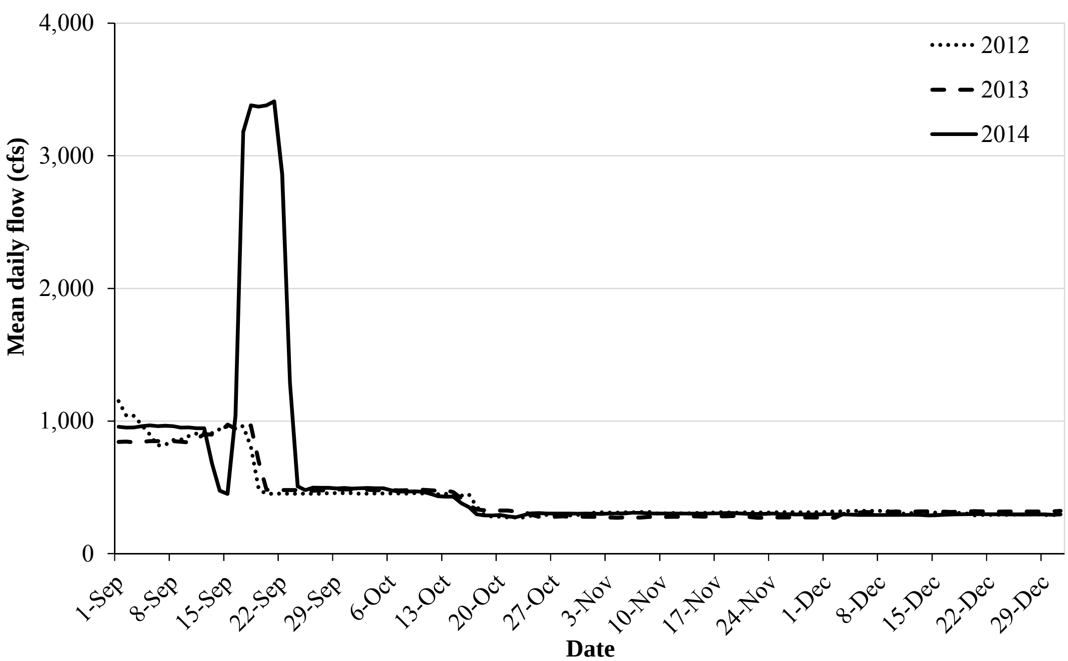


Figure 4. Trinity River discharge at Lewiston Dam during the 2012, 2013, and 2014 survey seasons. Flow measured at USGS Gage 11525500 courtesy of the U.S. Geological Survey.

From 2012 to 2014, 5,776, 2,007, and 2,863 Chinook Salmon carcasses were examined over all survey reaches, respectively (Table 3–Table 5). Totals of 4,474, 1,371, and 2,107 were fresh (conditions 1 and 2), and of these 224 (5.0%), 102 (7.4%), and 182 (8.6%) were ad-clipped, respectively. In addition, 31, 38, and 44 Chinook Salmon carcasses were recovered with ad-clips that were in an advanced state of deterioration (conditions 3–5) from 2012 to 2014, respectively. In 2012, 2,479 fresh spawned female Chinook Salmon were collected, of which 133 (5.4%) were ad-clipped. In 2013, 796 fresh spawned female Chinook Salmon carcasses were collected, of which 58 (7.3%) were ad-clipped. In 2014, 995 fresh spawned female Chinook Salmon carcasses were collected, of which 85 (8.5%) were ad-clipped. CWTs from ad-clipped Chinook Salmon revealed that most spring- and fall-run hatchery fish were recovered within 10 km of Lewiston Dam (94.4, 92.6, and 92.9% from 2012 to 2014, respectively; Figure 5). The CWT Chinook Salmon carcasses yielded an average annual production multipliers (i.e., marking rates) of 0.243, 0.244, and 0.233 from 2012 to 2014, respectively (Appendix D–Appendix F). These production multipliers were used in the inference modeling analysis to expand the number of ad-clipped female carcasses.

From 2012 to 2014, 258, 709, and 294 Coho Salmon carcasses were examined, respectively (Table 6–Table 8). Totals of 210, 459, and 243 were fresh (conditions 1 and 2), and of these 185 (88.1%), 338 (73.6%), and 182 (75.0%) were right maxillary-clipped, respectively. In 2012, 70 fresh spawned female Coho Salmon carcasses were collected, of which 59 (84.3%) were right maxillary-clipped. In 2013, 226 fresh spawned female Coho Salmon were collected, of which 201 (88.9%) were right maxillary-clipped. In 2014, 69 fresh spawned female Coho Salmon were collected, of which 55 (79.7%) were right maxillary-clipped. Most right maxillary-clipped spawned female Coho Salmon were recovered within 10 km of Lewiston Dam (76.2, 88.9, and 70.2% from 2012 to 2014, respectively; Figure 6). From

Table 3. Summary of Chinook Salmon carcass data by reach, 2012 Trinity River surveys.

Reach	Total observed [a]	Fresh males	Fresh females	Male–female ratio	Ad-clipped	Weir-tagged
1	1,524	377	786	0.48	155	25
2	1,217	430	464	0.93	78	23
3	577	222	251	0.88	14	4
4	522	194	215	0.90	3	6
5	279	105	154	0.68	3	5
6	499	155	254	0.61	2	10
7	529	153	234	0.65	0	12
9	310	89	131	0.68	0	5
10	157	52	51	1.02	0	0
12	93	39	48	0.81	0	2
13	56	23	31	0.74	0	0
14	13	6	8	0.75	0	0
Total	5,776	1,845	2,627	0.70	255	92

[a] total observed includes carcasses of all conditions that were not recaptured

Table 4. Summary of Chinook Salmon carcass data by reach, 2013 Trinity River surveys.

Reach	Total observed [a]	Fresh males	Fresh females	Male–female ratio	Ad-clipped	Weir-tagged
1	415	82	187	0.44	69	17
2	436	119	133	0.89	56	13
3	131	55	53	1.04	5	6
4	130	43	54	0.80	3	5
5	106	24	58	0.41	3	2
6	185	58	89	0.65	1	2
7	101	32	54	0.59	2	0
9	100	25	42	0.60	0	0
10	77	19	35	0.54	0	0
12	117	21	55	0.38	1	2
13	176	40	70	0.57	0	7
14	33	12	11	1.09	0	0
Total	2,007	530	841	0.63	140	54

[a] total observed includes carcasses of all conditions that were not recaptured

Table 5. Summary of Chinook Salmon carcass data by reach, 2014 Trinity River surveys.

Reach	Total observed [a]	Fresh males	Fresh females	Male–female ratio	Ad-clipped	Weir-tagged
1	633	136	341	0.40	121	23
2	590	223	179	1.25	59	12
3	302	99	102	0.97	20	5
4	280	120	81	1.48	12	0
5	230	84	86	0.98	2	3
6	311	127	114	1.11	5	3
7	134	45	59	0.76	3	2
9	107	32	57	0.56	1	3
10	60	24	23	1.04	0	1
12	124	49	46	1.07	2	3
13	63	20	33	0.61	1	1
14	29	8	18	0.44	0	0
Total	2,863	967	1,139	0.85	226	56

[a] total observed includes carcasses of all conditions that were not recaptured

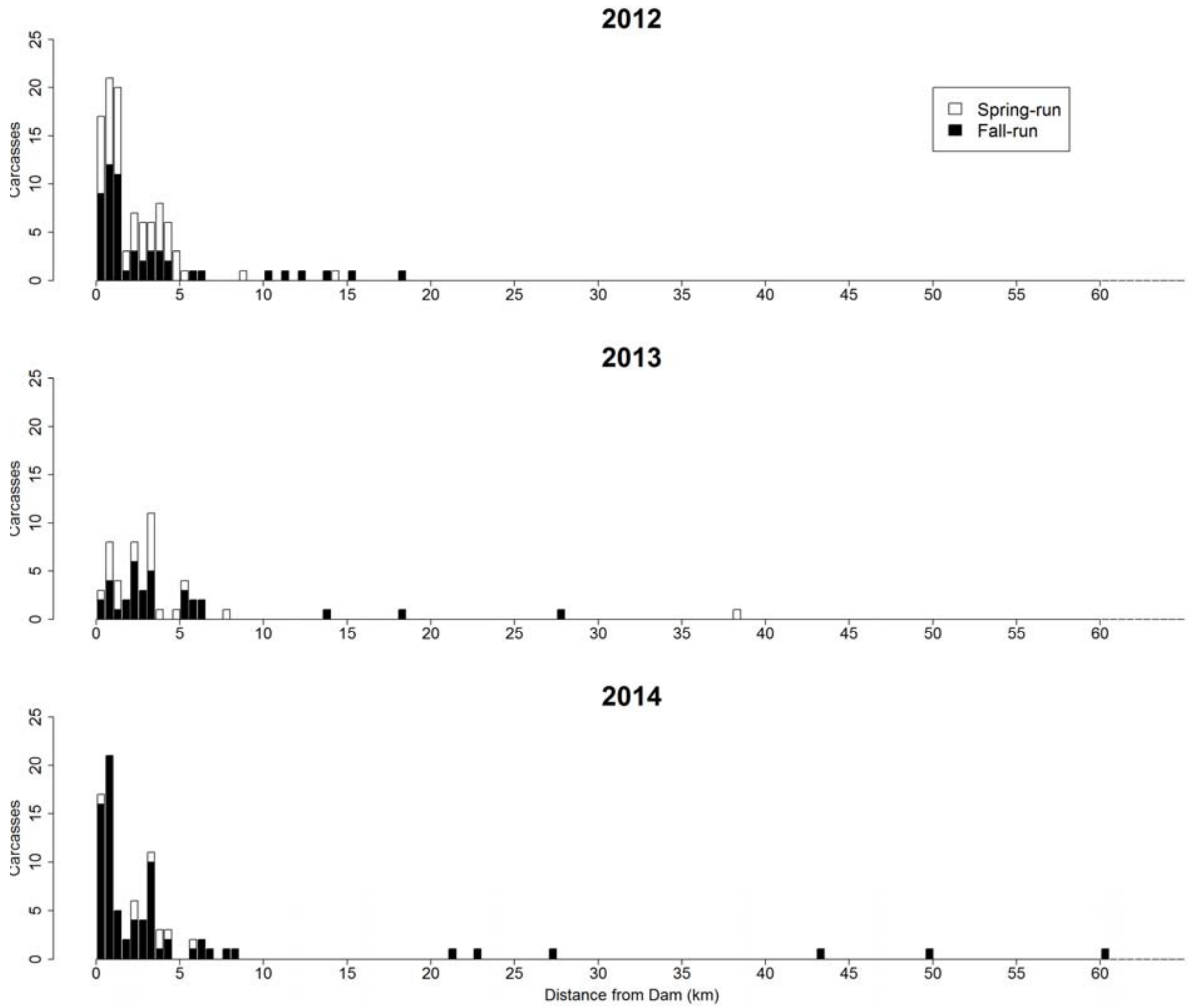


Figure 5. Distribution of coded-wire-tagged (CWT) spring- and fall-run Chinook Salmon carcasses located in the mainstem Trinity River downstream of Lewiston Dam from 2012 to 2014.

Table 6. Summary of Coho Salmon carcass data by reach, 2012 Trinity River surveys.

Reach	Total observed [a]	Fresh males	Fresh females	Male–female ratio	Ad-clipped	Weir-tagged
1	135	69	40	1.73	125	5
2	51	25	14	1.79	43	3
3	23	6	13	0.46	18	0
4	10	0	9	0.00	8	0
5	2	2	0	-	1	0
6	13	4	8	0.50	10	1
7	8	3	4	0.75	7	1
9	5	0	3	0.00	5	1
10	1	0	1	0.00	1	0
12	4	1	2	0.50	3	1
13	2	1	1	1.00	2	0
14	4	2	2	1.00	3	0
Total	258	113	97	1.16	226	12

[a] total observed includes carcasses of all conditions that were not recaptured

Table 7. Summary of Coho Salmon carcass data by reach, 2013 Trinity River surveys.

Reach	Total observed [a]	Fresh males	Fresh females	Male–female ratio	Ad-clipped	Weir-tagged
1	335	88	125	0.70	301	2
2	291	97	88	1.10	242	4
3	40	13	14	0.93	32	1
4	9	3	3	1.00	5	2
5	10	3	3	1.00	5	0
6	11	7	3	2.33	9	0
7	5	0	5	0.00	5	1
9	2	1	1	1.00	1	0
10	0	0	0	-	0	0
12	4	1	2	0.50	2	0
13	1	1	0	-	0	0
14	1	0	1	0.00	1	0
Total	709	214	245	0.87	603	10

[a] total observed includes carcasses of all conditions that were not recaptured

Table 8. Summary of Coho Salmon carcass data by reach, 2014 Trinity River surveys.

Reach	Total observed [a]	Fresh males	Fresh females	Male–female ratio	Ad-clipped	Weir-tagged
1	38	21	8	2.63	33	9
2	123	46	52	0.88	104	17
3	47	22	18	1.22	35	6
4	24	12	12	1.00	19	1
5	14	5	7	0.71	10	3
6	16	8	7	1.14	12	4
7	13	8	3	2.67	11	1
9	5	2	1	2.00	5	0
10	6	1	3	0.33	5	0
12	4	1	3	0.33	3	1
13	2	1	0	-	0	0
14	2	1	1	1.00	2	0
Total	294	128	115	1.11	239	42

[a] total observed includes carcasses of all conditions that were not recaptured

2012 to 2014, one, three, and two Coho Salmon carcasses were recovered with left maxillary clips, respectively. These fish are believed to be strays released from Iron Gate Hatchery on the Klamath River.

Carcass Estimates

In Reach 1 we estimated 7,109 (95% CI: 6,052–8,469) total Chinook Salmon carcasses (including both sexes and prespawn mortalities) in 2012, 951 (95% CI: 707–1,472) in 2013, and 2,274 (95% CI: 1,809–2,980) in 2014. Reach 2 estimates were 7,597 Chinook Salmon carcasses (95% CI: 6,064–9,775) in 2012, 813 (95% CI: 662–1,014) in 2013, and 1,758 (95% CI: 1,407–2,301) in 2014 (Appendix G).

In Reach 1, we estimated 4,845 (95% CI: 4,077–5,884) fresh spawned-female Chinook Salmon carcasses in 2012, 586 (95% CI: 435–898) in 2013, and 1,450 (95% CI: 1,142–1,896) in 2014. In Reach 2, estimates were 3,712 (95% CI: 2,911–4,818) fresh spawned-female Chinook Salmon carcasses in 2012, 400 (95% CI: 312–522) in 2013, and 789 (95% CI: 580–1,171) in 2014 (Appendix G).

Pre-spawn Mortality

Pre-spawn mortality of female Chinook Salmon from 2009 to 2014 ranged between 2.4% (in 2012) and 11.5% (in 2014; Table 9). In 2011–2013, Chinook Salmon pre-spawn mortality was highest in the first weeks of the surveys, ranging between 14.4% (in 2013) and 37.0% (in 2011), and generally decreased and remained at relatively low rates (1.1–7.0% in 2011, 0.0–3.4% in 2012, 2.6–6.8% in 2013) after Calendar Week 40 (early October; Figure 7).

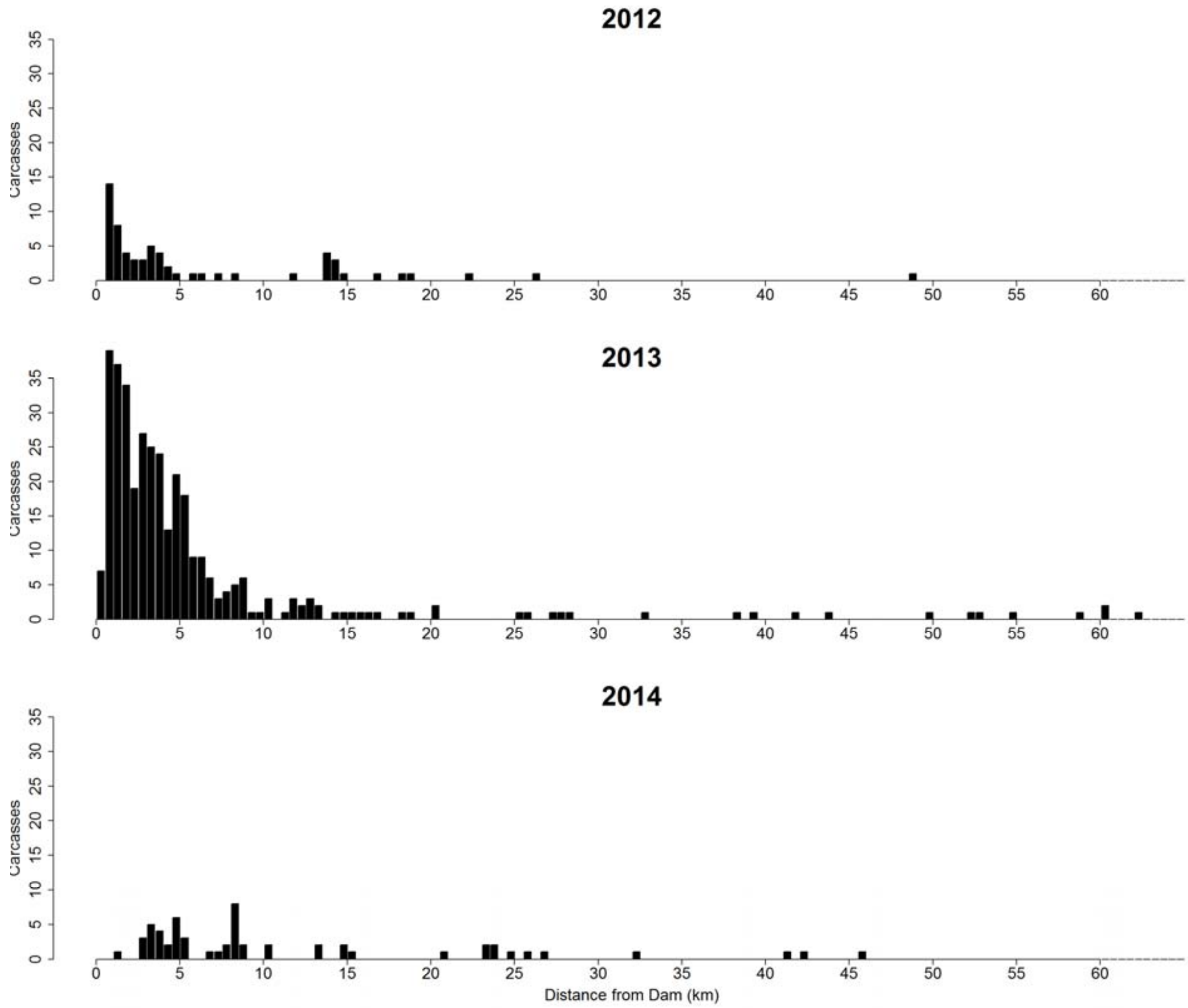
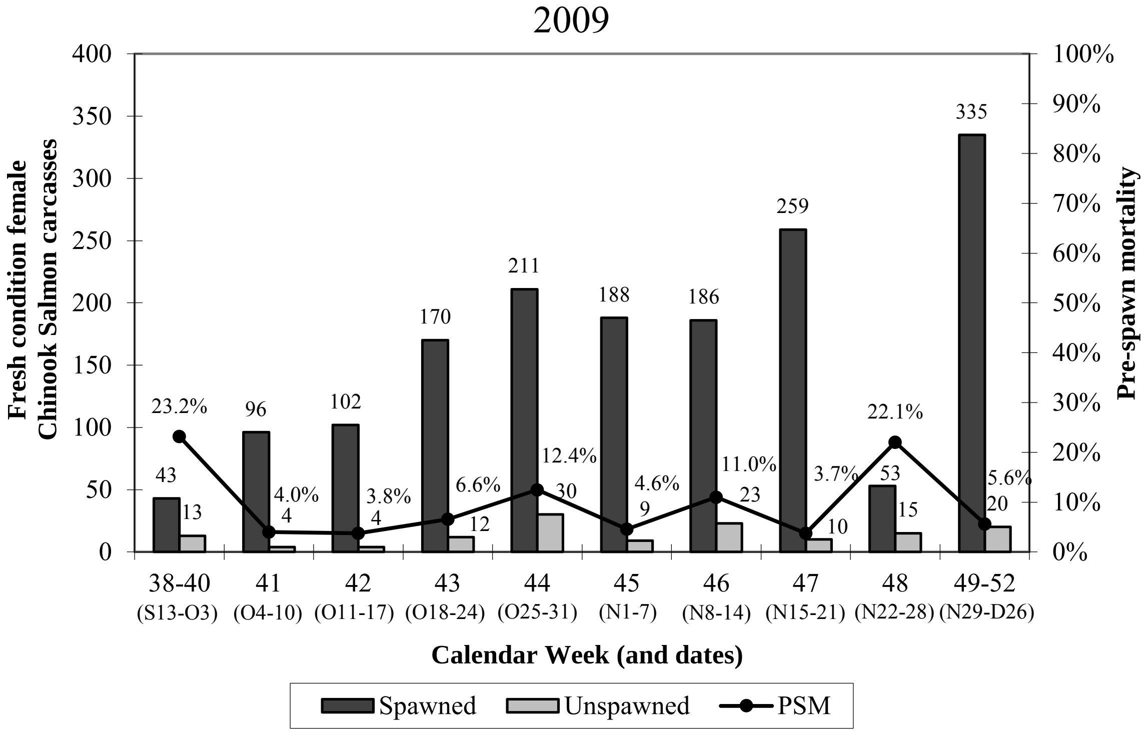


Figure 6. Distribution of maxillary-clipped spawned female Coho Salmon carcasses located in the mainstem Trinity River downstream of Lewiston Dam from 2012 to 2014.

Table 9. Pre-spawn mortality rates of Chinook Salmon in the Trinity River below Lewiston Dam (Reaches 1–14) and in the restoration reach (Reaches 1–7), 2009–2014 surveys. Pre-spawn mortalities by week and reach for unmarked and ad-clipped Chinook Salmon are presented in Appendix H.

Year	Reaches 1-14 (Lewiston Dam to Klamath River)	Reaches 1-7 (Lewiston Dam to North Fork)
2009	7.9%	6.8%
2010	10.2%	9.5%
2011	4.6%	4.6%
2012	2.4%	2.4%
2013	5.1%	6.1%
2014	11.5%	9.1%



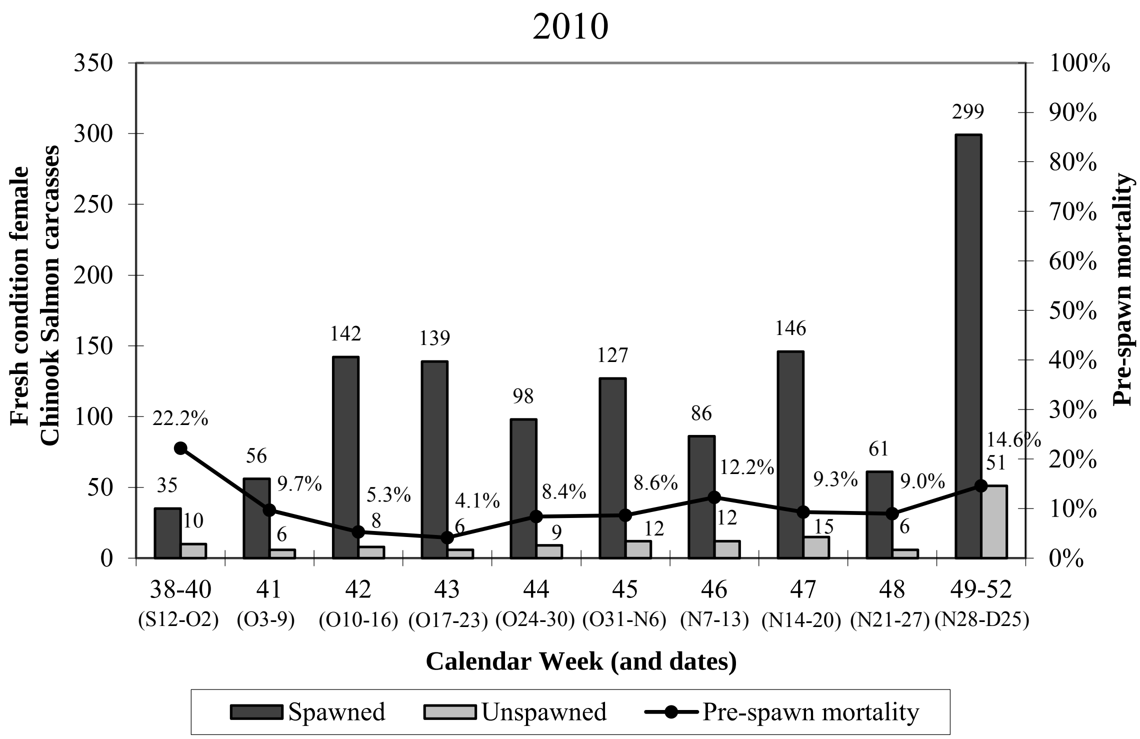
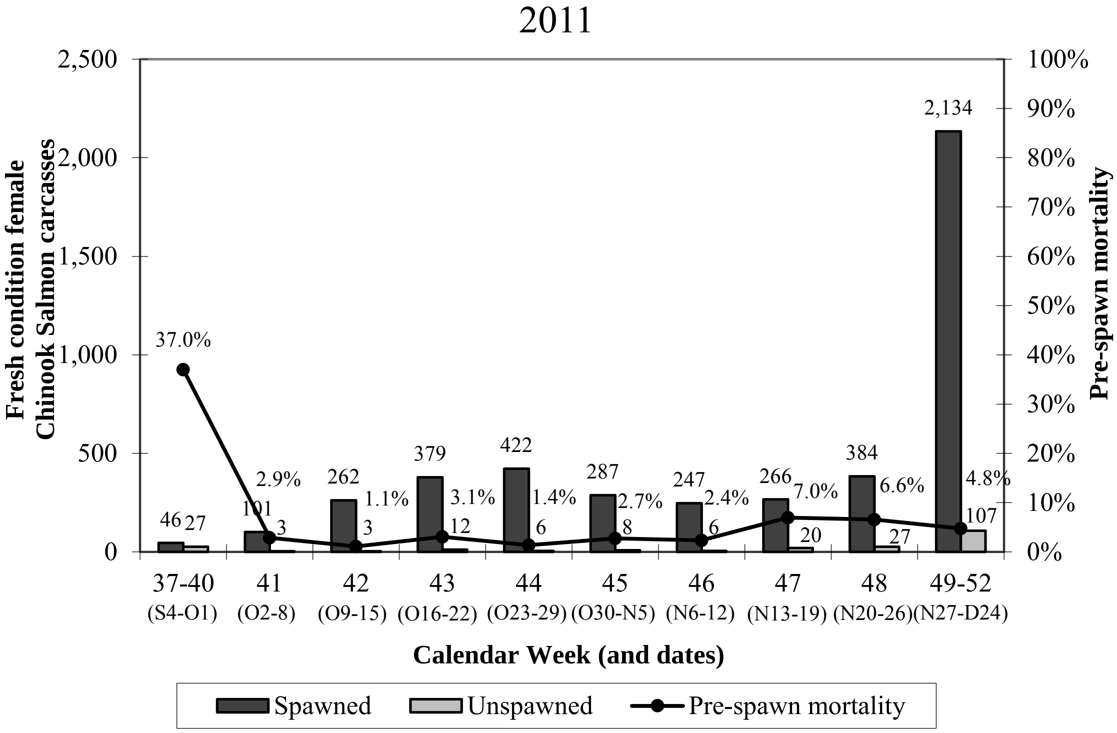


Figure 7. Weekly pre-spawn mortality derived from fresh (conditions 1 and 2) female Chinook Salmon carcasses, Trinity River surveys, 2009–2014. Calendar Weeks 38–40 and 49–52 were combined since sample sizes were low in at least one of those years.



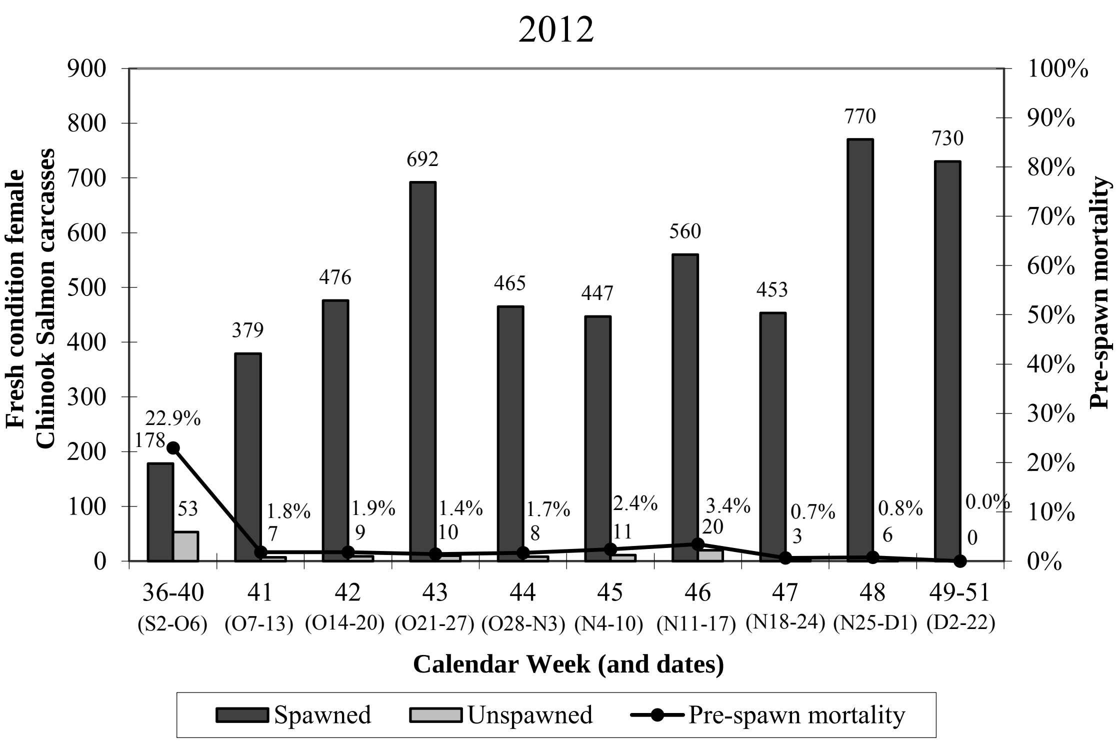
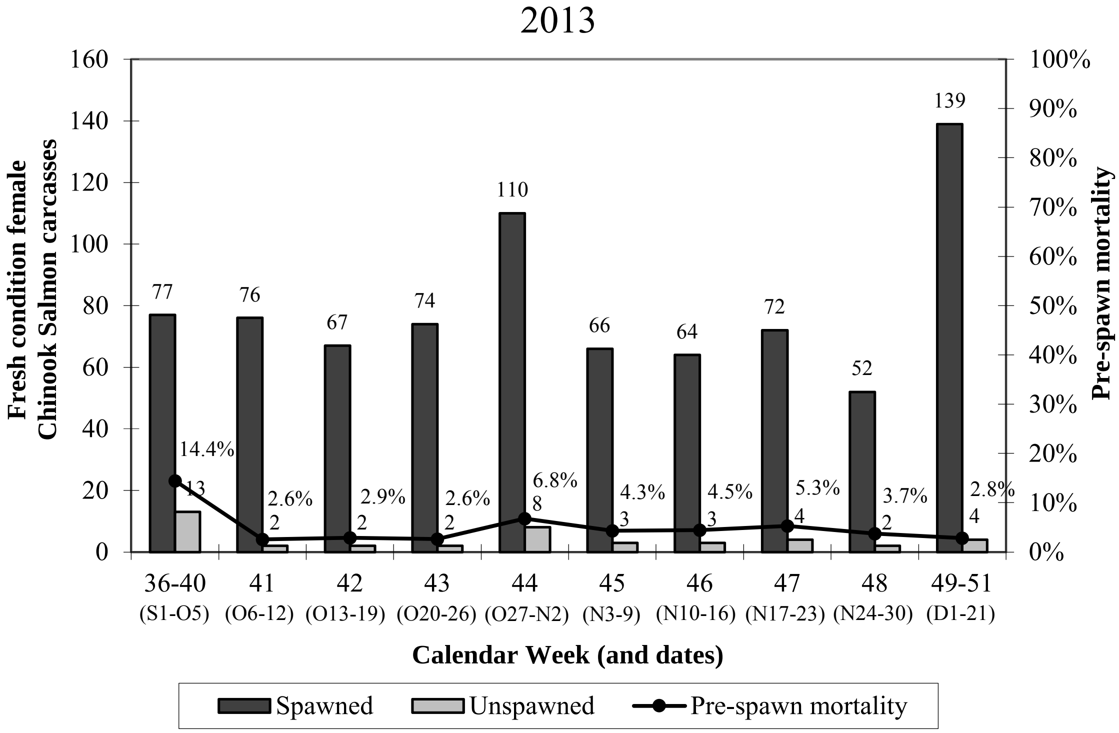


Figure 7 (continued). Weekly pre-spawn mortality from fresh (conditions 1 and 2) female Chinook Salmon carcasses by year, Trinity River surveys, 2009–2014. Calendar Weeks 38–40 and 49–52 were combined since sample sizes were low in at least one of those years.



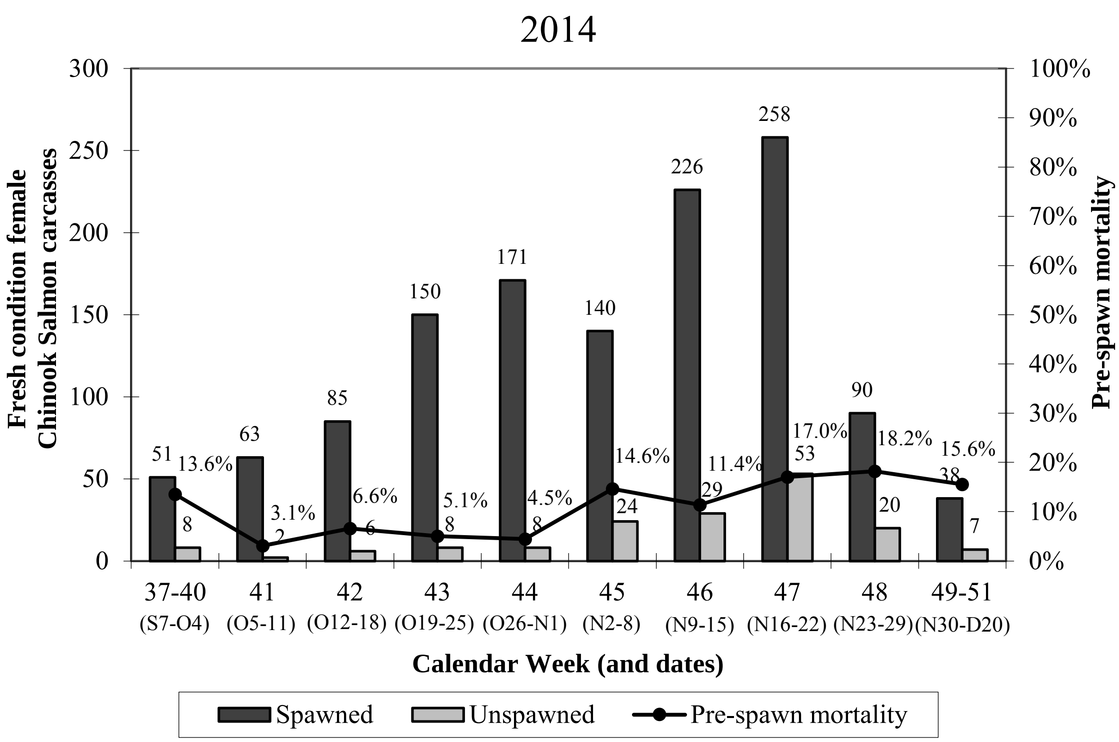


Figure 7 (continued). Weekly pre-spawn mortality from fresh (conditions 1 and 2) female Chinook Salmon carcasses by year, Trinity River surveys, 2009–2014. Calendar Weeks 38–40 and 49–52 were combined since sample sizes were low in at least one of those years.

Pre-spawn mortality was also highest during the first weeks of the survey in 2009 and 2010 (23.2% and 22.2%, respectively) but then dropped to lows of 3.8% in Calendar Week 42 of 2009 and 4.1% in Calendar Week 43 in 2010 before increasing to as high as 22.1% in 2009 and 14.6% in 2010. In 2014, weekly pre-spawn mortality ranged between 3.1% and 13.6% through September and October (Calendar Weeks 37–44) and then slightly increased to 11.4–18.2% in November and December (Calendar Weeks 45–51).

Pre-spawn mortality of female Coho Salmon *through late December only* (i.e., before the spawning period was completed) ranged between 6.6% (2013) and 29.8% (2014) between 2009 and 2014 (Table 10). Differences between the observed pre-spawn mortality rates of natural- and hatchery-origin fish ranged between 4.6% and 13.2% with neither origin type consistently higher or lower.

Salmon Redds

During the 2012–2014 surveys, 7,588, 4,303, and 4,117 salmon redds were identified and mapped, respectively, over the entire survey area (Table 11–Table 13). Reach 1, immediately downstream of Lewiston Dam, had the highest redd counts in all years. The majority of redds were estimated to have been constructed by natural-origin Chinook Salmon (81.3, 62.3, and 66.4% in 2012–2014, respectively; Table 14). Redds constructed by hatchery-origin Chinook Salmon accounted for 15.1, 14.0, and 22.1% of the total redd count from 2012 to 2014, respectively. Natural-origin Coho Salmon redds accounted for 0.4, 3.5, and 2.6% of all redds from 2012 to 2014, respectively. Hatchery-origin Coho Salmon redds accounted for 3.2, 20.2, and 8.8% of all redds from 2012 to 2014, respectively. Of the redds attributed to Chinook Salmon from 2012 to 2014, 84.3, 81.6, and 75.0% were constructed by natural-origin Chinook Salmon, respectively. Of the redds attributed to Coho Salmon, 11.4, 14.6, and 23.0% were constructed by natural-origin Coho salmon, respectively. These percentages should not be used to infer hatchery and natural proportions of brood year progeny because they do not account for hatchery-origin males spawning with natural-origin females.

Table 10. Pre-spawn mortality rates of natural- and hatchery-origin Coho Salmon, Trinity River surveys, 2009–2014. Note that these pre-spawn mortality rates were based on data only collected through late December. Spawning success often varies, typically improving, over time and our surveys did not extend over the entire Coho Salmon spawning period. Pre-spawn mortalities by week and reach for natural- and hatchery-origin Coho Salmon are presented in Appendix I.

Year	Natural-origin	Hatchery-origin	Combined
2009	7.1%	20.3%	16.1%
2010	21.9%	16.2%	17.0%
2011	6.1%	15.1%	11.6%
2012	3.6%	11.8%	10.4%
2013	10.7%	6.1%	6.6%
2014	35.1%	28.5%	29.8%

Table 11. Redd counts (before species differentiated) by week and reach, 2012 Trinity River surveys. Dashes (-) indicate surveys not performed.

Week	Reach												
start	1	2	3	4	5	6	7	9	10	12	13	14	Total
9/3	0	-	-	-	-	-	-	-	-	-	-	-	-
9/10	0	3	13	7	1	0	0	0	0	-	-	-	24
9/17	5	10	49	45	26	0	0	-	-	-	-	-	135
9/24	27	46	86	42	105	14	8	6	4	-	-	-	338
10/1	199	90	85	89	106	84	86	-	-	-	-	-	739
10/8	243	-	63	74	-	141	132	248	141	-	-	-	1,042
10/15	132	71	83	66	139	150	153	-	-	11	0	1	806
10/22	156	108	58	60	69	157	146	343	162	-	-	-	1,259
10/29	173	60	16	28	17	225	114	-	-	219	-	-	852
11/5	201	19	9	-	19	50	54	148	91	-	-	-	591
11/12	297	92	35	23	-	35	-	-	-	231	286	70	1,069
11/19	270	-	-	-	-	-	-	-	-	-	-	-	270
11/26	222	48	-	-	4	10	8	-	-	-	-	-	292
12/3	111	11	6	0	-	-	-	-	-	-	-	-	128
12/10	35	1	0	0	-	0	0	0	0	-	-	-	36
12/17	7	0	0	-	-	-	-	-	-	-	-	-	7
Total	2,078	559	503	434	486	866	701	745	398	461	286	71	7,588

Table 12. Redd counts (before species differentiated) by week and reach, 2013 Trinity River surveys. Dashes (-) indicate surveys not performed.

Week	Reach												
start	1	2	3	4	5	6	7	9	10	12	13	14	Total
9/2	1	-	-	-	-	-	-	-	-	-	-	-	1
9/9	0	0	0	0	1	0	0	-	-	-	-	-	1
9/16	2	0	16	7	10	0	0	0	0	-	-	-	35
9/23	31	39	67	24	42	10	12	-	-	-	-	-	225
9/30	44	50	48	36	64	52	32	-	-	-	-	-	326
10/7	35	27	11	8	41	46	43	-	-	-	-	-	211
10/14	20	11	7	20	-	101	74	121	110	-	-	-	464
10/21	27	7	8	6	28	51	71	-	-	20	8	1	227
10/28	103	20	12	21	17	50	35	190	92	-	-	-	540
11/4	65	19	14	10	9	11	4	-	-	77	75	19	303
11/11	76	41	2	11	-	15	29	52	14	-	-	-	240
11/18	143	-	27	20	-	15	8	-	-	114	94	40	461
11/25	164	187	-	-	-	5	5	31	17	-	-	-	409
12/2	102	43	29	-	23	7	5	-	-	68	94	43	414
12/9	33	42	38	22	15	2	0	3	0	-	-	-	155
12/16	25	35	16	14	-	0	1	-	-	79	99	22	291
Total	871	521	295	199	250	365	319	397	233	358	370	125	4,303

Table 13. Redd counts (before species differentiated) by week and reach, 2014 Trinity River surveys. Dashes (-) indicate surveys not performed.

Week	Reach												
start	1	2	3	4	5	6	7	9	10	12	13	14	Total
9/1	0	-	-	-	-	-	-	-	-	-	-	-	-
9/8	0	0	3	0	0	0	0	-	-	-	-	-	3
9/15	8	7	-	-	-	0	0	-	-	-	-	-	15
9/22	23	21	50	23	25	8	4	-	-	-	-	-	154
9/29	29	39	61	29	62	49	10	9	6	-	-	-	294
10/6	19	62	50	37	52	84	42	-	-	4	0	0	350
10/13	22	42	76	75	68	56	33	125 [a]	87	-	-	-	584
10/20	60	32	26	9	76	107	85	-	-	45	5	-	445
10/27	79	39	30	16	36	83	68	143	61	-	-	-	555
11/3	205	39	24	2	13	57	43	-	-	100	25	12	520
11/10	231	145	7	22	-	6	3	12	13	-	-	-	439
11/17	132	56	11	3 [a]	26	3	12	-	-	92	77	21	433
11/24	46	27	-	-	-	2	2	6	3	-	-	-	86
12/1	26	20	35	9	25	1	4	-	-	50	17	0	187
12/8	10	26	6	-	-	0	0	0	2	-	-	-	44
12/15	4	4	0	0	0	-	-	-	-	-	-	-	8
Total	894	559	379	225	383	456	306	295	172	291	124	33	4,117

[a] partial count due to technical difficulties

Table 14. Salmon redd estimates by species and origin observed in the mainstem Trinity River from 2012 to 2014. Hatchery- and natural-origin estimates are for maternal 1st generation only. Bootstrap-generated 95% confidence intervals are in parenthesis.

Species	Origin	Redd estimates 2012	2013	2014
Chinook Salmon	All	7,315 (7,219–7,391)	3,285 (3,225–3,345)	3,642 (3,519–3,765)
	Natural	6,170 (5,909–6,347)	2,682 (2,551–2,833)	2,733 (2,537–3,008)
	Hatchery	1,145 (967–1,412)	603 (459–726)	909 (657–1,088)
Coho Salmon [a]	All	273 (197–367)	1,018 (958–1,078)	473 (350–596)
	Natural	31 (14–62)	149 (85–224)	109 (32–200)
	Hatchery	242 (167–335)	869 (784–945)	364 (264–490)

[a] Our survey season only partially covers the Coho Salmon spawning period

Female natural- and hatchery-origin Chinook and Coho salmon spawned in distinct spatial patterns on the Trinity River. Natural-origin Chinook Salmon redds were constructed throughout the mainstem Trinity River, from Lewiston Dam to the confluence with the Klamath River (Figure 8–Figure 10). Conversely, hatchery-origin Chinook and hatchery-origin Coho salmon redds were consistently skewed toward Lewiston Dam. Natural-origin Coho Salmon redds were present in low density (<5 redds/km) near Lewiston Dam and decreased with distance from the dam. We detected little to no spawning by hatchery-origin Chinook Salmon and natural- and hatchery-origin Coho Salmon downstream of Big Flat (rkm 74.5 from Lewiston Dam).

Natural-origin Chinook Salmon spawning distribution shifted downstream from 2002 to 2014. From Lewiston Dam to Cedar Flat the combined mean distance from Lewiston Dam of natural-origin Chinook Salmon redds increased over this time frame ($R^2 = 0.617$, $p = 0.001$; Figure 11). This trend was not evident for redds constructed by hatchery-origin Chinook Salmon ($R^2 = 0.049$, $p = 0.467$), which consistently spawned near Lewiston Dam.

Although natural-origin Chinook Salmon redd densities varied annually in many spawning locations throughout the mainstem Trinity River, the density of redds in particular locations (e.g., crests of specific riffles) were consistently high regardless of run size (Figure 12–

Figure 14). For example, the following riffles maintained relatively high peak densities (>40 redds/100 m of river centerline) from 2012 to 2014: ‘Last Hole on Left’ riffle (rkm ~43 from Lewiston Dam), ‘Sheridan’ riffle (rkm ~49 from Lewiston Dam), ‘Baghdad’ riffle (rkm ~63 from Lewiston Dam), ‘Big Bar Bridge’ riffle (rkm ~78 from Lewiston Dam), and ‘Campora’ riffle (rkm ~133 from Lewiston Dam).

Spawn Timing

Over the entire survey area, significant evidence (non-zero slope, p-values <0.01) supports a positive correlation between distance from Lewiston Dam and the estimated date of redd construction by natural-origin female Chinook Salmon from 2012 to 2014, though the strength of the relationship varies among years (2012: $R^2 = 0.058$, 2013: $R^2 = 0.511$, 2014: $R^2 = 0.174$; Figure 15–Figure 17). Mean natural-origin Chinook Salmon spawn timing was estimated to be earlier in upstream portions of the river and later in downstream portions. This trend was significant during the three survey years despite inability to complete late-season surveys in Reaches 12–14 in 2012 and 2014 due to weather conditions (Appendix A–Appendix C). The spatial distribution of hatchery-origin Chinook Salmon is too small (~10 km) to evaluate its relationship with spawn timing.

Redd Abundance and Distribution: System and Restoration Reach Scales

Over the long-term redd data set from 2002 to 2014, the number of mainstem Trinity River salmon redds ranged between 4,022 and 7,588. The number of redds constructed by natural-origin Chinook Salmon in the mainstem Trinity River varied with no significant trend ($R^2 = 0.006$, $p = 0.794$), while the number of redds constructed by hatchery-origin Chinook Salmon declined over this time frame ($R^2 = 0.376$, $p = 0.026$; Figure 18).

Trends in redd abundance within the TRRP restoration reach (the 64 km below Lewiston Dam) mirror the mainstem-wide data (Figure 18). From 2002 to 2014, the number of redds constructed by natural-origin Chinook Salmon in the restoration reach varied with no significant trend ($R^2 = 0.034$, $p = 0.548$) while the number of redds constructed by hatchery-origin Chinook Salmon within the restoration reach decreased over the same time frame ($R^2 = 0.370$, $p = 0.027$).

Downstream of the restoration reach the number of natural-origin Chinook Salmon redds increased from 2002 to 2014, though the trend is not as significant ($R^2 = 0.301$, $p = 0.052$; Figure 18). Few to no redds were constructed by hatchery-origin Chinook Salmon in this section of river.

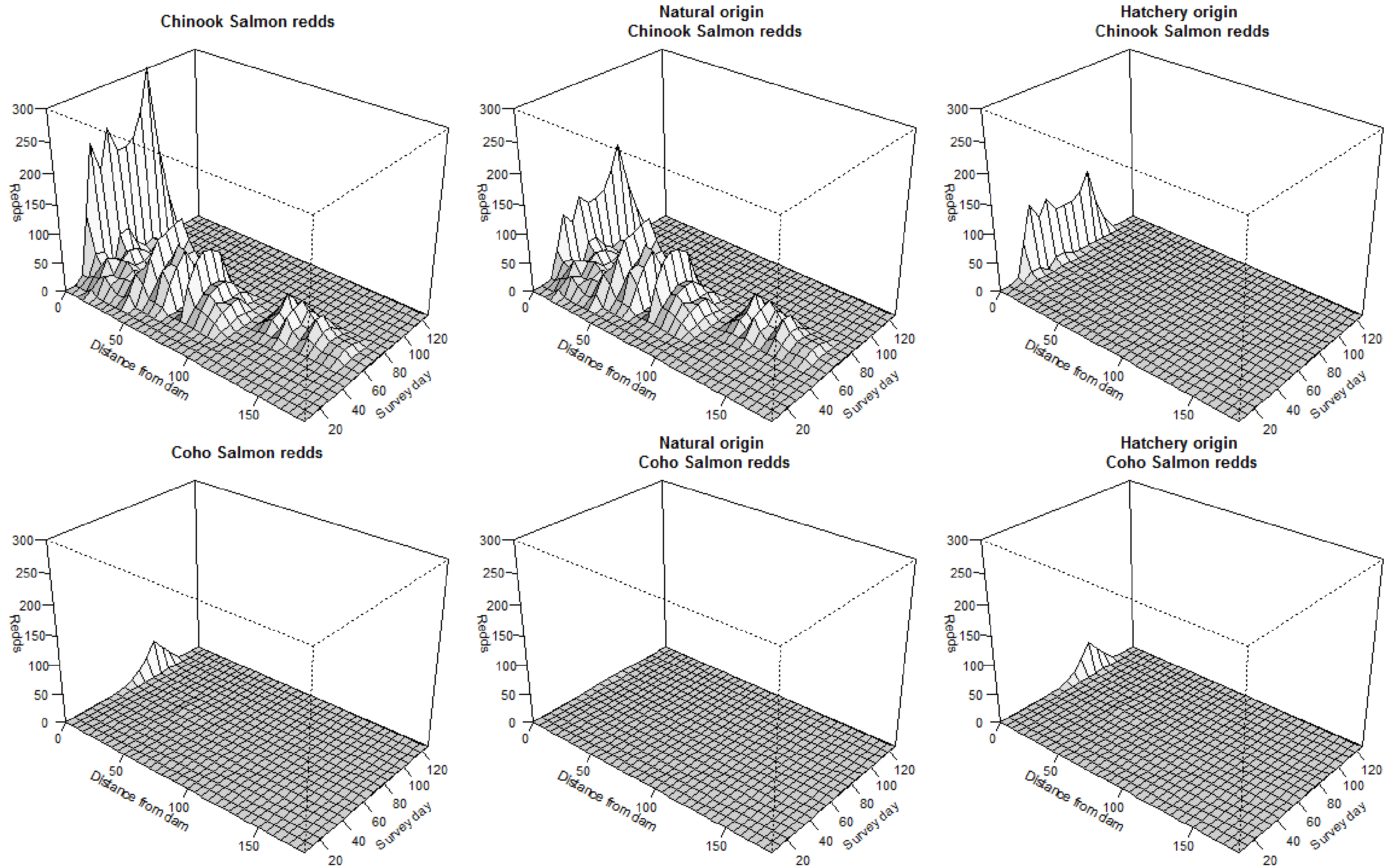


Figure 8. Spatiotemporal distribution of 2012 mainstem Trinity River salmon redds from Lewiston Dam to Weitchpec. Surveys were not conducted in Reaches 8 (rkm 107.6–117.4) and 11 (rkm 63.4–79.1). Distance from dam is in river kilometers.

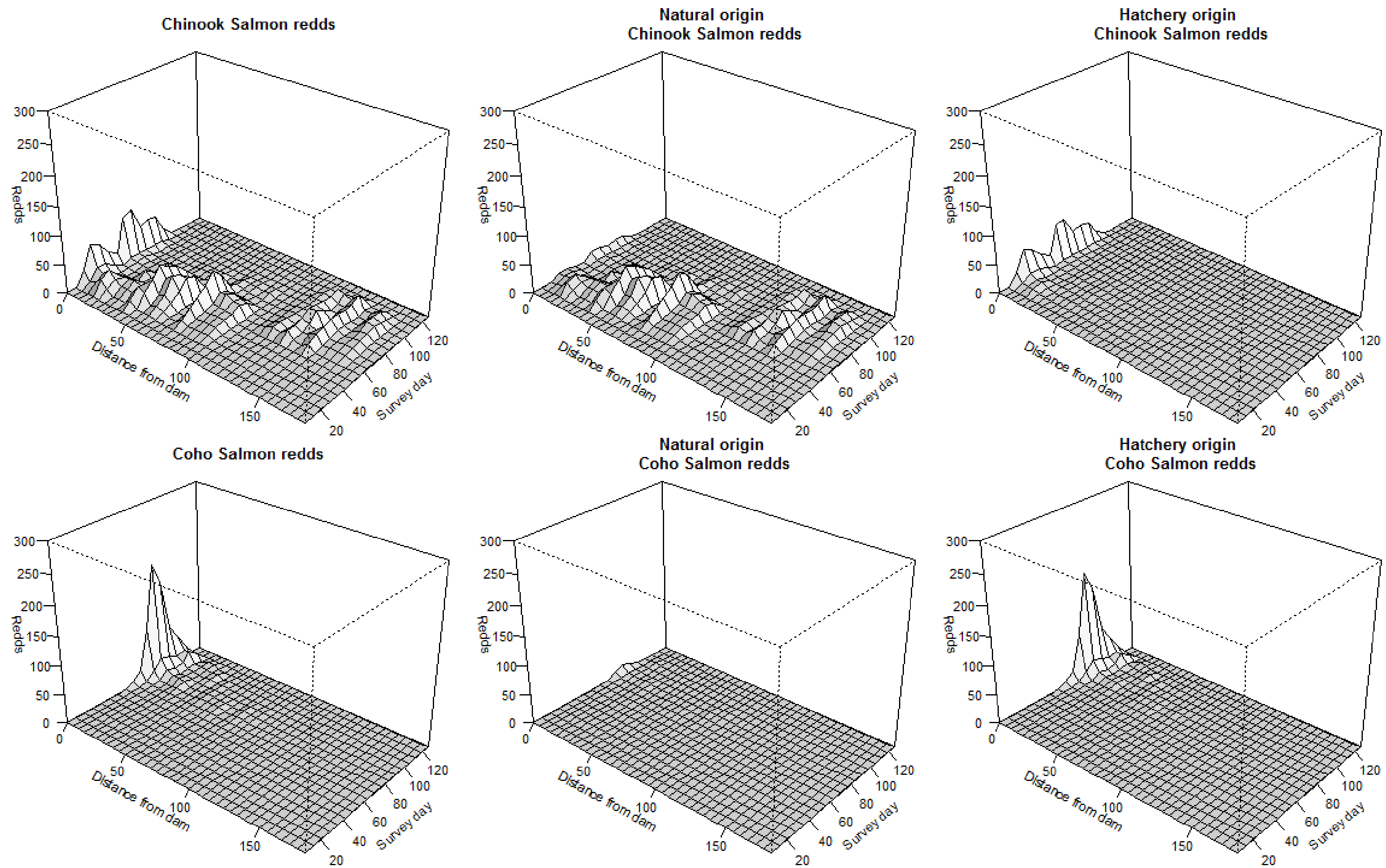


Figure 9. Spatiotemporal distribution of 2013 mainstem Trinity River salmon redds from Lewiston Dam to Weitchpec. Surveys were not conducted in Reaches 8 (rkm 107.6–117.4) and 11 (rkm 63.4–79.1). Distance from dam is in river kilometers.

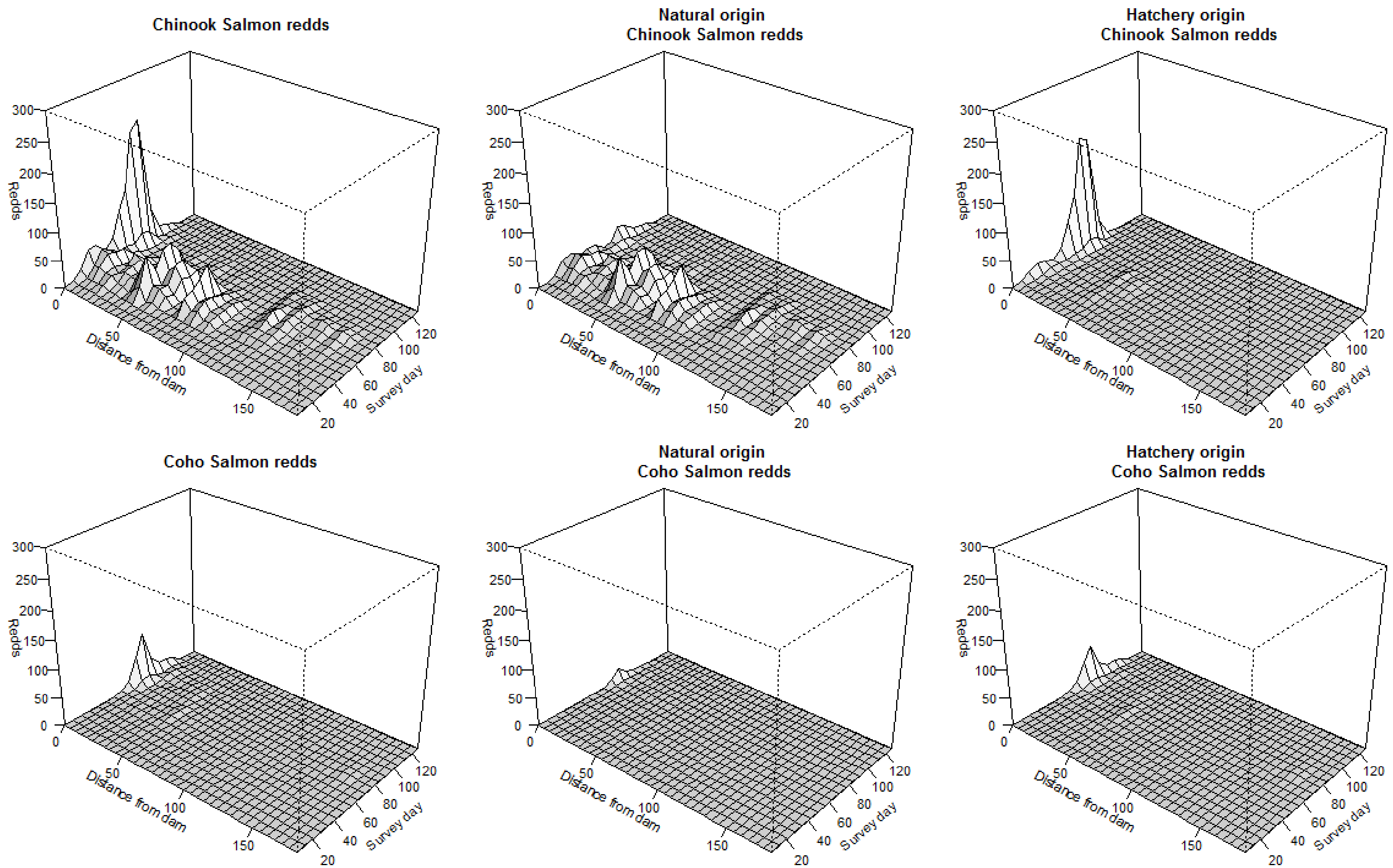


Figure 10. Spatiotemporal distribution of 2014 mainstem Trinity River salmon redds from Lewiston Dam to Weitchpec.Surveys were not conducted in Reaches 8 (rkm 107.6–117.4) and 11 (rkm 63.4–79.1). Distance from dam is in river kilometers.

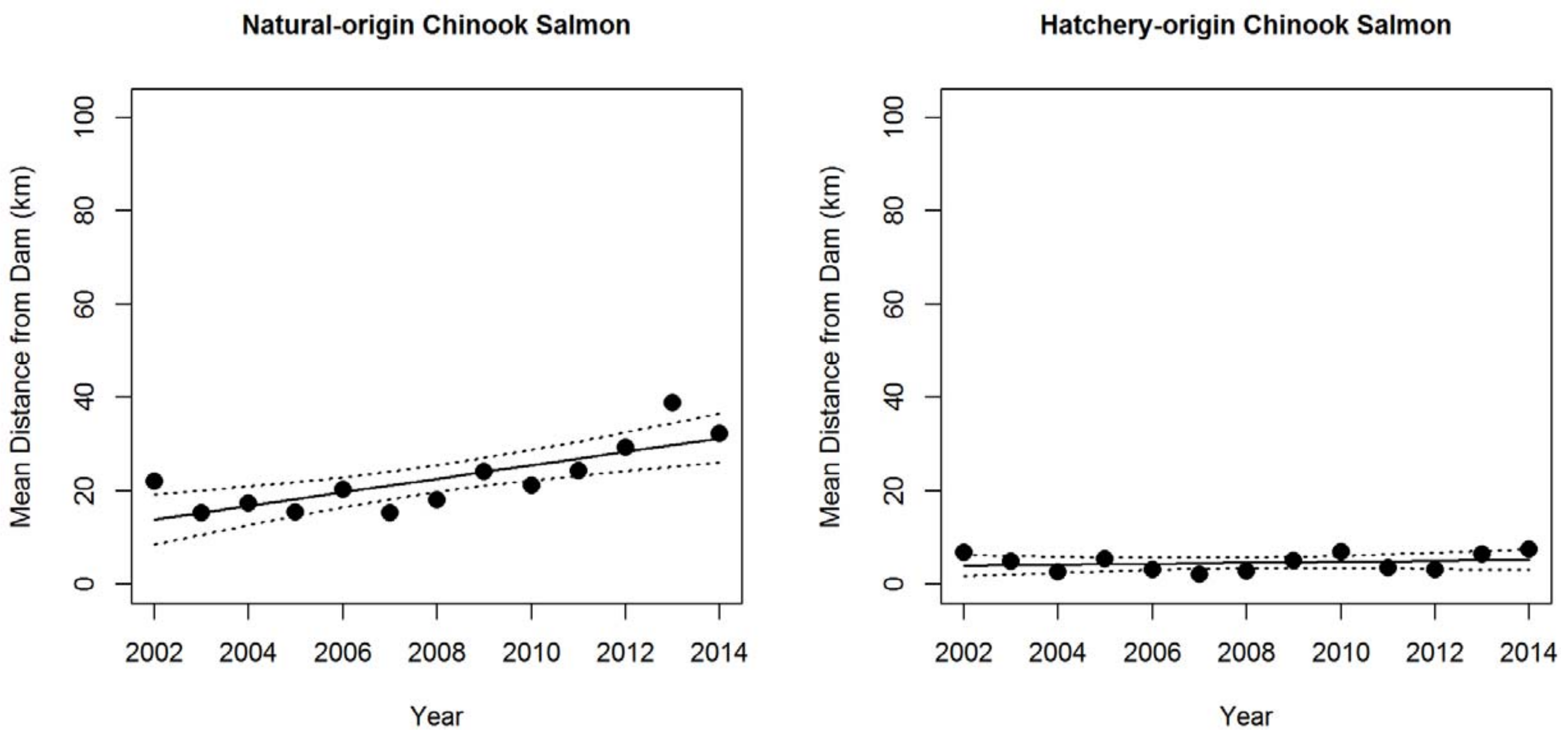


Figure 11. Mean distance from Lewiston Dam of redds constructed by natural- (left) and hatchery-origin (right) Chinook Salmon females between Lewiston Dam and Cedar Flat on the mainstem Trinity River, 2002-2014. Dotted lines represent 95% confidence limits of the linear model.

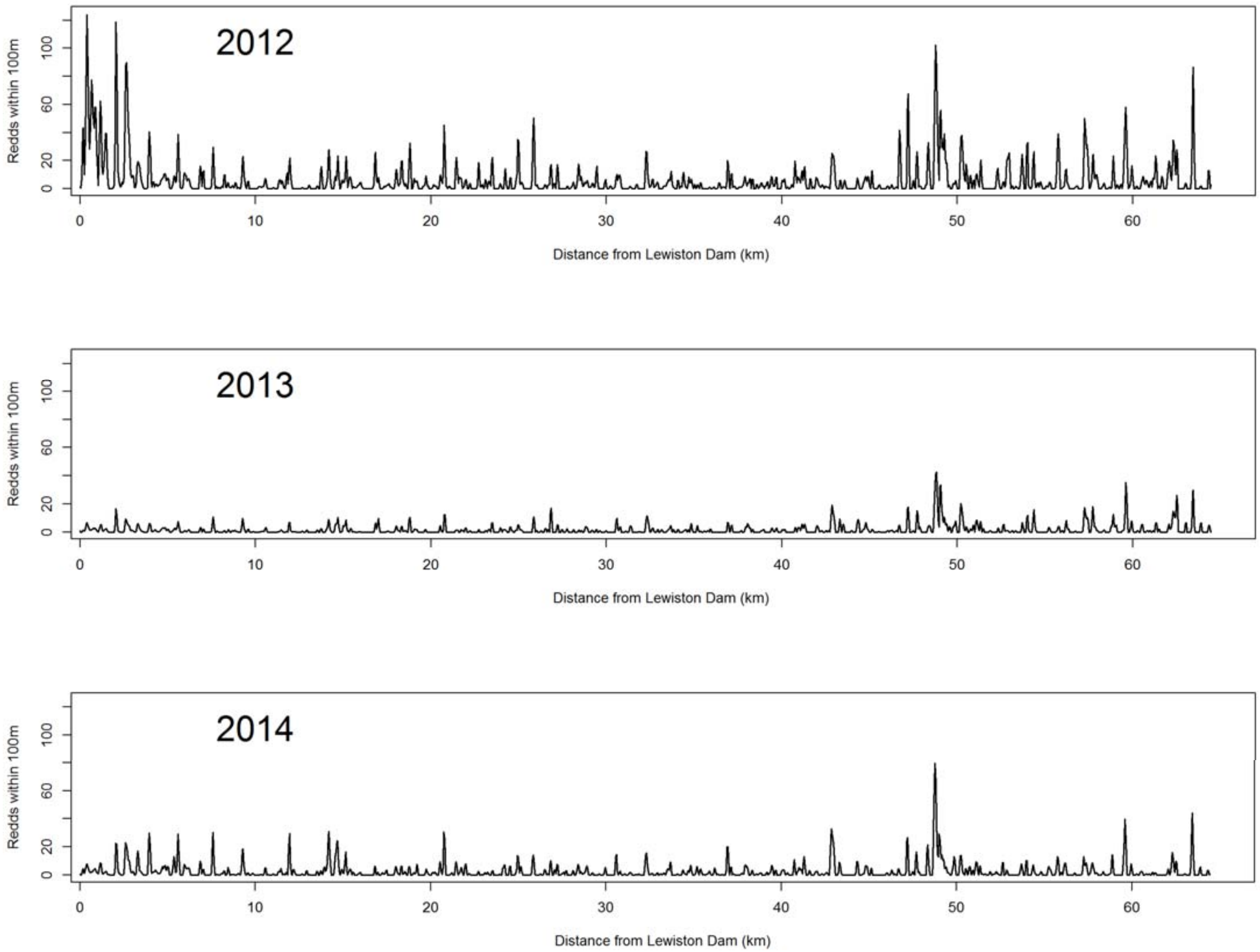


Figure 12. Density of redds constructed by natural-origin Chinook Salmon between 0.0 and 64.5 km below Lewiston Dam, Trinity River 2012–2014. Density values are calculated in 100-m segments that extend from 50 m upstream to 50 m downstream of points along the 2009 river centerline.

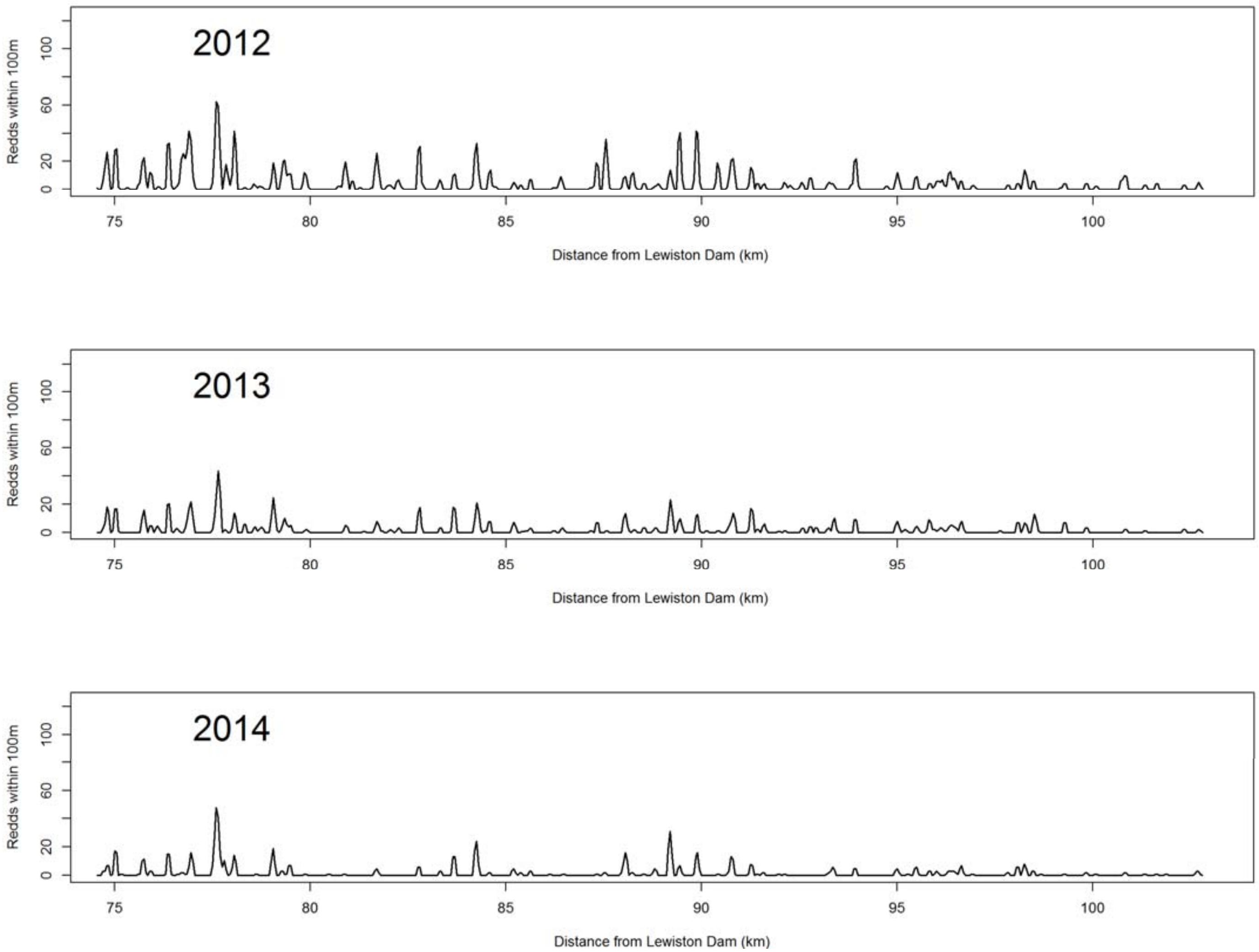


Figure 13. Density of redds constructed by natural-origin Chinook Salmon between 74.5 and 102.8 km below Lewiston Dam, Trinity River 2012–2014 Density values are calculated in 100-m segments that extend from 50 m upstream to 50 m downstream of points along the 2009 river centerline.

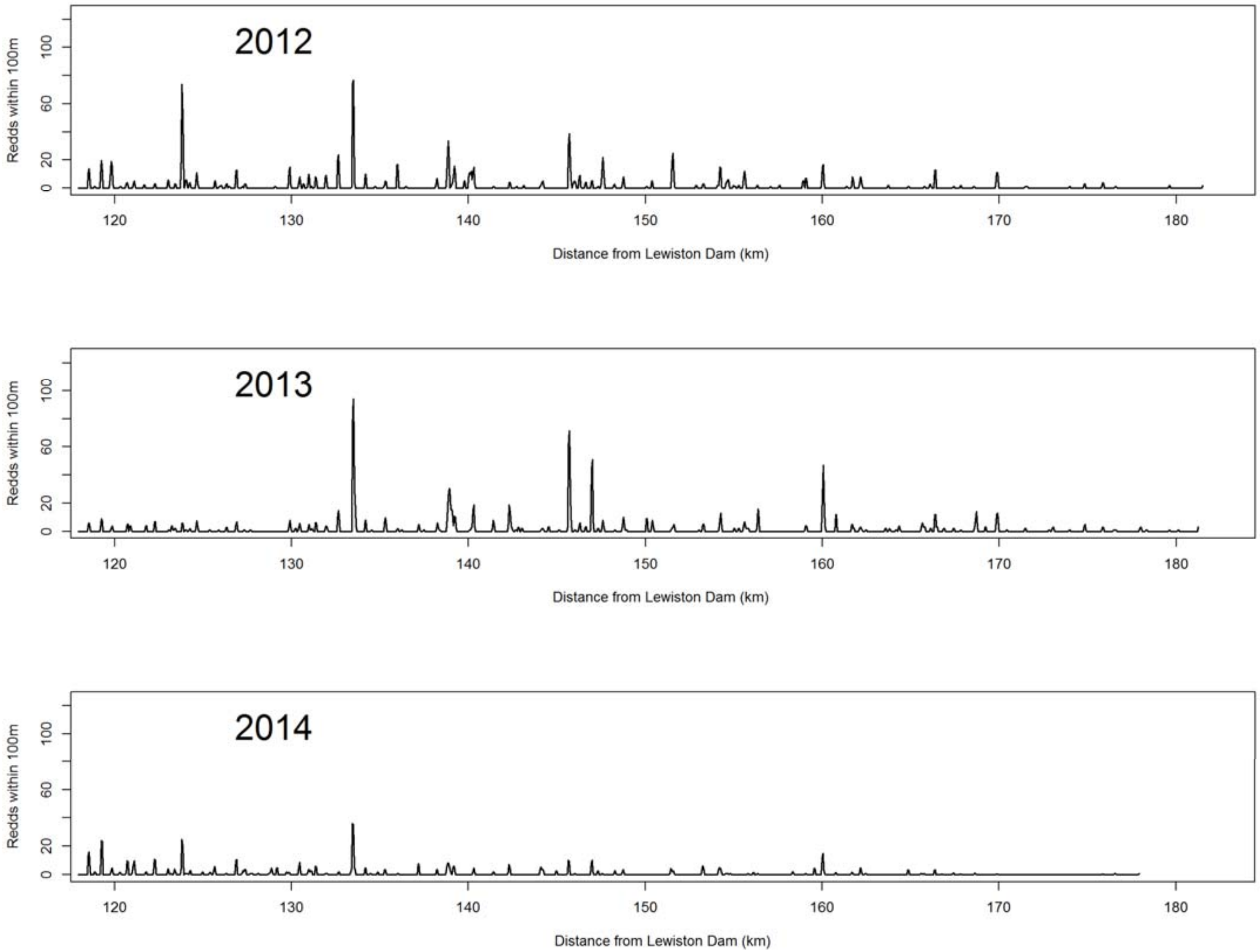


Figure 14. Density of redds constructed by natural-origin Chinook Salmon between 117.9 and 182.0 km below Lewiston Dam, Trinity River 2012–2014. Density values are calculated in 100-m segments that extend from 50 m upstream to 50 m downstream of points along the 2009 river centerline.

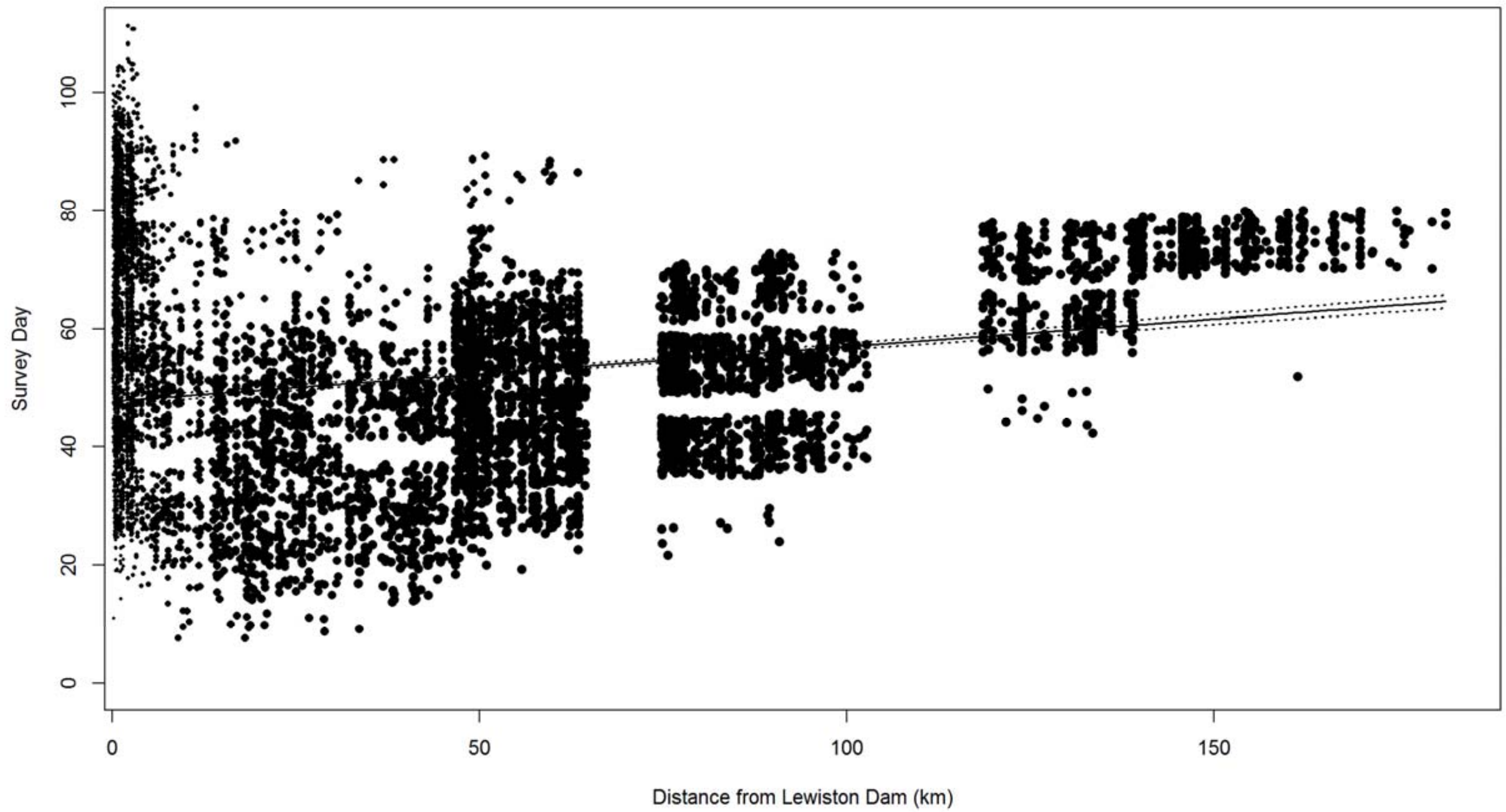


Figure 15. Temporal distribution of salmon redds in the Trinity River from 2012, with dot size representative of the probability that the redd was constructed by a natural-origin Chinook Salmon. Data points were jittered (i.e., vertically expanded) to show detail. Dotted lines represent the 95% confidence limits of the linear model.

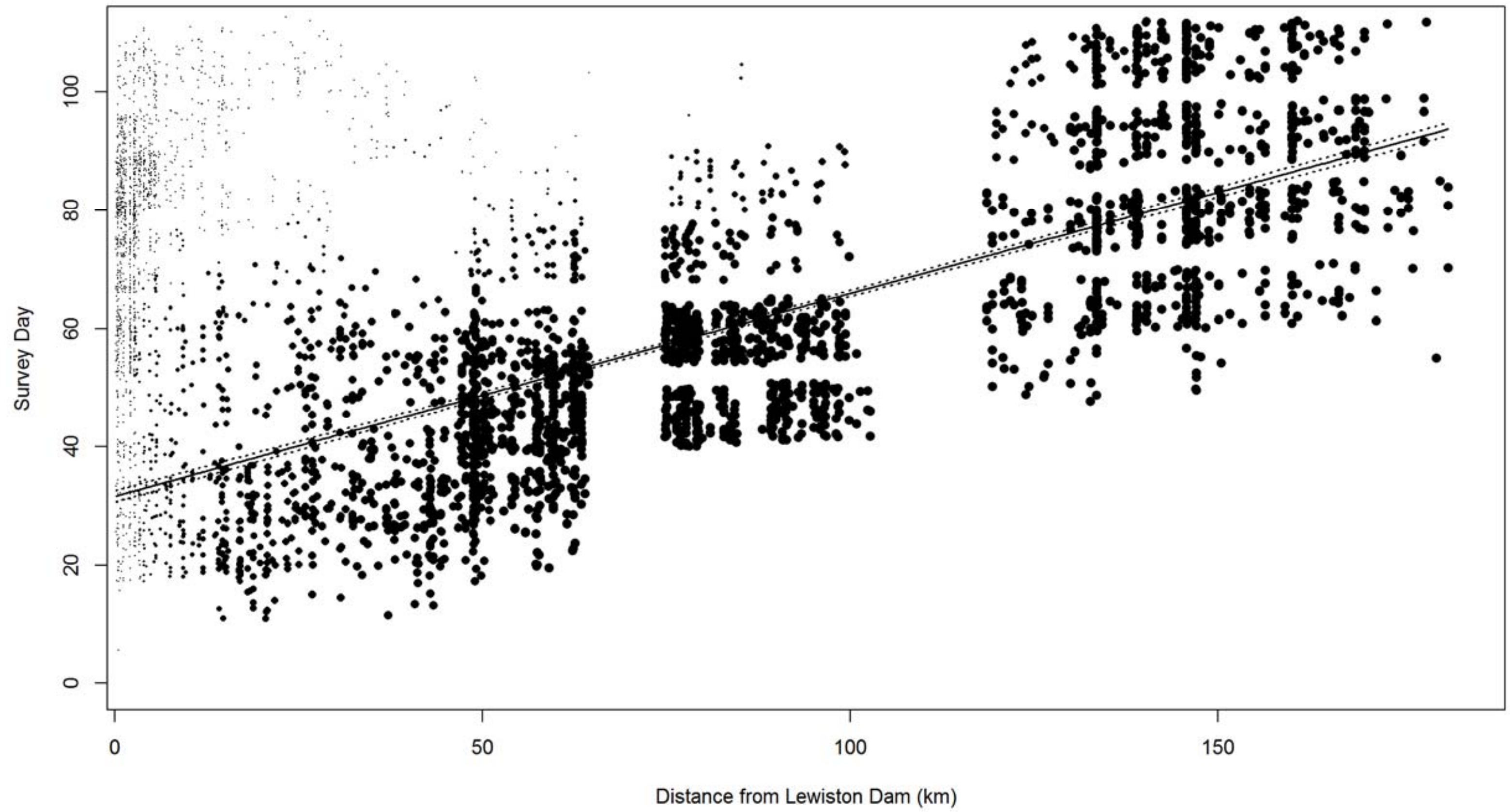


Figure 16. Temporal distribution of salmon redds in the Trinity River from 2013, with dot size representative of the probability that the redd was constructed by a natural-origin Chinook Salmon. Data points were jittered (i.e., vertically expanded) to show detail. Dotted lines represent the 95% confidence limits of the linear model.

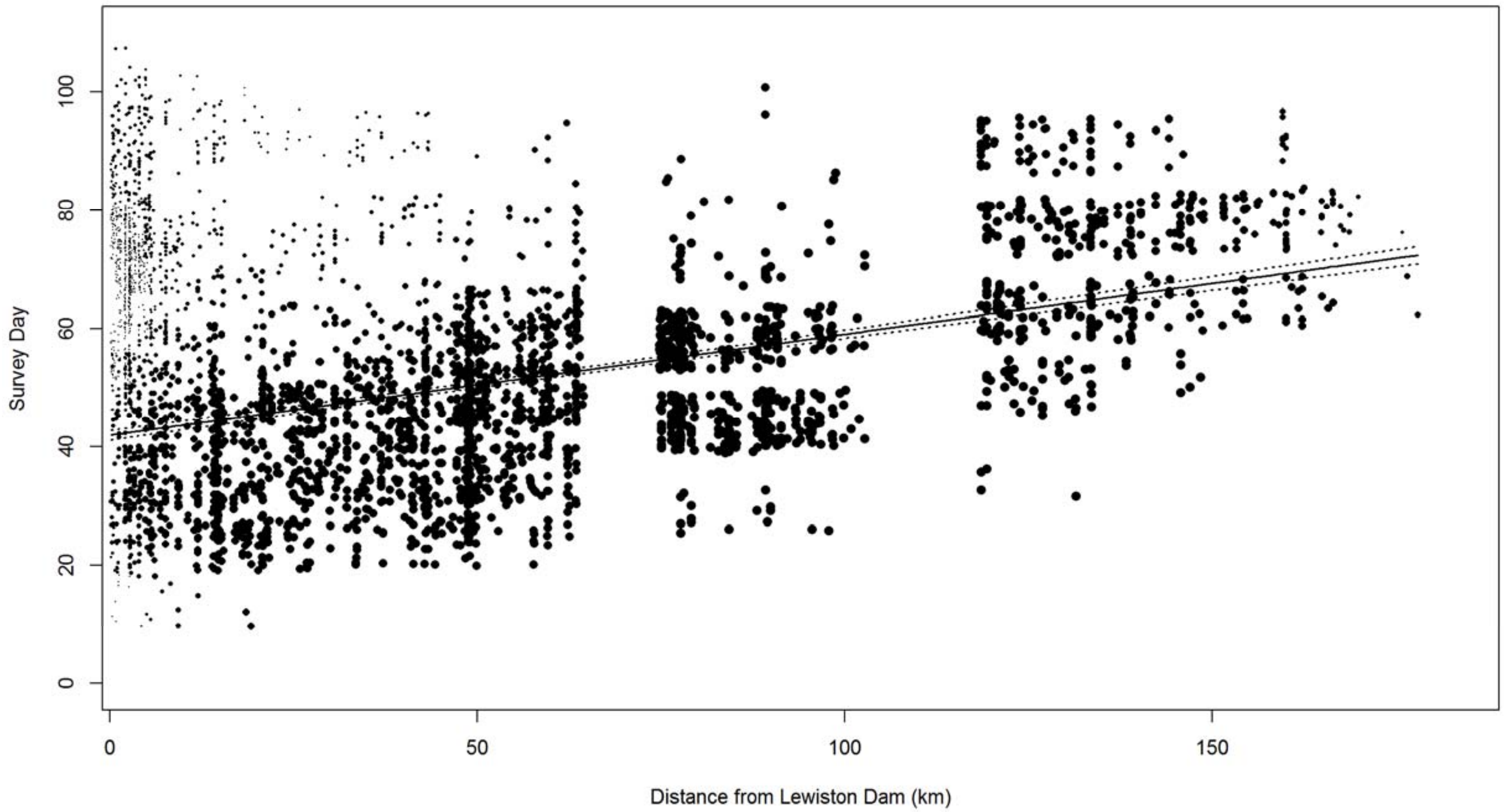


Figure 17. Temporal distribution of salmon redds in the Trinity River from 2014, with dot size representative of the probability that the redd was constructed by a natural-origin Chinook Salmon. Data points were jittered (i.e., vertically expanded) to show detail. Dotted lines represent the 95% confidence limits of the linear model.

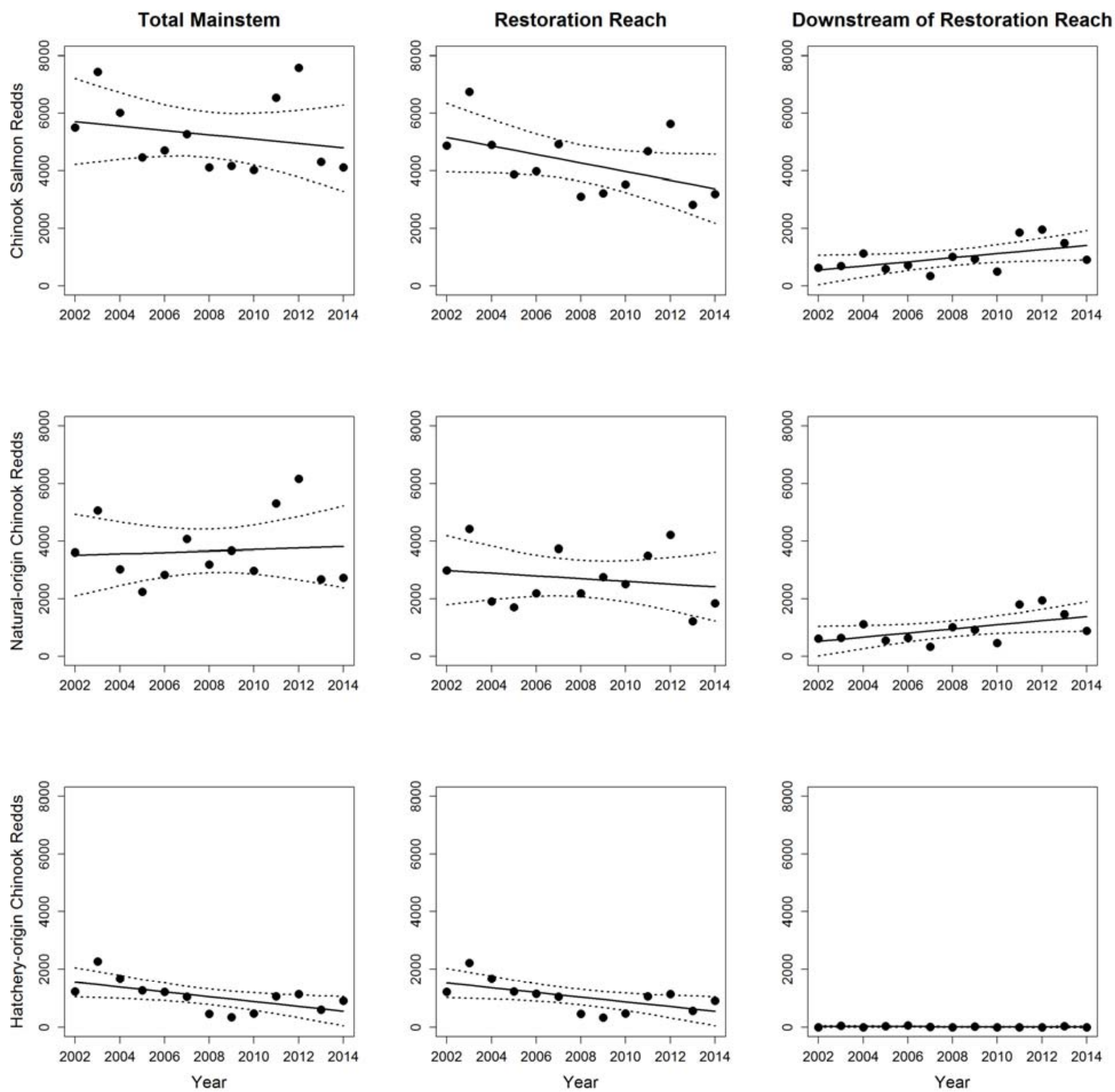


Figure 18. Estimated number of redds constructed in the mainstem (left), within the restoration reach (center), and downstream of the restoration reach (right) by all Chinook Salmon (top), natural-origin Chinook Salmon (middle), and hatchery-origin Chinook Salmon (bottom) from 2002 to 2014. Dotted lines represent the 95% confidence limits of the linear model.

Redd Abundance and Distribution: Reach Scale

Long-term changes in Chinook Salmon redd distribution were particularly detectable at the reach scale (~10–20 km). Between 2002 and 2014, the annual number of natural-origin Chinook Salmon redds in the Lewiston rehabilitation reach decreased (R^2 = 0.394, p =

0.022; Figure 19). Within this same time frame, no significant trends were evident for the number of natural-origin Chinook Salmon redds in the Limekiln (R^2 = 0.079, p = 0.353), Douglas City (R^2 = 0.006, p = 0.803), Junction City (R^2 = 0.284, p = 0.061), and North Fork (R^2 = 0.249, p = 0.083) rehabilitation reaches. Outside the restoration reach, the number of natural-origin Chinook Salmon redds significantly increased in the Big Flat (Reach 9; R^2 = 0.389, p = 0.023) and Del Loma (Reach 10; R^2 = 0.504, p = 0.007) reaches. In the shorter 2007–2014 data set, no significant changes in the number of natural-origin Chinook Salmon redds were detected in the South Fork (Reach 12; R^2 = 0.343, p = 0.127), Willow Creek (Reach 13; R^2 = 0.051, p = 0.590), and Hoopa (Reach 14; R^2 = 0.048, p = 0.603) reaches.

To account for variation in escapement between years, we compared the proportion of natural-origin Chinook Salmon redds within each of the 10 reach-scale segments to the annual total mainstem natural-origin Chinook Salmon redds (Figure 20). The proportion of natural-origin Chinook Salmon redds decreased in the Lewiston rehabilitation reach (R^2 = 0.626, p = 0.001) from 2002 to 2014. The proportion of natural-origin Chinook Salmon redds did not significantly change in the Limekiln (R^2 = 0.179, p = 0.129) and Douglas City (R^2 = 0.058, p = 0.430) rehabilitation reaches. The proportion of natural-origin Chinook Salmon redds increased in the Junction City (R^2 = 0.626, p = 0.001) and North Fork (R^2 = 0.411, p = 0.018) rehabilitation reaches. Downstream of the restoration reach, the proportion of total natural-origin Chinook Salmon redds increased in Big Bar (R^2 = 0.629, p = 0.001), Del Loma (R^2 = 0.745, p < 0.001), and South Fork (R^2 = 0.566, p = 0.031) reaches. The proportion of natural-origin Chinook Salmon redds in the Willow Creek (R^2 = 0.065, p = 0.542) and Hoopa (R^2 = 0.066, p = 0.539) reaches exhibited no significant trends.

No significant change in the annual number or proportion of hatchery-origin Chinook Salmon redds were detected within any of the rehabilitation reaches from 2002 to 2014 (Figure 21). In the Lewiston rehabilitation reach, where most hatchery-origin Chinook Salmon construct redds, the number nor the proportion of hatchery-origin Chinook Salmon redds did not change significantly (number of redds: R^2 = 0.232, p = 0.096; proportion of redds: R^2 = 0.009, p = 0.754). Consistently through this time frame, most hatchery-origin Chinook Salmon redds were constructed in the Lewiston rehabilitation reach (~86%) and, to a much lesser degree, the Limekiln rehabilitation reach (~8%; Figure 22).

Redd Abundance and Distribution: Site Scale

Data from 2002 to 2014 were used to evaluate changes in natural-origin Chinook Salmon spawning activity within the TRRP mechanical restoration sites (Appendix J). The spatial response in spawning activity following construction in restoration sites was inconsistent. Spawning activity at some sites responded positively following mechanical restoration (e.g., Valdor Gulch and Pear Tree Gulch), negatively at some (e.g., Sven Olbertson and Dark Gulch), and some exhibited no change (e.g., Hoadly Gulch and Trinity House Gulch) with regard to the proportion of redds counted within the site relative to the total restoration reach count (Figure 23). Sites without mechanical restoration work exhibited similar variability. The proportion of natural-origin Chinook Salmon redds increased in some non-restoration sites (e.g., Dutch Creek and Sheridan Creek), exhibited no change (e.g., Evans Bar and The Canyon Part 1), or decreased (e.g., Poker Bar and McIntyre Gulch) between 2002 and 2014.

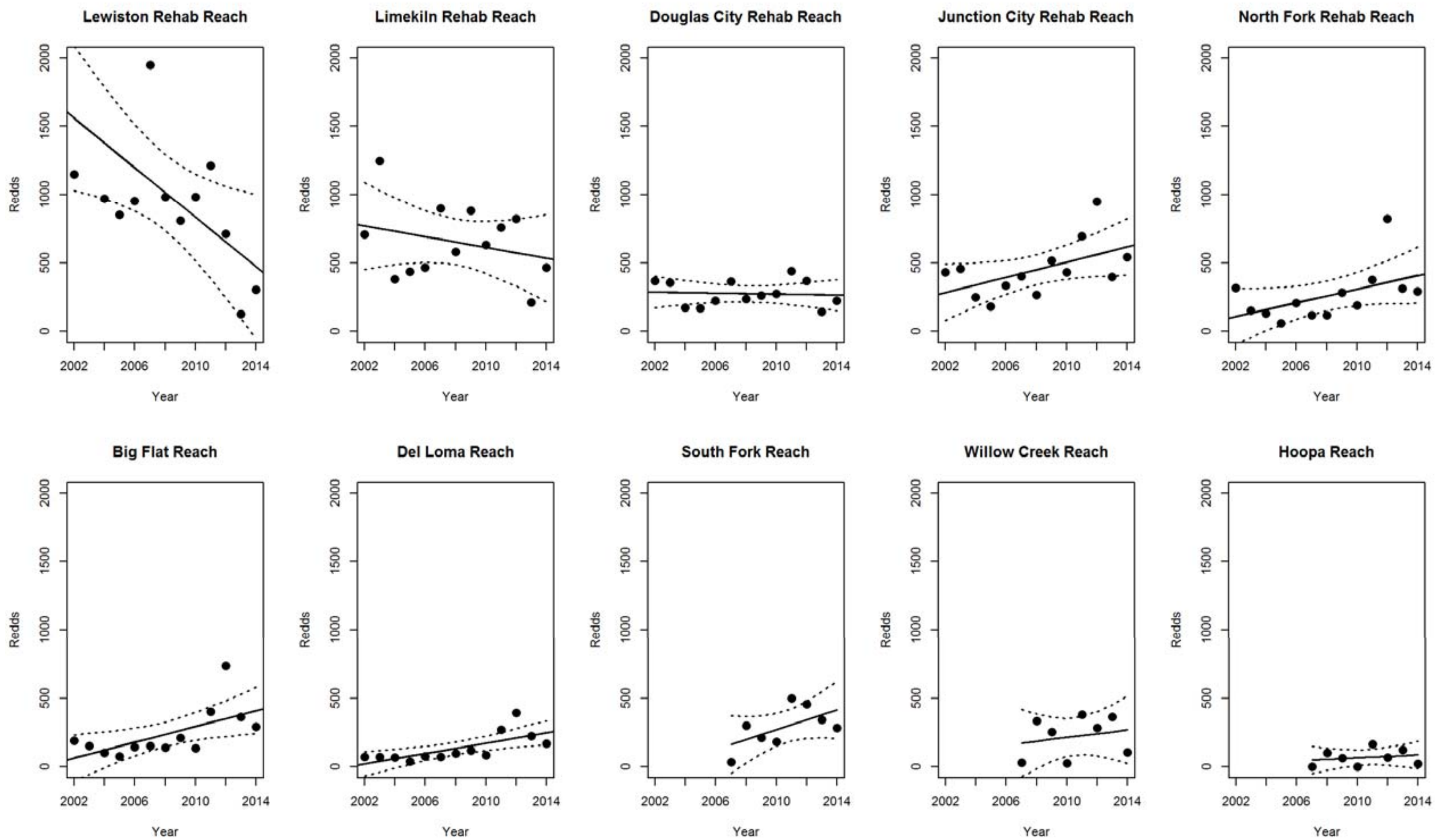


Figure 19. Estimated number of mainstem Trinity River natural-origin Chinook Salmon redds at five rehabilitation reaches (HVT et al. 2011) and Big Flat (Reach 9), Del Loma (Reach 10), South Fork (Reach 12), Willow Creek (Reach 13), and Hoopa (Reach 14) reaches, 2002–2014. Dotted lines represent the 95% confidence limits of the linear model.

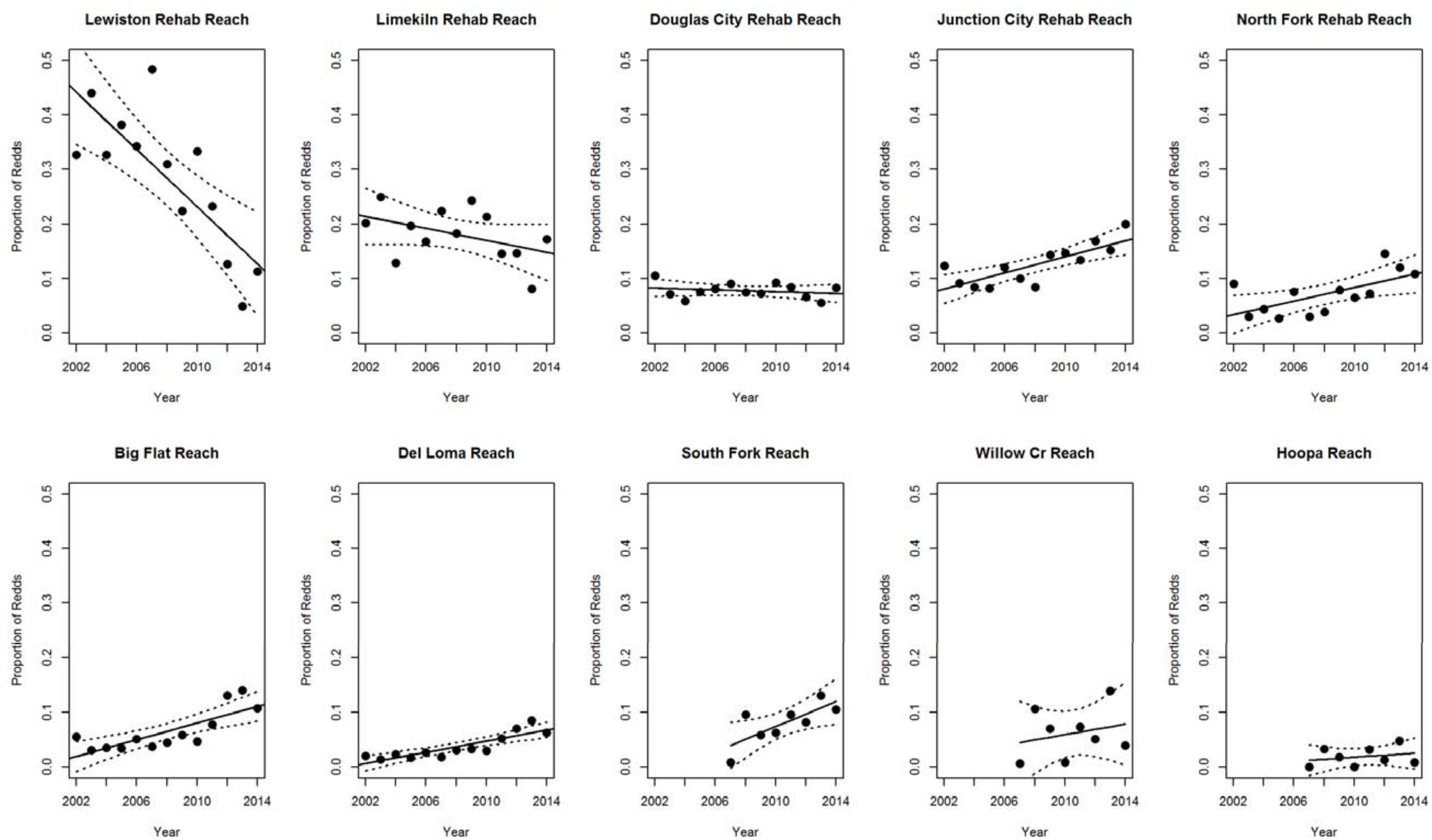


Figure 20. Proportions of mainstem Trinity River natural-origin Chinook Salmon redds relative to the total mainstem count of natural-origin Chinook Salmon redds within five rehabilitation reaches (HVT et al. 2011) and Big Flat (Reach 9), Del Loma (Reach 10), South Fork (Reach 12), Willow Creek (Reach 13) and Hoopa (Reach 14) reaches, 2002–2014. Dotted lines represent the 95% confidence limits of the linear model.

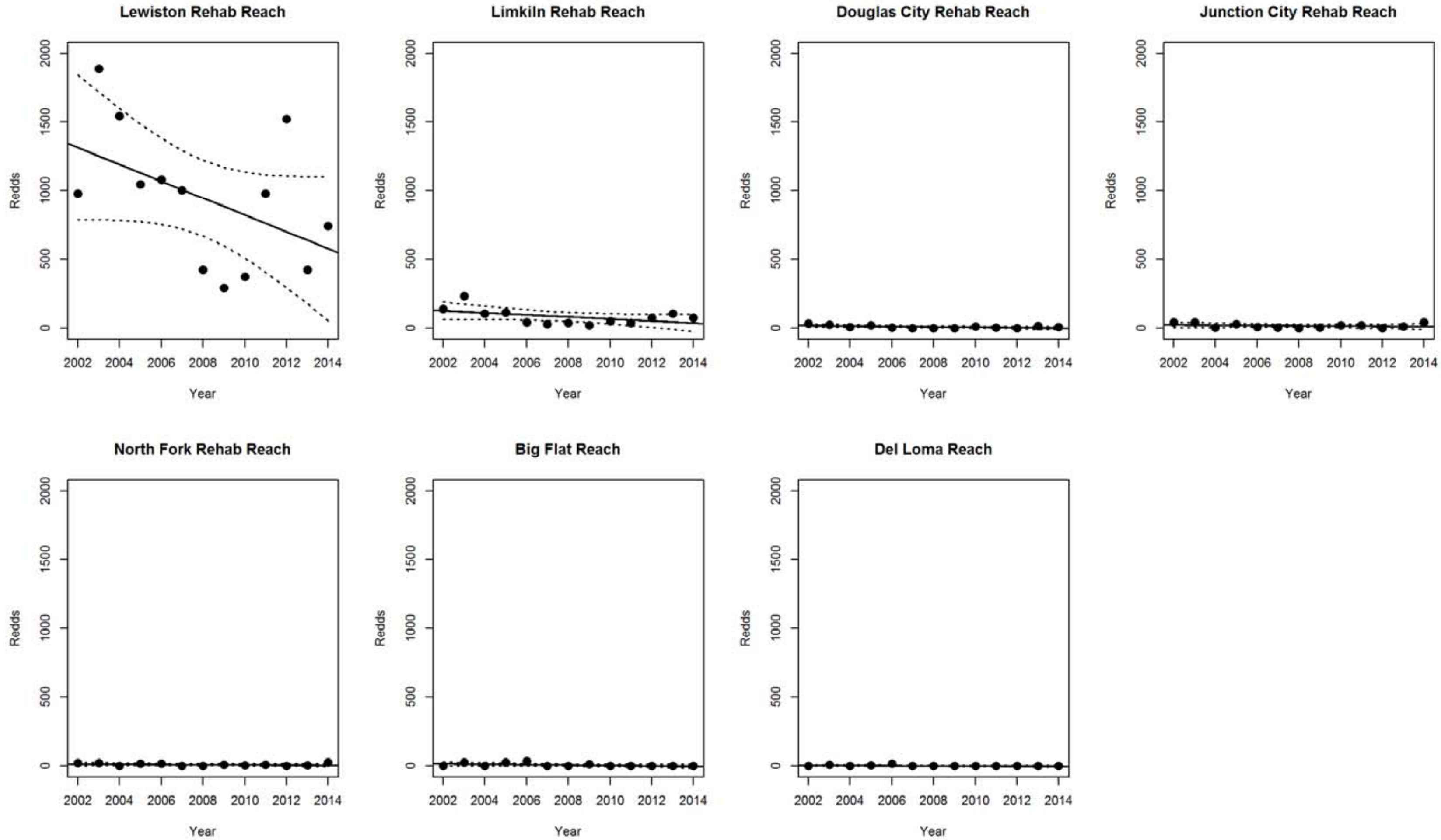


Figure 21. Estimated number of mainstem Trinity River hatchery-origin Chinook Salmon redds at five rehabilitation reaches (HVT et al. 2011), Big Flat Reach (Reach 9), and Del Loma Reach (Reach 10), 2002–2014. Dotted lines represent the 95% confidence limits of the linear model.

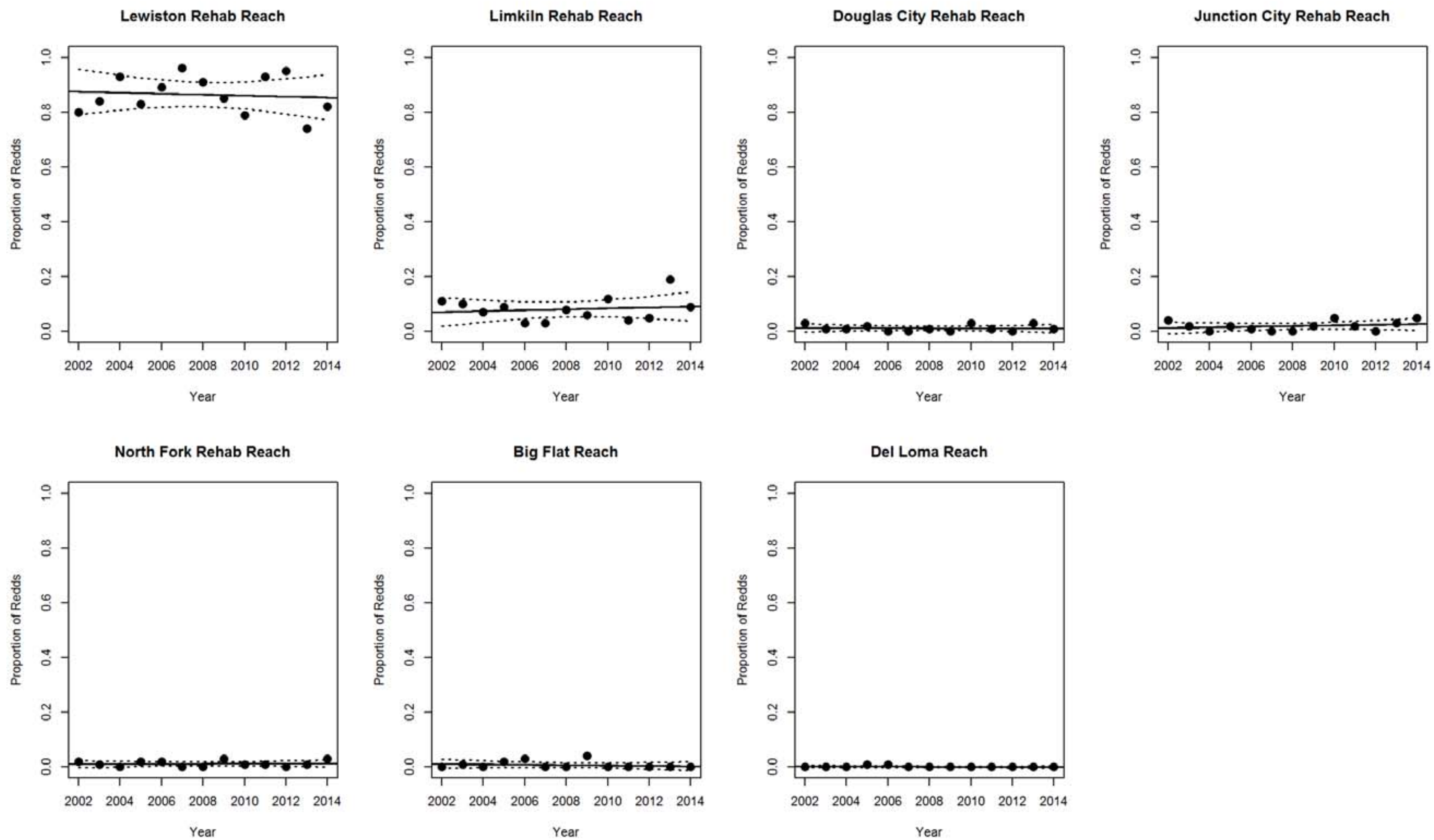


Figure 22. Proportions of mainstem Trinity River hatchery-origin Chinook Salmon redds relative to the total mainstem count of hatchery-origin Chinook Salmon redds within five rehabilitation reaches (HVT et al. 2011), Big Flat Reach (Reach 9), and Del Loma Reach (Reach 10), 2002–2014. Dotted lines represent the 95% confidence limits of the linear model.

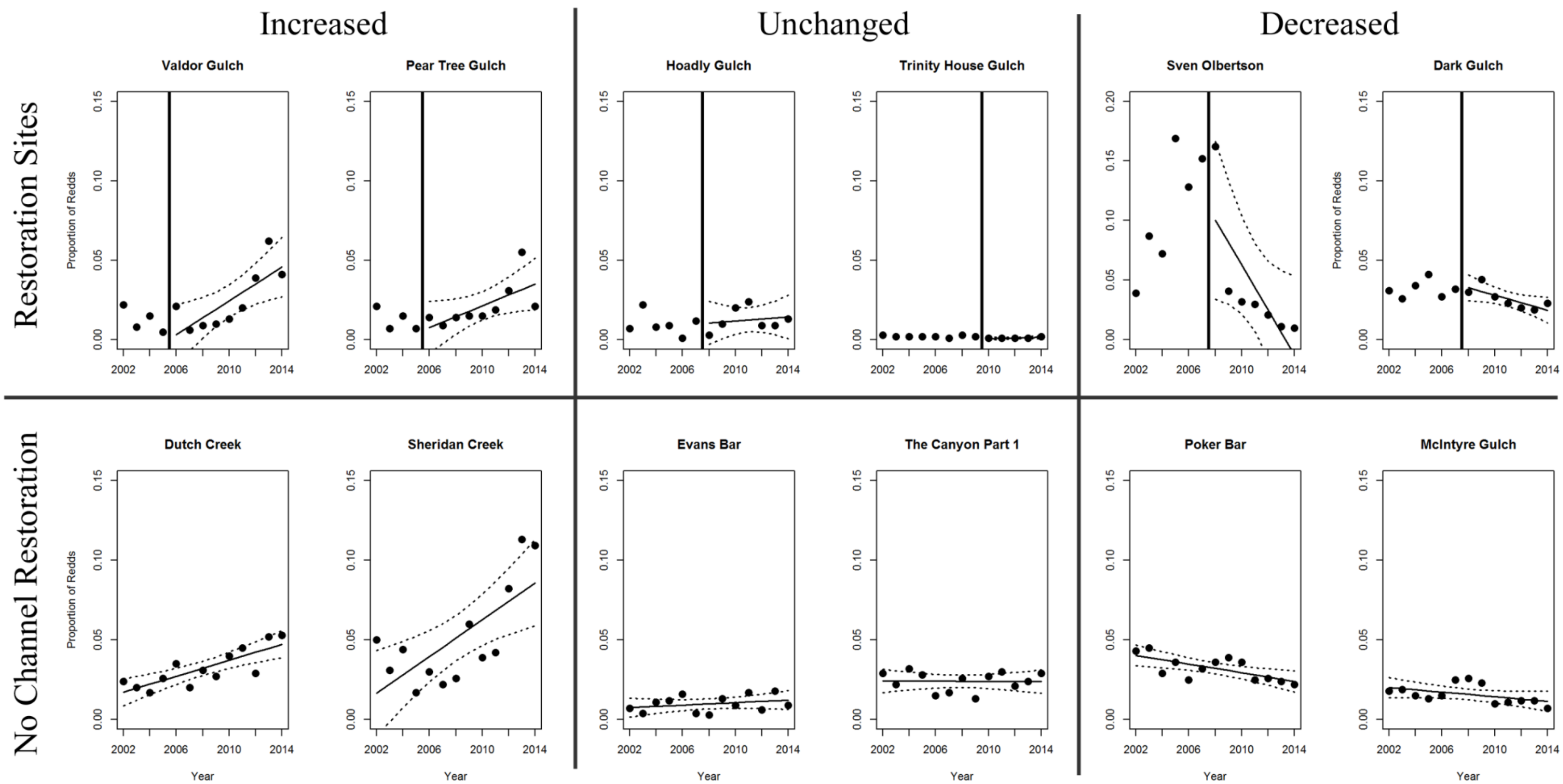


Figure 23. Proportions of natural-origin Chinook Salmon redds within specified example sites of the Trinity River relative to the total count of natural origin-Chinook Salmon redds in the restoration reach, 2002–2014. Each of these example sites represents a generally recognized section of river with or without TRRP restoration. The vertical bars represent the completion of TRRP mechanical restoration action. Dotted lines represent the 95% confidence limits of the linear model. Note that the scale of the *y*-axis may vary.

Spawning trends at the site-scale appear to be dictated by the overarching changes at the reach scale. For example, sites (mechanical restoration and non-restoration sites) within the North Fork rehabilitation reach were more likely to undergo a positive response because the overall spawning in that rehabilitation reach is also increasing. Conversely, spawning activity in sites (mechanical restoration and non-restoration sites) within the Lewiston rehabilitation reach was more likely to decrease since overall spawning in that rehabilitation reach also decreased.

Redd–Carcass Relationship

Chinook Salmon redds (log-transformed) were positive linearly correlated with fresh spawned female Chinook Salmon carcass estimates (log-transformed) in Reaches 1 and 2, 2012–2014 (R^2 = 0.690, p = 0.041; Figure 24). No difference was detected between a slope of ‘1’ and the slope of the linear regression between Chinook Salmon redd counts (log-transformed) and fresh spawned female Chinook Salmon carcass estimates (log-transformed) (slope = 1.398, 95% CI: -1.188–1.574). Therefore, we conclude that Chinook Salmon redds were marked proportionately to the estimated number of carcasses and that density-dependent effects (e.g., redd super-imposition, carcass dispersion, etc.) were not a factor in the crews’ ability to observe redds and carcasses.

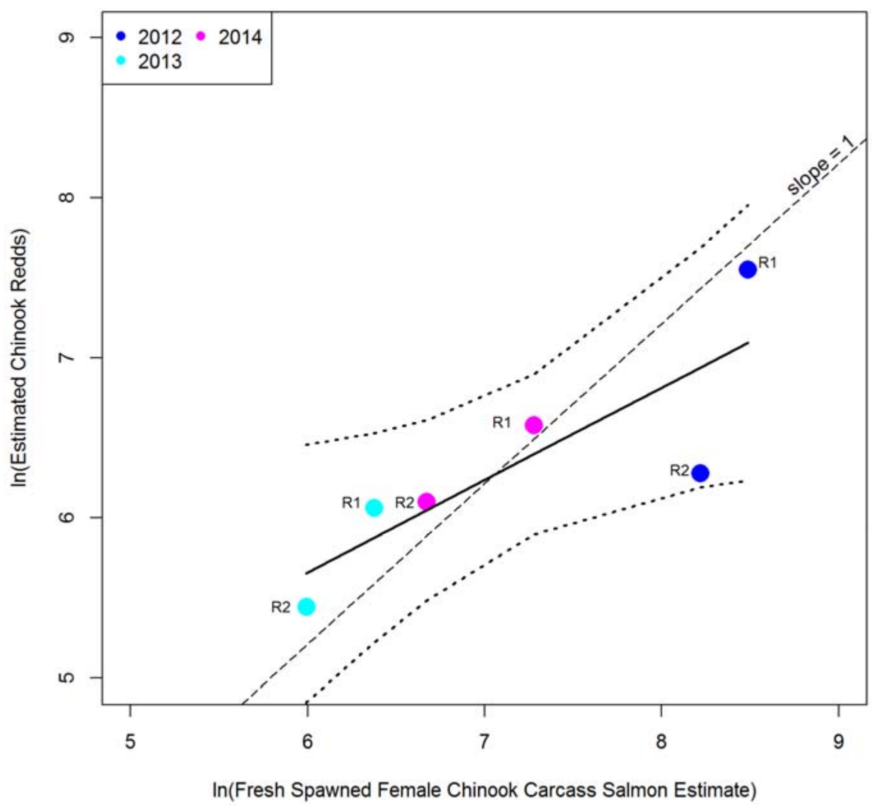


Figure 24. Relationship between Chinook Salmon redds and estimated number of fresh spawned female Chinook Salmon carcasses in Reaches 1 (R1) and 2 (R2), 2012–2014. Dotted lines represent the 95% confidence limits of the linear model. The dashed line represents a slope of ‘1’.

Discussion

Data from our spawning surveys provide insight into the dynamics of salmon spawning activity on the Trinity River. The main themes that emerge are 1) the annual abundance of Chinook Salmon redds is variable and did not trend upward from 2002 to 2014, 2) the spatial distribution of natural-origin Chinook Salmon spawning continues to slowly change, 3) the spawning distribution of natural-origin Chinook Salmon is shifting within and beyond the restoration reach, 4) mechanical channel restoration has had inconsistent short-term effects on the number of fish spawning at individual restoration sites, but the distribution of redds within a site can change considerably, 5) straying and spawning of hatchery-origin salmon in the river is generally confined to areas near the hatchery, and 6) annual pre-spawn mortality is variable.

The number of natural-origin Chinook Salmon redds within the mainstem Trinity River showed no detectable trend from 2002 to 2014 while the number of hatchery-origin Chinook Salmon redds decreased (Figure 18). These results are contrary to expected increases in spawner abundance in response to restoration (sub-objective 3.1 of the IAP; TRRP and ESSA 2009) even though the TRH releases a constant number (4.3 million) of juvenile Chinook Salmon each year. Factors beyond river conditions (e.g., harvest, ocean conditions) may be influencing escapement and masking responses to river restoration.

Although the annual abundance of Chinook Salmon redds did not increase from 2002 to 2014, the spatial distribution of natural-origin Chinook Salmon redds shifted. The mean distance from Lewiston Dam of natural-origin Chinook Salmon redds increased (Figure 11). The IAP suggestion that redd distribution would shift longitudinally in response to restoration was supported by our data (TRRP and ESSA 2009).

The rehabilitation-reach scale (approximately 10–20 km segments) may be the most informative for evaluating spawning trends of natural-origin Chinook Salmon (Figure 19–Figure 20). Redd numbers have decreased directly below Lewiston Dam (Lewiston Rehabilitation Reach) and increased within mid-river sections (Big Bar and Del Loma reaches) since 2002. The proportional abundance of natural-origin Chinook Salmon redds trended upwards within the Junction City Valley and downstream to the South Fork Trinity confluence. While the IAP's hypothesis that longitudinal distribution of redds should increase was supported, they are also contradictory to the IAP's expectation that redd abundance in the reaches below the North Fork Trinity River would not increase until the "restoration goals" were met (TRRP and ESSA 2009); a larger portion of the Trinity River may be responding to TRRP restoration efforts than just the restoration reach.

Without a spawning habitat model, we are unable to predict habitat changes and relate these changes to spawning habitat use. However we do believe that adult salmonid spawning and holding habitats are improving throughout the restoration reach. During the approximate four salmon broods (assuming 3-year brood cycles) that have spanned the time since the introduction of ROD restoration flows, high flow releases and TRRP restoration efforts have altered habitat on the mainstem Trinity River (2003–2014). For example, active channel areas and stable bars where salmon spawn increased (Appendix M; Curtis et al. 2015). Also, flow and tributary management have reduced fine sediments within the river substrate (Appendix K; Graham Matthews and Associates 2010; TRRP 2016), which in turn likely improved salmon egg survival (Jensen et al. 2009). Continuing since before the ROD, water temperatures are lower (CRWQCB–NCR 1991; USFWS and HVT 1999) and most pools upstream of the North Fork Trinity River have been maintained or deepened (Appendix L; Gaeuman and Krause 2013) as a result of higher flow releases from Trinity Dam, thus improving adult salmon holding opportunities. Cumulatively, these changes give Trinity River salmon better opportunities to occupy preferred habitats and complete their life cycle throughout the once degraded restoration reach.

The extent of our spawning surveys allows us to recognize distributional changes that occur throughout the mainstem Trinity River. The longitudinal distributional shifts mentioned above indicate increased spawning activity in locations far from Lewiston Dam. Trinity River Chinook Salmon may be slowly changing from spatially skewed post-dam spawning to a more diverse spawning distribution. Isaak et al. (2003) suggests that a desynchronized spawning distribution is an indication of a diverse population, and diversity in a population increases its ability to withstand unforeseeable deleterious events. This response should therefore be considered a beneficial result of restoration.

Channel restoration was largely implemented to jumpstart alluvial processes and increase juvenile rearing habitat. As alluvial processes change habitat availability at restoration sites, a response is expected from spawning salmon with regard to redd distribution (Chamberlain et al. 2012). However, Chinook Salmon spawning surveys conducted from 2002 to 2014 reveal no clear post-construction response to restoration at rehabilitation sites. This spatial scale may be too broad to indicate whether redd distribution changed due to channel restoration. The use of a finer, feature-based scale (i.e., a constructed bar or side channel) of design elements that are specifically designed to increase spawning habitat may be more appropriate to assess responses to restoration. Also, the post-construction time frames of all of the restorations sites is less than 10 years (first sites completed in 2005), which may not be long enough to assess ongoing responses. Many restoration sites may not have experienced enough time to fully mature geomorphically and develop the characteristics that long-term fluvial processes are expected to create and maintain (i.e., reduced fines or riparian re-vegetation). Furthermore, a full response by salmon populations may take multiple generations to develop. Our results indicate, however, that channel rehabilitation has altered the locations of spawning habitat and influenced where salmon choose to build redds within restoration sites. For example, at the Wheel Gulch site, the annual number of redds remained relatively stable, but the areas where salmon built redds immediately shifted following mechanical restoration (Figure 25–Figure 26). The distribution within this site shifted again after it was altered by high flows (Figure 27–Figure 28). This response further supports that the effect on spawning from changes in channel morphology may be better evaluated at particular features. In the future, restoration site designers should explicitly define where features are built that are intended to increase spawning habitat.

Spawning by spring- and fall-run hatchery-origin Chinook Salmon in the Trinity River was consistently skewed toward Lewiston Dam. Since 2002, the vast majority of redds from both races of hatchery-origin Chinook Salmon have been constructed within 10 km of the dam (Figure 5). The distribution of ad-clipped carcasses indicates that hatchery fish returned to areas near the TRH, regardless of their race. Since many hatchery-origin Chinook Salmon successfully build redds below Lewiston Dam, their progeny are attributed as natural-origin when recovered as adults.

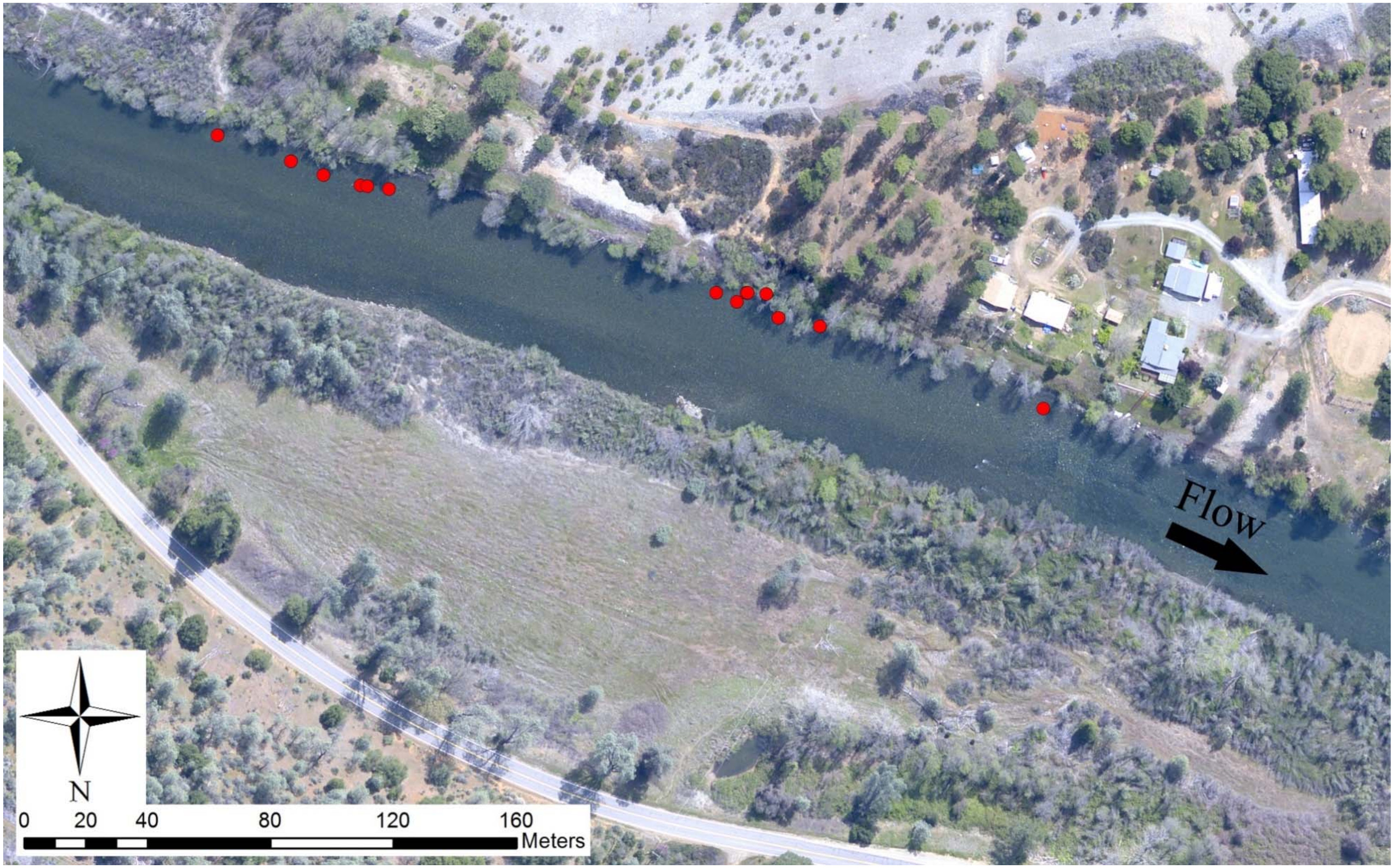


Figure 25. Pre-construction aerial view of the Wheel Gulch site from 2010 with salmon redds represented as red dots. Note that all redds in this area were constructed along the left bank.

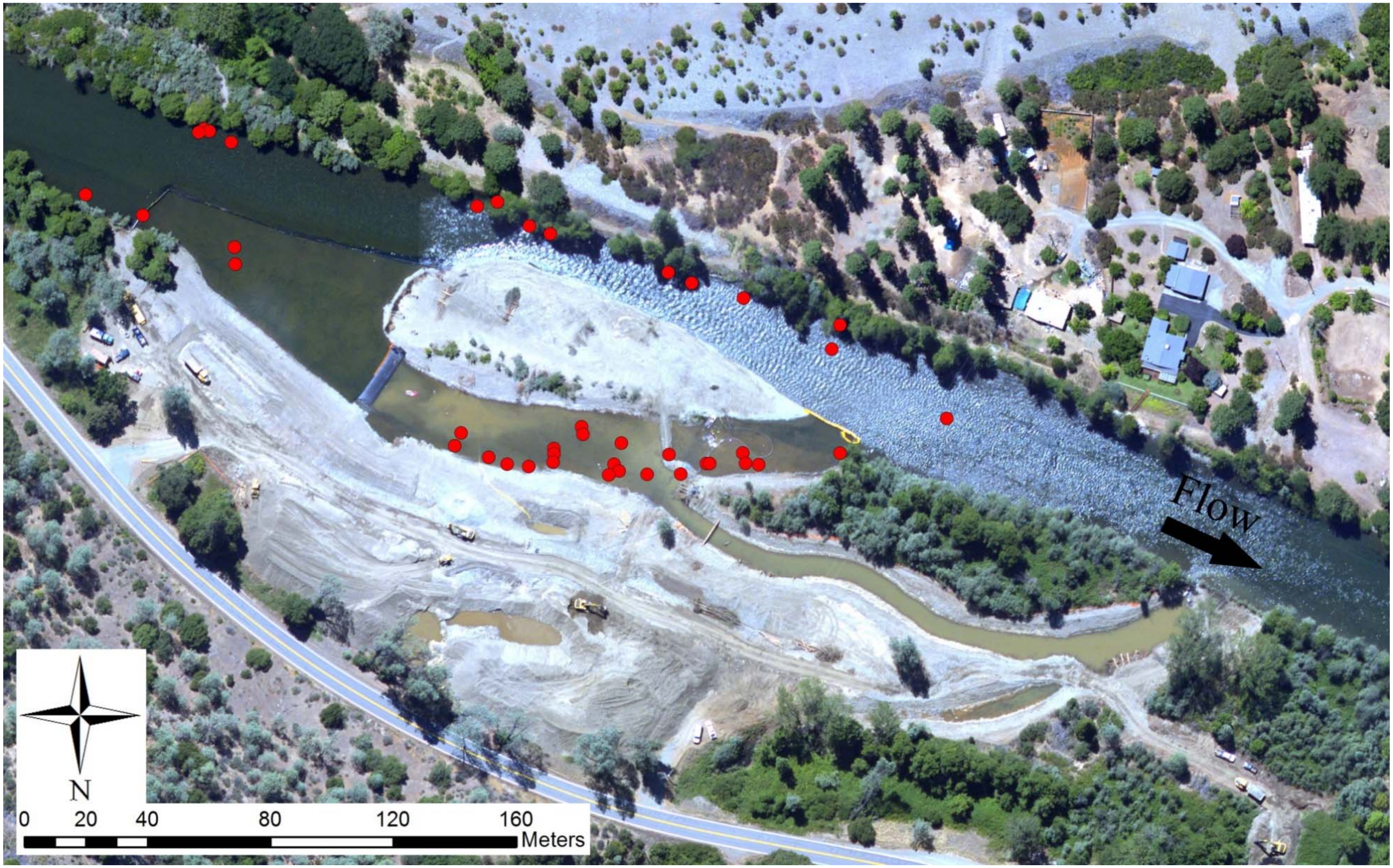


Figure 26. Aerial view of the Wheel Gulch site from 2011 during construction with salmon redds represented as red dots. In-river construction was completed before salmon begin spawning in the fall. Note that redds are along both banks and clustered in the downstream half of the newly constructed split flow.

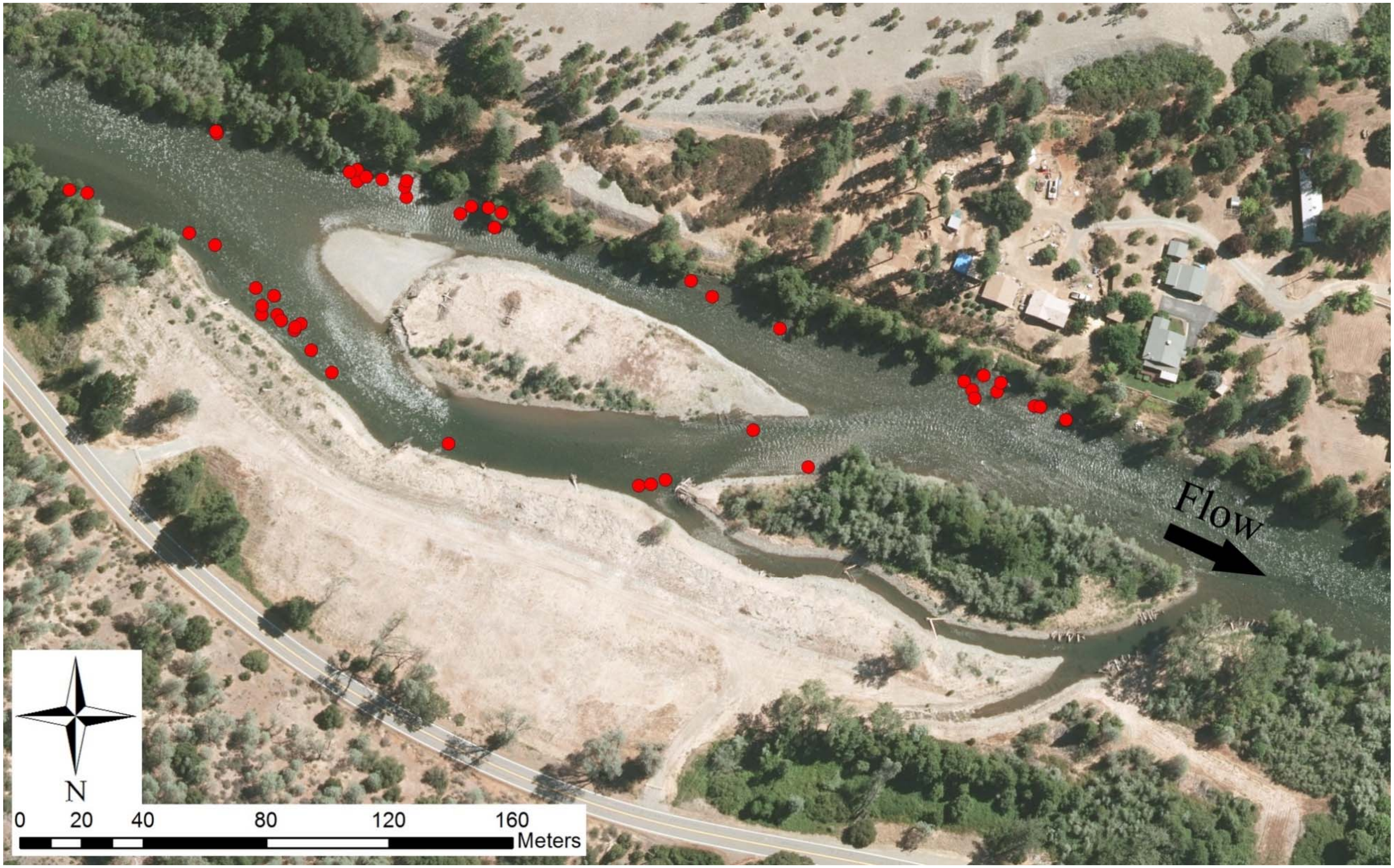


Figure 27. Aerial view of the Wheel Gulch site from 2012, post-construction, after one high flow event with salmon redds represented as red dots. Note that redds are along both banks and clustered in the upstream half of the newly constructed split flow.

Figure 28. Aerial view of the Wheel Gulch site from 2013, post-construction, after two high flow events with salmon redds represented as red dots. Note that redds are along both banks and clustered in the upstream half of the newly constructed split flow.

Natural-origin Chinook Salmon that began spawning earlier tended to spawn near the Lewiston Dam while late-season spawning tended to occur in the Hoopa Valley area (Figure 15–Figure 17). This spawn timing phenomenon is apparent in the three years depicted in this report (2012–2014), though late-season surveys of Reaches 12–14 in 2012 and 2014 were limited because of high flows and turbid water. Late-season spawning activity in the downstream-most portions on the Trinity River is indicative of a unique spatial and temporal spawning distribution. These fish spawn latter in the year and lower in the river (between Hawkins Bar below Burnt Ranch Gorge and the Klamath–Trinity confluence) than the spring and fall runs. These late-fall Chinook Salmon are also common among lower Trinity and Klamath tributaries that do not see increased flows until typically November and December (Williams et al. 2011). This race may even continue to spawn further into winter, as they have been observed spawning in the Hoopa Valley as late as February (T. Masten, *personal communication*). The full temporal distribution of spawning by late-fall run Chinook Salmon were missed because surveys ended in mid-December and late-season surveys are often inhibited by turbidity and elevated river flows.

The importance of describing pre-spawn mortality has increased in recent years with ongoing drought conditions and associated higher risks of epizootic disease events. Aguilar et al. (1996) reported that pre-spawn mortality for Chinook Salmon ranged between 1.1% and 44.9% in the mainstem Trinity River above the North Fork confluence from 1978 to 1982 and 1987 to 1995. In comparison, pre-spawn mortality rates that we measured from 2009 to 2014 were relatively low at 2.4–9.5% in the same area (Table 9). Our observation that salmon pre-spawn mortality rates were typically highest at the beginning of the spawning seasons and decreased as the seasons advanced is consistent with observations by Aguilar et al. (1996) for the Trinity River and by Gough and Williamson (2012) for the Klamath River. Aguilar et al. (1996) also reported a positive correlation between pre-spawn mortality and run size for Trinity River Chinook Salmon above the North Fork confluence from 1978 to 1995. However, we observed a negative relationship (albeit not significant; $p = 0.14$) between run size and pre-spawn mortality of Trinity River Chinook Salmon from 2009 to 2014 (Figure 29). Chinook Salmon pre-spawn mortality was lowest in years with the highest redd counts (2011 and 2012) and highest in two of the three years with the lowest redd counts (2010 and 2014). Patterns observed during the two highest years were somewhat unique in that pre-spawning mortality generally increased throughout the spawning season (Figure 7). Temperature objectives established for holding and spawning adult salmonids were met 97–100% of the days in October on the mainstem Trinity River at the North Fork confluence in years with lower pre-spawning mortality (2011, 2012, and 2013), 94% of the days in October 2009 when pre-spawn mortality was relatively moderate, and 52–77% of the days in October in years with higher pre-spawn mortality (2010 and 2014; Polos 2016). The lower incidence of meeting temperature objectives in 2010 and 2014 may have contributed to the higher overall pre-spawning mortality of Chinook Salmon. Similarly, Coho Salmon experienced their highest rates of pre-spawn mortality in 2010 and 2014 as well. Note that pre-spawn mortality rates were based on data collected through late December while Coho Salmon spawning continues after this time period. Pre-spawn mortality of salmon often varies, typically highest at the beginning of a spawning season (Seesholtz et al. 2005; Gough and Williamson 2012) as observed for Chinook Salmon, and our surveys did not extend over the entire Coho Salmon spawning period.

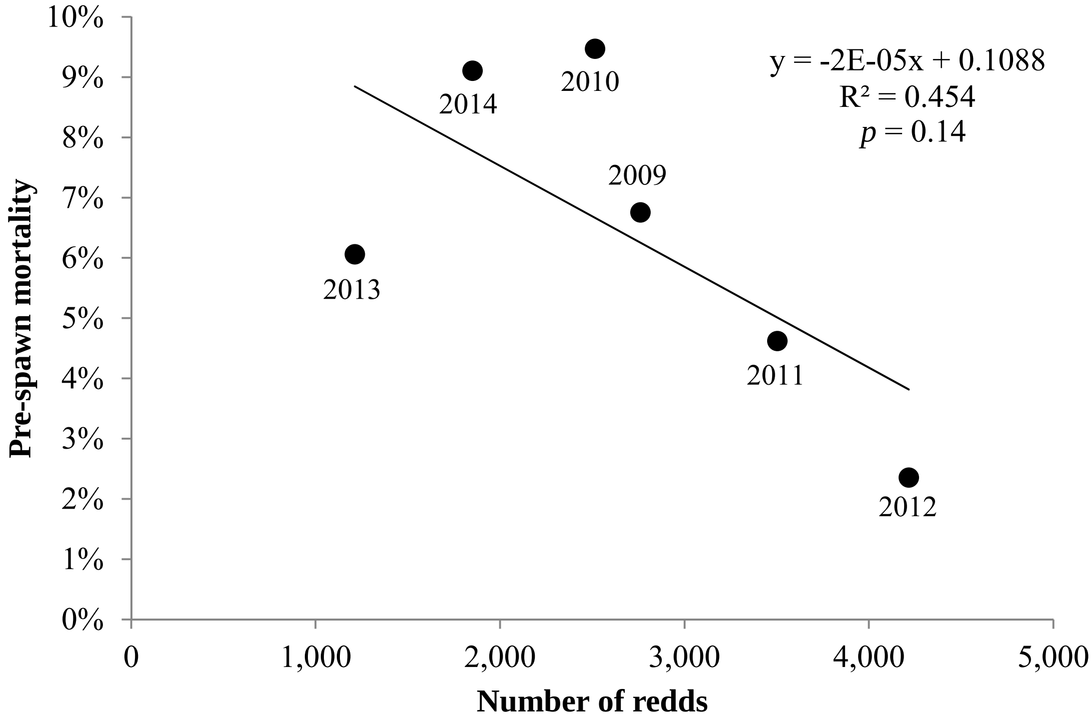


Figure 29. Natural-origin Chinook Salmon redd counts versus estimates of pre-spawn mortality, Trinity River surveys above the North Fork confluence, 2009–2014.

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Literature Cited

Aguilar, B., L. D. Davis, B. W. Collins, L. Hanson, W. Sinnen, M. Zuspan, and M. Dean. 1996. Annual Report: Trinity River Basin salmon and steelhead monitoring project, 1994–1995 season. R. M. Kano, editor. California Department of Fish and Game, Inland Fisheries Division, Sacramento, California. 223 p.

Borok, S., S. Cannata, J. Hileman, A. Hill, and M. C. Kier. 2014. Annual Report: Trinity River basin salmon and steelhead monitoring project, 2012–2013 season. California Department of Fish and Wildlife, Redding, California.

Buffington, J., C. Jordan, M. Merigliano, J. Peterson, and C. Stalnaker. 2014. Review of the Trinity River Restoration Program following Phase 1, with emphasis on the Program's channel rehabilitation strategy. Prepared by the Trinity River Restoration Program's Science Advisory Board for the Trinity River Restoration Program with assistance from Anchor QEA, LLC, Stillwater Sciences, BioAnalysts, Inc., and Hinrichsen Environmental Services.

Burner, C. J. 1951. Characteristics of spawning nests of Columbia River salmon. U.S. Fish and Wildlife Service, Fisheries Bulletin 61:97–110.

Canty, A. and B. Ripley. 2015. boot: Bootstrap R (S-Plus) Functions. R package version 1.3–16.

Cederholm, C. J., D. B. Houston, D. L. Cole, and W. J. Scarlett. 1989. Fate of Coho Salmon (*Oncorhynchus kisutch*) carcasses in spawning streams. Canadian Journal of Fisheries and Aquatic Sciences 46(8):1347–1355.

Chamberlain, C. D., S. Quinn, and W. Matilton. 2012. Distribution and abundance of Chinook Salmon redds in the mainstem Trinity River 2002 to 2011. U.S. Fish and Wildlife Service. Arcata Fish and Wildlife Office, Arcata Fisheries Technical Report TR 2012-16, Arcata, California.

CRWQCB–NCR (California Regional Water Quality Control Board–North Coast Region). 1991. Public report on proposed action to amend the Water Quality Control Plan for the North Coast Region to include a site-specific temperature objective and an Interim Action Plan for the Trinity River. 198 p.

Curtis, A. J., S. C. Wright, J. T. Minear, and L. E. Flint. 2015. Assessing geomorphic change along the Trinity River downstream from Lewiston Dam, 1980 to 2011. U.S. Geological Survey Scientific Investigations Report 2015–5046, prepared in cooperation with the Trinity River Restoration Program.

Davison, A. C., and D. V. Hinkley. 1997. Bootstrap methods and their applications. Cambridge University Press, Cambridge, United Kingdom.

Duffy, W. G. 2005. Protocols for monitoring the response of anadromous salmon and steelhead to watershed restoration in California. Draft report prepared for California Department of Fish and Game.

Gaeuman, D., and A. Krause. 2013. Assessment of pool depth changes in the Trinity River between Lewiston Dam and the North Fork Trinity River. Technical Report: TR-TRRP-2013-1, U.S. Bureau of Reclamation, Trinity River Restoration Program, Weaverville, California.

Gallagher, S. P. 2003. Discrimination of Chinook (*Oncorhynchus tshawytscha*) and Coho (*O. kisutch*) salmon and steelhead (*O. mykiss*) redds and evaluation of the use of redd data for estimating escapement in several unregulated streams in northern California. California Department of Fish and Game, Fort Bragg, California.

Gallagher, S. P., and C. M. Gallagher. 2005. Discrimination of Chinook and Coho salmon and steelhead redds and evaluation of the use of redd data for estimating escapement in several unregulated streams in northern California. North American Journal of Fisheries Management 25:284–300.

Gallagher, S. P., P. B. Adams, D. W. Wright, and B. W. Collins. 2010. Performance of spawner survey techniques at low abundance levels. North American Journal of Fisheries Management 30(5):1086–1097.

Glock, J. W., G. Hartman, and L. L. Conquest. 1980. Skagit River Chum Salmon carcass drift study. University of Washington Center for Quantitative Science. Seattle City Light Department Technical Report, Seattle, Washington.

GMA (Graham Matthews and Associates). 2010. Trends in substrate composition of the Trinity River, 1991–2009. Final Report to Trinity River Restoration Program.

Gough, S. A., and S. C. Williamson. 2012. Fall Chinook Salmon run characteristics and escapement for the main-stem 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.

Hampton, M. 1988. Development of Habitat Criteria for Anadromous salmonids on the Trinity River. Trinity River Flow Evaluation Program. U.S. Fish and Wildlife Service, Sacramento, California

Hampton, M., T. R. Payne, and J. A. Thomas. 1997. Microhabitat suitability criteria for anadromous salmonids of the Trinity River. U.S. Fish and Wildlife Service, Arcata, California.

HVT (Hoopa Valley Tribe), McBain and Trush, and Northern Hydrology and Engineering. 2011. Channel rehabilitation design guidelines for the mainstem Trinity River. Prepared for the Trinity River Restoration Program, Hoopa, California.

Isaak, D. J., R. F. Thurow, B. E. Rieman, and J. B. Dunham. 2003. Temporal variations in synchrony among Chinook Salmon (*Oncorhynchus tshawytscha*) redd counts from wilderness areas in central Idaho. Canadian Journal of Fisheries and Aquatic Sciences 60:840–848.

Jensen, D. W., E. A. Steel, A. H. Fullerton, and G. R. Pess. 2009. Impact of fine sediment on egg-to-fry survival of Pacific salmon: a meta-analysis of published studies. Reviews in Fisheries Science 17(3):348–359.

Kery, M., and M. Schaub. 2012. Bayesian population analysis using WinBUGS. Academic Press, Oxford, United Kingdom.

KRTT (Klamath River Technical Team). 2012. Ocean abundance projections and prospective harvest levels for Klamath River fall Chinook, 2012 season. Pacific Fishery Management Council, Portland, Oregon.

Laufle, J. C., G. B. Pauley, and M. F. Shepard. 1986. Species profiles: life histories and environmental requirements of coastal fishes and invertebrates (Pacific Northwest) – Coho Salmon. U.S. Fish and Wildlife Service. Biological Report 82(11.48). U.S. Army Corps of Engineers TR EL-82-4.

Moffett, J. W., and S. H. Smith. 1950. Biological investigations of the fishery resources of the Trinity River, California. Special Scientific Report No. 12, U.S. Fish and Wildlife Service. 71 p.

Murdoch, A. R., T. N. Pearsons, and T. W. Maitland. 2009a. Use of carcass recovery data in evaluating the spawning distribution and timing of spring Chinook Salmon in the Chiwawa River, Washington. North American Journal of Fisheries Management 29:1206–1213.

Murdoch, A. R., T. N. Pearsons, and T. W. Maitland. 2009b. The number of redds constructed per female spring Chinook Salmon in the Wenatchee River Basin. North American Journal of Fisheries Management 29:441–446.

Perrin, C. J., and J. R. Irvine. 1990. A review of survey life estimates as they apply to the area-under-the-curve method for estimating the spawning escapement of pacific salmon. Canadian Technical Report of Fisheries and Aquatic Sciences 1733. 49 p.

Polos, J. 2016. Adult salmon water temperature targets. Trinity River Restoration Program Performance Measure. TRRP, Weaverville, California. 6 p.

Plummer, M. 2003. JAGS: a program for analysis of Bayesian graphical model using Gibbs sampling. Proceedings of the 3rd International Workshop on Distributed Statistical Computing. Vienna, Austria. ISSN 1609-395X.

Quihillalt, R. R. 1999. Mainstem Trinity River fall Chinook Salmon spawning redd survey, 1996 through 1998. U.S. Fish and Wildlife Service, Arcata, California.

R Core Team. 2015. R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. http://www.R-project.org/.

Riggers, B., S. Jacobs, and J. White. 1999. Calibration methods to survey for fall Chinook Salmon in North Fork Nehalem and South Fork Coos rivers. Annual progress report, Coastal Salmonid Inventory Project, Oregon Department of Fish and Wildlife. 23 p.

Rogers, D. W. 1972. King Salmon (*Oncorhynchus tshawytscha*) and Silver Salmon (*Oncorhynchus kisutch*) spawning escapement and spawning habitat in the upper Trinity River, 1970. California Fish and Game, Region 1, Anadromous Fisheries Branch Administrative Report Number 73-10.

Seesholtz, A., J. Kindopp, R. Kurth, and B. Cavallo. 2005. 2005 Feather River Chinook Salmon spawning escapement summary. California Department of Water Resources, Division of Environmental Services. 8 p.

TRRP (Trinity River Restoration Program) and ESSA (ESSA Technologies Ltd.). 2009. Integrated Assessment Plan, Version 1.0 – September 2009. Draft report prepared for the Trinity River Restoration Project, Weaverville, California. 285 p.

TRRP (Trinity River Restoration Program). 2016. Fine Sediment Criteria for the Trinity River. Fish Work Group Memorandum. Trinity River Restoration Program, Weaverville, California.

USBOR (U.S. Bureau of Restoration). 2015. Draft long-term plan for protecting late summer adult salmon in the lower Klamath River. U.S. Bureau of Reclamation, Klamath Basin Area Office, Klamath Falls, Oregon.

USDOI (U.S. Department of Interior). 2000. Record of Decision: Trinity River mainstem fishery restoration final Environmental Impact Statement / Environmental Report.

USFWS (U.S. Fish and Wildlife Service). 1986, 1987. Trinity River flow evaluation study, 2 reports. Annual Report, U.S. Fish and Wildlife Service, Sacramento, California.

USFWS (U.S. Fish and Wildlife Service) and HVT (Hoopa Valley Tribe). 1999. Trinity River flow evaluation, Final Report. U.S. Fish and Wildlife Service, Arcata Fish and Wildlife Office, Arcata, California and Hoopa Valley Tribe, Hoopa, California.

Williams, T. H., J. C. Garza, N. Hetrick, S. T. Lindley, M. S. Mohr, J. M. Myers, M. R. O’Farrell, R. M. Quiñones, and D. J. Teel. 2011. Upper Klamath and Trinity river Chinook Salmon biological review team report. National Marine Fisheries Service, U.S. Fish and Wildlife Service, and U.S. Forest Service. Southwest Fisheries Science Center, Santa Cruz, California.

Wood, S. N. 2004. Stable and efficient multiple smoothing parameter estimation for generalized additive models. Journal of the American Statistical Association 99:673-686.

Appendices

Appendix A. Trinity River water visibility (m) by week and reach throughout the 2012 survey period. Grey boxes represent surveys with sub-optimal visibility. NS = No Survey for scheduled surveys that were missed. Dashes (-) represent days when surveys were not performed.

Week	Reach											
start	1	2	3	4	5	6	7	9	10	12	13	14
9/3	>3.0	-	-	-	-	-	-	-	-	-	-	-
9/10	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	>3.0	1.5-3.0	1.5-3.0	-	-	-
9/17	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	0.9-1.5	1.5-3.0	1.5-3.0	-	-	-	-	-
9/24	>3.0	>3.0	>3.0	>3.0	>3.0	1.5-3.0	>3.0	>3.0	>3.0	-	-	-
10/1	1.5-3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	-	-	-	-	-
10/8	>3.0	NS	1.5-3.0	>3.0	>3.0	>3.0	1.5-3.0	1.5-3.0	>3.0	-	-	-
10/15	>3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	>3.0	>3.0	>3.0
10/22	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	0.9-1.5	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	-
10/29	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	0.9-1.5	NS	NS
11/5	1.5-3.0	1.5-3.0	1.5-3.0	NS	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	-
11/12	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	NS	1.5-3.0	NS	-	-	0.9-1.5	1.5-3.0	1.5-3.0
11/19	1.5-3.0	NS	NS	NS	NS	NS	NS	1.5-3.0	1.5-3.0	-	-	-
11/26	1.5-3.0	0.9-1.5	NS	NS	<0.9	1.5-3.0	1.5-3.0	-	-	-	-	-
12/3	1.5-3.0	0.9-1.5	<0.9	0.9-1.5	NS	NS	NS	-	-	NS	NS	NS
12/10	0.9-1.5	0.9-1.5	1.5-3.0	1.5-3.0	NS	1.5-3.0	0.9-1.5	0.9-1.5	0.9-1.5	-	-	-
12/17	>3.0	>3.0	>3.0	NS	NS	NS	NS	-	-	NS	NS	NS

Appendix B. Trinity River water visibility (m) by week and reach throughout the 2013 survey period. Grey boxes represent surveys with sub-optimal visibility. NS = No Survey for scheduled surveys that were missed. Dashes (-) represent days when surveys were not performed.

Week	Reach											
start	1	2	3	4	5	6	7	9	10	12	13	14
9/2	1.5-3.0	-	-	-	-	-	-	-	-	-	-	-
9/9	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	>3.0	-	-	-	-	-
9/16	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	>3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	-
9/23	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	-	-	-
9/30	1.5-3.0	>3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	-	-	-
10/7	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	-	-	-	-	-
10/14	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	NS	>3.0	>3.0	>3.0	>3.0	-	-	-
10/21	>3.0	>3.0	1.5-3.0	>3.0	1.5-3.0	>3.0	1.5-3.0	-	-	1.5-3.0	1.5-3.0	>3.0
10/28	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	-
11/4	1.5-3.0	>3.0	>3.0	>3.0	>3.0	>3.0	>3.0	-	-	>3.0	>3.0	1.5-3.0
11/11	1.5-3.0	>3.0	>3.0	>3.0	NS	1.5-3.0	>3.0	1.5-3.0	>3.0	-	-	-
11/18	1.5-3.0	NS	1.5-3.0	1.5-3.0	NS	>3.0	>3.0	-	-	>3.0	1.5-3.0	>3.0
11/25	1.5-3.0	1.5-3.0	NS	NS	NS	>3.0	>3.0	1.5-3.0	1.5-3.0	-	-	-
12/2	1.5-3.0	1.5-3.0	1.5-3.0	NS	1.5-3.0	1.5-3.0	1.5-3.0	-	-	1.5-3.0	1.5-3.0	1.5-3.0
12/9	0.9-1.5	0.9-1.5	0.9-1.5	0.9-1.5	NS	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	-	-	-
12/16	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	NS	1.5-3.0	1.5-3.0	-	-	1.5-3.0	1.5-3.0	>3.0

Appendix C. Trinity River water visibility (m) by week and reach throughout the 2014 survey period. Grey boxes represent surveys with sub-optimal visibility. NS = No Survey for scheduled surveys that were missed. Dashes (-) represent days when surveys were not performed.

Week	Reach											
start	1	2	3	4	5	6	7	9	10	12	13	14
9/1	No data	-	-	-	-	-	-	-	-	-	-	-
9/8	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	>3.0	-	-	-	-	-
9/15	1.5-3.0	1.5-3.0	NS	NS	NS	>3.0	>3.0	-	-	-	-	-
9/22	0.9-1.5	0.9-1.5	0.9-1.5	0.9-1.5	1.5-3.0	>3.0	>3.0	-	-	-	-	-
9/29	0.9-1.5	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	>3.0	-	-	-
10/6	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	>3.0	-	-	1.5-3.0	>3.0	>3.0
10/13	0.9-1.5	1.5-3.0	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	>3.0	>3.0	>3.0	-	-	-
10/20	0.9-1.5	1.5-3.0	1.5-3.0	0.9-1.5	1.5-3.0	>3.0	>3.0	-	-	>3.0	1.5-3.0	NS
10/27	1.5-3.0	1.5-3.0	1.5-3.0	>3.0	>3.0	>3.0	>3.0	>3.0	0.9-1.5	-	-	-
11/3	<0.9	1.5-3.0	1.5-3.0	0.9-1.5	>3.0	>3.0	>3.0	-	-	1.5-3.0	>3.0	1.5-3.0
11/10	<0.9	0.9-1.5	1.5-3.0	0.9-1.5	NS	>3.0	>3.0	1.5-3.0	>3.0	-	-	-
11/17	<0.9	0.9-1.5	0.9-1.5	1.5-3.0	0.9-1.5	>3.0	>3.0	-	-	>3.0	>3.0	>3.0
11/24	<0.9	0.9-1.5	NS	NS	NS	1.5-3.0	1.5-3.0	>3.0	1.5-3.0	-	-	-
12/1	<0.9	0.9-1.5	0.9-1.5	0.9-1.5	0.9-1.5	1.5-3.0	1.5-3.0	-	-	1.5-3.0	0.9-1.5	<0.9
12/8	<0.9	0.9-1.5	1.5-3.0	NS	NS	1.5-3.0	1.5-3.0	0.9-1.5	0.9-1.5	-	-	-
12/15	<0.9	0.9-1.5	<0.9	0.9-1.5	0.9-1.5	NS	NS	-	-	NS	NS	NS

Appendix D. Coded-wire tag (CWT) information retrieved from adipose fin-clipped Chinook Salmon carcasses, 2012.

Carcasses	CWT	Brood Year	Run type	Release type	Production multiplier
1	68810	2007	spring	yearling	0.249
2	68812	2008	spring	fry	0.246
4	68813	2008	spring	fry	0.242
3	68814	2008	fall	fry	0.245
4	68815	2008	fall	fry	0.245
2	68816	2008	fall	fry	0.249
2	68817	2008	fall	fry	0.248
1	68818	2008	fall	fry	0.247
3	68819	2008	spring	yearling	0.244
12	68820	2008	fall	yearling	0.248
33	68821	2009	spring	fry	0.241
34	68822	2009	spring	fry	0.239
11	68823	2009	fall	fry	0.239
9	68824	2009	fall	fry	0.244
1	68825	2009	fall	fry	0.245
9	68826	2009	fall	fry	0.243
1	68828	2009	fall	fry	0.248
2	68831	2009	spring	fry	0.237
8	68832	2009	spring	fry	0.237
1	68833	2009	fall	fry	0.221
1	68834	2009	fall	fry	0.221
6	68836	2009	spring	yearling	0.245
37	68837	2009	fall	yearling	0.248
68		--Missing CWT/head --			NA
					Mean = 0.243

Appendix E. Coded-wire tag (CWT) information retrieved from adipose fin-clipped Chinook Salmon carcasses, 2013.

Carcasses	CWT	Brood Year	Run type	Release type	Production multiplier
1	68773	2010	spring	fry	0.234
1	68774	2010	spring	fry	0.238
3	68775	2010	spring	fry	0.220
2	68777	2010	fall	fry	0.236
2	68778	2010	spring	fry	0.244
2	68779	2010	fall	fry	0.246
4	68781	2010	fall	yearling	0.242
5	68821	2009	spring	fry	0.241
10	68822	2009	spring	fry	0.239
2	68823	2009	fall	fry	0.239
4	68824	2009	fall	fry	0.244
3	68825	2009	fall	fry	0.245
4	68826	2009	fall	fry	0.243
5	68827	2009	fall	fry	0.246
2	68828	2009	fall	fry	0.248
1	68831	2009	spring	fry	0.237
3	68832	2009	spring	fry	0.237
6	68836	2009	spring	yearling	0.245
45	68837	2009	fall	yearling	0.248
35		--Missing CWT/head --			NA
					Mean = 0.244

Appendix F. Coded-wire tag (CWT) information retrieved from adipose fin-clipped Chinook Salmon carcasses, 2014.

Carcasses	CWT	Brood Year	Run type	Release type	Production multiplier
2	60490	2012	Spring	fry	0.239
1	60491	2012	Spring	fry	0.240
1	60492	2012	Spring	fry	0.237
1	60504	2012	Fall	yearling	0.225
2	68773	2010	Spring	fry	0.237
4	68774	2010	Spring	fry	0.240
4	68776	2010	Spring	yearling	0.236
19	68777	2010	Fall	fry	0.238
14	68778	2010	Fall	fry	0.245
2	68779	2010	Fall	fry	0.246
3	68780	2010	Fall	fry	0.236
66	68781	2010	Fall	yearling	0.243
1	68792 [a]	2010	Fall	fry	0.247
1	68793 [a]	2010	Fall	fry	0.236
1	68794 [a]	2010	Fall	fry	0.248
1	68795 [a]	2010	Fall	fry	0.082
1	68821	2009	Spring	fry	0.241
1	68826	2009	Fall	fry	0.244
1	68828	2009	Fall	fry	0.249
1	68830	2011	Fall	fry	0.165
1	68835	2010	Fall	fry	0.233
3	68837	2009	Fall	yearling	0.249
1	68840	2011	Spring	fry	0.231
7	68841	2011	Fall	fry	0.197
4	68842	2011	Fall	fry	0.210
3	68844	2011	Fall	fry	0.232
2	68845	2011	Fall	fry	0.223
39	68847	2011	Fall	yearling	0.231
39		--Missing CWT/head --			NA
					Mean = 0.236

[a] produced at Iron Gate Hatchery on the Klamath River

Appendix G. Estimates of total and fresh spawned female (FSF) Chinook Salmon carcasses in Reaches 1 and 2, 2012–2014.

Year	Reach	Chinook Salmon	Estimate	95% confidence limits Lower	Upper
2012	1	Total	7,109	6,052	8,469
	1	FSF	4,845	4,077	5,884
	2	Total	7,597	6,064	9,775
	2	FSF	3,712	2,911	4,818
2013	1	Total	951	707	1,472
	1	FSF	586	435	898
	2	Total	813	662	1,014
	2	FSF	400	312	522
2014	1	Total	2,274	1,809	2,980
	1	FSF	1,450	1,142	1,896
	2	Total	1,758	1,407	2,301
	2	FSF	789	580	1,171

Appendix H. Pre-spawn mortality numbers by week and reach of unmarked and ad-clipped fresh (conditions 1 and 2) female Chinook Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like mark-type carcasses. Ad-clipped carcass numbers were not expanded by CWT-specific production multipliers and are therefore about 25% of hatchery-origin carcass numbers. Likewise, unmarked carcass numbers include hatchery-origin carcasses that were not ad-clipped. NS = no survey and dashes (-) represent a sample size of zero.

2009 unmarked

Calendar		Reach													All reaches	
week	Dates	1	2	3	4	5	6	7	8	9	10	12	13	14	n	Pct.
36	Aug. 30 - Sep. 5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 6 - 12	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
38	Sep. 13 - 19	2	2	-	NS	NS	-	-	-	-	-	NS	NS	NS	**4**	**100.0%**
39	Sep. 20 - 26	1	0	-	-	-	-	-	NS	NS	NS	NS	NS	NS	**1**	**33.3%**
40	Sep. 27 - Oct. 3	2	0	3	1	0	0	-	-	-	-	NS	NS	NS	**6**	**15.0%**
41	Oct. 4 - 10	2	1	1	0	0	-	-	NS	NS	NS	-	-	-	**4**	**4.2%**
42	Oct. 11 - 17	0	1	0	0	NS	0	3	NS	NS	NS	NS	NS	NS	**4**	**3.9%**
43	Oct. 18 - 24	1	4	3	1	1	1	0	NS	NS	NS	-	1	-	**12**	**6.7%**
44	Oct. 25 - 31	2	1	10	7	8	0	1	-	0	1	NS	NS	NS	**30**	**12.6%**
45	Nov. 1 - 7	2	2	0	0	0	2	2	NS	NS	1	0	-	-	**9**	**4.6%**
46	Nov. 8 - 14	3	15	0	0	NS	1	0	0	3	0	NS	NS	NS	**22**	**10.7%**
47	Nov. 15 - 21	2	3	1	0	0	1	0	NS	NS	NS	1	0	1	**9**	**3.5%**
48	Nov. 22 - 28	NS	NS	4	0	0	NS	0	0	10	1	NS	NS	NS	**15**	**22.1%**
49	Nov. 29 - Dec. 5	2	5	0	0	0	0	1	NS	NS	NS	7	2	0	**17**	**8.3%**
50	Dec. 6 - 12	0	0	0	NS	0	NS	NS	-	0	NS	NS	NS	NS	**0**	**0.0%**
51	Dec. 13 - 19	0	0	0	-	NS	NS	NS	NS	NS	0	2	NS	NS	**2**	**2.9%**
52	Dec. 20 - 26	0	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**19**	**34**	**22**	**9**	**9**	**5**	**7**	**0**	**13**	**3**	**10**	**3**	**1**	***135***	***7.8%***

2009 ad-clipped

Calendar		Reach													All reaches	
week	Dates	1	2	3	4	5	6	7	8	9	10	12	13	14	n	Pct.
36	Aug. 30 - Sep. 5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 6 - 12	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
38	Sep. 13 - 19	2	-	-	NS	NS	-	-	-	-	-	NS	NS	NS	**2**	**50.0%**
39	Sep. 20 - 26	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	**-**	**-**
40	Sep. 27 - Oct. 3	0	0	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
41	Oct. 4 - 10	0	0	-	-	-	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
42	Oct. 11 - 17	0	0	-	-	NS	-	-	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
43	Oct. 18 - 24	0	-	-	-	-	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
44	Oct. 25 - 31	0	0	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
45	Nov. 1 - 7	0	-	-	-	-	-	-	NS	NS	-	-	-	-	**0**	**0.0%**
46	Nov. 8 - 14	1	-	0	-	NS	-	-	-	-	-	NS	NS	NS	**1**	**25.0%**
47	Nov. 15 - 21	1	-	0	-	-	-	-	NS	NS	NS	-	-	-	**1**	**7.1%**
48	Nov. 22 - 28	NS	NS	0	-	-	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
49	Nov. 29 - Dec. 5	0	1	-	-	-	-	-	NS	NS	NS	-	-	-	**1**	**20.0%**
50	Dec. 6 - 12	0	-	0	NS	-	NS	NS	-	-	NS	NS	NS	NS	**0**	**0.0%**
51	Dec. 13 - 19	0	-	-	-	NS	NS	NS	NS	NS	-	-	NS	NS	**0**	**0.0%**
52	Dec. 20 - 26	-	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**-**	**-**
	All weeks	**4**	**1**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	***5***	***9.4%***

Appendix H (continued). Pre-spawn mortality numbers by week and reach of unmarked and ad-clipped fresh (conditions 1 and 2) female Chinook Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like mark-type carcasses. Ad-clipped carcass numbers were not expanded by CWT-specific production multipliers and are therefore about 25% of hatchery-origin carcass numbers. Likewise, unmarked carcass numbers include hatchery-origin carcasses that were not ad-clipped. NS = no survey and dashes (-) represent a sample size of zero.

2010 unmarked

Calendar		Reach													All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 29 - Sep. 4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 5 - 11	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
38	Sep. 12 - 18	2	0	1	-	-	-	-	-	-	-	NS	NS	NS	**3**	**33.3%**
39	Sep. 19 - 25	1	-	0	-	-	-	1	NS	NS	NS	NS	NS	NS	**2**	**28.6%**
40	Sep. 26 - Oct. 2	1	0	0	1	0	-	-	-	1	-	NS	NS	NS	**3**	**12.0%**
41	Oct. 3 - 9	1	2	1	0	0	0	0	NS	NS	NS	-	1	1	**6**	**9.7%**
42	Oct. 10 - 16	0	1	1	0	1	4	0	0	1	-	NS	NS	NS	**8**	**5.4%**
43	Oct. 17 - 23	1	1	0	0	0	4	0	NS	NS	NS	-	-	-	**6**	**4.2%**
44	Oct. 24 - 30	0	0	2	2	1	0	2	-	2	NS	NS	NS	NS	**9**	**8.5%**
45	Oct. 31 - Nov. 6	3	0	2	1	1	4	0	NS	NS	-	1	-	-	**12**	**8.7%**
46	Nov. 7 - 13	6	NS	0	2	0	4	0	NS	0	0	NS	NS	NS	**12**	**12.8%**
47	Nov. 14 - 20	4	7	0	0	1	1	1	NS	NS	NS	1	-	0	**15**	**9.9%**
48	Nov. 21 - 27	NS	5	1	-	0	0	0	NS	-	0	NS	NS	NS	**6**	**9.0%**
49	Nov. 28 - Dec. 4	20	10	1	NS	0	0	0	NS	NS	NS	5	NS	NS	**36**	**16.8%**
50	Dec. 5 - 11	0	4	-	1	-	NS	NS	NS	NS	NS	NS	NS	NS	**5**	**14.3%**
51	Dec. 12 - 18	3	2	1	0	-	0	0	NS	NS	NS	NS	NS	NS	**6**	**10.9%**
52	Dec. 19 - 25	1	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**1**	**3.3%**
	All weeks	**43**	**32**	**10**	**7**	**4**	**17**	**4**	**0**	**4**	**0**	**7**	**1**	**1**	***130***	***10.1%***

2010 ad-clipped

Calendar		Reach													All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 29 - Sep. 4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 5 - 11	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
38	Sep. 12 - 18	1	1	-	-	-	-	-	-	-	-	NS	NS	NS	**2**	**66.7%**
39	Sep. 19 - 25	0	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
40	Sep. 26 - Oct. 2	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**-**	**-**
41	Oct. 3 - 9	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	**-**	**-**
42	Oct. 10 - 16	0	-	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
43	Oct. 17 - 23	-	0	-	-	-	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
44	Oct. 24 - 30	0	-	-	-	-	-	-	-	-	NS	NS	NS	NS	**0**	**0.0%**
45	Oct. 31 - Nov. 6	0	0	-	-	-	-	-	NS	NS	-	-	-	-	**0**	**0.0%**
46	Nov. 7 - 13	0	NS	-	-	-	-	-	NS	-	-	NS	NS	NS	**0**	**0.0%**
47	Nov. 14 - 20	0	0	-	-	-	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
48	Nov. 21 - 27	NS	0	-	-	-	-	-	NS	-	-	NS	NS	NS	**0**	**0.0%**
49	Nov. 28 - Dec. 4	3	0	-	NS	-	-	-	NS	NS	NS	-	NS	NS	**3**	**25.0%**
50	Dec. 5 - 11	-	-	-	-	-	NS	NS	NS	NS	NS	NS	NS	NS	**-**	**-**
51	Dec. 12 - 18	0	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
52	Dec. 19 - 25	0	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**4**	**1**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	***5***	***12.5%***

Appendix H (continued). Pre-spawn mortality numbers by week and reach of unmarked and ad-clipped fresh (conditions 1 and 2) female Chinook Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like mark-type carcasses. Ad-clipped carcass numbers were not expanded by CWT-specific production multipliers and are therefore about 25% of hatchery-origin carcass numbers. Likewise, unmarked carcass numbers include hatchery-origin carcasses that were not ad-clipped. NS = no survey and dashes (-) represent a sample size of zero.

2011 unmarked

Calendar		Reach													All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 28 - Sep. 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 4 - 10	5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**5**	**100.0%**
38	Sep. 11 - 17	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**-**	**-**
39	Sep. 18 - 24	3	3	0	1	0	-	-	NS	NS	NS	NS	NS	NS	**7**	**41.2%**
40	Sep. 22 - Oct. 1	6	2	0	1	1	0	-	-	-	1	NS	NS	NS	**11**	**23.9%**
41	Oct. 2 - 8	3	0	0	0	0	0	0	-	-	-	NS	NS	NS	**3**	**2.9%**
42	Oct. 9 - 15	0	1	1	0	0	0	0	NS	-	1	NS	NS	NS	**3**	**1.2%**
43	Oct. 16 - 22	1	3	0	2	0	0	2	NS	NS	NS	0	2	2	**12**	**3.1%**
44	Oct. 23 - 29	1	1	3	0	0	0	0	NS	0	0	NS	NS	NS	**5**	**1.2%**
45	Oct. 30 - Nov. 5	4	0	0	1	1	1	1	NS	NS	NS	0	0	-	**8**	**2.8%**
46	Nov. 6 - 12	0	2	2	NS	0	0	1	1	0	0	NS	NS	NS	**6**	**2.5%**
47	Nov. 13 - 19	7	8	1	0	0	0	0	NS	NS	NS	1	0	-	**17**	**6.4%**
48	Nov. 20 - 26	14	10	NS	NS	NS	0	0	NS	0	NS	NS	NS	NS	**24**	**6.6%**
49	Nov. 27 - Dec. 3	31	8	2	0	0	0	0	NS	NS	0	2	0	NS	**43**	**5.9%**
50	Dec. 4 - 10	25	5	0	0	0	0	0	NS	1	0	NS	NS	1	**32**	**4.7%**
51	Dec. 11 - 17	11	2	0	0	-	NS	NS	NS	NS	NS	4	0	0	**17**	**3.5%**
52	Dec. 18 - 24	0	1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**1**	**0.9%**
	All weeks	**111**	**46**	**9**	**5**	**2**	**1**	**4**	**1**	**1**	**2**	**7**	**2**	**3**	***194***	***4.4%***

2011 ad-clipped

Calendar		Reach													All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 28 - Sep. 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 4 - 10	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**-**	**-**
38	Sep. 11 - 17	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**-**	**-**
39	Sep. 18 - 24	1	2	-	-	-	-	-	NS	NS	NS	NS	NS	NS	**3**	**75.0%**
40	Sep. 22 - Oct. 1	1	-	-	-	-	-	-	-	-	-	NS	NS	NS	**1**	**100.0%**
41	Oct. 2 - 8	0	-	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
42	Oct. 9 - 15	0	-	-	0	-	-	-	NS	-	-	NS	NS	NS	**0**	**0.0%**
43	Oct. 16 - 22	0	-	-	-	0	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
44	Oct. 23 - 29	1	0	0	-	-	-	0	NS	-	-	NS	NS	NS	**1**	**7.7%**
45	Oct. 30 - Nov. 5	0	-	-	-	-	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
46	Nov. 6 - 12	0	0	0	NS	-	0	-	-	-	-	NS	NS	NS	**0**	**0.0%**
47	Nov. 13 - 19	2	1	-	0	-	-	-	NS	NS	NS	-	-	-	**3**	**13.6%**
48	Nov. 20 - 26	0	3	NS	NS	NS	-	-	NS	-	NS	NS	NS	NS	**3**	**6.0%**
49	Nov. 27 - Dec. 3	8	0	-	-	-	-	-	NS	NS	-	-	-	NS	**8**	**9.2%**
50	Dec. 4 - 10	5	1	-	-	-	-	-	NS	-	-	NS	NS	-	**6**	**8.5%**
51	Dec. 11 - 17	0	0	-	-	-	NS	NS	NS	NS	NS	-	-	-	**0**	**0.0%**
52	Dec. 18 - 24	0	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**18**	**7**	**0**	**0**	**0**	**0**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	***25***	***7.0%***

Appendix H (continued). Pre-spawn mortality numbers by week and reach of unmarked and ad-clipped fresh (conditions 1 and 2) female Chinook Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like mark-type carcasses. Ad-clipped carcass numbers were not expanded by CWT-specific production multipliers and are therefore about 25% of hatchery-origin carcass numbers. Likewise, unmarked carcass numbers include hatchery-origin carcasses that were not ad-clipped. NS = no survey and dashes (-) represent a sample size of zero.

2012 unmarked

Calendar		Reach												All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Sep. 5 - 8	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**3**	**100.0%**
37	Sep. 9 - 15	5	3	5	-	1	-	-	-	-	NS	NS	NS	**14**	**100.0%**
38	Sep. 16 - 22	7	1	2	0	-	-	-	NS	NS	NS	NS	NS	**10**	**62.5%**
39	Sep. 23 - 29	1	5	1	0	0	1	-	1	-	NS	NS	NS	**9**	**25.0%**
40	Sep. 30 - Oct. 6	3	3	0	1	1	0	1	NS	NS	NS	NS	NS	**9**	**6.1%**
41	Oct. 7 - 13	4	1	0	0	1	0	0	1	0	NS	NS	NS	**7**	**1.9%**
42	Oct. 14 - 20	0	0	0	3	0	1	0	NS	NS	-	3	2	**9**	**2.0%**
43	Oct. 21 - 27	0	0	2	0	2	2	4	0	0	NS	NS	NS	**10**	**1.5%**
44	Oct. 28 - Nov. 3	8	0	0	0	0	0	0	NS	NS	0	NS	NS	**8**	**1.8%**
45	Nov. 4 - 10	0	8	0	NS	0	0	0	0	0	NS	NS	NS	**8**	**1.9%**
46	Nov. 11 - 17	8	2	2	2	NS	0	NS	NS	NS	1	0	1	**16**	**3.0%**
47	Nov. 18 - 24	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**3**	**0.7%**
48	Nov. 25 - Dec. 1	5	0	NS	NS	1	0	0	NS	NS	NS	NS	NS	**6**	**0.8%**
49	Dec. 2 - 8	0	0	-	-	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
50	Dec. 9 - 15	0	-	-	-	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
51	Dec. 16 - 22	0	0	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
52	Dec. 23 - 29	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**47**	**23**	**12**	**6**	**6**	**4**	**5**	**2**	**0**	**1**	**3**	**3**	***112***	***2.3%***

2012 ad-clipped

Calendar		Reach												All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Sep. 5 - 8	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**-**	**-**
37	Sep. 9 - 15	1	4	-	-	-	-	-	-	-	NS	NS	NS	**5**	**100.0%**
38	Sep. 16 - 22	2	-	-	-	-	-	-	NS	NS	NS	NS	NS	**2**	**100.0%**
39	Sep. 23 - 29	1	-	-	-	-	-	-	-	-	NS	NS	NS	**1**	**100.0%**
40	Sep. 30 - Oct. 6	0	0	0	-	-	-	-	NS	NS	NS	NS	NS	**0**	**0.0%**
41	Oct. 7 - 13	0	0	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
42	Oct. 14 - 20	0	0	-	-	0	-	-	NS	NS	-	-	-	**0**	**0.0%**
43	Oct. 21 - 27	0	0	-	0	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
44	Oct. 28 - Nov. 3	0	0	-	-	-	-	-	NS	NS	-	NS	NS	**0**	**0.0%**
45	Nov. 4 - 10	3	0	-	NS	-	-	-	-	-	NS	NS	NS	**3**	**11.1%**
46	Nov. 11 - 17	4	0	0	-	NS	0	NS	NS	NS	-	-	-	**4**	**10.0%**
47	Nov. 18 - 24	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
48	Nov. 25 - Dec. 1	0	0	NS	NS	-	-	-	NS	NS	NS	NS	NS	**0**	**0.0%**
49	Dec. 2 - 8	0	0	-	-	-	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
50	Dec. 9 - 15	0	-	-	-	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
51	Dec. 16 - 22	0	-	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
52	Dec. 23 - 29	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**11**	**4**	**0**	**0**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	***15***	***3.6%***

Appendix H (continued). Pre-spawn mortality numbers by week and reach of unmarked and ad-clipped fresh (conditions 1 and 2) female Chinook Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like mark-type carcasses. Ad-clipped carcass numbers were not expanded by CWT-specific production multipliers and are therefore about 25% of hatchery-origin carcass numbers. Likewise, unmarked carcass numbers include hatchery-origin carcasses that were not ad-clipped. NS = no survey and dashes (-) represent a sample size of zero.

2013 unmarked

Calendar		**Reach**												**All reaches**	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Sep. 1 - 7	2	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**2**	**50.0%**
37	Sep. 8 - 14	-	1	-	1	-	-	-	NS	NS	NS	NS	NS	**2**	**100.0%**
38	Sep. 15 - 21	1	-	1	1	-	-	-	-	-	NS	NS	NS	**3**	**75.0%**
39	Sep. 22 - 28	1	1	0	0	0	-	-	NS	NS	NS	NS	NS	**2**	**9.1%**
40	Sep. 29 - Oct. 5	0	1	1	0	0	0	1	NS	NS	NS	NS	NS	**3**	**5.8%**
41	Oct. 6 - 12	0	0	0	1	0	0	0	NS	NS	NS	NS	NS	**1**	**1.5%**
42	Oct. 13 - 19	1	0	0	1	NS	0	0	0	0	NS	NS	NS	**2**	**3.1%**
43	Oct. 20 - 26	0	1	0	0	0	0	0	NS	NS	-	1	-	**2**	**2.7%**
44	Oct. 27 - Nov. 2	1	4	1	1	0	0	0	1	0	NS	NS	NS	**8**	**6.9%**
45	Nov. 3 - 9	0	0	0	0	0	0	0	NS	NS	1	0	-	**1**	**1.7%**
46	Nov. 10 - 16	3	0	0	-	NS	0	0	0	0	NS	NS	NS	**3**	**5.1%**
47	Nov. 17 - 23	3	1	0	0	0	0	0	NS	NS	0	0	-	**4**	**5.6%**
48	Nov. 24 - 30	2	0	NS	NS	NS	-	-	0	0	NS	NS	NS	**2**	**4.3%**
49	Dec. 1 - 7	2	0	-	NS	0	0	-	NS	NS	0	1	0	**3**	**4.2%**
50	Dec. 8 - 14	0	-	0	-	0	-	-	0	0	NS	NS	NS	**0**	**0.0%**
51	Dec. 15 - 21	0	0	-	-	NS	-	-	NS	NS	0	1	0	**1**	**1.7%**
52	Dec. 22 - 28	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**16**	**9**	**3**	**5**	**0**	**0**	**1**	**1**	**0**	**1**	**3**	**0**	***39***	***5.0%***

2013 ad-clipped

Calendar		**Reach**												**All reaches**	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Sep. 1 - 7	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**-**	**-**
37	Sep. 8 - 14	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	**-**	**-**
38	Sep. 15 - 21	0	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
39	Sep. 22 - 28	1	-	-	-	-	-	-	NS	NS	NS	NS	NS	**1**	**100.0%**
40	Sep. 29 - Oct. 5	0	-	-	-	0	-	-	NS	NS	NS	NS	NS	**0**	**0.0%**
41	Oct. 6 - 12	1	0	-	-	-	-	-	NS	NS	NS	NS	NS	**1**	**9.1%**
42	Oct. 13 - 19	0	0	-	-	NS	0	-	-	-	NS	NS	NS	**0**	**0.0%**
43	Oct. 20 - 26	0	0	-	0	-	-	-	NS	NS	-	-	-	**0**	**0.0%**
44	Oct. 27 - Nov. 2	0	-	0	-	-	-	0	-	-	NS	NS	NS	**0**	**0.0%**
45	Nov. 3 - 9	1	1	-	-	-	-	-	NS	NS	-	-	-	**2**	**22.2%**
46	Nov. 10 - 16	0	0	-	-	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
47	Nov. 17 - 23	0	-	-	-	NS	-	-	NS	NS	-	-	-	**0**	**0.0%**
48	Nov. 24 - 30	0	0	NS	NS	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
49	Dec. 1 - 7	0	-	-	NS	0	-	-	NS	NS	-	-	-	**0**	**0.0%**
50	Dec. 8 - 14	0	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
51	Dec. 15 - 21	-	-	-	-	NS	-	-	NS	NS	-	-	-	**-**	**-**
52	Dec. 22 - 28	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**3**	**1**	**0**	**0**	**0**	**0**	**0**	**-**	**-**	**-**	**-**	**-**	***4***	***6.3%***

Appendix H (continued). Pre-spawn mortality numbers by week and reach of unmarked and ad-clipped fresh (conditions 1 and 2) female Chinook Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like mark-type carcasses. Ad-clipped carcass numbers were not expanded by CWT-specific production multipliers and are therefore about 25% of hatchery-origin carcass numbers. Likewise, unmarked carcass numbers include hatchery-origin carcasses that were not ad-clipped. NS = no survey and dashes (-) represent a sample size of zero.

2014 unmarked

Calendar		**Reach**												**All reaches**	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 31 - Sep. 6	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
37	Sep. 7 - 13	1	-	-	-	-	-	-	NS	NS	NS	NS	NS	**1**	**100.0%**
38	Sep. 14 - 20	-	1	NS	NS	NS	-	-	NS	NS	NS	NS	NS	**1**	**100.0%**
39	Sep. 21 - 27	1	2	0	0	-	-	-	NS	NS	NS	NS	NS	**3**	**30.0%**
40	Sep. 28 - Oct. 4	0	0	0	0	0	0	-	1	1	NS	NS	NS	**2**	**4.7%**
41	Oct. 5 - 11	0	0	0	0	0	0	0	NS	NS	1	0	0	**1**	**1.7%**
42	Oct. 12 - 18	0	0	0	0	0	4	2	0	0	NS	NS	NS	**6**	**6.7%**
43	Oct. 19 - 25	2	0	0	0	1	0	0	NS	NS	2	2	NS	**7**	**4.5%**
44	Oct. 26 - Nov. 1	2	2	1	1	0	0	1	1	0	NS	NS	NS	**8**	**4.6%**
45	Nov. 2 - 8	7	2	1	1	0	0	0	NS	NS	2	5	5	**23**	**15.2%**
46	Nov. 9 - 15	15	5	1	1	NS	0	1	0	0	NS	NS	NS	**23**	**10.6%**
47	Nov. 16 - 22	12	8	1	0	0	0	1	NS	NS	7	10	6	**45**	**18.1%**
48	Nov. 23 - 29	8	4	NS	NS	NS	0	0	0	0	NS	NS	NS	**12**	**15.6%**
49	Nov. 30 - Dec. 6	0	0	-	-	0	2	-	NS	NS	2	2	1	**7**	**23.3%**
50	Dec. 7 - 13	0	0	0	NS	NS	0	-	-	-	NS	NS	NS	**0**	**0.0%**
51	Dec. 14 - 20	-	0	-	-	-	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
52	Dec. 21 - 27	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**48**	**24**	**4**	**3**	**1**	**6**	**5**	**2**	**1**	**14**	**19**	**12**	***139***	***11.0%***

2014 ad-clipped

Calendar		**Reach**												**All reaches**	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 31 - Sep. 6	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
37	Sep. 7 - 13	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
38	Sep. 14 - 20	-	1	NS	NS	NS	-	-	NS	NS	NS	NS	NS	**1**	**100.0%**
39	Sep. 21 - 27	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
40	Sep. 28 - Oct. 4	0	0	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
41	Oct. 5 - 11	0	0	0	-	-	0	-	NS	NS	1	-	-	**1**	**20.0%**
42	Oct. 12 - 18	-	0	-	-	0	-	-	-	-	NS	NS	NS	**0**	**0.0%**
43	Oct. 19 - 25	0	1	-	-	-	0	-	NS	NS	-	-	NS	**1**	**33.3%**
44	Oct. 26 - Nov. 1	0	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
45	Nov. 2 - 8	1	0	-	-	-	-	-	NS	NS	-	-	-	**1**	**7.7%**
46	Nov. 9 - 15	6	0	0	0	NS	-	-	-	-	NS	NS	NS	**6**	**15.4%**
47	Nov. 16 - 22	0	4	2	0	-	1	-	NS	NS	-	1	-	**8**	**12.9%**
48	Nov. 23 - 29	8	-	NS	NS	NS	-	0	-	-	NS	NS	NS	**8**	**24.2%**
49	Nov. 30 - Dec. 6	-	-	-	-	-	-	-	NS	NS	-	-	-	-	-
50	Dec. 7 - 13	0	-	-	NS	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
51	Dec. 14 - 20	-	-	-	-	-	NS	NS	NS	NS	NS	NS	NS	-	-
52	Dec. 21 - 27	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**15**	**6**	**2**	**0**	**0**	**1**	**-**	**-**	**-**	**1**	**1**	**-**	***26***	***15.4%***

Appendix I. Pre-spawn mortality numbers of natural- (unmarked) and hatchery-origin (right maxillary-clipped) and fresh (conditions 1 and 2) female Coho Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like-origin carcasses. Data were only collected through late December. Spawning success often varies, typically improving, over time and our surveys did not extend over the entire Coho Salmon spawning period. NS = no survey and dashes (-) represent a sample size of zero.

2009 unmarked

Calendar		Reach													All reaches	
week	Dates	1	2	3	4	5	6	7	8	9	10	12	13	14	n	Pct.
36	Aug. 30 - Sep. 5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 6 - 12	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
38	Sep. 13 - 19	-	-	-	NS	NS	-	-	-	-	-	NS	NS	NS	-	-
39	Sep. 20 - 26	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	-	-
40	Sep. 27 - Oct. 3	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
41	Oct. 4 - 10	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	-	-
42	Oct. 11 - 17	-	-	-	-	NS	-	-	NS	NS	NS	NS	NS	NS	-	-
43	Oct. 18 - 24	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	-	-
44	Oct. 25 - 31	-	-	-	-	-	-	-	-	-	0	NS	NS	NS	**0**	**0.0%**
45	Nov. 1 - 7	-	-	-	-	-	-	-	NS	NS	-	-	-	-	-	-
46	Nov. 8 - 14	0	-	0	-	NS	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
47	Nov. 15 - 21	0	0	-	-	-	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
48	Nov. 22 - 28	NS	NS	-	-	-	NS	-	-	-	-	NS	NS	NS	-	-
49	Nov. 29 - Dec. 5	0	1	0	-	-	-	-	NS	NS	NS	-	-	-	**1**	**10.0%**
50	Dec. 6 - 12	0	-	-	NS	-	NS	NS	-	-	NS	NS	NS	NS	**0**	**0.0%**
51	Dec. 13 - 19	-	0	1	-	NS	NS	NS	NS	NS	-	-	NS	NS	**1**	**25.0%**
52	Dec. 20 - 26	0	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**0**	**1**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	**0**	**-**	**-**	**-**	***2***	***7.1%***

2009 right maxillary-clipped

Calendar		Reach													All reaches	
week	Dates	1	2	3	4	5	6	7	8	9	10	12	13	14	n	Pct.
36	Aug. 30 - Sep. 5	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 6 - 12	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
38	Sep. 13 - 19	-	-	-	NS	NS	-	-	-	-	-	NS	NS	NS	-	-
39	Sep. 20 - 26	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	-	-
40	Sep. 27 - Oct. 3	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
41	Oct. 4 - 10	-	-	-	-	-	-	-	NS	NS	NS	-	-	1	**1**	**100.0%**
42	Oct. 11 - 17	-	-	-	-	NS	-	-	NS	NS	NS	NS	NS	NS	-	-
43	Oct. 18 - 24	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	-	-
44	Oct. 25 - 31	-	0	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
45	Nov. 1 - 7	1	1	1	-	-	-	-	NS	NS	-	-	-	-	**3**	**100.0%**
46	Nov. 8 - 14	1	2	0	1	NS	-	-	-	-	-	NS	NS	NS	**4**	**28.6%**
47	Nov. 15 - 21	1	0	0	-	-	-	-	NS	NS	NS	-	-	-	**1**	**4.8%**
48	Nov. 22 - 28	NS	NS	0	-	-	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
49	Nov. 29 - Dec. 5	1	0	-	-	-	-	-	NS	NS	NS	-	-	-	**1**	**10.0%**
50	Dec. 6 - 12	-	0	0	NS	-	NS	NS	-	-	NS	NS	NS	NS	**0**	**0.0%**
51	Dec. 13 - 19	1	0	-	1	NS	NS	NS	NS	NS	-	-	NS	NS	**2**	**66.7%**
52	Dec. 20 - 26	-	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**5**	**3**	**1**	**2**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	**1**	***12***	***20.3%***

Appendix I (continued). Pre-spawn mortality numbers of natural- (unmarked) and hatchery-origin (right maxillary-clipped) and fresh (conditions 1 and 2) female Coho Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like-origin carcasses. Data were only collected through late December. Spawning success often varies, typically improving, over time and our surveys did not extend over the entire Coho Salmon spawning period. NS = no survey and dashes (-) represent a sample size of zero.

2010 unmarked

Calendar		Reach													All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 29 - Sep. 4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 5 - 11	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
38	Sep. 12 - 18	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**-**	**-**
39	Sep. 19 - 25	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	**-**	**-**
40	Sep. 26 - Oct. 2	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
41	Oct. 3 - 9	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	**-**	**-**
42	Oct. 10 - 16	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**-**	**-**
43	Oct. 17 - 23	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	**-**	**-**
44	Oct. 24 - 30	-	-	-	-	-	-	-	-	-	NS	NS	NS	NS	**-**	**-**
45	Oct. 31 - Nov. 6	1	-	-	-	-	-	-	NS	NS	-	-	-	-	**1**	**100.0%**
46	Nov. 7 - 13	-	NS	-	-	-	-	-	NS	-	-	NS	NS	NS	**-**	**-**
47	Nov. 14 - 20	1	-	-	-	-	0	-	NS	NS	NS	-	-	-	**1**	**20.0%**
48	Nov. 21 - 27	NS	0	-	-	-	-	-	NS	-	-	NS	NS	NS	**0**	**0.0%**
49	Nov. 28 - Dec. 4	1	1	-	NS	-	-	-	NS	NS	NS	-	NS	NS	**2**	**33.3%**
50	Dec. 5 - 11	-	1	-	-	-	NS	NS	NS	NS	NS	NS	NS	NS	**1**	**25.0%**
51	Dec. 12 - 18	0	2	0	-	-	-	-	NS	NS	NS	NS	NS	NS	**2**	**33.3%**
52	Dec. 19 - 25	0	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**3**	**4**	**0**	**-**	**-**	**0**	**-**	**-**	**-**	**-**	**-**	**-**	**-**	***7***	***21.9%***

2010 right maxillary-clipped

Calendar		Reach													All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 29 - Sep. 4	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 5 - 11	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
38	Sep. 12 - 18	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**-**	**-**
39	Sep. 19 - 25	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	**-**	**-**
40	Sep. 26 - Oct. 2	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**-**	**-**
41	Oct. 3 - 9	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	**-**	**-**
42	Oct. 10 - 16	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	**-**	**-**
43	Oct. 17 - 23	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	**-**	**-**
44	Oct. 24 - 30	-	-	1	-	-	-	-	-	-	NS	NS	NS	NS	**1**	**100.0%**
45	Oct. 31 - Nov. 6	0	-	-	-	2	-	-	NS	NS	-	-	-	-	**2**	**66.7%**
46	Nov. 7 - 13	2	NS	-	-	-	-	-	NS	-	-	NS	NS	NS	**2**	**50.0%**
47	Nov. 14 - 20	0	2	1	-	-	-	-	NS	NS	NS	-	-	-	**3**	**33.3%**
48	Nov. 21 - 27	NS	2	0	-	-	-	0	NS	-	-	NS	NS	NS	**2**	**16.7%**
49	Nov. 28 - Dec. 4	3	7	0	NS	-	0	-	NS	NS	NS	1	NS	NS	**11**	**24.4%**
50	Dec. 5 - 11	0	4	-	0	-	NS	NS	NS	NS	NS	NS	NS	NS	**4**	**12.1%**
51	Dec. 12 - 18	1	5	0	0	-	0	-	NS	NS	NS	NS	NS	NS	**6**	**10.7%**
52	Dec. 19 - 25	0	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**6**	**20**	**2**	**0**	**2**	**0**	**0**	**-**	**-**	**-**	**1**	**-**	**-**	***31***	***16.2%***

Appendix I (continued). Pre-spawn mortality numbers of natural- (unmarked) and hatchery-origin (right maxillary-clipped) and fresh (conditions 1 and 2) female Coho Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like-origin carcasses. Data were only collected through late December. Spawning success often varies, typically improving, over time and our surveys did not extend over the entire Coho Salmon spawning period. NS = no survey and dashes (-) represent a sample size of zero.

2011 unmarked

Calendar		Reach													All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 28 - Sep. 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 4 - 10	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
38	Sep. 11 - 17	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
39	Sep. 18 - 24	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	-	-
40	Sep. 22 - Oct. 1	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
41	Oct. 2 - 8	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
42	Oct. 9 - 15	-	-	-	0	-	-	-	NS	-	-	NS	NS	NS	**0**	**0.0%**
43	Oct. 16 - 22	-	-	-	-	-	-	-	NS	NS	NS	-	-	-	-	-
44	Oct. 23 - 29	-	-	0	-	-	-	-	NS	0	0	NS	NS	NS	**0**	**0.0%**
45	Oct. 30 - Nov. 5	-	-	-	-	-	-	0	NS	NS	NS	-	-	-	**0**	**0.0%**
46	Nov. 6 - 12	0	1	-	NS	-	-	-	-	-	-	NS	NS	NS	**1**	**50.0%**
47	Nov. 13 - 19	-	-	0	-	-	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
48	Nov. 20 - 26	0	0	NS	NS	NS	-	-	NS	-	NS	NS	NS	NS	**0**	**0.0%**
49	Nov. 27 - Dec. 3	0	1	-	-	-	-	-	NS	NS	0	0	-	NS	**1**	**14.3%**
50	Dec. 4 - 10	0	-	0	-	-	-	-	NS	0	-	NS	NS	-	**0**	**0.0%**
51	Dec. 11 - 17	0	1	0	-	-	NS	NS	NS	NS	NS	-	0	-	**1**	**6.7%**
52	Dec. 18 - 24	0	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**0**	**3**	**0**	**-**	**0**	**-**	**0**	**-**	**0**	**0**	**0**	**0**	**-**	***3***	***6.1%***

2011 right maxillary-clipped

Calendar		Reach													All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 28 - Sep. 3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
37	Sep. 4 - 10	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
38	Sep. 11 - 17	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
39	Sep. 18 - 24	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	NS	-	-
40	Sep. 22 - Oct. 1	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
41	Oct. 2 - 8	-	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
42	Oct. 9 - 15	-	-	-	-	-	-	-	NS	-	-	NS	NS	NS	-	-
43	Oct. 16 - 22	-	-	-	-	-	-	-	NS	NS	NS	-	-	1	**1**	**100.0%**
44	Oct. 23 - 29	-	-	-	-	-	-	-	NS	-	-	NS	NS	NS	-	-
45	Oct. 30 - Nov. 5	-	-	1	-	-	-	-	NS	NS	NS	-	-	-	**1**	**100.0%**
46	Nov. 6 - 12	0	-	1	NS	-	0	-	-	1	-	NS	NS	NS	**2**	**50.0%**
47	Nov. 13 - 19	-	0	-	-	-	-	-	NS	NS	NS	-	-	-	**0**	**0.0%**
48	Nov. 20 - 26	0	3	NS	NS	NS	0	-	NS	0	NS	NS	NS	NS	**3**	**27.3%**
49	Nov. 27 - Dec. 3	2	0	-	0	-	-	-	NS	NS	-	-	-	NS	**2**	**28.6%**
50	Dec. 4 - 10	0	1	-	-	-	-	-	NS	-	-	NS	NS	-	**1**	**8.3%**
51	Dec. 11 - 17	1	0	0	-	-	NS	NS	NS	NS	NS	-	-	-	**1**	**5.0%**
52	Dec. 18 - 24	0	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
	All weeks	**3**	**4**	**2**	**0**	**-**	**0**	**-**	**-**	**1**	**-**	**-**	**-**	**1**	***11***	***15.1%***

Appendix I (continued). Pre-spawn mortality numbers of natural- (unmarked) and hatchery-origin (right maxillary-clipped) and fresh (conditions 1 and 2) female Coho Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like-origin carcasses. Data were only collected through late December. Spawning success often varies, typically improving, over time and our surveys did not extend over the entire Coho Salmon spawning period. NS = no survey and dashes (-) represent a sample size of zero.

2012 unmarked

Calendar		**Reach**												**All reaches**	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Sep. 5 - 8	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
37	Sep. 9 - 15	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
38	Sep. 16 - 22	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
39	Sep. 23 - 29	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
40	Sep. 30 - Oct. 6	-	-	-	0	-	-	-	NS	NS	NS	NS	NS	**0**	**0.0%**
41	Oct. 7 - 13	0	-	0	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
42	Oct. 14 - 20	-	-	-	-	-	-	-	NS	NS	-	-	-	-	-
43	Oct. 21 - 27	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
44	Oct. 28 - Nov. 3	-	-	-	-	-	1	-	NS	NS	-	NS	NS	**1**	**100.0%**
45	Nov. 4 - 10	0	-	-	NS	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
46	Nov. 11 - 17	-	-	0	0	NS	-	NS	NS	NS	-	-	-	**0**	**0.0%**
47	Nov. 18 - 24	0	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
48	Nov. 25 - Dec. 1	0	0	NS	NS	-	-	-	NS	NS	NS	NS	NS	**0**	**0.0%**
49	Dec. 2 - 8	-	-	-	-	NS	NS	NS	NS	NS	NS	NS	NS	-	-
50	Dec. 9 - 15	-	-	-	-	NS	-	-	-	-	NS	NS	NS	-	-
51	Dec. 16 - 22	-	-	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
52	Dec. 23 - 29	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**0**	**0**	**0**	**0**	**-**	**1**	**-**	**-**	**-**	**-**	**-**	**-**	***1***	***3.6%***

2012 right maxillary-clipped

Calendar		**Reach**												**All reaches**	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Sep. 5 - 8	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
37	Sep. 9 - 15	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
38	Sep. 16 - 22	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
39	Sep. 23 - 29	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
40	Sep. 30 - Oct. 6	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
41	Oct. 7 - 13	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
42	Oct. 14 - 20	-	-	-	-	-	-	1	NS	NS	-	1	2	**4**	**100.0%**
43	Oct. 21 - 27	-	-	-	4	-	1	2	-	-	NS	NS	NS	**7**	**100.0%**
44	Oct. 28 - Nov. 3	0	-	0	4	-	1	-	NS	NS	-	NS	NS	**5**	**45.5%**
45	Nov. 4 - 10	-	-	-	NS	-	1	1	1	0	NS	NS	NS	**3**	**50.0%**
46	Nov. 11 - 17	2	2	0	1	NS	1	NS	NS	NS	-	-	-	**6**	**24.1%**
47	Nov. 18 - 24	3	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**3**	**7.1%**
48	Nov. 25 - Dec. 1	0	0	NS	NS	-	0	-	NS	NS	NS	NS	NS	**0**	**0.0%**
49	Dec. 2 - 8	0	-	-	0	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
50	Dec. 9 - 15	0	0	0	-	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
51	Dec. 16 - 22	-	0	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
52	Dec. 23 - 29	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**5**	**2**	**0**	**9**	**-**	**4**	**4**	**1**	**0**	**-**	**1**	**2**	***28***	***11.8%***

Appendix I (continued). Pre-spawn mortality numbers of natural- (unmarked) and hatchery-origin (right maxillary-clipped) and fresh (conditions 1 and 2) female Coho Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like-origin carcasses. Data were only collected through late December. Spawning success often varies, typically improving, over time and our surveys did not extend over the entire Coho Salmon spawning period. NS = no survey and dashes (-) represent a sample size of zero.

2013 unmarked

Calendar		Reach												All reaches	
week	Dates	1	2	3	4	5	6	7	9	10	12	13	14	n	Pct.
36	Sep. 1 - 7	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
37	Sep. 8 - 14	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
38	Sep. 15 - 21	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
39	Sep. 22 - 28	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
40	Sep. 29 - Oct. 5	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
41	Oct. 6 - 12	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
42	Oct. 13 - 19	-	-	-	-	NS	-	-	-	-	NS	NS	NS	-	-
43	Oct. 20 - 26	-	-	-	-	-	-	-	NS	NS	-	-	-	-	-
44	Oct. 27 - Nov. 2	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
45	Nov. 3 - 9	-	-	-	-	-	-	-	NS	NS	-	-	-	-	-
46	Nov. 10 - 16	-	-	-	-	NS	-	-	-	-	NS	NS	NS	-	-
47	Nov. 17 - 23	0	1	0	-	NS	-	-	NS	NS	-	-	-	**1**	**14.3%**
48	Nov. 24 - 30	2	0	NS	NS	NS	-	-	0	-	NS	NS	NS	**2**	**28.6%**
49	Dec. 1 - 7	0	0	0	NS	-	-	-	NS	NS	-	-	-	**0**	**0.0%**
50	Dec. 8 - 14	0	0	-	-	-	-	-	-	-	NS	NS	NS	**0**	**0.0%**
51	Dec. 15 - 21	0	-	-	-	NS	-	-	NS	NS	-	-	-	**0**	**0.0%**
52	Dec. 22 - 28	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**2**	**1**	**0**	**-**	**-**	**-**	**-**	**0**	**-**	**-**	**-**	**-**	***3***	***10.7%***

2013 right maxillary-clipped

Calendar		Reach												All reaches	
week	Dates	1	2	3	4	5	6	7	9	10	12	13	14	n	Pct.
36	Sep. 1 - 7	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
37	Sep. 8 - 14	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
38	Sep. 15 - 21	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
39	Sep. 22 - 28	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
40	Sep. 29 - Oct. 5	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
41	Oct. 6 - 12	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
42	Oct. 13 - 19	-	-	-	-	NS	-	-	-	-	NS	NS	NS	-	-
43	Oct. 20 - 26	-	-	-	-	-	-	1	NS	NS	-	-	1	**2**	**100.0%**
44	Oct. 27 - Nov. 2	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
45	Nov. 3 - 9	-	-	-	0	-	-	-	NS	NS	-	-	-	**0**	**0.0%**
46	Nov. 10 - 16	0	0	-	-	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
47	Nov. 17 - 23	2	-	1	0	NS	-	0	NS	NS	-	-	-	**3**	**20.0%**
48	Nov. 24 - 30	1	1	NS	NS	NS	0	0	-	-	NS	NS	NS	**2**	**5.7%**
49	Dec. 1 - 7	0	3	0	NS	-	-	0	NS	NS	-	-	-	**3**	**3.3%**
50	Dec. 8 - 14	1	1	0	-	0	0	0	-	-	NS	NS	NS	**2**	**4.3%**
51	Dec. 15 - 21	0	0	0	0	NS	-	-	NS	NS	1	-	-	**1**	**5.0%**
52	Dec. 22 - 28	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**4**	**5**	**1**	**0**	**0**	**0**	**1**	**-**	**-**	**1**	**-**	**-**	***13***	***6.1%***

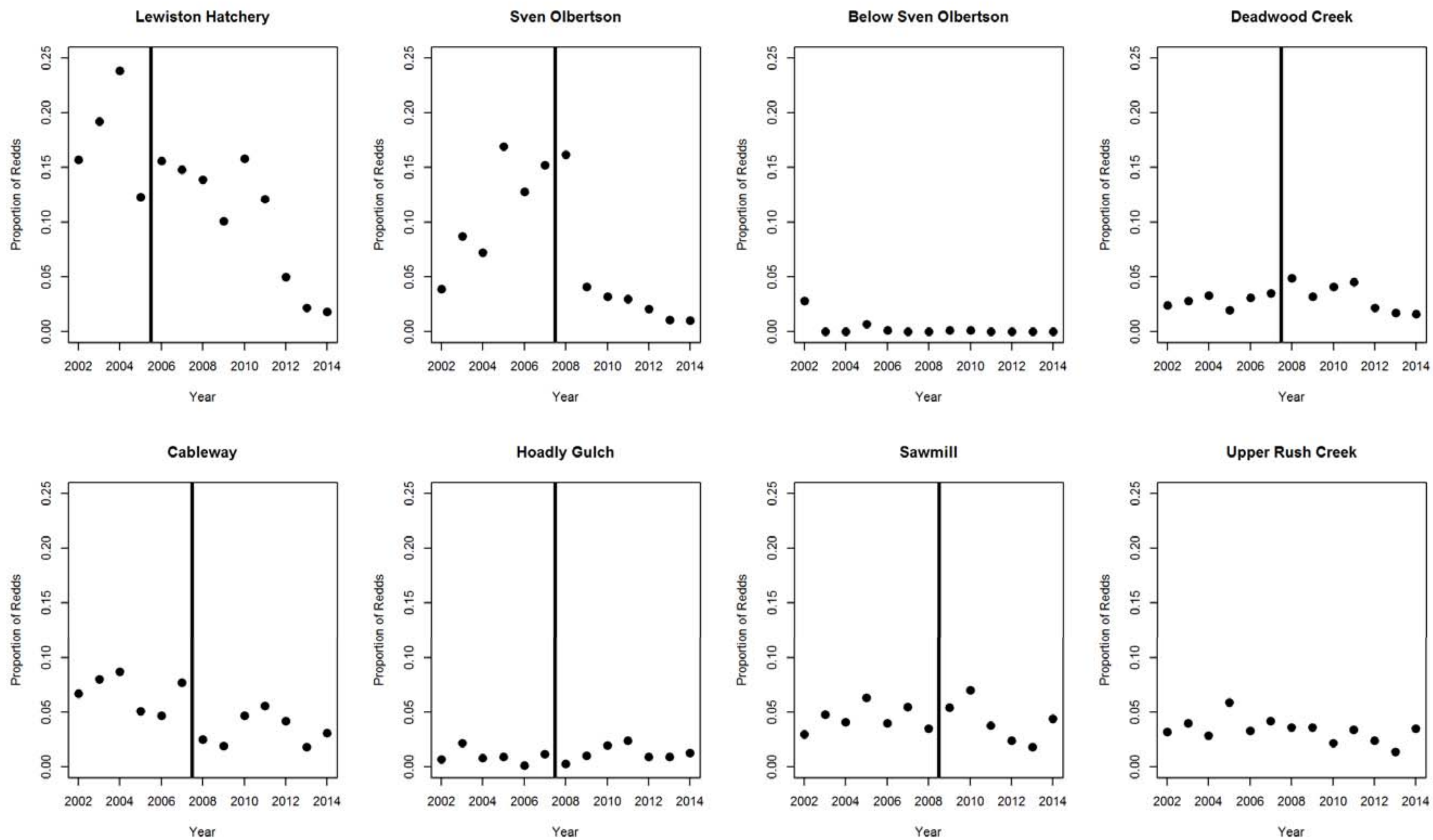
Appendix I (continued). Pre-spawn mortality numbers of natural- (unmarked) and hatchery-origin (right maxillary-clipped) and fresh (conditions 1 and 2) female Coho Salmon carcasses, mainstem Trinity River surveys, 2009–2014. Also included are weekly pre-spawn mortality proportions among like-origin carcasses. Data were only collected through late December. Spawning success often varies, typically improving, over time and our surveys did not extend over the entire Coho Salmon spawning period. NS = no survey and dashes (-) represent a sample size of zero.

2014 unmarked

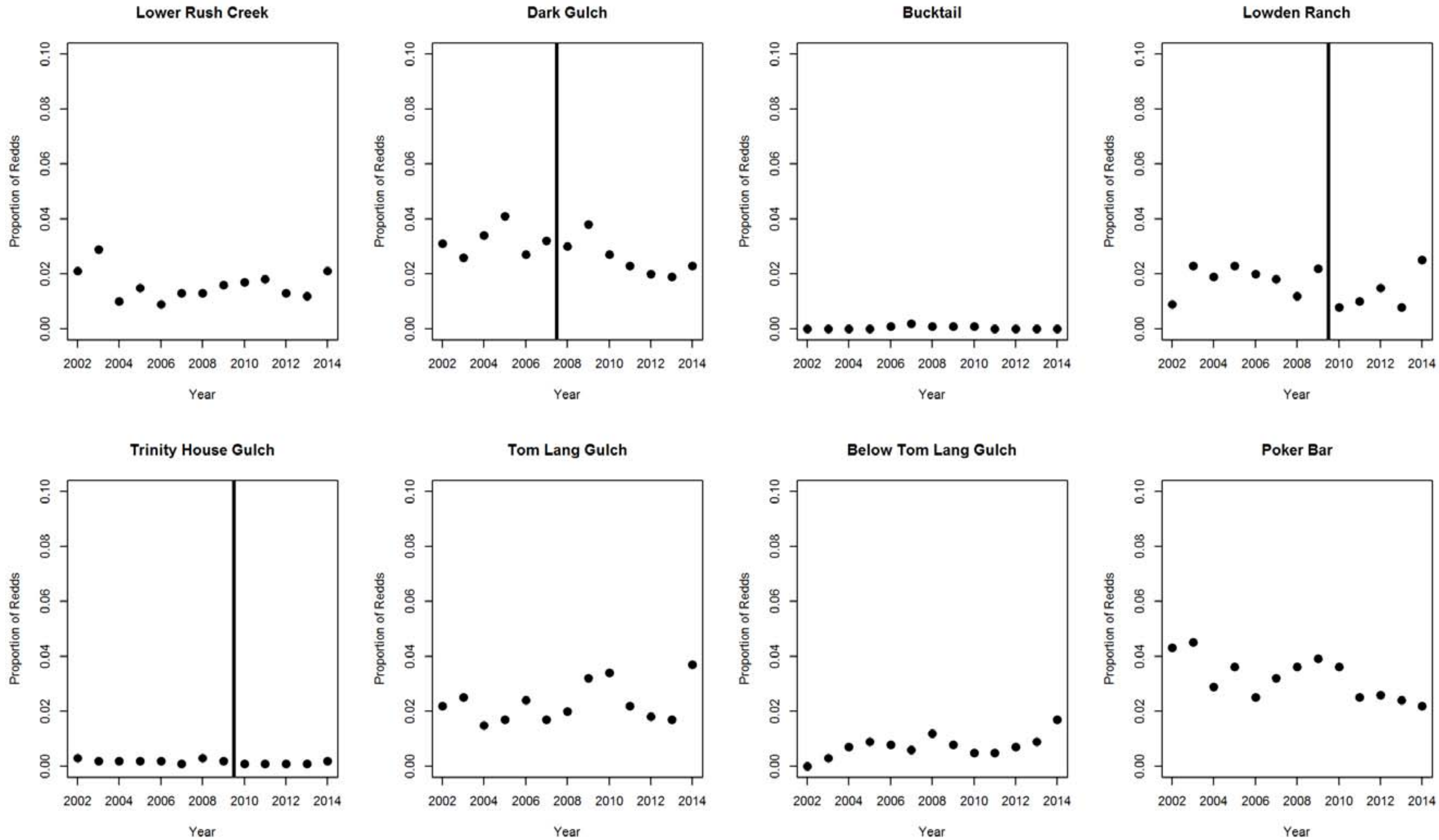
Calendar		Reach												All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 31 - Sep. 6	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
37	Sep. 7 - 13	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
38	Sep. 14 - 20	-	-	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-
39	Sep. 21 - 27	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
40	Sep. 28 - Oct. 4	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
41	Oct. 5 - 11	-	-	-	-	-	-	-	NS	NS	-	-	-	-	-
42	Oct. 12 - 18	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
43	Oct. 19 - 25	-	-	0	-	-	-	-	NS	NS	-	-	NS	**0**	**0.0%**
44	Oct. 26 - Nov. 1	-	-	-	-	1	0	-	-	-	NS	NS	NS	**1**	**50.0%**
45	Nov. 2 - 8	1	-	-	-	-	-	1	NS	NS	1	-	-	**3**	**75.0%**
46	Nov. 9 - 15	-	1	-	-	NS	-	-	-	-	NS	NS	NS	**1**	**33.3%**
47	Nov. 16 - 22	-	4	1	0	1	-	-	NS	NS	-	-	-	**6**	**42.9%**
48	Nov. 23 - 29	-	0	NS	NS	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
49	Nov. 30 - Dec. 6	-	-	-	-	-	-	-	NS	NS	-	-	-	**0**	**0.0%**
50	Dec. 7 - 13	-	2	-	NS	NS	-	-	-	-	NS	NS	NS	**2**	**50.0%**
51	Dec. 14 - 20	-	-	-	-	-	NS	NS	NS	NS	NS	NS	NS	-	-
52	Dec. 21 - 27	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**1**	**7**	**1**	**0**	**2**	**0**	**1**	**0**	**0**	**1**	**0**	**0**	***13***	***35.1%***

2014 right maxillary-clipped

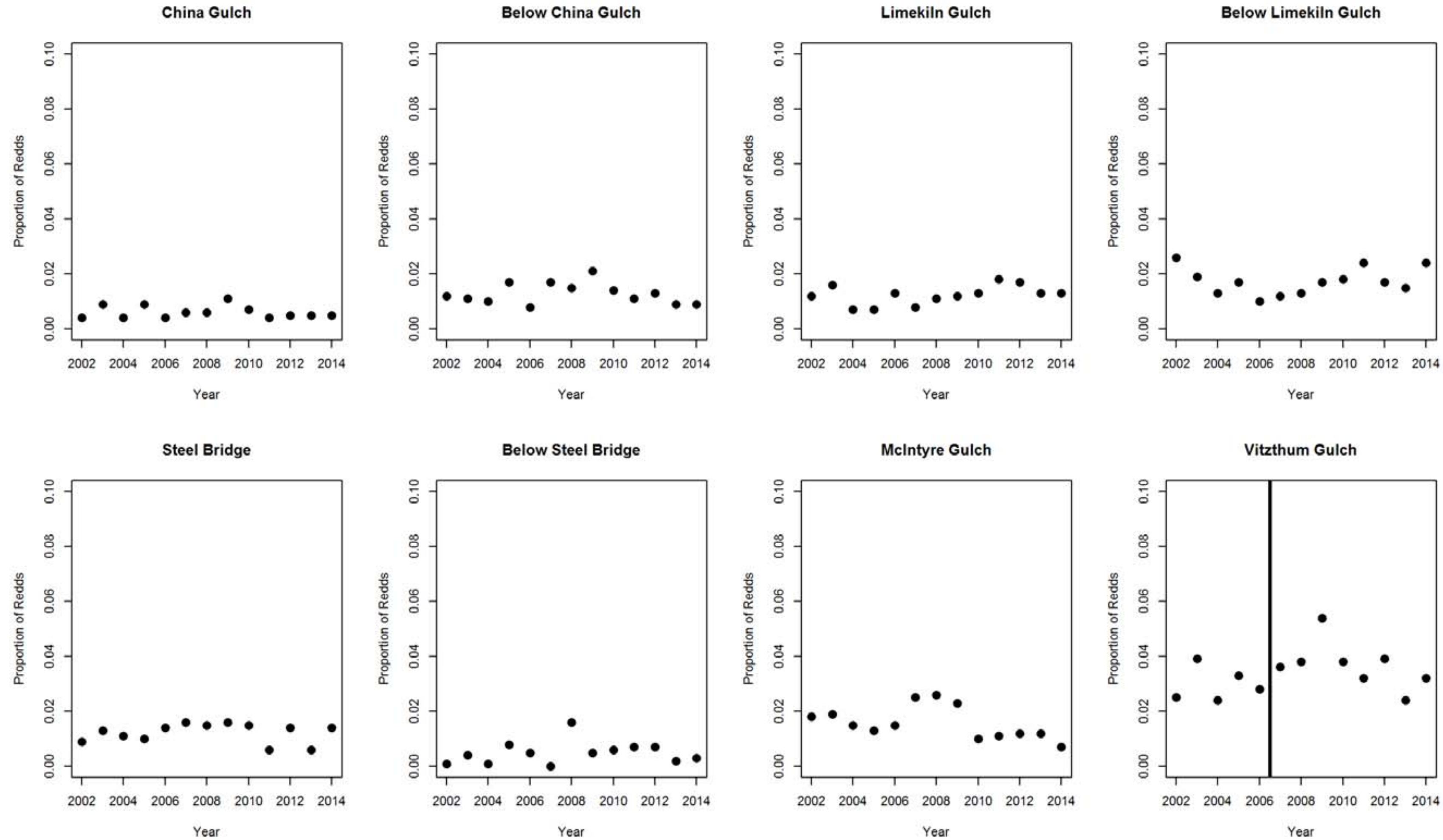
Calendar		Reach												All reaches	
week	**Dates**	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**9**	**10**	**12**	**13**	**14**	**n**	**Pct.**
36	Aug. 31 - Sep. 6	-	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	-	-
37	Sep. 7 - 13	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
38	Sep. 14 - 20	-	-	NS	NS	NS	-	-	NS	NS	NS	NS	NS	-	-
39	Sep. 21 - 27	-	-	-	-	-	-	-	NS	NS	NS	NS	NS	-	-
40	Sep. 28 - Oct. 4	-	-	-	-	-	-	-	-	-	NS	NS	NS	-	-
41	Oct. 5 - 11	-	-	-	-	-	-	-	NS	NS	1	-	1	**2**	**100.0%**
42	Oct. 12 - 18	-	-	-	-	-	-	-	0	-	NS	NS	NS	**0**	**0.0%**
43	Oct. 19 - 25	-	-	-	-	-	-	-	NS	NS	-	-	NS	-	-
44	Oct. 26 - Nov. 1	-	3	-	1	0	1	1	-	1	NS	NS	NS	**7**	**70.0%**
45	Nov. 2 - 8	0	1	0	0	-	2	-	NS	NS	-	-	-	**3**	**42.9%**
46	Nov. 9 - 15	0	5	1	0	NS	-	-	-	1	NS	NS	NS	**7**	**26.9%**
47	Nov. 16 - 22	0	12	4	1	1	2	1	NS	NS	0	-	-	**21**	**26.9%**
48	Nov. 23 - 29	0	0	NS	NS	NS	-	-	-	-	NS	NS	NS	**0**	**0.0%**
49	Nov. 30 - Dec. 6	0	0	0	-	-	-	-	NS	NS	-	-	-	**0**	**0.0%**
50	Dec. 7 - 13	-	2	1	NS	NS	-	-	-	-	NS	NS	NS	**3**	**37.5%**
51	Dec. 14 - 20	-	0	-	-	-	NS	NS	NS	NS	NS	NS	NS	**0**	**0.0%**
52	Dec. 21 - 27	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	**NS**	**NS**
	All weeks	**0**	**23**	**6**	**2**	**1**	**5**	**2**	**0**	**2**	**1**	**-**	**1**	***43***	***28.5%***



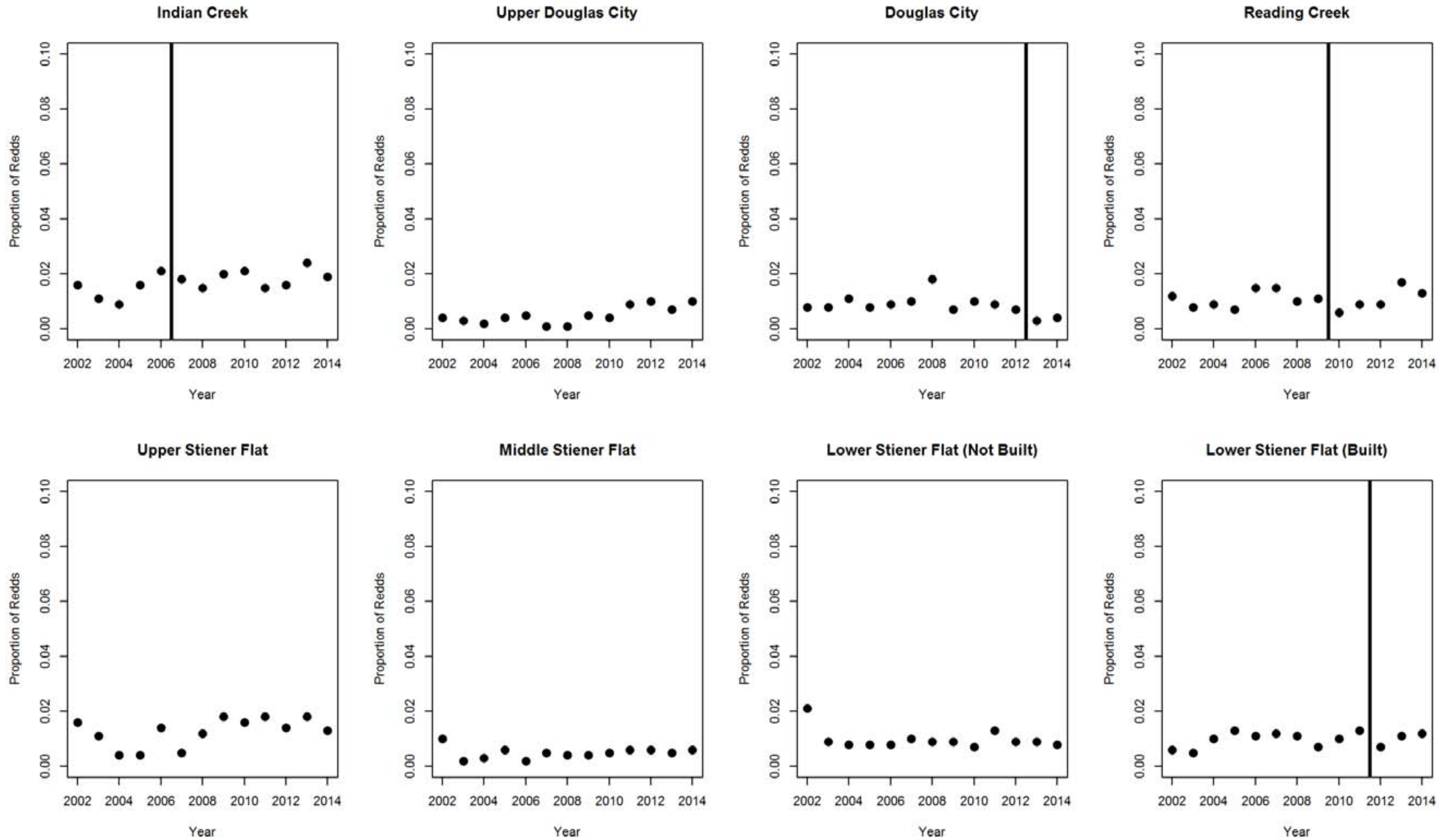
Appendix J. Proportions of natural-origin Chinook Salmon redds within specific sites in the Trinity River relative to the total count of natural-origin Chinook Salmon redds from the restoration reach, 2002–2014. Each site is an amalgamation of 200-m bins that generally represent a section of river or TRRP restoration site and may be of varying lengths. Vertical bars represent completion of TRRP mechanical restoration action. Note that the scale of the *y*-axis may vary.



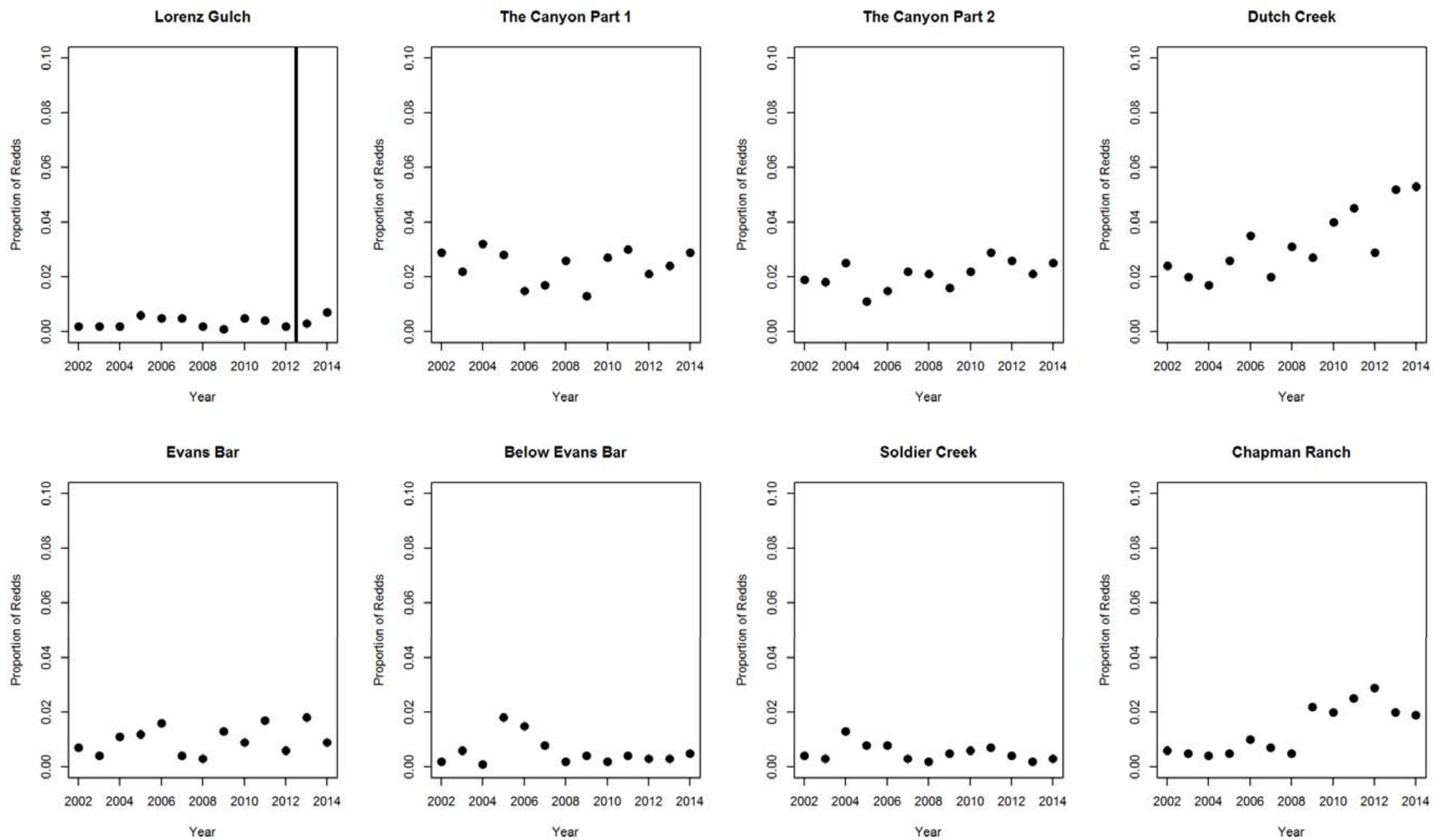
Appendix J (continued). Proportions of natural-origin Chinook Salmon redds within specific sites in the Trinity River relative to the total count from the restoration reach, 2002–2014. Each site is an amalgamation of 200-m bins that generally represent a section of river or TRRP restoration site and may be of varying lengths. Vertical bars represent completion of TRRP mechanical restoration action. Note that the scale of the *y*-axis may vary.



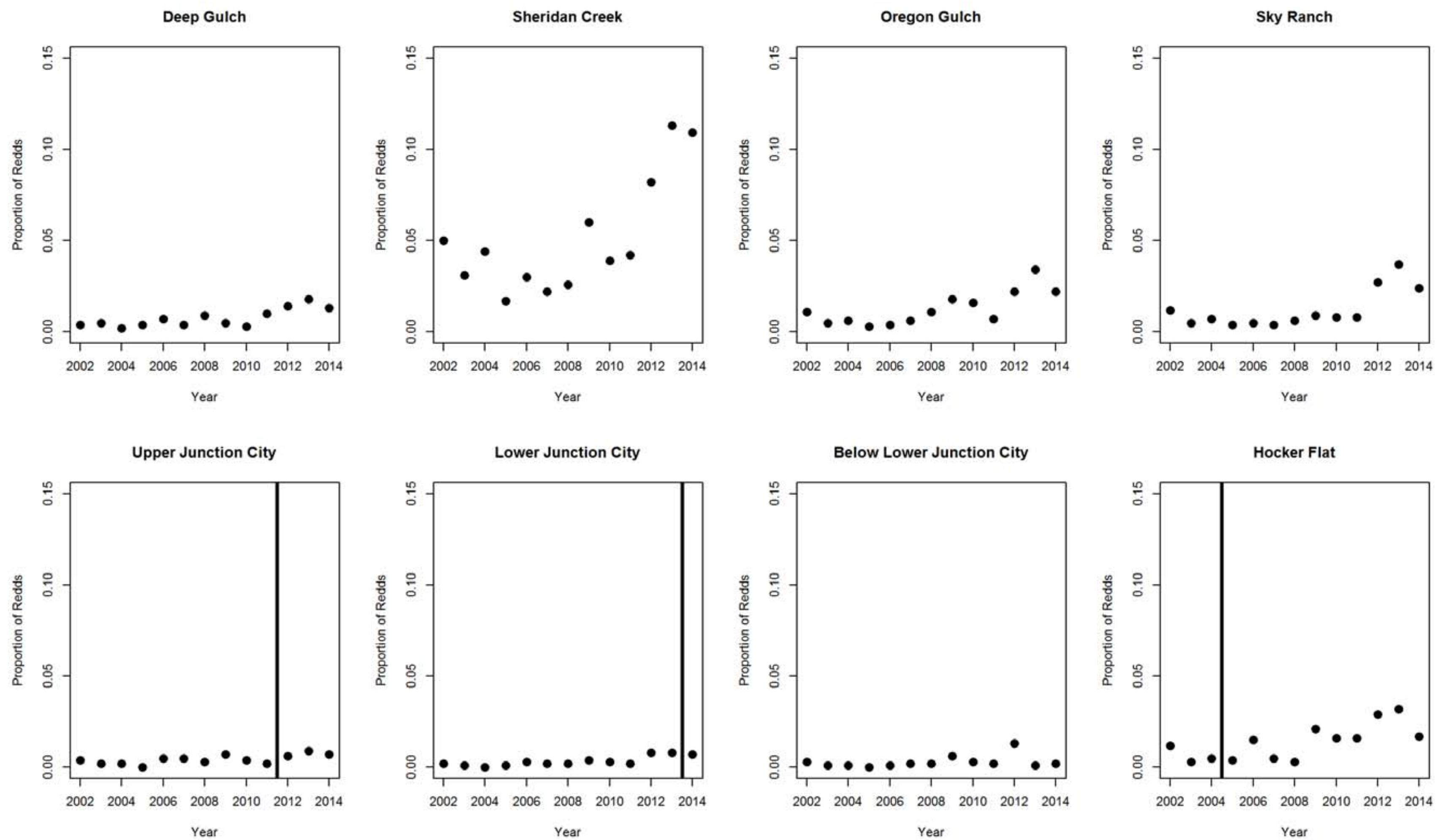
Appendix J (continued). Proportions of natural-origin Chinook Salmon redds within specific sites in the Trinity River relative to the total count from the restoration reach, 2002–2014. Each site is an amalgamation of 200-m bins that generally represent a section of river or TRRP restoration site and may be of varying lengths. Vertical bars represent completion of TRRP mechanical restoration action. Note that the scale of the *y*-axis may vary.



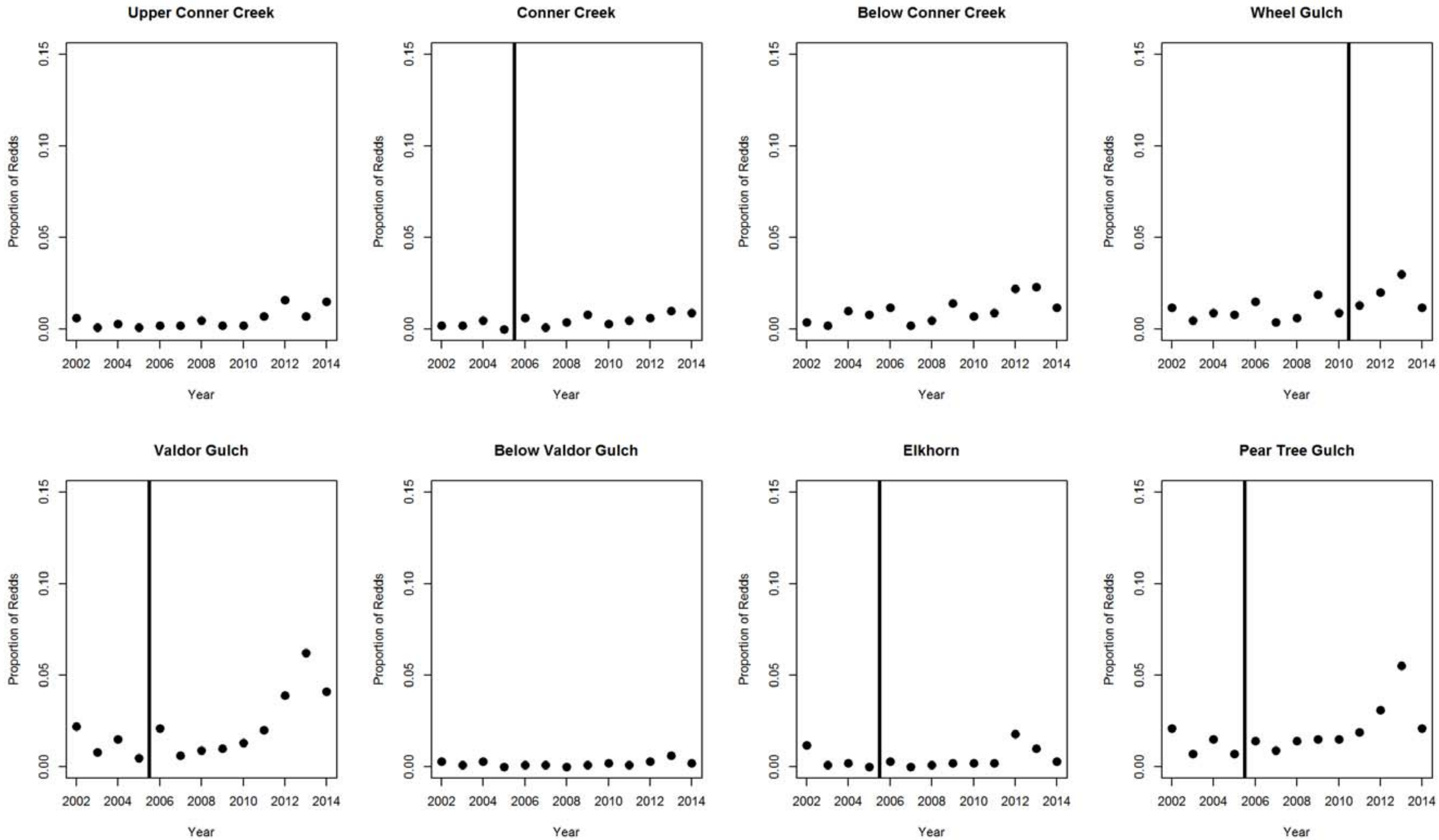
Appendix J (continued). Proportions of natural-origin Chinook Salmon redds within specific sites in the Trinity River relative to the total count from the restoration reach, 2002–2014. Each site is an amalgamation of 200-m bins that generally represent a section of river or TRRP restoration site and may be of varying lengths. Vertical bars represent completion of TRRP mechanical restoration action. Note that the scale of the *y*-axis may vary.



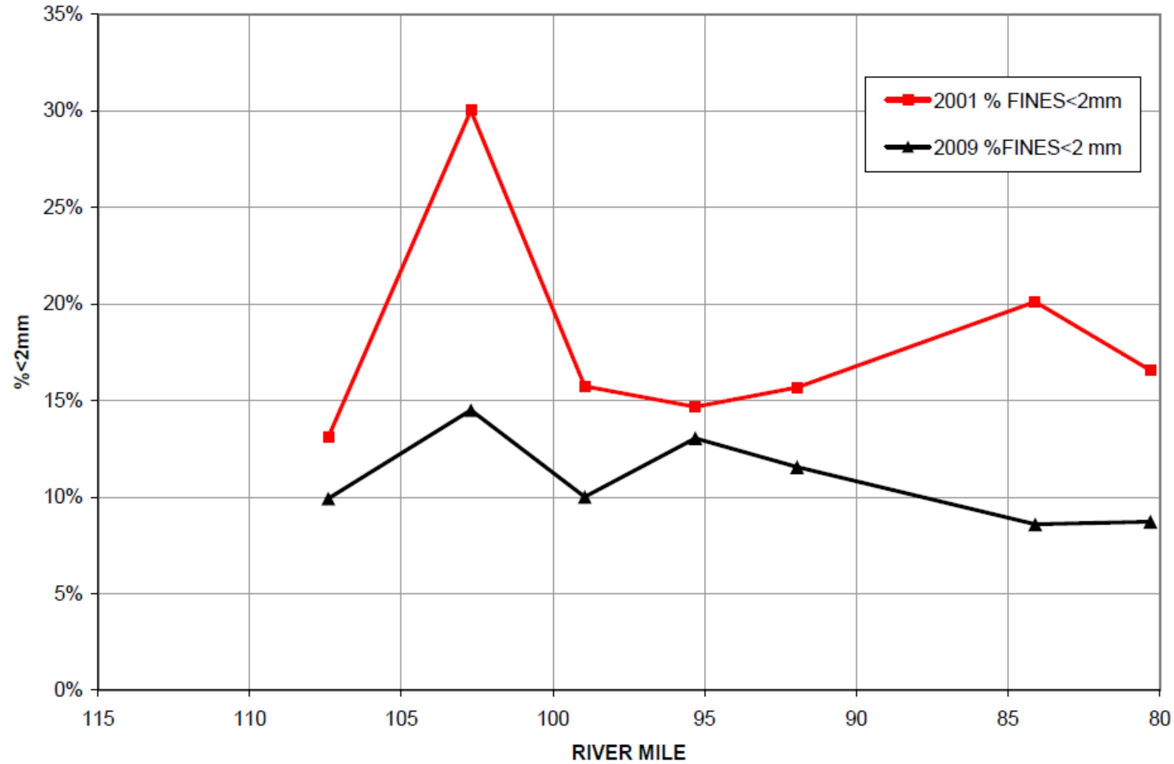
Appendix J (continued). Proportions of natural-origin Chinook Salmon redds within specific sites in the Trinity River relative to the total count from the restoration reach, 2002–2014. Each site is an amalgamation of 200-m bins that generally represent a section of river or TRRP restoration site and may be of varying lengths. Vertical bars represent completion of TRRP mechanical restoration action. Note that the scale of the *y*-axis may vary.



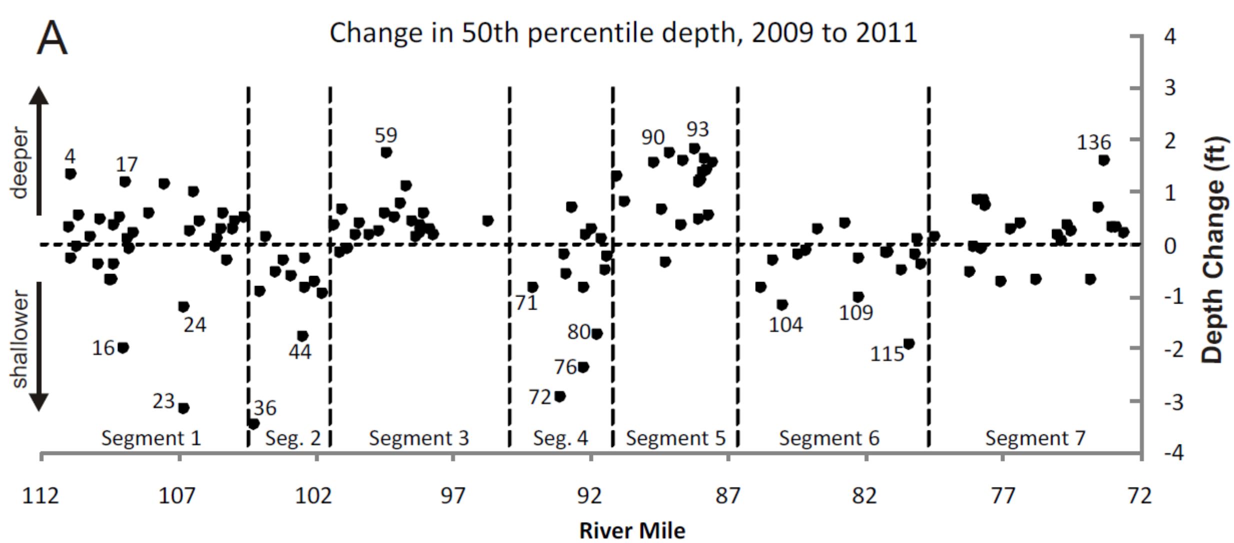
Appendix J (continued). Proportions of natural-origin Chinook Salmon redds within specific sites in the Trinity River relative to the total count from the restoration reach, 2002–2014. Each site is an amalgamation of 200-m bins that generally represent a section of river or TRRP restoration site and may be of varying lengths. Vertical bars represent completion of TRRP mechanical restoration action. Note that the scale of the *y*-axis may vary.



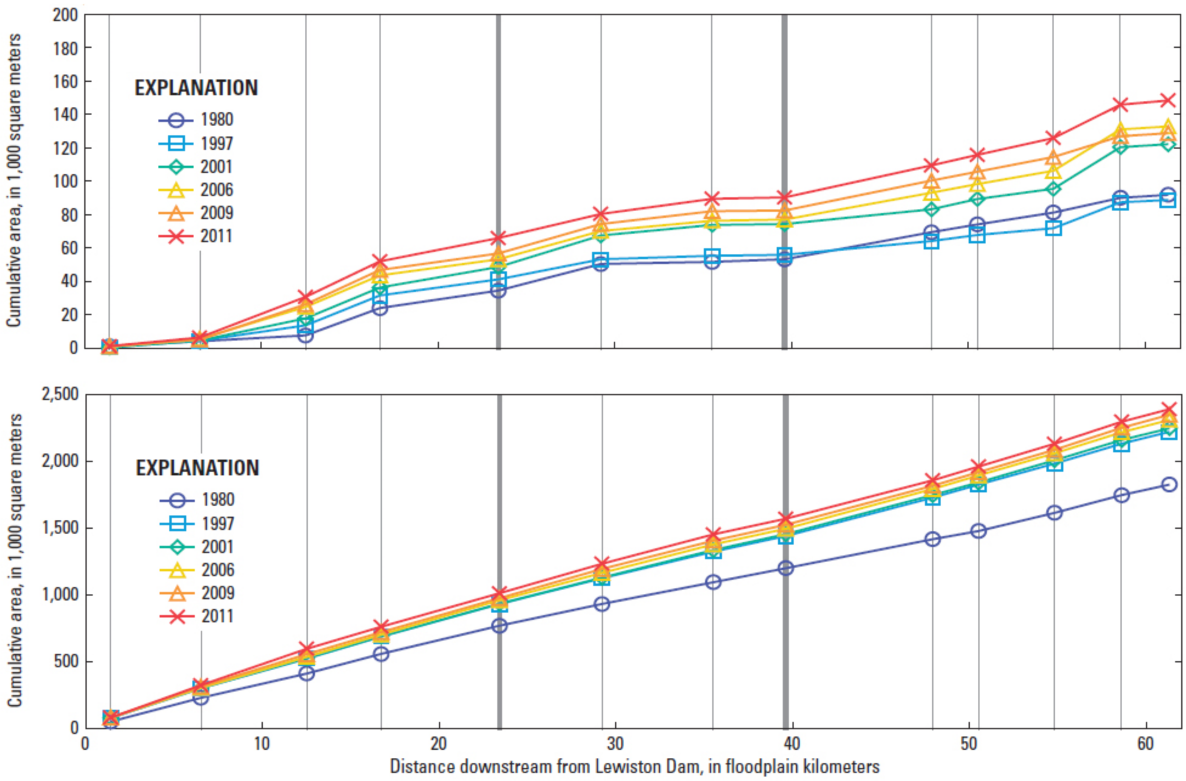
Appendix J (continued). Proportions of natural-origin Chinook Salmon redds within specific sites in the Trinity River relative to the total count from the restoration reach, 2002–2014. Each site is an amalgamation of 200-m bins that generally represent a section of river or TRRP restoration site and may be of varying lengths. Vertical bars represent completion of TRRP mechanical restoration action. Note that the scale of the *y*-axis varies.



Appendix K. Percent of substrate <2 mm wide from 2001 and 2009 bulk samples from seven sites on the Trinity River. Adapted from GMA (2010).



Appendix L. Change in the 50th-percentile depth as determined from grid-based comparisons for select pools on the Trinity River, 2009–2011. Adapted from Gaeuman and Krause (2013).



Appendix M. Cumulative distribution of stable bars (top) and active channel (bottom) along the Trinity River downstream of Lewiston Dam, California, 1980–2011. Adapted from Curtis et al. 2015.