Estimating The Abundance Of Clear Creek Juvenile Chinook Salmon And Steelhead Trout By Use Of A Rotary-Screw Trap

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Abstract— Juvenile salmonid monitoring with a rotary-screw trap was conducted by the U.S. Fish and Wildlife Service on Clear Creek from 5 December 1998 through 21 April 2000. Our primary objective was to produce juvenile production estimates (JPE's) for chinook salmon and steelhead trout. This and subsequent baseline data will be used to assess the relative effectiveness of specific habitat restoration activities currently underway in the Clear Cr. Watershed. Fall, late-fall and spring chinook salmon and steelhead were captured. The JPE for brood year 1998 (BY98) and BY99 fall chinook was 7,322,381 and 7,005,269, respectively. The JPE's for BY99 late-fall and spring chinook were 272,966 and 57,189, respectively. Juvenile winter chinook salmon were present as determined by length at date criteria. However, the emigration pattern and size of captured fish was not indicative of natural reproduction and, therefore, winter chinook presence is questionable. The individuals were likely late spawning or slow growing late-fall chinook.

Sixty-three mark/recapture trials were conducted to determine rotary-screw trap efficiency for generation of juvenile production estimates. Individual efficiencies ranged from 0.0 to 33.3 % ($\bar{x}$ = 14.4, S.E. = 1.4). To determine if the rotary-screw trap was selective for larger or smaller individuals, paired samples on median fork lengths (mm) of released versus recaptured fish were analyzed using a Wilcoxin Signed Rank Test. For trials using fish $\leq$ 40.0 mm (FL), significant differences in median fork length were not detected (p = 0.154, n = 30). They did exist, however, for fish greater than 40.0 mm (p = 0.017, n = 13), in that fish of a greater median fork length were recaptured versus released.

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Introduction

The anadromous fish that inhabit Clear Creek (Cr.) include chinook salmon (*Oncorhynchus tshawytscha*), steelhead trout (*Onchorhynchus mykiss*) and Pacific lamprey (*Lampetra tridentatus*). There were four distinct races (runs) of chinook salmon present in Clear Cr., based on established length criteria. Of these, two are federally listed under the Endangered Species Act (ESA, Act) of 1973. Winter chinook are listed as endangered while spring chinook and steelhead trout are listed as threatened. These species were listed due to dramatic declines in abundance from a variety of anthropogenic impacts to their environment. Dams and water diversions, mining operations, and forest management practices are primary factors contributing to the loss of habitat and the resulting salmonid population declines.

Large-scale restoration activities are currently being conducted throughout the Central Valley of California; one of these projects is occurring in the Clear Cr. watershed. Clear Cr. is a tributary of the upper Sacramento River. Evaluation of augmented flows and water temperatures, spawning gravel placement, riparian community restoration, and dam removal projects are currently being conducted in an effort to rehabilitate habitat and restore salmonid populations.

By directly monitoring the annual juvenile production in Clear Cr., managers will obtain an empirical basis for adaptively modifying (adaptive management) restoration actions within the basin in an effort to improve and restore physical conditions for anadromous salmonids. The Central Valley Project Improvement Act (CVPIA) legislation specifically identifies the doubling of anadromous salmonid populations as a target goal. Actions taken to assess the population of chinook salmon and steelhead in Clear Cr. will indirectly contribute to the assessment of the Anadromous fish Restoration Program (AFRP), Section 3406 (b)(1) to "make all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967 - 1991". Restoration actions underway include projects that are part of the Anadromous Fish Restoration Program's Plan (USFWS 1997). These projects are being implemented by various actions throughout the Central Valley.

Our specific objectives include:

1) Generate juvenile production estimates (JPE's) for all runs of chinook salmon and steelhead trout.

8) Estimate seasonal, temporal and diel patterns of abundance for juvenile salmon and steelhead trout.

9) Obtain important life-history, condition and behavioral (migratory) information for all runs of chinook salmon and steelhead trout.

Study Area

The lower Clear Cr. watershed encompasses approximately 12,550 hectares. It ranges from Whiskeytown Dam southeast approximately 25 km to the Sacramento River (Fig. 1). Clear Cr. receives supplemental water from a cross-basin transfer between Lewiston Lake (Trinity River system) and Whiskeytown Reservoir (Sacramento River system).

Land use and ownership within the watershed is divergent between private/commercial, state and federal (Bureau of Land Management, National Park Service) entities.

The geology of the area is comprised of assorted granitics, clay and sand. Some areas of the stream channel have been hydraulically scoured or mined so extensively that only clay hardpan remains and gravel recruitment is limited by Whiskeytown Dam.

Ambient air temperatures range from approximately 0.0 ^{0}C in winter to summer highs in excess of 46.0 ^{0}C. The average rainfall is approximately 152 cm with most precipitation occurring between November and April. Little or no rain occurs during the summer months.

The rotary-screw trapping site was located 1.7 km above it's confluence with the Sacramento River (latitude 40^0 30' 23" north and longitude 122^0 23' 45" west) and was situated directly below a channel constriction where stream gradient ranged from 1.0 to 1.5 degrees.

Methods

Rotary-screw trapping was conducted from 5 December 1998 through 21 April 2000 to sample emigrating salmonids. The data in this report are reported in a weekly or monthly time step to reduce variation in catch, effort, trap efficiency, mortality, and fork length while retaining sufficient detail to evaluate trends in timing and abundance. Data were typically consolidated to represent weekly or monthly sums, medians, and means. Weeks began on Monday and ended on Sunday and were identified by number. Week 1 was defined as the first week of 1999 (i.e., contains 1 January 1999). Weeks prior to week 1 were consecutively numbered in descending order from 52; weeks after week 1 were numbered in ascending order.

Our sampling protocol followed that described by the CVPIA Comprehensive Assessment and Monitoring Protocol for rotary-screw trap sampling (CVPIA 1997), where applicable.

The rotary-screw trap was made by E.G. Solutions® of Corvallis, Oregon. It consists of a 1.5-m tubular cone covered with 3-mm diameter perforated stainless steel screen to act as a sieve separating fish from the water sampled. The cone is supported between two pontoons and it's auger type action passes water, fish and debris to the rear of the trap and directly into an aluminum live box.

Two trees approximately 30 - 45 cm diameter at breast height were selected on opposite banks of the creek to use as attachment anchors from which the trap was secured in the stream flow. The trees were 67-m apart and far enough removed from the active stream channel such that their integrity as anchor points would not be undermined by high flow events.

Routine trap access was by wading, but during high flows the trap was pulled into shallow water for boarding and then returned to the thalweg to collect environmental data. The trap was checked and cleared of debris and fish once daily, unless high flows and heavy debris loads necessitated that it be cleared twice daily to reduce mortality of captured fish or sinking of the trap. Information such as fishing dates, times, cone depth, water depth, amount and types of debris, weather conditions and trap condition, were recorded at each checking. Water temperatures were obtained with an in-stream Onset Optic Stow Away® temperature data logger. Water turbidity was measured with a HACH® Model 2100 turbidimeter. Water velocity was measured using an Oceanic® Model 2030 flow torpedo.

The contents of the live box were removed and fish and debris were separated on a fish sorting table. When catch did not exceed 250 fish, all fish were identified, enumerated, fork lengths (FL) measured (nearest 1.0-mm) and classified according to their life stage development (fry, parr, silvery parr, smolt). Steelhead trout were classified similarly, but with the addition of a yolk-sac fry life stage, as requested by the Interagency Ecological Program Steelhead Project Work Team.

To investigate the relative condition of juvenile salmonids, approximately 150 individuals (when present) were weighed to the nearest 0.01-g twice weekly (300 per week) using a battery-operated Ohaus Scout® digital scale. Also, three times per week 200 juvenile salmon (600 per week) were held and dye-marked with bismark brown (a chemical stain) for use in mark/recapture trap efficiency trials.

When catch exceeded 250 individuals, fish were transported from the trap and placed off-shore in a 121-L fish retention container. The container was designed and fabricated to provide a continuous supply of fresh water. A random subsample was taken and the sampled fish (≈150 - 250 fish) were placed in a 19-L tub filled with water. These fish were anesthetized in a 3.8-L tub using Tricaine methanesulfonate (MS-222). An additional 19-L tub was used to allow fish to recover from the anesthetic effects before being released. Water in the tubs was replaced as necessary to maintain adequate temperature and oxygen levels. All fish in the random subsample were identified and enumerated. All juvenile chinook and up to 50 juvenile steelhead and 20 individuals from non-salmonid species were measured (FL). However, when extremely large catches (< 1000) of juvenile salmon occurred, counts were estimated based on the weight and enumeration of individuals from three random subsamples and the weight of the total catch.

Estimates of direct mortality were generated by calculating the proportion of dead specimens within a random subsample and expanding that proportion to the unsampled catch.

Each week tissue samples were collected from four juvenile salmon as part of the Central Valley Genetics Project conducted by the California Department of Water Resources. When available, tissues from recently expired fish were used, otherwise a 1-mm x 1-mm sample of tissue from the caudal fin of live individuals was taken.

Mark/recapture trials— Only naturally produced (unmarked) juvenile salmon captured by rotary-screw traps were used for mark/recapture trials. Fish were marked in a Bismark brown solution concentrated at 4-g Bismark brown per 189-L of water for 40 minutes. Fish were then held in fresh water for 24-h so that any fish acutely affected by the marking procedure (usually < 5%) could be removed from use in trials. Fish were transported 0.8 km above the trap and released in the center of the stream. Initially, 100 juvenile salmon were marked and released each day from Monday through Friday. No fish were released on Saturdays or Sundays to allow marked fish sufficient time to emigrate below the trap. By early spring of 1999, we started marking 200 fish per day, three times per week (600 fish per week when present) Monday through Friday.

In January 2000, we evaluated and implemented a new technique for marking fish using a Photonic Marking and Tagging™ procedure developed by [1]New West Technologies. It involves the subcutaneous injection of microscopic "latex beads". This injection system allows for multiple mark types based on color and location of tag (dorsal, caudal or anal fin). This technique provided the ability for investigators to assign recaptured fish to specific release groups rather than consolidating trials within a week, which had been necessary with our previous marking technique. Also, the fluorescent photonic tag is not readily visible, therefore, we implemented Bismark brown staining in combination with photonic tagging. This enabled investigators to easily recognize marked fish and isolate them for further inspection of the photonic tag. After this secondary inspection, fish were assigned to a particular release group based on the photonic color and tag location.

Due to high ambient air temperatures in late spring and the summer months, a portable water chiller unit was used to maintain ambient stream temperature and reduce stress and mortality during transport to the release location. Marked fish recaptured by the rotary-screw trap after release were enumerated and measured and released down-stream of the trap.

Trap efficiency estimates were generated by use of the equation:

$$E = R / M$$

Where:

E is the estimated trap efficiency,

R is the number of marked fish recaptured,

and M is the number of marked fish released.

Weekly juvenile production estimates (JPE's) were generated by use of the equation:

$$A = C / E$$

where;

A is the estimated abundance,

C is the summed catch for that week,

E is the estimated trap efficiency.

Juvenile production estimates for salmonids were generated using the weekly

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New West Technologies, Research and Engineering Laboratories, 131 Stony Circle, Suite 500 (P.O. Box 7286) Santa Rosa. California.

estimates or mean estimates (when more than one trial occurred during the week) of trap efficiency using methods described by Thedinga et al. (1994) and Keenan et al. (1994). When mark/recapture trials could not be conducted or were not satisfactorily completed, trap efficiencies were generally assigned or adjusted by generating a mean efficiency using the trial immediately prior to and immediately following the week in question, if stream discharge was similar. However, if stream discharge was not similar, weekly efficiencies were assigned or adjusted using a mean efficiency from a greater number of trials preceding and following the week in question. The exact number of trials used to estimate or assign trap efficiencies varied depending on stream conditions preceding and following the week in question.

Ninety-five percent confidence limits (C.I.'s) for weekly JPE's were generated using one of three techniques described by Krebs (1999), with some modification. The techniques for determining these C.I.'s are for a single species using a standard Peterson population estimate. To modify these techniques for use with multiple species (i.e., fall, late-fall, winter, and spring chinook and steelhead trout), we summed, by week, all salmonids and developed our C.I.'s around those weekly JPE's. For any particular species of salmon, we simply multiplied the upper and lower C.I.'s by that species proportion of the weekly JPE. However, when weekly salmonid catch was less than 300 individuals (weeks 28-44), the C.I.'s became unstable, and therefore, we chose not to generate C.I.'s for those weekly JPE's.

Results

Sampling effort— Sampling effort was high during the period covered by this report. The rotary trap sampled 435 complete days (24-h/day) out of 478 possible days (91%). Periods of inactivity were generally concomitant with high flows and heavy debris loading during the winter months (Fig. 2). Mean daily flows ranged from142 cfs in August 1999 to 744 cfs in March 2000. The Clear Cr. hydrograph is reflective of the seasonality of rainfall in the northern Central Valley of California, in that most precipitation occurred between January and April. Numerous high flow events occurred during these months with individual events ranging from approximately 400 cfs to 700 cfs per event. Stream discharge information was provided by the U.S. Geological Survey IGO gaging station, located approximately 14.4 km above the rotary-screw trap location.

Mean daily water temperatures in Clear Cr. ranged from 5.8 ^{0}C in February 1999 to 20.1 ^{0}C in July 1999 (Fig. 3). Cooler water temperatures were prevalent during the winter months and co-occurred with winter rains in both years. Water transparency was generally high, however, turbidity increased with rainfall and high flow events (Fig. 4) and was moderately correlated with discharge (Fig. 5, R^2 = 0.38).

Fish assemblage— The fish assemblage in Clear Cr. was moderately diverse during the period covered by this report. During this time, the rotary-screw trap captured over 20 non-anadromous species (Table 1). The majority of these species were non-indigenous to the Clear Cr. watershed, but were not as numerically dominant as the native fishes. Hardhead (*Mylopharodon conocephalus*) was the most common non-salmonid species captured and was present year round (Table 1). A total of 1,576 hardhead were captured with large numbers being collected in April, May and June (226, 730 and 201, respectively) of 1999. Sacramento sucker (*Catostomus occidentalis*), Sacramento pikeminnow (*Ptychocheilus grandis*) and Riffle sculpin (*Cottus gulosus*) were also frequently captured in Clear Cr. Large catches of these species occurred from April through September of 1999 (Table 1). Pacific lamprey (*Lampetra tridentata*) was the only anadromous non-salmonid species collected. Peak emigration of lamprey occurred in January of each year (Table 1) and was usually associated with high flow events. However, only transforming lamprey were identified to species and ammocoetes were common but were not distinguished between Pacific or River lamprey (*Lampetra ayresi*).

Fall chinook salmon— By far, chinook salmon was the most common fish captured. Brood year 1998 (BY98) juvenile fall chinook salmon began to appear in December 1998 and their capture increased rapidly. This increasing trend continued and peaked in mid-March before declining (Fig. 6). Catch per unit volume (CPUV) for individual days ranged from 0.6 - 377.9 fish per acre-foot in January, 4.2 - 325.1 in February and 13.3 - 645.8 fish per acre-foot in March.

Fall chinook juveniles were captured each week through week 33 of 1999. None were captured in week 34 but low numbers were present again from week 35 through week 39. The last date of capture of BY98 fall chinook occurred on 25 October 1999, and the total number of BY98 fall chinook captured was 692,611. Brood year 1999 juvenile fall-run demonstrated a similar trend in run-timing and abundance as did BY98, but with subtle differences (Fig. 6). Capture began in December 1999 and daily catch increased rapidly through week 3 of 2000. Weekly totals over this period ranged from 1,225 (week 48) to 193,960 (week 3) fall chinook. Daily CPUV varied from 0.45 to 48.2 fish per acre-foot in December, 11.9 to 1,014.8 fish per acre-foot in January and 20.7 to 377.4 fish per acre-foot in February. From 1 December 1999 through 21 April 2000, 512,492 BY99 fall chinook were captured. The temporal pattern of emigration was similar for BY98 and BY99 but differed in magnitude temporally between years (Fig. 6). Specifically, higher numbers of fall chinook were captured in the early period of emigration for BY99 than for BY98.

Fall-run fork lengths (mm) ranged from 20.0 to 137.0 mm in 1999 and 24.0 to 83.0 mm in 2000 (Fig. 7). Brood year 1998 median fork length increased slowly from week 49 of 1998 through week 14 of 1999 (32.0 - 37.0 mm) and then rapidly from weeks 14 to 17 (37.0 - 56.0 mm, Appendix 1). Weekly median fork lengths of BY99 fall chinook were very similar to those observed from BY98 through week 16 (the last week covered under this report).

Length frequency distributions of BY98 and BY99 fall chinook were highly skewed towards newly emerging fish (Fig. 8) and in turn, the great majority were classified as fry (Fig. 9). Over 82% of BY98 and 90% of BY99 fall chinook captured were between 30.0 and 39.0 mm (Fig. 8).

Late-fall chinook salmon— BY99 juvenile late-fall chinook began to appear in rotary trap catch in week 13 of 1999 and were captured weekly through week 33. Moderate to high numbers were captured from week 14 through week 23 with daily CPUV ranging from 1.1 to 32.2 fish per acre-foot (Fig. 10). Late-fall juveniles appeared intermittently from week 35 through week 52. Increased catch occurred from mid-November through December associated with high flow events. Catch and fork length data from BY2000 late-fall chinook is limited to weeks 13 through 16 (2000) in this report and is therefore too abbreviated for discussion. However, this data is presented in tabular and graphic form throughout the report.

Juvenile late-fall fork lengths (mm) ranged from 30.0 to 143.0 mm (Fig. 7). Median fork lengths increased moderately from weeks 13 to 22 (33.0 - 44.0 mm, Appendix 2) of 1999. The length frequency distributions of late-fall juveniles was similar to that of fall chinook in that it was skewed towards newly emerging fish (Fig. 8) which were primarily classified as fry (Fig. 9). Over 77% of late-fall chinook captured in 1999 were between 30.0 and 39.0 mm (Fig. 8). However, in contrast to fall chinook, a greater proportion of late-fall juveniles were classified as smolts (Fig. 9).

Winter chinook salmon— Very few BY99 winter chinook juveniles were captured on Clear Cr. and only a small proportion of those were less than 40.0 mm (Appendix 3, Fig. 8). Only 113 fish were assigned winter-run designation (based on length criteria) in 1999 and 25 in 2000 (1 January through 21 April). Daily CPUV ranged from 0.001 fish per acre-foot in early July to 0.150 fish per acre-foot in January (Fig. 11). The majority of winter chinook were large individuals captured in November and December 1999 (Appendix 3). Over all, more than 85% of winter chinook captured during this study were greater than 80.0 mm (FL). Consequently, higher proportions were classified as silvery parr and smolts relative to fall and late-fall chinook.

Spring chinook salmon— Spring chinook juveniles began to appear in screw trap catch in mid- to late October of 1999 and daily CPUV ranged from 0.1 to 13.0 fish per acre-foot (Fig.12). The majority of individuals were captured in November and December of 1999 and ranged in fork length from 26.0 to 95.0 mm (Appendix 4). Over 67% in 1999 and greater than 99% of juveniles captured in 2000 were classified as parr or silvery parr (Fig. 9).

Steelhead trout— Steelhead juveniles were captured year round in 1999 in Clear Cr. However, there was a definitive period of emigration. Peak capture occurred from April through July 1999 with CPUV ranging from 0.01 in April to a high of 0.57 fish per acre-foot in early June (Fig. 13). Steelhead CPUV was generally greater from week 1 through week 16 in 2000 than for the same period in 1999 (Fig. 13). Steelhead median fork lengths were highly variable during the study period in contrast to other salmonids (Appendix 5). This high variability was due to the almost weekly capture of steelhead between 75.0 and 124.0 mm (FL) combined with emergents (Fig. 14). Greater than 75% of steelhead captured during this study were less than 70.0 mm (FL) (Fig. 15) and greater than 63% were classified as parr (Fig. 9).

Mark/recapture trials— Mark/recaptures trials were conducted weekly to estimate trap efficiency for generation of passage estimates. A total of 63 trials were conducted during the study period. Weekly trap efficiencies ranged from 0.00 to 33.3 percent (Table 2 & 3). The number of fish marked and released varied but was usually between 200 - 500 individuals. Trap selectivity was also evaluated to determine if the rotary-screw trap was selective for larger or smaller individuals (Fig. 16). Paired samples on median fork lengths of released versus recaptured fish were analyzed using a Wilcoxin Signed Rank

Test. However, because the variability in median fork lengths was much greater for trials conducted using fish > 40.0 mm, a separate analysis was performed on chinook ≤ 40.0 mm and fish > 40.0 mm (FL). For trials using fish ≤ 40.0 mm (FL), significant differences were not detected ($p = 0.154$, $n = 30$). They did exist, however, for fish greater than 40.0 mm (FL) ($p = 0.017$, $n = 13$), in that fish of a greater median fork length were recaptured versus released.

Juvenile production estimates— Estimates of trap efficiency were used to generate juvenile production estimates (JPE's) for each run of chinook, as well as steelhead trout. The JPE for BY98 and BY99 fall chinook was 7,322,381 and 7,005,269, respectively. Note that BY99 fall chinook data is limited to the period from 1 December 1999 through 21 April 2000. Upper and lower 95% confidence limits (C.I.) about these estimates were 10,731,546 and 4,955,014 for BY98 and 9,411,522 and 5,467,975 for BY99, respectively. For BY98, weekly JPE's were greater than 500,000 from weeks 6 through 11 with highest passage occurring in week 7 at 1,279,853 fall chinook (Appendix 6, Fig. 17). After week 11, weekly JPE's declined but were never less than 30,000 through week 22 (Appendix 6). Weekly JPE's for BY99 fall chinook exceeded 100,000 from week 52 (1999) to week 11 (2000). From week 3 through week 6, the weekly JPE was greater than 970,000 and peaked at 1,433,080 in week 4 (Appendix 6, Fig. 17).

The JPE for BY99 late-fall chinook was 272,966. Upper and lower 95% C.I.'s for this estimate were 338,894 and 224,482 (Appendix 6). Late-fall weekly JPE's increased from 1,161 in week 13 to greater than 44,000 from week 14 through week 16 (Fig. 18). The JPE declined through week 19 but then increased through week 21, peaking at 34,592 before declining through week 26.

The JPE for BY99 winter chinook was 3,656. However, very few emergents were observed. Only 12 winter chinook less than 50.0 mm (FL) were captured, and these were sampled in week 27 and 28. Zero BY99 winter chinook were collected from week 29 through week 36; the expected emergent period (Fig. 19). The highest JPE occurred in week 6 (2000) where we estimated that 2,519 winter chinook passed our rotary-trap. This single weekly JPE represents 70% of the total JPE for BY99 winter chinook.

Unlike winter chinook juveniles, spring-run juveniles exhibited a definitive emigration pattern and the JPE for BY99 was 57,189. Upper and lower 95% C.I.'s were 71,275 and 47,931 about this estimate. However, these estimates only account for the first 23 weeks of their emigration and are, therefore, incomplete. Weekly passage estimates exceeded 750 spring chinook from week 45 through week 52 (Appendix 7, Fig. 20). Weekly passage peaked at 16,088 in week 48. Capture of spring chinook was intermittent and highly variable from week 2 through week 6. A secondary mode in abundance was observed from week 7 through week 16 with JPE's ranging between 117 and 1,536 (Appendix 7).

Steelhead JPE's were also generated for BY99 and limited data for BY2000 (1 January through 21 April, 2000). The JPE for BY99 was 4,938 and C.I.'s about this estimate were 6,078 and 3,848. Weekly JPE's ranged from 0 to 548 from week 1 through week 30, but the majority of passage occurred from week 18 to week 27 and JPE's were generally above 200 during this period (Appendix 7, Fig. 21). The JPE for BY2000 steelhead was 5,824 through week 16 and weekly JPE's ranged from 4 to 1,483 during this abbreviated period. Weekly JPE's were greater than 400 for weeks 11 through 16

(Appendix 7).

Trapping mortality was also evaluated to assess the possible negative impacts from this project on emigrating chinook salmon. High mortality occurred in February, March and April of 1999, where estimated mortality for all chinook (primarily fall-run) was 11,571, 32,005 and 4,344, respectively (Table 4). In 2000, high estimated mortality occurred in January (15,324 fish) but was much reduced in February and March over that reported in 1999 (Table 4). Monthly relative mortality (dead/estimated passage) ranged between 0.21 and 1.48% from January through April in 1999, and 0.27 to 0.76% for the same period in 2000 (Table 4). The highest relative mortality occurred from August through October of 1999 (primarily late-fall chinook). During this period relative mortality ranged from 1.97 to 4.48%, but only included 49 individuals.

Discussion

Emigration timing— Emigration timing of juvenile salmonids in Clear Cr. was similar to that of other upper Sacramento River tributaries (Battle Cr., U.S.F.W.S., unpublished data). However, comparisons to other tributaries, as well as between year contrast in abundance and run timing, are difficult to develop given the limited duration of this project. However, some comparisons and contrasts can be made.

Brood-year 1999 fall emigration was incomplete when production of this report began, but the great majority of juveniles may have emigrated in January and February, based on declining catch in March and April and other similarities to the BY98 emigration pattern. Therefore, a comparison of emigration patterns can be made. It appears that the first moderate rain events in January 2000 may have triggered an earlier emigration of a large number of BY99 fall chinook, relative to BY98, even though rain events occurred with the same general frequency but greater magnitude during BY98 emigration (Fig. 6). Increased turbidity in January 2000, relative to 1999, may be a factor in this earlier movement of fall chinook juveniles. Differences and similarities in emigration patterns can not be contrasted for late-fall, winter or spring chinook due to the short duration of this project.

Steelhead trout appeared to demonstrate an earlier emigration and greater abundance in 2000 relative to 1999 (Fig. 14), and is likely to be a much stronger brood-year based on estimated passage through week 16. In 1999, the greatest passage of steelhead occurred from weeks 19 through 27. If the BY2000 steelhead emigration pattern is similar to that observed in 1999, then certainly BY2000 will be a much stronger year class than BY1999. Continued juvenile monitoring is needed to critically assess these and similar phenomena.

Winter chinook abundance— Winter chinook abundance, or even presence, in Clear Cr. is questionable. While individuals meeting the winter chinook length criteria were captured, the emigration pattern and size of captured fish was not indicative of natural reproduction. Only three juvenile chinook meeting the BY98 winter-run length criteria were captured. One was captured in December of 1998 and two in January of 1999. However, the rotary-screw trap was not in operation until December of 1998, thus, the period of expected juvenile emergence (July, August, and September of 1998) was not sampled. In 1999, very few BY99 emergents (< 15) were captured, and the rotary-screw trap was especially efficient (20-25%) during the period when capture of emergents was expected (July, August, and September of 1999). Larger individuals (> 70.0 mm FL) were captured in November and December of that year, however, we would still have expected to capture greater numbers of emergents, even if these larger individuals were simply rearing to a greater size before emigration. Most, if not all of these larger individuals were probably slow-growing or late-spawning late-fall chinook (Fig. 7).

Our estimates of catch and passage of winter chinook may exceed their true value. This is primarily caused from our rotary-screw trap sampling protocol. During periods of high catch (> 1000 per trap check), a random subsample of the catch was taken and processed. Results from this subsample, primarily enumeration, fork length and run designation, are expanded to the unsampled portion. For example, the passage estimate for winter chinook in week 6 of 2000 was 2,519 (Fig. 19). This is based on the capture of a single individual at a time when extremely large catches of fall chinook were occurring. This individual fish was expanded 243 times based on its relative proportion in the subsampled group. When the expanded number (243) is divided by the trap efficiency (9.6%) for that week, the resulting estimate of passage exceeds 2,500. We certainly realize that this sampling protocol would tend to underestimate and overestimate catch and passage equally. However, given that capture of emergents (fish < 40.0 mm FL) was almost nonexistent (Fig. 7), we feel that mis-assignment of run designation, in most cases, is responsible for what few captures of winter chinook we have documented on Clear Cr.

Trap efficiency— Generating experimentally sound and statistically valid passage estimates requires continuous trap efficiency trials, such that biotic and abiotic factors (flow, water temperature, turbidity, temporal variation, diel components, and associated behavioral responses) may be adequately addressed. By conducting trials under differing environmental factors and conditions, the robustness and accuracy of trap efficiency and passage estimates are improved. However, there are periods when trap efficiency trials are neither practical nor possible. For example, when abundance is low, capture of sufficient numbers of fish for conducting efficiency trials is not possible. Under this circumstance the investigator must use efficiencies generated from other trials.

Flow/discharge volume is the primary factor affecting trap efficiencies; therefore, trap efficiencies generated from trials conducted during similar flow regimes should provide the most accurate JPE's if weekly efficiencies were not available. In most cases, estimates of trap efficiency for weeks when trials were not conducted or satisfactorily completed were based on a mean efficiency using the previous and following trial, because stream discharge and other factors were similar. If steam discharge was not similar, then a mean efficiency was calculated using a greater number of trials before and after the week in question. The exact number of mark/recapture trials used to estimate or assign weekly trap efficiencies varied depending on stream conditions during that week. Each situation was evaluated and addressed independently. An alternative method would be to calculate a mean efficiency from all trials conducted and use that mean efficiency for all weeks. This would be appropriate from a replication or standardization perspective. However, with this method the accuracy of passage estimates for any given week may be far from the actual number of emigrating chinook. Therefore, we chose to address each situation independently, realizing that replication of our statistical procedures would be sacrificed to increase temporal accuracy in JPE's.

The choice of accuracy over standardization was made to better define, in sufficient detail, magnitude and temporal patterns of emigration. We decided that accuracy of passage estimates should be paramount during those times when high numbers of juveniles were emigrating (primarily fall chinook in January, February, and March). However, in most cases when weekly trap efficiency trials could not be conducted, very few chinook were emigrating (week 48 through 52 in 1998, and week 30 through 49 in 1999). In those situations weekly estimates of passage were inconsequential to overall run strength, irrelevant of accuracy during those periods. Moreover, stream discharge and turbidity was very low and stable at these times and, therefore, trap efficiencies were assumed to be stable as well.

Project impacts— There are two calculated levels of impact resulting from trapping mortality, those on the individuals captured and those on the population based on the proportion of captured individuals. The level of delayed mortality is unknown, and an investigation to assess this is beyond the scope of this project. Most mortalities are the direct result of over-crowding, high debris loads and to a lesser extent, time spent in the livebox. These factors usually co-occur and may synergistically contribute to mortality. High flow events during the period of greatest emigration of juvenile fall chinook (January, February and March) and associated heavy debris loading challenge our ability to reduce impacts. To offset these factors, we implemented multiple trap clearings within a day (when staffing was available) to remove fish and debris in a timely manner, thereby reducing stress to captured individuals.

The impact on salmonid populations from rotary trapping operations on Clear Cr. was evaluated. Daily estimated catch has exceeded 10,000 individuals 36 times since trapping began on Clear Cr. The highest daily catch of chinook was 77,019 and occurred on 17 January 2000. These are enormous numbers of fish to process in a manner that minimizes handling stress and mortality.

The negative impacts on the chinook population due to trapping mortality was much reduced in 2000 (1 January through 21 April) from that which occurred in 1999. Staffing was increased in February 2000 and allowed more frequent trap clearings when large numbers of fish and heavy debris loading occurred. The highest absolute mortality occurred in February and March of 1999 and January and February of 2000 (Table 4). Most mortalities occurring from January through March were concomitant with high flow events and high juvenile emigration.

Recommendations

We have modified the rotary-screw trap in a manner that will reduce the number of fish captured during periods of high emigration (primarily January through March). By retrofitting an escape opening at the terminus of the cone and installing an aluminum plate blocking entry into the livebox, one-half of the catch is diverted back into the stream without passing into the livebox or being handled. In effect, these fish are excluded from capture. This modification can be performed because the interior of the cone is divided into two halves by a vane or "flute" which operates similar to an auger. Therefore, fish entering on one side of the cone are diverted into the livebox along a different path than are those entering the opposite side of the cone. We assume an equal probability exists for a fish to enter either side of the cone, and therefore, an equal probability of capture or exclusion. These modifications to the trap can be retrofitted such that the escape panel and the plate used to block entry into the livebox can easily be removed and reinstalled. By implementing this modification we expect to reduce our catch and mortality by at least one-half of that previously occurring.

Another potential strategy to reduce catch and associated impacts of the fishery may be a modification of the sampling protocol. For example, randomly select periods of the day and/or night using uniform or non-uniform probabilities, and only sample during those selected periods. This method may be appropriate if statistical analysis and experimental design considerations are not compromised. However, the major consideration to this and other scenarios that result in higher effort sampling is increased staff. As sampling effort increases so does staff time, and therefore, greater project costs. In contrast, by simple modification of the trap, described previously, we can reduce the total number of captures and the associated impact on the fishery resource, with no added cost for staffing.

Optimal staffing for this and other juvenile monitoring programs requires sufficient staff to monitor the trap intensively or continuously during periods of peak emigration. For Clear Cr., that period occurs during fall chinook emigration. The proposed staffing for this program was four field staff year round with an additional five temporary field staff from December through June. This 4/9 field crew is the minimum staff needed for sampling, and does not include personnel for project oversight, data management, reporting, and project representation. This staffing plan and its associated cost insures sufficient personnel to provide multiple trap checks daily during those periods when high catches occur. It will also provide sufficient staff for conducting trap efficiency trials (a labor intensive effort) which must be performed to generate valid JPE’s.

Acknowledgments

Funding for this project was provided by the Restoration Fund of the Central Valley Project Improvement Act. Numerous individuals have helped with the development and implementation of this project including, but not limited to, Glenn Allison, Dennis Blakeman, Brett Bonner, Caryl Brown, Monty Currier, Lia Daniels, Brian Dobruck, Richard Dykstra, Christian Eggleston, Tom Kisanuki, Jennifer Lamb, Daniel Lantz, Craig Martin, Kyle Martins, William McKinney, John Moran, David Nieman, Robert Null, William Poytress, Amanda Robillard, Barbara Rowden, Jim Smith, Derek Stein, and Scott Steltzner.

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Table 1.— Summary of non-salmonid species captured by rotary-screw trap on Clear Cr. (RM 1.7) from 5 December 1998 through 21 April 2000. Results include species and number captured by month of year.

Species	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Nov.	Dec.
							1998				
black bullhead											0
bluegill sunfish											1
brown bullhead											0
California roach											0
Centrarchidae fry[1]											0
Cottus fry[1]											0
Cypriniformes fry[2]											2
green sunfish											0
hardhead											13
hitch											0
Lampetra spp.[1]											1
largemouth bass											0
mosquito fish											2
Pacific lamprey											7
prickly sculpin											0
riffle sculpin											3
Sacramento pikeminnow											9
Sacramento sucker											5
smallmouth bass											0

Table 1.— (continued)

Species	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Nov.	Dec.
						1998					
speckled dace											0
spotted bass											0
threespine stickleback											0
tule perch											0
white catfish											0
white crappie											0
						1999					
black bullhead	0	0	0	0	0	0	1	0	0	0	0
bluegill sunfish	0	3	12	11	11	3	3	2	7	5	40
brown bullhead	0	0	0	0	0	0	0	0	0	0	1
California roach	0	0	0	0	0	0	1	1	0	0	0
Centrarchidae fry[1]	0	2	0	0	2	124	5	0	0	0	6
Cottus fry[1]	0	0	0	0	0	177	229	0	0	0	0
Cypriniformes fry[2]	1	0	0	4	26	0	5	18	6	2	2
green sunfish	0	1	1	0	1	66	8	6	2	7	22
hardhead	11	8	23	226	730	201	57	31	8	16	111
hitch	0	0	0	0	0	0	0	0	0	0	1
Lampetra spp.[1]	29	32	9	11	7	12	1	5	3	5	2

Table 1.— (continued)

Species	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Nov.	Dec.
							1999				
largemouth bass	0	0	0	0	0	0	0	1	7	1	23
mosquito fish	1	0	0	0	3	1	3	4	1	2	3
Pacific lamprey	1,072	7	1	0	0	6	3	12	0	8	9
prickly sculpin	0	0	0	1	0	0	0	0	0	0	0
riffle sculpin	0	1	3	7	11	7	273	40	4	20	3
Sacramento pikeminnow	6	6	14	55	35	29	20	30	5	5	12
Sacramento sucker	0	11	1	1	1	14	190	240	64	10	65
smallmouth bass	0	0	0	0	0	0	0	0	0	0	0
speckled dace	0	0	0	0	0	0	5	5	1	1	0
spotted bass	0	0	0	0	1	1	0	0	1	0	0
threespine stickleback	0	0	0	0	0	0	0	0	0	0	0
tule perch	0	0	0	0	0	0	0	4	1	1	0
white catfish	0	0	0	0	0	0	0	0	0	0	0
white crappie	0	0	0	0	0	0	0	0	0	0	0
							2000				
black bullhead	0	0	0	0							
bluegill sunfish	1	15	56	87							
brown bullhead	0	0	0	0							
California roach	1	0	1	0							

Table 1.— (continued)

Species	Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Nov.	Dec.
							2000				
Centrarchidae fry[1]	0	11	4	7							
Cottus fry[1]	0	0	0	0							
Cypriniformes fry[2]	0	0	4	3							
green sunfish	1	14	7	12							
hardhead	2	9	39	71							
hitch	0	27	21	1							
Lampetra spp.[1]	1	34	29	23							
largemouth bass	0	3	0	0							
mosquito fish	1	9	3	1							
Pacific lamprey	267	3	2	1							
prickly sculpin	0	0	0	0							
riffle sculpin	1	7	27	15							
Sacramento pikeminnow	3	6	16	4							
Sacramento sucker	6	12	3	3							
smallmouth bass	0	1	0	0							
speckled dace	1	1	0	0							
spotted bass	0	0	0	0							
threespine stickleback	0	0	1	0							

[1]Fry were grouped by Family or Genus.
[2]Fry were grouped by order.

Table 2.— Summary of data gathered from mark/recapture trials conducted on Clear Creek (SM 1.7) from 5 December 1998 through 31 December 1999. Between one and three separate trials were conducted for each week. The number of fish released and the number of fish recaptured within a week were used to determine trap efficiencies.

Week	Number released	Number recaptured	Weekly efficiency (%)
1	260	27	10.38
2	250	20	8.00
5	160	0	0.00
6	159	12	7.55
7	264	16	6.06
8	267	29	10.86
9	264	26	9.85
10	262	28	10.69
11	524	49	9.35
12	305	53	17.38
13	537	135	25.14
14	532	81	15.23
15	415	82	19.76
16	538	114	21.19
17	556	149	26.80
18	539	159	29.50
19	521	94	18.04
20	483	120	24.84
21	444	67	15.09
22	625	208	33.28
23	537	142	26.44
24	506	161	31.82
25	369	104	28.18
26	146	38	26.03
27	658	36	5.47
28	182	49	26.92
29	70	15	21.43
50	991	54	5.45
51	510	117	22.94
52	363	62	17.08

Table 3.— Summary of data gathered from mark/recapture trials conducted on Clear Creek (SM 1.7) in 2000. Between one and three separate trials were conducted for each week. The number of fish released and the number of fish recaptured within a week were used to determine trap efficiencies.

Week	Number released	Number recaptured	Weekly efficiency (%)
1	501	115	22.95
2	520	2	0.38
3	501	84	16.77
4	334	3	0.90
5	309	27	8.74
6	923	89	9.64
7	510	60	11.76
8	899	15	1.67
9	495	16	3.23
10	959	80	8.34
11	945	59	6.24
12	1064	61	5.73
13	828	69	8.33
14	510	35	6.86
15	596	63	10.57
16	529	51	9.64

Table 4.— Summary of mortality of juvenile chinook and steelhead captured by rotary-screw trap on Clear Cr. (SM 1.7). Results include the estimated number dead (N) and percent dead (%) by month and salmonid species (run), as well as a total (all chinook runs combined). Percent dead is expressed as a proportion of estimated passage. The number of dead specimens (N) was estimated by enumerating dead specimens from a random sample and applying that proportion to the total number of fish captured .

	Chinook salmon										Steelhead	
	Fall run		Late-fall run		Winter run		Spring run		Total (all runs)			
Month	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)
					1998							
December	24	0.68	0	0.00	0	0.00	0	0.00	24	0.67	0	0.00
					1999							
January	2,311	0.21	0	0.00	0	0.00	0	0.00	2,311	0.21	0	0.00
February	11,566	0.33	0	0.00	0	0.00	5	0.40	11,571	0.33	0	0.00
March	31,986	1.48	0	0.00	0	0.00	19	0.88	32,005	1048	0	0.00
April	3,042	1.41	1,300	0.80	0	0.00	2	0.88	4,344	1015	1	2.50
May	2,191	0.72	802	0.99	0	0.00	0	0.00	2,993	0.77	0	0.00
June	324	1.32	251	1.35	0	0.00	0	0.00	575	1.33	0	0.00
July	31	0.45	25	0.41	0	0.00	0	0.00	56	0.43	0	0.00
August	3	8.82	23	4.21	0	0.00	0	0.00	26	4.48	0	0.00
September	1	1.85	15	2.89	0	0.00	0	0.00	16	2.70	0	0.00
October	0	0.00	5	1.58	2	6.67	0	0.00	7	1.97	0	0.00
November	0	0.00	61	1.65	7	1.24	152	0.61	220	0.76	0	0.00
December	1,776	0.68	14	2.41	2	2.41	431	1.78	2,222	0.77	0	0.00

Table 4.— (continued)

Month	Chinook salmon										Steelhead	
	Fall run		Late-fall run		Winter run		Spring run		Total (all runs)			
	N	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)	*N*	(%)
2000												
January	15,313	0.35	0	0.00	1	0.44	9	0.60	15,324	0.35	0	0.00
February	5,373	0.27	0	0.00	5	0.20	6	0.14	5,384	0.27	0	0.00
March	1,262	0.34	0	0.00	0	0.00	5	0.29	1,270	0.34	1	0.74
April	362	0.76	251	0.62	0	0.00	7	1.09	620	0.69	0	0.00

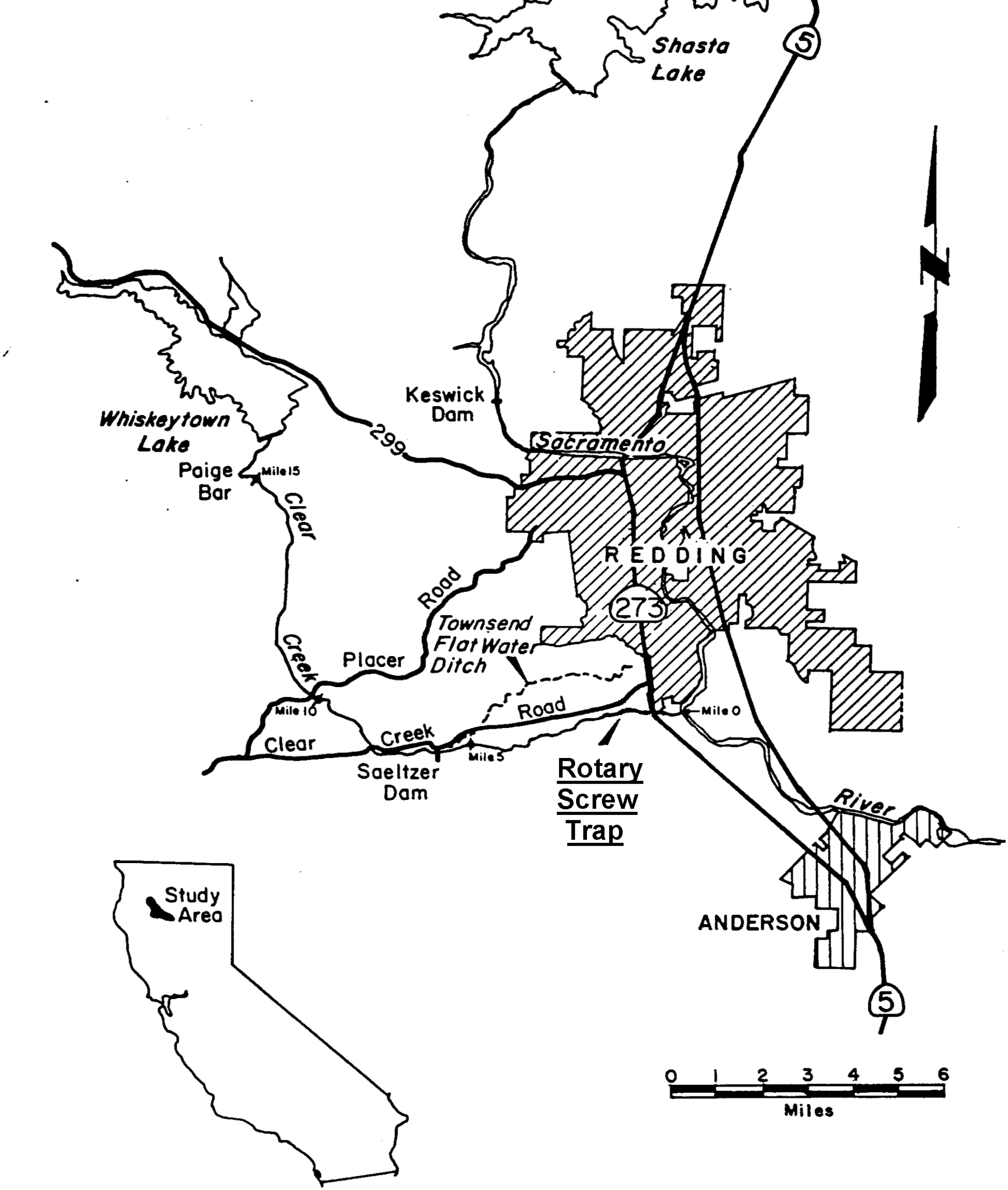

Figure 1. Location of rotary screw trap at stream-mile 1.7 of Clear Creek, Shasta County,

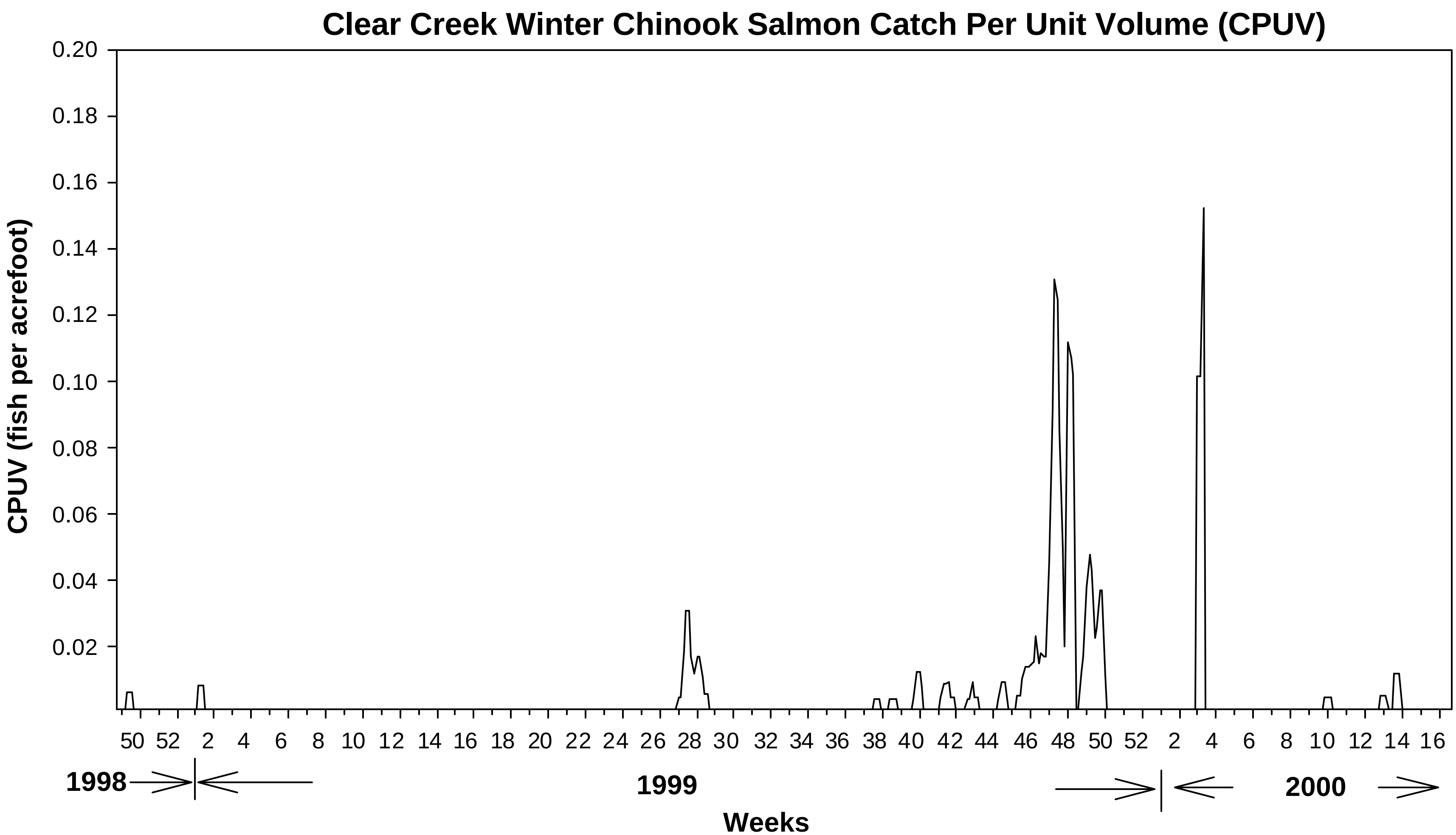

Figure 11. Summary of catch per unit volume (CPUV) expressed in fish per acrefoot for winter chinook salmon captured by rotary-screw trap on Clear Creek (stream mile 1.7). Run designation was assigned based on length criteria developed by the California Department of Water Resources. Each data point represents a three day rolling average of CPUV comprised of the day before, the day of, and the day after the sample was gathered.

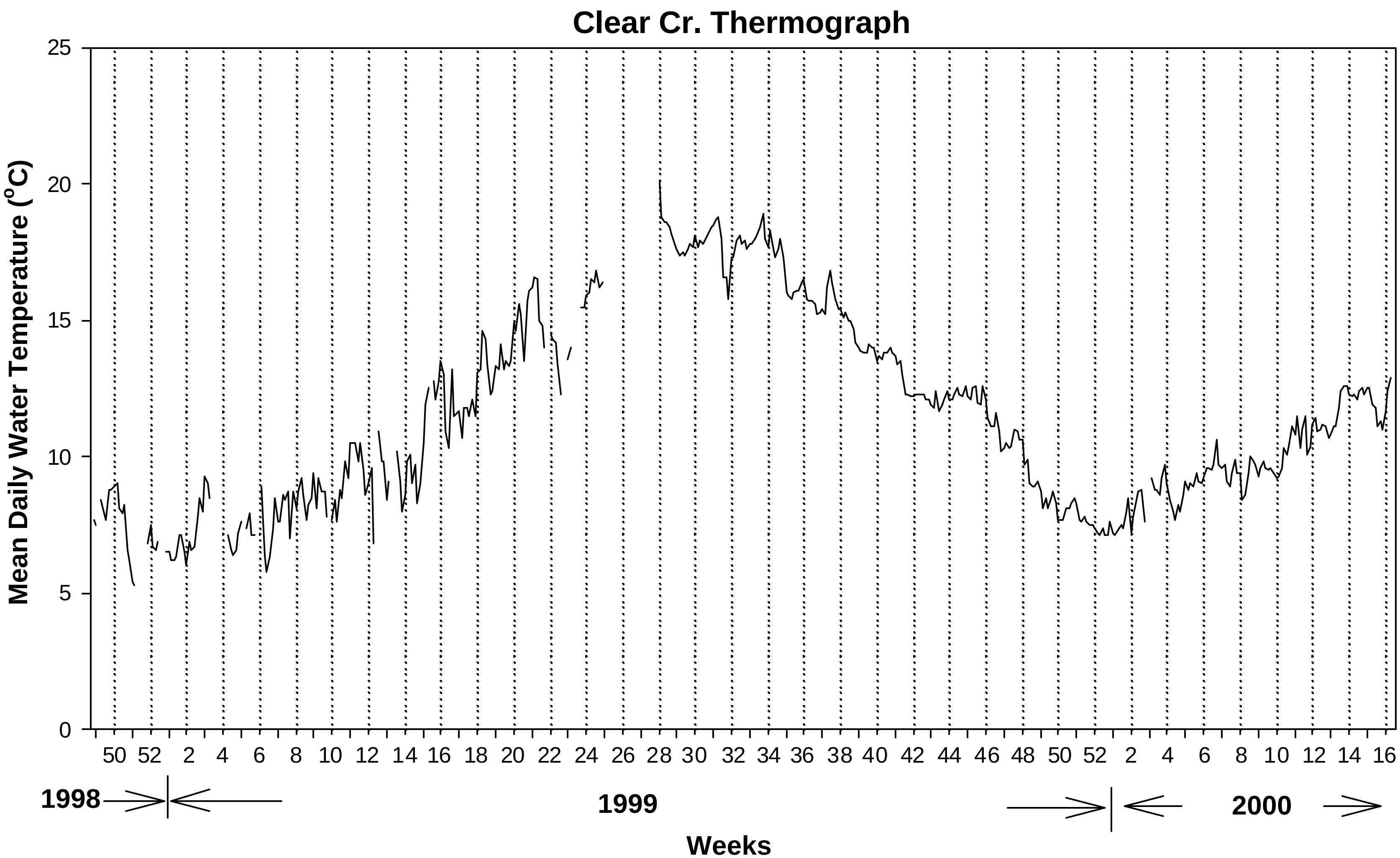

Figure 3. Daily mean water temperature (ºC) recorded for Clear Cr. (SM 1.7) from 5 December 1998 through 21 April 2000. Breaks in the thermograph represent days when trapping was not conducted or equipment malfunction.

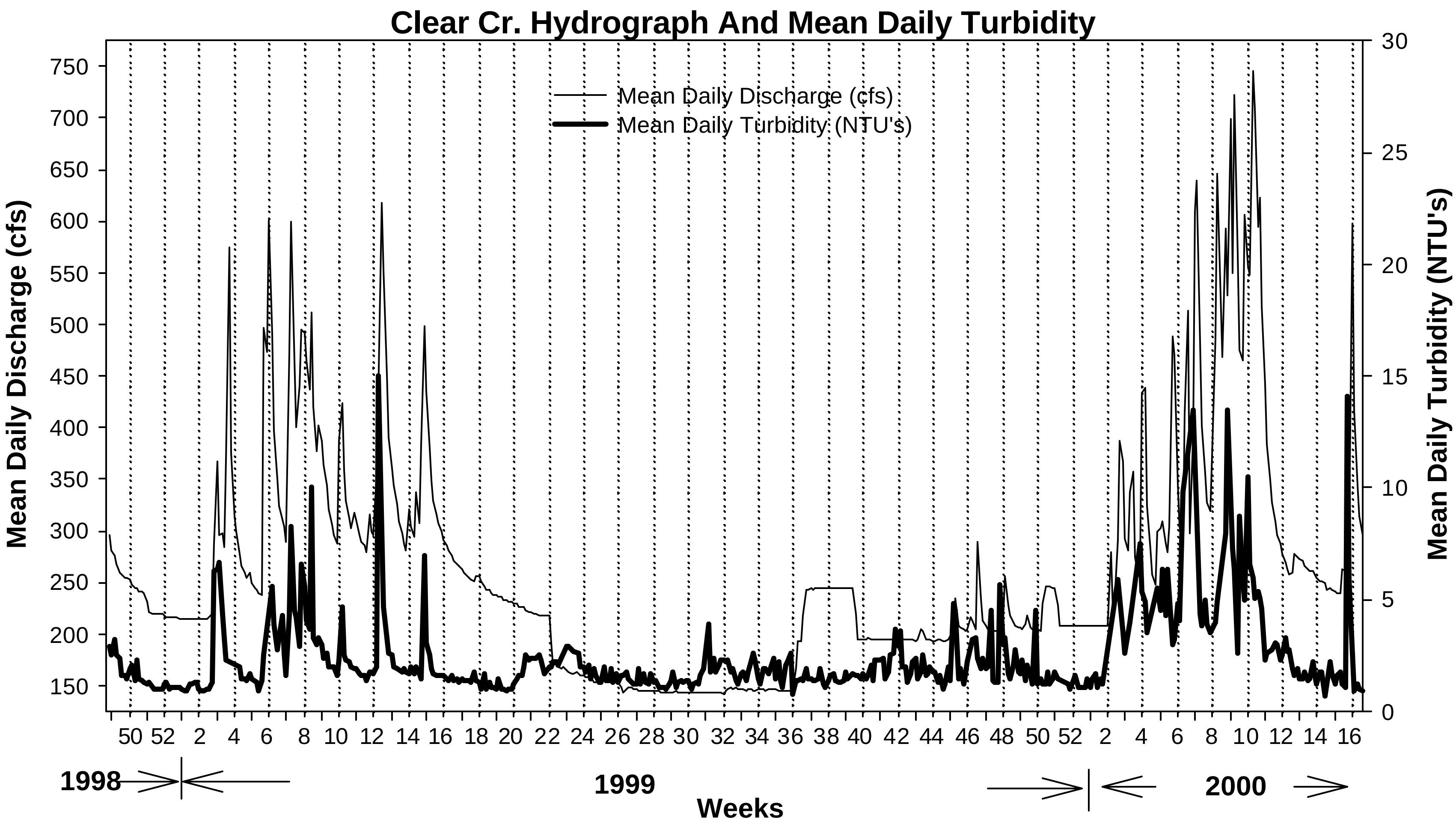

Figure 4. Mean daily discharge (cfs) and turbidity (NTU's) for Clear Cr. (SM 1.7) for the period 5 December 1998 through 21 April 2000.

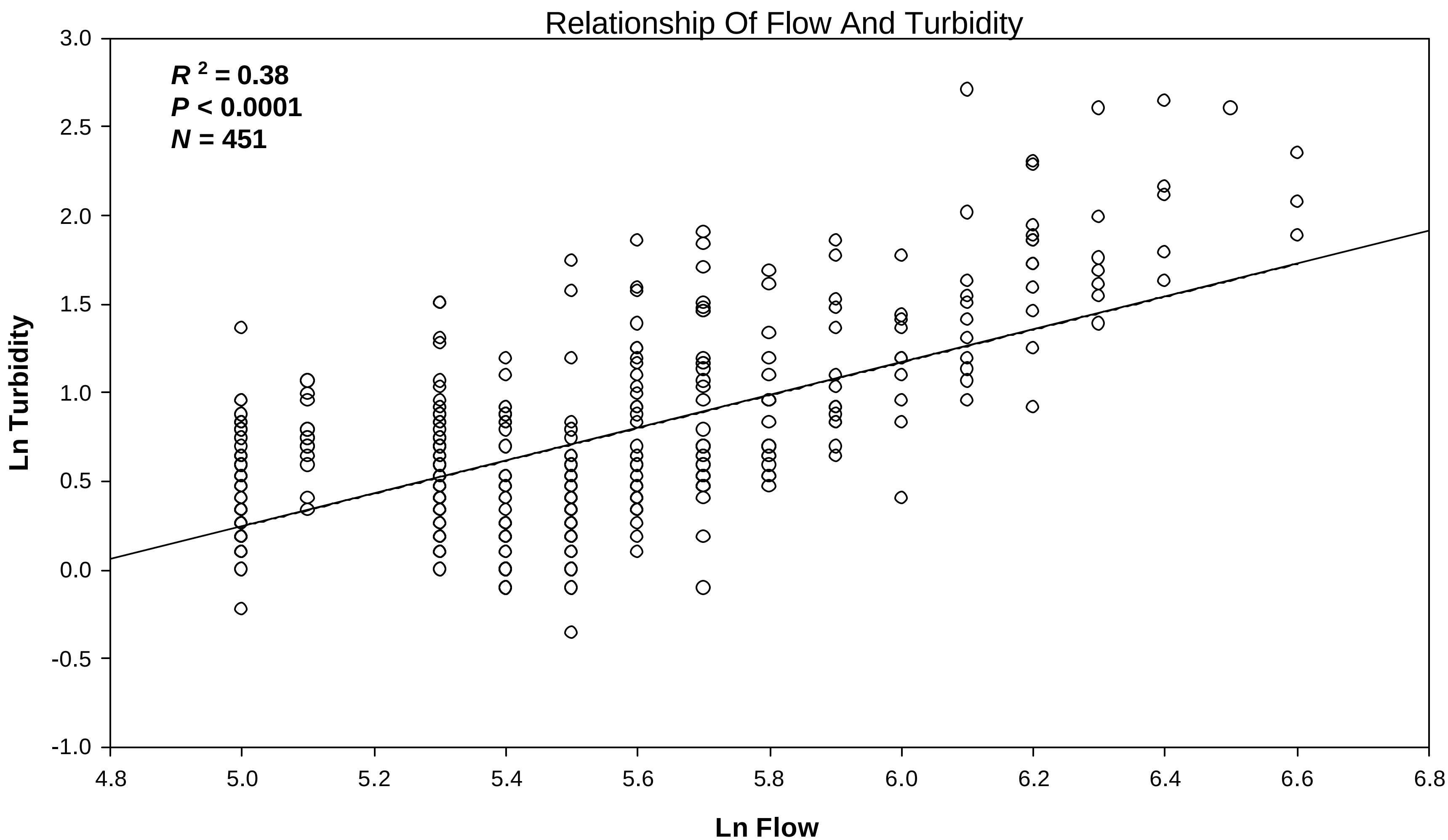

Figure 5. Relationship of flow and turbidity for Clear Creek (SM 1.7) from 5 December 1998 through 21 April 2000. Raw data was log transformed (Ln) to standardize error variance. A least squares regression line was then fitted to the data to explain the relationship of these two variables. Flow was a moderate predictor of turbidity with R^2 = 0.38 and the slope of the least squares regression line was significantly different than zero.

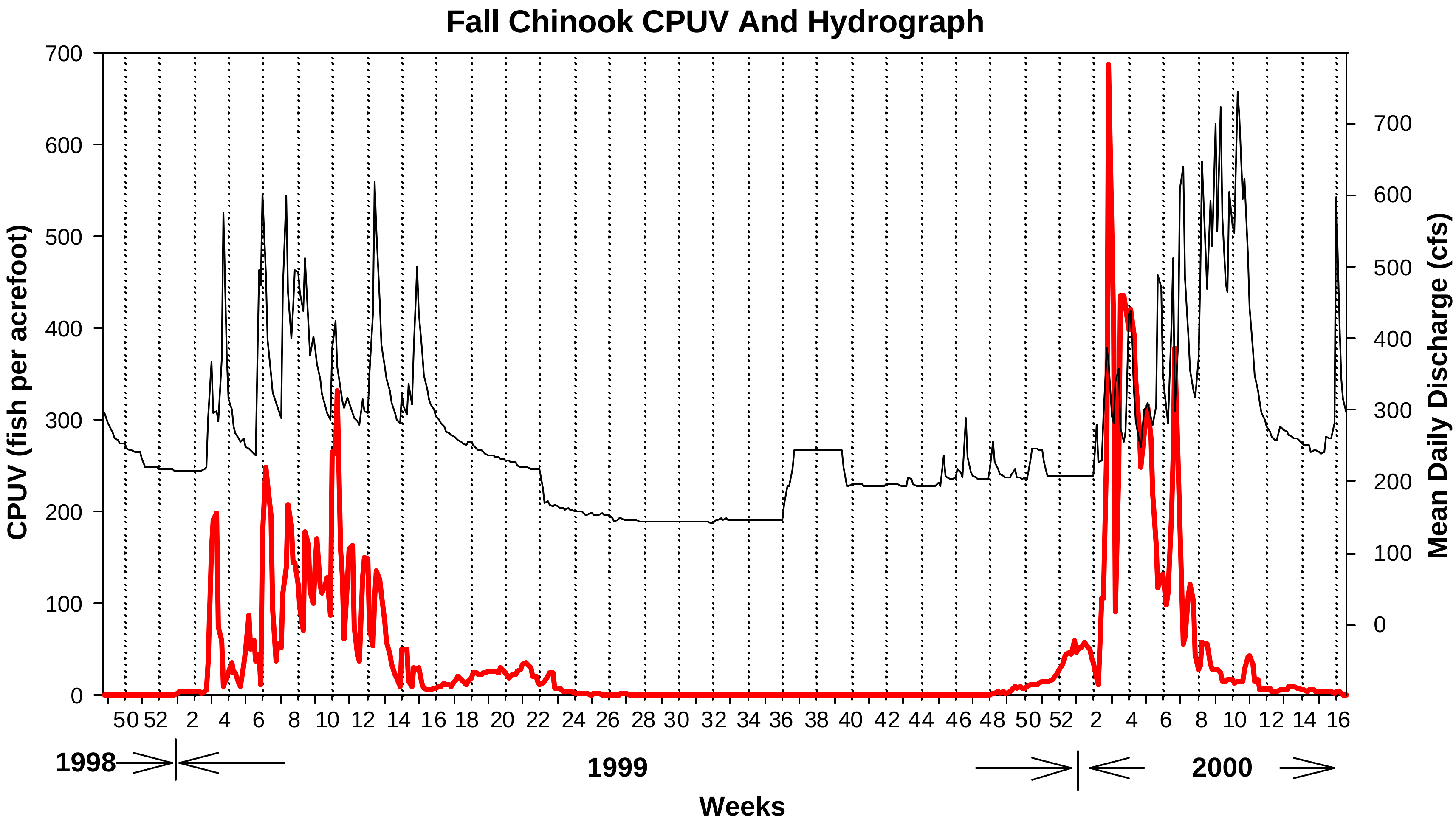

Figure 6. Summary of catch per unit volume (CPUV) expressed in fish per acrefoot for fall chinook salmon captured by rotary-screw trap on Clear Creek (stream mile 1.7) for the period 5 December through 21 April. Run designation was assigned based on length criteria developed by the California Department of Water Resources. Each data point represents a three day rolling average of CPUV comprised of the day before, the day of, and the day after the sample was gathered. Mean daily flow is presented as discharge (cfs).

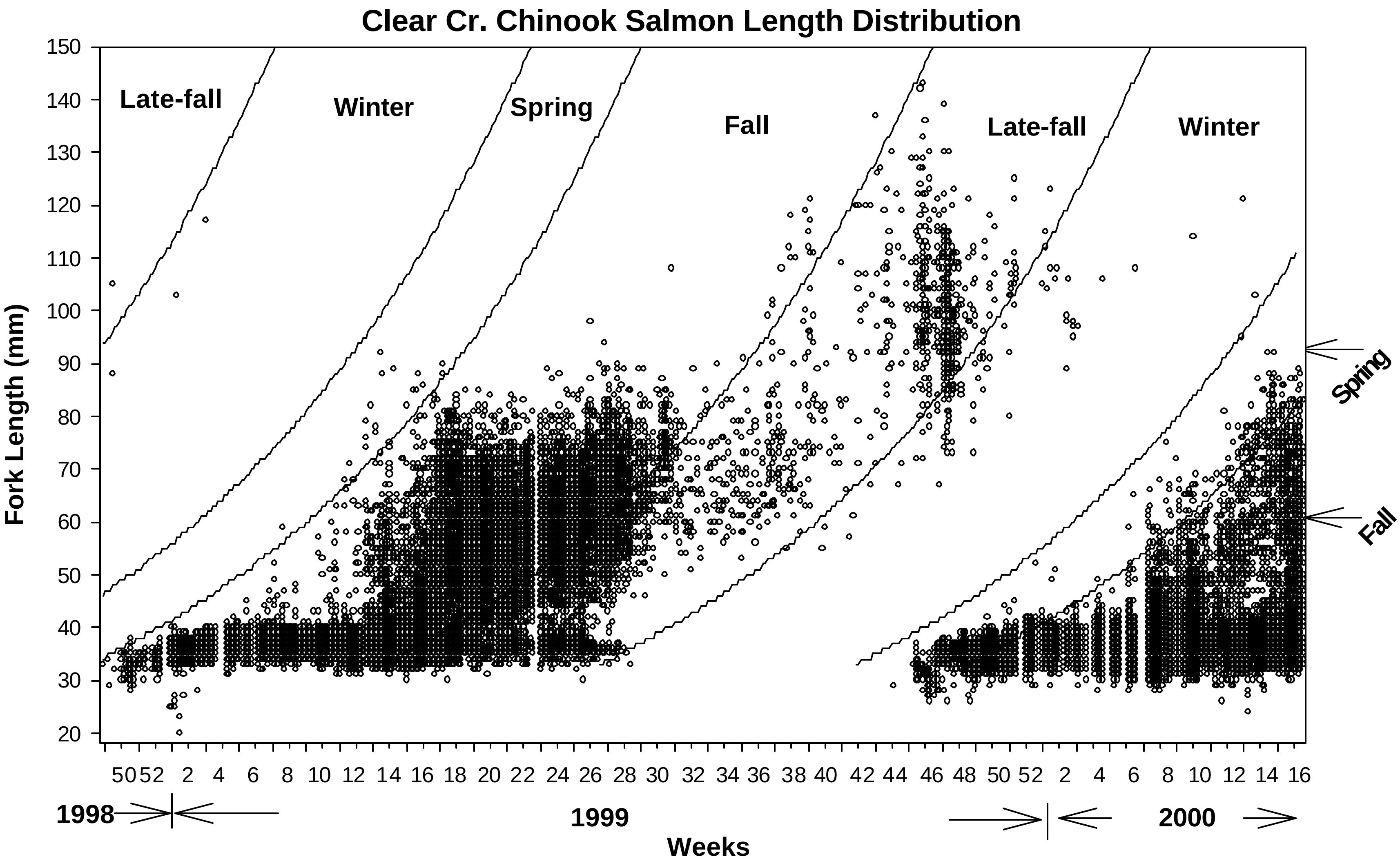

Figure 7. Daily fork length distribution by run for Chinook salmon captured by rotary-screw trap on Clear Cr. (SM1.7) for the period 5 December 1998 through 21 April 2000. Spline curves represent the maximum fork length expected by date for each run, based on criteria developed by the California Department of Water Resources.

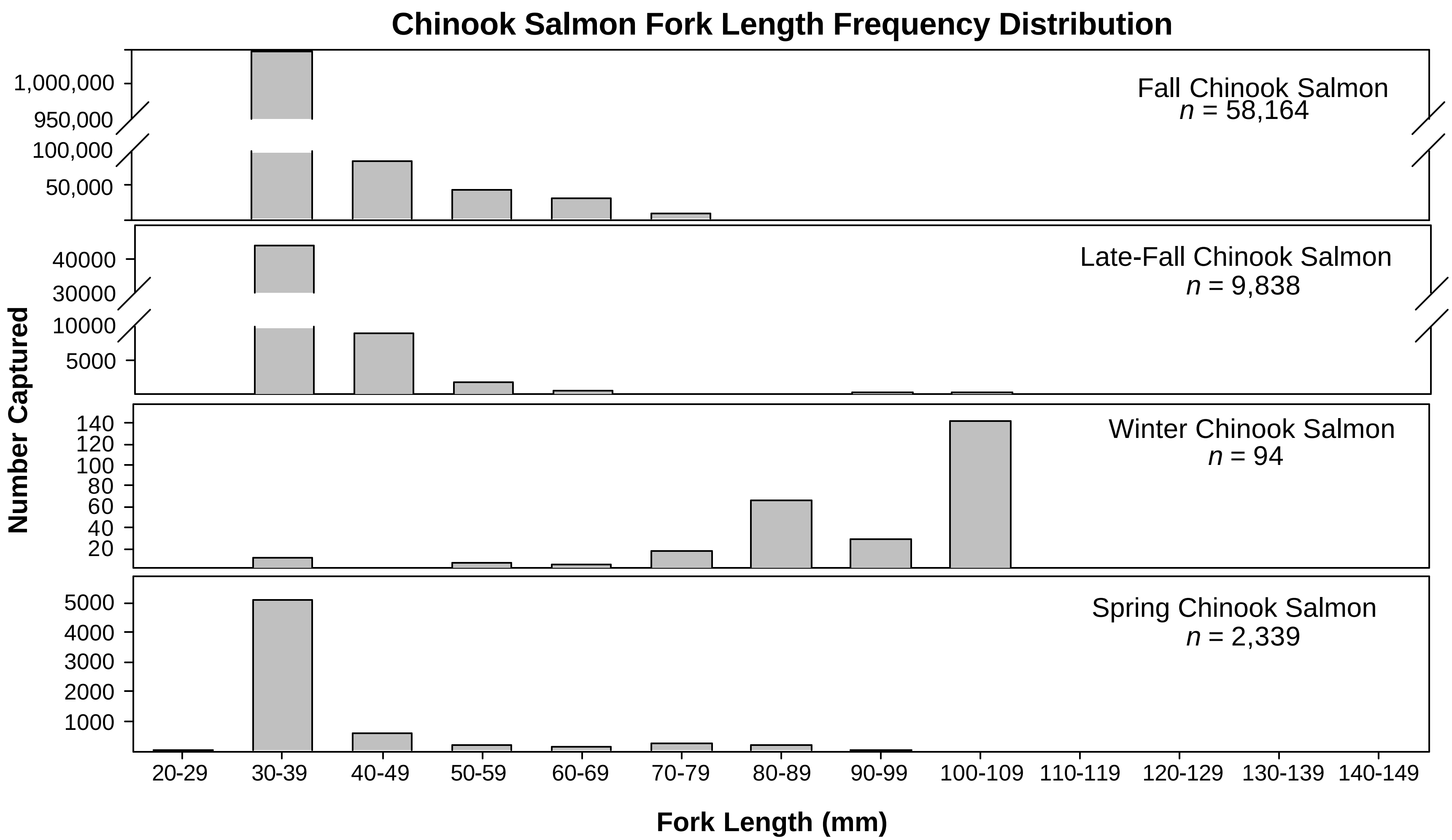

Figure 8. Fork length frequency distribution by run for Chinook salmon captured by rotary-screw trap on Clear Cr. (SM 1.7) from 5 December 1998 through 21 April 2000. Fork length frequencies were assigned based on the proportional frequency of occurrence, in 10.0 mm increments, within a random subsample of the daily rotary-screw trap catch. "*n*" represents the number of fish measured.

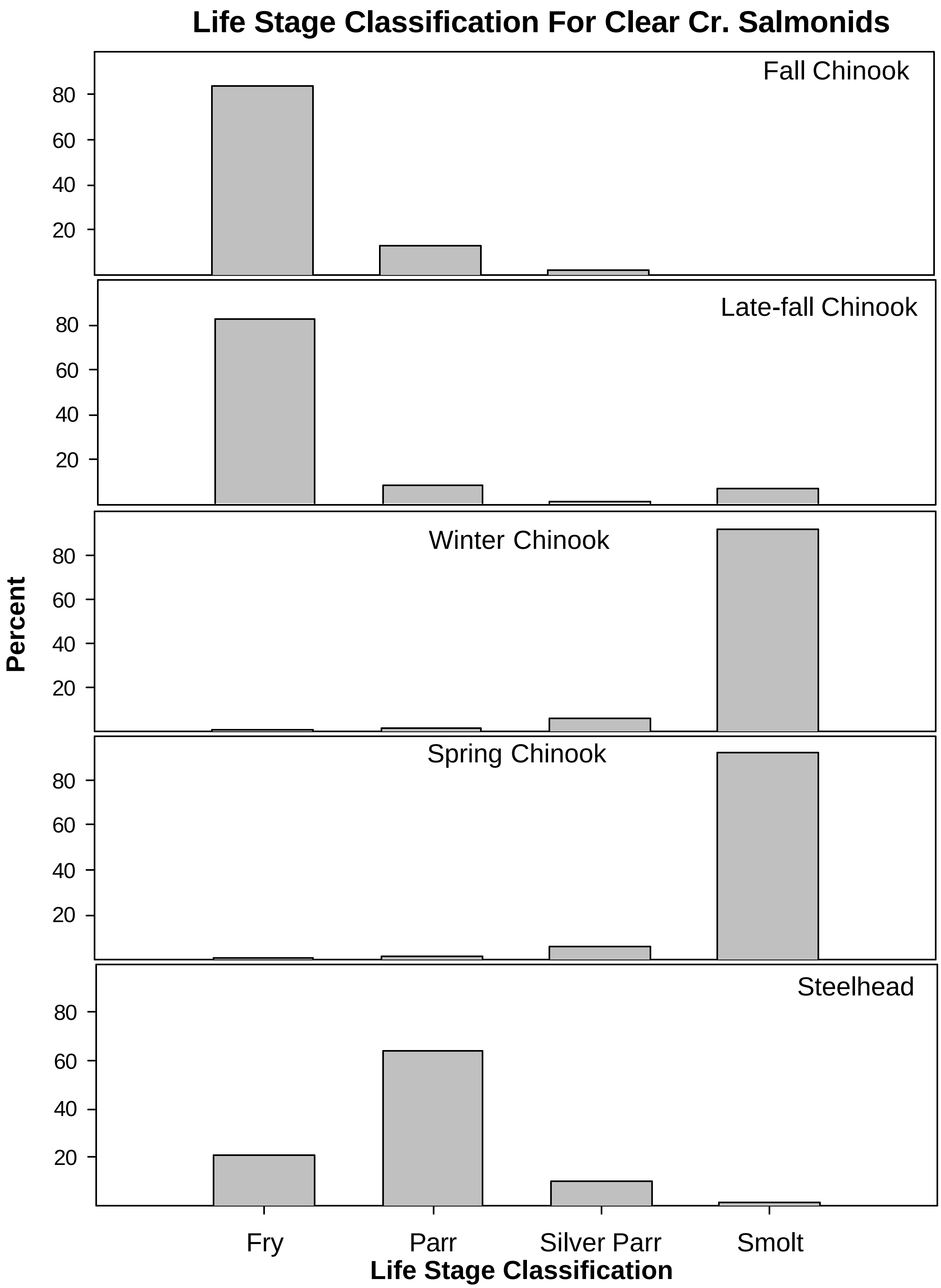

Figure 9. Life stage classification by percentage of fall, late-fall, winter and spring chinook and steelhead trout captured by rotary-screw trap on Clear Cr. (SM 1.7) for the period 5 December 1998 through 21 April 2000.

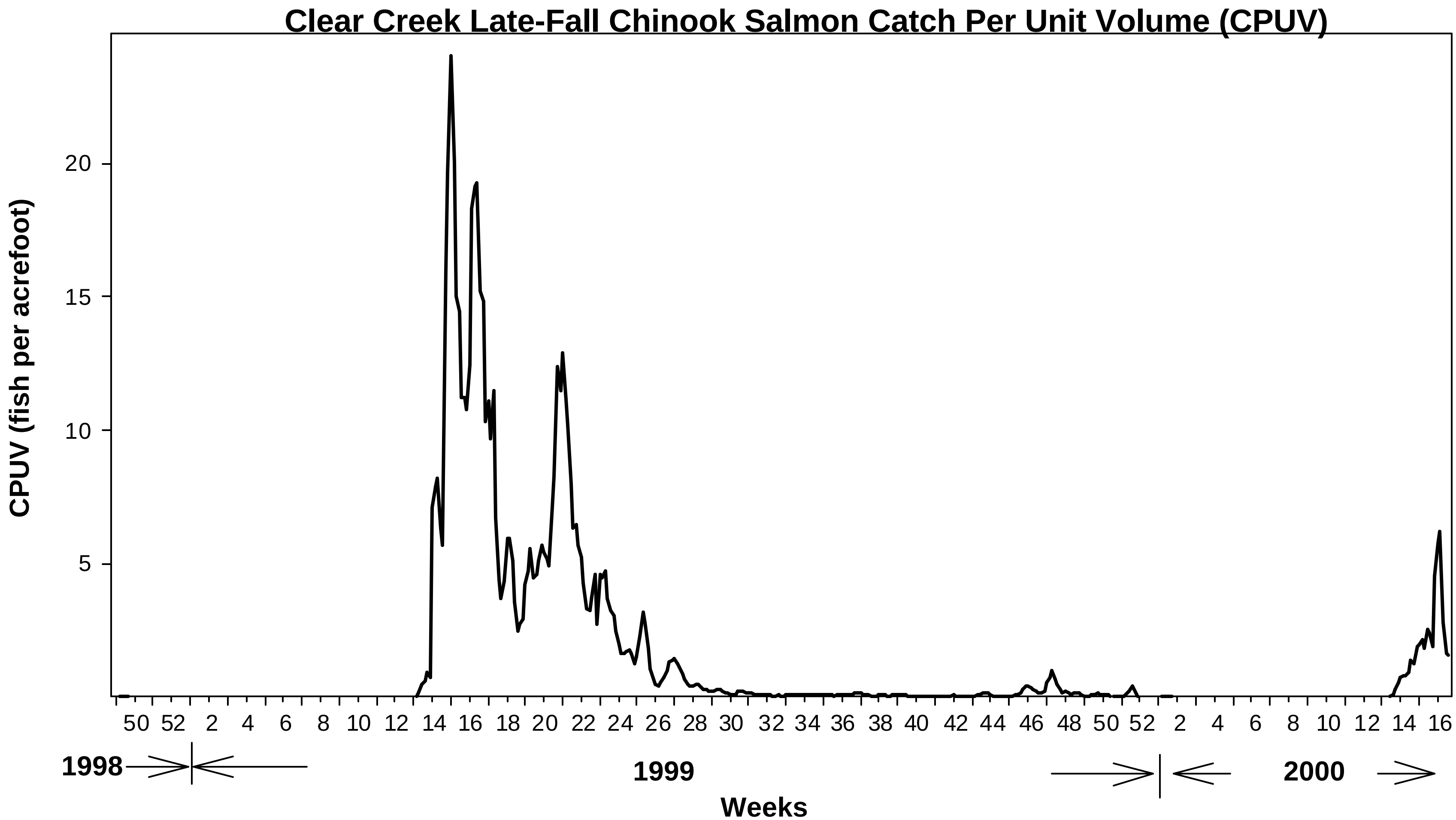

Figure 10. Summary of catch per unit volume (CPUV) expressed in fish per acrefoot for late-fall chinook salmon captured by rotary-screw trap on Clear Creek (stream mile 1.7) for the period 5 December 1998 through 21 April 2000. Run designation was assigned based on length criteria developed by the California Department of Water Resources. Each data point represents a three day rolling average of CPUV comprised of the day before, the day of, and the day after the sample was gathered.

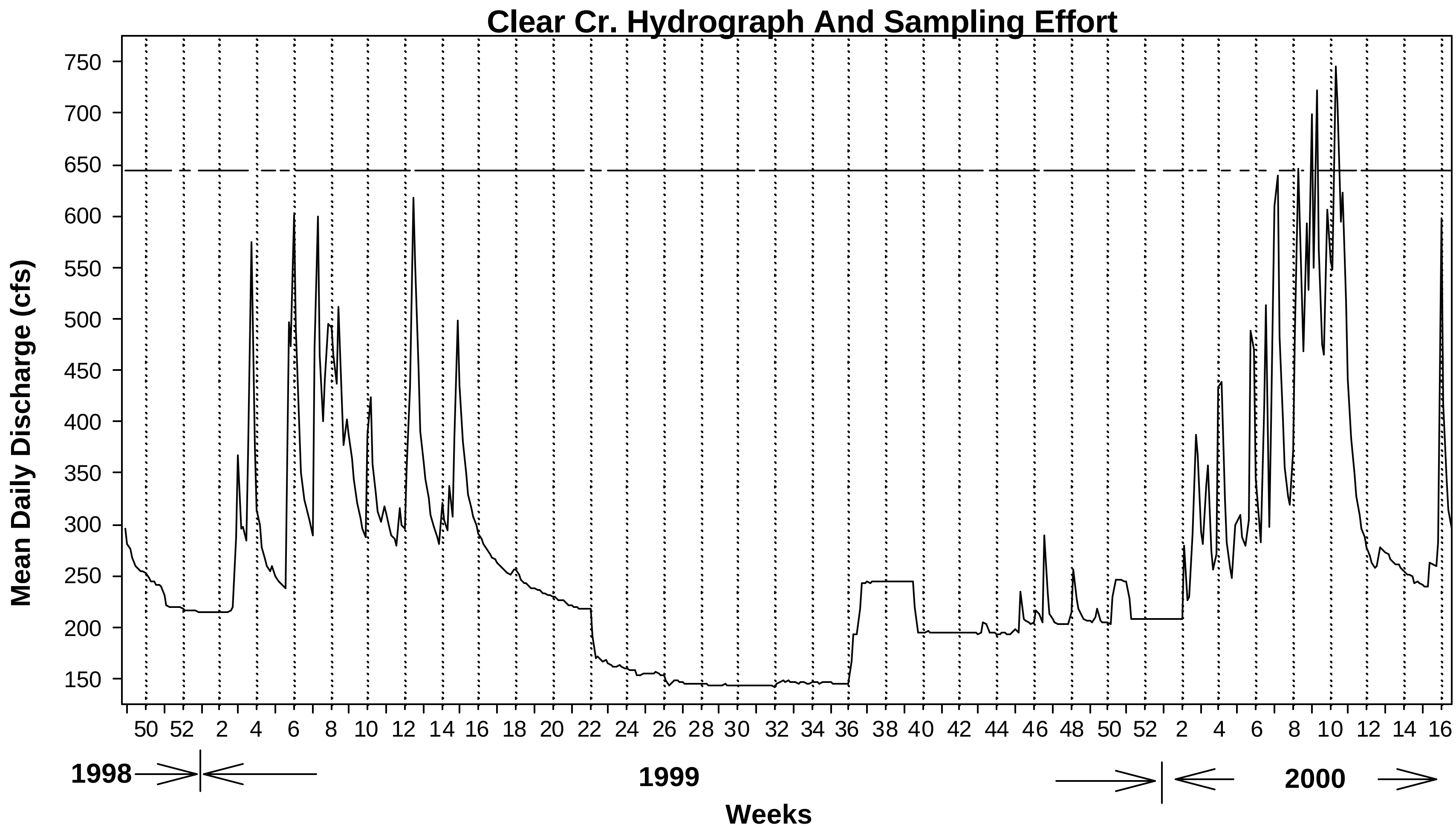

Figure 2. Daily mean discharge (cfs) and rotary-trapping effort on Clear Cr. (SM 1.7) from 5 December 1998 through 21 April 2000. The horizontal dashed line indicates 24-hr. samples. Breaks in the line represent days when rotary trapping was not conducted (usually due to high flow events).

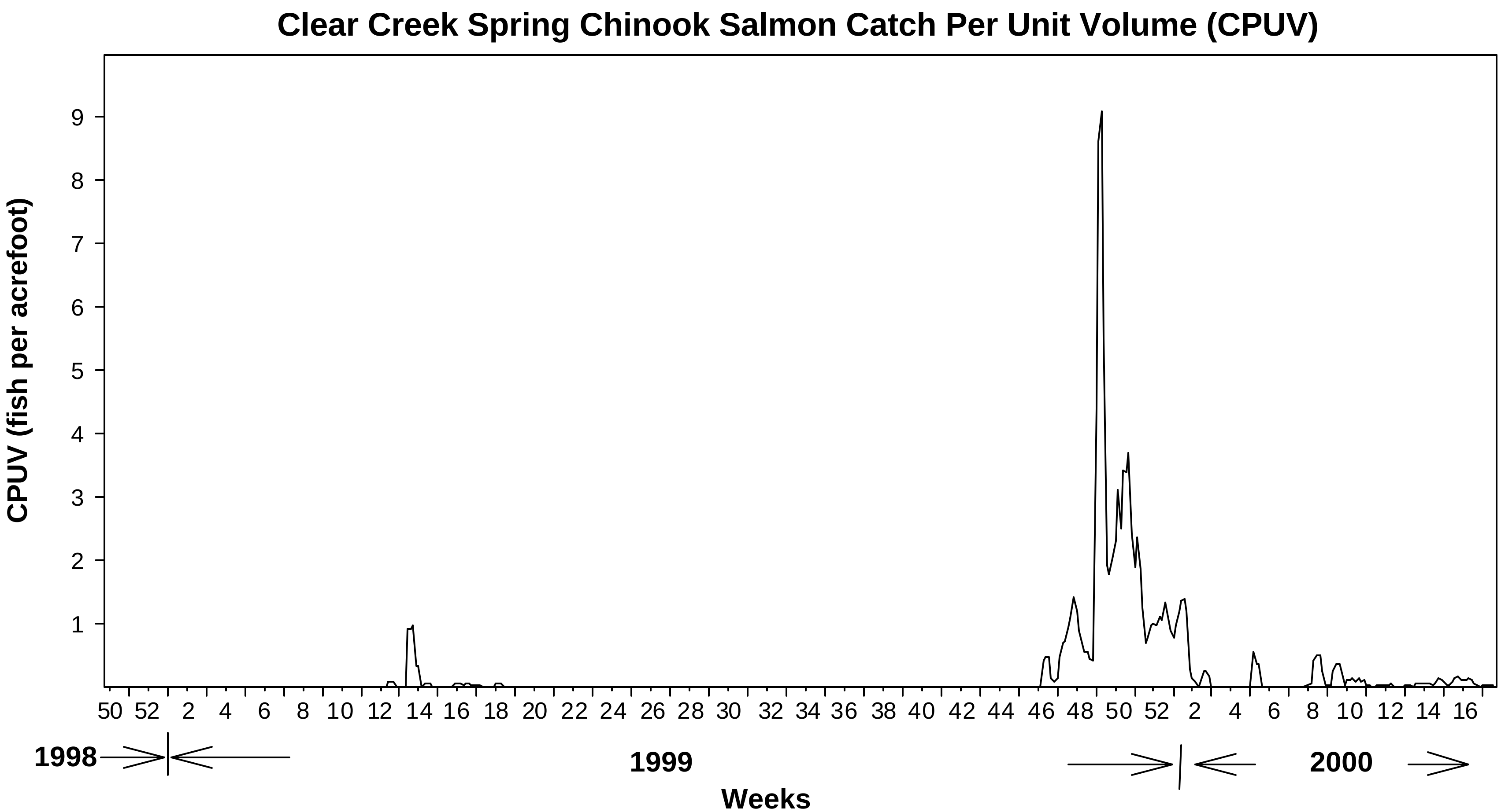

Figure 12. Summary of catch per unit volume (CPUV) expressed in fish per acrefoot for spring chinook salmon captured by rotary-screw trap on Clear Creek (stream mile 1.7). Run designation was assigned based on length criteria developed by the California Department of Water Resources. Each data point represents a three day rolling average of CPUV comprised of the day before, the day of, and the day after the sample was gathered.

Clear Creek Steelhead Trout Catch Per Unit Volume (CPUV)

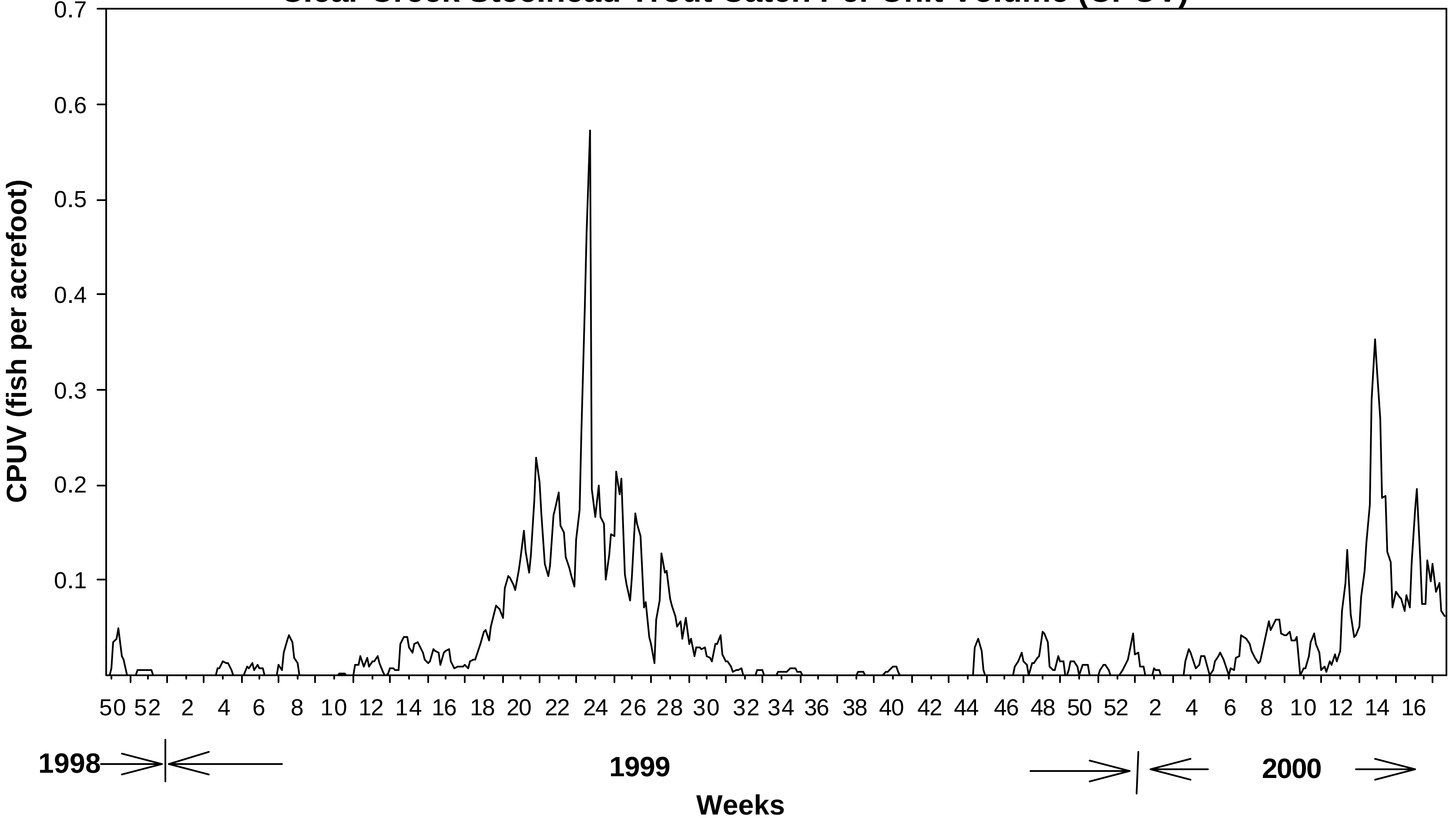

Figure 13. Summary of catch per unit volume (CPUV) expressed in fish per acrefoot for steehead trout captured by rotary-screw trap on Clear Creek (stream mile 1.7). Run designation was assigned based on length criteria developed by the California Department of Water Resources. Each data point represents a three day rolling average of CPUV comprised of the day before, the day of, and the day after the sample was gathered.

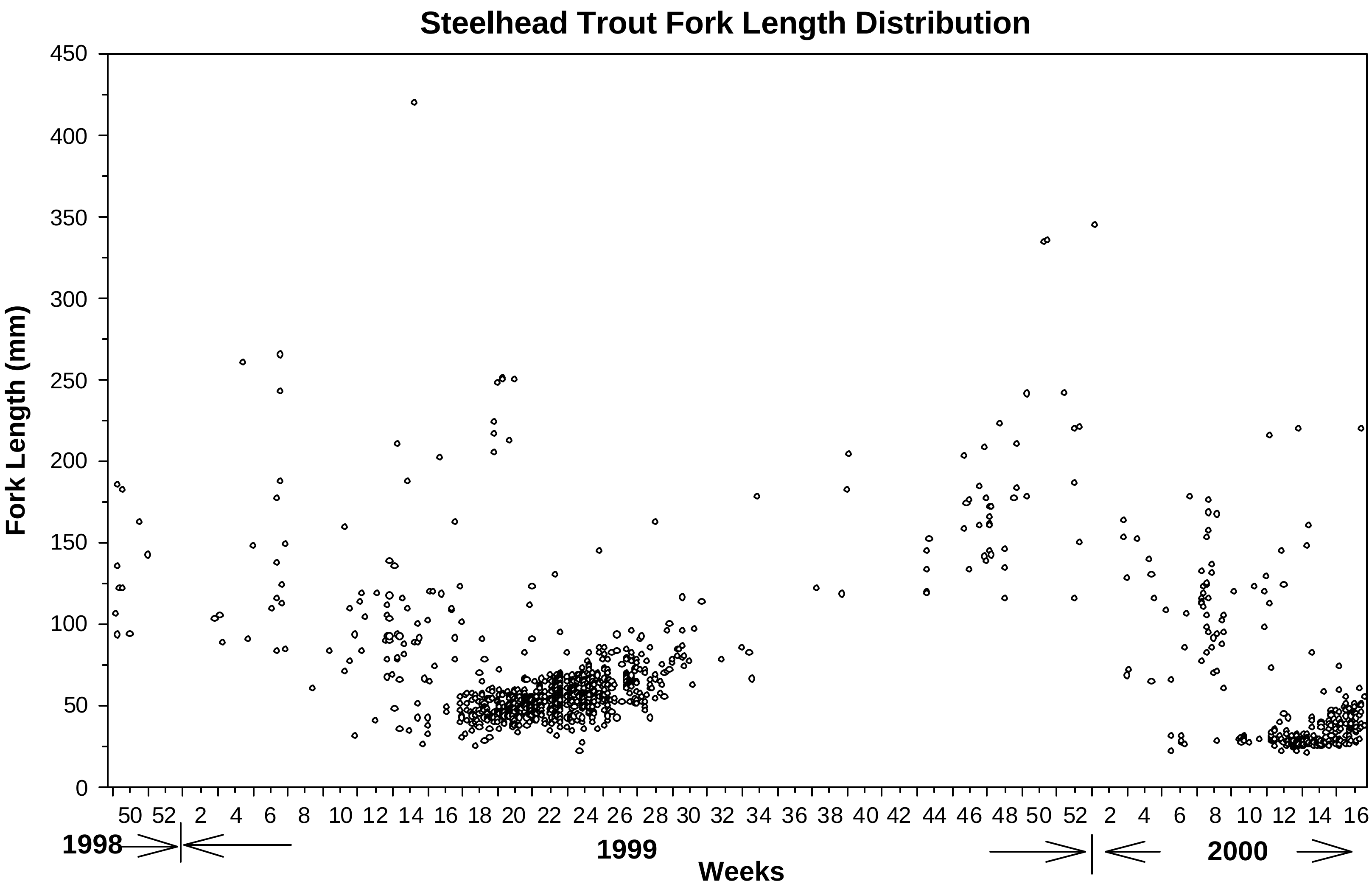

Figure 14. Daily fork length distribution of steelhead trout captured by rotary-screw trap on Clear Cr. (SM1.7) for the period 5 December 1998 through 21 April 2000.

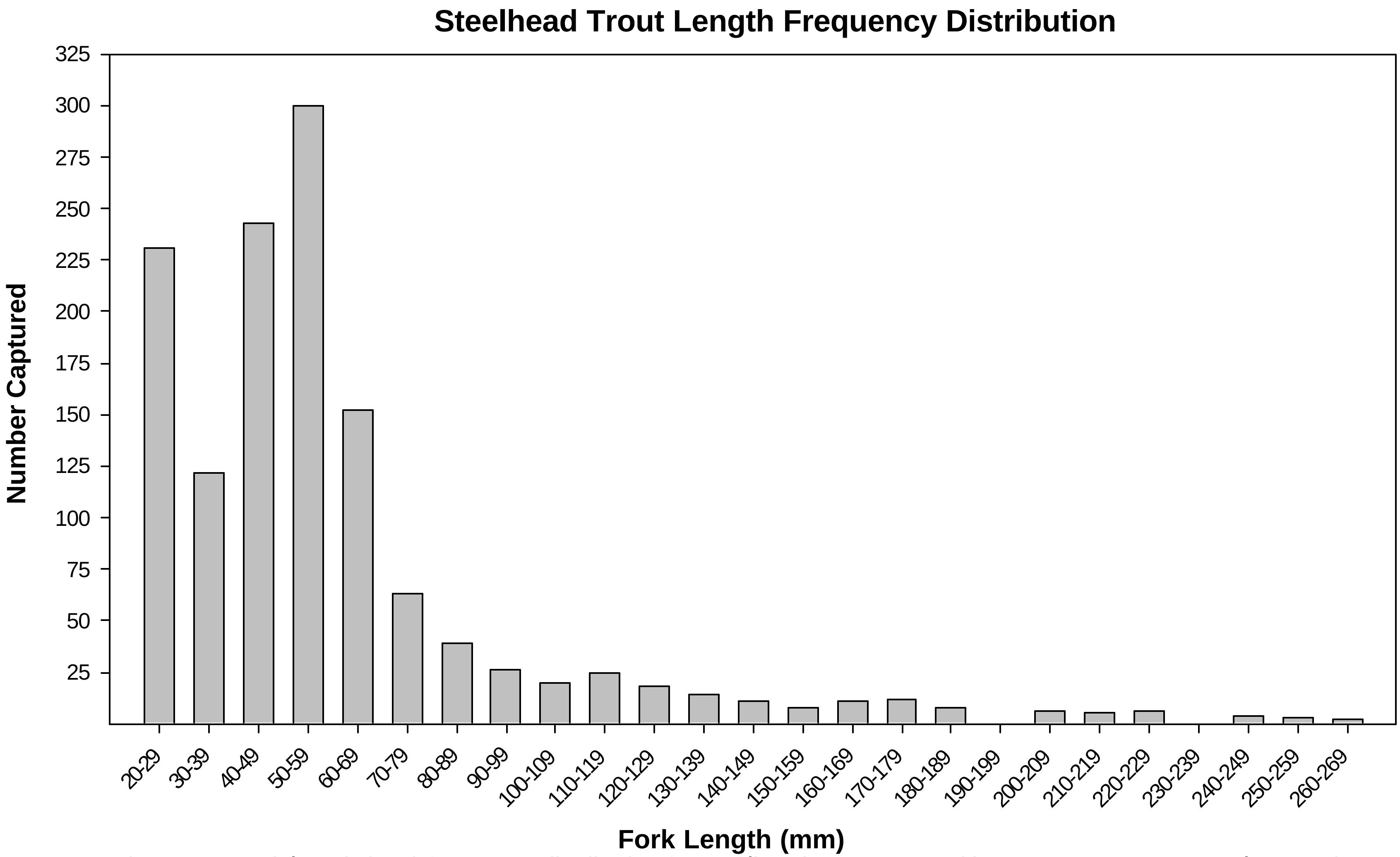

Figure 15. Fork length (mm) frequency distribution for steelhead trout captured by rotary-screw trap on Clear Cr. (SM 1.7) for the period 5 December 1998 through 21 April 2000.

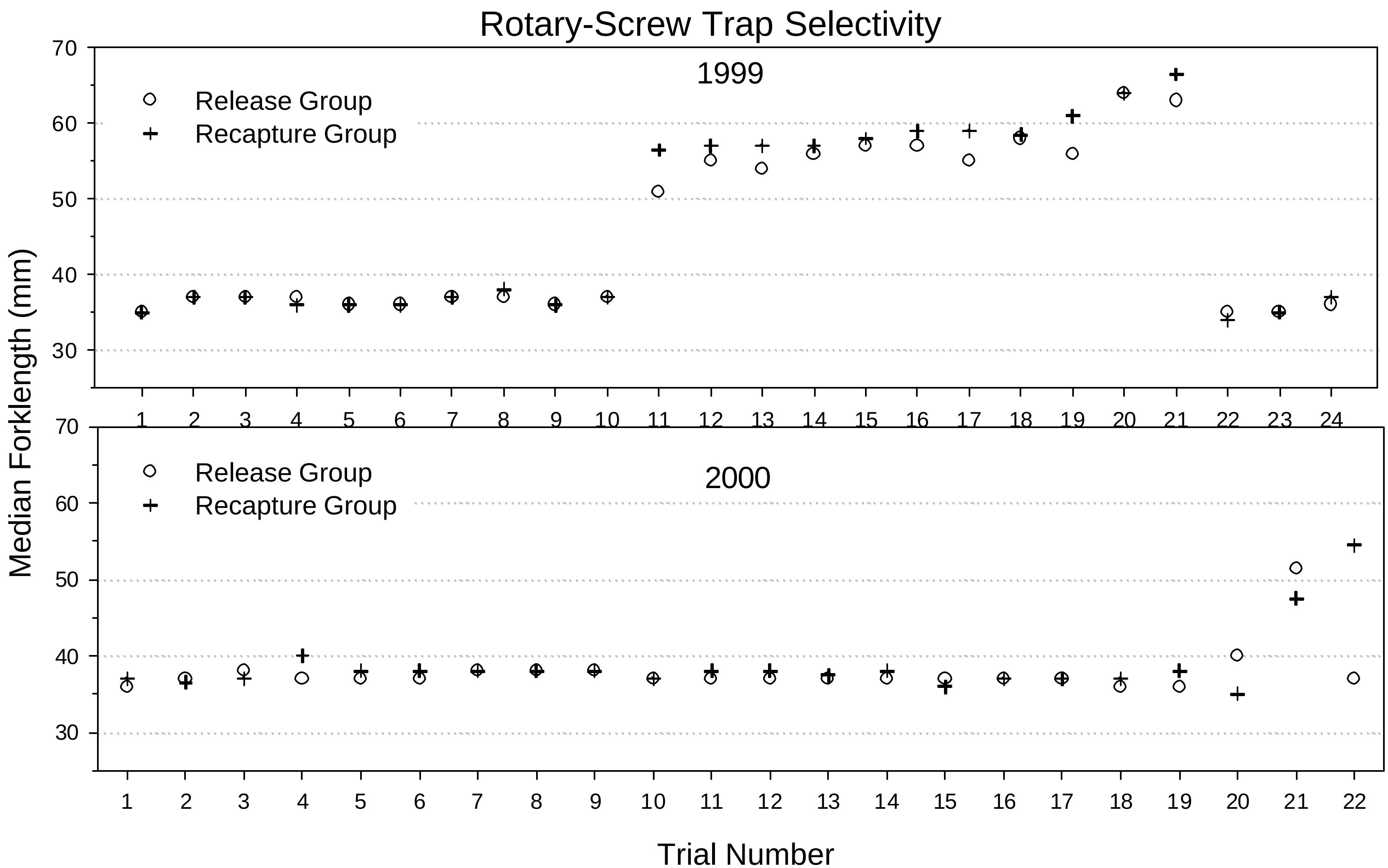

Figure 16. Summary of mark/recapture trials evaluating rotary-screw trap selectivity. Data represent the median fork length (mm) of marked and recaptured chinook salmon on Clear Cr. (SM 1.7) for the period 5 December 1998 through 21 April 2000. Note that no trials were conducted in December of 1998.

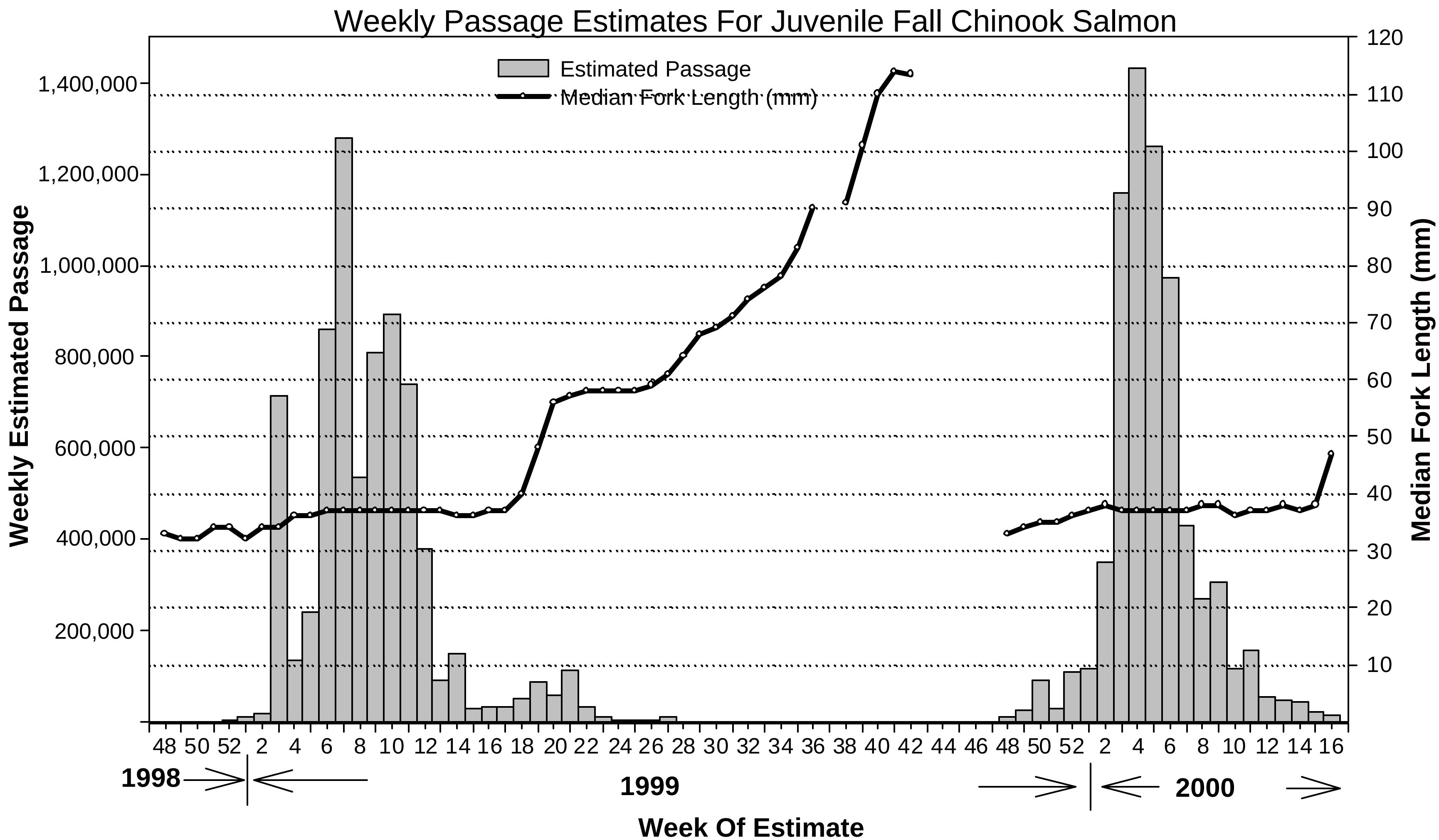

Figure 17. Weekly estimated passage and median fork length (mm) of juvenile fall chinook emigrants from Clear Creek (SM 1.7) for the period 5 December 1998 through 21 April 2000. Estimates were derived by summing the total catch for a given week and dividing that number by trap efficiency. Trap efficiencies were generated through the use of multiple mark/recapture trials.

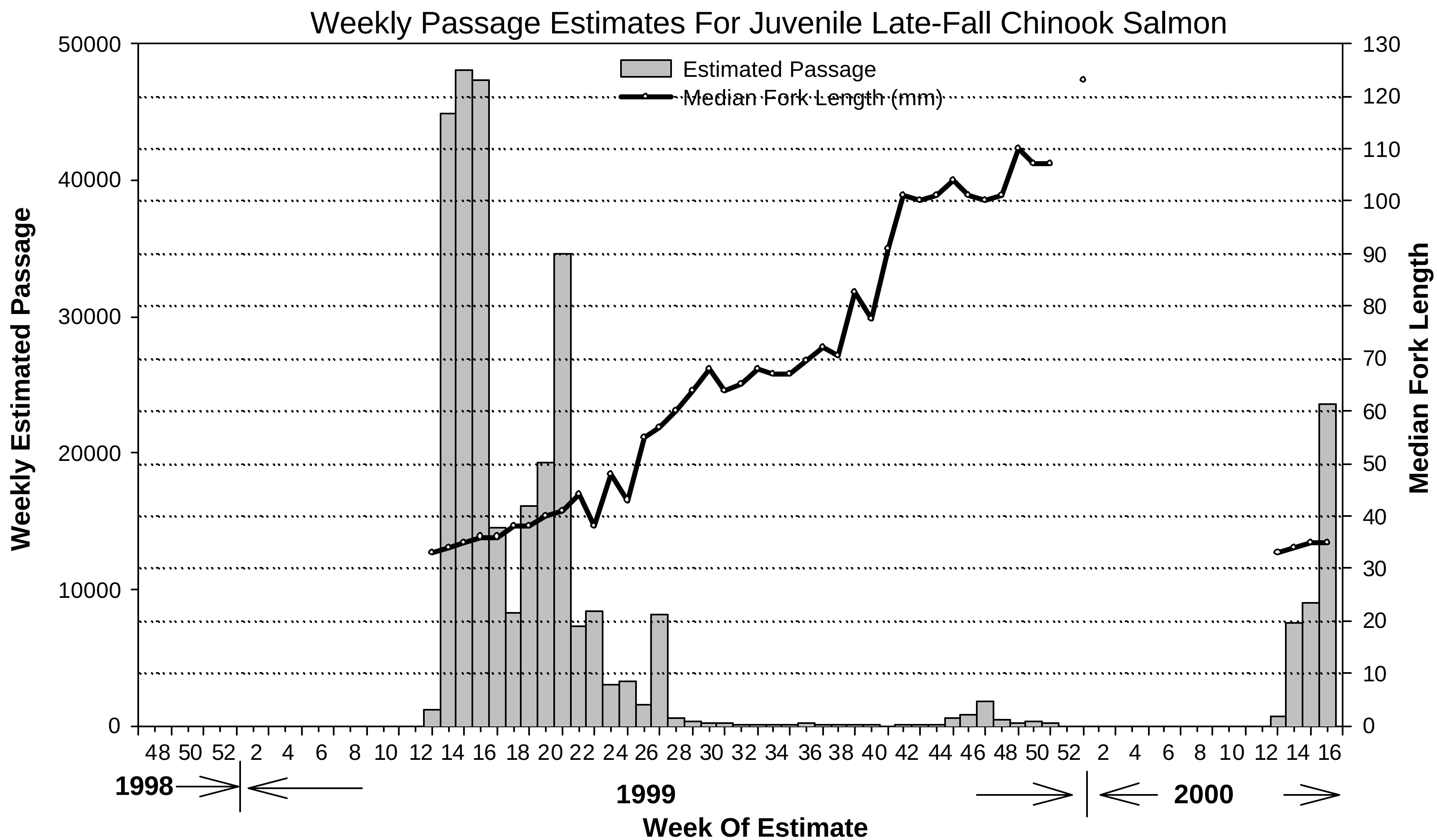

Figure 18. Weekly estimated passage of juvenile late-fall chinook emigrants from Clear Creek (SM 1.7) for the period 5 December 1998 through 21 April 2000. Estimates were derived by summing the total catch for a given week and dividing that number by trap efficiency. Trap efficiencies were generated through the use of multiple mark/recapture trials.

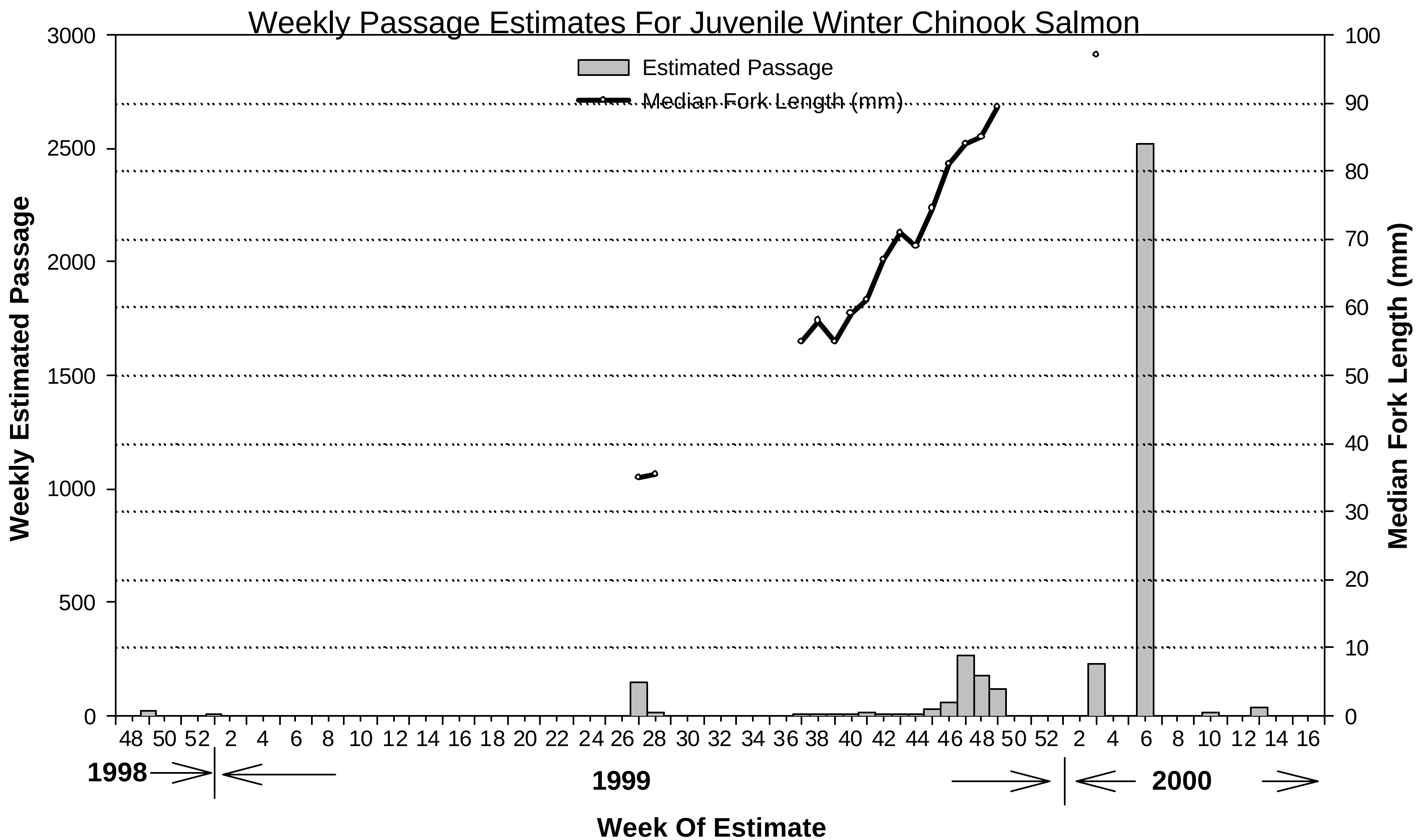

Figure 19. Weekly estimated passage and median fork length of juvenile winter chinook emigrants from Clear Creek (SM 1.7) for the period 5 December 1998 through 21 April 2000. Estimates were derived by summing the total catch for a given week and dividing that number by trap efficiency. Trap efficiencies were generated through the use of multiple mark/recapture trials.

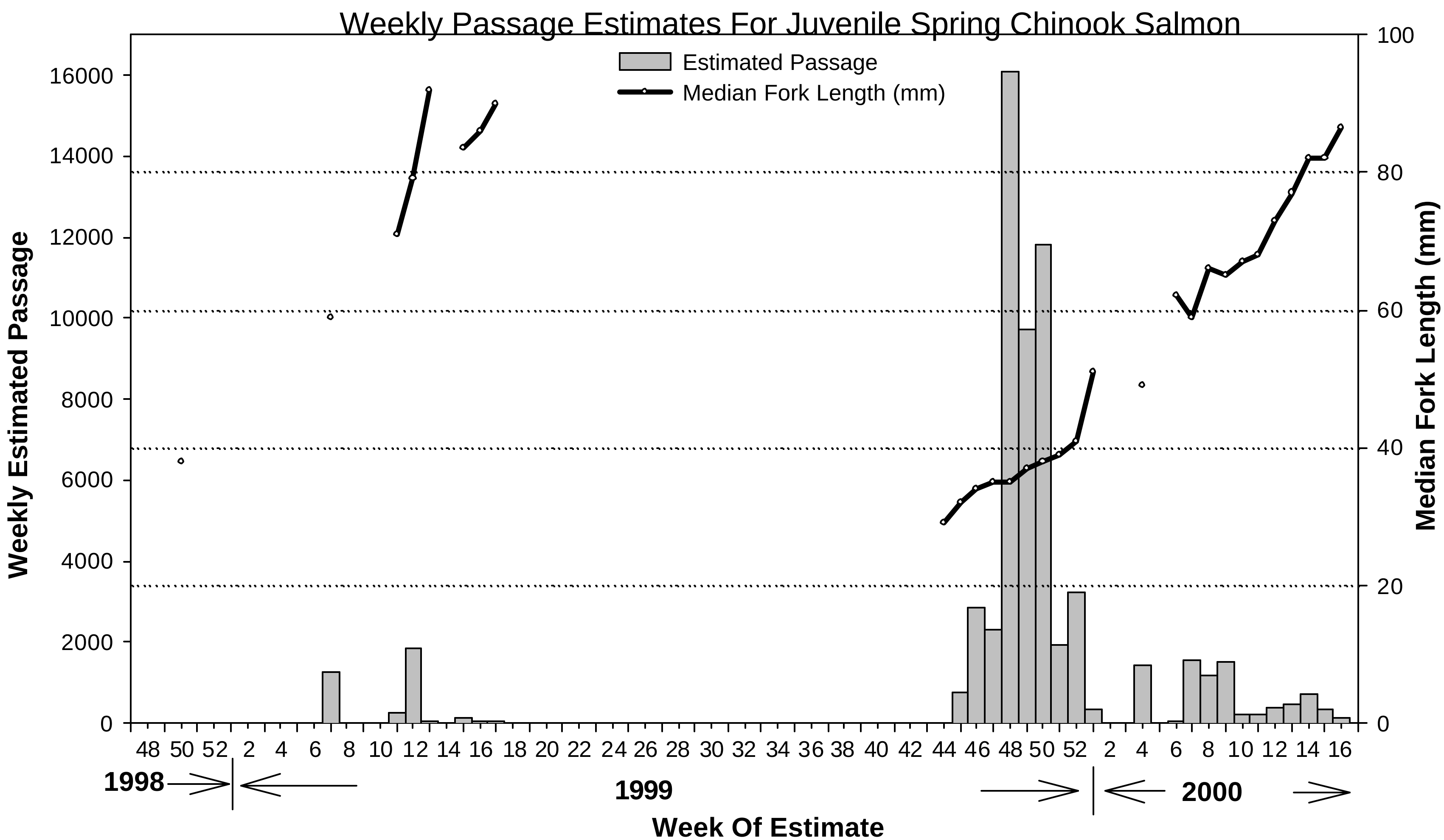

Figure 20. Weekly estimated passage and median fork length of juvenile spring chinook emigrants from Clear Creek (SM 1.7) for the period 5 December 1998 through 21 April 2000. Estimates were derived by summing the total catch for a given week and dividing that number by trap efficiency. Trap efficiencies were generated through the use of multiple mark/recapture trials.

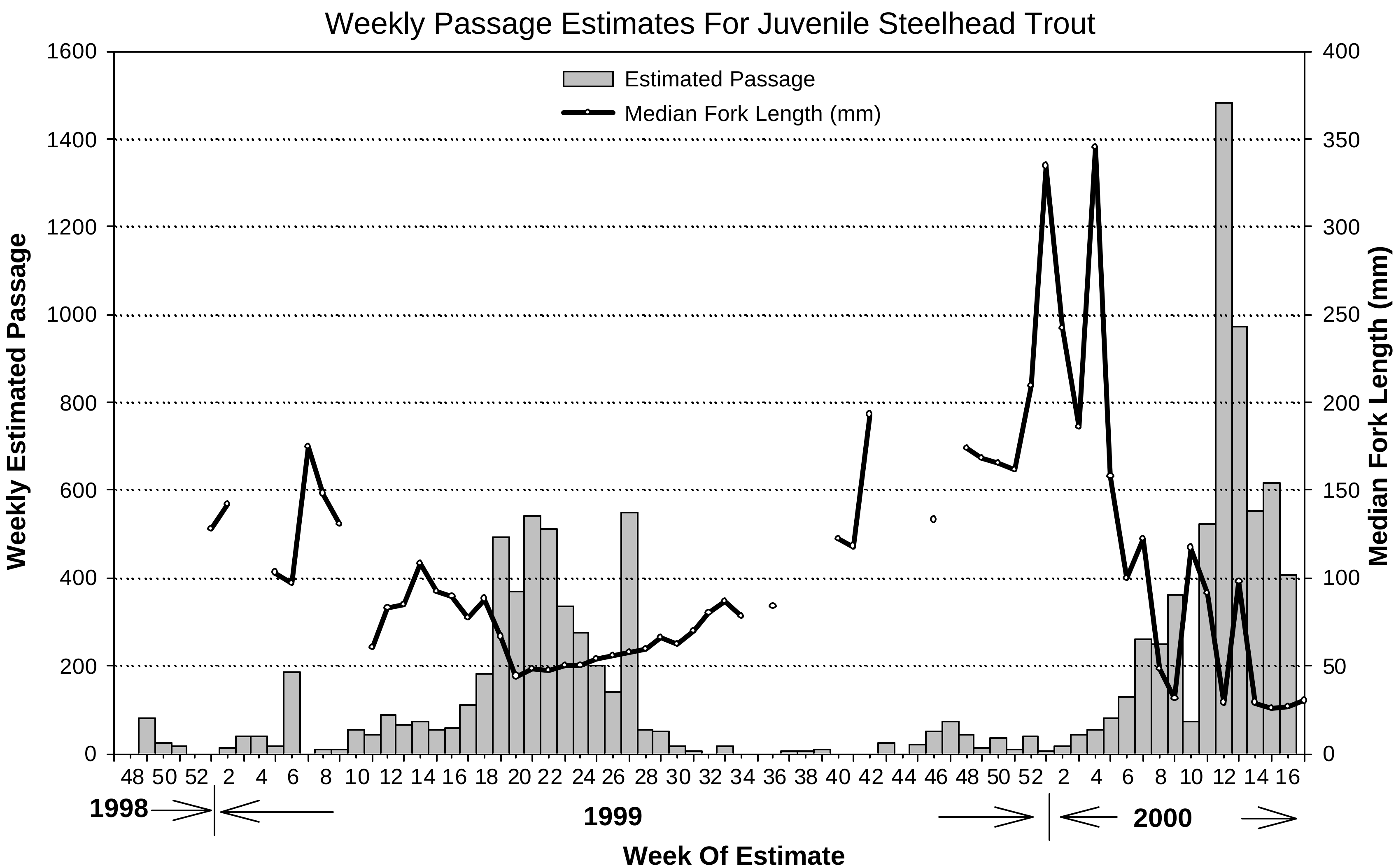

Figure 21. Weekly estimated passage of juvenile steelhead trout from Clear Creek (SM 1.7) for the period 5 December 1998 through 21 April 2000. Estimates were derived by summing the total catch for a given week and dividing that number by trap efficiency. Trap efficiencies were generated through the use of multiple mark/recapture trials.

Appendix 1. — Summary of sampling effort, sample size and fork length (mm) statistics for juvenile fall chinook salmon captured by rotary-screw trap on Clear Cr. (SM 1.7) from Dec. 5, 1998 through April 21, 2000. Results include the number of 24-hr samples within the week (days fished), sample size (*N*), mean, minimum, maximum and median fork length and standard deviation (S.D.).

				Fork length statistics (mm)				
Year	Week	Effort (days fished)	*N*	Mean	Maximum	Minimum	Median	S. D.
1998	48	1	1	33.0	33.0	33.0	33.0	0.00
	49	7	3	31.7	34.0	29.0	32.0	2.52
	50	7	72	32.3	37.0	28.0	32.0	2.14
	51	5	36	34.0	36.0	30.0	34.0	1.31
	52	5	65	34.3	38.0	30.0	34.0	1.43
1999	1	7	798	35.6	40.0	20.0	36.0	1.64
	2	7	557	35.9	39.0	28.0	36.0	1.41
	3	5	396	36.7	40.0	33.0	37.0	1.37
	4	5	921	37.0	42.0	31.0	37.0	1.65
	5	5	512	37.1	45.0	33.0	37.0	1.62
	6	6	778	37.0	47.0	32.0	37.0	1.66
	7	7	880	36.9	52.0	32.0	37.0	1.68
	8	7	787	36.7	48.0	32.0	37.0	1.65
	9	7	583	36.6	43.0	32.0	37.0	1.51
	10	7	744	37.0	63.0	31.0	37.0	1.94
	11	7	1,450	36.5	66.0	31.0	36.0	1.58
	12	6	1,565	37.0	64.0	31.0	36.0	3.79
	13	7	1,645	37.7	73.0	32.0	37.0	4.71
	14	7	1,115	37.8	75.0	35.0	37.0	4.44
	15	7	650	43.7	80.0	37.0	40.0	8.23
	16	7	576	50.9	84.0	38.0	48.0	9.98
	17	7	870	57.3	88.0	40.0	56.0	9.64
	18	7	1,325	57.6	85.0	42.0	57.0	8.39
	19	7	1,164	57.8	85.0	44.0	58.0	7.55
	20	7	916	58.2	84.0	46.0	58.0	7.33
	21	6	959	58.9	84.0	47.0	58.0	7.14
	22	5	1,039	59.0	83.0	49.0	58.0	6.16
	23	7	868	60.0	89.0	51.0	59.0	5.78
	24	7	897	61.7	88.0	54.0	61.0	5.29

Appendix 1. (continued)

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
1999	25	7	546	64.7	85.0	56.0	64.0	5.65
	26	7	507	68.5	98.0	59.0	68.0	5.98
	27	7	541	69.8	90.0	62.0	69.0	5.50
	28	7	149	71.6	89.0	65.0	71.0	4.78
	29	7	47	74.9	89.0	69.0	74.0	4.77
	30	7	81	77.5	108.0	72.0	76.0	5.15
	31	6	7	78.3	81.0	76.0	78.0	1.60
	32	7	4	83.8	89.0	80.0	83.0	4.11
	33	7	1	90.0	90.0	90.0	90.0	0.00
	34	7	0					
	35	7	1	91.0	91.0	91.0	91.0	0.00
	36	7	3	100.7	102.0	99.0	101.0	1.53
	37	7	2	110.0	112.0	108.0	110.0	2.83
	38	7	4	114.3	119.0	110.0	114.0	4.92
	39	7	6	114.5	121.0	111.0	113.5	3.99
	40	7	0					
	41	7	0					
	42	7	0					
	43	6	1	137.0	137.0	137.0	137.0	0.00
	44	7	0					
	45	7	0					
	46	6	0					
	47	7	0					
	48	7	438	32.9	34.0	26.0	33.0	1.10
	49	7	979	33.9	36.0	29.0	34.0	0.98
	50	7	1,483	34.5	37.0	30.0	35.0	1.29
	51	4	1,001	35.1	38.0	31.0	35.0	1.53
	52	4	1,409	36.2	40.0	25.0	36.0	1.74
2000	1	4	1,871	36.7	42.0	29.0	37.0	1.74
	2	4	507	37.4	44.0	31.0	38.0	1.83
	3	4	1,188	37.2	44.0	29.0	37.0	1.80
	4	4	2,229	37.3	46.0	28.0	37.0	1.90
	5	4	1,876	36.8	47.0	29.0	37.0	2.14

Appendix 1. (continued)

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
2000	6	4	2,160	37.1	52.0	28.0	37.0	2.31
	7	5	2,346	37.3	55.0	28.0	37.0	2.73
	8	4	1,865	37.9	58.0	28.0	38.0	3.01
	9	6	2,251	38.5	60.0	29.0	38.0	4.24
	10	7	2,994	36.9	62.0	30.0	36.0	3.24
	11	6	1,634	37.2	67.0	26.0	37.0	2.99
	12	7	1,569	37.8	68.0	29.0	37.0	5.32
	13	7	2,067	38.2	74.0	24.0	38.0	5.27
	14	7	2,126	38.8	78.0	34.0	37.0	7.05
	15	7	1,244	43.0	81.0	36.0	38.0	11.05
	16	5	1,032	49.7	83.0	38.0	47.0	11.55

Appendix 2. — Summary of sampling effort, sample size and fork length (mm) statistics for juvenile late-fall chinook salmon captured by rotary-screw trap on Clear Cr. (SM 1.7) from Dec. 5, 1998 through April 21, 2000. Results include the number of 24-hr samples within the week (days fished), sample size (*N*) , mean, minimum, maximum and median fork length and standard deviation (S.D.).

				Fork length statistics (mm)				
Year	Week	Effort (days fished)	*N*	Mean	Maximum	Minimum	Median	S. D.
1998	48	1	0					
	49	7	1	105.0	105.0	105.0	105.0	0.00
	50	7	0					
	51	5	0					
	52	5	0					
1999	1	7	0					
	2	7	0					
	3	5	0					
	4	5	0					
	5	5	0					
	6	6	0					
	7	7	0					
	8	7	0					
	9	7	0					
	10	7	0					
	11	7	0					
	12	6	0					
	13	7	45	33.3	34.0	32.0	33.0	0.75
	14	7	306	34.3	35.0	31.0	34.0	0.72
	15	7	1,046	35.3	37.0	30.0	35.0	1.04
	16	7	845	36.0	39.0	31.0	36.0	1.41
	17	7	388	36.0	41.0	30.0	36.0	1.75
	18	7	205	37.6	43.0	33.0	38.0	2.32
	19	7	212	38.5	45.0	31.0	38.0	3.62
	20	7	324	39.9	47.0	33.0	40.0	4.27
	21	6	293	40.7	48.0	33.0	41.0	4.25
	22	5	253	42.7	49.0	33.0	44.0	5.21
	23	7	625	41.0	53.0	32.0	38.0	6.22
	24	7	548	45.4	655.0	33.0	48.0	7.14

Appendix 2.— (continued).

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
1999	25	7	676	44.1	58.0	30.0	43.0	8.28
	26	7	320	52.4	60.0	34.0	55.0	7.30
	27	7	438	54.9	63.0	35.0	57.0	7.29
	28	7	158	59.4	66.0	46.0	60.0	4.50
	29	7	85	62.3	69.0	46.0	61.0	4.86
	30	7	62	67.0	72.0	50.0	68.0	4.48
	31	6	33	64.5	75.0	54.0	64.0	6.24
	32	7	25	63.7	75.0	51.0	65.0	6.48
	33	7	26	67.8	82.0	58.0	68.0	7.33
	34	7	30	68.1	83.0	56.0	67.0	7.47
	35	7	31	67.9	85.0	53.0	67.0	8.11
	36	7	44	71.6	94.0	59.0	69.5	8.75
	37	7	33	72.5	92.0	61.0	72.0	7.05
	38	7	28	73.9	100.0	61.0	70.5	10.76
	39	7	26	85.2	104.0	63.0	82.5	11.56
	40	7	10	79.2	93.0	71.0	77.5	7.74
	41	7	8	93.0	120.0	74.0	91.0	16.19
	42	7	15	99.7	120.0	71.0	101.0	15.24
	43	6	30	101.2	127.0	78.0	100.0	13.35
	44	7	14	103.5	130.0	90.0	101.0	13.35
	45	7	83	105.1	143.0	82.0	104.0	12.67
	46	6	92	103.4	136.0	84.0	101.0	11.48
	47	7	250	100.6	139.0	87.0	100.0	8.15
	48	7	27	102.5	121.0	92.0	101.0	7.73
	49	7	10	107.9	118.0	97.0	110.0	6.30
	50	7	4	108.5	116.0	102.0	107.0	5.37
	51	4	5	106.8	108.0	106.0	107.0	0.77
	52	4	0					
2000	1	4	1	123.0	123.0	123.0	123.0	0.00
	2	4	0					
	3	4	0					
	4	4	0					
	5	4	0					

Appendix 2.— (continued).

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
2000	6	4	0					
	7	5	0					
	8	4	0					
	9	6	0					
	10	7	0					
	11	6	0					
	12	7	0					
	13	7	21	32.6	33.0	31.0	33.0	0.64
	14	7	341	33.8	35.0	28.0	34.0	0.99
	15	7	538	34.8	37.0	30.0	35.0	1.19
	16	5	1,284	35.3	38.0	31.0	35.0	1.18

Appendix 3. — Summary of sampling effort, sample size and fork length (mm) statistics for juvenile winter chinook salmon captured by rotary-screw trap on Clear Cr. (SM 1.7) from Dec. 5, 1998 through April 21, 2000. Results include the number of 24-hr samples within the week (days fished), sample size (*N*) , mean, minimum, maximum and median fork length and standard deviation (S.D.).

				Fork length statistics (mm)				
Year	Week	Effort (days fished)	*N*	Mean	Maximum	Minimum	Median	S. D.
1998	48	1	0					
	49	7	1	88	88	88	88	0.00
	50	7	0					
	51	5	0					
	52	5	0					
1999	1	7	1	103	103	103	103	0.00
	2	7	0					
	3	5	0					
	4	5	0					
	5	5	0					
	6	6	0					
	7	7	0					
	8	7	0					
	9	7	0					
	10	7	0					
	11	7	0					
	12	6	0					
	13	7	0					
	14	7	0					
	15	7	0					
	16	7	0					
	17	7	0					
	18	7	0					
	19	7	0					
	20	7	0					
	21	6	0					
	22	5	0					
	23	7	0					
	24	7	0					

Appendix 3.— (continued).

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
1999	25	7	0					
	26	7	0					
	27	7	8	34.6	35.0	33.0	35.0	0.74
	28	7	4	35.0	36.0	33.0	35.5	1.41
	29	7	0					
	30	7	0					
	31	6	0					
	32	7	0					
	33	7	0					
	34	7	0					
	35	7	0					
	36	7	0					
	37	7	1	55.0	55.0	55.0	55.0	0.00
	38	7	1	58.0	58.0	58.0	58.0	0.00
	39	7	1	55.0	55.0	55.0	55.0	0.00
	40	7	2	59.0	59.0	59.0	59.0	0.00
	41	7	3	61.3	66.0	57.0	61.0	4.51
	42	7	1	67.0	67.0	67.0	67.0	0.00
	43	6	1	71.0	71.0	71.0	71.0	0.00
	44	7	2	69.0	71.0	67.0	69.0	2.83
	45	7	4	75.3	80.0	72.0	74.5	3.95
	46	6	7	79.1	84.0	67.0	81.0	5.67
	47	7	36	82.3	89.0	73.0	84.0	4.60
	48	7	8	84.5	89.0	73.0	85.0	3.05
	49	7	5	89.5	91.0	87.0	89.5	1.61
	50	7	0					
	51	4	0					
	52	4	0					
2000	1	4	0					
	2	4	0					
	3	4	1	97.0	97.0	97.0	97.0	0.00
	4	4	0					
	5	4	0					

Appendix 3. — (continued).

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
2000	6	4	1	108.0	108.0	108.0	108.0	0.00
	7	5	0					
	8	4	0					
	9	6	0					
	10	7	1	114.0	114.0	114.0	114.0	0.00
	11	6	0					
	12	7	0					
	13	7	2	109.0	121.0	103.0	103.0	10.39
	14	7	0					
	15	7	0					
	16	5	0					

Appendix 4. — Summary of sampling effort, sample size and fork length (mm) statistics for juvenile spring chinook salmon captured by rotary-screw trap on Clear Cr. (SM 1.7) from Dec. 5, 1998 through April 21, 2000. Results include the number of 24-hr samples within the week (days fished), sample size (*N*) , mean, minimum, maximum and median fork length and standard deviation (S.D.).

				Fork length statistics (mm)				
Year	Week	Effort (days fished)	*N*	Mean	Maximum	Minimum	Median	S. D.
1998	48	1	0					
	49	7	0					
	50	7	1	38.0	38.0	38.0	38.0	0.00
	51	5	0					
	52	5	0					
1999	1	7	0					
	2	7	0					
	3	5	0					
	4	5	0					
	5	5	0					
	6	6	0					
	7	7	1	59.0	59.0	59.0	59.0	0.00
	8	7	0					
	9	7	0					
	10	7	0					
	11	7	1	71.0	71.0	71.0	71.0	0.00
	12	6	5	78.3	82.0	74.0	79.0	3.18
	13	7	1	92.0	92.0	92.0	92.0	0.00
	14	7	0					
	15	7	3	83.5	85.0	82.0	83.5	1.53
	16	7	1	86.0	86.0	86.0	86.0	0.00
	17	7	1	90.0	90.0	90.0	90.0	0.00
	18	7	0					
	19	7	0					
	20	7	0					
	21	6	0					
	22	5	0					
	23	7	0					
	24	7	0					

Appendix 4.— (continued).

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
1999	25	7	0					
	26	7	0					
	27	7	0					
	28	7	0					
	29	7	0					
	30	7	0					
	31	6	0					
	32	7	0					
	33	7	0					
	34	7	0					
	35	7	0					
	36	7	0					
	37	7	0					
	38	7	0					
	39	7	0					
	40	7	0					
	41	7	0					
	42	7	0					
	43	6	0					
	44	7	1	29.0	29.0	29.0	29.0	0.00
	45	7	107	32.5	37.0	28.0	32.0	1.64
	46	6	338	33.2	37.0	26.0	34.0	2.15
	47	7	319	34.9	38.0	26.0	35.0	1.43
	48	7	612	35.4	39.0	32.0	35.0	1.48
	49	7	438	36.7	42.0	35.0	37.0	1.14
	50	7	232	37.7	44.0	37.0	38.0	0.93
	51	4	61	39.5	45.0	39.0	39.0	1.03
	52	4	41	41.4	52.0	40.0	41.0	1.96
2000	1	4	4	48.3	51.0	42.0	51.0	3.66
	2	4	0					
	3	4	0					
	4	4	1	49.0	49.0	49.0	49.0	0.00
	5	4	0					

Appendix 4.— (continued).

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
2000	6	4	2	62.0	65.0	59.0	62.0	4.24
	7	5	12	59..3	66.0	56.0	59.0	2.13
	8	4	9	67.1	75.0	57.0	66.0	5.46
	9	6	16	64.6	72.0	60.0	65.0	2.52
	10	7	8	66.5	69.0	64.0	67.0	1.61
	11	6	4	69.4	81.0	68.0	68.0	3.88
	12	7	12	74.4	95.0	70.0	73.0	5.65
	13	7	23	77.1	87.0	73.0	77.0	3.16
	14	7	42	82.2	92.0	77.0	82.0	3.67
	15	7	26	82.1	87.0	80.0	82.0	2.09
	16	5	18	86.4	89.0	83.0	86.5	1.85

Appendix 5. — Summary of sampling effort, sample size and fork length (mm) statistics for juvenile steelhead trout captured by rotary-screw trap on Clear Cr. (SM 1.7) from Dec. 5, 1998 through April 21, 2000. Results include the number of 24-hr samples within the week (days fished), sample size (*N*) , mean, minimum, maximum and median fork length and standard deviation (S.D.).

				Fork length statistics (mm)				
Year	Week	Effort (days fished)	*N*	Mean	Maximum	Minimum	Median	S. D.
1998	48	1	0					
	49	7	7	135.0	185.0	93.0	122.0	35.71
	50	7	2	128.0	162.0	94.0	128.0	48.08
	51	5	1	142.0	142.0	142.0	142.0	0.00
	52	5	0					
1999	1	7	0					
	2	7	1	103.0	103.0	103.0	103.0	0.00
	3	5	3	96.5	105.0	88.0	96.5	12.02
	4	5	3	175.0	260.0	90.0	175.0	120.21
	5	5	1	148.0	148.0	148.0	148.0	
	6	6	14	148.8	265.0	83.0	130.5	58.77
	7	7	0					
	8	7	1	60.0	60.0	60.0	60.0	0.00
	9	7	1	83.0	83.0	83.0	83.0	0.00
	10	7	6	90.0	159.0	31.0	85.0	42.76
	11	7	4	104.8	119.0	83.0	108.5	15.76
	12	6	15	95.4	138.0	40.0	92.0	25.03
	13	7	16	99.9	210.0	35.0	89.5	46.27
	14	7	11	100.6	420.0	26.0	77.0	115.24
	15	7	11	101.2	202.0	32.0	102.0	59.87
	16	7	12	79.8	162.0	39.0	66.5	38.94
	17	7	30	45.7	101.0	25.0	44.0	14.43
	18	7	53	58.6	224.0	28.0	48.0	41.04
	19	7	89	56.9	251.0	35.0	47.5	41.81
	20	7	92	52.9	250.0	33.0	50.0	23.24
	21	6	82	52.1	123.0	38.0	50.0	11.22
	22	5	121	55.0	130.0	31.0	54.0	11.40
	23	7	89	55.0	82.0	22.0	56.0	10.21
	24	7	88	59.7	145.0	35.0	57.5	13.71

Appendix 5.— (continued).

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
1999	25	7	56	60.8	93.0	37.0	59.5	12.51
	26	7	37	67.5	96.0	51.0	66.0	9.85
	27	7	30	65.0	92.0	42.0	62.5	13.26
	28	7	14	76.6	162.0	54.0	69.5	28.04
	29	7	11	84.8	116.0	74.0	80.0	11.92
	30	7	4	87.3	113.0	62.0	87.0	22.37
	31	6	1	78.0	78.0	78.0	78.0	0.00
	32	7	0					
	33	7	4	102.8	178.0	66.0	83.5	50.86
	34	7	0					
	35	7	0					
	36	7	0					
	37	7	1	122.0	122.0	122.0	122.0	0.00
	38	7	1	118.0	118.0	118.0	118.0	0.00
	39	7	2	193.0	204.0	182.0	193.0	15.56
	40	7	0					
	41	7	0					
	42	7	0					
	43	6	5	133.8	152.0	119.0	133.0	14.72
	44	7	0					
	45	7	3	178.3	203.0	158.0	174.0	22.81
	46	6	6	167.0	208.0	133.0	168.0	28.04
	47	7	11	166.5	223.0	138.0	165.0	23.29
	48	7	6	160.8	210.0	115.0	161.5	35.24
	49	7	2	209.5	241.0	178.0	209.5	44.55
	50	7	2	334.5	335.0	334.0	334.5	0.71
	51	4	1	242.0	242.0	242.0	242.0	0.00
	52	4	5	178.4	221.0	115.0	186.0	45.91
2000	1	4	1	345.0	345.0	345.0	345.0	0.00
	2	4	2	158.0	163.0	153.0	158.0	7.07
	3	4	4	105.0	152.0	68.0	100.0	41.62
	4	4	4	112.0	139.0	64.0	122.5	33.50
	5	4	4	56.5	108.0	22.0	48.0	39.01

Appendix 5.— (continued).

Year	Week	Effort (days fished)	*N*	Fork length statistics (mm) Mean	Maximum	Minimum	Median	S. D.
2000	6	4	7	68.7	178.0	26.0	31.0	58.09
	7	5	22	120.5	176.0	77.0	117.0	26.35
	8	4	11	88.2	167.0	28.0	91.0	34.38
	9	6	10	38.1	120.0	27.0	29.0	28.80
	10	7	6	71.0	123.0	27.0	63.5	47.54
	11	6	28	48.3	215.0	22.0	29.0	45.82
	12	7	85	30.3	220.0	22.0	26.0	23.56
	13	7	81	31.2	160.0	21.0	27.0	20.80
	14	7	38	32.5	58.0	25.0	29.0	7.56
	15	7	65	35.7	74.0	25.0	35.0	9.27
	16	5	28	47.3	220.0	27	43.0	35.01

Appendix 6.— Weekly juvenile production estimates for fall, late-fall and winter chinook salmon captured by rotary-screw trap on Clear Cr. (SM 1.7). Passage estimates were generated by dividing weekly catch by trap efficiency. Trap efficiency was determined through the use of multiple mark/recapture trials. Upper and lower 95% confidence limits were determined by methods described in Krebs (1999). Upper and lower C.I.'s were not generated for weeks 28-44 due to low numbers of captured salmonids.

		Fall chinook			Late-fall chinook			Winter chinook		
Year	Week	Estimated passage	Lower 95% C.I.	Upper 95% C.I.	Estimated passage	Lower 95% C.I.	Upper 95% C.I.	Estimated passage	Lower 95% C.I.	Upper 95% C.I.
1998	48	12	8	19	0	0	0	0	0	0
	49	69	49	110	23	12	370	23	12	37
	50	842	599	1,340	0	0	0	0	0	0
	51	585	460	1,001	0	0	0	0	0	0
	52	2,047	1,695	4,778	0	0	0	0	0	0
1999	1	11,854	8,210	17,259	0	0	0	10	7	14
	2	18,725	12,129	27,230	0	0	0	0	0	0
	3	713,078	430,563	1,132,702	0	0	0	0	0	0
	4	134,673	101,991	268,314	0	0	0	0	0	0
	5	238,778	144,499	380,141	0	0	0	0	0	0
	6	860,240	489,942	1,359,994	0	0	0	0	0	0
	7	1,279,853	778,615	1,939,561	0	0	0	0	0	0
	8	533,770	370,470	774,940	0	0	0	0	0	0
	9	809,952	546,645	1,189,576	0	0	0	0	0	0
	10	893,701	616,275	1,252,837	0	0	0	0	0	0
	11	740,972	564,078	982,376	0	0	0	0	0	0

Appendix 6.— (continued).

		Fall chinook			Late-fall chinook			Winter chinook		
Year	Week	Estimated passage	Lower 95% C.I.	Upper 95% C.I.	Estimated passage	Lower 95% C.I.	Upper 95% C.I.	Estimated passage	Lower 95% C.I.	Upper 95% C.I.
1999	12	378,722	298,413	518,173	0			0	0	0
	13	90,577	77,536	108,893	1,161	994	1,396	0	0	0
	14	148,310	121,817	189,529	44,826	36,819	57,284	0	0	0
	15	30,422	25,021	38,798	48,070	39,535	61,305	0	0	0
	16	33,420	28,251	40,904	47,330	40,010	57,929	0	0	0
	17	32,188	27,758	38,302	14,536	12,535	17,297	0	0	0
	18	49,862	43,181	58,989	8,248	7,143	9,758	0	0	0
	19	88,448	73,605	110,790	16,112	13,408	20,182	0	0	0
	20	57,267	48,599	69,699	19,248	16,335	23,426	0	0	0
	21	113,626	91,700	149,330	34,592	27,917	45,462	0	0	0
	22	30,831	27,169	35,635	7,315	6,446	8,455	0	0	0
	23	11,453	9,854	13,672	8,389	7,218	10,014	0	0	0
	24	5,205	4,527	6,122	3,064	2,665	3,603	0	0	0
	25	2,543	2,144	3,125	3,275	2,762	4,024	0	0	0
	26	2,604	1,907	3,651	1,568	1,148	2,199	0	0	0
	27	10,064	7,302	13,758	8,159	5,920	11,153	146	106	200
	28	553			587			15		
	29	219			397			0		
	30	341			262			0		

Appendix 6.— (continued).

Year	Week	Fall chinook Estimated passage	Fall chinook Lower 95% C.I.	Fall chinook Upper 95% C.I.	Late-fall chinook Estimated passage	Late-fall chinook Lower 95% C.I.	Late-fall chinook Upper 95% C.I.	Winter chinook Estimated passage	Winter chinook Lower 95% C.I.	Winter chinook Upper 95% C.I.
1999	31	34			161			0		
	32	17			105			0		
	33	4			109			0		
	34	0			126			0		
	35	4			130			0		
	36	13			184			0		
	37	8			138			4		
	38	17			117			4		
	39	25			109			4		
	40	0			42			8		
	41	0			29			13		
	42	0			63			4		
	43	5			147			5		
	44	0			59			8		
	45	0	0	0	603	514	726	29	25	35
	46	0	0	0	781	674	934	60	51	71
	47	0	0	0	1,816	1,492	2,387	262	215	344
	48	8,900	7,993	10,042	446	401	503	180	162	203
	49	23,508	20,466	27,617	180	157	212	116	101	136

Appendix 6.— (continued).

Year	Week	Fall chinook Estimated passage	Fall chinook Lower 95% C.I.	Fall chinook Upper 95% C.I.	Late-fall chinook Estimated passage	Late-fall chinook Lower 95% C.I.	Late-fall chinook Upper 95% C.I.	Winter chinook Estimated passage	Winter chinook Lower 95% C.I.	Winter chinook Upper 95% C.I.
1999	50	90,683	71,660	123,455	288	228	393	0	0	0
	51	29,706	25,180	36,216	165	140	201	0	0	0
	52	109,845	87,980	146,173	0	0	0	0	0	0
2000	1	116,736	98,730	142,776	25	21	31	0	0	0
	2	349,198	293,483	433,845	0	0	0	0	0	0
	3	1,156,603	952,871	1,471,145	0	0	0	228	188	290
	4	1,433,080	1,127,614	1,973,707	0	0	0	0	0	0
	5	1,261,971	872,923	1,834,873	0	0	0	0	0	0
	6	971,524	804,467	1,226,149	0	0	0	2,519	2,086	3,179
	7	429,280	342,632	574,585	0	0	0	0	0	0
	8	267,640	216,918	349,482	0	0	0	0	0	0
	9	306,906	186,393	464,314	0	0	0	0	0	0
	10	116,500	95,630	149,024	0	0	0	12	10	15
	11	154,692	123,319	207,474	0	0	0	0	0	0
	12	53,727	43,033	71,494	0	0	0	0	0	0
	13	45,873	37,177	59,878	654	530	853	39	32	51
	14	43,496	31,336	61,622	7,496	5,400	10,620	0	0	0
	15	19,856	15,956	26,281	9,062	7,282	11,994	0	0	0
	16	15,544	12,214	21,371	23,590	18,537	32,433	0	0	0

Appendix 7.— Weekly juvenile production estimates for spring chinook salmon and steelhead trout captured by rotary-screw trap on Clear Cr. (SM 1.7). Passage estimates were generated by dividing weekly catch by trap efficiency. Trap efficiency was determined through the use of multiple mark/recapture trials. Upper and lower 95% confidence limits (C.I.) were determined by methods described in Krebs (1999). Upper and lower C.I.'s were not generated for weeks 28-44 due to low numbers of captured salmonids.

		Spring chinook			Steelhead		
Year	Week	Estimated passage	Lower 95% C.I.	Upper 95% C.I.	Estimated passage	Lower 95% C.I.	Upper 95% C.I.
1998	48	0	0	0	0	0	0
	49	0	0	0	82	58	131
	50	12	8	19	23	17	37
	51	0	0	0	16	13	28
	52	0	0	0	0	0	0
1999	1	0	0	0	0	0	0
	2	0	0	0	13	8	18
	3	0	0	0	41	25	65
	4	0	0	0	41	31	82
	5	0	0	0	16	9	25
	6	0	0	0	185	106	293
	7	1,257	765	1,905	0	0	0
	8	0	0	0	9	6	13
	9	0	0	0	10	7	15
	10	0	0	0	56	39	79
	11	274	209	364	43	33	57

Appendix 7.— (continued).

Year	Week	Spring chinook Estimated passage	Spring chinook Lower 95% C.I.	Spring chinook Upper 95% C.I.	Steelhead trout Estimated passage	Steelhead trout Lower 95% C.I.	Steelhead trout Upper 95% C.I.
1999	12	1,852	1,459	2,534	87	69	120
	13	45	38	54	64	54	77
	14	0	0	0	72	59	92
	15	130	107	166	56	46	71
	16	44	37	54	57	48	69
	17	54	47	64	112	97	133
	18	0	0	0	180	156	213
	19	0	0	0	493	411	618
	20	0	0	0	370	314	451
	21	0	0	0	541	437	712
	22	0	0	0	513	452	593
	23	0	0	0	337	290	502
	24	0	0	0	277	241	325
	25	0	0	0	199	168	244
	26	0	0	0	142	104	199
	27	0	0	0	548	398	750
	28	0			56		
	29	0			51		
	30	0			17		

Appendix 7.— (continued).

Year	Week	Spring chinook Estimated passage	Spring chinook Lower 95% C.I.	Spring chinook Upper 95% C.I.	Steelhead trout Estimated passage	Steelhead trout Lower 95% C.I.	Steelhead trout Upper 95% C.I.
1999	31	0			5		
	32	0			0		
	33	0			17		
	34	0			0		
	35	0			0		
	36	0			0		
	37	0			4		
	38	0			4		
	39	0			8		
	40	0			0		
	41	0			0		
	42	0			0		
	43	0			24		
	44	4			0		
	45	778	663	936	22	19	26
	46	2,873	2,480	3,434	51	44	61
	47	2,311	1,899	3,039	73	60	96
	48	16,088	14,448	18,152	44	39	49
	49	9,724	8,465	11,423	15	13	17

Appendix 7.— (continued).

Year	Week	Spring chinook Estimated passage	Spring chinook Lower 95% C.I.	Spring chinook Upper 95% C.I.	Steelhead trout Estimated passage	Steelhead trout Lower 95% C.I.	Steelhead trout Upper 95% C.I.
1999	50	11,817	9,338	16,088	37	29	50
	51	1,939	1,644	2,364	8	7	10
	52	3,246	2,600	4,319	41	33	55
2000	1	320	271	391	4	4	5
	2	0	0	0	18	15	22
	3	0	0	0	42	34	53
	4	1,413	1,112	1,946	55	43	76
	5	0	0	0	80	55	116
	6	49	40	62	128	106	161
	7	1,536	1,226	2,056	262	209	350
	8	1,184	960	1,546	248	201	324
	9	1,516	921	2,293	362	220	548
	10	210	173	269	72	59	92
	11	219	175	294	524	418	702
	12	363	291	483	1,483	1,188	1,973
	13	451	365	588	972	788	1,269
	14	707	509	1,002	554	399	784
	15	323	260	428	615	494	814
	16	117	92	161	407	319	559