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**1996 Fall-Run Chinook  
Salmon Spawning Escapement  
in the Yuba River**

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# Table of Contents

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	Page
INTRODUCTION .....	1
METHODS .....	1
RESULTS .....	2
River Conditions .....	2
Spawning Escapement .....	2
Spawning Timing .....	3
Spawning Distribution .....	3
Run Composition .....	3
Hatchery Fish .....	3
Recovery Rates .....	4
DISCUSSION .....	4
CITATIONS .....	5
Printed References .....	5
Personal Communications .....	6

## Appendix A. Tables

Table A-1: Weekly Recoveries of Adult Salmon Carcasses  
in the Rose Bar Reach, 1996

Table A-2: Weekly Population Estimates of Adult Salmon  
in the Rose Bar Reach, 1996

Table A-3: Weekly Recoveries of Adult Salmon Carcasses  
in the Parks Bar Reach, 1996

Table A-4: Weekly Population Estimates of Adult Salmon  
in the Parks Bar Reach, 1996

Table A-3: Weekly Recoveries of Adult Salmon Carcasses in the  
Daguerre Point Reach, 1996

Table A-4: Weekly Population Estimates of Adult Salmon in the  
Daguerre Point Reach, 1996

## List of Tables

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	<b>Follows Page</b>
1	1996 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- (1972-1996) New Bullards Bar Reservoir Periods . . . . . 4

# List of Figures

---

		Follows Page
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, 1996 . . . . .	2
3	Mean Daily Yuba River Water Temperatures Measured at the Marysville Gauge, October 1 - December 15, 1996 . . . . .	2
4	Weekly Counts of Fresh Salmon Carcasses by Survey Reach, 1996 . . . . .	3
5	Annual Fall-Run Chinook Salmon Spawning Escapement in the Lower Yuba River during Pre- (1953-1971) and Post- (1972-1996) 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-run chinook salmon (*Oncorhynchus tshawytscha*) spawning escapement (i.e., the number of salmon that escape being caught and return 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 carcass surveys in 1995 and 1996; DFG was unable to participate.

This report presents the results of the 1996 surveys. The results of the 1991, 1992, 1993, and 1994 surveys were summarized in the report submitted to YCWA in February 1995. The results of the 1995 survey were summarized in the report submitted to YCWA in July 1996.

## 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-run chinook salmon spawning season (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 1996 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 1996 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 adults if they were greater than 26.5 inches fork length (FL) or grilse if they were less than 26.5 inches FL. This cut-off length was determined from length-frequency data collected from spring-run chinook salmon that entered Feather River Hatchery in September 1996, and was used to separate adults from grilse during carcass surveys on the Feather River in fall 1996 (Meyer pers. comm.).

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). These reaches include nearly all of the spawning areas used by chinook salmon in the Yuba River; some fish may spawn between Rose Bar and Englebright Dam although spawning gravels are relatively scarce in this reach. For many years, carcass surveys did not include the reach above Parks Bar; 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, the results indicated that 23% of the run spawned in the Rose Bar reach during the week following November 21.

Weekly carcass surveys were conducted from October 8 to December 5, 1996.

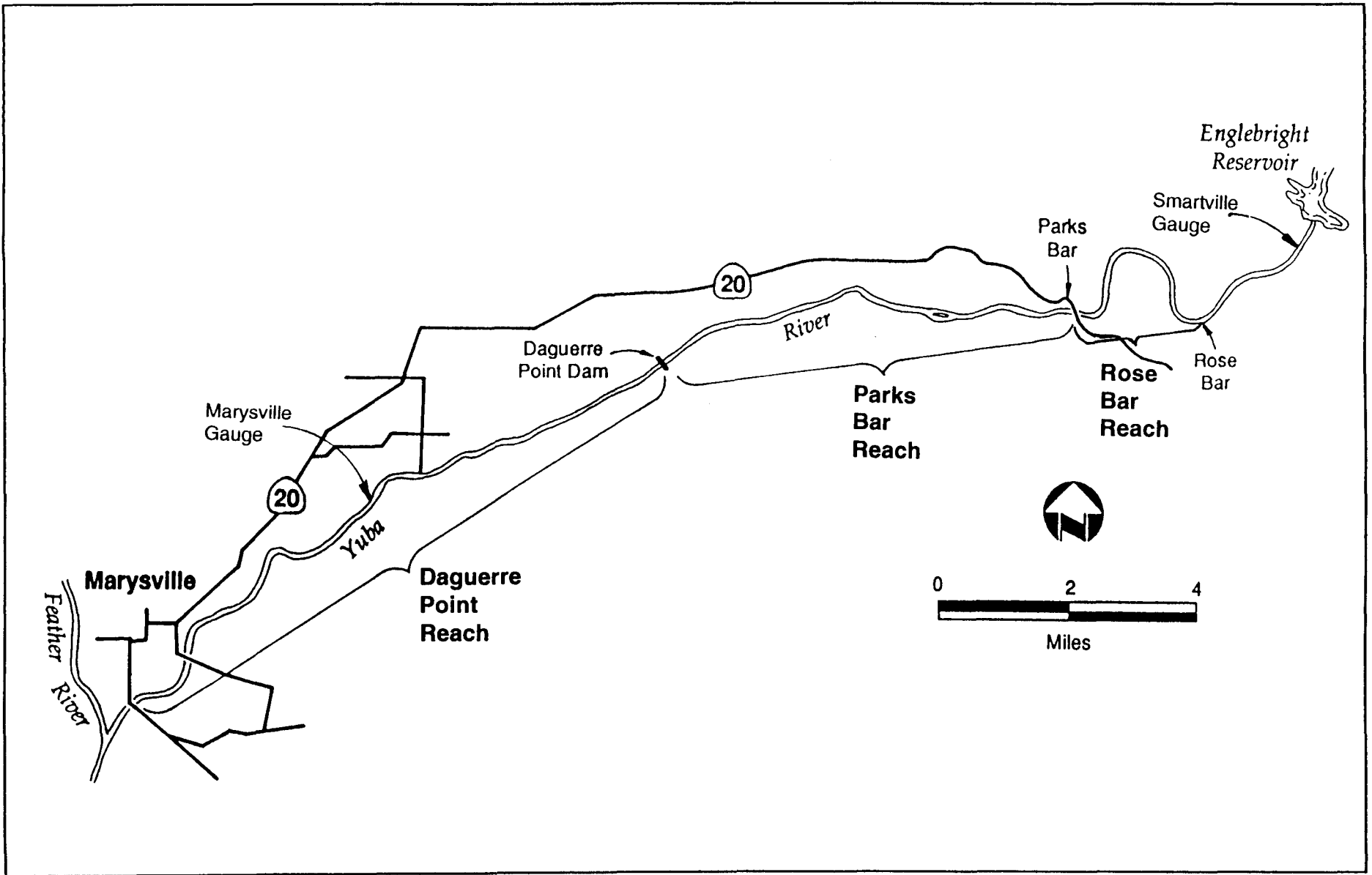
## RESULTS

### River Conditions

Figures 2 and 3 present daily average Yuba River flows and water temperatures during the 1996 chinook salmon spawning season. Flows were stable throughout most of the season, averaging approximately 1,100 cubic feet per second (cfs) below Englebright Dam (Smartville gauge) and 1,400 cfs near Marysville (Marysville gauge). Flows increased in early December 1996 during a series of major storm events. The mean daily water temperature at the Marysville gauge was near 59°F in early October and declined to nearly 51°F by mid-December. Water visibility ranged from 5 to 20 feet, providing fair to good conditions for observing and retrieving carcasses. Inclement weather and high flows following the December 3, 4, and 5 surveys precluded surveys scheduled for the following weeks.

### Spawning Escapement

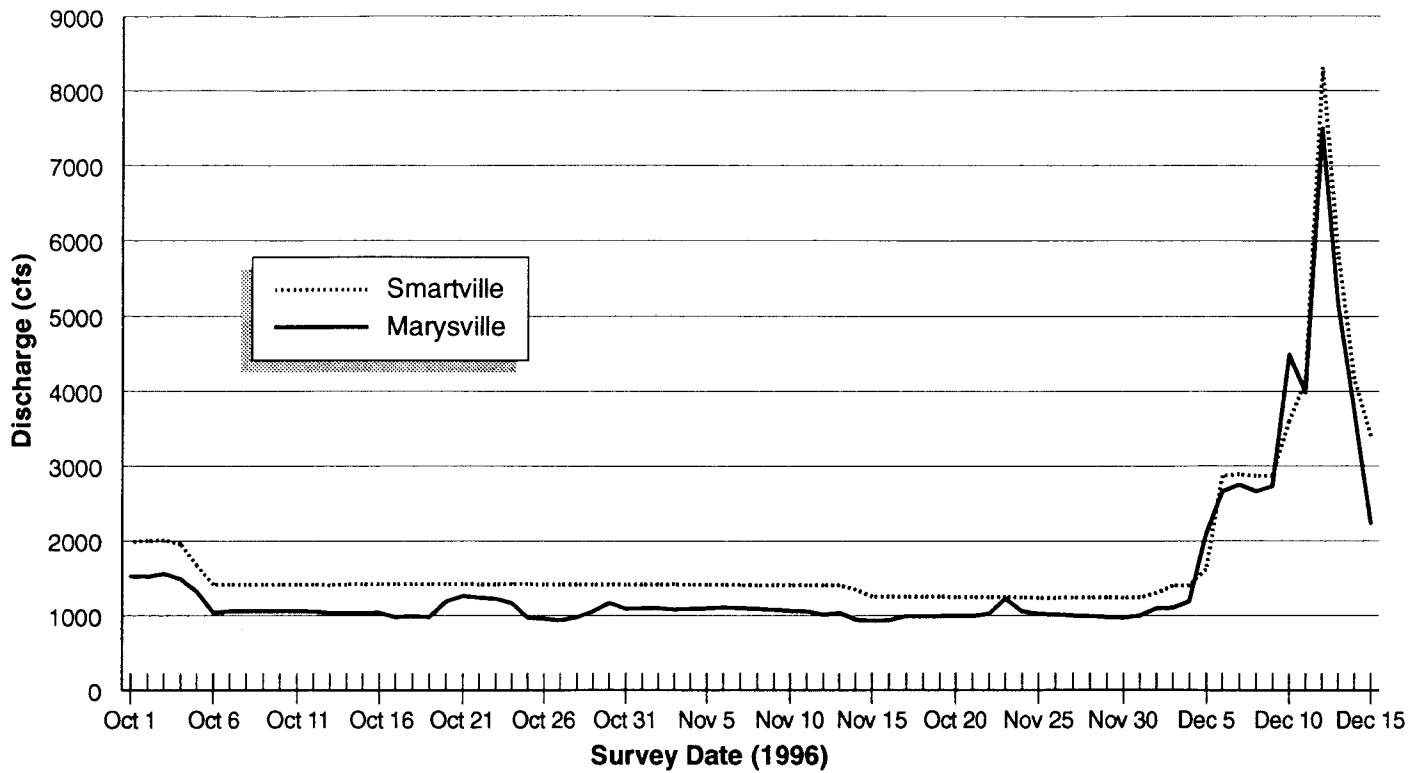
An estimated 27,520 chinook salmon (23,172 adults and 4,348 grilse) spawned in the Yuba River in the fall of 1996 (Table 1).



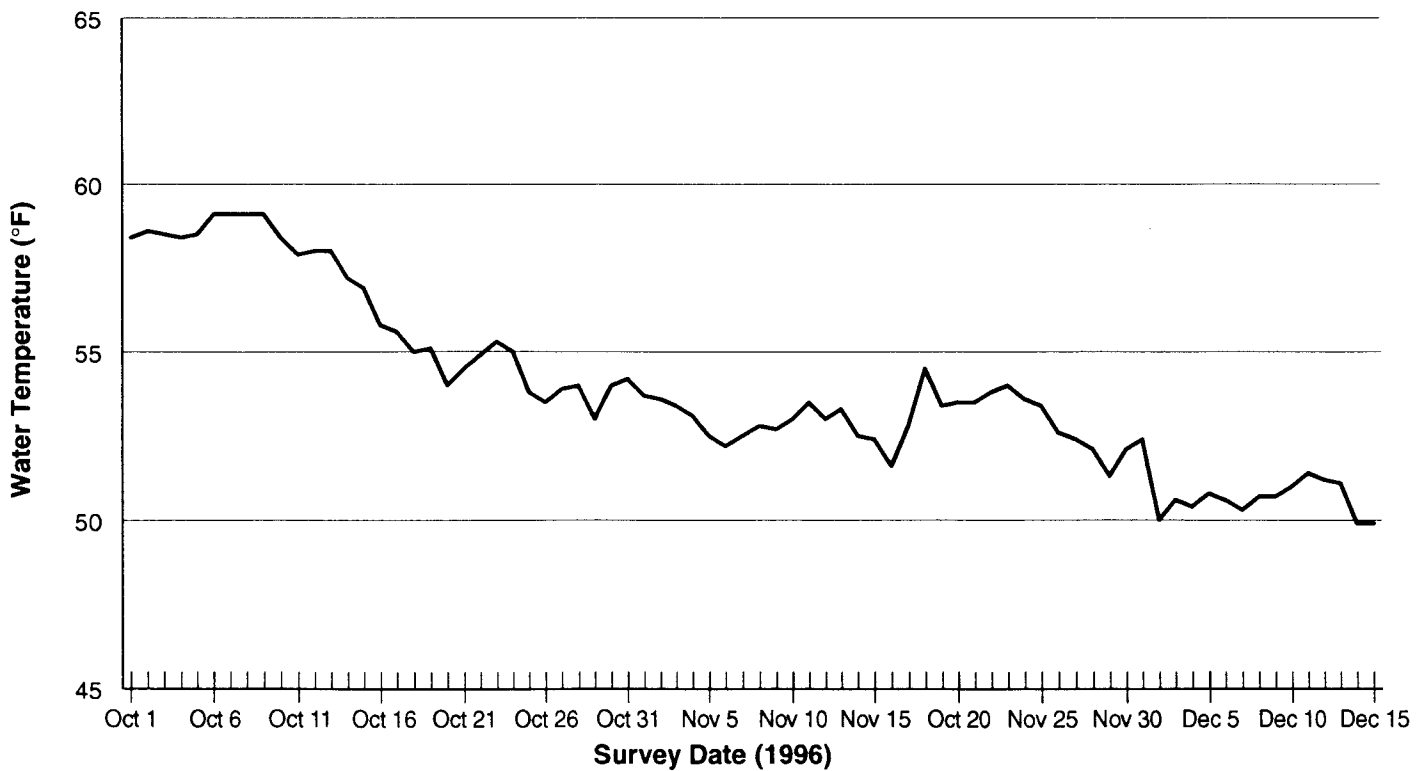
Jones & Stokes Associates, Inc.

**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, 1996**



**Figure 3**  
**Mean Daily Yuba River Water Temperatures Measured at the Marysville Gauge, October 1 - December 15, 1996**



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Table 1. 1996 Yuba River Chinook Salmon Spawning Escapement Estimates  
by Reach and Age Class

Survey Reach	Adults	Grilse	Total
Rose Bar	8,599	1,614	10,213
Parks Bar	7,308	1,371	8,679
Daguerre	7,265	1,363	8,628
Total	23,172	4,348	27,520

The spreadsheets used to compute the 1996 spawning escapement estimates are presented in Appendix A, Tables A-1 through A-6. The computation spreadsheets for the 1991-1994, and the 1995 runs can be found in previous reports (Jones & Stokes Associates 1992, 1994, 1995).

### **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 Rose Bar reach indicated that spawning began before October 8 and reached a peak in late October. Weekly counts of fresh carcasses in the Parks Bar reach indicated that spawning began before October 9 and reached a peak in early November. Downstream of Daguerre Point Dam, spawning activity was first evident on October 17. A substantial increase in spawning activity was evident on November 7, and two apparent peaks in spawning activity occurred during November.

### **Spawning Distribution**

An estimated 37.1% of the run spawned in the Rose Bar reach, 31.5% of the run spawned in the Parks Bar reach, and 31.4% spawned in the Daguerre Point Dam reach.

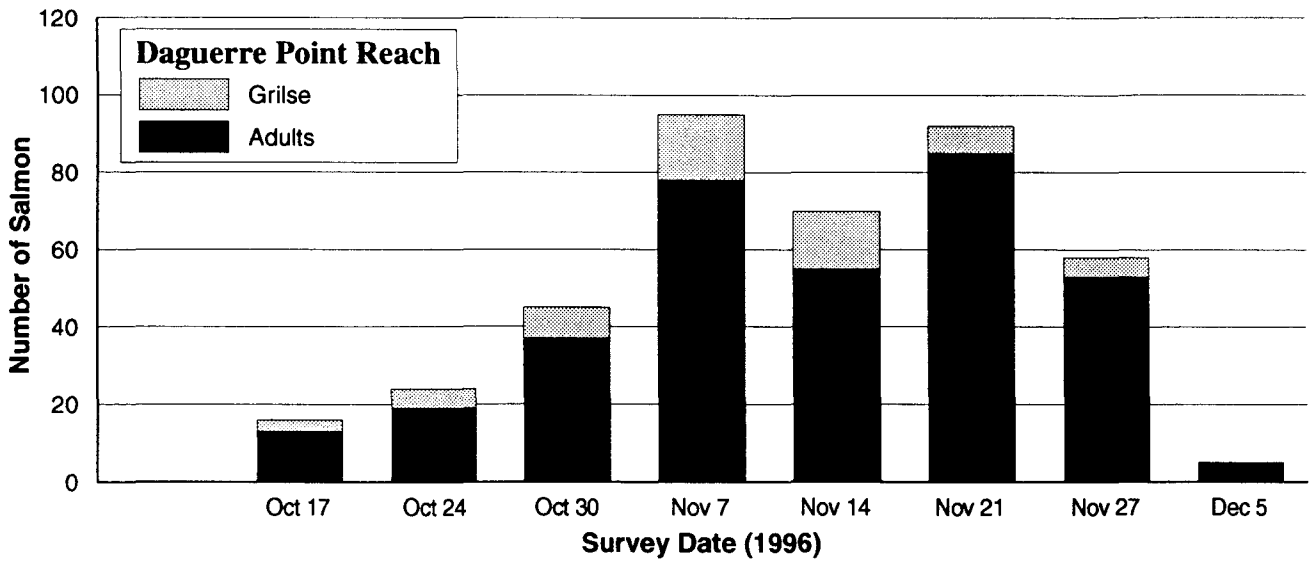
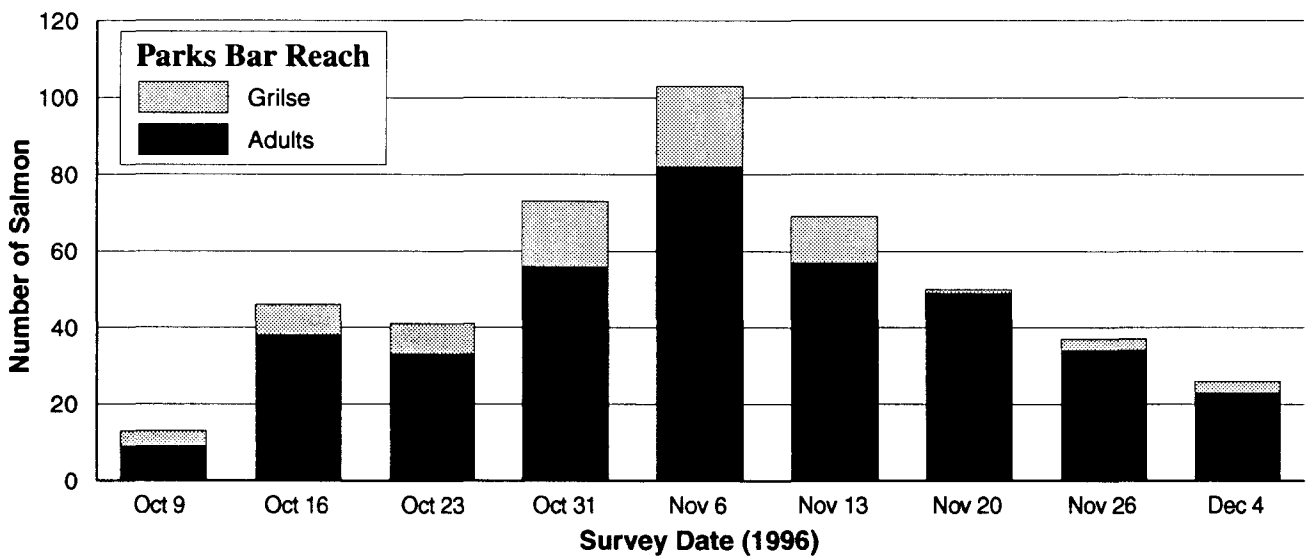
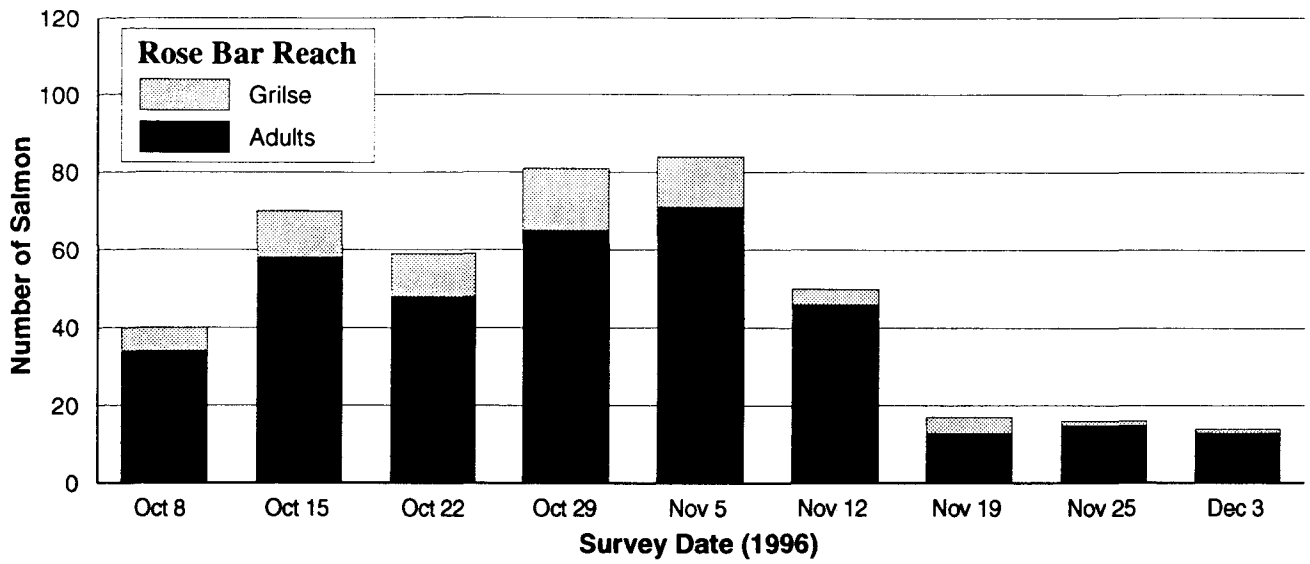
### **Run Composition**

Grilse salmon comprised 15.8% of the total number of fresh carcasses observed during the 1996 surveys (Table 1). The numbers of grilse tagged and later recovered were generally too small to obtain a reliable estimate of total spawning escapement; only 13% of the tagged grilse were recovered.

Adult male and female salmon comprised 45% and 55%, 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.

### **Hatchery Fish**

No coded-wire-tagged salmon were recovered from the Yuba River during the 1996 surveys.



Jones & Stokes Associates, Inc.

**Figure 4**  
**Weekly Counts of Fresh Salmon Carcasses**  
**by Survey Reach, 1996**

## Recovery Rates

Recovery rates of adult salmon carcasses (i.e., percent of tagged carcasses that were recovered) averaged 19% in the Rose Bar reach, 20% in the Parks Bar reach and 14% in the Daguerre Point reach during the 1996 surveys. Because of small numbers of grilse and low recovery rates, an independent estimate of grilse could not be made. Therefore, the overall proportion of fresh grilse observed during the surveys (15.8%) was used to estimate the total number of grilse.

## DISCUSSION

Annual chinook salmon spawning escapement in the lower Yuba River in 1996 was over twice 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) indicate that annual spawning escapement of fall-run chinook salmon in recent years has been increasing from the generally low levels that occurred in the early 1990s (Pacific Marine Fisheries Commission 1996). Large numbers of salmon in recent years are also reflected by ocean landings. The total estimate of ocean commercial and sport landings of Central Valley chinook salmon in 1995 was the highest on record (1970-1995). While ocean landings have increased in recent years, so has the ocean harvest rate index. This index shows the proportion of the total salmon population harvested in the ocean each year (nearly 80% in some years) (Figure 6).

The 1996 spawning escapement estimate of 27,520 salmon in the Yuba River is considered a conservative estimate compared with 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.

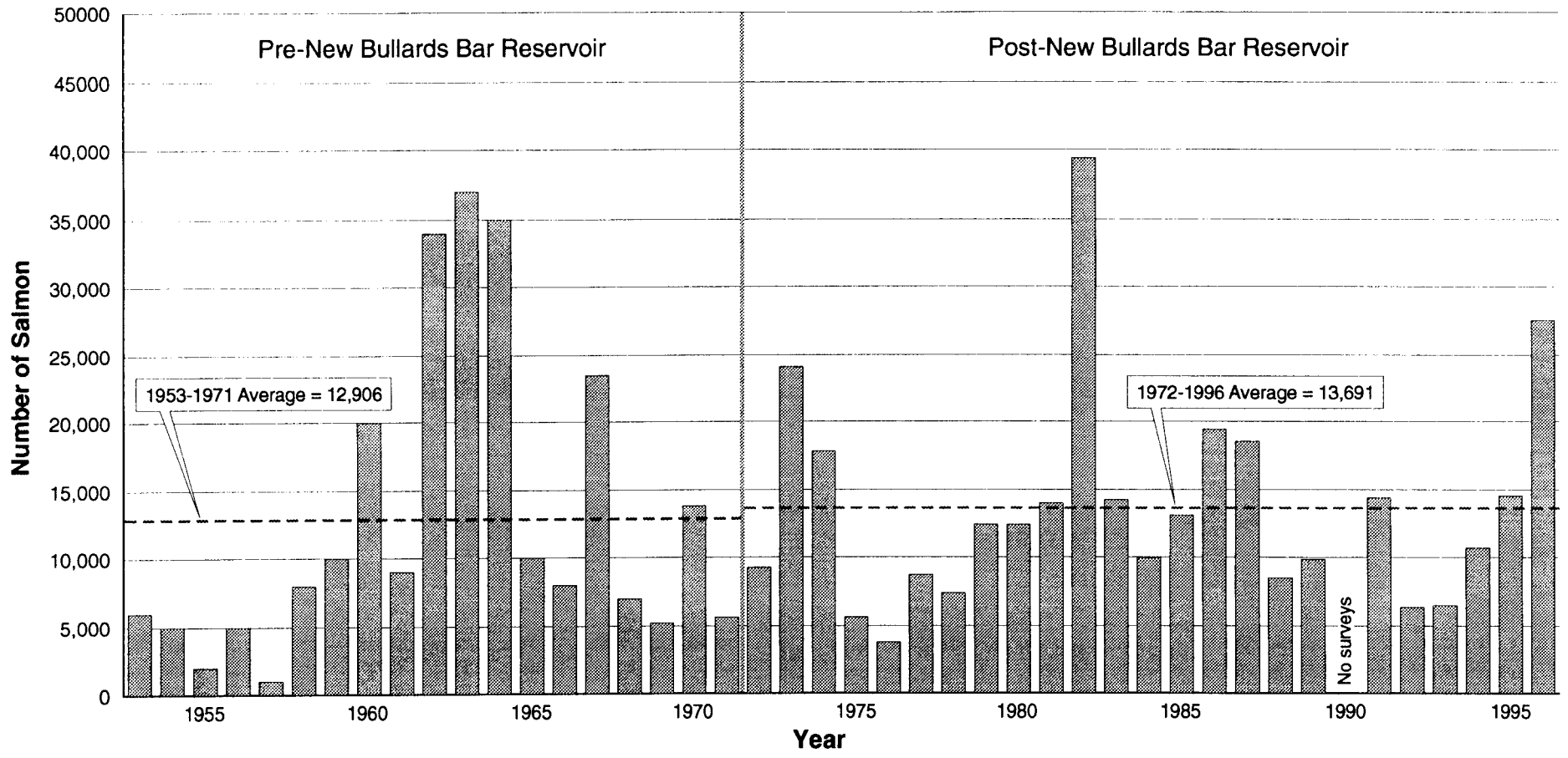
The influence of water temperature on the timing of chinook salmon spawning was evident in 1996. Water temperatures throughout the season were very similar to those in 1995. In 1995, significant spawning activity in the Parks Bar reach was first evident in mid-October, whereas significant spawning activity in the Daguerre Point reach was not evident until approximately two weeks later. Although not as pronounced, a similar pattern was observed in 1996. This pattern appears to be related to the timing of suitable water temperatures. 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 those 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

Table 2. Annual Fall-Run Chinook Salmon Spawning Escapement in the Yuba River during Pre- (1953-1971) and Post- (1972-1996) 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
		1996	27,520
Average	12,906	Average	13,691

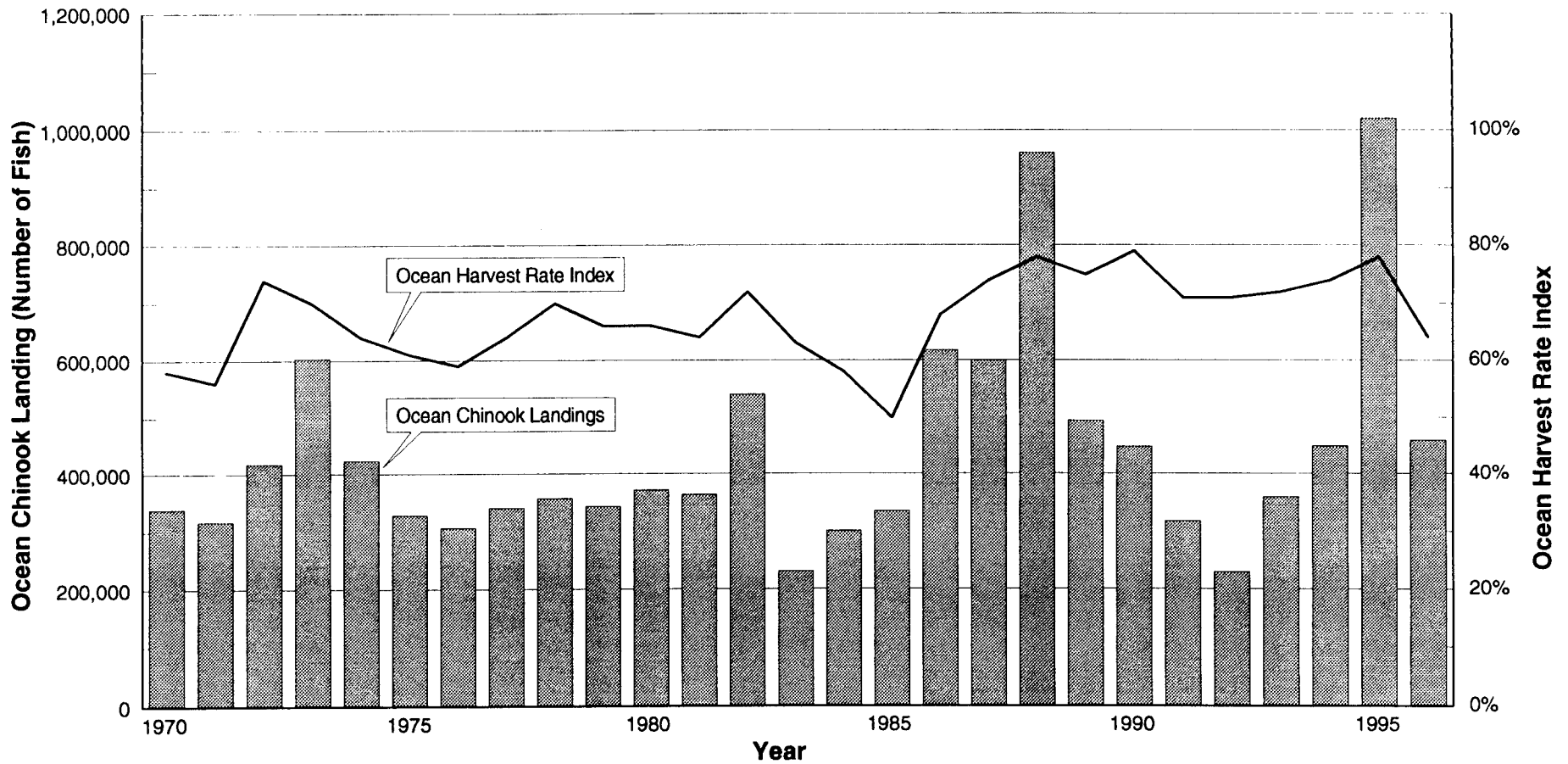
<sup>a</sup> No carcass surveys conducted.

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).

**Figure 5**  
**Annual Fall-Run Chinook Salmon Spawning Escapement in the Lower Yuba River during Pre- (1953-1971) and Post- (1972-1996) New Bullards Bar Reservoir Periods**



SOURCE:  
PFMC (1997)



Jones & Stokes Associates, Inc.

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



weather conditions (Salmon pers. comm.). This would explain the delay in spawning activity below Daguerre Point Dam compared to upstream reaches.

## 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.
- \_\_\_\_\_. 1996. 1995 fall chinook salmon spawning escapements in the Yuba River. July. (JSA 95-076.) 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 1996 - telephone conversation regarding 1996 jack-adult chinook criteria.

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

## Appendix A. Tables

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Table A-1. Weekly Recoveries of Adult Salmon Carcasses in the Rose Bar Reach, 1996

Week of Recovery (j)	Week of Tagging (i)								Tagged Carcasses Recovered (Rj)	Total Carcasses Recovered (Cj)
	Oct 8	Oct 15	Oct 22	Oct 29	Nov 5	Nov 12	Nov 19	Nov 25		
Oct 15	7								7	184
Oct 22	3	9							12	203
Oct 29	1	4	12						17	316
Nov 5	0	0	2	4					6	284
Nov 12	0	0	0	1	10				11	185
Nov 19	0	0	0	0	2	6			8	139
Nov 25	0	0	0	0	0	2	0		2	82
Dec 3	0	0	0	0	0	0	1	1	2	77
Tagged Carcasses Recovered										
(Ri)	11	13	14	5	12	8	1	1	65	
Total										
Carcasses Tagged										
(Mi)	34	58	48	65	71	46	13	15	350	
Ri/Mi	0.32	0.22	0.29	0.08	0.17	0.17	0.08	0.07	0.19	

Table A-2. Weekly Population Estimates of Adult Salmon in the Rose Bar Reach, 1996

Week of Recovery (j)	Week of Tagging (i)								Total
	Oct 8	Oct 15	Oct 22	Oct 29	Nov 5	Nov 12	Nov 19	Nov 25	
Oct 15	569								569
Oct 22	157	679							836
Oct 29	57	332	765						1154
Nov 5	0	0	325	2461					2786
Nov 12	0	0	0	219	995				1214
Nov 19	0	0	0	0	206	599			805
Nov 25	0	0	0	0	0	472	0		472
Dec 3	0	0	0	0	0	0	501	578	1079
Total	783	1011	1090	2680	1201	1071	501	578	8915
Adjusted Total									8599



