

DEPARTMENT OF FISH AND GAME  
Sacramento Valley-Central Sierra Region

**Lower American River Chinook Salmon Escapement Survey  
October – December 2001**

By

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## Introduction

Adult fall-run Chinook salmon ascend the American River for approximately 23 miles from the confluence of the Sacramento River near Discovery Park to the terminous of anadromous migration at Nimbus Dam. Spawning occurs within the eighteen miles of river from about Paradise Beach to Nimbus Dam. However, most spawning occurs in the uppermost three miles of the river near Sunrise Avenue bridge upstream to the Nimbus weir.

Spawner escapement surveys have been conducted on the lower American River to estimate the number of returning adult Chinook salmon for nearly 60 years. This information is important in guiding development and evaluation of management decisions. The three goals of the 2001 lower American River spawner escapement survey were (1) estimate the number of spawners; (2) determine the sex and age composition of the fall run; and (3) determine the egg retention of the females in the run.

Materials and Methods:

The lower American River salmon escapement survey was conducted from the Nimbus weir downstream to the Watt Avenue bridge; a distance of 12.9 river miles. The river was stratified into three reaches (Table 1). All reaches were surveyed once a week from October 29 through December 28, 2001. Each weekly survey took three to four days to complete and was dependent on the number of crew members and number of carcasses in the river. During Week 5 the number of personnel available to complete the survey was less than the previous weeks. During Week 7, only half of the first reach was surveyed due to lack of personnel and safety equipment. Therefore, these weeks had to be collapsed and combined with adjacent weeks to eliminate outliers in the Schaefer model.

Table 1. Reach and length of the three reaches for the 2001 lower American River fall-run Chinook salmon escapement survey, October – December, 2001.		
Reach	Location	Miles
1	Sailor Bar to Elmanto Access	3.4
2	Elmanto Access to Goethe Park Footbridge	3.5
3	Goethe Park Footbridge to Watt Avenue Bridge	6
Total		12.9

Each week all fresh carcasses (either one clear eye or pink gills) were counted and tagged with a color-coded hog ring on the upper jaw. A unique color was used each week to identify the carcasses to a specific tagging week. Each tagged carcass was returned to flowing water for dispersal. All fresh carcasses below Gristmill Fishing Access were chopped to avoid tagged fish from floating out of the study area.

Fresh carcasses were sexed and a subset was measured to the nearest centimeter (cm) Fork Length (FL). Fish greater than or equal to 70 cm FL were considered adults, and those <70 cm FL were classified as a grilse, or young adult. All fresh female carcasses were identified as either completely spawned (0 to 30% eggs remaining), partially spawned (>30 to 70% eggs remaining), or un-spawned (nearly full ovaries) to determine the degree of egg retention.

All observed decomposing carcasses were counted but not tagged. Decomposing and recovered (previously tagged) carcasses were chopped in half to prevent recounting. The Schaefer mark-recovery method (Schaefer, 1951) as modified by Taylor (1974) was applied to the tagged and recovered fresh carcasses, and total number of carcasses counted (both fresh and decayed) to produce an escapement estimate. The grilse population was determined by the ratio of grilse to adults from the fresh carcasses measured. The total Chinook salmon escapement is calculated by summing the in-river population estimate with the total number collected at Nimbus Fish Hatchery.

Daily water temperature, flow, and turbidity were collected throughout the sampling period. Mean daily water temperature and flow were obtained from U.S. Bureau of Reclamation gaging stations located throughout the lower American River. Water turbidity, measured in Nephelometric Turbidity Units (NTU), was obtained from the Faribairn Water Treatment Plant located on the lower American River near Sacramento State University.

## Results

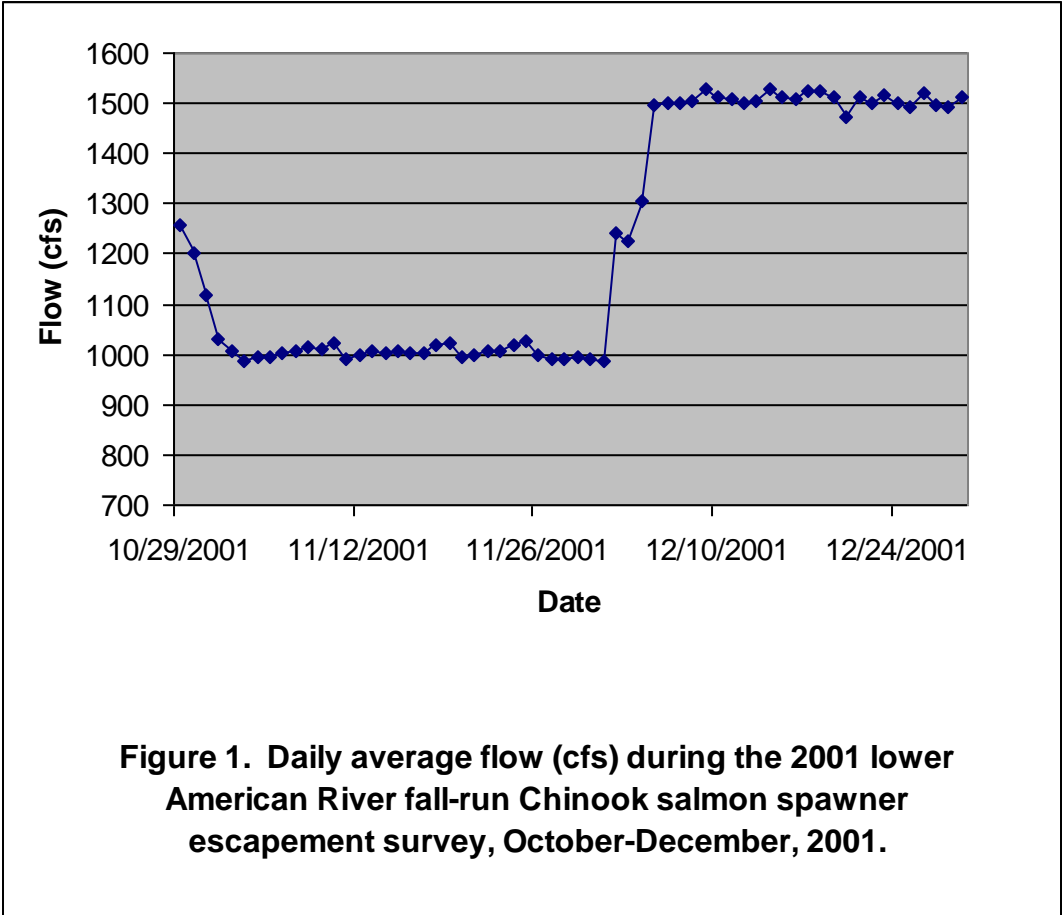
A total 43,439 salmon carcasses were observed during the 2001 American River spawner escapement survey, including 2,086 fresh and 41,353 non-fresh carcasses (Table 2). Mean daily flow ranged from 988 cfs in early November to 1,528 cfs during the second week of December (Figure 1). Water turbidity ranged from 1.8 to 10.7 NTU's during the lower American River Chinook salmon spawner escapement survey (Figure 2). Average water turbidity measurements during the weekly survey were low during the beginning of the survey and increased as the season progressed. Water temperature in the American River was 19 °C (66.2 °F) during the first week of the survey and did not reach 15.6 °C (60 °F) until Week 4. Water temperatures decreased each week after Week 4 to 10.6 °C (51 °F) by the end of the survey.

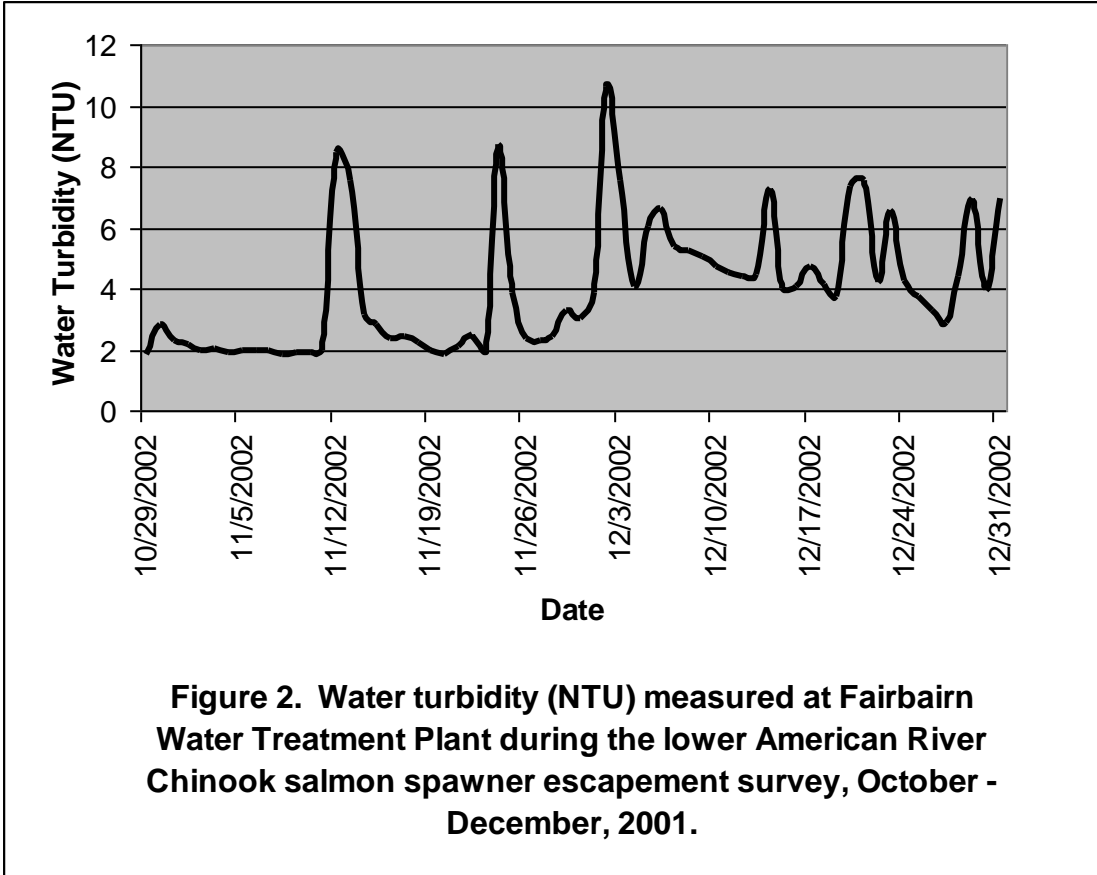
Table 2. General survey information for the 2001 lower American River fall-run Chinook salmon spawner escapement survey, October – December, 2001.

Week	Dates	Flow (cfs) <u>1/</u>	Turbidity NTU's <u>1/</u>	Water		Carcasses	
				Temp. <u>1/</u>		Observed	
				°C	°F	Fresh	Non-fresh
1	Oct 29-Nov 2	1,227	2.3	19.0	66.2	67	814
2	Nov 5-9	1,040	1.9	18.1	64.6	259	2,164
3	Nov 12-16	1,010	2.8	16.5	61.7	576	6,982
4	Nov 19-23	1,037	1.9	14.8	58.7	490	8,207
5	Nov 26-30	1,026	2.7	12.9	55.2	342	11,281
6	Dec 3-4	1,359	5.9	12.9	55.2	215	8,925
7 <u>2/</u>	Dec 10-14	1,541	4.8	11.9	53.4	38	806
8	Dec 17-21	1,528	6.2	10.9	51.7	79	1,557
9	Dec 24-28	1,530	4.8	10.7	51.2	20	617
Total						2,086	41,353

1/ Average measurements taken during the weekly survey

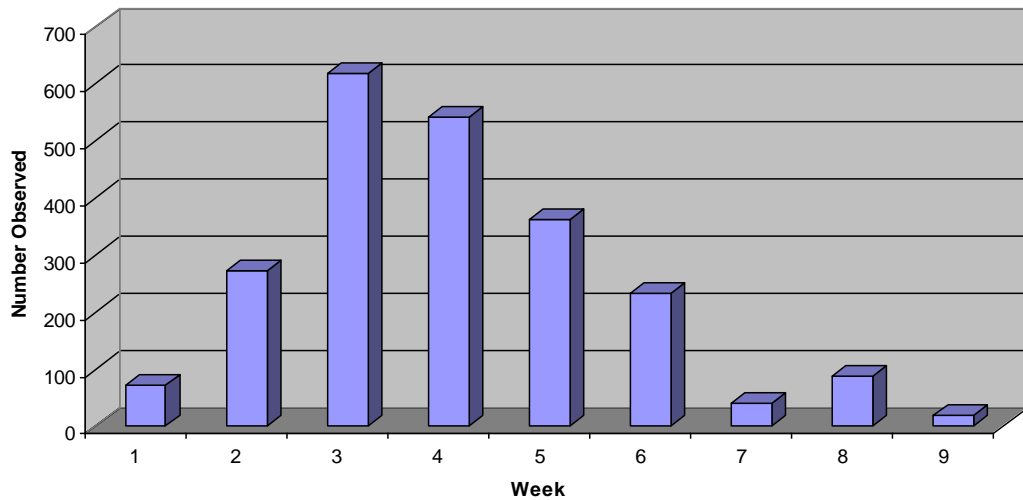
2/ Only upper portion of Section 1 was surveyed during Week 7.





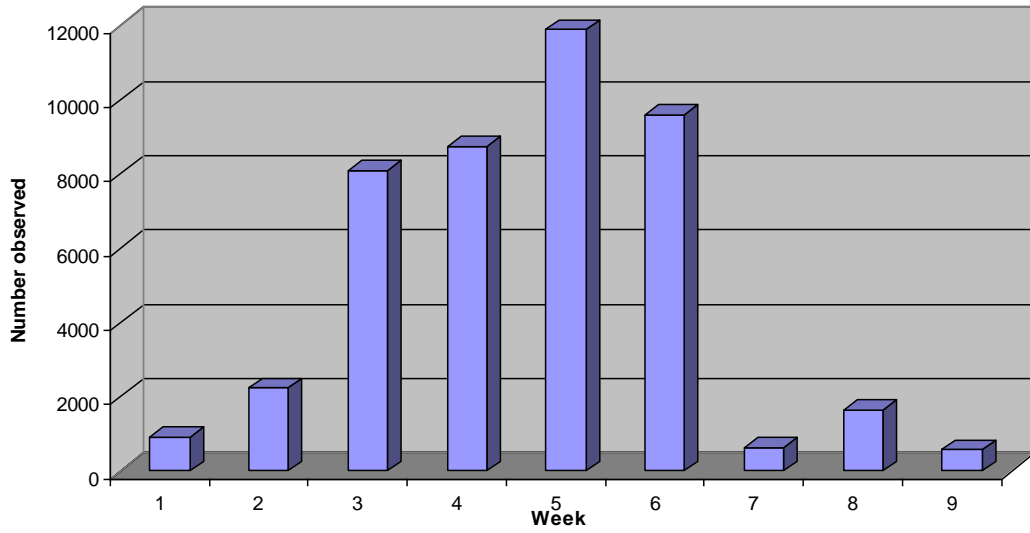
## Temporal Distribution

Fresh carcasses were observed during Week 1 and were present throughout the survey period (Figure 3). The number of fresh carcasses observed peaked during Week 3. The number of non-fresh carcasses increased beginning in Week 3 and peaked during Week 5 of the survey (Figure 4).



**Figure 3. Weekly distribution of fresh carcasses observed during the 2001 lower American River fall-run Chinook salmon spawner escapement survey, October-December 2001.**





**Figure 4. Weekly distribution of non-fresh carcasses observed during the 2001 lower American River fall-run Chinook salmon spawner escapement survey, October-December 2001.**

## Size Distribution

Chinook salmon lengths ranged from 47 to 116 cm and averaged 86 cm (FL) (Table 3). Average length of male Chinook salmon (89 cm) was larger than female average lengths (84 cm).

Table 3. Size and sex statistics for all fresh Chinook salmon carcasses measured during the 2001 lower American River fall-run Chinook salmon spawner escapement survey, October-December 2001.

Week	All salmon			Male salmon			Female salmon		
	Number	Length (cm)		Number	Length (cm)		Number	Length (cm)	
		Avg.	Range		Avg.	Range		Avg.	Range
1	64	82	54-111	24	86	54-111	40	80	59-96
2	233	84	55-115	111	87	55-115	122	82	57-100
3	301	87	53-116	123	89	55-116	178	85	53-105
4	244	87	52-115	104	89	52-115	140	85	55-106
5	139	89	56-111	50	93	62-111	89	87	56-103
6	27	88	59-102	13	88	59-102	14	88	78-99
7	6	78	67-89	2	88	87-89	4	73	67-88
8	49	88	47-107	21	91	47-107	28	87	65-102
9	1	89		1	89				
Total	1,064	86	47-116	449	89	47-116	615	84	53-106

## Age Composition

Grilse comprised 8% (86) of the total catch of fresh measured carcasses (Table 4) and weekly percent composition ranged from 4% to 33%. The greatest number of grilse was observed during Week 4 (24). Adults comprised 92% (989) of the measured carcasses. The greatest number of adults (283) was observed during Week 3.

Table 4. Age composition (grilse and adult) of carcasses measured during the 2001 lower American River fall-run Chinook salmon spawner escapement survey, October-December 2001.				
Week	Grilse		Adult	
	Number	Percent	Number	Percent
1	9	14	55	86
2	20	8	220	92
3	22	7	283	93
4	24	10	220	90
5	5	4	134	96
6	1	4	26	96
7	2	33	4	67
8	3	6	46	94
9			1	100
Total (Mean)	86	(8)	989	(92)

## Sex Composition

Female Chinook salmon comprised 60% (776) of the 1,291 fresh carcasses examined (Table 5). Most female (76%) and male (57%) fresh carcasses were collected in Reach 1.

Table 5. Sex composition of all fresh Chinook salmon carcasses examined during the 2001 fall-run Chinook salmon spawner escapement survey, October-December 2001.			
Reach	Male	Female	Total
1	292	597	889
2	147	117	264
3	76	62	138
Total	515	776	1,291

Male Chinook salmon comprised 42% (449) of the 1,064 fresh carcasses examined (Table 6). Twelve percent of the 449 male fresh carcasses and 7% of the 615 female carcasses aged were grilse. The overall ratio of male to female adult spawners was 1 to 1.5. Adult females were dominant every week except for Week 9. The overall ratio of male grilse to female grilse was 1.5 to 1. Female grilse were only dominant during Week 1 and Week 7.

Table 6. Sex composition of fresh Chinook salmon grilse and adult carcasses measured and sexed during the 2001 fall-run Chinook salmon spawner escapement survey, October-December 2001.

Week	Grilse				Adult			
	Male		Female		Male		Female	
	Number	Percent	Number	Percent	Number	Percent	Number	Percent
1	4	44	5	56	20	36	35	64
2	13	68	6	32	98	45	116	55
3	13	59	9	41	110	39	169	61
4	15	63	9	37	89	40	131	60
5	3	60	2	40	47	35	87	65
6	1	100	0	0	12	46	14	54
7	0	0	2	100	2	50	2	50
8	2	67	1	33	19	41	27	59
9	0	0	0	0	1	100	0	0
Total (Mean)	51	(60)	34	(40)	398	(41)	581	(59)

## Spawning Success

Of the 629 fresh adult and grilse female carcasses that were observed for egg retention, 20% had completely spawned, 13% were partially spawned, and 67% were unspawned (Table 7).

Table 7. Spawning completion (egg retention) summary for female Chinook salmon carcasses examined during the 2001 lower American River fall-run Chinook salmon spawner escapement survey, October-December 2001.				
Week	# females checked for egg retention	Spawned	Unspawned	Partially Spawned
		Number (%)	Number (%)	Number (%)
1	34	1 (3)	31 (91)	2 (6)
2	105	5 (5)	95 (90)	5 (5)
3	205	14 (7)	170 (83)	21 (10)
4	139	25 (18)	85 (61)	29 (21)
5	58	27 (47)	20 (34)	11 (19)
6	37	18 (49)	12 (32)	7 (19)
7	15	8 (53)	4 (27)	3 (20)
8	36	26 (72)	7 (20)	3 (8)
9	0	0	0	0
Total	629	124 (20)	424 (67)	81 (13)

Substantial numbers of unspawned and partially spawned female salmon were observed throughout the survey period. A high percentage of unspawned females were

counted at the beginning of the survey, but decreased as the season progressed. Conversely, the percentage of spawned females increased as the season progressed. The percentage of females classified as unspawned or partially spawned was higher (>50%) than spawned females through Week 6 of the survey. Completely spawned females comprised 53 and 72 percent of the female carcasses examined during Weeks 7 and 8, respectively.

### Population Estimate

A total of 1,116 fresh adult carcasses were tagged from Week 1 through Week 8 of which 406 tags were subsequently recovered (Table 8). Overall tag recovery rate was 36% and ranged from 28 to 51 percent. The Schaefer model produced an adult spawner in-river escapement estimate of 120,322 (Table 9). Since adults made up 92% of the escapement, a total escapement (adult and grilse) of 130,785 was calculated by dividing the adult estimate by .92.

The population estimates for salmon spawning in the American River below the Nimbus weir are as follows:

Total estimate:      130,785  
 Adult estimate:      120,322  
 Grilse estimate:      10,463

Table 8. Collapsed weekly summary of tagging and recapture of fresh adult Chinook salmon carcasses during the 2001 lower American River fall-run Chinook salmon spawner escapement survey, October-December 2001.							
Week of recovery $(i)$	Week of tagging				Tags recovered $R_{(i)}$	Carcasses counted $C_{(i)}$	Ratio $C_{(i)}/R_{(i)}$
	1	2	3	4			
2	22				22	3,261	148.2
3		59			59	7,558	128.1
4		7	232		239	19,848	83.0
5			1	85	86	11,925	138.7
$R_{(i)}$	22	66	233	85	(Tagged fish recovered) = 406		
$T_{(i)}$	43	238	543	292	(Total fish tagged) = 1,116		
$T_{(i)}/R_{(i)}$	1.95	3.61	2.33	5.36	(Ratio)		

Table 9. Lower American River adult Chinook salmon population estimate using the Schaefer model based on tagging fresh carcasses with all captured untagged carcasses removed, October-December 2001.					
Population Estimate <sup>(i)</sup>					
Week of recovery <sup>(j)</sup>	Week of tagging				
	1	2	3	4	Totals
2	6,374				6,374
3		27,255			27,255
4		2,096	44,900		46,996
5			323	40,490	40,813
Subtotals	6,374	29,351	45,223	40,490	121,438
Tagged	-43	-238	-543	-292	-1,116
Estimated population of natural spawning adults					120,322

In addition to the 130,785 salmon that spawned in the lower American River downstream of Nimbus weir, there were 11,644 salmon that entered Nimbus Hatchery. The total number of adult and grilse Chinook salmon collected at the Nimbus Fish Hatchery was 9,688 and 1,956, respectively.

There were an additional 4,552 adult and grilse carcasses removed from the Nimbus weir. By combining the in-river escapement (130,785) with the total number of Chinook salmon collected at the Nimbus Fish Hatchery (11,644) and at the weir (4,552), the 2001 fall-run Chinook salmon escapement for the lower American River was estimated to be 146,981.



## Discussion

A Chinook salmon spawner escapement survey was conducted on the lower American River in 2001. Up through Week 4, there were sufficient numbers of crew members to accomplish the 2001 lower American River Chinook salmon spawner escapement survey. After Week 4, the number of personnel available to perform the survey diminished due to people leaving, illnesses, and injuries. In addition, only the upper section of Reach 1 was surveyed during Week 7. Lack of personnel reduced the consistent effort in the survey during these weeks and, therefore, violated the assumptions of equal effort for the Schaefer model. Therefore, these weeks had to be collapsed and combined with adjacent weeks to eliminate the outliers in the Schaefer model.

The escapement of adult Chinook salmon in the lower American River derived from the modified Schaefer method was estimated to be 120,322. The Schaefer adult escapement estimate was more than three times higher than the previous 34 years' (1967-2000) average of 36,859 fish.

Most fresh adult Chinook carcasses observed in the lower American River were female (59%). Eight percent of the total carcasses observed in the lower American River were grilse, which were dominated by male (60%).

Although the first spawning redd was identified during Week 2 (November 6) when water temperature was 18.1 °C (64.6 °F), water temperature in the lower American River were above 15.6 °C (60 °F) during the first four weeks of the survey (through November 16). Elevated water temperatures likely contributed to the low spawning success (20%) that was observed in the lower American River during the 2001 spawner survey. Therefore, the estimated number of successful spawning females is substantially reduced to 14,198 due to the prolonged elevated water temperatures in the lower American River.

## Literature Cited

Schaefer, M.B. 1951. Estimation of the size of animal populations by marking experiments. U.S. Fish and Wildlife Bulletin, 52: 189-203.

Taylor, S.N. (Editor) 1974. King (Chinook) salmon spawning stocks in California's Central Valley, 1973. California Department of Fish and Game, Anadromous Fisheries Administrative Report No. 74-12. 32 p.