Mainstem Trinity River Fall Chinook Salmon Spawning Redd Survey, 1996 through 1998

***Fiscal Year* 1999**

***Photo By*: Ernest Keeley**

Prepared by:

Rick R. Quihillalt

US Fish & Wildlife Service
Arcata Fish and Wildlife Office
1125 16th Street #209
Arcata, California 95521
707/ 822-7201

September, 1999

Funded by: Trinity River Basin Fish and Wildlife Management Reauthorization Act (P.L. 104-143), 1995.

DISCLAIMER

Mention of trade names or commercial products in this report does not constitute endorsement by the U.S. Fish and Wildlife Service.

ACKNOWLEDGEMENTS

This report was co-authored by Jay D. Glase, whose contributions, edits, technical expertise, and guidance were invaluable.

The authors wish to acknowledge the following persons whose efforts were praiseworthy in the collection of field data and preparation of this report.

Members of the AFWO, Arcata staff who assisted with field data collection:

Charlie D. Chamberlain
Sean P. Gallagher
Cynthia Glase
Mike Prall
John D. Williamson
Jeff Hartman for technical editing.

Volunteers who assisted with field data collection:

Lynn Gunn-Morrison
Dan Gunn
Members of the Minors Alliance, Big Bar, CA.
Sean Kelley

TABLE OF CONTENTS

Page

DISCLAIMER ii

ACKNOWLEDGMENTS iii

TABLE OF CONTENTS iv

LIST OF FIGURES v

LIST OF TABLES vi

ABSTRACT vii

INTRODUCTION 1

STUDY AREA 1
- Survey Reach Locations 1

MATERIALS AND METHODS 4
- Rafting 4
- Redd Data 5
- Redd Substrate Data 5
- Suction Dredge Mining 5

RESULTS 6
- Redd Surveys and Counts 6
- Survey Results of Reaches 1 through 3, 1996-1998 6
- Spawning Redd Counts by Mainstem Tributaries 12
- Redd Substrate Composition 14
- Mainstem Water Temperatures 14
- Suction Dredge Mining 14

DISCUSSION 16

REFERENCES 20

PERSONAL COMMUNICATIONS 20

LIST OF FIGURES

Figure		Page
1.	Trinity River chinook spawning survey study area. North Fork Trinity River to Cedar Flat, 23.9 miles (38.5 rkm)	3
2.	Reach 1. North Fork Trinity river to Big Flat river access (10.1 rkm). Redd distribution 1996-1998	8
3.	Reach 2. Big Flat river access to one mile downstream of Big French Creek (14.1 rkm). Redd distribution 1996-1998	9
4.	Reach 3. One mile downstream Big French Creek to Cedar Flat river access (14.3 rkm). Redd distribution 1996-1998	11
5.	Yearly chinook salmon redd frequency (%) occurrence between mainstem tributaries. North Fork Trinity River (116.7 rkm) to Cedar Flat (79.6 rkm), 1996-1998	13
6.	Comparison of redd substrate composition by study reach, 1997-1998. (1997: n=110, 1998: n=60)	15
7.	Discharge, in CFS at Cedar Flat gauging station (USGS). Water Years 1997-1999 correspond to survey years 1996-1998	18

LIST OF TABLES

Table | Page

1. Summary of mainstem Trinity River redd counts, 1996-1998. Total percentages by reach are in parentheses……………………………………………………………7

2. Yearly redd frequency, in percent, between major tributaries on the mainstem Trinity River, North Fork to Cedar Flat, 1996-1998……………………………12

3. Spawning escapement of fall chinook salmon (in-river and hatchery), adult and grilse expasion, spawning survey redd numbers and percentage of hatchery origin fish in the Trinity River 1996-1998……………………………………………..17

ABSTRACT

During the fall spawning season from 1996 through 1998, we surveyed 39 km of the mainstem Trinity River (from the North Fork Trinity confluence to Cedar Flat) to determine chinook salmon (*Oncorhynchus tshawytscha*) redd distribution and abundance. Spawning was active throughout the mainstem; in 1996, we identified 602 redds in this section, in 1997 we found 928, and in 1998 we counted a total of 187.

Redd numbers were consistently highest in Reach 2, between Big Bar Creek and Big French Creek. This is consistent for all three years of the surveys with 66%, 57%, and 64% of the total number of redds counted in 1996, 1997, 1998, respectively. The lowest redd numbers in all three years were recorded in Reach 1, from the North Fork Trinity confluence to Big Flat river access, with just 10%, 10%, and 17% of the total redds observed.

A more detailed evaluation of spatial distribution between mainstem tributaries revealed declines in redd frequency between Eagle Creek and Sailor Bar Creek, and between Deer Creek and Little French Creek. Increases in redd frequency were noted between the North Fork Trinity and Miller Creek, and from Big Bar Creek to Price Creek, suggesting possible modification of spawning habitats from flooding.

Changes in the distribution of salmon spawning are not yet well understood. The abundance and distribution of redds may also be related to the adult escapement of hatchery-origin fish in the system. A cursory review of related data revealed that when there was a greater percentage of hatchery-origin fish in the river, we observed less spawning in the mainstem study area; the likewise also was true: with fewer fish of hatchery-origin in the river, we counted more mainstem chinook redds within our study area.

In the last three years, 72 redds (4%) were counted on or near the tailings from suction dredge mining operations.

Introduction

Over the last 120 years, the fishery resources of the Trinity River? once a major source of chinook salmon (*Oncorhynchus tschawyscha*) and other anadromous fish? have declined. Human activities in the basin have resulted in losses of spawning and rearing habitat, which have sharply reduced the Trinity River's historical contribution to California's sport, commercial, and tribal fisheries.

In October 1984, Congress enacted the Trinity River Basin Fish and Wildlife Management Program (P.L. 98-541) to restore natural salmon and steelhead production in the Trinity. One of the objectives of this program was to evaluate the effects of restoration projects on fisheries production (TRBFWMP, 1982). This program was authorized through Fiscal Year 1995. The Trinity River Basin Fish and Wildlife Management Reauthorization Act of 1995 (P.L. 104-143) extended the restoration program through September 1998. The reauthorization emphasized that successful fisheries restoration should be measured by escapement levels of returning adults and by the success of dependent user groups in harvesting fisheries which have been enhanced by restoration efforts.

The Trinity River Flow Evaluation Final Report (USFWS, HVT 1999) recommends five different annual flow regimes for the Trinity River ranging from 369,000 acre-feet to 815,000 acre-feet, based on water-year type. It is anticipated that these increases in flow in conjunction with mechanical restoration activities will help restore some of the natural morphology of the river. However, the effects of increased flows and of potential morphologic changes on spawning adult salmon distribution and abundance in the Trinity are not known. To determine what these effects may be, it is important that there be adequate information regarding spawner distribution prior to the implementation of changes in flow management.

Previous spawning surveys were conducted in the mainstem Trinity River between the North Fork Trinity River and Cedar Flat by the U.S. Fish and Wildlife Service (Service) from 1987 to 1991 (USFWS, 1987-1991), however, methods and survey reaches were not consistent each year. As part of the continuing monitoring effort on the mainstem Trinity, the Service's Arcata Fish and Wildlife Office (AFWO) conducted these surveys to determine the abundance and distribution of spawning chinook salmon in 1996, 1997, and 1998. The California Department of Fish and Game has also conducted salmon redd and carcass surveys in the Trinity River from Lewiston Dam downstream to the North Fork Trinity since 1988 (CDFG, 1998a). These surveys provide additional information on distribution and abundance in the upper reaches of the river.

Study Area

The Trinity River is the largest tributary to the Klamath River, with a watershed area of approximately 7679 km^2 (2965 mi^2) in Trinity and Humboldt counties of Northwestern California. Lewiston Dam, at river kilometer (rkm) 180, is the upstream limit of salmon migration. The redd survey area begins at rkm 116.7, near the confluence with the North Fork Trinity River, and extends 38.5 km (23.9 miles) downstream to Cedar Flat at rkm 78.2 (Figure 1).

Survey Reach Locations

The mainstem Trinity River from the North Fork to Cedar Flat was divided into four reaches for 1996 and 1997. For 1998, the two downstream reaches were combined. (Figure 1). These reaches were surveyed every other week unless adverse weather limited visibility to less than 1 meter deep or high flow conditions existed.

Reach 1: North Fork Trinity River access (rkm 116.7) to Big Flat river access (rkm 106.6).

Reach 2: Big Flat river access (rkm 106.6) to French Bar river access (rkm 94.6).

Reach 3: French Bar river access (rkm 94.6) to Little Swede Creek river access (rkm 87.7).

Reach 4: Little Swede Creek river access (rkm 87.7) to Cedar Flat river access (rkm 78.2).

Reach three was shortened and combined with reach four during the 1998 survey. This combined section was approximately 14.3 km long but due to the relatively low number of redds observed in this reach, surveys only required approximately eight hours to complete.

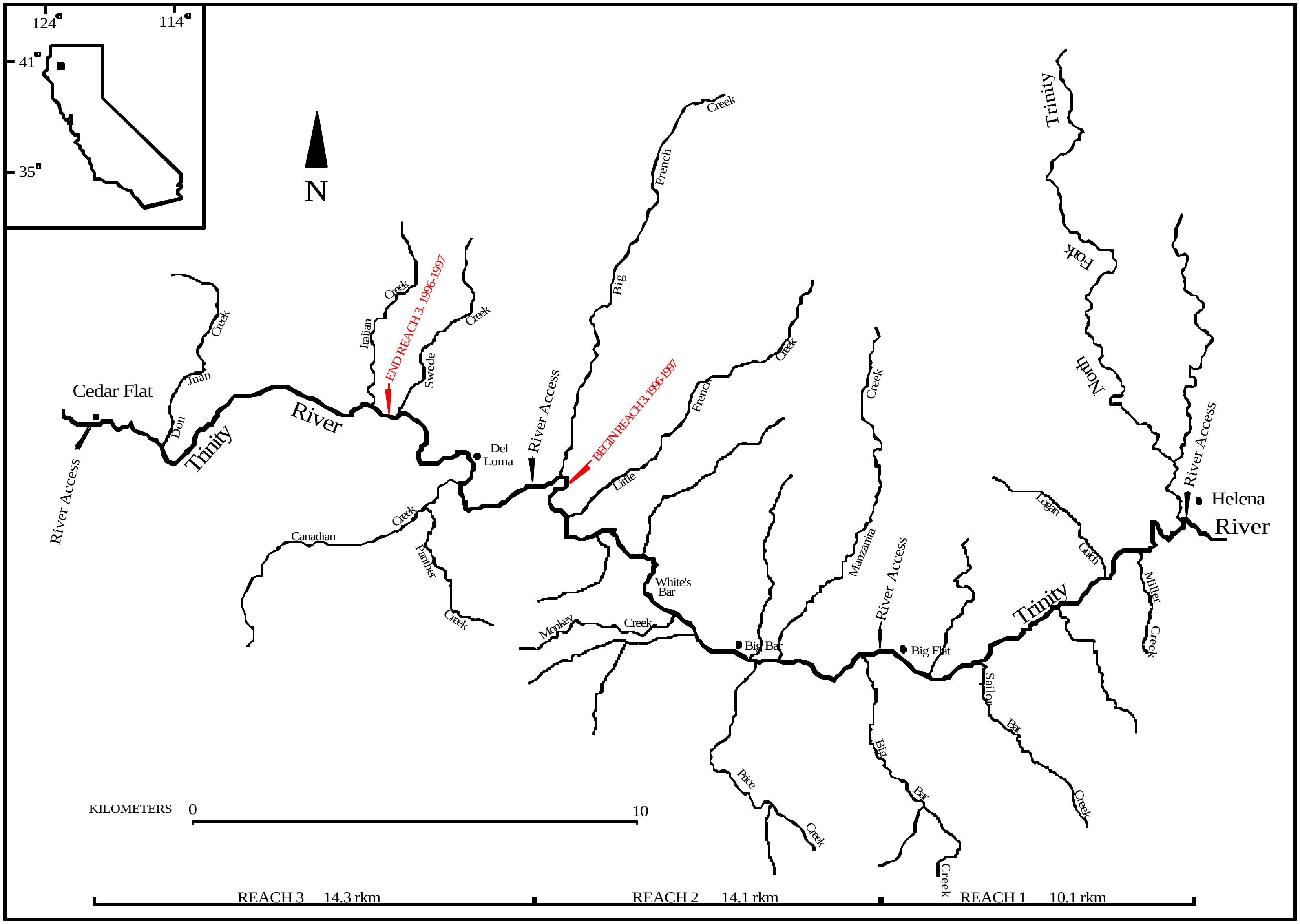

Figure 1. Trinity River chinook spawning survey study area. North Fork Trinity River confluence to Cedar Flat, 23.9 miles (38.5 rkm).

Materials and Methods

Rafting

Inflatable rafts were considered the most effective method of surveying redds of fall chinook salmon in the mainstem of the Trinity River. Spawning surveys are timed to include spawning activity before and after peak runs and are performed from mid-October to late November or early December. Visual observations of fall chinook redds were conducted from inflatable rafts. Two 12-foot inflatable Avon rafts equipped with rowing frames were operated by two biologists who rotated between observing and rowing. In 1996, one raft per survey reach was used to count redds across the entire channel width. During 1997 and 1998 surveys, both rafts were used to count redds in each reach throughout the survey period. The observers stood at the front of the raft and viewed from the mid-channel area to either the right or left bank as the raft was maneuvered downstream. The same crew surveyed the same bank throughout the study period. Communication between rafts helped to avoid over-counting of redds located in mid-channel areas. Generally, if rafts were not adjacent to each other, the first raft through an area would count mid channel redds and inform the other raft. When side channels were encountered, the rower would drop off the observer at the top of the side channel then continue the survey down the mainstem of the river. The observer would survey the side channel on foot and meet the raft at the bottom of the side channel.

Redd Data

Plastic survey flagging was attached to trees and other permanent fixtures to mark locations of individual redds and groups of redds along the riverbank in each reach. The date, number of redds, stream location of redds, and redd site number were recorded on each flag. A different color survey flag was used each survey to insure that redds were not double counted. Redd sites were also recorded on topographic maps and on data forms. Data collected included unit type (run, riffle, pool, glide, etc.), location in the unit (left bank, mid channel, top or bottom etc.), flagging location (adjacent, up or downstream of actual redd location), presence of live fish, and age of the redd (old or fresh). Only completed redds or redds with fish on them were included in the daily counts. Test redds were omitted. Redds included in the survey exhibited a freshly scoured oval pattern with a distinct mound downstream and a pit, or depression, upstream of the mound. Some superimposition of redds (redds constructed on top of other redds) was noted and counted accordingly. Redds observed on or near suction dredge tailings were also noted, and their proximity upstream or downstream was recorded. New redds and lost flags were recognized by corresponding flagging with field notes and topographic maps.

Redd Substrate Data

Surface substrate composition was visually estimated for a random selection of redds. Substrate composition was divided into five particle categories that included large cobble (15-30 cm), small cobble (8-15 cm), large gravel (3.5-8 cm), small gravel (0.5-3.5 cm), and sand/silt/clay (SSC) particles (<0.5 cm). When recording substrate composition, caution was used to minimize disturbance in and around the redd site.

Suction Dredge Mining

During the fall 1996 survey, some redds were noted on or near suction dredge mining tailings. These sites may be attractive for redd construction because tailing deposits can create appropriate depth and velocity conditions suitable for redd construction, and they provide loose, appropriately sized substrate. In response to this, increased efforts were made in 1997 and 1998 to enumerate and identify redds in proximity to dredge tailings. Survey crews were instructed to note whether a redd was constructed on suction dredge tailings, or within 1000 meters of mining tailings.

Results

Redd Surveys and Counts

We counted 602 redds in 1996, 928 redds in 1997, and 187 redds in 1998 (Table 1). The 1996 survey resulted in two counting efforts in each reach. Reach one was surveyed on October 31. Reaches two through four were surveyed on November 6 and 7. All four reaches were again surveyed on December 3. Each reach was surveyed with only one raft.

We surveyed each reach three times in 1997. Surveys were conducted October 14-17, October 27-30 and November 3-6. We used two rafts per reach during each survey effort this year. High flows and turbid river conditions prevented additional surveys for the season.

In 1998, each reach was again surveyed three times with two rafts. We combined reaches three and four this year (due to the relatively low numbers of redds observed) and completed each effort in three days. Surveys were conducted October 13-15, October 26-28, and November 9-11. We attempted additional surveys during the weeks of November 24-26 and December 8-10, but the onset of high flows and turbid river conditions prevented further efforts. Because we combined reaches three and four during the 1998 surveys, results are reported for three reaches in each year. See Table 1 for further detail of numbers of redds in all reaches for all three years.

Survey Results of Reaches 1 through 3, 1996-1998.

Reach 1: North Fork Trinity River to Big Flat river access (Table 1, Figure 2).

Reach 1 had the lowest number of redds per reach in all three years. We counted a total of 60, 98, and 33 redds in 1996-1998 respectively, which equates to 10%, 10%, and 18% of total redds per year. Redd density in this reach was 5.9, 9.7 and 3.3 redds/rkm, respectively. Total counts for 1998 were only 34% and 55% of the 1997 and 1996 counts. There was a noticeable decline in spawning activity between the two survey efforts in 1996 (Table 1). In 1997, spawning peaked during survey two and declined after that. In 1998, numbers declined consistently from survey one through survey three. The timing of peak spawning activity was similar in 1996 and 1997 (Table 1). The left bank (facing downstream) consistently had more redds than the right in this reach.

Reach 2: Big Flat to French Bar (Del Loma in 1998) river access (Table 1, Figure 3).

Reach 2 had the highest number of redds per reach in all three years. We counted a total of 401, 534, and 120 redds in 1996-1998 respectively, which equates to 67%, 58%, and 64% of total redds per year. Redd density in this reach was 28.4, 37.9 and 8.5 redds/rkm, respectively. Total counts for 1998 were only 22% and 30% of the 1997 and 1996 counts. Peak spawning in this reach occurred around the same time (October 26-31) each year. The greatest aggregation of redds in reach 2 was on a well-known riffle and side

Table 1. Summary of mainstem Trinity River redd counts, 1996-1998. Total percentages by reach are in parentheses.

REACH	1996			1997				1998			
	Week 1 Oct 31st	Week 2 Dec 3rd	1996 Total	Week 1 Oct 14th	Week 2 Oct 27th	Week 3 Nov 3rd	1997 Totals	Week 1 Oct 13th	Week 2 Oct 26th	Week 3 Nov 9th	1998 Totals
REACH 1: NORTH FORK TRINITY TO BIG FLAT RIVER ACCESS	45	15	60 (10%)	27	53	18	98 (11%)	15	11	7	33 (18%)
REACH 2: BIG FLAT RIVER ACCESS TO FRENCH BAR RIVER ACCESS	354	47	401 (67%)	159	232	143	534 (58%)	26	62	32	120 (64%)
REACH 3: FRENCH BAR RIVER ACCESS TO LITTLE SWEDE CREEK RIVER ACCESS	100	3	103 (17%)	73	89	28	190 (20%)	2	15	17	34 (18%)
REACH 4: LITTLE SWEDE CREEK RIVER ACCESS TO CEDAR FLAT	35	3	38 (6%)	35	54	17	106 (11%)				
TOTAL	534	68	602	294	428	206	928	43	88	56	187

Reaches 3 and 4 were combined for 1998.

7

8

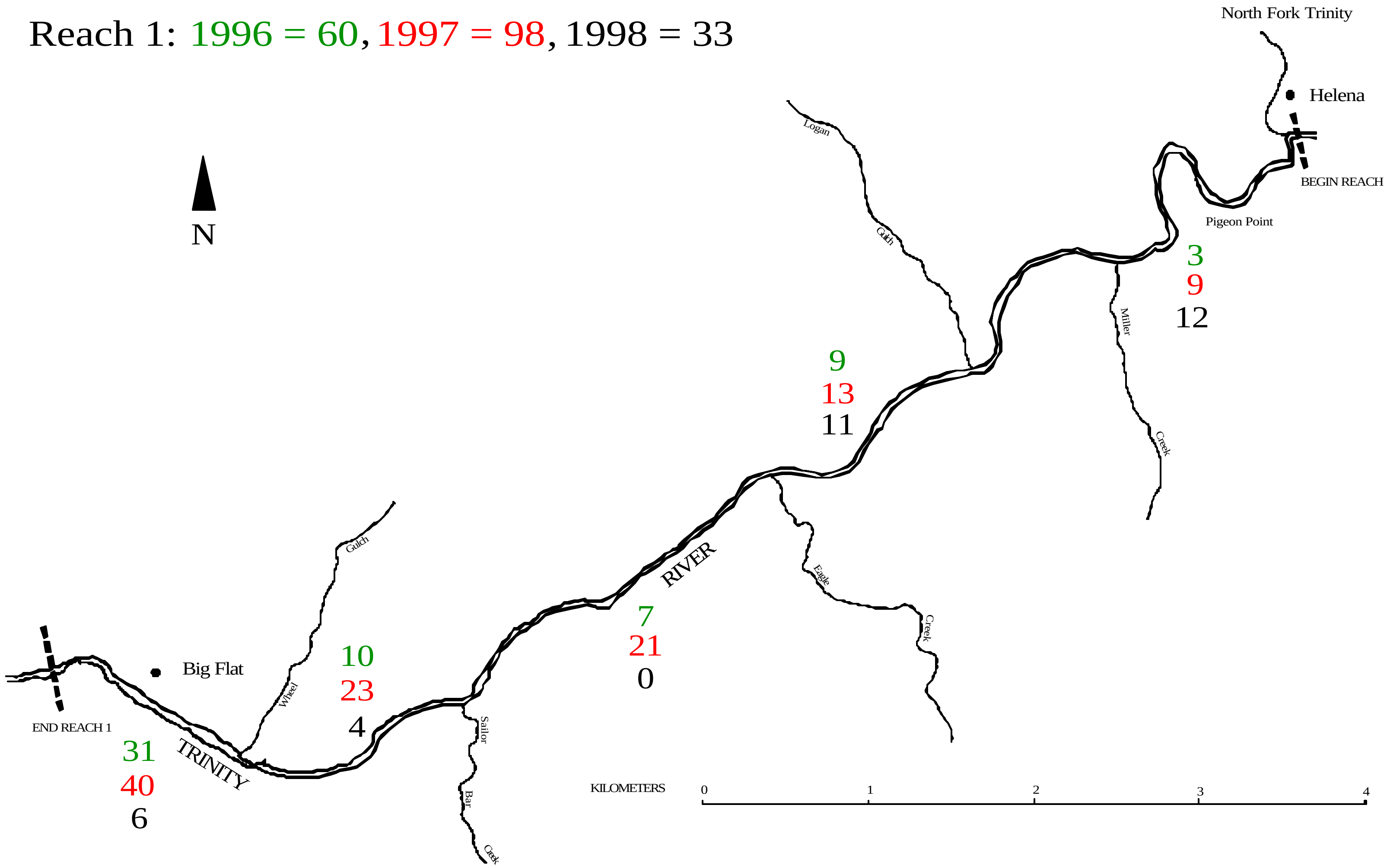

Figure 2. Reach 1. North Fork Trinity River to Big Flat river access (10.1 rkm). Redd Distribution 1996-1998.

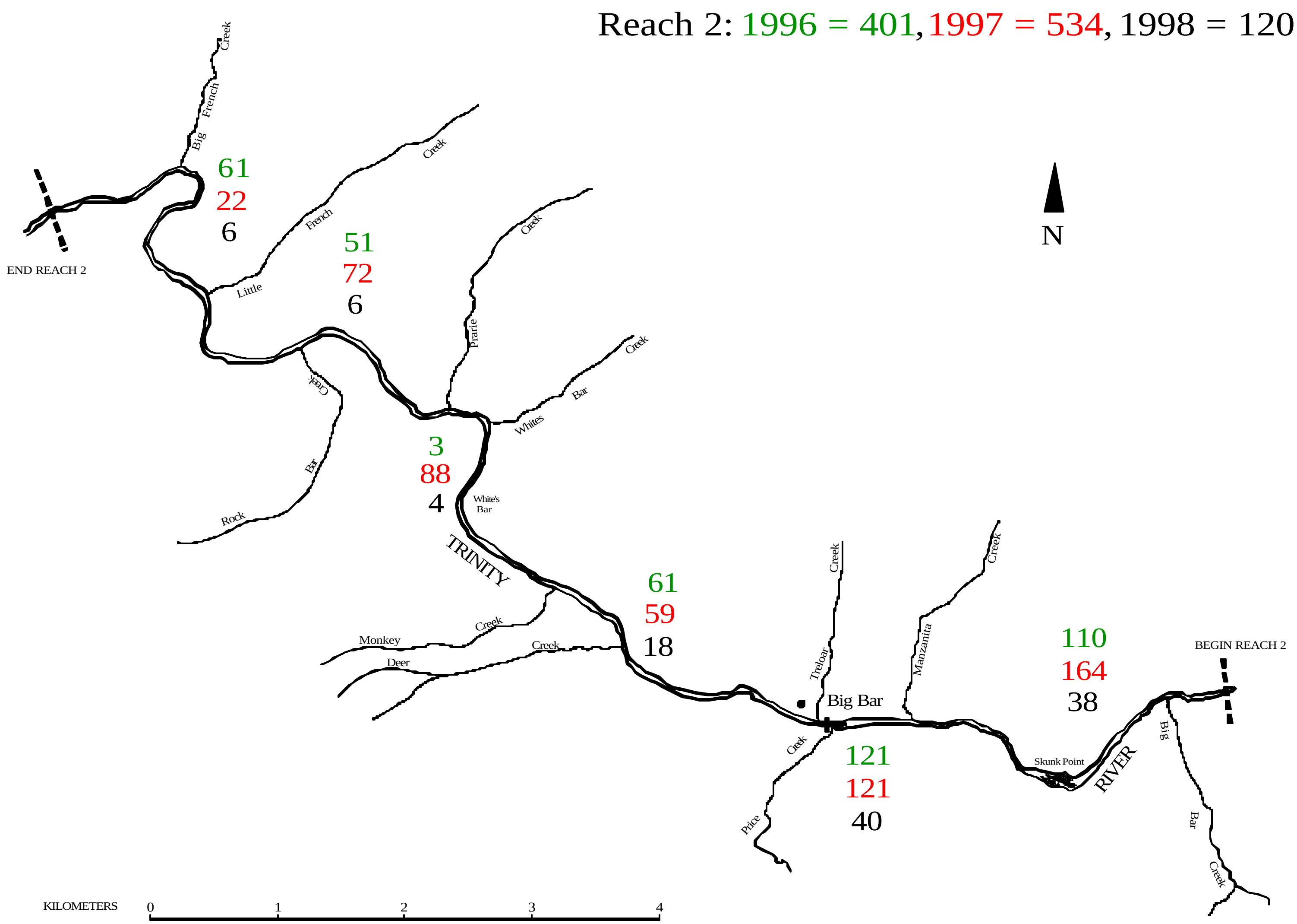

Figure 3. Reach 2. Big Flat river access to one mile downstream of Big French Creek (14.1 rkm). Redd distribution 1996-1998.

channel immediately upstream of the Big Bar bridge (approximate rkm 103). This reach also consistently had higher numbers of redds on the left bank than on the right each year.

Reach 3: French Bar (Del Loma in 1998) to Cedar Flat river access (Table 1, Figure 4).

Reach 3 had the second highest number of redds per reach in all three years, although in 1998 there was only one more redd in this section than in reach 1. We counted a total of 141, 296, and 34 redds in 1996-1998 respectively, which equates to 23%, 32%, and 18% of total redds per year. Redd density in this reach was 9.9, 20.7, and 2.4 redds/rkm, respectively. Total counts for 1998 were only 11% and 24% of the 1997 and 1996 counts. Peak spawning activity in this reach occurred during the last week of October or first week of November in all three years. Numbers of redds were similar on both banks for all three years in this reach.

Reach 3: 1996 = 141, 1997 = 296, 1998 = 34

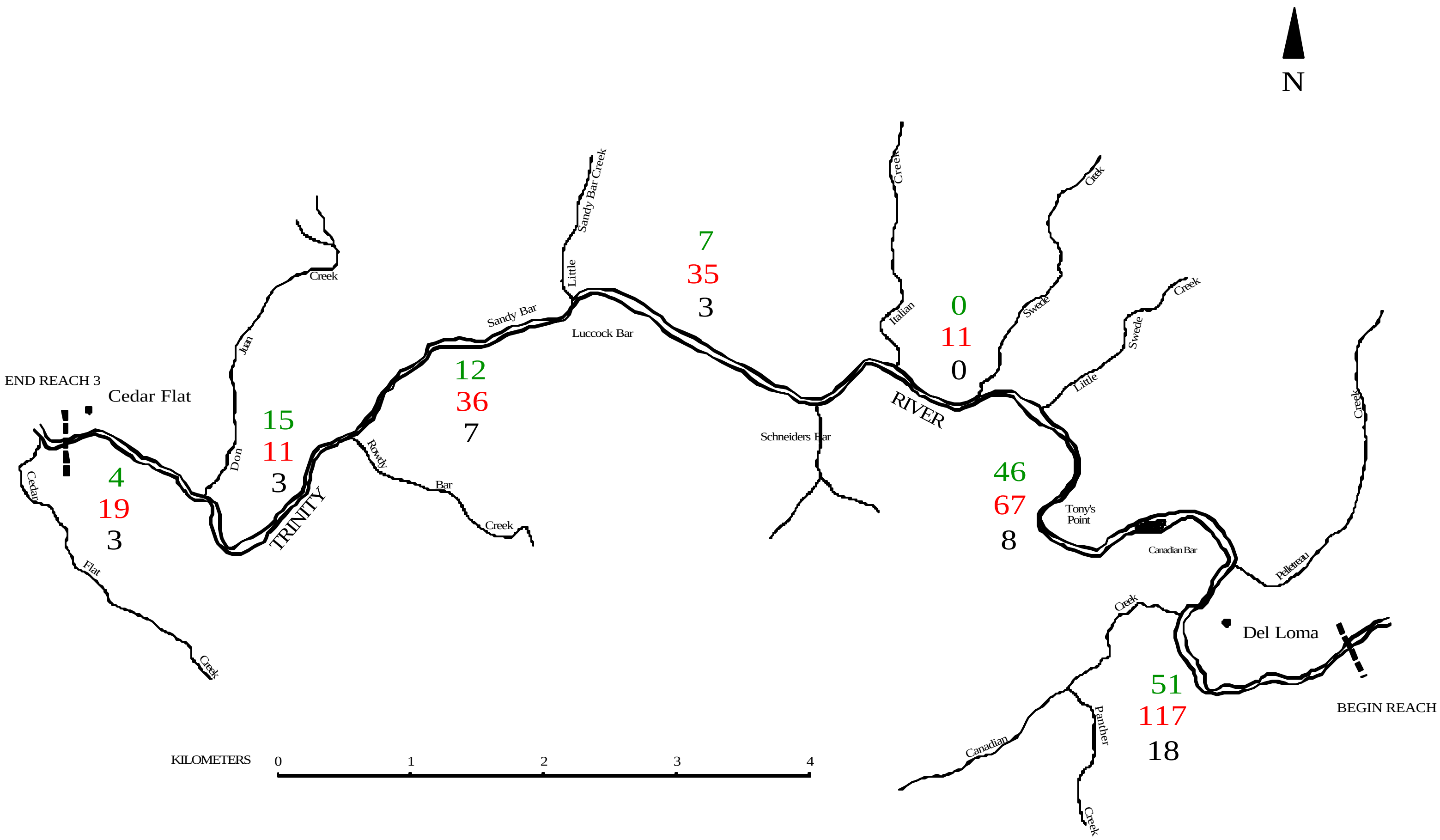

Figure 4. Reach 3. One mile downstream Big French Creek to Cedar Flat river access (14.3 rkm). Redd distribution 1996-1998.

Redd Counts by Mainstem Tributaries

The mainstem was divided to describe frequency of spawning redd occurrence, in percent, by yearly redd counts between mainstem tributaries (Table 2). The Reach 1 end point falls between Wheel Gulch and Big Bar Creek, therefore, tributary total numbers are different than the reach total. Similarly, the reach 2 end point for 1998 is between Big French Creek and Canadian Creek so totals by tributary differ from Reach 2 totals.

Table 2. Yearly redd frequency, in percent, between major tributaries on the mainstem Trinity River, North Fork to Cedar Flat, 1996-1998.

TRIBUTARY REACH (rkm)	RIVER DISTANCE	REACH	DISTANCE BETWEEN TRIBS	PERCENT REDD OCCURRENCE		
				1996	1997	1998
NF Trinity (116.7) – Miller Creek (114.6)	116.7	1	2.1	0.5	1.0	6.4
Miller Creek (114.6) – Eagle Creek (111.8)	114.6	1	2.8	1.5	1.4	5.9
Eagle Creek (111.8) – Sailor Bar Creek (109.4)	111.8	1	2.4	1.2	2.3	0
Sailor Bar Creek (109.4) – Wheel Gulch (108.0)	109.4	1	1.4	1.7	2.5	2.1
Wheel Gulch (108.0) – Big Bar Creek (106.0)	108.0	1	2.0	5.1	4.3	3.2
Big Bar Creek (106.0) – Manzanita Creek (103.6)	106.0	2	2.4	18.3	17.7	20.3
Manzanita Creek (103.6) – Price Creek (103.0)	103.6	2	0.6	20.1	13.0	21.4
Price Creek (103.0) – Deer Creek (101.2)	103.0	2	1.8	10.1	6.3	9.6
Deer Creek (101.2) – Prairie Creek (98.3)	101.2	2	2.9	0.5	9.5	2.1
Prairie Creek (98.3) – Little French Creek (95.7)	98.3	2	2.6	8.5	7.7	3.2
Little French Creek (95.7) – Big French Creek (94.1)	95.7	2	1.6	10.1	2.4	3.2
Big French Creek (94.1) – Canadian Creek (90.9)	94.1	3	3.2	8.5	12.6	9.6
Canadian Creek (90.9) – Little Swede Creek (87.7)	90.9	3	3.2	7.6	7.1	4.3
Little Swede Creek (87.7) – Italian Creek (86.4)	87.7	3	1.3	0	1.2	0
Italian Creek (86.4) – Little Sandy Bar Creek (84.0)	86.4	3	2.4	1.2	3.8	1.6
Little Sandy Bar Creek (84.0) – Rowdy Creek (80.9)	84.0	3	3.1	2.0	3.9	3.7
Rowdy Creek (80.9) – Don Juan Creek (79.6)	80.9	3	1.3	2.5	1.2	1.6
Don Juan Creek (79.6) – Cedar Flat (78.2)	79.6	3	1.4	0.7	2.0	1.6

Although the spatial pattern of redd occurrence remains similar between years, there are some changes in yearly redd occurrence within the study area. Declines in percentage of redds between mainstem tributaries are apparent between Eagle Creek and Sailor Bar Creek in 1998, as well as in the 5.5 rkm segment between Deer Creek and Little French Creek in 1998. Increases in percentages of redds were observed in reach 1, from the North Fork Trinity River to Eagle Creek (Table 2; Figure 5).

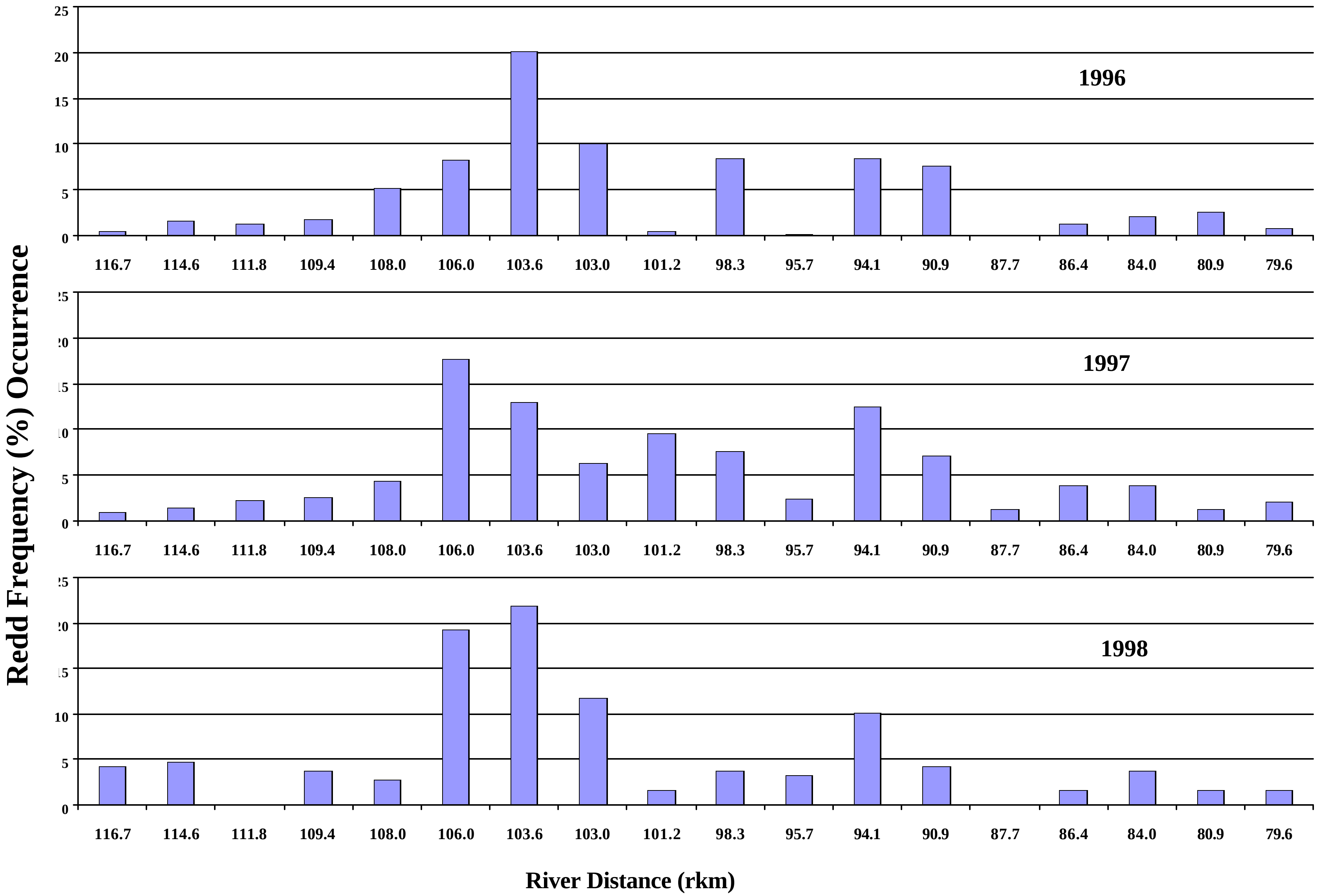

Figure 5. Yearly Chinook salmon redd frequency (%) occurrence between mainstem tributaries. North Fork Trinity River (116.7 rkm) to Cedar Flat (79.6 rkm), 1996-1998.

13

For all years of the survey, the area of highest redd production occurred in the 4.8 rkm portion of reach 2 from Big Bar Creek to Deer Creek, accounting for 49%, 37%, and 53% of the total redds surveyed for 1996-1998, respectively. The area showing the second highest redd production was in the 10.6 rkm stretch of reach 2, from Prairie Creek to Little Swede Creek with 35%, 30%, and 21% of the total redds surveyed.

Redd Substrate Composition

In 1997, 92 (10%) of the 928 total redds were estimated for percent substrate composition. The average substrate percentage used by fall chinook during the survey was 4% large cobble, 22% small cobble, 44% large gravel, 27% small gravel, and 3% sand/silt/clay. Of the 187 total fall chinook redds observed during the 1998 survey, 60 redds (32%) were estimated for percent substrate composition and the average substrate percentages used was 5% large cobble, 20% small cobble, 35% large gravel, 32% small gravel, and 8% sand/silt/clay (Figure 6.).

Mainstem Water Temperatures

Mainstem water temperatures during the 1996 spawning survey ranged between 10.0$^{?}$C (50.0$^{?}$F) during week 1, to 9.1$^{?}$C (48.4$^{?}$F) in week 2. For 1997 mainstem temperatures ranged between 10.6$^{?}$C (51.1$^{?}$C) during week 1 to, 9.7$^{?}$C (49.5$^{?}$F) during week 2, and 8.9$^{?}$C (48$^{?}$F) during week 3. For 1998 mainstem temperatures were 11.8$^{?}$C (53.2$^{?}$F) in week 1, 11.7$^{?}$C (53.1$^{?}$F) in week 2, and 9.6$^{?}$C (49.3$^{?}$F) (CDEC, 1999). These temperatures are within the temperature range (5.6$^{?}$C-13.9$^{?}$C) preferred by fall chinook salmon (Reiser and Bjornn, 1979). Visual estimates of water clarity ranged between 4 to 10 feet (approximately) during all years of the survey period and was adequate to detect chinook salmon redds in all reaches.

Suction Dredge Mining

Suction dredge mining occurs throughout the 24 miles of the mainstem study area. A total of 14 redds were noted on or near suction dredge mining tailings in 1996, therefore, increased efforts were made in 1997 and 1998 to enumerate and identify redds in proximity to dredge tailings. In 1997, a total of 38 redds were observed in close proximity to dredge tailings. Again, in 1998, 20 redds were observed on or near (<1000 m) dredge tailings. During the past three years a total of 72 redd (4% of all redds counted) were counted on or near suction dredge tailings; 23 were on tailing deposits, 49 were on gravel that were obviously suction dredged within the last two seasons. Redds on mining tailings were particularly heavy in reach 2 where 57 of the 72 (79%) redds were observed.

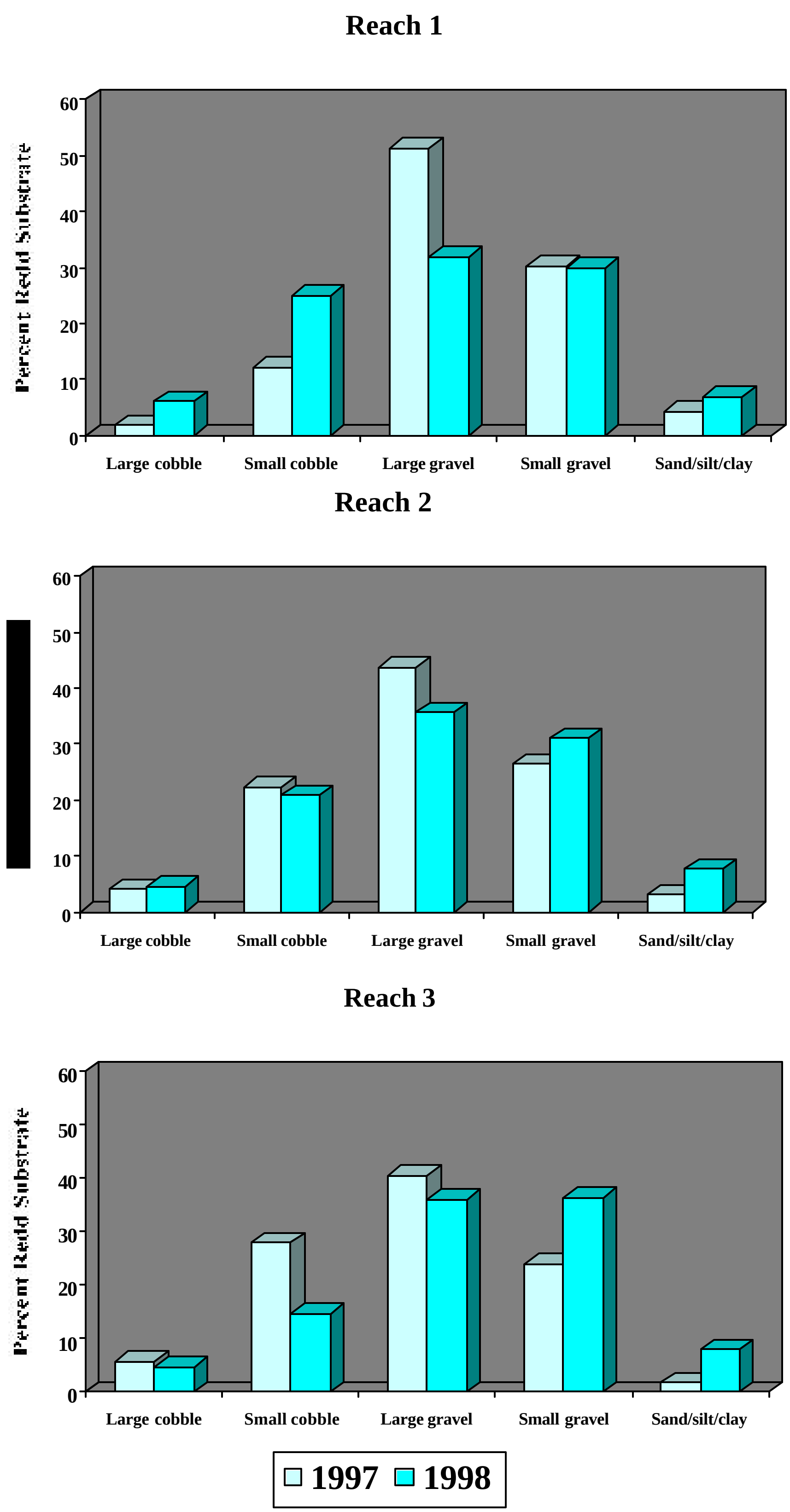

Figure 6~~x~~. Comparison of redd substrate composition by study reach, 1997-1998. (1997: n = 110, 1998: n = 60).

Discussion

Redds were located throughout the 24 mile mainstem survey area between the North Fork Trinity River and Cedar Flat in all three years. In 1996, approximately 66% of all redds observed were in reach 2. In 1997 just over 57% of the total redds identified were in reach 2. For 1998 approximately 64% of all redds counted were in reach 2, between Big Bar Creek and immediately downstream of Big French Creek (13.4 rkm).

Dissimilar redd distributions were apparent in reach 1 between the North Fork Trinity and Big Flat. In reach 1, the percentage of total redds for 1996 and 1997 remained roughly the same (10%), but in 1998 this increased to 18% in spite of an 80% decrease in the total number of redds within the study area. For the combined Reach 3, there was an increase from approximately 23% in 1996 to 32% in 1997. A decrease to 18% was observed from 1997 to 1998.

Although there is no clear empirical evidence to explain this fluctuation in redd distribution, dramatic alteration of notable spawning areas on the Klamath River was observed after the flood of January 1, 1997 (USFWS, 1997). Spawning gravel alterations could play a role in redd distribution differences on the Trinity River.

Spatial distribution of adult spawners has varied considerably and mysteriously on the Trinity (Zuspan, pers. comm., 1993 as cited in Bartholow 1996). For example, during California Department of Fish and Game (CDFG) surveys, in the heavily-seeded 1988 and 1989, about 45% of the spawners concentrated in the upstream-most 8% of the study area near the fish hatchery outfall. In contrast, only 12% of the lightly-seeded 1992's spawners used the same area, spreading themselves more uniformly throughout available spawning habitat (Bartholow 1996).

Several environmental factors affect spawning behavior and spawner distribution. Water temperature and discharge, photoperiod, and ocean conditions can all cause fluctuations in numbers of fish and migration distances. Distribution of redds could be related to the total number of fish in the river in a given year. It could also be related to the percentage of hatchery origin fish in the system. Hatchery origin fish composed 33%, 29% and 46% of the population of fall chinook above Willow Creek in 1996, 97 and 98.

Conceivably, when there is a greater percentage of hatchery origin fish in the river, more of these fish would move further upstream (towards the hatchery) to spawn. However, without basinwide comparisons of redd distribution and abundance, it is not possible to determine if this phenomenon actually occurs or if there is a significant relationship. Based on CDFG estimates, the natural fall chinook spawner escapement on the mainstem Trinity River (above Willow Creek) for 1996 was 42,646 adults and 4,478 jacks. The estimate for 1997 was 11,507 adults and 2,845 jacks and for 1998 it was 24,460 adults and 1,974 jacks (CDFG, 1998b). Table 3 provides more information on adult and jack estimates for natural spawners, adult returns to the Trinity River Hatchery and hatchery produced fish that spawned in-river.

Table 3. Spawning escapement of fall chinook salmon (in-river and hatchery), adult and grilse expansion, spawning survey redd numbers and percentage of hatchery origin fish in the Trinity River 1996-1998.

Spawner Escapement	1996			1997			1998		
	Grilse	Adult	Totals	Grilse	Adult	Totals	Grilse	Adult	Totals
Trinity River Basin	4,478	42,646	47,124	2,845	11,507	14,352	1,974	24,460	26,434
Trinity River Hatchery	249	6,411	6,660	820	5,387	6,207	192	14,296	14,488
Total Spawner Escapement	4,727	49,057	53,784	3,665	16,894	20,559	2,116	38,756	40,922
Spawning Survey Redds		**602**			**928**			**187**	
Percent In-River Hatchery Origin Fish *		**33%**			**29%**			**46%**	

* Derived from CDFG data.

Because of the various factors affecting distribution and abundance, without several seasons of consistent basinwide sampling efforts, it is difficult to determine the reasons for, or relative importance of, changes in spawner distribution and density.

Suction Dredge Mining

Observations between Big Bar Creek (rkm 106.0) and Little Swede Creek (rkm 87.7), during all years of the survey, where redd concentrations were highest, indicate that suction dredge mining pressure in high-density redd habitats could impact the survival of incubating chinook salmon eggs. Suction dredging activity may affect the viability of spawning redds on the Trinity River by altering the stability of spawning gravels. The integrity of newly formed redds, particularly on the wetted bank edge or at the tail crests of pools, could be jeopardized by this activity. There is a growing body of knowledge about effects of dredge tailings and salmonid reproduction. Previously published reviews indicate that salmonid spawning and embryo development can be affected by instability of spawning gravels (Harvey and Lisle, 1998). Increased efforts by our survey crews were made to enumerate redds on or near dredging operations. In the last three years 72 redds (4%) were counted on or near mining operations. Redds near mining operations were particularly heavy in reach 2 where 57 of the 72 (79%) redds were observed. Dredge tailings may be attractive sites for redd construction because tailings are often located near riffle crests where fish frequently spawn, and they provide loose, appropriately sized substrate. However, embryos in tailings may suffer high mortality if high flows scour the tailings, thereby destroying the redds (Harvey et al. 1998). During the 1998 surveys (water year 1999), redd scouring near mining tailings may not be a concern due to the relatively low flows that occurred that year. However, high flows during late fall and early winter of survey years 1996 and 1997 may be of concern. Peaks in flow for the three survey years can be seen in Figure 7 which shows stream discharges at Cedar Flat gauging station for water years 1997-1999 (Miyashita, USGS pers. comm. 1999). Additional observations or more detailed study would be necessary to determine

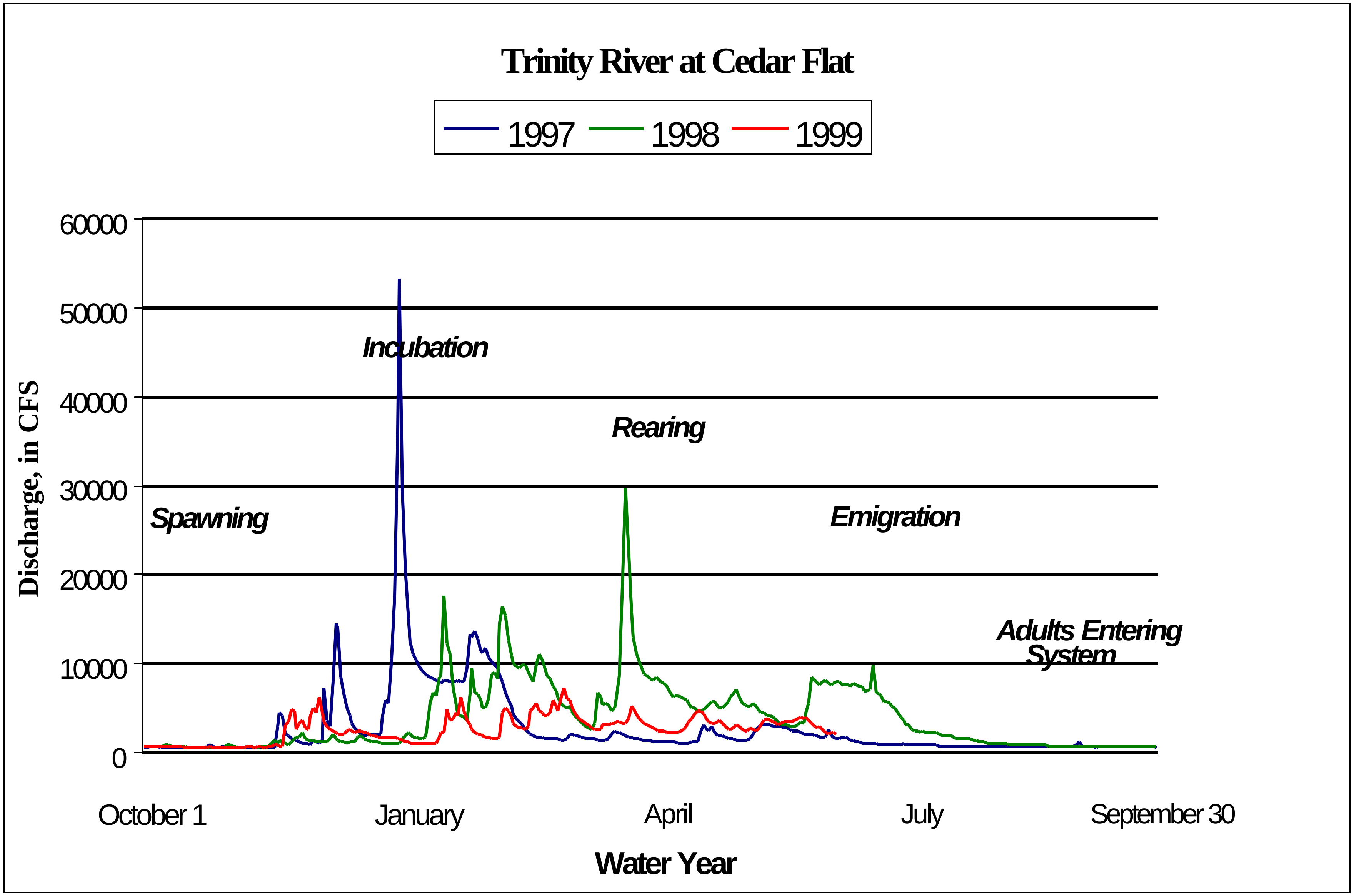

Figure 7. Discharge, in CFS at Cedar Flat gauging station (USGS). Water Years 1997-1999 correspond to survey years 1996-1998.

flow rates that actually cause bedload movement and potential redd scouring at mine tailing areas.

Several members of the Trinity River mining community participated in surveys with us during the 1997 effort, to learn redd identification techniques and to better understand where chinook salmon spawning occurs. Their desire to learn about salmon redd locations may help alleviate the potential negative impacts of suction dredge mining on salmon redds.

With the Interior Secretary’s anticipated flow management decision for the Trinity River expected during the spring of 2000, and other developmental activities continuing, further monitoring is needed to address questions surrounding the impacts on mainstem spawning habitat and escapement. More "pre-implementation" information is necessary to determine if changes in flow will have specific beneficial or negative effects on salmon populations by shifting spawner distributions and abundance. Observed changes in distribution and abundance may be pertinent to future flow management decisions and channel rehabilitation efforts. The information provided by the Arcata Fish and Wildlife Office’s spawning surveys supplies fishery managers with accurate and reliable yearly estimates of mainstem Trinity River fall chinook spawning distribution and abundance. Surveys of the entire mainstem would provide much more usable information. This information could be beneficial for the adaptive environmental assessment and management plan in the Trinity River Flow Evaluation Report (USFWS, HVT 1999). Furthermore, the method of direct observation from rafts to conduct “real time” spawning surveys provides timely spawning data and habitat observations necessary to aid in the evaluation of activities that are detrimental or beneficial to chinook salmon habitat, particularly during critical spawning and egg incubation periods.

REFERENCES

Bartholow, J. M. 1996. Sensitivity of a salmon population model to alternative formulations and initial conditions. Ecological Modeling 88: 215-226.

CDEC (California Data Exchange Center), 1999. California Department of Water Resources, Division of Flood Management, Sacramento, CA. Web Site.

CDFG (California Department of Fish and Game), 1998. Klamath River basin chinook salmon run-size in-river harvest and spawner escapement-1998 season.

CDFG (California Department of Fish and Game). 1998. Annual Report, Trinity River Basin salmon and steelhead monitoring project, 1996-1997 season. Inland Fisheries Division, Sacramento, CA. 30 pp.

Harvey, B. C., T. E. Lisle, 1998. Effects of suction dredging on streams: a review and an evaluation strategy. Fisheries 23 (8): 8-17.

Moffett, J. W., S. H. Smith, 1950. Biological investigations of the fishery resources of the Trinity River, California. USDI special scientific report-fisheries No. 12. 71 pp.

Reiser, D. W., T. C. Bjornn. 1979. Habitat requirements of anadromous salmonids. General Tech. Reports PNW-96 USDA Forest Service, Portland, OR. 56 pp.

TRBFWMP (Trinity River Basin Fish and Wildlife Management Plan), 1982. Trinity River fish and wildlife task force.

USFWS (U.S. Fish and Wildlife Service). 1987-1991. Trinity River Flow Evaluation - Annual Report. U.S. Fish and Wildlife Service, Division of Ecological Services. Sacramento, CA.

USFWS (U.S. Fish and Wildlife Service). 1994. Rehabilitation of the mainstem Trinity River background report. Trinity River rehabilitation program, US Fish and Wildlife Service. Weaverville, CA. 14pp.

USFWS (U.S. Fish and Wildlife Service). 1997. Mainstem Klamath River fall chinook spawning survey. US Fish and Wildlife Service. Coastal California Fish and Wildlife Office, Arcata, CA. 22pp.

USFWS/HVT (U. S. Fish and Wildlife Service and Hooppa Vally Tribe) 1999. Trinity River flow evaluation final report. Arcata Fish and Wildlife Office, Arcata, CA. Hoopa Valley Tribe, P.O. Box 417, Hoopa CA. 310pp.

PERSONAL COMMUNICATIONS

Hydeki Miyashita. March 1999. Hydrologic clerk, U.S. Geological Survey, Sacramento, CA.