DEPARTMENT OF FISH AND GAME
Sacramento Valley-Central Sierra Region

# Lower American River Chinook Salmon Escapement Survey October 2003– January 2004

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 terminus 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 four goals of the 2003 lower American River spawner escapement survey were (1) estimate the number of spawners; (2) determine the sex and age composition; (3) determine the egg retention of the females in the run; and (4) determine the percentage of coded-wire tagged (CWT) fish within the fresh samples.

## 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 14, 2003 through January 14, 2004. Each weekly survey consisted of a crew of six to seven people and took three to four days to complete.

Table 1. American River fall-run Chinook salmon escapement survey reaches.

| 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 | 6.0 |
| 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 with missing adipose fins were identified as carcasses with a CWT. Heads were removed from the CWT carcasses and affixed with a jaw tag for further analysis of any CWT's. The remaining portion of the CWT carcasses were then chopped in half and recorded as a fresh chopped carcass.

A subset of fresh carcasses and all CWT carcasses were sexed and measured to the nearest centimeter (cm) Total Length (TL). Fish > 68 cm TL were considered adults, and those ≤ 68 cm TL 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 used 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 clarity were collected throughout the sampling period. Mean daily water temperature and flow were obtained from U.S. Bureau of Reclamation gauging stations located on the lower American River at Hazel Avenue, William Pond Park, and Watt Avenue. Water clarity was measured with a secchi disk to the nearest cm.

## Results

Mean daily flow ranged from 2,012 cfs to 3,542 cfs during the three month survey period. Flow was relatively constant at just above 2,000 cfs throughout the period with the exception of two flow fluctuations during the beginning and end of the survey (Figure 1). Water temperature in the American River ranged from 17.6 ºC (63.7 ºF) to 10.1 ºC (50.1 ºF) (Figure 2). Water clarity ranged from 2 to 4.7 meters during the survey (Table 2). Water clarity was lowest during Week 13 (January 5-7).

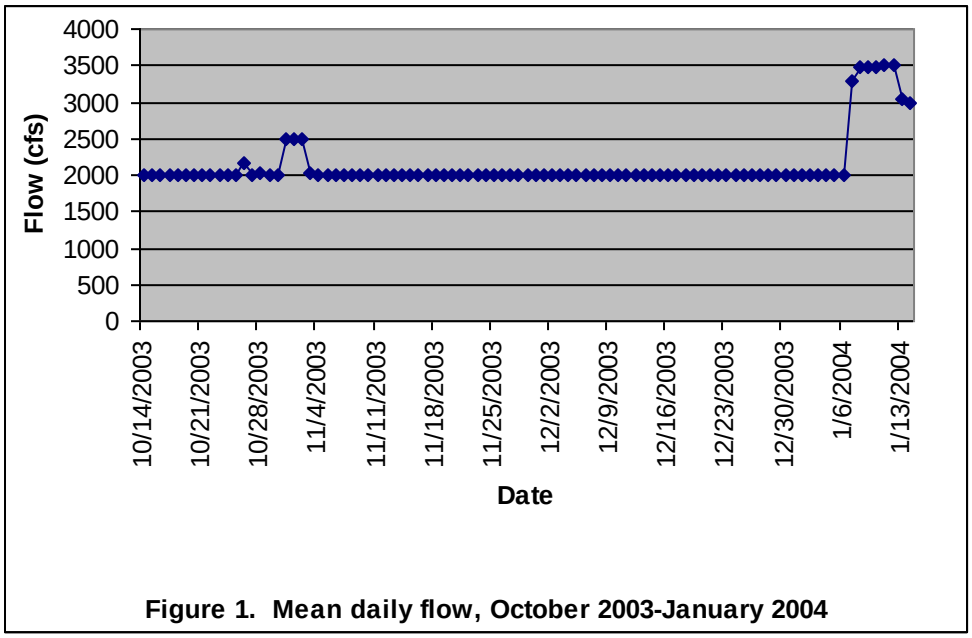


**Figure 1. Mean daily flow, October 2003-January 2004**

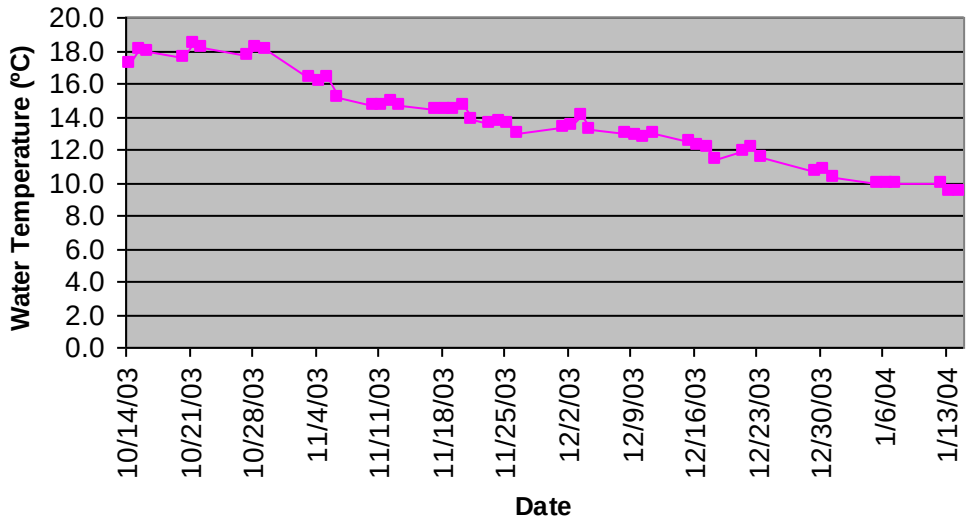


**Figure 2. Mean daily water temperature, October 2003 January 2004.**

Temporal Distribution

A total 57,158 salmon were observed during the 2003 American River escapement survey, including 6,468 fresh and 50,690 non-fresh carcasses (Table 2). Fresh carcasses were observed during Week 1 and were present throughout the survey

period (Figure 3). The number of fresh carcasses observed increased through Week 6 and then decreased. The number of non-fresh carcasses observed exhibited a similar trend (Figure 4). Given an estimated 2 week delay for spawning and mortality (Snider and Vyverberg, 1995), these results indicate that the bulk of spawning occurred during Weeks 4 through 6 (November 3 through November 21, 2003).

Table 2. General survey information for the American River fall-run Chinook salmon escapement survey, October 14, 2003–January 14, 2004.

| Week | Dates | Flow (cfs) 1/ | Secchi (meters) 1/ | Water Temp. 1/ | | Carcasses Observed | |
|---|---|---|---|---|---|---|---|
| | | | | ºC | ºF | Fresh | Non-fresh |
| 1 | Oct 14-Oct 16 | 2,005 | 4.3 | 17.7 | 63.9 | 21 | 44 |
| 2 | Oct 20- Oct 22 | 2,006 | 4.7 | 18.1 | 64.6 | 21 | 69 |
| 3 | Oct 27- Oct 29 | 2,012 | 4.0 | 18.0 | 64.4 | 53 | 196 |
| 4 | Nov 3-Nov 6 | 2,007 | 3.9 | 16.0 | 60.8 | 172 | 385 |
| 5 | Nov 10-Nov 13 | 2,003 | 3.5 | 14.7 | 58.5 | 486 | 942 |
| 6 | Nov 17-Nov 21 | 1,998 | 3.9 | 14.3 | 57.7 | 1,644 | 4,803 |
| 7 | Nov 23-Nov 26 | 2,003 | 3.2 | 13.4 | 56.1 | 1,378 | 6,262 |
| 8 | Dec 1-Dec 4 | 2,003 | 3.4 | 13.5 | 56.3 | 975 | 12,643 |
| 9 | Dec 8-Dec 11 | 1,999 | 3.1 | 12.9 | 55.2 | 757 | 11,345 |
| 10 | Dec 15-Dec 18 | 1,998 | 2.8 | 12.1 | 53.8 | 538 | 7,175 |
| 11 | Dec 21-Dec 23 | 2,003 | 2.8 | 11.8 | 53.2 | 312 | 3,715 |
| 12 | Dec 29-Dec 31 | 2,001 | 2.2 | 10.6 | 51.1 | 67 | 2,083 |
| 13 | Jan 5-Jan 7 | 2,428 | 2.0 | 10.0 | 50.0 | 30 | 849 |
| 14 | Jan 12-Jan 14 | 3,182 | 2.2 | 9.7 | 49.5 | 14 | 188 |
| Total | | | | | | 6,468 | 50,690 |

1/ Mean daily measurement.

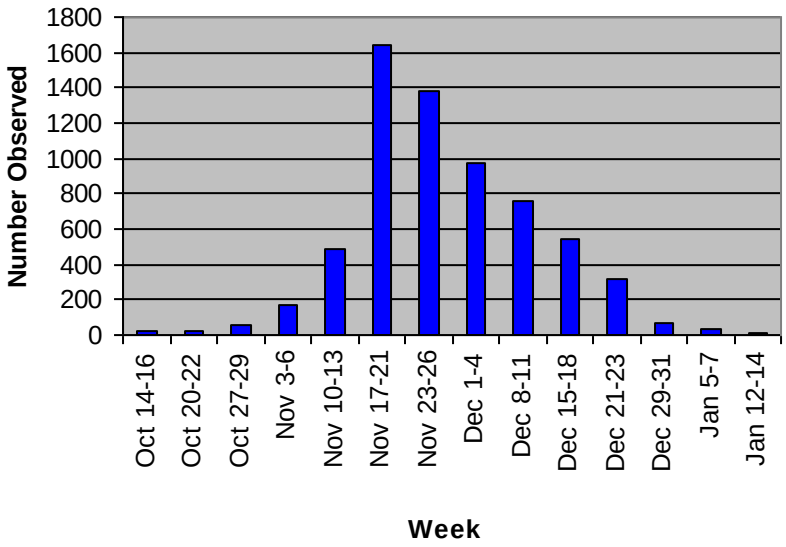


**Figure 3. Weekly distribution of fresh carcasses, October 2003-January 2004.**

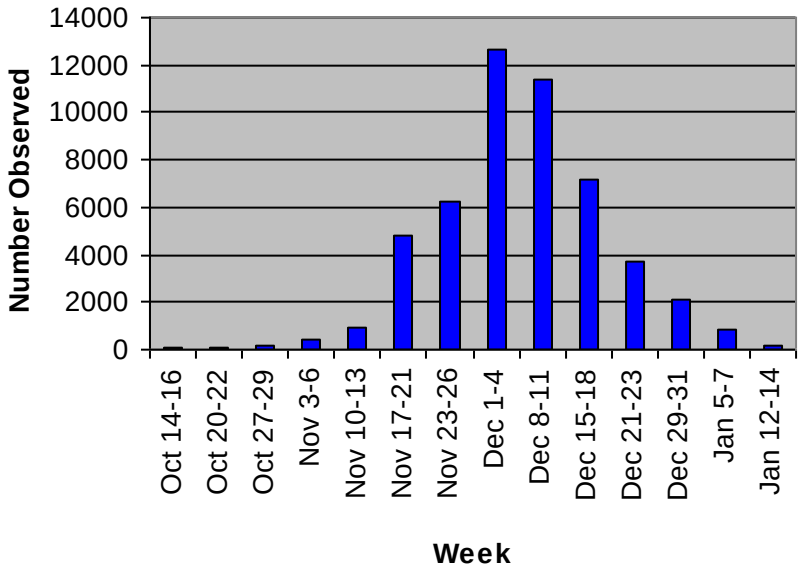


**Figure 4. Weekly distribution of non-fresh carcasses, October 2003-January 2004.**

Age Composition

Grilse comprised 7.3% (183) of the total catch of fresh measured carcasses (Table 3) and weekly percent composition ranged from 0% to 12.5%. The greatest number of grilse (42) was observed during Week 5. Adults comprised 92.6% (2,313) of the measured carcasses. The greatest number of adults (514) was observed during Week 6.

Table 3. Age composition (grilse and adult) of carcasses measured, October 2003-January 2004.

| Week | Grilse | | Adult | |
|---|---|---|---|---|
| | Number | Percent | Number | Percent |
| 1 | 0 | 0 | 20 | 100 |
| 2 | 1 | 5 | 20 | 95 |
| 3 | 4 | 8 | 47 | 92 |
| 4 | 20 | 12 | 150 | 88 |
| 5 | 42 | 9 | 423 | 91 |
| 6 | 35 | 6 | 514 | 94 |
| 7 | 25 | 7 | 351 | 93 |
| 8 | 11 | 5 | 231 | 95 |
| 9 | 21 | 9 | 214 | 91 |
| 10 | 8 | 5 | 159 | 95 |
| 11 | 9 | 7 | 124 | 93 |
| 12 | 7 | 12.5 | 49 | 87.5 |
| 13 | 0 | 0 | 4 | 100 |
| 14 | 0 | 0 | 7 | 100 |
| Total (Mean) | 183 | (7.3) | 2,313 | (92.7) |

Sex Composition

Female Chinook salmon comprised 61% (1,523) of the 2,496 fresh carcasses examined, while male Chinook salmon comprised 39% (973) (Table 4). Most female (80%) and male (66%) fresh carcasses were collected in Reach 1.

Table 4. Sex composition of all fresh Chinook salmon carcasses, October 2003-January 2004.

| Reach | Male | Female | Total |
|---|---|---|---|
| 1 | 641 | 1,223 | 1,864 |
| 2 | 259 | 246 | 505 |
| 3 | 73 | 54 | 127 |
| Total | 973 | 1,523 | 2,496 |

Fourteen percent of the 973 fresh male carcasses and 3% of the 1,523 fresh female carcasses aged were grilse (Table 5). The overall ratio of adult male to adult female spawners was 1 to 1.8. Adult females were most abundant every week except towards the beginning and end of the carcass survey. The overall ratio of male grilse to female grilse was 3 to 1. Female grilse were most abundant only during weeks 3 and 10.

Table 5. Sex composition of fresh Chinook salmon grilse and adult carcasses, October 2003-January 2004.

| Week | Grilse | | | | Adult | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | | Female | | Male | | Female | |
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| 1 | 0 | - | 0 | - | 11 | 55 | 9 | 45 |
| 2 | 1 | 100 | 0 | - | 6 | 30 | 14 | 70 |
| 3 | 1 | 25 | 3 | 75 | 19 | 40 | 28 | 60 |
| 4 | 18 | 90 | 2 | 10 | 58 | 39 | 92 | 61 |
| 5 | 35 | 83 | 7 | 17 | 142 | 34 | 281 | 66 |
| 6 | 28 | 80 | 7 | 20 | 177 | 34 | 337 | 66 |
| 7 | 19 | 76 | 6 | 24 | 105 | 30 | 246 | 70 |
| 8 | 6 | 55 | 5 | 45 | 82 | 35 | 149 | 65 |
| 9 | 15 | 71 | 6 | 29 | 82 | 38 | 132 | 62 |
| 10 | 3 | 37 | 5 | 63 | 68 | 43 | 91 | 57 |
| 11 | 7 | 78 | 2 | 22 | 53 | 43 | 71 | 57 |
| 12 | 5 | 71 | 2 | 29 | 26 | 53 | 23 | 47 |
| 13 | 0 | - | 0 | - | 1 | 25 | 3 | 75 |
| 14 | 0 | - | 0 | - | 5 | 71 | 2 | 29 |
| Total (Mean) | 138 | (75) | 45 | (25) | 835 | (36) | 1,478 | (64) |

Spawning Success

Of the 1,523 fresh adult and grilse female carcasses that were observed for egg retention, 48% had completely spawned, 37% were unspawned, and 15% were partially spawned (Table 6). Unspawned female salmon were observed nearly each week through Week 12. A high percentage ($\geq$90%) of unspawned females was counted through week 4, but decreased as the season progressed. The percentage of females classified as unspawned or partially spawned was higher than spawned females through Week 5. However, $\geq$23% of females were unspawned from Week 6 through

Week 11. From Week 6 through Week 14, completely spawned females ranged from 50 to 100 percent of the female carcasses examined during a given week.

Table 6. Spawning completion (egg retention) summary for female Chinook salmon carcasses, October 2003-January 2004.

| Week | # females checked for egg retention | Spawned | Unspawned | Partially Spawned |
|---|---|---|---|---|
| | | Number (%) | Number (%) | Number (%) |
| 1 | 9 | 0 (0) | 9 (100) | 0 (0) |
| 2 | 14 | 0 (0) | 12 (86) | 2 (14) |
| 3 | 31 | 0 (0) | 30 (94) | 1 (6) |
| 4 | 94 | 4 (4) | 84 (90) | 6 (6) |
| 5 | 288 | 76 (27) | 162 (56) | 50 (17) |
| 6 | 344 | 177 (52) | 97 (28) | 70 (20) |
| 7 | 252 | 154 (61) | 61 (24) | 37 (15) |
| 8 | 154 | 86 (56) | 42 (27) | 26 (17) |
| 9 | 138 | 90 (65) | 33 (24) | 15 (11) |
| 10 | 96 | 67 (70) | 22 (23) | 7 (7) |
| 11 | 73 | 46 (63) | 18 (25) | 9 (12) |
| 12 | 25 | 23 (92) | 1 (4) | 1 (4) |
| 13 | 3 | 3 (100) | 0 (0) | 0 (0) |
| 14 | 2 | 1 (50) | 0 (0) | 1 (50) |
| Total (mean) | 1,523 | 727 (48) | 571 (37) | 225 (15) |

Coded-wire tagged fish

Of the 6,468 fresh carcasses that were observed during the survey, 464 were observed with missing adipose fins and classified as CWT fish. Weekly percentage of CWT fish ranged form 4.8 to 28.6% and averaged 7.2% (Table 7). The highest percentage of CWT fish was observed during Weeks 2 and 14.

Grilse comprised 6.3% of the total number of CWT Chinook salmon and weekly percent composition ranged from 0 to 25% (Table 8). The greatest number of CWT grilse (11) was observed during Week 6. Adult CWT Chinook salmon comprised 93.7% (435) of the measured CWT carcasses. The greatest number of adult CWT Chinook salmon was observed during Week 6 and 7.

| Table 7. Number and percentage of fresh CWT Chinook salmon carcasses, October 2003-January 2004. | | |
|---|---|---|
| Week | Number of fresh carcasses observed | Number of CWT fish observed (Percent) |
| 1 | 21 | 1 (4.8) |
| 2 | 21 | 4 (19) |
| 3 | 53 | 5 (9.4) |
| 4 | 172 | 18 (10.5) |
| 5 | 486 | 72 (14.8) |
| 6 | 1,644 | 99 (6) |
| 7 | 1,378 | 94 (6.8) |
| 8 | 975 | 57 (5.8) |
| 9 | 757 | 58 (7.7) |
| 10 | 538 | 28 (5.2) |
| 11 | 312 | 16 (5.1) |
| 12 | 67 | 4 (6) |
| 13 | 30 | 4 (13.3) |
| 14 | 14 | 4 (28.6) |
| Total | 6,468 | 464 (7.2) |

| Table 8. Age composition (grilse and adult) of CWT carcasses measured, October 2003-January 2004. | | | | | |
|---|---|---|---|---|---|
| Week | Number of fresh CWT carcasses observed | Grilse | | Adult | |
| | | Number | Percent | Number | Percent |
| 1 | 1 | 0 | 0 | 1 | 100 |
| 2 | 4 | 0 | 0 | 4 | 100 |
| 3 | 5 | 0 | 0 | 5 | 100 |
| 4 | 18 | 1 | 5.6 | 17 | 94.4 |
| 5 | 72 | 4 | 5.6 | 68 | 94.4 |
| 6 | 99 | 11 | 11 | 88 | 89 |
| 7 | 94 | 5 | 5.3 | 89 | 94.7 |
| 8 | 57 | 2 | 3.5 | 55 | 96.5 |
| 9 | 58 | 5 | 8.6 | 53 | 91.4 |
| 10 | 28 | 0 | 0 | 28 | 100 |
| 11 | 16 | 0 | 0 | 16 | 100 |
| 12 | 4 | 1 | 25 | 3 | 75 |
| 13 | 4 | 0 | 0 | 4 | 100 |
| 14 | 4 | 0 | 0 | 4 | 100 |
| Total (Mean) | 464 | 29 | (6.3) | 435 | (93.7) |

There were more adult CWT female Chinook salmon (62%) observed than adult male CWT Chinook salmon (Table 9). In contrast, there were more male CWT grilse (72%) than female CWT grilse.

Table 9. Sex composition of CWT Chinook salmon grilse and adult carcasses, October 2003-January 2004.

| Week | Grilse | | | | Adult | | | |
|---|---|---|---|---|---|---|---|---|
| | Male | | Female | | Male | | Female | |
| | Number | Percent | Number | Percent | Number | Percent | Number | Percent |
| 1 | 0 | - | 0 | - | 1 | 100 | 0 | 0 |
| 2 | 0 | - | 0 | - | 1 | 25 | 3 | 75 |
| 3 | 0 | - | 0 | - | 3 | 60 | 2 | 40 |
| 4 | 0 | - | 1 | 100 | 6 | 35 | 11 | 65 |
| 5 | 2 | 50 | 2 | 50 | 23 | 34 | 45 | 66 |
| 6 | 9 | 82 | 2 | 18 | 34 | 28 | 54 | 72 |
| 7 | 4 | 80 | 1 | 20 | 29 | 33 | 60 | 67 |
| 8 | 2 | 100 | 0 | 0 | 21 | 45 | 34 | 55 |
| 9 | 3 | 60 | 2 | 40 | 18 | 34 | 35 | 66 |
| 10 | 0 | - | 0 | - | 15 | 54 | 13 | 46 |
| 11 | 0 | - | 0 | - | 7 | 43 | 9 | 57 |
| 12 | 1 | 100 | 0 | 0 | 2 | 67 | 1 | 33 |
| 13 | 0 | - | 0 | - | 1 | 25 | 3 | 75 |
| 14 | 0 | - | 0 | - | 3 | 750 | 1 | 25 |
| Total (Mean) | 21 | (72) | 8 | (28) | 164 | (38) | 271 | (62) |

Population Estimate

A total of 4,186 fresh adult carcasses was tagged from Week 1 through Week 12 of which 1,527 tags were subsequently recovered (Table 10). Overall tag recovery rate was 36.5% and ranged from 14 to 45 percent. The modified Schaefer model produced an adult in-river escapement estimate of 146,945 (Table 11). Since adults made up 92.7% of the escapement, a total escapement (adult and grilse) of 158,516 was calculated by dividing the adult estimate by 0.927. Grilse comprised 7.3% (11,571) of the population.

Table 10. Weekly summary of tagging and recapture of fresh adult Chinook salmon carcasses, October 2003-January 2004.

| Week of recovery (i) | Week of tagging | | | | | | | | | | | | Tags recovered R(j) | Carcasses counted C(j) | Ratio C(j)/R(j) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | | | |
| 2 | 9 | | | | | | | | | | | | 9 | 162 | 18.00 |
| 3 | | 6 | | | | | | | | | | | 6 | 251 | 41.83 |
| 4 | | | 4 | | | | | | | | | | 4 | 531 | 132.75 |
| 5 | | | | 34 | | | | | | | | | 34 | 1364 | 40.12 |
| 6 | | | 1 | 9 | 111 | | | | | | | | 121 | 6090 | 50.33 |
| 7 | | | | | 11 | 304 | | | | | | | 315 | 7393 | 23.47 |
| 8 | | | | | 3 | 67 | 257 | | | | | | 327 | 12889 | 39.42 |
| 9 | | | | | | 15 | 55 | 189 | | | | | 259 | 11456 | 44.23 |
| 10 | | | | | | 1 | 4 | 31 | 133 | | | | 169 | 7431 | 43.97 |
| 11 | | | | | | | 8 | 4 | 33 | 104 | | | 149 | 3881 | 26.05 |
| 12 | | | | | | 1 | | 4 | 12 | 40 | 44 | | 101 | 2142 | 21.21 |
| 13 | | | | | | | 2 | | | 1 | 7 | 14 | 24 | 861 | 35.88 |
| 14 | | | | | | | | 1 | 2 | 3 | | 3 | 9 | 199 | 22.11 |
| R(i) | 9 | 6 | 5 | 43 | 125 | 388 | 326 | 229 | 180 | 148 | 51 | 17 | Tagged fish recovered = 1,527 | | |
| M(i) | 20 | 17 | 36 | 138 | 368 | 1,077 | 830 | 588 | 486 | 419 | 151 | 56 | Total fish tagged = 4,186 | | |
| M(i)/R(i) | 0.45 | 0.35 | 0.14 | 0.31 | 0.34 | 0.36 | 0.39 | 0.39 | 0.37 | 0.35 | 0.34 | 0.30 | Overall ratio = 36.5% | | |

Table 11. Lower American River adult Chinook salmon population estimate using the Schaefer model based on tagging fresh carcasses with all captured untagged carcasses removed, October 2003-January 2004.

| Population Estimate (i) | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Week of recovery (i) | Week of tagging | | | | | | | | | | | | |
| | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 | 10 | 11 | 12 | Totals |
| 1 | 360 | | | | | | | | | | | | |
| 2 | | 711 | | | | | | | | | | | |
| 3 | | | 3,823 | | | | | | | | | | |
| 4 | | | | 4,377 | | | | | | | | | |
| 5 | | | 362 | 1,454 | 16,447 | | | | | | | | |
| 6 | | | | | 760 | 19,805 | | | | | | | |
| 7 | | | | | 348 | 7,330 | 25,791 | | | | | | |
| 8 | | | | | | 1,842 | 6,194 | 21,465 | | | | | |
| 9 | | | | | | 122 | 448 | 3,500 | 15,790 | | | | |
| 10 | | | | | | | 531 | 268 | 2,321 | 7,669 | | | |
| 11 | | | | | | 59 | | 218 | 687 | 2,402 | 2,763 | | |
| 12 | | | | | | | 183 | | | 102 | 744 | 1,654 | |
| 13 | | | | | | | | 57 | 119 | 188 | | 219 | |
| Subtotals | 360 | 711 | 4,186 | 5,831 | 17,555 | 29,158 | 33,146 | 25,507 | 18,917 | 10,360 | 3,506 | 1,873 | 151,111 |
| Tagged | | -17 | -36 | -138 | -368 | -1,077 | -830 | -588 | -486 | -419 | -151 | -56 | -4,166 |
| Estimated population of natural spawning adults | | | | | | | | | | | | | 146,945 |

In addition to the 158,516 salmon that returned to the lower American River downstream of Nimbus weir, there were 14,887 salmon that entered Nimbus Hatchery. The total number of adult and grilse Chinook salmon collected at the Nimbus Fish Hatchery was 11,875 and 3,012, respectively.

There were an additional 5,226 adult and grilse carcasses removed from the Nimbus weir. By combining the in-river escapement (158, 516) with the total number of Chinook salmon collected at the Nimbus Fish Hatchery (14,887) and at the weir (5,226), the 2003 fall-run Chinook salmon escapement for the lower American River was estimated to be 178,629.

## Conclusion and Discussion

A Chinook salmon escapement survey was conducted on the lower American River in 2003. Three reaches in the lower American River took three to five days to complete. Equal effort was applied to each reach by maintaining a consistent crew of six to seven people throughout the survey period.

The in-river escapement of Chinook salmon in the lower American River derived from the modified Schaefer method was estimated to be 158,516. The adult escapement estimate is more than three and three quarters greater than the previous 35 year (1967-2002) average of 41,445 fish (Table 12).

Since 2000, there has been an increasing trend in the number of returning fall-run Chinook salmon in the lower American River, and with that, a high degree of pre-spawning mortality. Water temperatures in early October most likely contributed to the high pre-spawning mortality observed during the beginning of the escapement survey (Weeks 1-4). After which, competition for spawning habitat was likely the cause of the steady trend ($\geq$23%) of pre-spawning mortality for female carcasses examined from Weeks 6-11.

The overall pre-spawning mortality averaged 37% for the entire period. Therefore, the number of returning females (61%) to the lower American River is reduced by 37%, or approximately 35,777 female Chinook salmon died before they spawned. This results in a spawning escapement estimate of approximately 122,739.

| Table 12. American River Chinook salmon escapement estimates, 1967-2002. | | | |
|---|---|---|---|
| Year | Grilse | Adult | Total |
| 1967 [a] | 3,132 | 14,868 | 18,000 |
| 1968 [a] | 2,777 | 23,423, | 26,200 |
| 1969 [a] | 8,208 | 35,452 | 43,660 |
| 1970 [a] | 2,753 | 25,927 | 28,680 |
| 1971 [a] | 5,210 | 36,470 | 41,680 |
| 1972 [a] | 3,352 | 14,107 | 17,459 |
| 1973 [a] | 4,688 | 77,554 | 82,242 |
| 1974 [b] | 1,769 | 51,827 | 53,596 |
| 1975 [a] | 2,699 | 29,433 | 32,132 |
| 1976 [b] | 1,181 | 21,978 | 23,159 |
| 1977 [b] | 4,701 | 36,904 | 41,605 |
| 1978 [b] | 595 | 12,334 | 12,929 |
| 1979 [b] | 896 | 36,419 | 37,315 |
| 1980 [b] | 8,805 | 25,454 | 34,259 |
| 1981 [b] | 2,521 | 40,941 | 43,462 |
| 1982 [a] | 4,323 | 28,677 | 33,000 |
| 1983 [a] | 7,313 | 19,087 | 26,400 |
| 1984 [c] | 2,196 | 25,251 | 27,447 |
| 1985 [b] | 11,392 | 44,728 | 56,120 |
| 1986 [b] | 4,443 | 44,929 | 49,372 |
| 1987 [b] | 2,960 | 18,185 | 24,145 |
| 1988 [d] | 1,905 | 13,974 | 15,879 |
| 1989 [b] | 2,459 | 14,619 | 17,078 |
| 1990 [b] | 1,167 | 5,541 | 6,708 |
| 1991 [b] | 1,506 | 16,639 | 18,145 |
| 1992 [b] | 1,297 | 3,175 | 4,472 |
| 1993 [b] | 6,162 | 20,624 | 26,786 |
| 1994 [b] | 2,927 | 28,405 | 31,332 |
| 1995 [b] | 7,010 | 63,086 | 70,096 |
| 1996 [b] | 6,592 | 59,323 | 65,915 |
| 1997 [b] | 4,220 | 42,668 | 46,888 |
| 1998 [b] | 10,760 | 32,282 | 43,042 |
| 1999 [b] | 7,716 | 40,509 | 48,225 |
| 2000 [b] | 5,922 | 92,783 | 98,705 |
| 2001 [b] | 10,463 | 120,322 | 130,785 |
| 2002 [b] | 11,811 | 106,303 | 118,114 |
| Average | 4,662 | 36,783 | 41,445 |
| [a] Expanded direct counts; [b] Schaefer method; [c] Petersen method; [d] Jolly-Seber method | | | |

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