

@2838

JSA 95-076

Ref ID 90865

**1995 Fall-Run Chinook  
Salmon Spawning Escapement  
in the Yuba River**

*Prepared for:*

Yuba County Water Agency  
1402 D Street  
Marysville, CA 95901  
Contact: Donn Wilson  
916/741-6278

*Prepared by:*

Jones & Stokes Associates, Inc.  
2600 V Street, Suite 100  
Sacramento, CA 95818-1914  
Contact: William T. Mitchell  
916/737-3000

July 1996

This document should be cited as:

Jones & Stokes Associates, Inc. 1996. 1995 fall-run chinook salmon spawning escapement in the Yuba River. July. (JSA 95-076.) Sacramento, CA. Prepared for Yuba County Water Agency, Marysville, CA.

# Table of Contents

---

	Page
INTRODUCTION .....	1
METHODS .....	1
RESULTS .....	2
River Conditions .....	2
Spawning Escapement .....	2
Spawning Timing .....	3
Spawning Distribution .....	3
Run Composition .....	3
Hatchery Fish .....	4
Recovery Rates .....	4
DISCUSSION .....	4
CITATIONS .....	6
Printed References .....	6
Personal Communications .....	6

## Appendix A

Table A-1: Weekly Recoveries of Adult Salmon Carcasses  
in the Parks Bar Reach, 1995

Table A-2: Weekly Population Estimates of Adult Salmon  
in the Parks Bar Reach, 1995

Table A-3: Weekly Recoveries of Adult Salmon Carcasses in the  
Daguerre Point Reach, 1995

Table A-4: Weekly Population Estimates of Adult Salmon in the  
Daguerre Point Reach, 1995

# List of Tables

---

	<b>Follows Page</b>
1	1995 Yuba River Chinook Salmon Spawning Escapement Estimates by Reach and Age Class . . . . . 2
2	Annual Fall-Run Chinook Salmon Spawning Escapement in the Yuba River during Pre- (1953-1971) and Post- (1972-1995) New Bullards Bar Reservoir Periods . . . . . 4

## List of Figures

---

	<b>Follows Page</b>
1	Lower Yuba River Chinook Salmon Spawning Escapement Survey Reaches . . . . . 2
2	Daily Yuba River Flows Measured at the Smartville and Marysville Gauges, October 1 - December 15, 1995 . . . . . 2
3	Mean Daily Yuba River Water Temperatures Measured at the Marysville Gauge, October 1 - December 15, 1995 . . . . . 2
4	Weekly Counts of Fresh Salmon Carcasses by Survey Reach, 1995 . . . . . 3
5	Annual Fall-Run Chinook Salmon Spawning Escapement in the Lower Yuba River during Pre- (1953-1971) and Post- (1972-1995) New Bullards Bar Reservoir Periods . . . . . 4
6	Annual Ocean Landings of Central Valley Chinook Salmon (Total Commercial and Sport Landings South of Point Arena) and Ocean Harvest Rate Index . . . . . 4

## INTRODUCTION

From 1953 to 1989, the California Department of Fish and Game (DFG) conducted annual surveys of chinook salmon carcasses on the lower Yuba River to estimate fall chinook salmon (*Oncorhynchus tshawytscha*) spawning escapement (i.e., the number of salmon returning to spawn each year). Because of budget and personnel cuts, DFG suspended their surveys of Yuba River salmon carcasses in 1990. In response, Yuba County Water Agency (YCWA) retained Jones & Stokes Associates, Inc., to conduct the 1991 surveys. In 1992, 1993, and 1994, annual carcass surveys were conducted jointly by DFG and Jones & Stokes Associates. Jones & Stokes Associates conducted the carcass surveys in 1995; DFG was unable to participate.

This report presents the results of the 1995 surveys. The results of the 1991, 1992, 1993, and 1994 surveys were summarized in the report submitted to Yuba County Water Agency in February 1995.

## METHODS

Since the 1970s, DFG has used a modified form of the Schaefer mark-recovery method to estimate the number of chinook salmon spawning each year in the Yuba River (Schaefer 1951). Weekly carcass surveys were conducted each year during the principal fall chinook salmon spawning season (early to mid-October through mid-December). During each survey, field personnel tagged fresh salmon carcasses and returned them to the river, chopped decomposed carcasses in half, and recovered carcasses tagged on previous survey dates. Weekly estimates were computed based on the proportion of tagged carcasses recovered compared to the total number of tagged carcasses at large and the total number of tagged and untagged carcasses observed. Weekly estimates were summed to obtain the total spawning escapement estimate for the year. The sampling methods are described further in previous reports (Jones & Stokes Associates 1992, 1994).

The sampling methods used during 1995 spawning escapement surveys on the Yuba River were generally consistent with those used by DFG during past surveys. DFG's practice has been to tag only adult (3-year-olds and older fish) carcasses and estimate the number of grilse (2-year-old salmon) by multiplying the adult estimate by the ratio of fresh grilse carcasses to fresh adult carcasses. This assumes that grilse carcasses are recovered at a rate similar to that of adult carcasses. However, by tagging both adults and grilse in recent years, Jones & Stokes Associates found that grilse are often recovered at significantly lower rates than those of adults. Boydston (1994) also made this observation, suggesting that grilse are more easily overlooked and disappear faster from the stream because of their smaller size. Because spawning escapement estimates are sensitive to differences in carcass recovery rates, both adults and grilse were tagged in 1995 in an effort to obtain independent estimates. Independent estimates of adults and grilse were also made for each reach because recovery rates can differ between reaches.

Salmon carcasses were classified as adult if they were greater than 26.4 inches fork length (FL) or grilse if they were less than 26.4 inches FL. This cut-off length was determined from length-frequency data collected from spring-run chinook salmon that entered Feather River Hatchery on September 11, 1995, and was used to separate adults from grilse observed during carcass surveys on the Feather River in fall 1995 (Meyer pers. comm.).

In 1994, weekly carcass surveys were conducted in the Rose Bar reach (Rose Bar to Parks Bar), the Parks Bar reach (Parks Bar to Daguerre Point Dam), and the Daguerre Point reach (Daguerre Point Dam to the Highway 70 bridge in Marysville) (Figure 1). For many years, carcass surveys did not include the reach above Parks Bar, and DFG estimated total salmon escapement by assuming that 15.5% of the run spawned above Parks Bar, based on the average proportion of total spawning escapement estimated for this reach during 1966-1971 (Konhoff pers. comm.). However, it appears this assumption may result in substantial error; weekly carcass surveys in the Rose Bar reach in 1994 revealed that 37% of the run spawned in this reach. Although only a partial survey (3 weeks) of the Rose Bar reach was possible in 1995, it provided a single weekly estimate of spawning escapement to compare with estimates for the downstream reaches in the same week.

## RESULTS

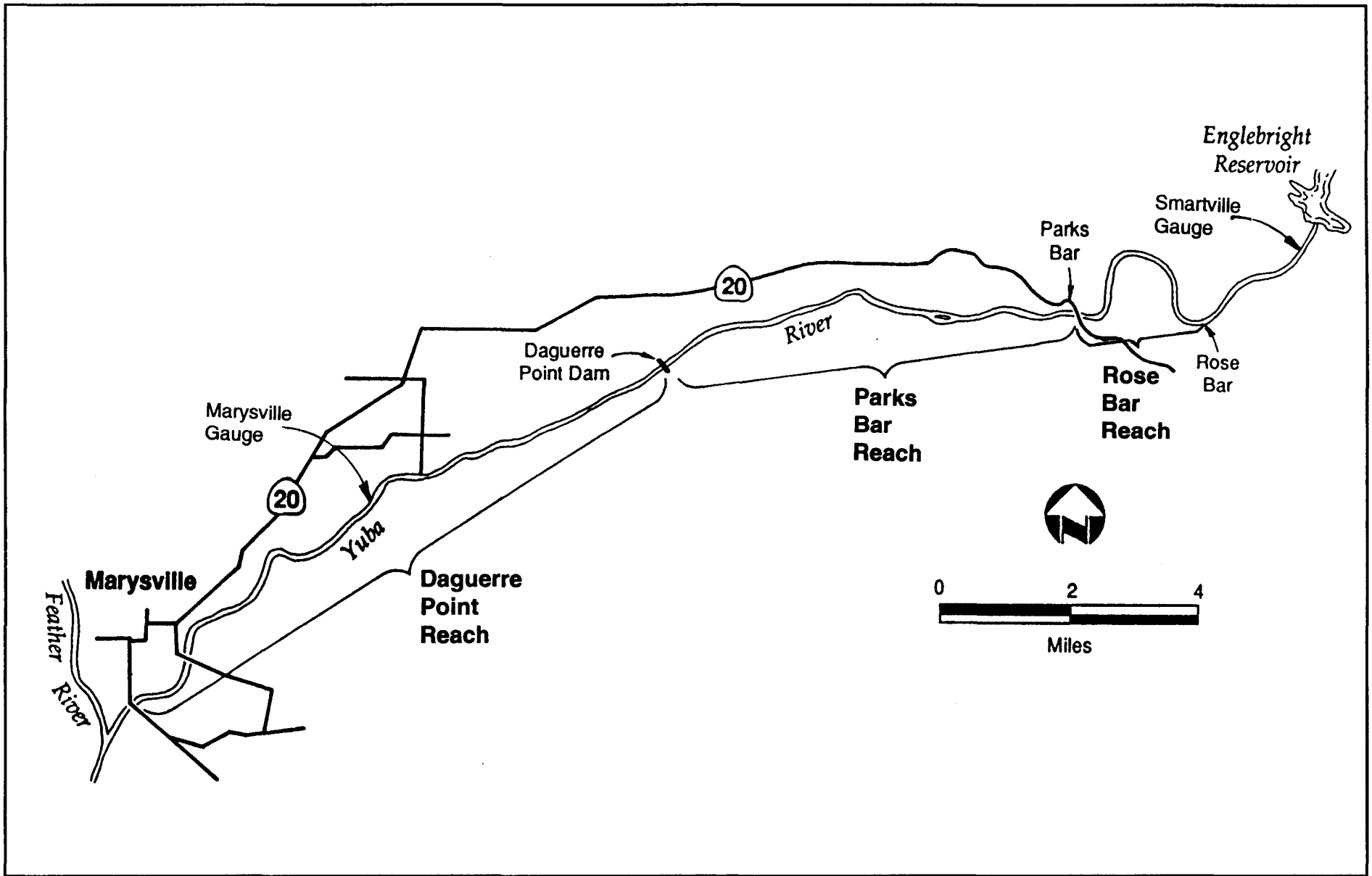
### River Conditions

Figures 2 and 3 present daily Yuba River flows and water temperatures during the 1995 chinook salmon spawning season. Flows were stable throughout most of the season, averaging approximately 1,250 cubic feet per second (cfs) below Englebright Dam (Smartville gauge) and 950 cfs near Marysville (Marysville gauge). Flows increased to over 4,000 cfs during a major storm event in early December 1995. The mean daily water temperature at the Marysville gauge was 59°F in early October and declined to nearly 50°F by mid-December.

### Spawning Escapement

An estimated 14,561 salmon (13,292 adults and 1,269 grilse) spawned in the lower Yuba River in 1995 (Table 1). Because surveys in the Parks Bar reach were limited to 3 weeks, an estimate of total spawning escapement in this reach was not possible. For consistency with past DFG estimates, total spawning escapement was estimated by assuming that 15.5% of the run spawned in the Parks Bar reach. The assumption is discussed later in the report in light of carcass recovery data collected during the 3-week survey period.

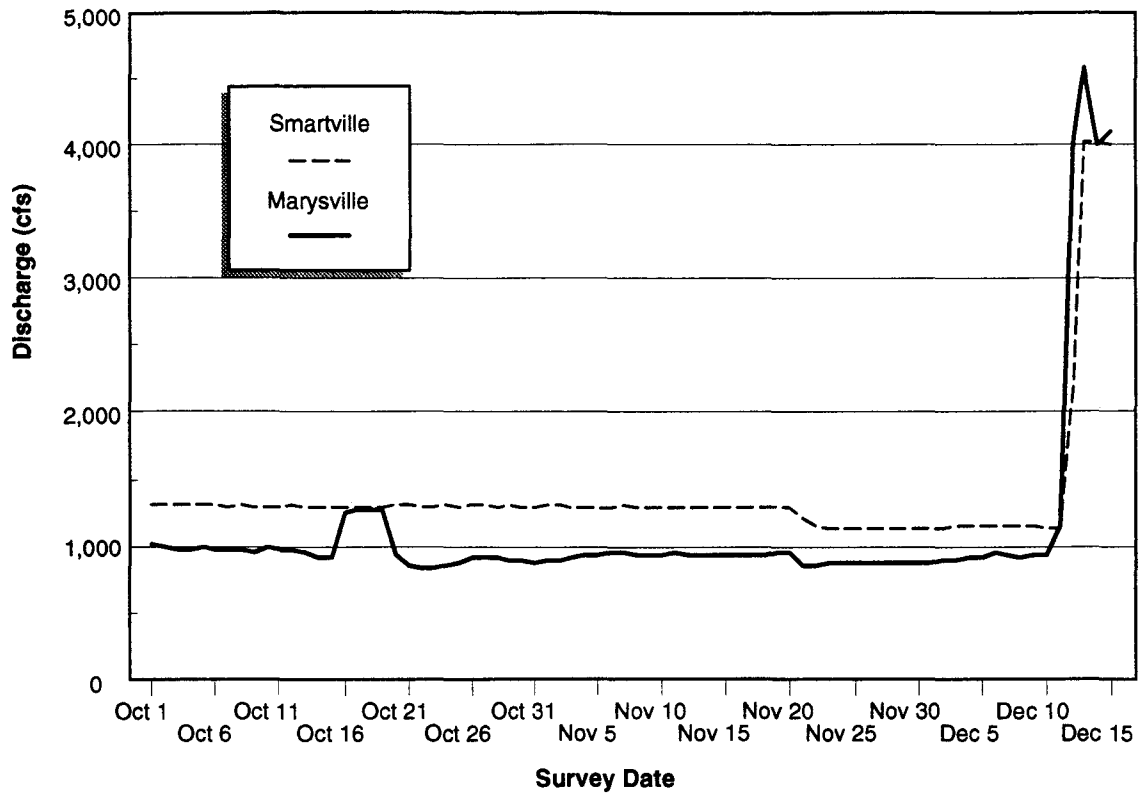
The spreadsheets used to compute the 1995 spawning escapement estimates are presented in Tables A-1, A-2, A-3, and A-4. The computation spreadsheets for the 1991-1994 runs can be found in previous reports (Jones & Stokes Associates 1992, 1994, 1995).



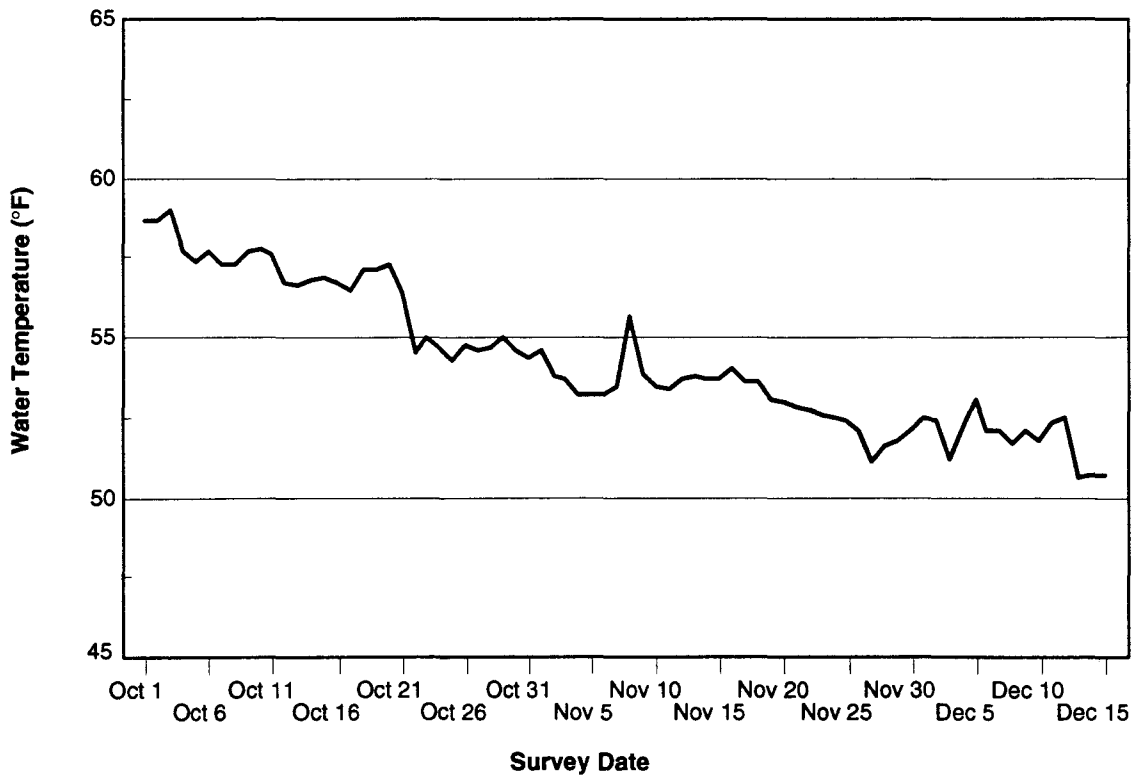
Jones & Stokes Associates, Inc.

**Figure 1**  
**Lower Yuba River Chinook Salmon Spawning**  
**Escapement Survey Reaches**





**Figure 2**  
Daily Yuba River Flows Measured at the Smartville and Marysville Gauges, October 1 - December 15, 1995



**Figure 3**  
Mean Daily Yuba River Water Temperatures Measured at the Marysville Gauge, October 1 - December 15, 1995

Table 1. 1995 Yuba River Chinook Salmon Spawning Escapement  
Estimates by Reach and Age Class

Reach	Adults	Grilse	Total
Daguerre to Marysville	5,086	609	5,695
Parks Bar to Daguerre	6,146	463	6,609
Narrows to Parks Bar*	2,060	197	2,257
Total	13,292	1,269	14,561

\* Assumes 15.5% of the population spawned in this reach

## Spawning Timing

The degree of decomposition of tagged carcasses recovered 1 or 2 weeks after tagging indicates that fresh carcasses represent fish that died within a week before tagging. Therefore, weekly counts of fresh carcasses provide the best approximation of the weekly distribution of spawning activity through the season (Figure 4).

Weekly counts of fresh carcasses in the Parks Bar reach indicated that spawning began by October 10 and reached a peak by November 7. Downstream of Daguerre Point Dam, spawning activity was first evident on October 18. A substantial increase in spawning activity was evident on November 2, and levels remained relatively constant through November.

High flows following the December 5 and 6 surveys precluded surveys scheduled for the following week. Only one untagged, decomposed carcass was recovered during a final survey of the Parks Bar reach on December 19. High flows had apparently dispersed carcasses downstream or beyond the channel and banks where carcasses normally accumulate. No spawning activity was observed during the December 19 survey.

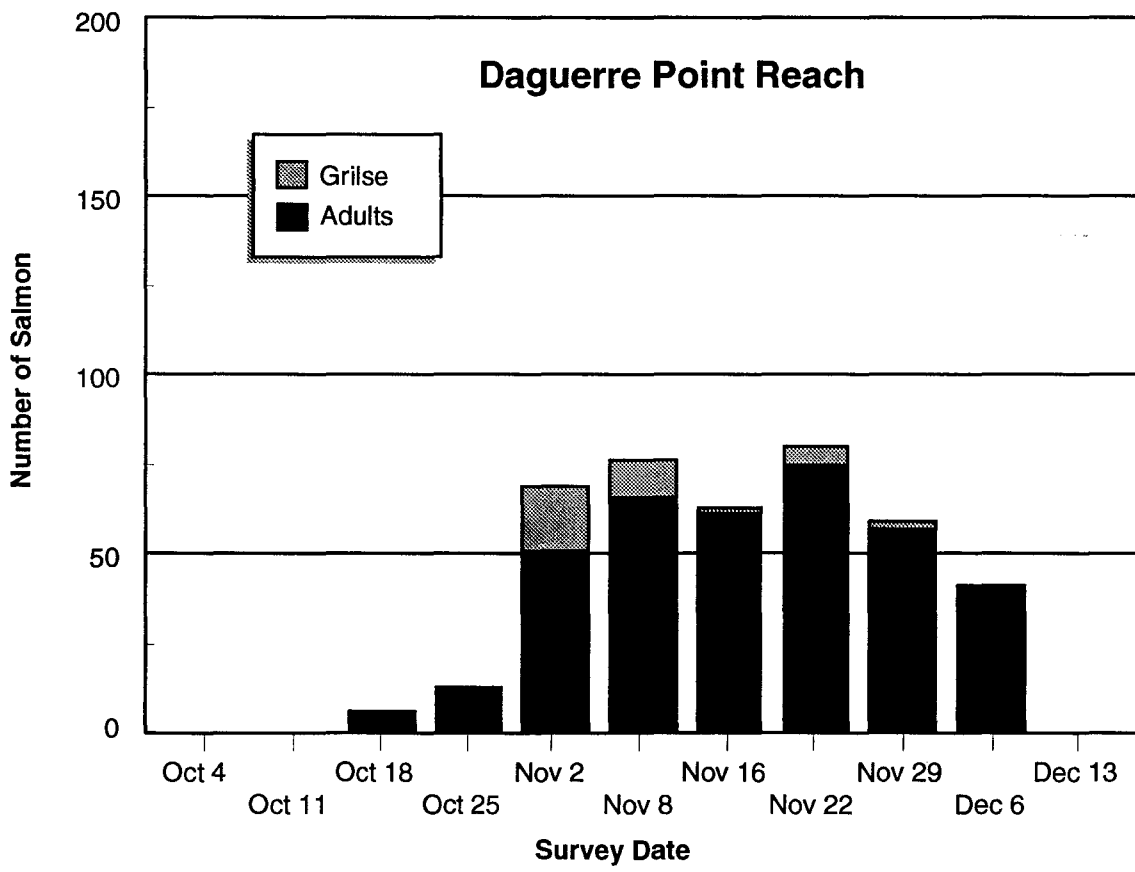
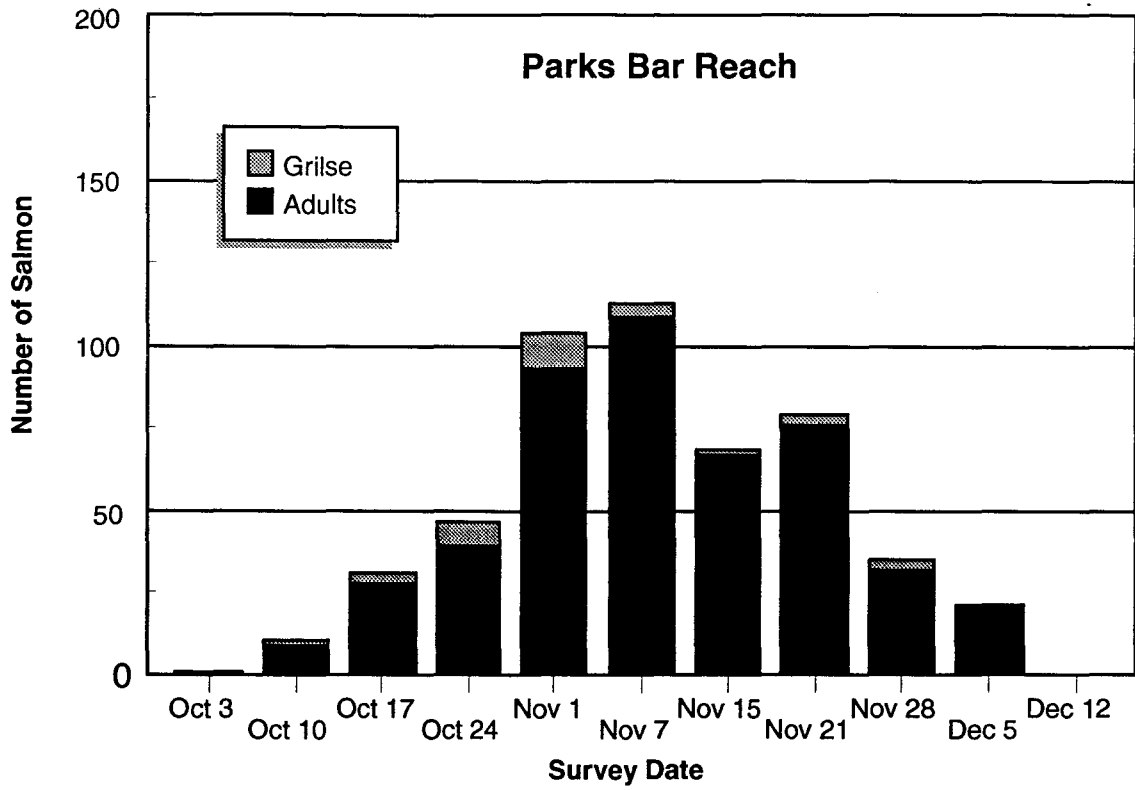
## Spawning Distribution

Assuming that 15.5% of the run spawned above Parks Bar, an estimated 45.4% of the run spawned in the Parks Bar reach, and 39.1% spawned in the Daguerre Point Dam reach.

## Run Composition

Grilse salmon comprised 8.7% of the total number of fresh carcasses observed during the 1995 surveys (Table 1). The numbers of grilse tagged and later recovered were generally too small to obtain a reliable estimate of total spawning escapement; in some weeks, only two to five fresh grilse carcasses were tagged and none of these carcasses were found again. On two occasions, the number of tag recoveries representing a given week of tagging exceeded the number of fish tagged in that week, suggesting that carcasses were either misclassified as grilse (as opposed to adults) or that carcasses tagged in the Parks Bar reach had entered the Daguerre Point reach. Under these circumstances, it was decided that the method typically used by DFG to estimate grilse numbers (refer to methods section) provided a better estimate than would be obtained using tag recovery data, despite the potential error associated with DFG's method.

Adult male and female salmon comprised 46% and 54%, respectively, of the fresh adult carcasses observed. The sex of grilse could not be reliably determined in the field, but the majority of grilse are typically male.



**Figure 4**  
**Weekly Counts of Fresh Salmon Carcasses**  
**by Survey Reach, 1995**

## Hatchery Fish

Four coded, wire-tagged salmon were recovered from the Yuba River during the 1995 surveys. Two adult females were recovered in the Parks Bar reach, one on October 17 (27.8 inches FL) and one on November 7 (29.1 inches FL). In the Daguerre Point reach, one male grilse (23.8 inches FL) was recovered on November 8 and one adult female (length not recorded) was recovered on November 16. The snouts from these carcasses were retained and submitted to DFG for tag removal and decoding. Tag data on these fish (e.g., brood year, hatchery of origin) were not available from DFG at the time of this writing.

## Recovery Rates

Recovery rates of adult salmon carcasses (i.e., percent of tagged carcasses that were recovered) averaged 32% in the Parks Bar reach and 26% in the Daguerre Point reach during the 1995 surveys. Recovery rates of grilse salmon carcasses averaged 52% in the Parks Bar reach and 19% in the Daguerre Point reach. As discussed earlier, grilse recovery rates were affected by low sample sizes and other potential sources of bias.

## DISCUSSION

Annual chinook salmon spawning escapement in the lower Yuba River in 1995 was about 12% higher than the long-term average run size of about 13,000 fish. Average annual chinook salmon spawning escapement since construction of New Bullards Bar Reservoir has remained at about 13,000 fish, the same level that existed before the reservoir was constructed (Table 2 and Figure 5).

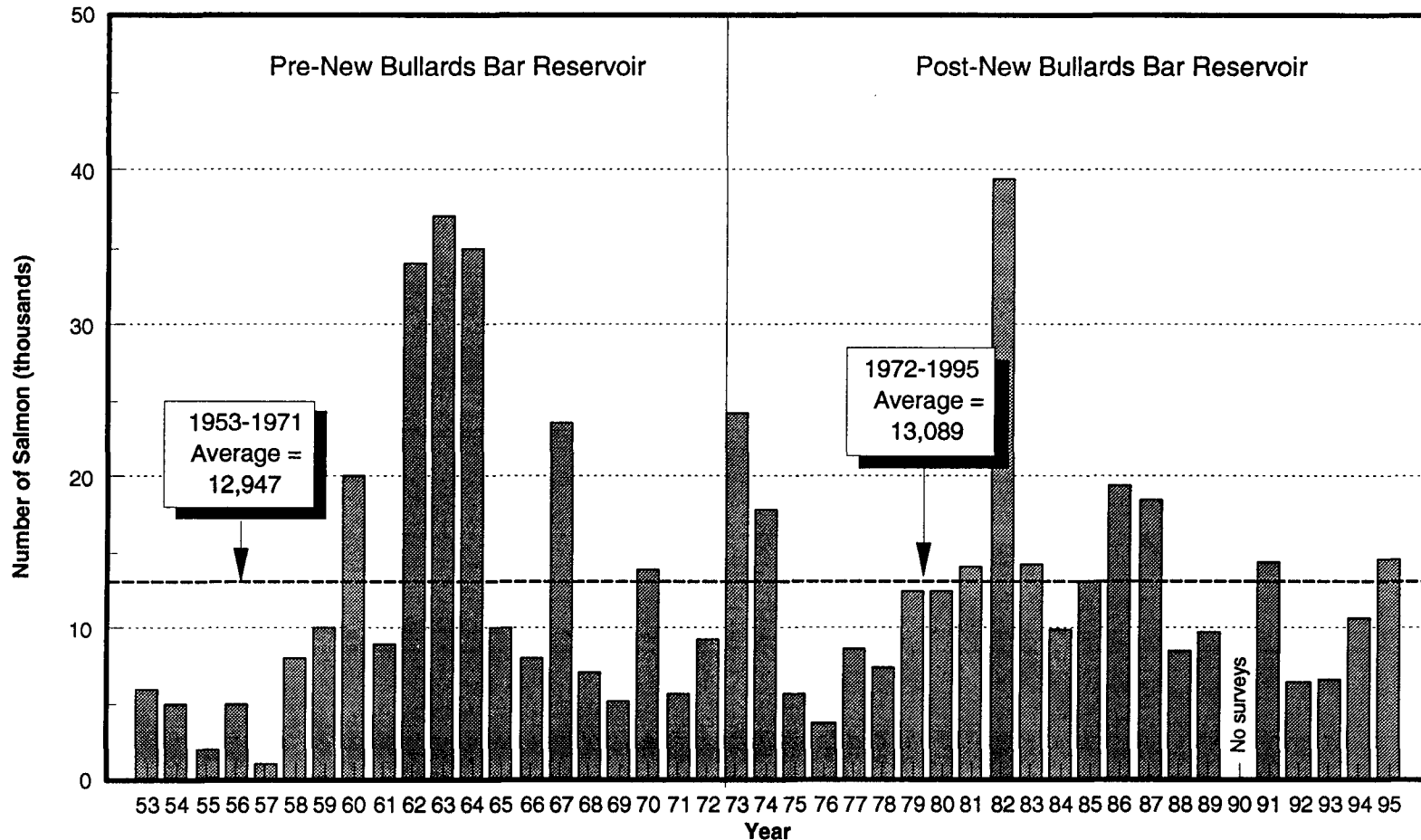
Preliminary estimates of annual fall-run chinook salmon spawning escapement in the mainstem Sacramento River and its major tributaries (including the Yuba River) in recent years indicate a dramatic increase in spawning escapement in 1995 from generally low levels that occurred in the early 1990s (Pacific Marine Fisheries Commission 1996). This increase can be attributed primarily to the 1992 year class (i.e., fish that were produced by spawners in fall 1992 and migrated to the ocean as juveniles in spring 1993), which accounted for large numbers of grilse (2-year-old salmon) returning to spawn in 1994 and large numbers of adults (3-year-old salmon) returning in 1995. Total ocean commercial and sport landings of Central Valley chinook salmon in 1995, as indexed by the Pacific Marine Fisheries Commission (1996), was the highest during the period of record (1970-1995), reflecting the success of the 1992 year class (Figure 6). Therefore, chinook salmon spawning escapement would have been even larger had it not been for high harvest rates in 1995.

Table 2. Annual Fall-Run Chinook Salmon Spawning Escapement in the Yuba River during Pre- (1953-1971) and Post- (1972-1995) New Bullards Bar Reservoir Periods

Year	Pre-Reservoir Escapement	Year	Post-Reservoir Escapement
1953	6,000	1972	9,258
1954	5,000	1973	24,119
1955	2,000	1974	17,809
1956	5,000	1975	5,641
1957	1,000	1976	3,779
1958	8,000	1977	8,722
1959	10,000	1978	7,416
1960	20,000	1979	12,430
1961	9,000	1980	12,406
1962	34,000	1981	14,025
1963	37,000	1982	39,367
1964	35,000	1983	14,256
1965	10,000	1984	9,965
1966	8,000	1985	13,066
1967	23,500	1986	19,406
1968	7,000	1987	18,510
1969	5,230	1988	8,501
1970	13,830	1989	9,837
1971	5,650	1990	-- <sup>a</sup>
		1991	14,413
		1992	6,361
		1993	6,516
		1994	10,691
		1995	14,561
Average	12,906	Average	13,089

<sup>a</sup> No carcass surveys conducted.

Source: 1953-1966: Hallock n.d.  
 1967-1989: Mills and Fisher 1994  
 1991-1995: Jones & Stokes Associates 1992, 1994, 1995.

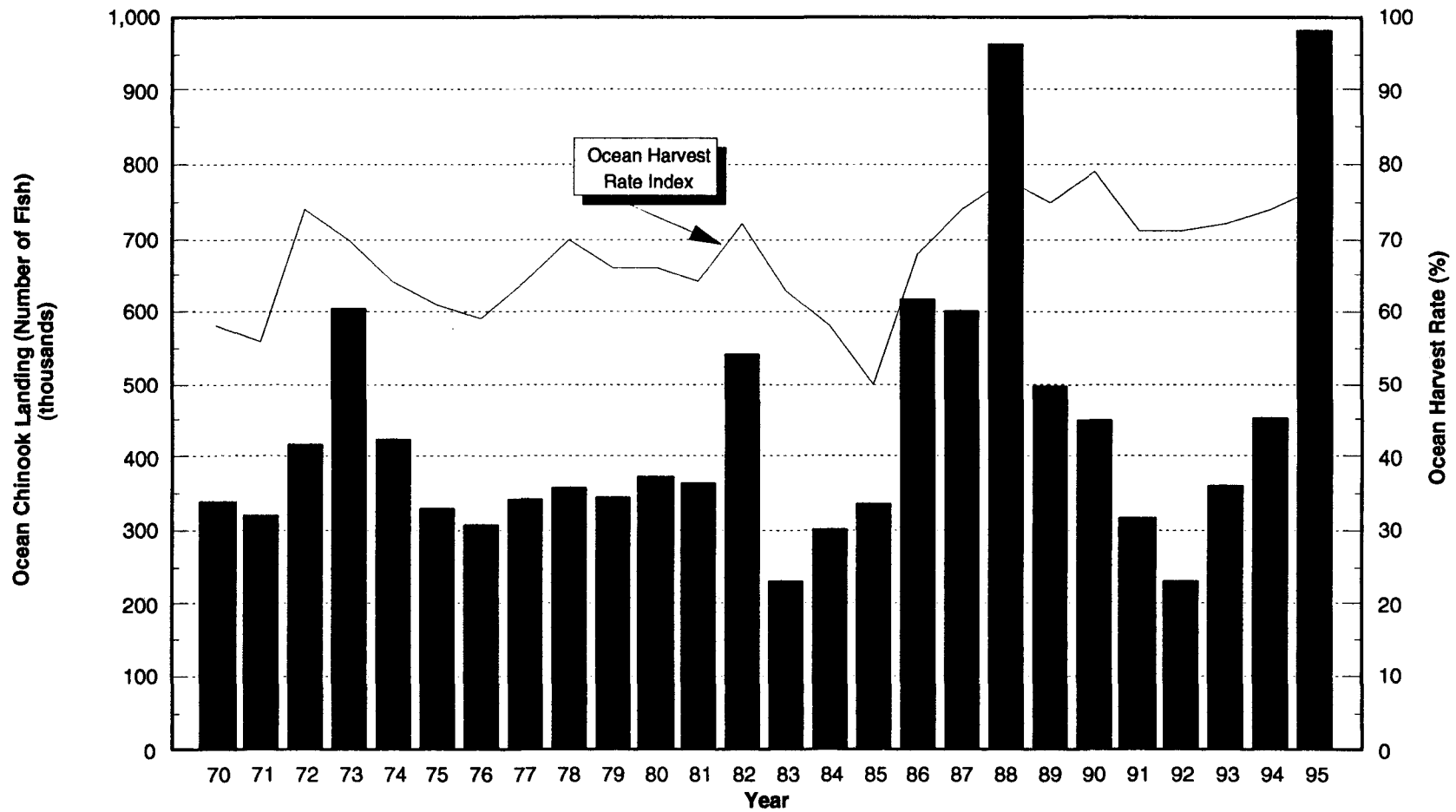


Sources: 1953-1966 Hallock (N.d.)  
 1967-1989 Mills and Fisher (1994)  
 1991-1995 Jones & Stokes Associates (1992, 1994, 1995, 1996)



Jones & Stokes Associates, Inc.

**Figure 5**  
**Annual Fall-Run Chinook Salmon Spawning Escapement in the**  
**Lower Yuba River during Pre- (1953-1971) and Post- (1972-1995)**  
**New Bullards Bar Reservoir Periods**



**Figure 6**  
**Annual Ocean Landings of Central Valley Chinook Salmon**  
**(Total Commercial and Sport Landings South of Point Arena)**  
**and Ocean Harvest Rate Index**



The 1995 spawning escapement estimate of 14,561 salmon in the Yuba River is considered a conservative estimate compared to past estimates that were derived using the Schaefer method. High flows in the second week of December precluded final surveys of the season and the possibility of recovering carcasses tagged in previous weeks. Therefore, estimates of fish spawning during the latter part of the season are incomplete. A potentially greater source of error is the assumption that 15.5% of the run spawned in the Rose Bar reach in 1995. The three surveys conducted in the Rose Bar reach resulted in an estimate of 623 adults for the week following November 21. Total estimates for the Parks Bar and Daguerre Point reaches for the same week were 886 and 1,191 adults, respectively. Thus, the estimated proportion of adults spawning in the Parks Bar reach that week was 23%. If this proportion is representative of the entire season, the estimate of total spawning escapement would have been approximately 16,000 fish.

The influence of water temperature on the timing of chinook salmon spawning was evident in 1995. Water temperatures early in the season were similar to those in 1993. In both 1993 and 1995, significant spawning activity in the Parks Bar reach was first evident in mid-October, whereas significant spawning activity in the Daguerre Point reach was not evident until approximately a week later. This pattern appears to be related to the timing of suitable water temperatures. For example, significant spawning activity in the Daguerre Point reach generally takes place as mean daily water temperatures measured at the Marysville gauge decline to levels below 57°F. Water temperature modeling by Bookman-Edmonston Engineering indicates that declining October water temperatures in the lower Yuba River are generally 1-4°F higher at the Marysville gauge than at Parks Bar, depending on flows and weather conditions (Salmon pers. comm.). This accounts for the delay in spawning activity observed below Daguerre Point Dam compared to the timing of spawning above the dam.

## CITATIONS

### Printed References

Boydston, L. B. 1994. Analysis of two mark-recapture methods to estimate the fall chinook salmon (*Oncorhynchus tshawytscha*) spawning run in Bogus Creek, California. *California Fish and Game* 80(1):1-13.

Hallock, R. J. n.d. Status of the Sacramento River system salmon resource and escapement goals. California Department of Fish and Game. Red Bluff, CA.

Jones & Stokes Associates, Inc. 1992. 1991 fall-run chinook salmon spawning escapement in the Yuba River. June. (JSA 91-219.) Sacramento, CA. Prepared for Yuba County Water Agency, Marysville, CA.

\_\_\_\_\_. 1994. 1992 fall-run chinook salmon spawning escapement in the Yuba River. February. (JSA 91-219.) Sacramento, CA. Prepared for Yuba County Water Agency, Marysville, CA.

\_\_\_\_\_. 1995. 1993 and 1994 fall chinook salmon spawning escapements in the Yuba River. February. (JSA 94-223.) Sacramento, CA. Prepared for Yuba County Water Agency, Marysville, CA.

Mills, T. J., and F. Fisher. 1994. Central Valley anadromous sport fish annual run-size, harvest, and population estimates, 1967 through 1991. Third draft. August. (Inland Fisheries Technical Report.) California Department of Fish and Game. Sacramento, CA.

Pacific Fishery Management Council. 1996. Review of 1995 ocean salmon fisheries. Portland, OR.

Schaefer, M. B. 1951. Estimation of size of animal populations by marking experiments. Volume 52. (Fishery Bulletin 69.) U.S. Fish and Wildlife Service. Washington, DC.

### Personal Communications

Konnoff, D. L. Fishery biologist. California Department of Fish and Game, Rancho Cordova, CA. January 27, 1988 - memorandum to DFG files regarding 1987 Yuba River chinook salmon spawning stock estimate.

Meyer, F. Associate fishery biologist. California Department of Fish and Game, Rancho Cordova, CA. October 4, 1995 - memorandum to Nick Villa regarding 1995 jack-adult chinook criteria.

Nelson, J. Associate fishery biologist. California Department of Fish and Game, Rancho Cordova, CA. March 9, 1994 - memorandum to Nick Villa regarding 1993 Yuba River chinook salmon spawning stock estimate.

Salmon, M. Engineer. Bookman-Edmonston Engineering, Sacramento, CA. November 27, 1991 - results of Yuba River water temperature simulations.

## Appendix A

---



