Salmonid Survey Spawning Report, October 2006 Through March 2007, Mokelumne River, California.

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Abstract: Weekly fall-run chinook salmon (*Oncorhynchus tshawytscha)* spawning surveys were conducted in the lower Mokelumne River from October 11, 2006 through January 8, 2007. The estimated escapement during this period was 5,861 chinook salmon. The estimated number of in-river chinook salmon spawners was 1,723 fish. During the survey period 755 chinook salmon redds were observed, of which 94 or 12.5% were superimposed. The reach from Camanche Dam to Mackville Road contained 651 salmon redds (88%) and the reach from Mackville Road to Elliott Road had 101 redds (12%). Bi-weekly steelhead (*Oncorhynchus mykiss*) spawning surveys were conducted in the lower Mokelumne River from January 8, 2007 through March 15, 2007. During the survey period, 65 steelhead redds were observed with peak spawning occurring on or around February 23, 2007.

INTRODUCTION

The 627 sq. mile Mokelumne River watershed ranges from the Sierran Crest to the Sacramento - San Joaquin Delta. Pardee and Camanche reservoirs, located on the Mokelumne River (Figure 1), are owned and operated by East Bay Municipal Utility District (EBMUD), which provides water for approximately 1.3 million customers in Alameda and Contra Costa Counties. Additionally, there are reservoirs and power generation facilities located upstream of Pardee Reservoir owned and operated by Pacific Gas & Electric Company (PG&E). Downstream of Camanche Dam, Woodbridge Irrigation District (WID) operates Woodbridge Dam (WD) and an associated system of irrigation canals near Lodi, CA.

The lower Mokelumne River (LMR) is used by fall-run chinook salmon *Oncorhynchus tshawytscha* and steelhead trout *O. mykiss* for spawning and rearing. Adult chinook salmon ascend the river as early as late August and may begin spawning in late September. The peak of the run usually occurs in November and tapers off through the month of December (Marine and Vogel 1994, Hartwell 1996, Setka 1997). The Mokelumne River Fish Hatchery (hatchery), constructed in 1964 to mitigate for spawning habitat lost with the construction of Camanche Dam, receives approximately 65.7% of the total run per year (1990-2005 average). EBMUD has conducted annual spawning surveys in the lower Mokelumne River (LMR) since 1990 (Hagar 1991, Hartwell 1996, Setka 1997). Concurrent with these surveys, EBMUD enumerates chinook salmon escapement at Woodbridge Dam. Data generated from carcass surveys allow for an estimation of the number of chinook salmon within the LMR at any time during the spawning season.

OBJECTIVES

The primary objective of the 2006 spawning survey was to enumerate chinook salmon redds in the LMR. Total escapement to the river was estimated using carcass survey estimates. The escapement estimate was used to associate the number of redds and their characteristics with population structure or density. Additional objectives included:

- Map locations of individual redds
- Enumerate redds impacted by superimposition
- Determine use of enhancement gravel areas

Environmental parameters and flow during the spawning period were summarized. An emergence timeline was constructed based on an egg model developed by Vogel (1993) from Piper et al. (1982).

METHODS

SURVEYS

The lower Mokelumne River is divided into 6 reaches between Camanche Dam and the confluence with the Sacramento-San Joaquin Delta. The reach designations are based on gradient, substrate and tidal influence. Reaches 5 and 6 cover a 15.8 km (9.8 mile) section of the river from Camanche Dam to Elliott Road. Beginning October 1, 2006, weekly redd surveys were conducted in the LMR from Camanche Dam to Elliott Road (Figure 1). The last survey was conducted January 8, 2007. A steelhead spawning survey was subsequently conducted from January through March. The reaches were surveyed on 1 or 2 days per week, depending on spawning activity. Surveys consisted of three individuals walking abreast down the river (water depths to 4 feet) and searching for signs of redd construction. This method has been used in past Mokelumne River spawning surveys and in other rivers and streams (Keefe et al. 1994, Fritsch 1995, Hartwell 1996, Setka 1997). A canoe was used to transport surveyors between spawning areas.

In previous surveys, redds were marked with numbered cattle ear tags and locations were recorded using a Global Positioning System (GPS) unit (Trimble Pro XR) and a laser range finder (Laser Atlanta Advantage). Beginning Fall 2007, redd locations were recorded directly using two hand-held GPS units (Trimble Geo XH). Individuals positioned themselves directly behind redds (on the downstream end of the tailspill) to record positions. Care was taken to avoid impacts to redds during the survey. This new GPS unit recorded more accurate positions (<1 meter real-time) than the older model and had capabilities to display previously recorded data in the field. The ability to see prior week's data in the field allowed surveys to be conducted without physically marking redds. Crew members determined if redds had been marked in previous surveys using the GPS display on which they could see their current position real-time overlaid with data collected in previous surveys.

DATA COLLECTION AND ANALYSIS

Location data for each redd were stored in the GPS unit using Terrasync software and later downloaded to an ArcMAP 9.2 (ESRI) data base. In addition to redd locations, notations were made regarding the characteristics of redds. These included redd depth and superimposition, if present. Water temperatures were measured using hand-held thermometers in the field. However, temperature data used for analysis was obtained from the EBMUD water quality station located at McIntire Road. Data analysis was performed using ArcMAP, Arc/Info (ESRI) systems and EBMUD LMR GIS.

RESULTS

CHINOOK SALMON ESCAPEMENT AND REDD NUMBERS

The total estimated escapement to the Mokelumne River from October 2006 through January 2007 was estimated to be 5,861 chinook salmon (adults and grilse). The estimate was based on weekly carcass surveys performed in reaches 5 and 6, during the spawning season and hatchery returns. Video counts from Woodbridge Dam were available up until November 1st but were discontinued at that time due to low levels in Lake Lodi.

Hatchery staff recorded 4,138 (70.5% of run) chinook salmon entering the hatchery during the 2006 spawning season. The sex and age composition of salmon returning to the hatchery was 1,611 adult females (39 %), 1,210 adult males (29 %), and 1,317 grilse (32%). The carcass counts gave an estimate of 1,723 in-river spawners during the 2006 season.

During the 2006 survey period, 752 redds were observed. The first redd was observed on October 11, 2006. Redd construction peaked during the second week of December and lasted through the end of the month (Figures 2 and 3). Reach 6 contained 651 redds (88% of the total), while Reach 5 contained 101 redds (12 % of the total). The season's redd count was considerably lower than the average redd count for the previous 5 years (1,099 redds). However, this average is skewed by the unusually large number of redds from last year (2,170 redds). This year's count is only about 10% lower than the average from 2001-2004 (832 redds). This compares favorably with the 1990-1995 average (pre-FERC) of 369 redds.

ENHANCEMENT GRAVEL USAGE

Since 1992, the District has conducted 12 gravel enhancement projects in the lower Mokelumne River in cooperation with federal and state agencies. Nearly all potential spawning areas in the Mokelumne River Day-Use Area have been enhanced since then. In 2006, 433 chinook salmon redds or 57.3% of the total number of redds were constructed in habitat enhancement areas (Figure 4). The overall percent use of enhancement areas increased in 2006 compared to 2005 from 54.7% to 57.3%, despite a decrease in the number of in-river spawners.

SUPERIMPOSITION

During the 2006 season 94 redds (12.5 %) were superimposed. Ninety-four percent of redd superimposition occurred in Reach 6, with the remaining 6% occurring in Reach 5. During the peak of the run, weekly SI levels remained steady at about 12% (Figure 5).

Site specific superimposition levels varied from 33% at Dock Island to 0% at five other enhancement sites (Figure 6). The 2006 level of superimposition (12.5 %) is a decrease from 18.8% in 2005 (Figure 7).

ENVIRONMENTAL DATA

Water temperatures below Camanche Dam during the survey period ranged from 16.7°C (November 11, 2006) to 10.5 °C (January 8, 2007) (Figure 8). All redds were constructed in water temperatures under 16.7°C. Releases from Camanche Dam during the survey period ranged from 340cfs (December 12, 2005) to 382cfs (December 29, 2005 (Figure 8). Most redds during the season were constructed at flows of about 340cfs. Some of the10 redds reported on the first survey on October 11th may have been constructed during the gravel cleansing flows before surveys were started.

EMERGENCE TIMELINE

Using the egg model it was predicted that fry began emerging from redds the week of December 5, 2006 and continued through April 3, 2007 (Figure 9). The peak of fry emergence was estimated to be the first week of March.

STEELHEAD REDD NUMBERS

Sixty five steelhead redds were observed during the survey period (January-March 2007). The week of February 23, 2007 had the highest number of redds (21) for the survey. Only 2 of the 65 redds were superimposed on salmon redds and none were superimposed on other steelhead redds. Forty-six (71%) of the steelhead redds were in Reach 6, while the remaining 19 (29%) were in Reach 5.

DISCUSSION

The 2006-2007 escapement of 5,861 salmon was 136% of the historical 1940 through present average (4,318) (Figure 12). The hatchery took 4,138 of these fish, leaving approximately 1,723 in-river spawners during the 2006 season. There were 755 redds observed this season, 87% of which were observed in Reach 6 while approximately 13% of the total redds were observed in Reach 5. The peak of spawning occurred in the second week of December this year, 3 weeks later than the third week of November as it has been for much the of the past decade. As a result of the later spawning, the peak of emergence was estimated to occur in early March. The later run timing is consistant with runs in the Sacramento system in the past few years and may not be the result of any particular set of circumstances on the Mokelumne River.

Superimposition levels decreased this season, likely as a result of the lower number of in-river spawners compared to last season. The superimposition rate for the 2006 season was 12.5%, with 94% of the superimposition occurring in Reach 6. Even the spawning area below the catwalk, which often has high superimposition levels, had only a moderate level of superimposition (21%). The dock island spawning area had the highest level of superimposition at 33%. However, this percentage was the result of only a few redds that were superimposed in an area that had a low number of redds overall. None of the other larger spawning areas had superimposition levels above 18%.

The new data collection methods used for the spawning surveys may have had small effects on the overall number of redds reported for the survey. The new GPS units have made collection of superimposition data and enumeration of redds more accurate. Under the old marking system, there was a possibility that an existing redd could be counted more than once because the tag or brick used to mark the redd was buried or lost. As a result, the old system could have slightly higher estimation of the number of redds than the new system, which uses electronic data and accurate field positions to collect redd data.

The new method could have also had an effect on superimposition numbers by providing more accurate information in the field than the old method. It is not clear whether this difference would result in more or less superimposition being recorded because of the subjectivity involved in the superimposition determination. We do know that the new data collection method results in more accurate data collection by eliminating some of the small sources of error present in the old system. Any differences between the data collection methods, however, are likely small enough to allow general comparisons of the data.

Sixty five steelhead redds were observed during the survey period. This is the largest number of steelhead redds recorded since surveys began in 1998. The next largest count occurred in 2002 when 50 redds were recorded.

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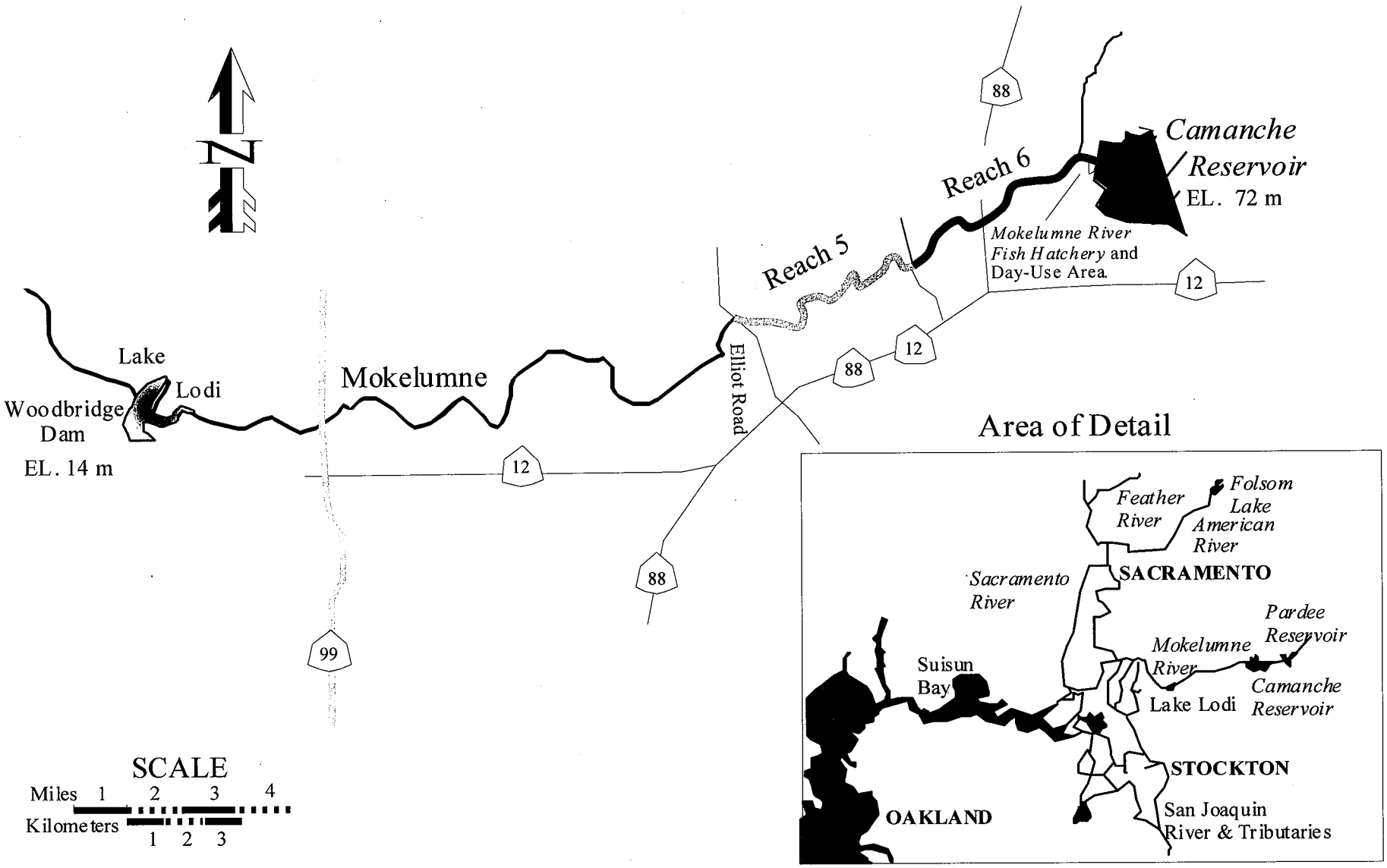

Figure 1. Spawning Reaches of the lower Mokelumne River,

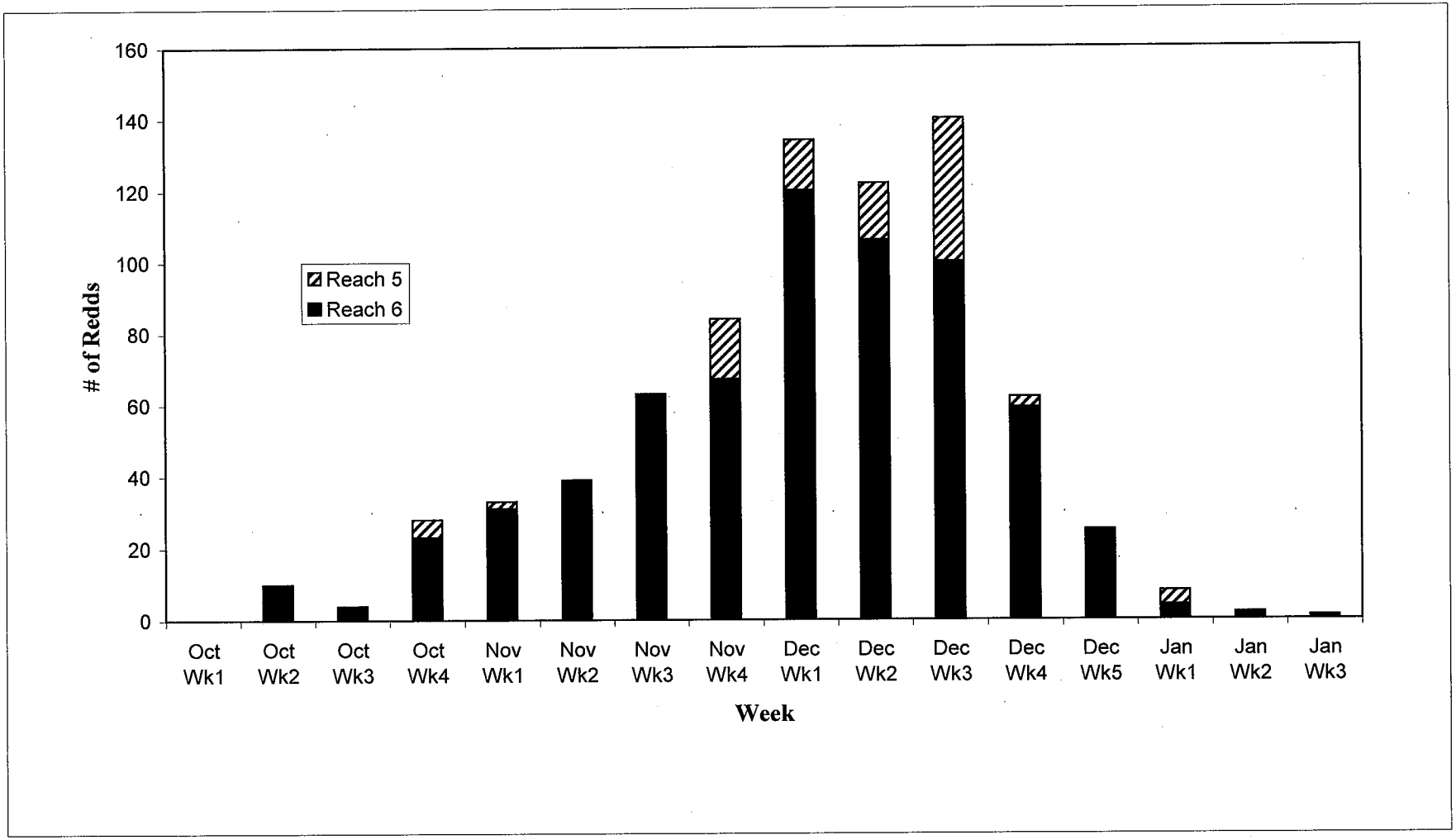

Figure 2. Weekly redd counts by reach in the lower Mokelumne River, California October 2006 - January 2007.

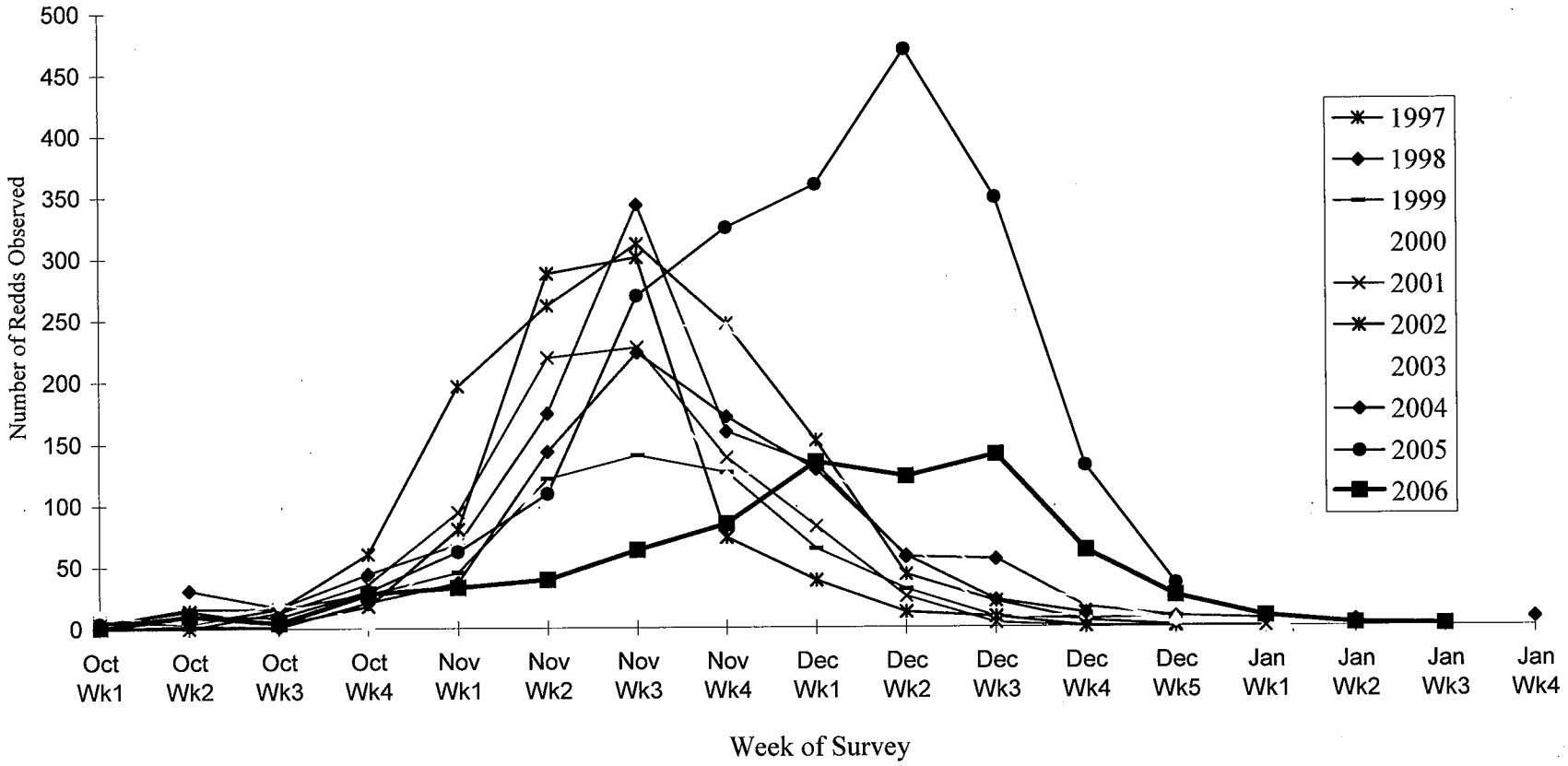

Figure 3. Chinook salmon redd counts per week 1997 - 2006 in the lower Mokelumne River, California.

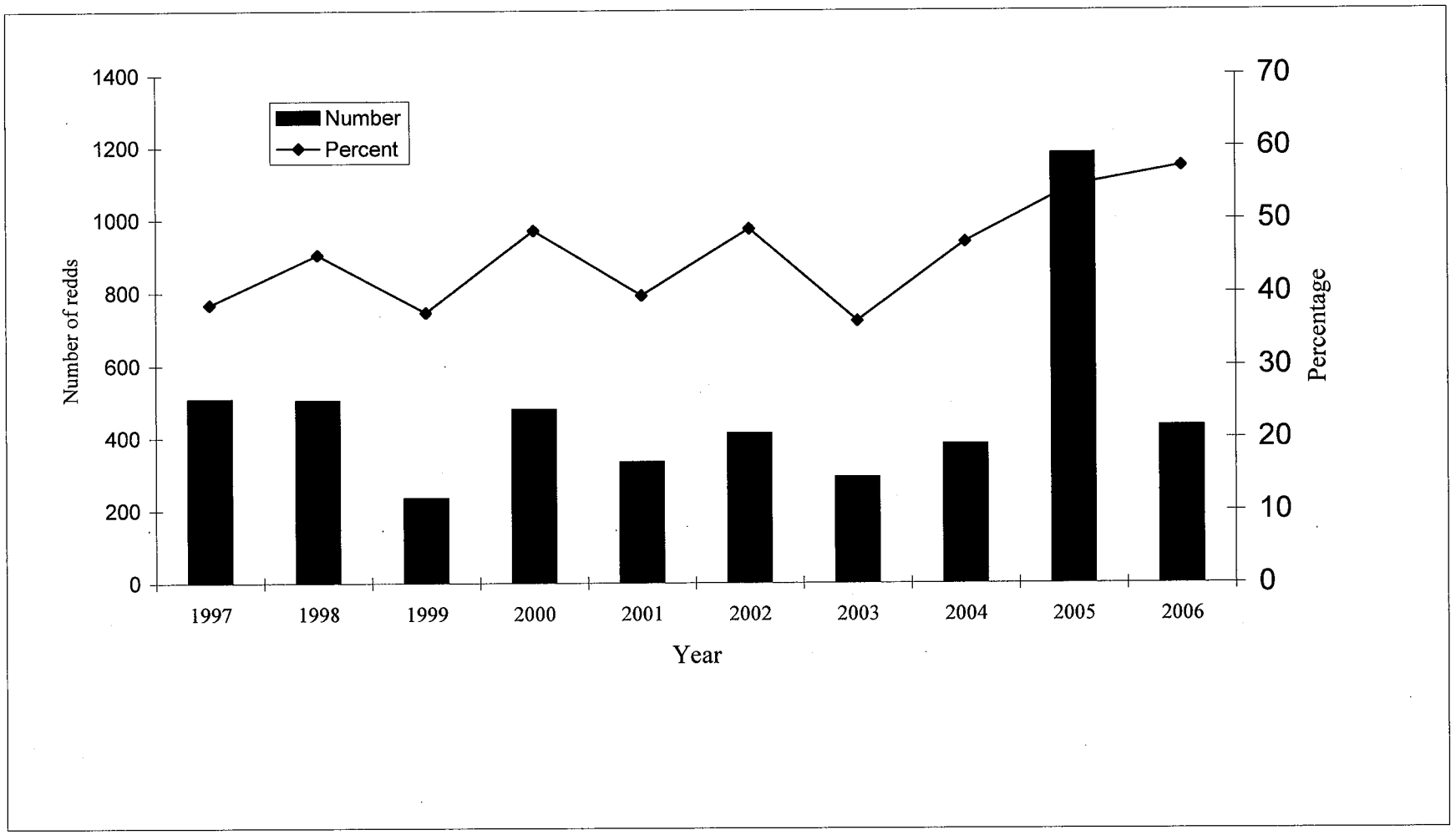

Figure 4. Number and percentage of total redds built from 1997 - 2006 within enhancement areas in the lower Mokelumne River, California.

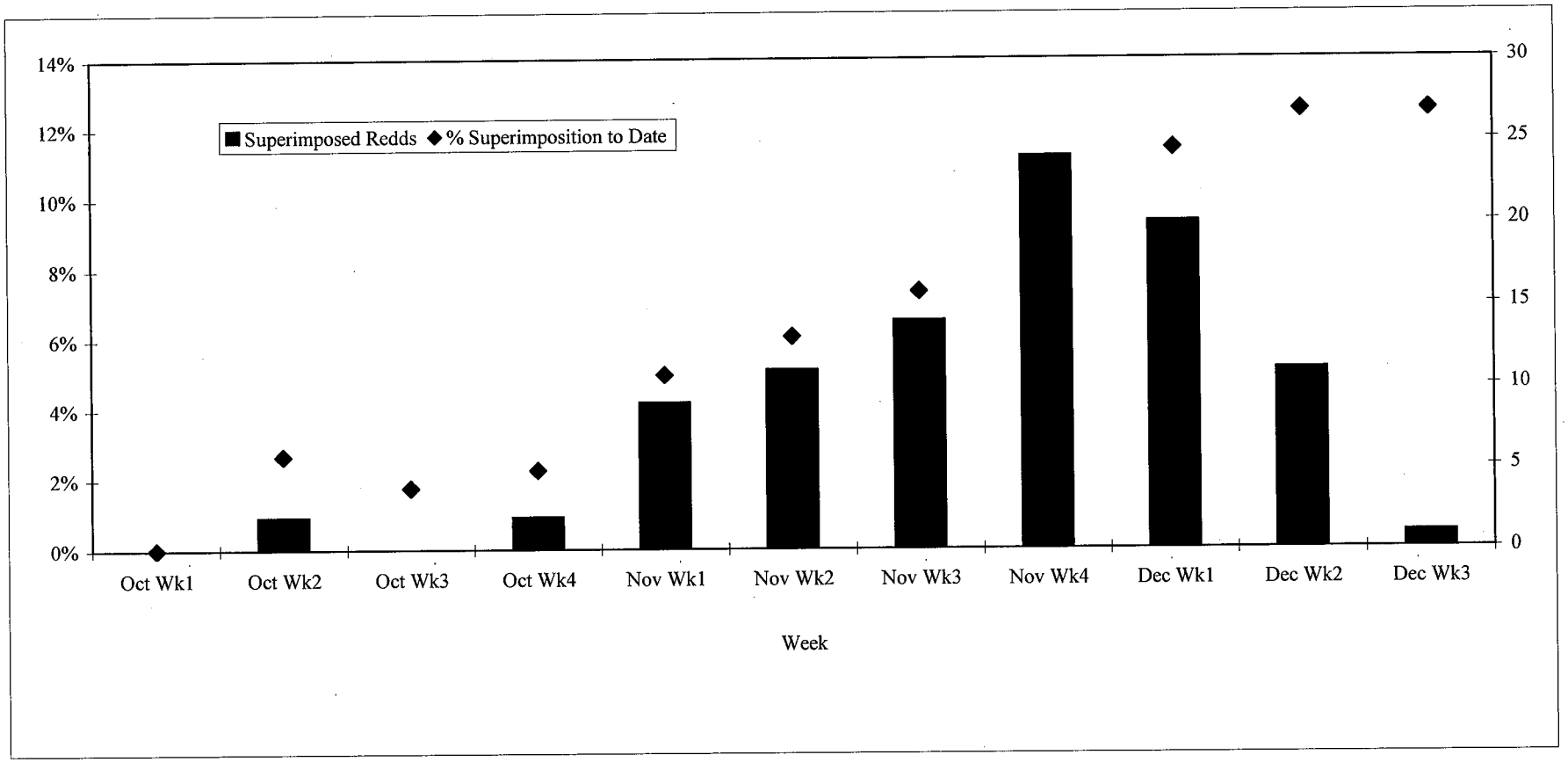

Figure 5. Number and percent of superimposed redds by week from October - December 2006 lower Mokelumne River, California.

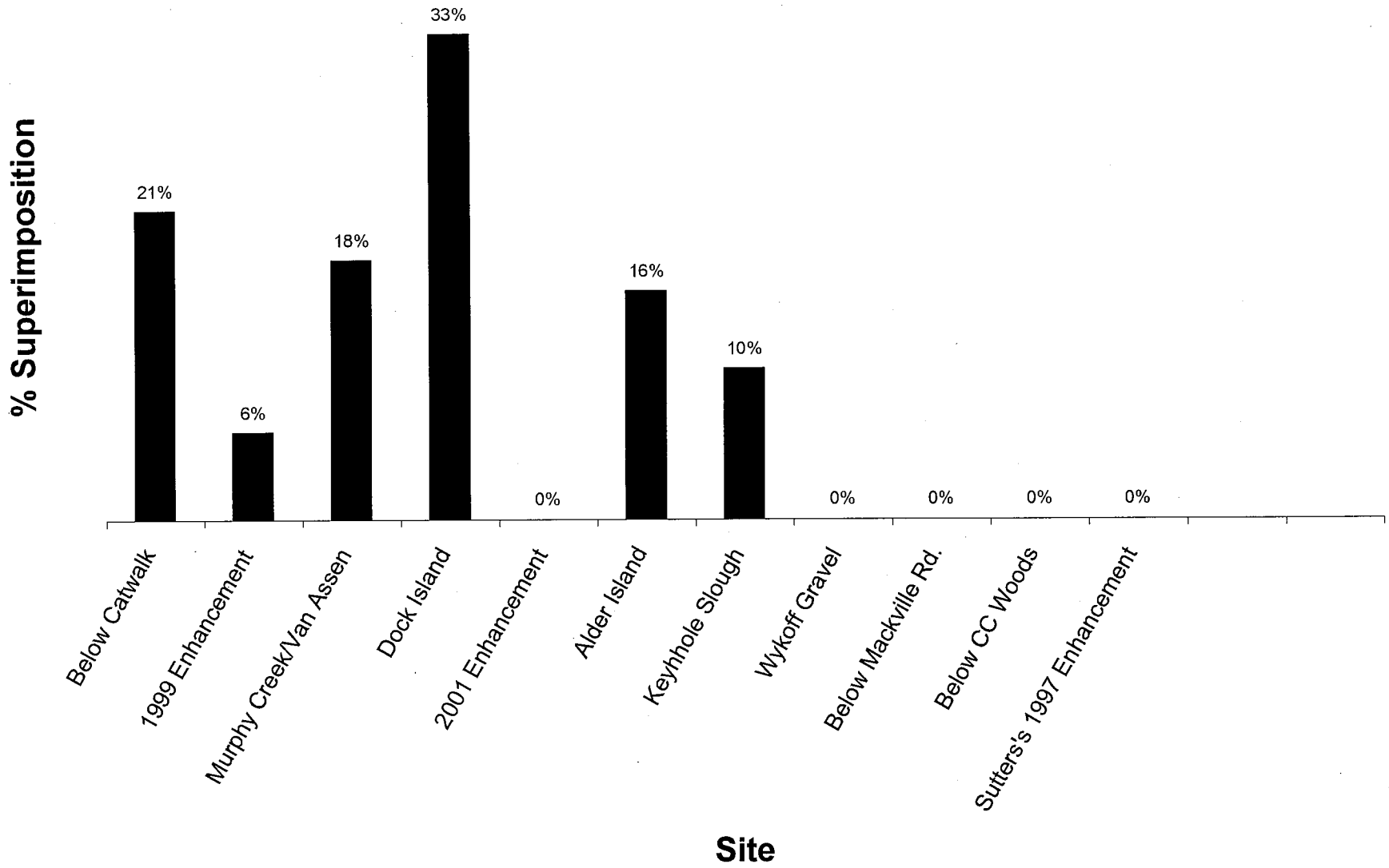

Figure 6: Site-specific superimposition levels at enhancement sites on the lower Mokelumne River, 2006.

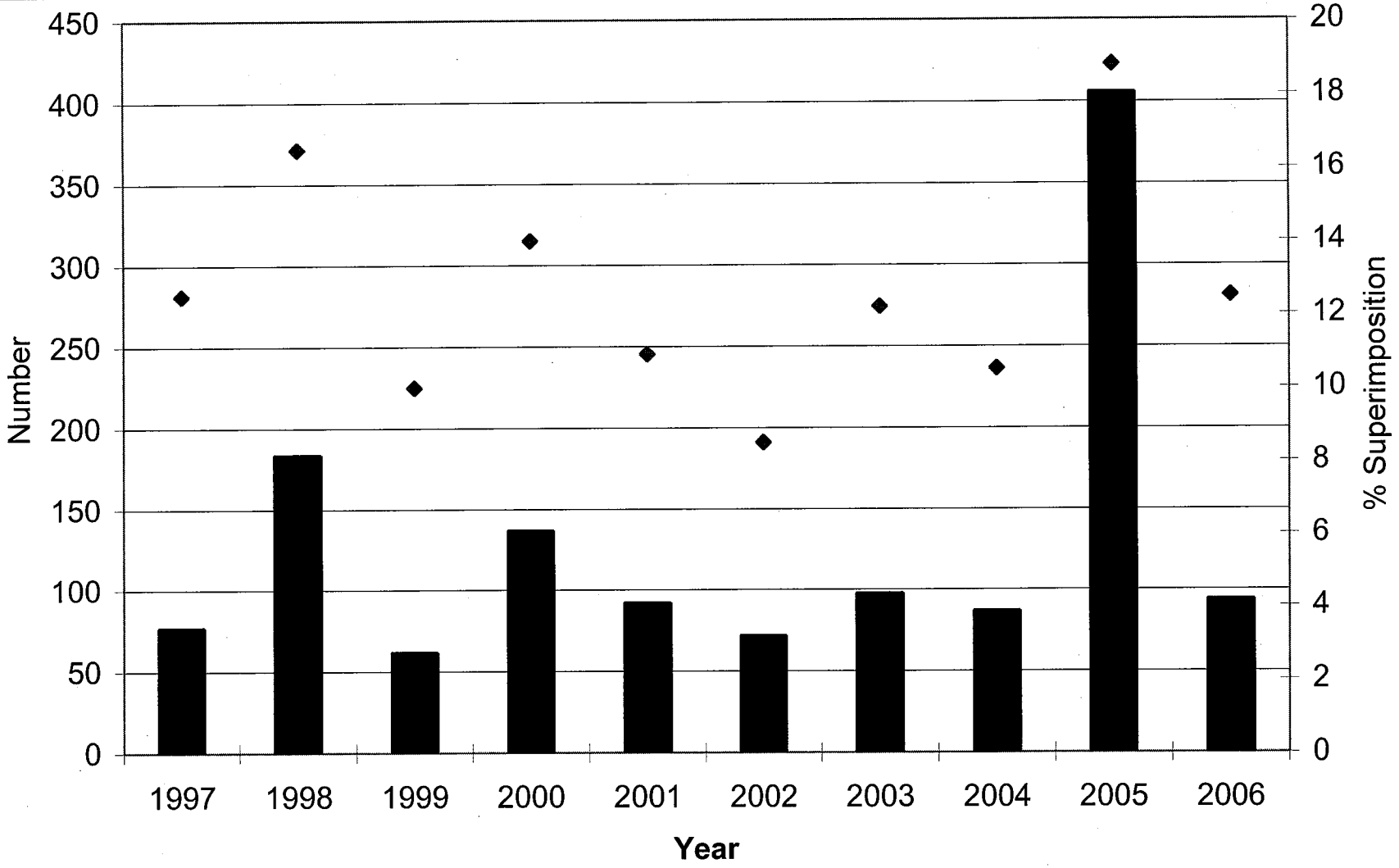

Figure 7: Number and percentage of redd superimposition on the lower Moklemne River, 1997-2006

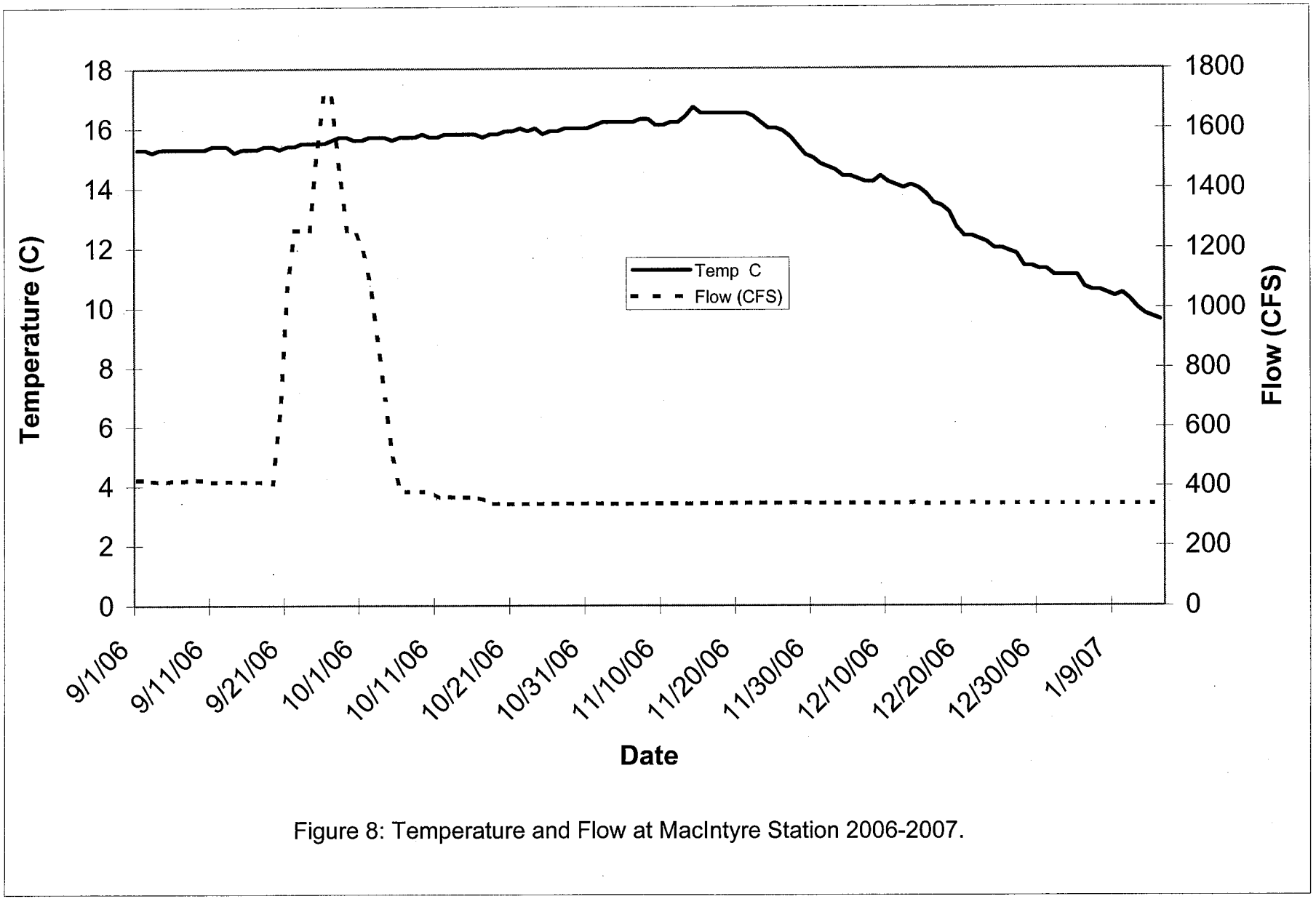

Figure 8: Temperature and Flow at MacIntyre Station 2006-2007.

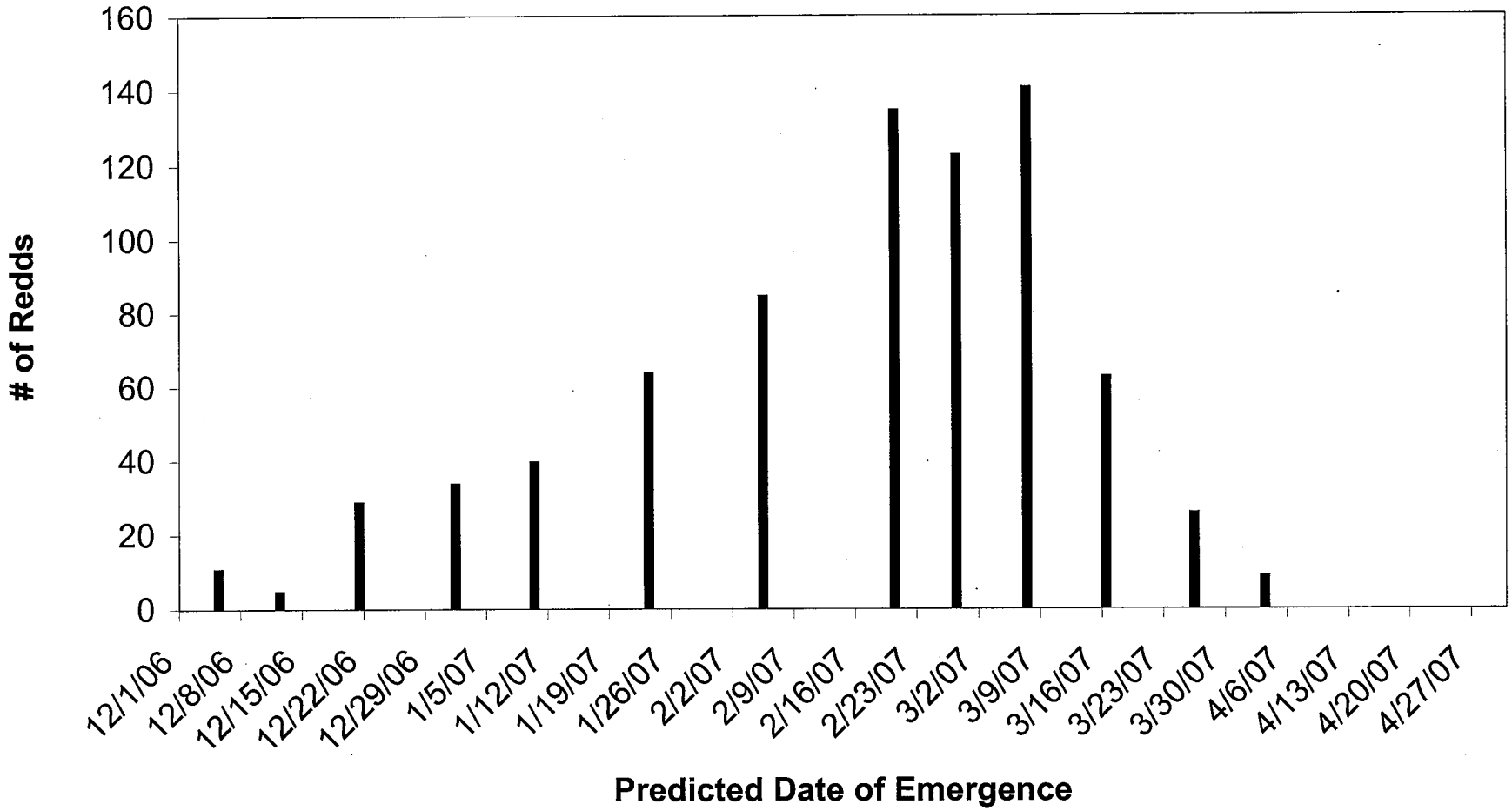

Figure 9. Estimated chinook salmon fry emergence for the lower Mokelumne River, CA 2006-2007

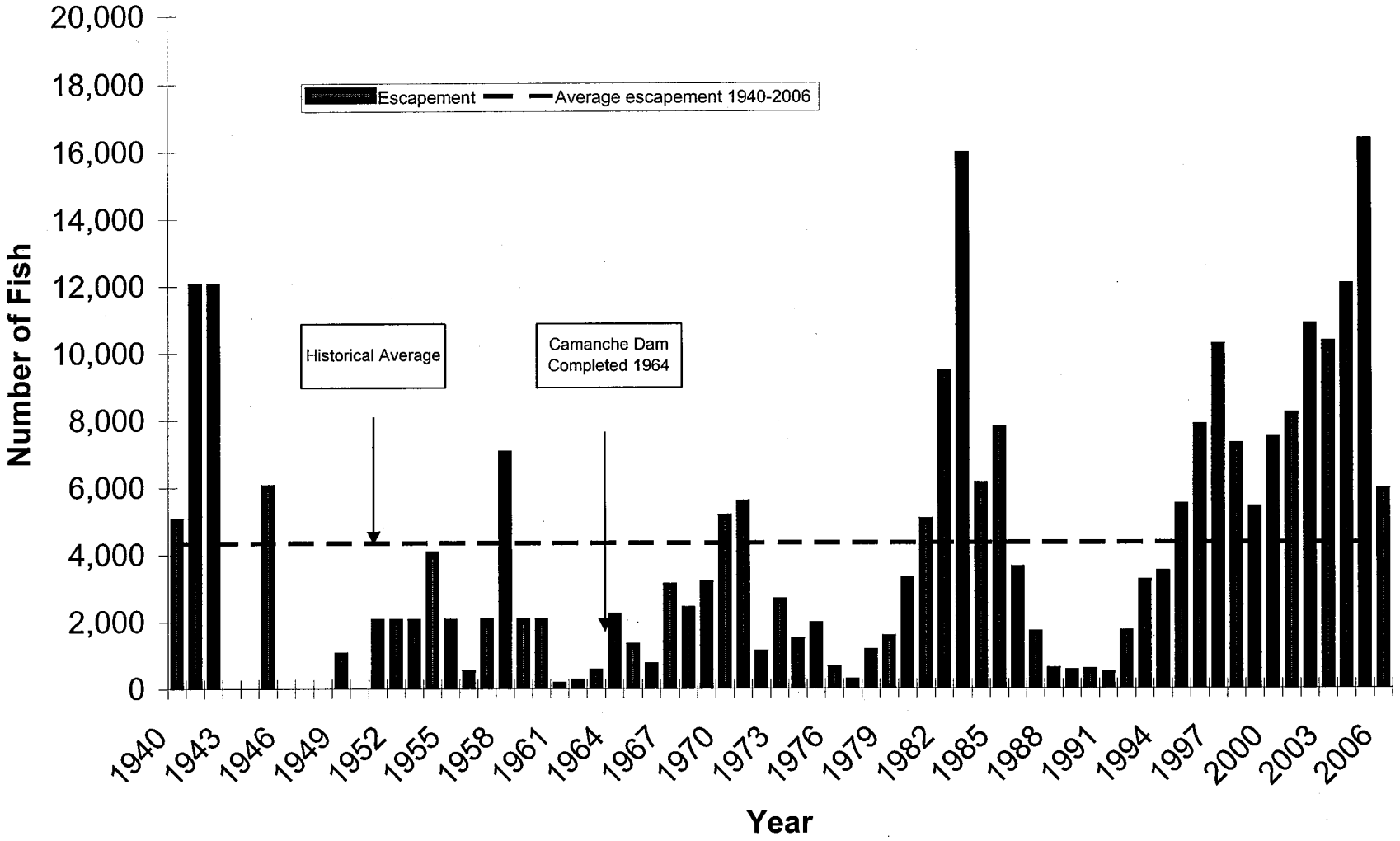

Figure 10. Estimated fall-run chinook salmon escapement to the lower Mokelumne River 1940-2006.