MOKELUMNE RIVER
CHINOOK SALMON AND STEELHEAD
MONITORING PROGRAM
1995–1996

Administered by:

East Bay Municipal Utility District
Watershed and Recreation Division
500 San Pablo Dam Road
Orinda, California 94563

A Technical Report on

Evaluation of the Downstream Migration of
Juvenile Chinook Salmon and Steelhead in the Lower
Mokelumne River and the Sacramento-San Joaquin Delta
(January through July 1996)

October 1998

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EXECUTIVE SUMMARY

The East Bay Municipal Utility District has developed the Mokelumne River Chinook Salmon and Steelhead Monitoring Program (monitoring program) as part of the Lower Mokelumne River Management Plan. The objective of the monitoring program is collection of information on the ecology and management of anadromous salmonids and other fishes inhabiting the lower Mokelumne River. This report provides data and assessment of the downstream migration of juvenile fall-run chinook salmon and steelhead, physiological smolt indices, and mark-recapture experiments of hatchery-reared juvenile salmon migrating through the Sacramento-San Joaquin Delta during the winter, spring, and summer seasons of 1996.

Two rotary screw traps were fished for 198 days between January 15 and July 31, 1996 at Woodbridge Dam. Juvenile chinook salmon were the most abundant species captured. Several species of sunfishes (Centrarchidae) were the next most abundant fishes trapped. A bimodal pattern of emigration was exhibited by young-of-year chinook salmon with distinct peaks for fry in February and for smolts during April through June. Fry were captured in diminishing numbers by mid-March. Most fry passing Woodbridge Dam appeared to be "buttoned-up" (nearly to fully absorbed yolk-sac), pre-feeding-stage fry. Abundance of naturally produced chinook salmon (fry and smolts) for the monitoring period was estimated at 184,014 (95% C.I.: 148,689 - 247,165). Approximately 56% were estimated to have emigrated as fry and 44% as fingerling-sized smolts. Juvenile salmon abundance in 1996 (BY95) was comparable to that reported for BY 1992 (183,448) and BY 1993 (143,224). It was about 40% of that reported for BY 1994 (434,206). Although trapping was started on slightly different dates for these years, estimates are for approximately similar periods.

Three hundred seventy steelhead smolts were captured from January through July, but were observed in greatest abundance after Mokelumne River Hatchery releases were made downstream at New Hope Landing. Eighty-eight steelhead fry were captured from April through July. Six kokanee salmon, presumed to have passed by Pardee and Camanche Dams, were captured from February through July.

River flows at Woodbridge Dam during the monitoring season ranged from about 200 cfs in early January, peaked near 3,000 cfs in February, then declined through March to around 1,000 cfs from early April through July. Water temperatures at Woodbridge Dam through the rearing and emigration season varied from 47°F to 63°F. No distinct associations were observed between the abundance of juvenile salmon emigrants and the range of river flows and water temperatures experienced in 1996. Several daily peaks in abundance of newly emerged fry were noted to correspond with storms and elevated turbidity levels during February which occurred during generally rising river flows. The abundance of fry was generally coincident with the expected timing of their emergence from the redds, so the relative effect of river flow level on their abundance is uncertain. Abundance of fingerling sized salmon smolts increased abruptly after mid-March, peaking during waning and waxing moon phases surrounding the new moons in April and May. During the peak migration period, salmon smolts migrated throughout the day

and night hours with notable peaks in abundance during dawn and dusk. No specific flow-related conditions appeared to be associated with the patterns of smolt emigration.

Two duplicated groups of approximately 102,000 hatchery young-of-year chinook salmon were coded-wire tagged and released in the Delta to evaluate migration survival during the peak of the migration and coincident with a managed Delta pulse flow in May 1996. A *test* group of marked fish was released in the Mokelumne River near its confluence with the Delta and a *control* group was released 5 days later in the San Joaquin River below the Mokelumne River confluence near Jersey Point. The estimate of relative survival was 14.6% (95% C.I. = 8.3% to 20.9%) for the test group compared to the control group.

From April 10 to July 25, 1996, 6,545 naturally produced chinook salmon captured and released at Woodbridge Dam were coded-wire tagged. These tagged fish will be used to track future contributions to the fisheries and spawning escapement of Mokelumne River salmon stock.

Physiological smolt development was monitored at Woodbridge Dam and upstream. Differences in size, condition factor, and gill Na^+/K^+-activated ATPase, an enzyme involved in regulating salt and water balance, between fish at these two locations were observed during the monitoring period. Fish migrating past the dam were generally larger than fish remaining on the rearing grounds. Migrating and rearing fry showed little difference in length, but condition factor was significantly lower for migrating fry. Na^+/K^+-activated ATPase activity increased through the season for all fish and was generally greater for migrant fingerlings, but this was statistically significant only near the beginning of the peak of their migration in mid-April. The condition factor was generally lower for migrant smolts, but was statistically significant only near the peak of migration in the latter half of May. Variation in the smolt indices were observed but no associations with specific environmental conditions were apparent. These data corroborate the past two years' data sets indicating that fingerling salmon migrating past Woodbridge Dam are likely smolting. However, additional data collected under different hydrological conditions are required to assess whether these smolt indices can be used as management tools.

I. OBJECTIVES

This report addresses two objectives of East Bay Municipal Utility District's (EBMUD) 1995–96 Mokelumne River Chinook Salmon (*Oncorhynchus tshawytscha*) and Steelhead (*Oncorhynchus mykiss*) Monitoring Program:

- Monitor abundance, migratory patterns, and physiological condition of downstream migrant salmonids within the Mokelumne River.
- Conduct mark-recapture experiments to determine survival of hatchery-reared chinook salmon smolts migrating through the Mokelumne channels of the Sacramento-San Joaquin Delta (Delta).

These objectives continue the ongoing collection of information on the ecology and management of juvenile anadromous salmonids in the lower Mokelumne River (Figure 1). Task objectives and approaches of the 1995–96 investigation were similar to those used in 1993 and 1995. Specific objectives of the 1995-96 program were to:

- Monitor the daily abundance and downstream migration patterns of naturally produced juvenile anadromous salmonids passing the Woodbridge Irrigation District Dam (WIDD).
- Monitor size and condition of emigrating juvenile anadromous salmonids and determine the proportions of juvenile salmon emigrating as fry and as smolt-sized salmon.
- Evaluate juvenile anadromous salmonid emigration patterns related to environmental factors (i.e., stream flow, water temperature, lunar phase, precipitation, water turbidity, and time of day).
- Evaluate the use of a physiological indicator of smoltification, gill sodium-potassium activated adenosine triphosphatase (gill Na^+/K^+ ATPase) activity, for monitoring juvenile chinook salmon responses to environmental conditions in the lower Mokelumne River.
- Coded-wire tag (CWT) naturally produced chinook salmon smolts for ongoing assessments of population-level responses to management actions and fishery recruitment of the Mokelumne River fall-run chinook salmon stock.
- Assess the relative survival of CWT Mokelumne River Fish Installation (MRFI)-reared salmon smolts migrating through the Delta under various hydrologic and water management conditions.
- Evaluate the results of the preceding tasks in the context of ongoing resource monitoring activities and management actions on the lower Mokelumne River.

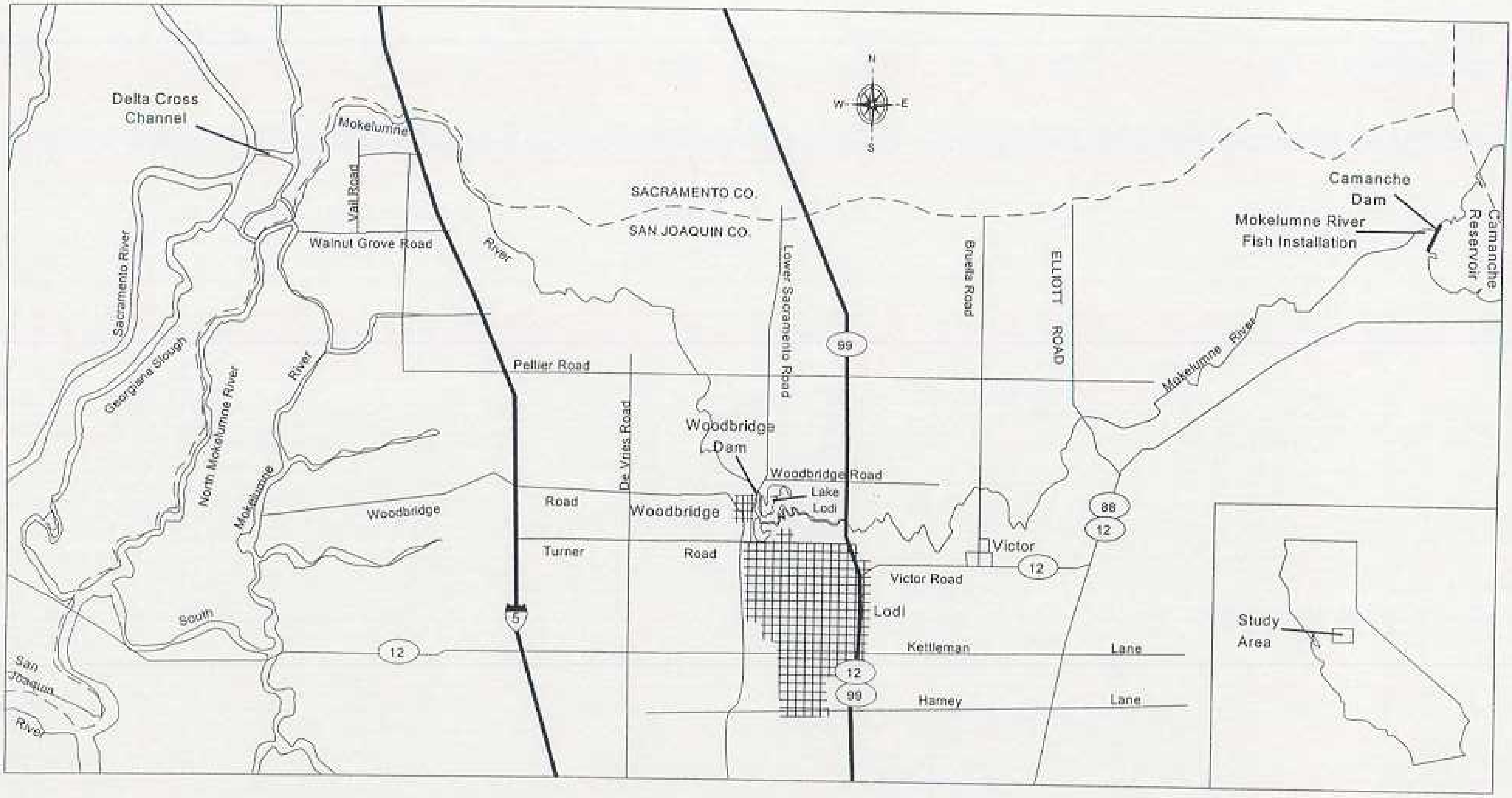

Figure 1. The Mokelumne River from Camanche Dam to the confluence of the San Joaquin River.

II. METHODS

2.1 Downstream Migrant Trapping at Woodbridge Dam

2.1.1 Rotary Screw Fish Traps

Woodbridge Dam has been used as a trapping site for downstream migrant salmonids since inception of EBMUD's Mokelumne River Fishery Monitoring Program in 1990. During January 15 to July 31, 1996, two 2.4-m-diameter rotary screw fish traps were fished in tandem immediately downstream from Woodbridge Dam (Figure 2). The two traps were rigidly connected side by side. The trap suspension and operation system at Woodbridge Dam was similar to that described by Vogel and Marine (1994). When feasible, traps were positioned where the trapping cone rotation could be maintained at a minimum 4 revolutions per minute.

2.1.2 Fish Handling and Measurements

The fish traps were tended twice daily. This was generally done early in the morning and late in the afternoon. During periods of high riverine debris loads and/or large catches of fish, the traps were attended two to three additional times daily, near mid-day and/or mid-evening. Fish captured were transferred from the trap live boxes with dip nets to 20-liter (L) buckets filled with fresh river water to which 30 to 50 mg/l of tricaine methane sulfonate[1] was added for rapid and short-term induction of a moderate level of sedation for most of the species captured (Summerfelt and Smith 1990). All fish were identified to species (when possible) and enumerated.

Up to 30 of each salmonid species captured in each trap during each trapping period were randomly sampled for measurements of total length (TL) and fork length (FL) in millimeters (mm) and weighed in grams (g) on an Ohaus CT1200 portable balance. Weighing was done in tared beakers of fresh water set on the balance pan. Individual sedated fish were gently blotted on a moist sponge to remove excess water before weighing to ensure measurement of true wet weight. These measurements were recorded along with observations of external disease and injury. All adipose fin-clipped salmon (indicating CWT implants) and salmon otherwise marked that were observed among the fish counted or measured were recorded. After counting and measuring, fish were gently placed in a 20-L bucket of fresh river water or live car placed in a flow-through tank with pumped-in river water to recover from sedation before being released downstream of the traps. Total processing time for individual fish from sedation and measurement to recovery and release was generally 15 to 30 minutes. Fish were distributed among several buckets or live cars to avoid overcrowding and depletion of dissolved oxygen (DO) during the processing procedures. To ensure DO remained at sufficient levels in holding buckets, water was exchanged at regular intervals (about every 5 to 10 minutes).

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[1]"Finquel" formulation, sold by Argent Chemical Laboratories, Redmond, Washington.

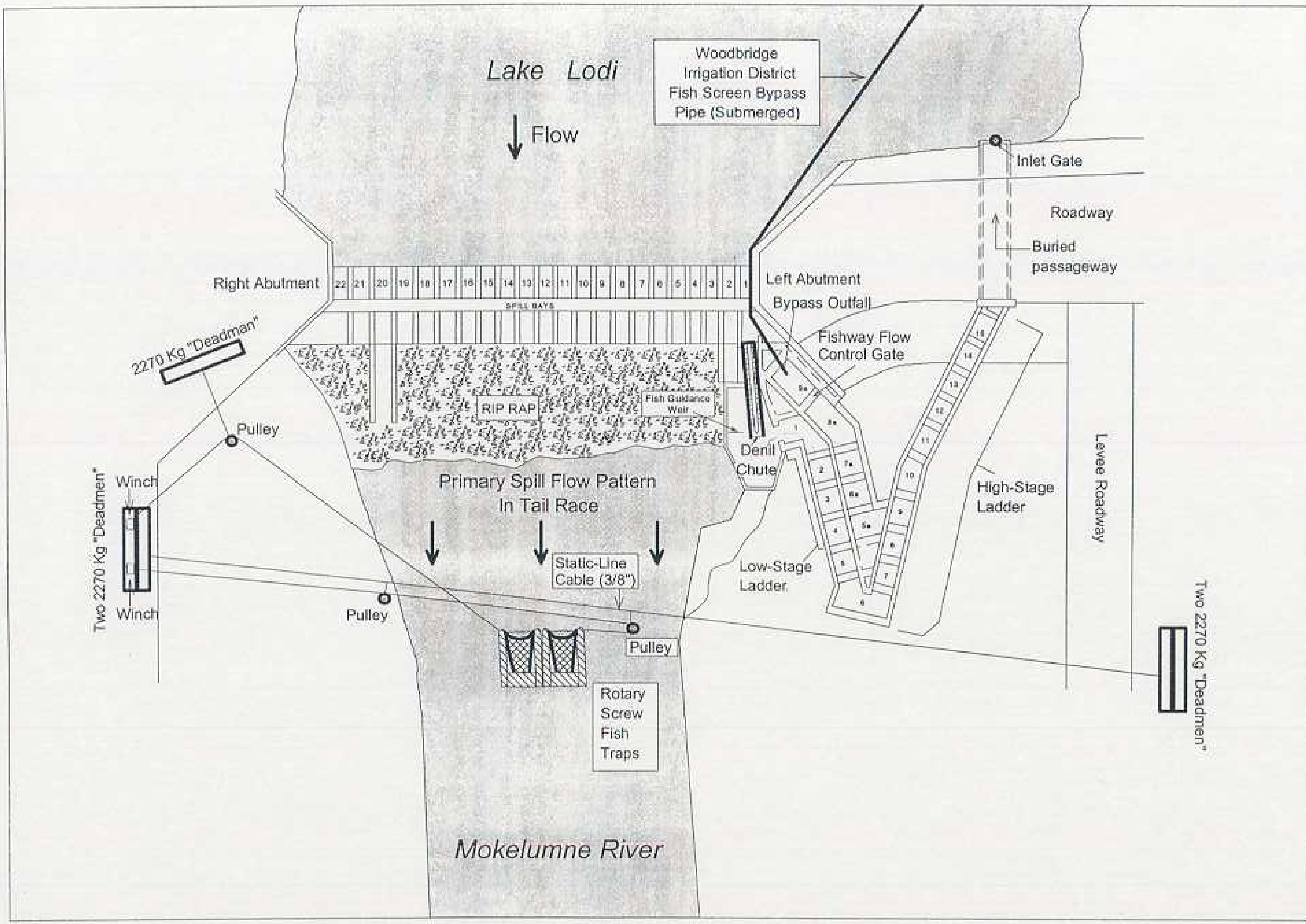

Figure 2. Plan view of Woodbridge Dam showing location of downstream migrant rotary screw traps employed during 1996.

Surface water temperature was measured with a mercury-filled thermometer and water clarity was measured with a secchi disk at the trapping site each time traps were attended. Any other relevant biological or environmental conditions potentially affecting trap performance or fish behavior (*e.g.*, incidence of predators, incidence of poaching, debris loads in traps, changes in river flow, or spill configurations at Woodbridge Dam) were recorded when observed.

2.1.3 Trap Maintenance and Debris Management

Riverine and urban-generated debris can impair operation of the rotary screw traps. Of particular importance at the Woodbridge Dam site are large tree limbs and floating lumber. Tree limbs and floating lumber larger than about 40 cm long and 10 cm in diameter entrained into a screw trap usually stopped rotation of the trap. These occurrences required increased trap inspection frequencies and were most common during the stormy winter season and during increases in discharges from Camanche Dam or adjustment of flashboards in Woodbridge Dam. Discarded monofilament fishing line was also a periodic problem especially during episodes of illegal fishing in the vicinity of the dam and traps during the spring and summer months. All debris and fishing line were cleared from the trap at least twice daily and up to four times daily during heavy accumulations.

Algal growth on the perforated rotating cone of the traps was removed by brushing all surfaces as often as twice daily. This algal growth occurred predominantly during the late spring and summer months.

Seals between the interior of the live boxes and the moving parts of the traps were inspected regularly to ensure proper fit and sealing. A vegetable oil-based lubricant composed of 2 parts vegetable-based oil, 1 part water, and 1 part liquid dish soap thoroughly mixed was periodically applied to nylon bushings that bear the rotating axle shaft of the trap.

2.1.4 Trap Calibrations for Abundance Estimates

Fish capture efficiency of the rotary screw trap system was measured at twelve intervals during the monitoring period to encompass the range of changes in fish sizes, river stage, turbidity, and Woodbridge Dam spill conditions. All juvenile salmon used for these mark-recapture tests were obtained from MRFI and were of Mokelumne River origin. Fin clips were used to mark fish for these assessments. Fin clips were made by excising a small portion of the upper or lower lobe of the caudal fin while the fish were anesthetized (*ca.* 70 to 100 mg/l tricaine solution). Fish were allowed to recover in cylindrical 25-liter PVC live cars (30 cm diameter, 40 cm long with soft nylon 2-mm Delta mesh covered ends) placed in a protected refuge in the low-stage fishway for 6 to 24 hours before their release for the tests. A sample of 30 to 50 fish from each release group was measured for FL and examined for mark quality before release.

Paired test releases, one during daylight (1-hour after sunrise to 1-hour before sunset) and one during night time (½-hour after sunset to ½-hour before sunrise), were made for each trap

6 to 24 hours before their release for the tests. A sample of 30 to 50 fish from each release group was measured for FL and examined for mark quality before release.

Paired test releases, one during daylight (1-hour after sunrise to 1-hour before sunset) and one during night time (½-hour after sunset to ½-hour before sunrise), were made for each trap efficiency measurement interval. Marked fish were released at the crest of the spill over flashboards on Woodbridge Dam (Figure 2). Fish were carefully released into the spill crest so that none escaped upstream into Lake Lodi. The release groups were divided into four or five groups of approximately equal sublots and released across the entire width of the dam's spillway. The hydraulic head differential between the upstream and downstream side of the dam ranged from about 0.5 to about 2.0 m. We assumed that the release distance from the trap and the spill configuration of the dam's discharge allowed fish to seek a preferred portion, or natural migration route, or to mix to a homogeneous distribution within the river flow before encountering the traps.

2.2 Abundance and Timing of Emigration

The numbers of each salmonid species within each age class captured were stratified by day and night and compiled daily. Morning (night) and afternoon (day) trap capture numbers were combined to provide daily totals. Daily counts were compiled into weekly totals for several analyses. Outmigrant young-of-year (YOY) chinook salmon abundance estimates were generated from trapping efficiency results. Diurnal and nocturnal abundances were estimated daily using the day and night trap efficiency rates, respectively. Daily nocturnal abundance estimates included fish passing during the full darkness and the crepuscular periods (dusk and dawn) of the preceding night. Daily diurnal abundance estimates included fish passing during full daylight, generally 1 to 2 hours after sunrise until 1 to 2 hours before sunset. Abundance was estimated using the calculation:

[*number of salmon captured*] ÷ [*trap efficiency for applicable period*].

2.3 Fish Size and Condition

Sizes (FL, TL) and weights obtained from subsamples of up to 60 salmonids per trap in each day's trap catches were compiled. Fulton's Condition Factor, given as (100 x weight/TL^3) by Bagenal and Tesch (1978), where weight is in grams and TL is in millimeters, was computed for each fish. Daily and weekly averages for FL, TL, weight, and condition factor of YOY and yearling salmon were computed and analyzed. Salmon fry were classified as ≤50 mm based on a general size criterion for ocean-type chinook salmon throughout their range (Healy 1991).

Injuries on trapped fish were described, recorded, and compiled daily, as well as the numbers of dead fish found in the traps. Incidents of injury and mortality were examined with regard to effects of predators, debris fouling of the traps, and other conditions that may have contributed to their occurrence.

2.4 Physical Environmental Data

Daily environmental data for the period January through July 1996 were obtained from the following sources:

- River Flow passing Woodbridge Dam: U.S. Geological Survey (USGS) gauging station (11325500) on the Mokelumne River located downstream of Woodbridge Dam near River Mile 37.
- WID's Canal Diversions: USGS gauging station (11325000) located in the canal near the point of diversion at Woodbridge, California.
- Local Watershed Precipitation: National Weather Service field data collection station at Camanche Dam, San Joaquin County, California; and a Campbell Scientific Instruments meteorological datalogger[2] at Woodbridge, California.
- River Temperature at Woodbridge Dam: Ryan Model RTM 2000 thermograph[3] installed in pool No. 6a of the low-stage fishway and surface temperatures generally measured twice daily, in the morning and in the afternoon, with a mercury-filled thermometer.
- Water Turbidity Index (Secchi Depth): Generally measured twice daily in the river channel off downstream end of screw traps, or in Lake Lodi immediately upstream from spillbay 1 at Woodbridge Dam.
- Lunar Age and Regional Sunrise/Sunset Timing: *1996 Old Farmer's Almanac*, Yankee Publishing Inc., Dublin, New Hampshire.
- Sacramento-San Joaquin Delta Water Conditions: U.S. Bureau of Reclamation, Central Valley Operations Coordinating Office, Sacramento, California and California Department of Water Resources, Sacramento, California.

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[2]Campbell Scientific Instruments, Inc., Logan, Utah

[3]Ryan Instruments Inc., Redmond, Washington

2.5 Diel Migration Pattern Surveys

Diel migration behavior patterns of chinook salmon smolts were assessed during the height of their emigration period. Diel surveys were conducted at the Woodbridge Dam trap site on May 8-9, May 15–16, June 02-03, and June 09–10, 1996. Traps were tended hourly for 24 hours during these surveys using the previously described fish handling and trap tending protocols. Numbers of juvenile salmon captured during each of the diel surveys were compiled on an hourly basis. Diurnal and nocturnal trap efficiencies were applied to hourly trap captures to compute hourly estimated abundances of downstream migrant salmon smolts during the survey periods.

2.6 Coded-Wire Tagging of Wild Smolts at Woodbridge Dam Trap Site

Tagging of naturally produced juvenile salmon with CWTs was initiated when increased numbers of juvenile salmon ≥60 mm FL were captured. Juvenile salmon smaller than 60 mm FL are difficult to tag and may not survive the tagging operation. Beginning on April 10, 1996 and continuing until July 31, 1996, all juvenile chinook salmon captured at the Woodbridge Dam site were tagged by injecting 0.5 mm binary CWTs (microtags) into their head cartilage using a NMT[4] Mark IV tagging machine and marked by excision of the adipose fin using Miltex fine-tipped surgical scissors. Fish were handled, as previously described for fish handling and measurement, with the additional procedures of injecting CWTs, passing fish through a field microtag detector to ensure tag implantation, and excising adipose fins before their placement into a recovery tank of fresh, flowing river water. A single tagging machine and field tag detector was set up adjacent to the high-stage fishway. Water was pumped from the fishway to provide cool flowing water to a 120 L plastic tank used as a recovery bath for the fish. A shade fabric (approximately 60 percent light reduction) was installed over the entire work area to reduce sun heating of equipment, personnel, and fish. Upon recovery, fish were placed in 20 L buckets at densities of no more than about 60 fish per bucket and released approximately 100 m downstream from the trap. Total time in transit was 2 to 5 minutes.

Two tag codes were used for tagging naturally produced chinook salmon smolts captured at Woodbridge Dam during 1996:

Tag Code	Time Period	Release Location
06-01-13-01-07	04/10/96 to 05/17/96	Woodbridge Dam
06-01-13-01-08	05/18/96 to 07/25/96	Woodbridge Dam

The quality of tagging and latent mortality associated with handling during tagging were assessed at seven different times. Samples ranging from 13 to 30 tagged fish were placed in 25 L PVC live cars (previously described) at densities of about 7 to 12 fish per live car and held in a

[4]Northwest Marine Technologies, Shaw Island, Washington.

protected area of the high-stage fishway (pool No.15) for 5 to 7 days[5]. The live cars were checked daily for mortalities. At the end of the holding period, all fish were mildly sedated with tricaine (*ca*. 30 to 50 mg/l), examined for quality of the adipose fin clip, and passed through the microtag detector to confirm tag retention. After this procedure, all fish were released as previously described.

2.7 Coded-Wire Tagging of Hatchery Smolts and Delta Survival Experiments

A 30-foot Wells Cargo® trailer outfitted with CWT equipment constructed by EBMUD was used to tag chinook salmon smolts reared at the MRFI for mark and recapture experiments of smolt survival in the Sacramento-San Joaquin Delta. The trailer was equipped with five marking stations each with a NMT Mark IV tagging machine, a quality control device (QCD), and a stainless steel anesthetic bath pan. A stainless steel trough running along the length of an interior wall of the trailer was supplied with continuously flowing water pumped from a hatchery water supply for loading and holding fish in the trailer prior to being tagged. A PVC return pipe manifold system that ran the length of the trailer's floor passing beneath each station served to collect and carry tagged fish outside to a receiving raceway. Each station was plumbed to receive water pumped from the hatchery water supply. This plumbing system provided water to operate the QCD's hydraulic sorting switches, which separated correctly tagged from untagged fish, and to carry tagged fish through the return pipe system. The trailer was also equipped with a recirculating anesthetic system. This system consisted of a 120 L plastic barrel supply tank, aerator, and submersible pump for pumping anesthetic solution through a heat exchanger in the bottom of the flow-through holding tank, then to a PVC distribution manifold leading to each station. Anesthetic solution returned to the supply tank through a return pipe for reconditioning.

The tagging procedure was as follows. Fish were loaded directly from the hatchery raceway into the trailer's holding trough from which fish tagging technicians netted groups of fish. Groups of about 50 to 60 fish were mildly anesthetized in aerated, salted (0.7–0.9 percent), buffered tricaine methane sulfonate solutions (*ca* 70 to 90 mg/l, with 1:1 sodium bicarbonate as buffer). The temperature of the anesthetic solution at each station was monitored regularly. The anesthetic solution was changed at 2 to 3 hour intervals or more frequently if the time for induction of anesthesia increased to more than about 1.5 to 2 minutes. Once the fish were anesthetized, a 1mm binary CWT was injected into the head cartilage of each fish using the tagging machine, the adipose fin was excised with a pair of fine-pointed surgical scissors, and the fish was passed through the QCD. Fish which the QCD detected as untagged were automatically directed to a recovery bucket and the QCD issued a warning tone to the operator. These fish were passed back through the QCD to check the rejection and retagged if necessary. Efficiency of tagging, proper operation of QCD's, and tag placement for each operator and tagging machine was checked two to three times daily during tagging operations. Samples of 25 to 100 fish were collected from each station's QCD outflow and passed back through another QCD for

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[5]Note: CDFG holds tagged hatchery fish for a minimum of 21 days for quality control assessment; however, this was not practicable under field conditions at the Woodbridge Dam site.

confirmation of tagging efficiency and QCD operation. A subsample of 3 to 10 of these fish was dissected to confirm proper placement of the tags and the tagging machines were adjusted if necessary. Machine cleaning and major repair or adjustments were conducted at the end of each tagging day.

Approximately 205,000 smolts at a size of about 90 fish per pound were tagged for the 1996 Delta survival study. These Feather River origin fish were incubated, hatched, and reared at MRFI. Four tag codes assigned to EBMUD were used during April 30 to May10, 1996 to tag these fish. The tag codes were allocated to four groups of about 52,500 fish each. Two tag codes were allocated to each of two experimental release groups. This experimental design creates two experimental groups composed of two tagged sublots which provides for estimating the level of "internal variation" for survival of each experimental release (Burnham et al. 1987). True independent, replicated experiments for this study have not been possible due to space and manpower constraints at MRFI. Each of the paired, tagged CWT groups were reared, loaded, and transported together to the release sites by CDFG. The resulting CWT release groups were as follows:

Experimental Group	Release Site	Tag Codes
"Test"	Mokelumne River - Thornton	06-02-16 and 06-02-17
"Control"	San Joaquin River - Jersey Point	06-02-18 and 06-02-19

The duplicated sublot releases allowed for limited estimation of within group sampling variance for assessing reliability of survival estimates for each experimental release.

During the holding period prior to release, CDFG maintained records of all mortalities in each of the tag code groups. Each of the tag groups were checked for tag retention 11 to 15 days after being tagged. Samples of about 250 to 300 fish for each of the tag groups were mildly sedated in a 50 mg/l solution of tricaine and individually passed through a QCD set up alongside the raceway. Then following the procedure outlined by CDFG, the proportion of fish detected without tags for each sample was used to adjust for total numbers of fish retaining tags after subtracting mortalities from the number originally tagged (F. Fisher, CDFG, Red Bluff, California, personal communication). Two days before release of each of the composite groups, a sample of 30 to 50 fish were measured (FL and TL) and weighed and their condition factors were calculated.

CDFG transported and released each of the composite tagged groups of fish. The "test" group, 06-02-16/17, was released at New Hope Landing near the confluence of the mainstem Mokelumne River and the central Delta on May 15, 1996 (Figure 1). The "control" group, 06-02-18/19, was released from Sherman Island across from Jersey Point on the San Joaquin River near its confluence with the Sacramento River on May 20, 1996. Marked experimental release groups were recaptured by the U.S. Fish and Wildlife Service's (USFWS) Sacramento-San Joaquin Estuary Fishery Resource Office using a standardized, routine trawl sampling program at the western outflow of the Delta near Chipps Island (P.L. Brandes, USFWS, Stockton, California, personal communication). USFWS processed recaptured fish and identified CWT samples. Reports of incidental recoveries at the Central Valley Project/State Water Project (CVP/SWP) diversion's fish salvage facilities and other Interagency Ecological Program sampling projects were obtained as well.

2.8 Coded-Wire Tag Summaries and Assessment

Data for both wild and hatchery-reared groups included initial numbers of fish tagged, tag retention, post-tagging mortality, size of fish at time of release, dates of release and release objectives. These data were submitted to CDFG in their reporting format during August 1996. Tagging data for wild and hatchery release groups are presented in this report. Tag recovery data for the Delta survival experimental releases were compiled by USFWS. USFWS provided computed survival indices (S_T) for each of the tag codes recovered during their surveys.

2.9 Physiological Monitoring of Smoltification of Fall-Run Chinook Salmon

This task assessed the usefulness of gill Na^+/K^+ ATPase measurements from naturally produced chinook salmon to detect fish responses to environmental conditions. At 2-week intervals from March to July 1996, YOY fall-run chinook salmon were collected from the lower Mokelumne River from (1) State Highway 99 bridge upstream to the Public Day Use Area near MRFI and (2) at Woodbridge Dam. Collections from both reaches were made within 2 days to minimize any temporal variations in measured parameters between groups. Fish collected from the upstream habitat were assumed to be primarily in the rearing "parr" life stage; while fish collected at Woodbridge Dam were assumed to be actively migrating smolts. Collections in the upstream reach were made by beach seining with a 20 m x 1.5 m x 2 mm Delta mesh nylon seine. Collections at Woodbridge Dam were from fish captured in the downstream migrant traps. Up to 10 fish were sampled from each location on each collection date. Fish were euthanized using a 200 to 250 mg/l solution of tricaine buffered with sodium bicarbonate and individually processed. Fish were measured and weighed as previously described. Gill filaments were excised from all right-side-gill arches and placed in a 2 ml vial of a fixative solution of sucrose, EDTA, and imidazole buffered to pH 7.2, and frozen on dry ice. Samples were kept frozen at - 18 to - 25°F until shipped to a laboratory for processing[6]. The samples were homogenized and analyzed using the whole tissue homogenate method for determining Na^+/K^+ ATPase activity (Johnson *et al*. 1977). The resulting data were subjected to analysis of variance (Neter and Wasserman 1974) to assess spatial and temporal differences and changes in gill Na^+/K^+ ATPase activity profiles among the groups of fish sampled.

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[6]BioTech Research and Consulting, Inc., Corvallis, Oregon.

III. RESULTS AND DISCUSSION

3.1 Fish Abundances Monitored at Woodbridge Dam

3.1.1 Numbers of Fish Trapped

Trapping was conducted for 198 days between January 15 and July 31, 1996 at Woodbridge Dam. Appendices A and B provide daily records of trapping effort and the numbers of juvenile fall-run chinook salmon and steelhead captured. Table 1 shows that juvenile chinook salmon were the most abundant species. The most abundant non-salmonid species were non-native centrarchid fish (sunfish family) and the native prickly sculpin (*Cottus asper*). Six juvenile kokanee (*Oncorhynchus nerka kennerlyi*) were captured between February and July. This species presumably escaped in the spill from Pardee and Camanche reservoirs. In general, the life stages of all species captured in the rotary screw traps were juveniles and subadults.

3.1.2 Abundance Estimate for Downstream Migrant Juvenile Chinook Salmon

Trap efficiency recovery rates varied for twelve test intervals during the season (Table 2). Four trap efficiency tests for fry-sized salmon ($FL \leq 50$ mm) resulted in two significantly different ($\alpha=0.05$) pairs of day-night trap efficiencies. One test exhibited no difference between day and night efficiencies, and in one of these tests a night release only was performed to verify a previous efficiency test. Significant differences ($\alpha=0.05$) between day and night trap efficiencies were detected in 4 out of 8 tests performed for smolt-sized salmon ($FL>50$ mm). When differences were detected among these latter tests, day trap efficiencies were higher early in the season and night efficiencies were higher later in the season. Trap efficiencies throughout the monitoring period were significantly different between day and night in over half of the paired tests. So, abundance estimates were subsequently stratified by day and night time periods to compute the overall abundance estimate. Similar differences in diel capture probabilities of rotary fish traps for downstream migrant chinook salmon have been reported for previous years on the Mokelumne River (Vogel and Marine 1994, 1996, 1998) and for the South Fork Umpqua River by Roper and Scarnecchia (1996).

Table 1. Fish species captured at the Woodbridge Dam trap site (January through July 1996).

Species		Jan	Feb	Mar	Apr	May	Jun	Jul
Chinook Salmon (*Oncorhynchus tshawytscha*)	Age YOY	265	5790	371	2102	4797	1546	67
Rainbow Trout/Steelhead (*Oncorhynchus mykiss*)	Age YOY	0	0	0	9	42	25	12
	Age 1+	52	117	40	113	26	13	9
Pacific Lamprey (*Lampetra tridentata*)		63	317	4	4	8	3	0
Sacramento Sucker (*Catostomus occidentalis*)		0	0	0	0	1	2	1
Bluegill (*Lepomis macrochirus*)		9	370	98	313	80	16	8
Largemouth Bass (*Micropterus salmoides*)		0	2	1	1	4	13	4
Smallmouth Bass (*Micropterus dolomieui*)		0	0	0	0	0	0	1
Striped Bass (*Morone saxatilis*)		0	0	0	1	0	3	1
Spotted Bass (*Micropterus punctulatus*)		0	19	1	1	32	25	15
Redear Sunfish (*Lepomis microlophus*)		0	4	0	3	9	5	5
Green Sunfish (*Lepomis cyanellus*)		0	0	1	2	3	0	0
Prickly Sculpin (*Cottus asper*)		55	296	113	105	165	303	214
Riffle Sculpin (*Cottus gulosus*)		0	1	0	0	1	0	0
White Crappie (*Pomoxis annularis*)		0	0	0	0	0	0	1
Black Crappie (*Pomoxis nigromaculatus*)		1	22	6	3	77	93	27
Channel Catfish (*Ictalurus punctatus*)		0	0	1	0	0	0	0
White Catfish (*Ameiurus catus*)		0	6	0	2	1	1	7
Brown Bullhead' (*Ameiurus nebulosus*)		0	14	1	1	0	1	1

Table 1. Fish species captured at the Woodbridge Dam trap site (January through July 1996) (continued).

Species	Jan	Feb	Mar	Apr	May	Jun	Jul
Goldfish *(Carassius auratus)*	0	0	0	0	0	1	0
Carp *(Cyprinus carpio)*	2	34	2	10	4	14	1
Hardhead *(Mylopharodon conocephalus)*	0	0	1	0	0	1	0
Golden Shiner *(Notemigonus crysoleucas)*	43	419	9	20	5	7	3
Hitch *(Lavinia exilicauda)*	0	0	1	2	1	4	0
Sacramento Squawfish *(Ptychocheilus grandis)*	0	0	0	2	4	1	0
Threadfin Shad *(Dorosoma Petenense)*	0	20	1	0	0	0	0
Bigscale Logperch *(Percina macrolepida)*	0	5	0	0	0	0	0
Tule Perch *(Hysterocarpus traski)*	0	3	0	3	0	2	6
Smelt *(Hypomesus spp.)*	0	0	1	0	0	0	0
Splittail *(Pogonichthys macrolepidotus)*	0	11	0	0	0	0	0
Mosquitofish *(Gambusia affinis)*	3	9	2	1	0	1	0
Sacramento Blackfish *(Orthodon mictolepidotes)*	0	0	1	5	0	1	0
California Roach *(Hesperoleucas symmetricus)*	0	0	0	0	1	1	0
Kokanee *(Oncorhynchus nerka kennerlyi)*	0	1	1	0	0	2	2

Table 2. Trap efficiency test results for tandem rotary screw traps fished at Woodbridge Dam during February through July 1996

	Numbers of Marked Fish-Day		Numbers of Marked Fish-Night		Chi-Square	Avg. Fork Length	Trap Efficiency		River Flow	Water Temp.	Secchi Depth	
Date of Test	Released	Recaptured	Released	Recaptured	day-night	(mm)	Day	Night	(cfs)	(deg. F)	(cm)	No. Traps
02/11/96	501	94	533	23	52.8 (p<0.001)	37.0	0.19	0.04	1660	52.6	85	2
02/16/96	437	55	498	66	3.3 N.S.	37.0	0.13	0.13	1890	52.1	65	2
02/22/96	496	101	510	5	101 (p<0.001)	40.0	0.20	0.01	2840	53.0	60	2
03/01/96	0	0	516	13	--	44.8	n/a	0.03	2860	52.8	90	2
03/13/96	515	74	553	17	43.3 (p<0.001)	51.4	0.14	0.03	2900	51.1	85	2
03/23/96	476	45	531	19	15.1(p<0.001)	65.6	0.10	0.04	2430	51.7	100	2
03/28/96	335	35	460	23	9.3 (p<0.01)	72.2	0.11	0.05	2190	52.2	115	2
04/16/96	463	76	495	58	4.2 N.S.	79.3	0.16	0.12	1130	55.4	240	2
04/30/96	442	62	436	49	1.5 N.S.	85.6	0.14	0.11	1040	57.3	210	2
05/22/96	471	30	511	66	11.8 (p<0.001)	103.4	0.06	0.13	739	55.7	185	2
06/10/96	298	44	382	41	2.7 N.S.	112.1	0.15	0.11	670	60.8	180	2
07/03/96	409	12	410	21	2.0 N.S.	123.5	0.03	0.05	944	60.8	195	2

Notes: Recapture period includes two trapping intervals following release (approximately 24h).

Average secchi depths, water temperatures, and stream flows at Woodbridge Dam are for the 24h period immediately following marked fish release.

All trap efficiency tests conducted with hatchery-reared chinook salmon.

Average trapping efficiencies were computed for relatively homogeneous time intervals when multiple tests were performed. A trapping time interval was considered homogeneous when river flow, turbidity, spill configuration, fish size, number of traps in service, and presence of predators did not change appreciably. Trap efficiency tests were applied as follows:

	Average Trap Efficiency		Range of
Trapping Period	Day (95% C.I.)	Night (95% C.I.)	River Flows (cfs)
1/01/96 to 1/31/96	N.A.	N.A.	204- 619
2/01/96 to 2/20/96	0.160 (0.140-0.180)	0.085 (0.068-0.102)	959-2,140
2/21/96 to 3/19/96	0.170 (0.147-0.193)	0.020 (0.013-0.027)	2,590-2,950
3/20/96 to 4/03/96	0.105 (0.084-0.126)	0.045 (0.038-0.052)	1,660-2,570
4/04/96 to 5/13/96	0.150 (0.127-0.173)	0.115 (0.095-0.135)	1,000-1,470
5/14/96 to 6/18/96	0.105 (0.083-0.127)	0.120 (0.099-0.141)	652- 927
6/19/96 to 7/31/96	0.030 (0.013-0.047)	0.050 (0.029-0.071)	870- 969

No trap efficiency tests were performed for the month of January since few hatchery fry had yet hatched. No abundance estimates were computed for this period only the numbers caught were used. Each day's diurnal and nocturnal abundance estimates were summed to produce daily abundances. The daily diurnal and nocturnal estimates of abundance, associated mean trap efficiencies, and the periods of estimation used to compute the overall abundance estimate are provided in Appendix C.

From January 15 through July 31, 1996, an estimate of 184,014 naturally produced YOY chinook salmon passed the Woodbridge Dam trap site. The 95% confidence interval for this abundance estimate ranged from 148,689 to 247,165. Based on the stratified diurnal/nocturnal trapping efficiencies, it was estimated that 23,703 (day) and 160,311 (night) YOY salmon passed Woodbridge Dam.

These abundance estimates should be considered as an index of relative temporal abundance for salmon migrating past the spill bays of Woodbridge Dam (versus passing the trap location). And, these estimates are not necessarily estimates of population size. These estimates do not quantify potential fish losses between the spill bays and the trap location but naturally incorporate and account for these losses in the abundance estimate. Actual fish losses between the spill bays, where trap calibration fish are released, and the traps, where trap calibration fish are recaptured, (e.g., attributable to predation) are not known and cannot be separately quantified with these indices.

3.2 Timing of the Downstream Migration of Juvenile Salmonids

YOY (BY95) fall-run chinook salmon exhibited a distinctly bimodal pattern of emigration from the lower Mokelumne River during 1996 (Figure 3). Substantial numbers of fry-sized fish migrated past Woodbridge Dam during January through early March followed by a period of relatively few fish passing the dam. Increases in numbers of larger juvenile salmon were observed beginning in the first week of April. The increased captures after the beginning of April were composed almost exclusively of smolt-sized fish (Figure 4). As observed in past years (Vogel and Marine 1994, 1996, 1998), this appeared to signal the beginning of a purposeful downstream smolt migration.

Approximately 56 percent of the BY95 natural production emigrated as fry (FL≤50 mm) during 1996. This was similar to the 60 percent of BY94 production estimated to have emigrated as fry (Vogel and Marine 1998). It is common to observe some proportion of a juvenile chinook salmon population to disperse downstream from the spawning grounds shortly after emergence (Healey 1991, Kjelson *et al*. 1982). Hydrologic conditions have been observed to have a great influence on the magnitude of the fry emigration in the Sacramento River with a greater proportion of fry emigrating from upstream river reaches during wet winters with high river flows than during drier years (Vogel *et al*. 1988). However, the destiny of these early migrating fry varies among populations, according to Healey (1991); while some migrate directly to estuaries, others may simply relocate to other suitable freshwater habitat along the river's length.

Figure 5 provides the weekly trap counts of YOY chinook salmon during January through July 1996. No yearling-sized chinook salmon were captured or observed at Woodbridge Dam during 1996. Juvenile steelhead were not very numerous at any time during the season (Table 1). Yearling and older (probably age 2+ based on size) juvenile steelhead were observed in traps every month but were most numerous from January through April, particularly immediately after MRFI released their steelhead production at New Hope Landing. YOY steelhead first appeared in the traps during April and were observed through July (Table 1).

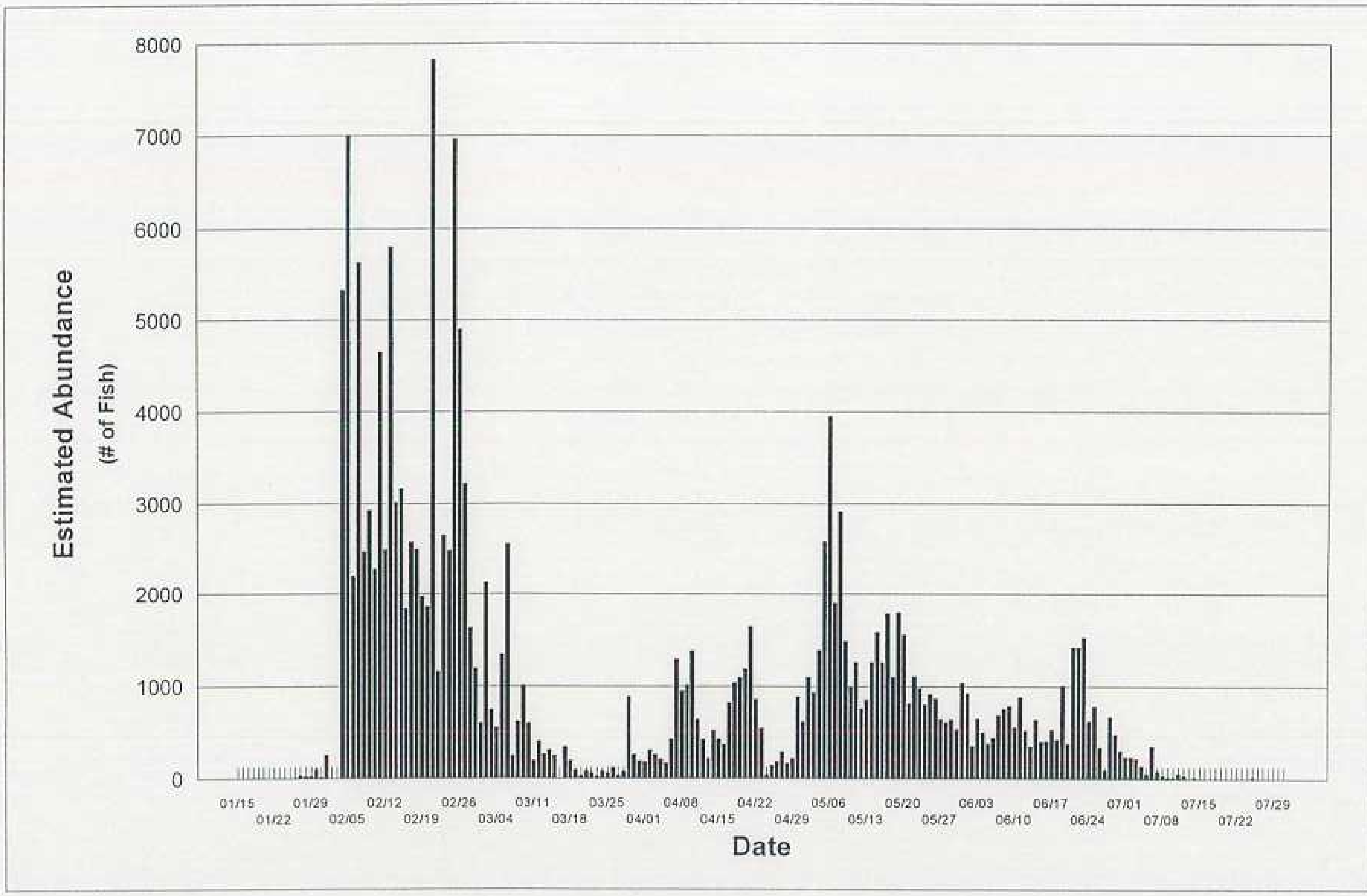


Figure 3. Estimated daily abundance of YOY fall-run chinook salmon passing Woodbridge Dam during January through July 1996.

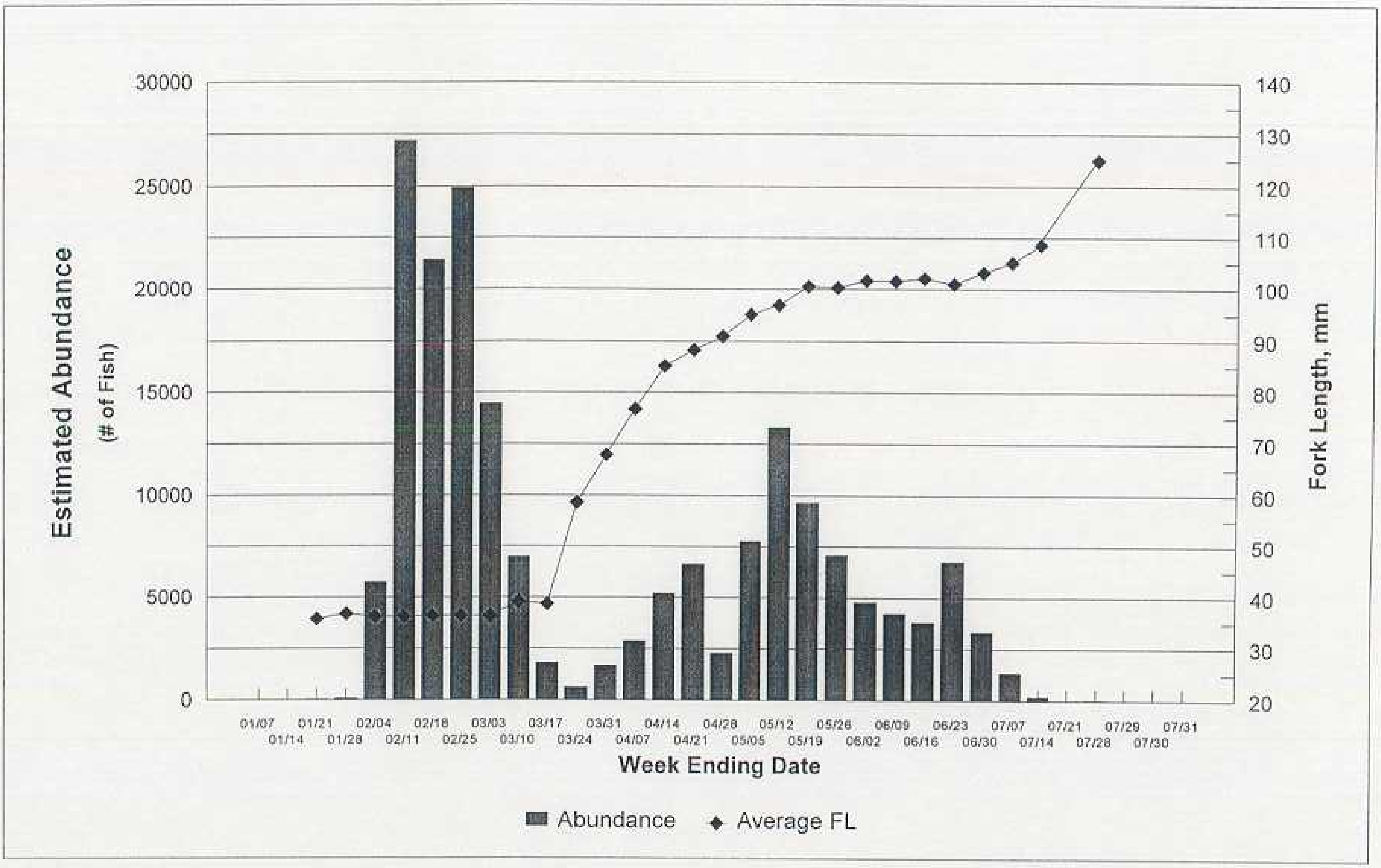


Figure 4. Estimated weekly abundance and mean size of YOY fall-run chinook salmon passing Woodbridge Dam during January through July 1996.

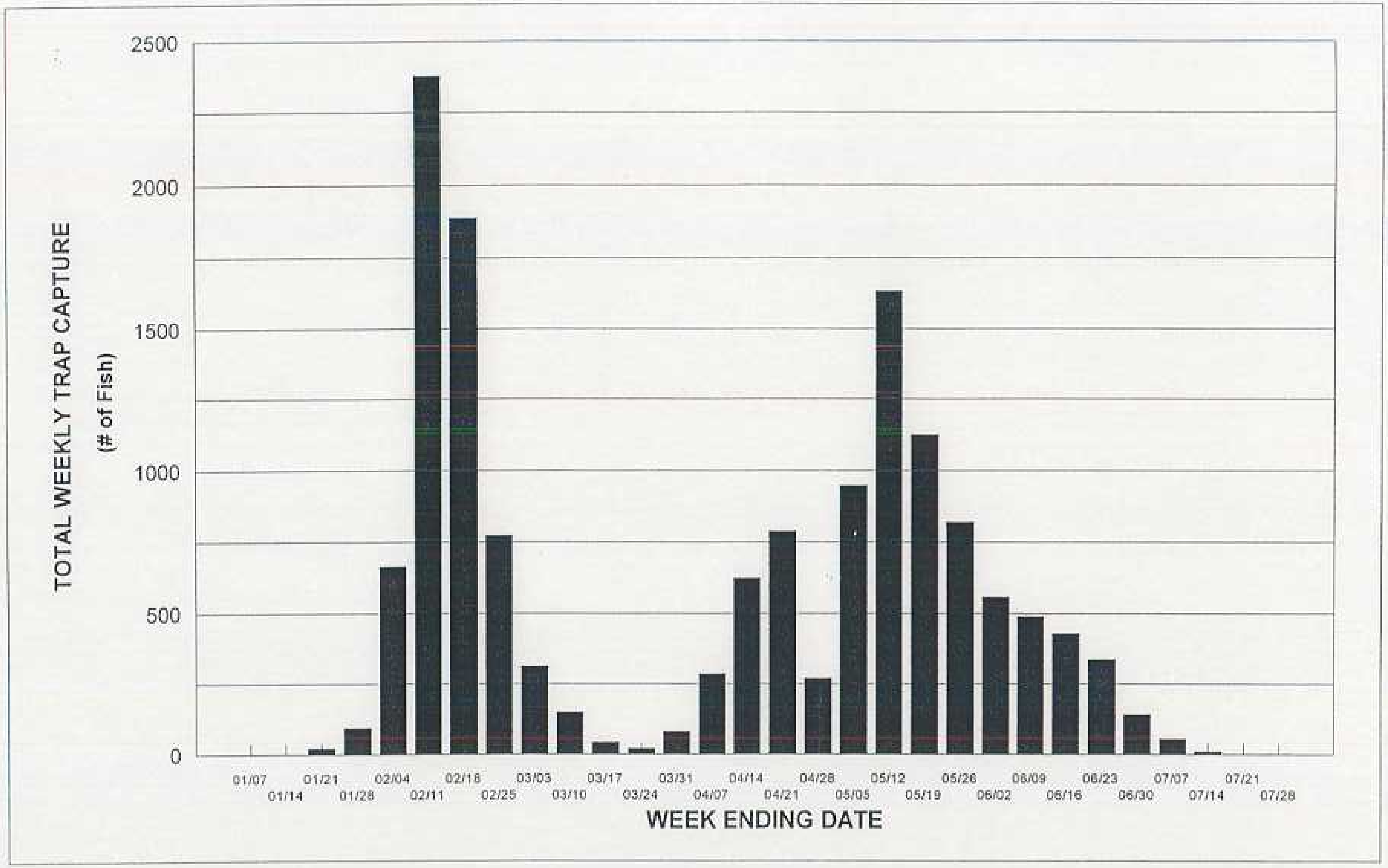


Figure 5. Weekly counts of YOY fall-run chinook salmon trapped in rotary screw fish traps at Woodbridge Dam on the Mokelumne River during January through July 1996.

3.3 Size and Condition of Downstream Migrant Salmon

Daily records of average TL, FL, weight, and condition factor, as well as the range in length and weight of YOY salmon captured at Woodbridge Dam are provided in Appendix D. Figure 6 shows the mean and range of fish lengths for YOY salmon based on sampling from January 15 to July 31, 1996. Fifty-six percent of BY95 production emigrated past Woodbridge Dam as fry and 44 percent as smolt sized salmon. As in past years (Vogel and Marine 1994, 1996, 1998), the size and number of YOY salmon increased abruptly during the first half of April, signaling the onset of the smolt emigration. Very few fry were observed after April 1. The size of smolts increased gradually for the duration of the season after the onset of this phase of the emigration.

The condition factor of emigrating fry-sized salmon ranged from about 5×10^{-4} to 7.5×10^{-4}, with the vast majority ranging from 5×10^{-4} to 6.5×10^{-4} (Figure 7). The earliest emigrating fry were predominately yolk-sac bearing fry. The majority of fry during the latter half of January through mid-March appeared to be post-absorptive (i.e., little to no yolk-sac remaining) fry. Average K of fry-sized salmon increased to between 6.5×10^{-4} and 8.5×10^{-4} during March. The abrupt occurrence of smolt sized salmon in the traps affected increases in the averages and the variation in size measurements during the latter half of March (Appendix D). The weight of smolts migrating by Woodbridge Dam generally increased throughout the smolt migration. Average condition factor varied, but generally increased through the fry and smolt emigrations (Figure 7). The pattern of change in K for the fry emigration period reflected the predominance of yolk-sac bearing fry early in the season (high K) followed by a predominance of post-absorptive fry through mid-March (lower K). The variable but slight decline in K for smolts near the beginning of their emigration [early-April] until the height of the emigration [mid-May] reflects a widely observed decrease in condition factor, or reduction of "plumpness", characteristic of smoltification in many salmomid species (Hoar 1988). During June and July, K for migrating smolts varied around 8×10^{-4}.

3.4 Effects of Physical Environmental Conditions on Downstream Migrants

3.4.1 Diel Periodicity of Fish Migration Past Woodbridge Dam

The effects of photoperiod (day length) on the physiology of salmonid smoltification and salmonid migration behavior, particularly at passage obstacles such as dams, are well documented (Banks 1969, Greenstreet 1992, Hoar 1988, Long 1959, McKeown 1984, Vogel *et al.* 1988). The diel hourly patterns of migration of smolt-sized chinook salmon passing Woodbridge Dam were documented on four occasions during May and June 1996 at the height of the smolt emigration. These results are shown in Figure 8. Chinook salmon smolts migrated nearly continuously throughout the day and night with a notable decrease in migration during the afternoon until about sunset. Migratory abundance of smolts appeared similar for the day and night hours in May with notable increased abundance during the hours surrounding sunrise and/or sunset. Migratory patterns exhibited a change during June when daytime abundance exceeded the night and the crepuscular pulse of fish was not as noticeable as during the May surveys. These patterns of diel migration abundance are similar to those reported for past years (Vogel and Marine 1994, 1996, 1998), except for the greater daytime abundance observed during in June. In general, higher night-time migratory abundance has been observed later in the season.

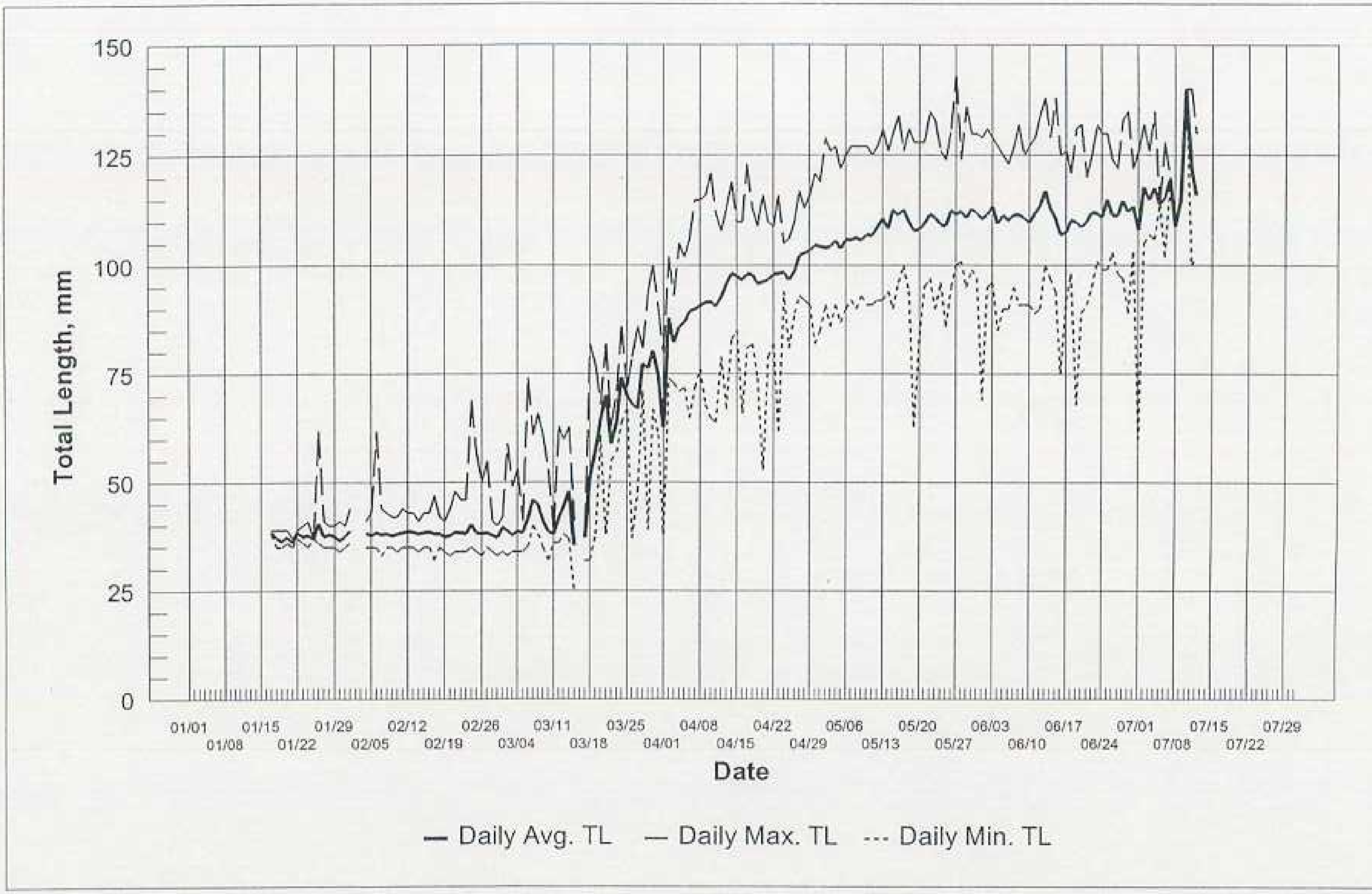


Figure 6. Daily average, maximum, and minimum total lengths of YOY fall-run chinook salmon captured in rotary screw fish traps at Woodbridge Dam on the Mokelumne River during January through July 1996.

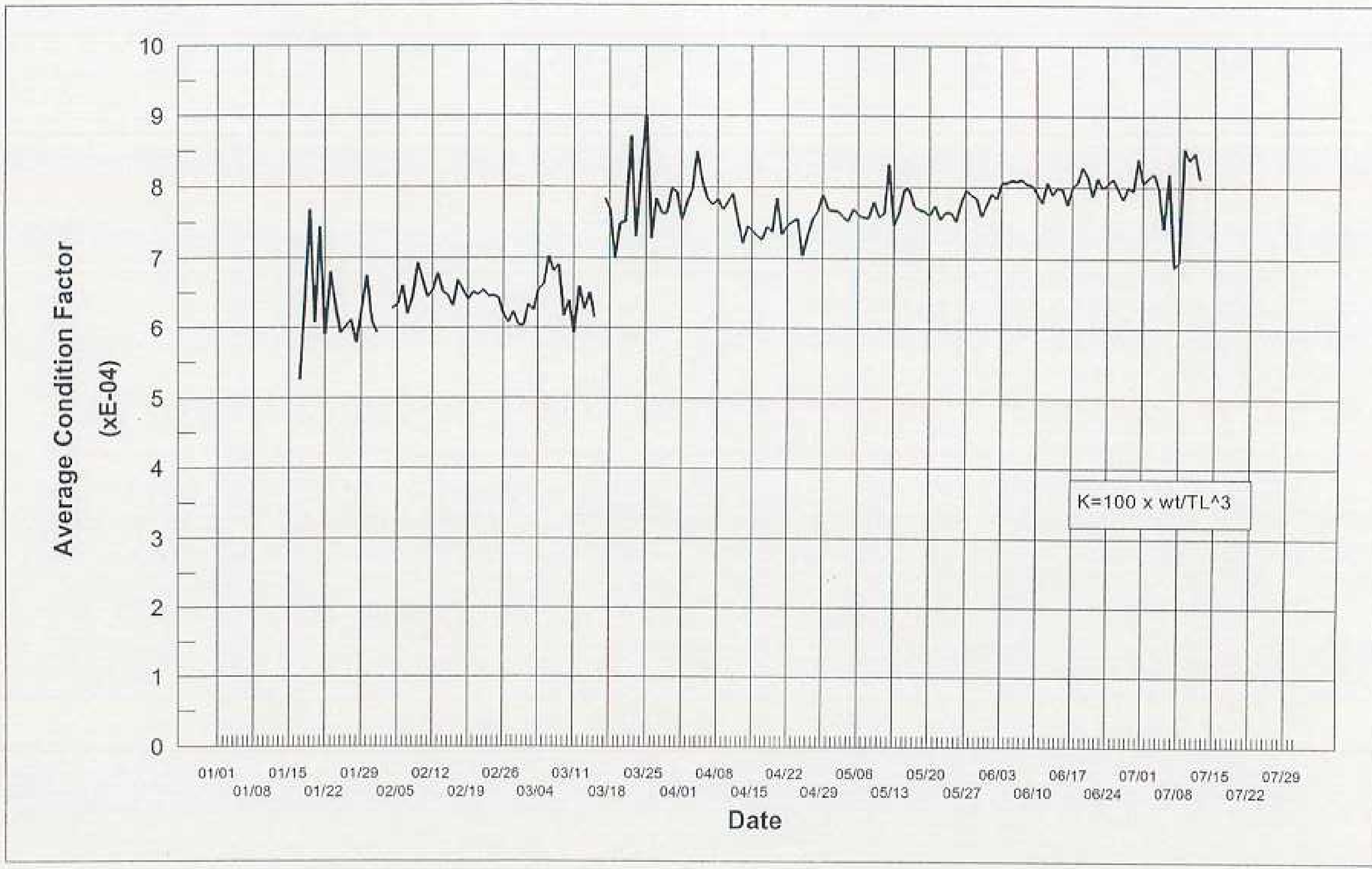


Figure 7. Daily average conditon factor (K) of YOY fall-run chinook salmon captured in rotary screw fish traps at Woodbridge Dam on the Mokelumne River during January through July 1996.

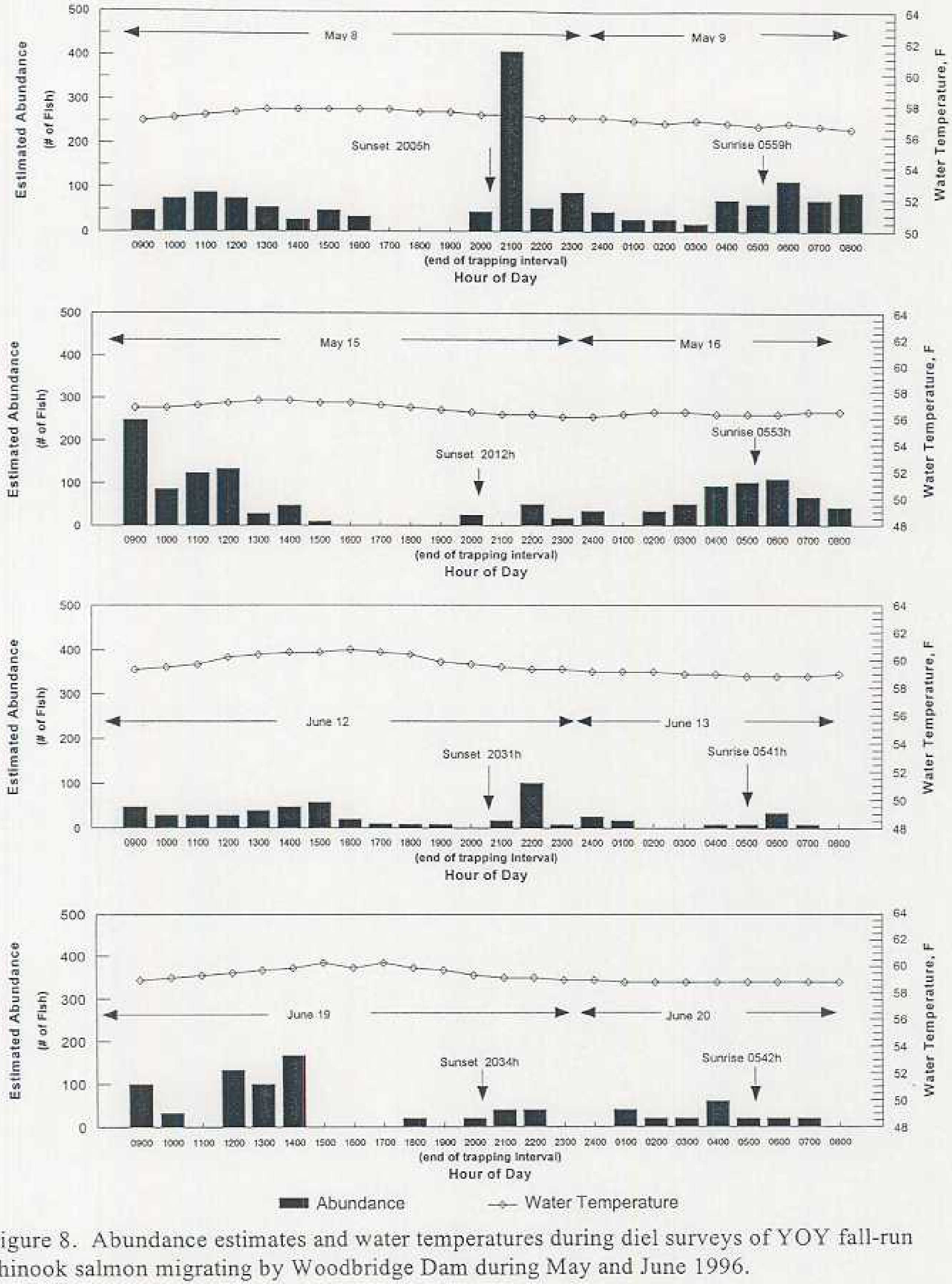


Figure 8. Abundance estimates and water temperatures during diel surveys of YOY fall-run chinook salmon migrating by Woodbridge Dam during May and June 1996.

3.4.2 Water Temperature, River Flow, Rainfall, Turbidity, and Lunar Phase

Daily average river flow, water clarity, and water temperatures for the Woodbridge Dam trap site are provided in Appendix E. Daily rainfall at Camanche Dam, rainfall and barometric pressure at Woodbridge, California, lunar phase and times of sunrise and sunset are included in the appendix tables.

Figure 9 shows the daily river flow, Woodbridge Canal diversions, periods of rainfall, and turbidity at Woodbridge Dam. Changes in river flow were primarily related to changes in releases from Camanche Dam. Increased releases through February, necessitated by heavy rainfall, watershed snowpack, and projected runoff, peaked near 2,900 cfs and began to decrease through the latter half of March to about 1,000 cfs near which flows remained through July. Rainfall caused transient, low magnitude increases in river flow generally lasting less than 2 days. The effects of rainfall at Woodbridge Dam are somewhat accentuated by accretions caused by urban drainage from the city of Lodi (Jim Burgess, EBMUD, personal communication). Turbidity fluctuated widely over the season in response to (in order of decreasing importance): periods of rainfall and subsequent runoff, changes in releases from Camanche Dam, and operations of Woodbridge Dam and Lake Lodi.

Figure 10 shows the hourly water temperatures recorded at the trapping site. Diel fluctuations in water temperatures increased through the season from less than 0.5 °F in January to between 2° and 4°F in June and July. We computed mean daily water temperatures for comparisons with the daily numbers of downstream migrating salmon.

Researchers have noted that juvenile salmon emigrations tend to occur in multiphasic peaks or pulses; these pulses may correspond to increased flow and other hydrologic events . For example, research by Kjelson *et al.* (1982) and Vogel (1989) reported increased downstream movements of fry chinook salmon corresponding to increased river flows and turbidity. We examined potential migratory responses to these environmental factors and the potential influence of water temperature, lunar phase, and precipitation. No general trends or associations of migration abundance with specific individual factors were apparent (Figures 11 and 12). However, several daily peaks in downstream migrant abundance (in particular for fry in February) were noted to correspond with storms and associated increases in turbidity. However, dramatic increase in fry abundance associated with increasing river flows during early February was coincidental with their expected time of emergence. Most changes in migrant abundance appeared to be associated with seasonal or size-related phenomena. This latter pattern is illustrated by the apparent size threshold response denoting the abrupt onset of migrating smolts after mid-March (Figure 5). This "threshold response" is supported by the observation of increasing numbers of smolt sized salmon in late March with relatively few salmon of intermediate size (40 - 50 mm FL) occurring in the traps after subsidence of the fry emigration in late February. Peak periods of smolt emigration in April and May occurred during the waning old moon and the waxing new moon in each of those months. This also occurred to a lesser degree in June.

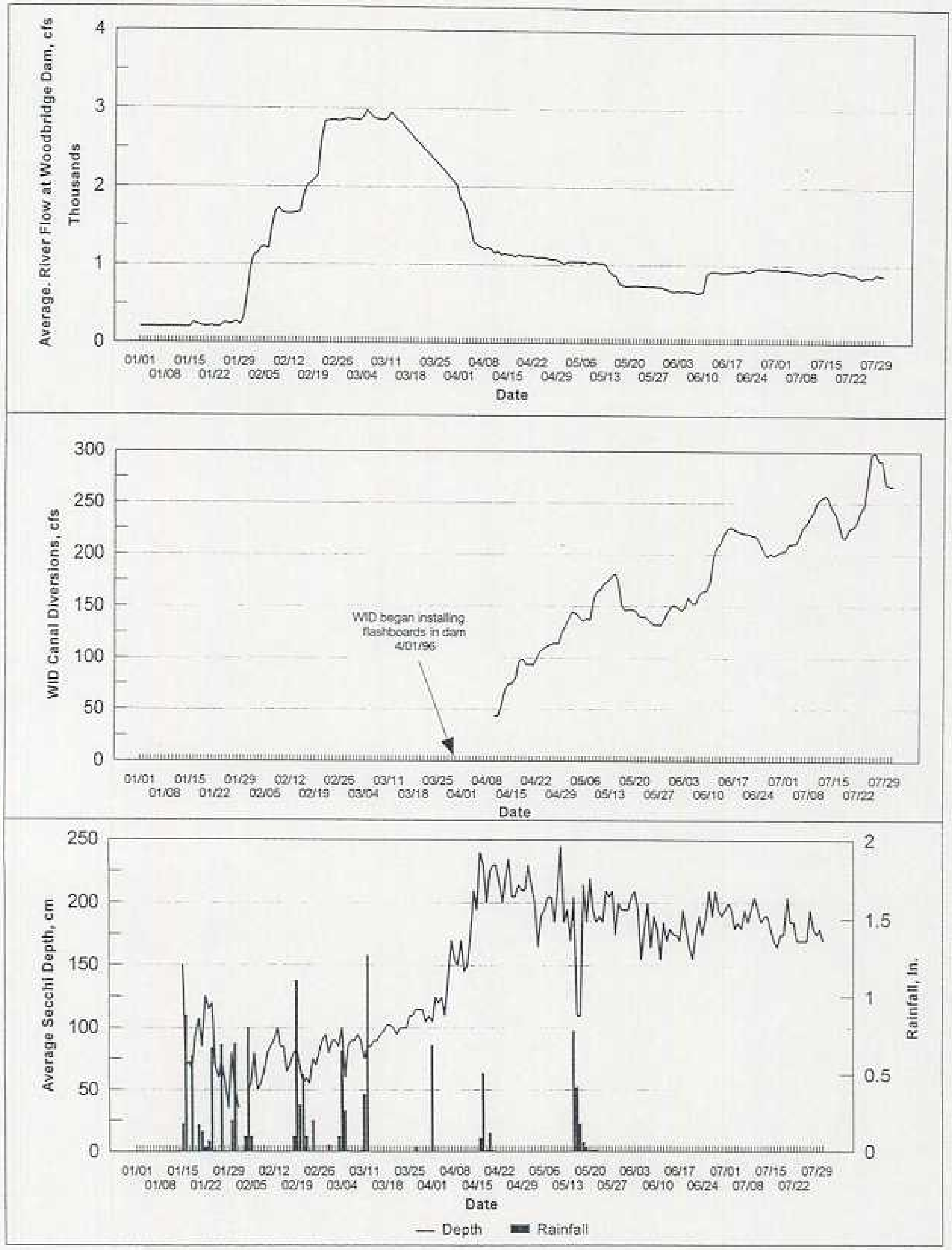


Figure 9. River flow passing Woodbridge Dam, WID canal diversions, daily average turbidity (as measured by Secchi visibility), and rainfall at Woodbridge Dam trap site during January through July 1996.

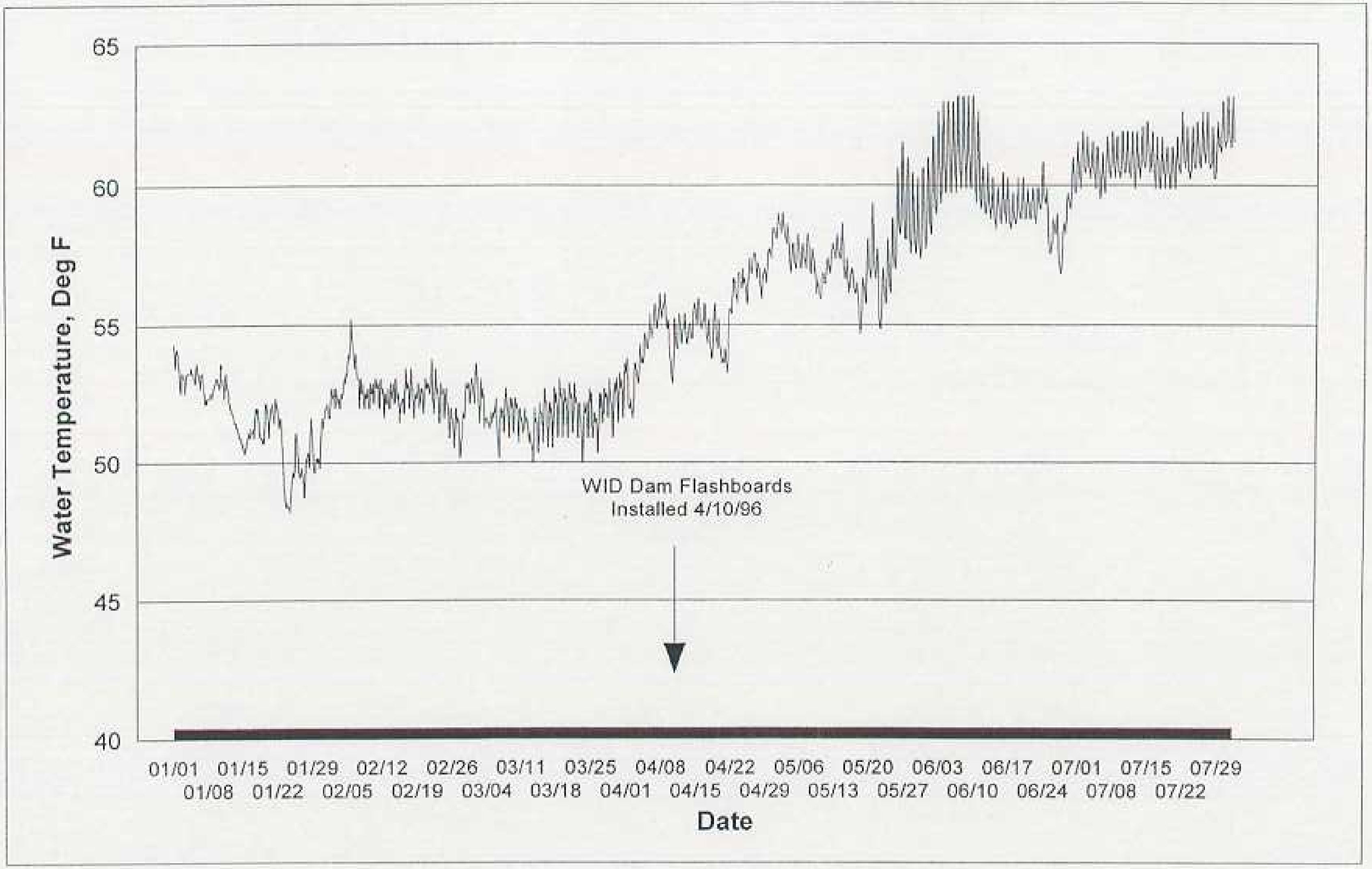


Figure 10. Hourly water temperatures recorded at Woodbridge Dam during January through July 1996.

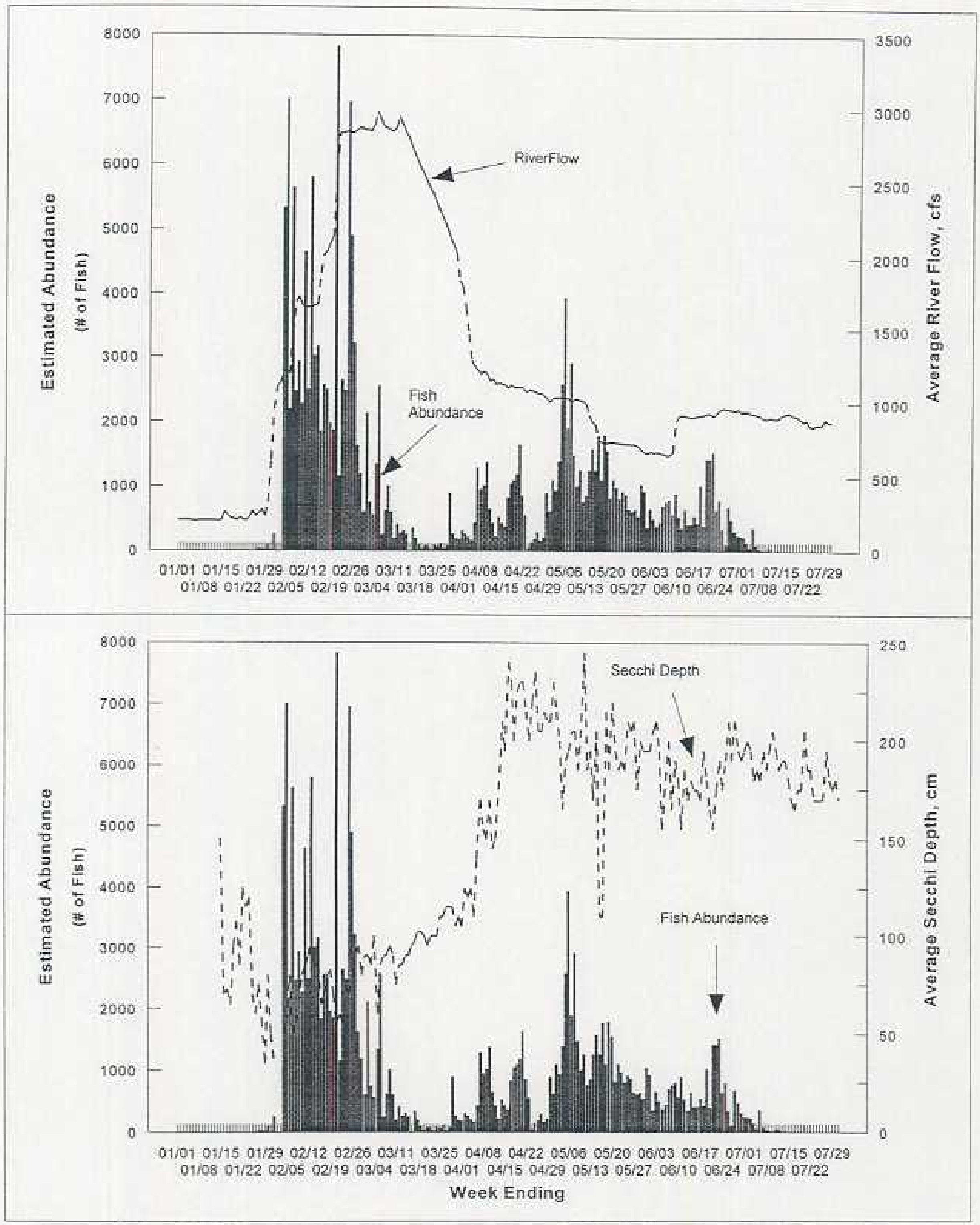


Figure 11. Estimated daily abundance of YOY fall-run chinook salmon passing Woodbridge Dam compared with average daily river flows passing Woodbridge Dam and water clarity (measured as Secchi depth) during January through July 1996.

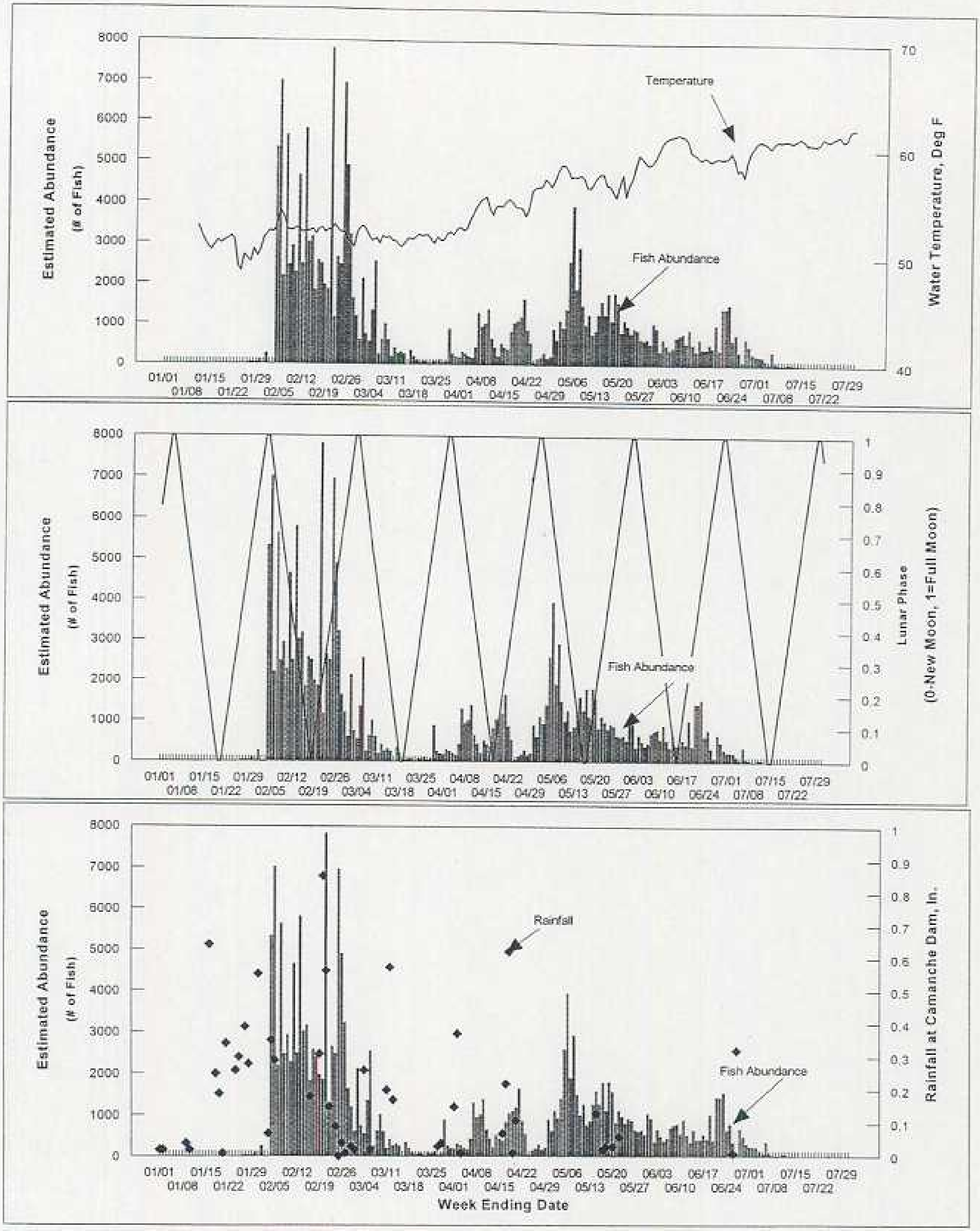


Figure 12. Estimated daily abundance of YOY fall-run chinook salmon passing Woodbridge Dam compared with daily water temperatures, lunar cycle, and daily rainfall measured during January through July 1996.

3.5 Comparison of Annual Juvenile Fall-Run Chinook Salmon Downstream Migration During 1990-1996

Monitoring of juvenile chinook salmon emigration in the Mokelumne River has been conducted since 1990. Prior to 1993, monitoring of outmigration at Woodbridge Dam relied on downstream migrant traps installed in the two fishways (due to low flow conditions). Because the monitoring methodologies were not the same, direct comparisons of some data between years are not possible. However, there are some comparisons between years that may be made.

Diel periodicity of migratory behavior in 1996 was not as dramatic as observed in earlier years of the monitoring program (Vogel and Marine 1998). Bianchi *et al.* (1992) reported for 1990 to 1992 that the greatest migration was seen during the morning twilight hours, but did not strongly correspond to changes in water temperature. Vogel and Marine (1994, 1996) observed during 1993 and 1994 that diel migration patterns varied during the season with some correlation with diel fluctuation in water temperature. The differences between years may be affected by operational conditions at the WID fish screens, where considerable debris has built up in the fish bypasses in the earlier years (Vogel 1992). Also, the 1990 to 1992 diel studies were all conducted in the month of May when daily water temperature fluctuations were not more than about 2°F and the influence of temperature may not have been important. The roles of these environmental cues in the emigration of Mokelumne River juvenile salmon are not certain at this time.

The timing of juvenile chinook salmon emigration past Woodbridge Dam during 1996 was similar to that reported for 1995 (Figure 13). These two years, with greater outmigrations of fry than smolts, differ from the emigration timing exhibited in previous years; although, comparison is only appropriate with 1993 and 1994 because of different methodolgy used in earlier years. The timing of the peak smolt emigration week varies within about ±2 weeks among years, but the migration period can be relatively protracted or contracted depending on the year. River flows during 1990, 1991, 1992, and 1994 were substantially lower during the principal migratory period than river flows in 1993, 1995, and 1996 (Bianchi *et. al.* 1992, Vogel and Marine 1994,1996, 1998). It appears that water temperatures recorded in 1991 and 1992 at Woodbridge Dam were approximately 1 to 5 °F higher than during comparable periods in later years (Bianchi *et. al.* 1992) . Water temperature data for 1990 were not available. Higher daily water temperatures during the early part of the smolt migration period may partially account for the earlier smolt-sized salmon outmigrations observed in 1991, 1992, and 1994 (data in Bianchi *et. al.* 1992, Vogel and Marine 1994, 1996).

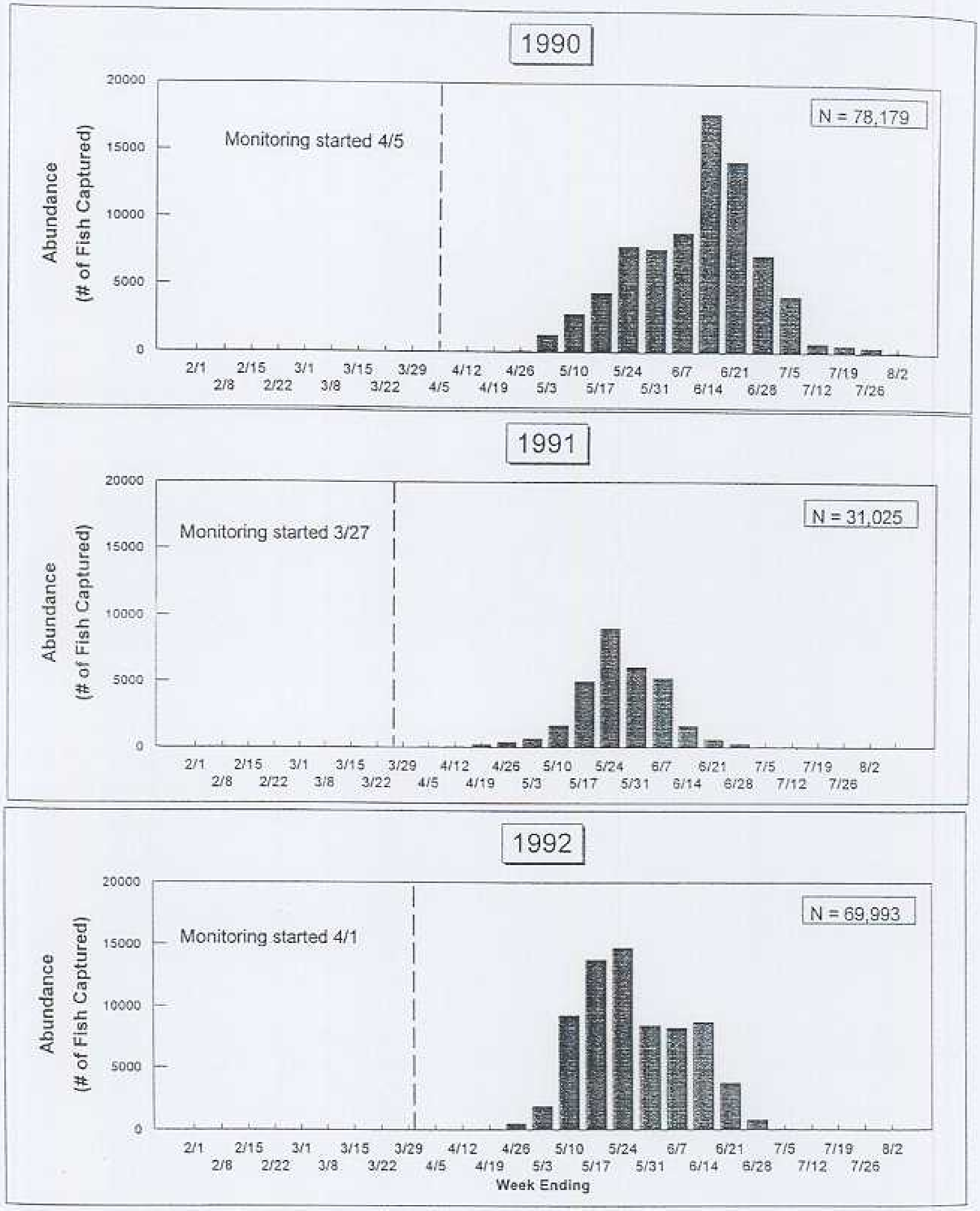
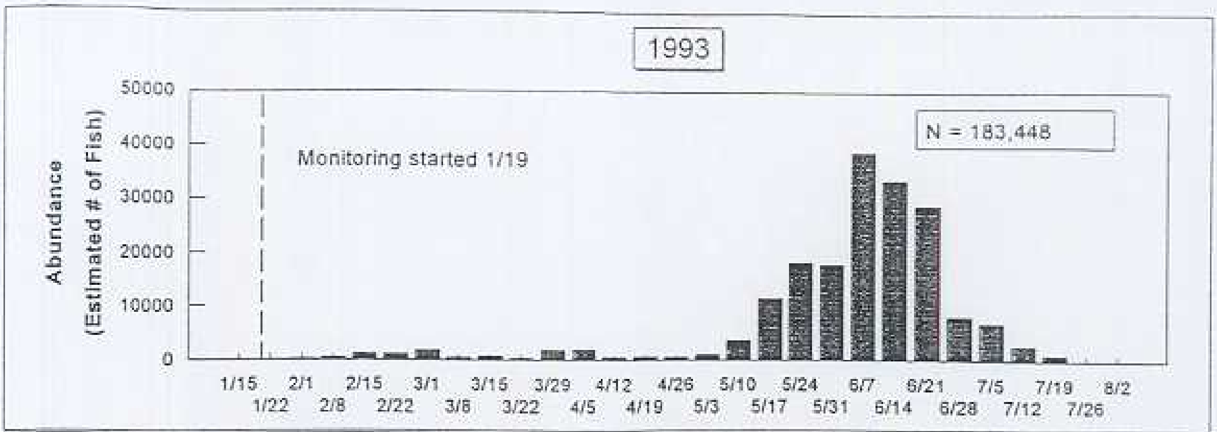
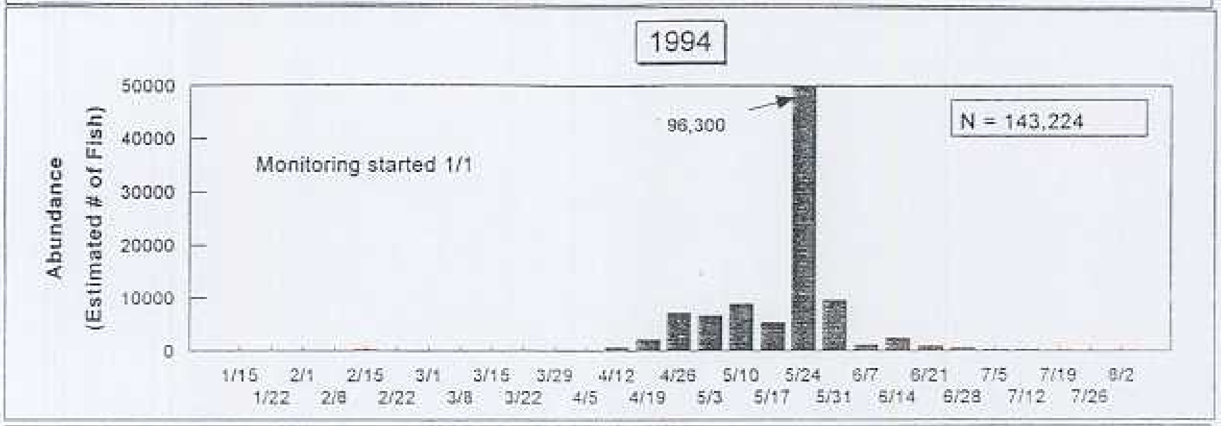
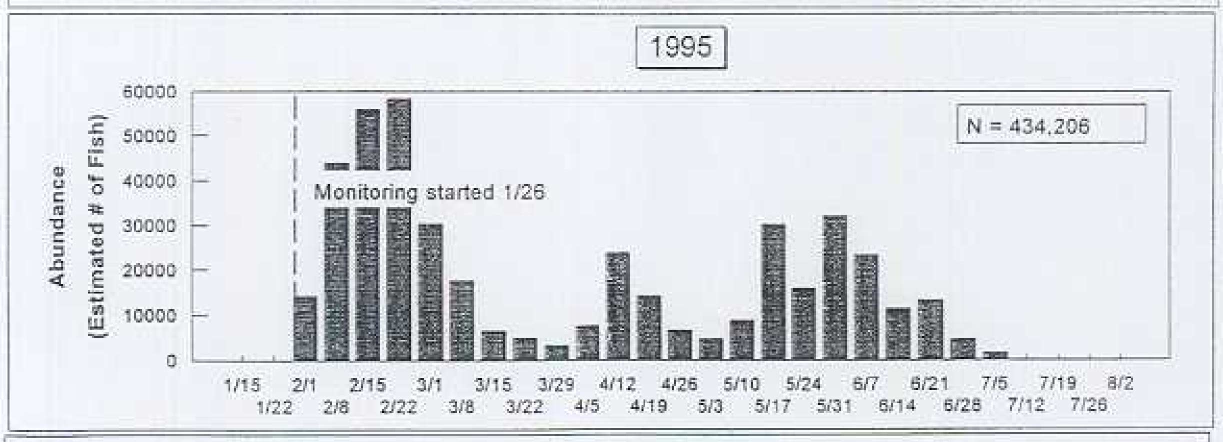
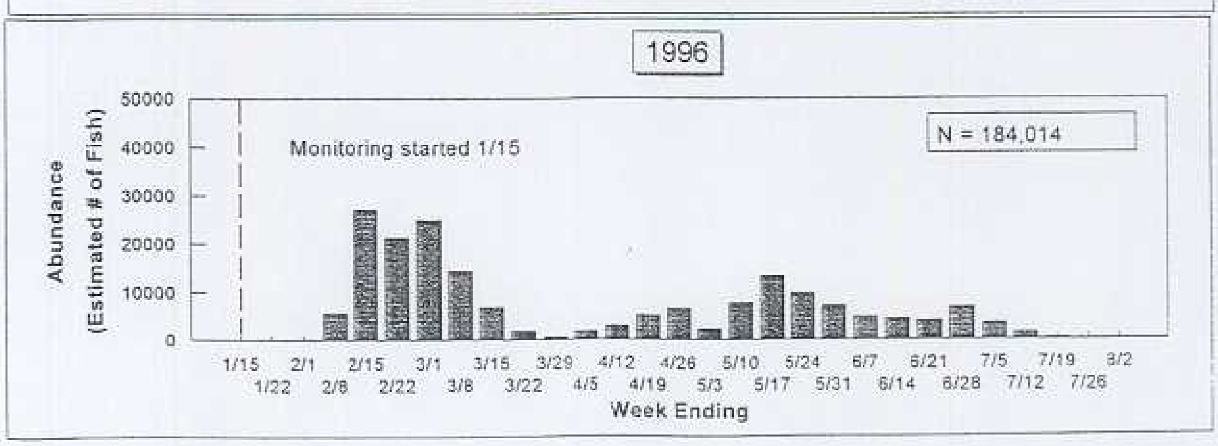


Figure 13. Weekly abundance of downstream migrant fall-run chinook salmon at Woodbridge Dam for 1990-1996. (Abundance for 1990-1992 was determined by capturing fish in fishway traps with nearly 100% of river flow passing through fishways. Abundance for 1993-1996 was estimated using calibrated rotary traps at dam.)


1993
N = 183,448
Monitoring started 1/19
Abundance
(Estimated # of Fish)


1994
N = 143,224
96,300
Monitoring started 1/1
Abundance
(Estimated # of Fish)


1995
N = 434,206
Monitoring started 1/26
Abundance
(Estimated # of Fish)


1996
N = 184,014
Monitoring started 1/15
Abundance
(Estimated # of Fish)
Week Ending

Natural production of juvenile fall-run chinook salmon emigrating from the Mokelumne River during 1996 (BY95), estimated at 184,014 (103,270 fry and 80,744 smolts), was similar to total production in 1993 and 1994, though most fish emigrated as smolts in these years. Caution should be used in making direct comparisons between and among years because of differences in sampling methods and sampling periods.

3.6 Assessment of Survival of Juvenile Chinook Salmon Migrating Through the Sacramento-San Joaquin Delta During the Spring of 1996.

3.6.1 MRFI Chinook Salmon

Table 3 provides the release and recovery data for tagged fish groups used for the 1996 assessment of Delta survival of salmon smolts emigrating from the Mokelumne River. Table 4 gives specific release data for all of the tag groups marked and released as part of Mokelumne River fishery assessments in 1996.

Table 3. Release and recovery information for four groups of Mokelumne River Fish Installation CWT juvenile fall-run chinook salmon captured at the Chipps Island USFWS trawling station, Spring 1996.

Tag Code	Release Date	Number of Fish Tagged	Date of First Catch	Date of Last Catch	Number of Fish Recovered	Days at Large	Minutes Sampled	Fraction of Time Sampled	Estimated Survival
06-02-16	05/15/96 Thornton	49,946	05/20/96	06/03/96	14	14	2,560	0.1185	0.31
06-02-17	05/15/96 Thornton	52,123	05/20/96	05/25/96	11	5	1,200	0.1389	0.20
06-02-18	05/20/96 Jersey Pt.	50,832	05/22/96	05/28/96	87	6	1,400	0.1389	1.60
06-02-19	05/20/96 Jersey Pt.	52,389	05/21/96	05/30/96	108	9	2,000	0.1389	1.93

The USFWS formula for calculating estimated fish survival based on recoveries of tagged fish in trawling samples collected by the USFWS near Chipps Island is:

Estimated Survival = R / [(M) (30 feet / 3900 feet) (Proportion of Time Sampled)]

where R = number of tagged fish recovered and M = number of fish tagged (Mark Pierce, USFWS, Stockton, personal communication). A calculated value of 1 would represent 100-percent survival.

Table 4. Spring 1996 CWT mark and release data for Mokelumne River fall-run chinook salmon.

Code ID	Egg Lot No.	Brood Year	Release Location	Date Released		Rearing Type	Purpose	Total No. Tagged	Estimated Tag Loss and Mortality Before Release, %	No. Tagged Fish Released[1]	Quality Control Days	No./lb at Release	Avg. Length in FL, mm	Rearing Location	Stock of Release Group
				First	Last										
6--02-16 *	Mixed	1995	New Hope Ldg. Mokelumne R.	5/15/96	5/15/96	Hatchery	Delta Mortality	53,421	6.5	49,946	15	54	90	MRFI	Feather R.
6-02-17 *	Mixed	1995	New Hope Ldg. Mokelumne R.	5/15/96	5/15/96	Hatchery	Delta Mortality	53,455	2.5	52,123	12	53	91	MRFI	Feather R.
6-02-18 *	Mixed	1995	Jersey Pt.- San Joaquin R.	5/20/96	5/20/96	Hatchery	Delta Mortality	52,792	3.7	50,832	13	43	97	MRFI	Feather R.
6-02-19 *	Mixed	1995	Jersey Pt.- San Joaquin R.	5/20/96	5/20/96	Hatchery	Delta Mortality	53,056	1.3	52,389	11	57	90	MRFI	Feather R.
6-1-13-1-07	Wild	1995	Woodbridge Dam	4/10/96	5/17/96	Wild	Survival& Fishery	4,098	6.0[3]	3,852	7	75-40[2]	83-103[2]	Mokelumne River	Mokelumne R.
6-1-13-1-08	Wild	1995	Woodbridge Dam	5/18/96	7/25/96	Wild	Survival& Fishery	2,953	8.8[3]	2,693	7	47-18[2]	98-132[2]	Mokelumne River	Mokelumne R.
6-02-20**	Mixed	1995	New Hope Ldg.	6/04/96	6/25/96	Hatchery	Mitigation	52,823	0.8	52,382	12	34	107	MRFI	Mokelumne R.
6-02-21**	Mixed	1995	New Hope Ldg.	6/04/96	6/25/96	Hatchery	Mitigation	53,556	2.5	52,205	11	39	102	MRFI	Mokelumne R.
6-02-28**	Mixed	1995	San Pablo Bay & Thornton[4]	6/06/96	6/13/96	Hatchery	Enhance	52,643	0.06	52,608	14	44	98	MRFI	Feather R.
6-02-29**	Mixed	1995	San Pablo Bay & Thornton[4]	6/06/96	6/13/96	Hatchery	Enhance	53,192	0.9	52,704	11	37	104	MRFI	Feather R.
6-48-05**	Mixed	1995	Woodbridge Dam	10/03/96	10/16/96	Hatchery	Yearling	53,426	20.5	42,466	103	8	161	MRFI	Mokelumne R.
6-48-06**	Mixed	1995	Woodbridge Dam	10/13/96	10/16/96	Hatchery	Yearling	53,791	20.4	42,807	103	8	161	MRFI	Mokelumne R.

* Paired groups were mixed, trucked, and released together, after individual tag retention and size checks.

** Paired groups reared together for 1 or more weeks prior to trucking and release. Tag retention checked prior to mixing.

1 Adjusted for estimated shed tags and prerelease mortality.

2 Range in average size for entire time interval over which tag code was used.

3 Based on five 7-day post-tagging holding periods.

4 Partial release of this paired group made at Thornton on Mokelumne River on 6/13/96.

Assessment of Mokelumne River smolt survival in the Delta utilized a "*test*" release made at New Hope Landing near the bifurcation of the Mokelumne River into north and south forks and a "*control*" release made downstream of the confluence of the Mokelumne River with the lower San Joaquin River near Jersey Point (Figure 1). Differential survival of *test* and *control* release groups was examined in this experiment. The *control* group was released 5 days after the *test* group, based on prior experience of the USFWS tagged fish releases, to correspond with passage of the test group by the *control* release site. This experimental factor insured consistent exposure of the two experimental groups to similar environmental and trawl sampling conditions during the time and at the area of recapture. Recovery of the tagged fish from the *test* group was low but comparable to past years' results for fish released at New Hope Landing. As expected, considerably more tagged fish from the *control* group were recaptured in the Chipp's Island trawl (Table 3). Estimates of *relative survival* between the *test* and *control* groups based on USFWS's survival index (Table 3), ranged from 0.104 to 0.194 with an average of 0.146 (95%C.I.=0.083 - 0.209). Delta hydrologic conditions varied during the periods following the release of fish. The daily average Delta outflow ranged from about 22,000 cfs (May 15) during the early part of the experimental period, to a peak of 89,820 cfs (May 20) at the time the control release was made, then gradually subsided to 28,490 cfs (June 3) when the last experimental fish were recovered by the trawl (Appendix F).

3.6.2 Wild Chinook Salmon Smolts Coded-Wire Tagged at Woodbridge Dam

Appendix A provides a daily record of the numbers of wild fall-run chinook salmon smolts captured and coded-wire tagged at Woodbridge Dam. Additional relevant data are provided in Table 4. Fish were tagged from April 10 until July 25, 1996. Two tag codes (0.5mm microtags) were used during the season (Table 4). One code was applied during approximately the first half of the smolt emigration period and the other during the latter half.

A 7.8% latent mortality (14 died out of 180) was observed during seven 5 to 7 day post-tagging observation periods performed from May 6 to July 6, 1996. Tag retention efficiency was 100% in six of the seven observation periods, with the exception being 78% for fish held and observed during the week of May 28, 1996. Tagging reports were submitted to the CDFG in August 1996.

None of these tagged wild chinook salmon were captured by the USFWS at their trawling station near Chipps Island.

3.7 Physiological Assessment of Smolt Development of Fall-Run Chinook Salmon

The temporal development of gill Na^+/K^+-activated ATPase activity has been used to characterize one of the many physiological metamorphoses that salmon undergo preparatory to their transition from early life in freshwater to their ocean life stage (Hoar 1988). The underlying physiological processes reflected by changes in gill Na^+/K^+-activated ATPase have also been demonstrated to be affected by environmental factors such as photoperiod, water chemistry, and water temperature, as well as, biological factors such as disease, social interactions, and nutrition (Lorz and McPherson 1977, Ewing *et al.* 1979, Wedemeyer *et al.* 1980, Zaugg 1982, Schreck *et al.* 1985, Rodgers *et al.* 1987).

Smolt development was monitored in downstream migrant chinook salmon collected in the rotary screw traps at Woodbridge Dam and in samples of fish collected upstream from Woodbridge Dam. Data for these measurements are provided in Appendix G and Figure 14 provides a summary of these results.

Size of fish sampled at both locations increased throughout the season. Fish migrating past Woodbridge Dam were significantly larger in length and weight ($p<0.001$, ANOVA) than fish collected upstream, except during the first two and last sampling periods. Condition factor of fish captured upstream was generally greater than that of fish migrating past Woodbridge Dam, but was statistically significant ($p<0.05$, Student's t-test) only on two dates (Figure 14). These general differences in size and condition factor between fish captured upstream and those passing Woodbridge Dam have been observed during each of the previous years of monitoring (Vogel and Marine 1994, 1996, 1998). The larger size of fish passing Woodbridge Dam, especially during the peak emigration in April through June, may reflect that fingerling-sized chinook smolts (50 mm$<$FL$<$100 mm) likely need to reach a size threshold, or critical size range, to begin downstream migration. Changes in condition factor were different between sites and likely reflect morphological changes (fish become less plump) associated with smoltification as reported for several species of salmonids (Woo *et al.* 1978, McKeown 1984, Hoar 1988). The significantly lower condition factor of fish passing Woodbridge Dam in early March may reflect the fact that most fry captured at Woodbridge Dam are recent "button-up" fry, with fully absorbed yolk-sacs; while, fry captured on the rearing grounds during this time are predominately "sac-fry", with yolk-sacs, or obviously feeding fry.

Statistical differences in gill Na^+/K^+-activated ATPase activity were detected among sites ($p=0.04$, MANOVA) and over time ($p<<0.001$, MANOVA). Paired comparisons for each date revealed that significant differences occured only the week of April 18 ($p=0.0002$, Bonferroni's paired inequalities), although levels were generally greater for fish migrating past Woodbridge Dam and only one fish was collected from the upstream rearing sites on each of the last two dates (Figure 14). A moderate peak in gill Na^+/K^+ ATPase activity occured in fish migrating past Woodbridge Dam during the week of April 18 (Figure 14). This peak in enzyme activity was followed by some cyclic activity for the duration of the season. Similar cycling in enzyme activity was reported for 1995, but was not observed during 1994 (Vogel and Marine 1996, 1998).

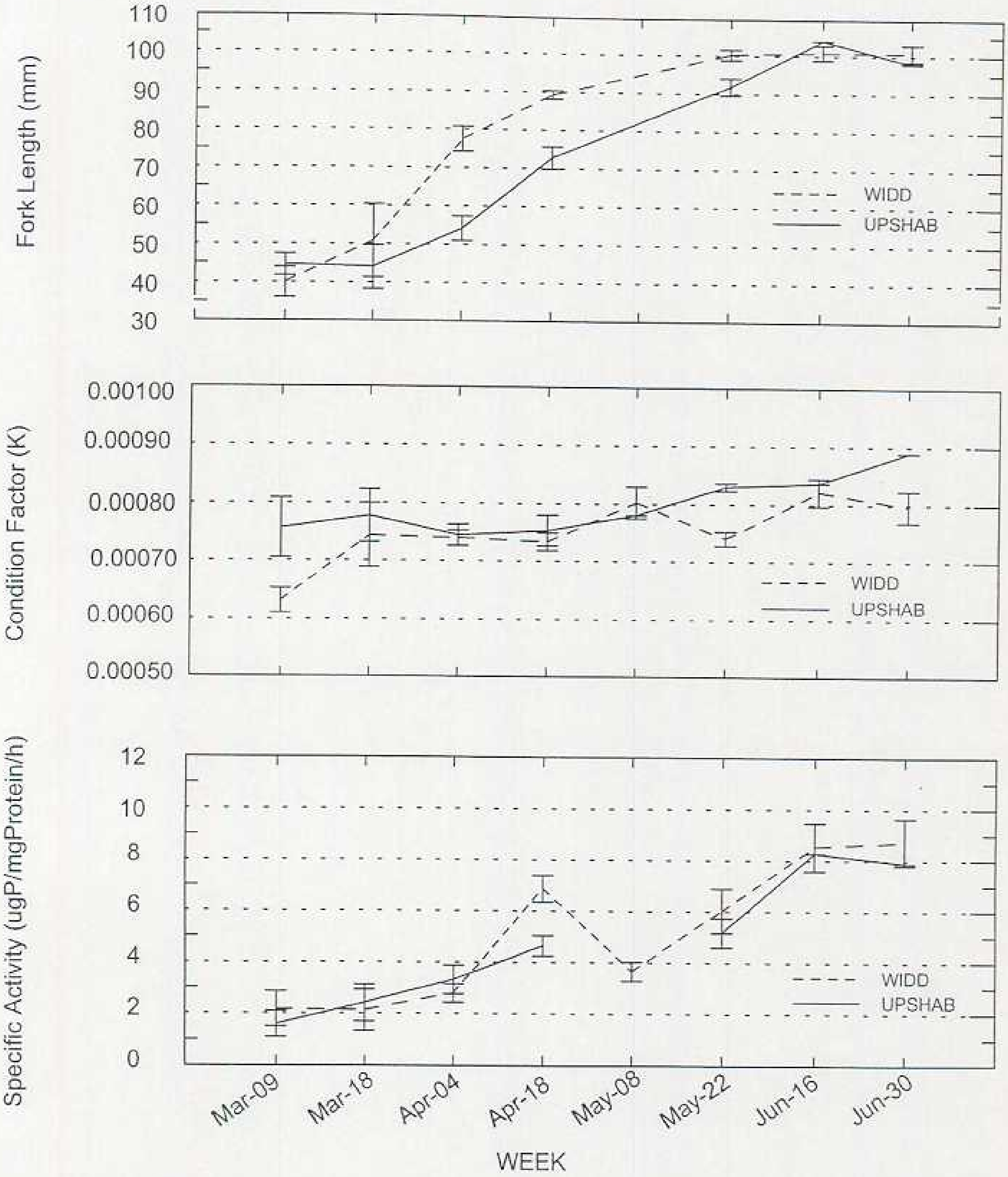


Figure 14. Temporal profiles of length, condition factor, and gill sodium-potassium activated ATPase activity from samples of young-of year fall-run chinook salmon collected upstream of (UPSHAB), and at Woodbridge Dam (WIDD) on the Mokelumne River during March through June 1996. Values are the means of 6 to 18 fish and bars indicate ± 1 standard error of the mean. However, values are for a single fish from the upstream habitat the weeks of May 8, June 16, and June 30.

Fry passing Woodbridge Dam early in the season (prior to mid-March) exhibit little difference in size or gill Na^+/K^+ ATPase activity compared to fry captured upstream. Gill Na^+/K^+ ATPase activities, along with other indices of smolt development such as condition factor, of fingerling-sized chinook salmon passing Woodbridge Dam may indicate that these fish are undergoing active smoltification preparatory to their transition to life in seawater.

Additional data collected under several differing hydrologic year types with different water temperature regimes will be required to fully evaluate this approach for its application as a management tool.

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ACRONYMS

Acronym/Abreviation	Definition
CDFG	California Department of Fish and Game
cfs	cubic feet per second
cm	centimeter
CVP	Central Valley Project
CWT	coded-wire tagged
DO	dissolved oxygen
EBMUD	East Bay Municipal Utility District
FL	fork length
K	average condition factor
L	Liter
m	meters
ml	milliliter
mm	millimeter
MRFI	Mokelumne River Fish Installation
Na^+/K^+ATPase	sodium-potassium activated adenosine triphosphatase
NRS	Natural Resource Scientists, Inc.
PVC	polyvinyl chloride
QCD	quality control device
RM	river mile
SD	standard deviation
SWP	State Water Project
TBS	to be supplied
TL	total length
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VCR	video camera recorder
WID	Woodbridge Irrigation District
WIDD	Woodbridge Irrigation District Dam
WQ	water quality
YOY	young-of-year

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APPENDICES

Appendix A. Daily trapping abundance of fall-run chinook salmon YOY: January -- July 1996.

	Nocturnal				Diurnal				Daily Totals				Trap Operations Data		
Date	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
01/01/96															
01/02/96															
01/03/96															
01/04/96															
01/05/96															
01/06/96															
01/07/96															
01/08/96															
01/09/96															
01/10/96															
01/11/96															
01/12/96															
01/13/96															
01/14/96															
01/15/96	0	0	0	0	0	0	0	0	0	0	0	0	1		07:40
01/16/96	0	0	0	0	0	0	0	0	0	0	0	0	1	16:20	07:40
01/17/96	2	0	0	0	0	0	0	0	2	0	0	0	1	16:50	07:30
01/18/96	5	0	0	0	0	0	0	0	5	0	0	0	1	16:00	07:45
01/19/96	7	0	0	0	0	0	0	0	7	0	0	0	1	16:15	08:00
01/20/96	6	0	0	0	0	0	0	0	6	0	0	0	1	16:15	07:45
01/21/96	2	0	0	0	0	0	0	0	2	0	0	0	1	16:00	07:40
01/22/96	2	0	0	0	1	0	0	0	3	0	0	0	1	16:20	08:00
01/23/96	7	0	0	0	0	0	0	0	7	0	0	0	1	16:00	06:00
01/24/96	7	0	0	0	0	0	0	0	7	0	0	0	1	18:00	08:00
01/25/96	1	0	0	0	0	0	0	0	1	0	0	0	1	16:00	06:00
01/26/96	8	0	1	0	1	0	0	0	9	0	1	0	1	18:30	05:30
01/27/96	27	1	0	0	13	0	0	0	40	1	0	0	1	18:30	07:30
01/28/96	26	1	0	0	1	0	0	0	27	1	0	0	1	18:00	06:00
01/29/96	23	0	0	0	6	0	0	0	29	0	0	0	1	16:00	08:00
01/30/96	97	4	0	0	6	0	0	0	103	4	0	0	1	18:10	07:20
01/31/96	17	3	0	0	0	0	0	0	17	3	0	0	2	16:15	06:30
02/01/96	16	0	0	0	11	1	0	0	27	1	0	0	2	17:45	06:00
02/02/96	Winches stolen - no data available														
02/03/96	Winches stolen - no data available														
02/04/96	413	183	0	0	76	8	0	0	489	191	0	0	2	22:00	05:30
02/05/96	589	18	0	0	13	2	0	0	602	20	0	0	2	16:00	07:45
02/06/96	180	52	0	0	13	3	0	0	193	55	0	0	2	16:15	07:30
02/07/96	470	105	1	0	17	2	0	0	487	107	1	0	2	19:00	05:30
02/08/96	189	32	0	0	40	3	1	0	229	35	1	0	2	16:30	07:30

Appendix A. Daily trapping abundance of fall-run chinook salmon YOY: January -- July 1996.

	Nocturnal				Diurnal				Daily Totals				Trap Operations Data		
Date	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
02/09/96	239	56	0	0	19	2	0	0	258	58	0	0	2	17:30	06:15
02/10/96	184	24	0	0	19	4	0	0	203	28	0	0	2	16:15	07:45
02/11/96	384	45	0	0	21	1	0	0	405	46	0	0	2	16:02	08:02
02/12/96	208	17	1	0	8	4	0	0	216	21	1	0	2	16:25	07:27
02/13/96	490	17	1	0	6	0	0	0	496	17	1	0	2	16:32	07:00
02/14/96	250	14	0	0	13	0	0	0	263	14	0	0	2	17:15	07:30
02/15/96	248	12	0	0	40	0	0	0	288	12	0	0	2	16:15	07:45
02/16/96	137	32	0	0	37	7	0	0	174	39	0	0	2	16:30	07:30
02/17/96	204	22	0	0	28	15	0	0	232	37	0	0	2	16:00	08:00
02/18/96	206	12	2	0	12	1	0	0	218	13	2	0	2	16:00	07:45
02/19/96	165	8	0	0	5	1	0	0	170	9	0	0	2	16:15	07:50
02/20/96	155	8	2	0	7	1	0	0	162	9	2	0	2	16:10	08:00
02/21/96	156	2	2	0	4	0	0	0	160	2	2	0	2	16:15	07:30
02/22/96	23	0	0	0	3	1	0	0	26	1	0	0	2	16:15	07:30
02/23/96	52	0	0	0	8	0	0	0	60	0	0	0	2	16:45	07:30
02/24/96	49	2	1	0	6	0	0	0	55	2	1	0	2	16:45	07:30
02/25/96	139	3	1	0	2	0	0	0	141	3	1	0	2	16:30	07:30
02/26/96	97	1	0	0	9	0	0	0	106	1	0	0	2	16:15	07:45
02/27/96	64	0	0	0	4	0	0	0	68	0	0	0	2	16:15	07:45
02/28/96	32	1	0	0	6	0	0	0	38	1	0	0	2	16:15	07:45
02/29/96	24	0	0	0	0	0	0	0	24	0	0	0	2	16:00	07:40
03/01/96	12	2	0	0	2	0	0	0	14	2	0	0	2	16:20	08:00
03/02/96	42	0	0	0	5	0	0	0	47	0	0	0	2	16:00	07:30
03/03/96	15	0	0	0	0	0	0	0	15	0	0	0	2	16:10	08:00
03/04/96	11	0	0	0	2	0	0	0	13	0	0	0	2	16:15	07:47
03/05/96	27	0	0	0	0	0	0	0	27	0	0	0	2	16:25	07:45
03/06/96	51	0	0	0	1	0	0	0	52	0	0	0	2	16:22	08:00
03/07/96	5	1	0	0	1	0	0	0	6	1	0	0	2	16:00	07:45
03/08/96	12	0	1	0	4	1	0	0	16	1	1	0	2	16:15	07:37
03/09/96	20	2	0	0	2	0	0	0	22	2	0	0	2	16:22	07:45
03/10/96	12	1	0	0	1	0	1	0	13	1	1	0	2	16:15	07:45
03/11/96	4	0	0	0	0	0	0	0	4	0	0	0	2	16:45	07:15
03/12/96	8	0	0	0	1	0	0	0	9	0	0	0	2	16:00	08:00
03/13/96	5	0	0	0	4	2	0	0	9	2	0	0	2	16:00	08:00
03/14/96	6	0	0	0	2	0	0	0	8	0	0	0	2	16:00	07:27
03/15/96	5	0	0	0	1	0	0	0	6	0	0	0	2	16:47	07:30
03/16/96	0	0	0	0	0	0	0	0	0	0	0	0	2	16:15	07:45
03/17/96	7	2	0	0	0	0	0	0	7	2	0	0	2	16:15	08:00
03/18/96	4	0	0	0	0	0	0	0	4	0	0	0	2	16:07	07:52

Appendix A. Daily trapping abundance of fall-run chinook salmon YOY: January -- July 1996.

	Nocturnal				Diurnal				Daily Totals				Trap Operations Data		
Date	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
03/19/96	2	0	0	0	0	0	0	0	2	0	0	0	2	16:15	07:45
03/20/96	2	0	0	0	0	0	0	0	2	0	0	0	2	16:15	07:45
03/21/96	4	0	0	0	0	0	0	0	4	0	0	0	2	16:15	07:30
03/22/96	3	1	0	0	0	0	0	0	3	1	0	0	2	16:15	08:00
03/23/96	1	0	0	0	1	0	0	0	2	0	0	0	2	16:15	07:15
03/24/96	4	0	0	0	0	0	0	0	4	0	0	0	2	16:20	07:50
03/25/96	3	0	0	0	0	0	0	0	3	0	0	0	2	16:10	07:40
03/26/96	5	0	0	0	1	0	0	0	6	0	0	0	2	16:20	07:40
03/27/96	2	0	0	0	0	0	0	0	2	0	0	0	2	16:45	07:25
03/28/96	2	0	0	0	4	0	0	0	6	0	0	0	2	16:35	07:45
03/29/96	38	0	0	0	5	0	0	0	43	0	0	0	2	16:00	07:45
03/30/96	12	0	3	0	0	0	0	0	12	0	3	0	2	16:30	09:35
03/31/96	8	0	1	0	2	0	0	0	10	0	1	0	2	14:10	09:30
04/01/96	8	0	0	0	1	0	0	0	9	0	0	0	2	14:45	07:45
04/02/96	13	0	0	0	2	0	0	0	15	0	0	0	1	16:30	07:30
04/03/96	12	5	0	0	0	0	0	0	12	5	0	0	1	16:15	07:45
04/04/96	23	0	1	0	2	0	0	0	25	0	1	0	2	16:15	07:45
04/05/96	20	0	0	0	0	0	0	0	20	0	0	0	1	16:15	
04/06/96	35	0	0	0	19	0	1	0	54	0	1	0	2	15:30	07:30
04/07/96	142	99	0	0	9	0	0	0	151	99	0	0	2	17:00	07:00
04/08/96	87	25	0	0	30	5	0	0	117	30	0	0	2	16:15	08:00
04/09/96	99	2	0	0	24	0	1	0	123	2	1	0	2	16:00	08:15
04/10/96	134	2	0	0	33	0	1	33	167	2	1	33	2	16:00	07:30
04/11/96	60	0	1	60	19	0	1	19	79	0	2	79	2	17:15	06:45
04/12/96	47	2	0	45	3	1	0	1	50	3	0	46	2	16:00	08:20
04/13/96	25	0	0	25	1	0	0	1	26	0	0	26	2	15:40	07:40
04/14/96	58	6	1	52	3	0	0	3	61	6	1	55	2	16:30	07:30
04/15/96	32	2	1	30	23	5	0	18	55	7	1	48	2	16:35	07:45
04/16/96	31	0	0	31	16	0	0	16	47	0	0	47	2	16:00	08:00
04/17/96	92	1	0	91	4	0	0	4	96	1	0	95	2	15:45	08:45
04/18/96	97	4	0	66	30	0	1	20	127	4	1	86	2	15:30	07:30
04/19/96	125	3	3	121	2	0	0	2	127	3	3	123	2	16:30	07:30
04/20/96	132	11	1	121	7	2	0	5	139	13	1	126	2	16:45	07:45
04/21/96	168	0	1	165	28	0	0	28	196	0	1	193	2	16:30	07:30
04/22/96	90	1	3	88	12	0	0	12	102	1	3	100	2	16:15	09:00
04/23/96	52	3	2	49	15	0	0	15	67	3	2	64	2	14:15	10:00
04/24/96	6	0	0	6	0	0	0	0	6	0	0	6	2	14:45	08:15
04/25/96	17	0	0	17	0	0	0	0	17	0	0	17	2	15:30	08:00
04/26/96	19	0	1	19	4	0	0	4	23	0	1	23	2	15:55	08:00

Appendix A. Daily trapping abundance of fall-run chinook salmon YOY: January -- July 1996.

	Nocturnal				Diurnal				Daily Totals				Trap Operations Data		
Date	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
04/27/96	29	0	1	29	6	0	0	6	35	0	1	35	2	16:35	07:15
04/28/96	18	0	0	18	2	0	1	2	20	0	1	20	2	16:30	07:15
04/29/96	18	3	1	14	9	2	0	7	27	5	1	21	2	17:00	07:30
04/30/96	82	7	0	74	27	0	1	26	109	7	1	100	2	16:30	07:15
05/01/96	51	2	2	48	27	0	0	27	78	2	2	75	2	17:00	07:15
05/02/96	110	5	2	105	22	0	2	21	132	5	4	126	2	16:22	08:07
05/03/96	95	0	2	95	17	0	2	16	112	0	4	111	2	15:30	08:40
05/04/96	103	1	0	99	75	0	1	0	178	1	1	99	2	15:20	08:30
05/05/96	250	2	2	0	62	0	1	62	312	2	3	62	2	15:30	08:00
05/06/96	383	12	2	371	93	0	1	93	476	12	3	464	2	16:02	09:22
05/07/96	170	0	0	160	64	0	0	64	234	0	0	224	2	15:15	07:45
05/08/96	285	0	1	283	66	0	0	66	351	0	1	349	2	15:15	08:15
05/09/96	127	4	1	122	58	1	0	57	185	5	1	179	2	15:00	08:30
05/10/96	72	1	2	70	57	1	1	55	129	2	3	125	2	16:30	07:20
05/11/96	93	1	3	92	68	0	0	68	161	1	3	160	2	16:10	07:15
05/12/96	57	3	2	54	40	0	0	40	97	3	2	94	2	16:50	07:45
05/13/96	61	1	0	60	49	0	0	49	110	1	0	109	2	16:00	09:25
05/14/96	109	1	0	108	37	0	0	37	146	1	0	145	2	14:35	09:20
05/15/96	109	20	3	87	71	0	0	71	180	20	3	158	2	14:10	07:00
05/16/96	74	0	0	23	68	0	0	68	142	0	0	91	2	15:00	08:10
05/17/96	187	2	2	184	24	0	0	24	211	2	2	208	2	16:30	07:50
05/18/96	101	2	0	99	28	0	1	28	129	2	1	127	2	16:00	08:00
05/19/96	147	2	2	145	60	0	0	60	207	2	2	205	2	16:00	07:45
05/20/96	120	3	0	117	59	0	0	58	179	3	0	175	2	16:25	08:20
05/21/96	94	0	0	94	4	0	1	4	98	0	1	98	2	15:40	08:20
05/22/96	102	4	2	98	27	0	1	27	129	4	3	125	2	15:30	08:00
05/23/96	72	2	0	69	40	2	1	38	112	4	1	107	2	16:00	08:00
05/24/96	74	0	1	74	20	0	0	20	94	0	1	94	2	16:00	08:00
05/25/96	78	1	3	77	28	0	0	28	106	1	3	105	2	16:00	08:00
05/26/96	84	5	1	79	18	0	0	18	102	5	1	97	2	16:20	07:40
05/27/96	57	1	0	56	18	0	1	18	75	1	1	74	2	16:00	07:45
05/28/96	60	13	0	47	12	0	0	11	72	13	0	58	2	16:15	07:45
05/29/96	70	1	0	69	6	0	0	6	76	1	0	75	2	16:05	08:00
05/30/96	50	1	2	46	13	0	0	11	63	1	2	57	2	16:10	08:00
05/31/96	95	7	1	74	26	0	1	26	121	7	2	100	2	16:10	07:50
06/01/96	84	0	0	84	24	0	0	21	108	0	0	105	2	15:50	07:40
06/02/96	34	2	1	28	8	0	0	8	42	2	1	36	2	16:20	07:55
06/03/96	53	2	0	51	22	0	0	22	75	2	0	73	2	16:05	08:10
06/04/96	45	1	1	44	13	0	0	13	58	1	1	57	2	16:00	08:00

Appendix A. Daily trapping abundance of fall-run chinook salmon YOY: January -- July 1996.

	Nocturnal				Diurnal				Daily Totals				Trap Operations Data		
Date	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
06/05/96	22	0	0	21	21	0	0	21	43	0	0	42	2	16:10	08:45
06/06/96	33	0	0	31	18	0	0	18	51	0	0	49	2	15:10	07:35
06/07/96	65	0	0	65	16	0	0	0	81	0	0	65	2	16:20	07:50
06/08/96	66	0	1	0	22	1	0	21	88	1	1	21	2	16:05	08:05
06/09/96	71	1	3	70	21	0	1	21	92	1	4	91	2	15:58	08:08
06/10/96	47	0	0	47	18	1	0	17	65	1	0	64	2	16:00	08:25
06/11/96	31	0	0	31	66	4	0	62	97	4	0	93	2	15:45	08:10
06/12/96	28	1	0	27	31	0	0	31	59	1	0	58	2	15:35	08:50
06/13/96	30	0	1	30	11	0	1	11	41	0	2	41	2	14:55	09:12
06/14/96	69	3	3	65	7	0	1	7	76	3	4	72	2	15:07	08:20
06/15/96	20	0	0	20	25	1	1	17	45	1	1	37	2	15:50	07:50
06/16/96	30	5	0	25	17	0	0	17	47	5	0	42	2	16:05	07:55
06/17/96	22	0	0	22	37	0	0	37	59	0	0	59	2	16:40	07:15
06/18/96	32	2	1	30	17	0	0	17	49	2	1	47	2	16:05	06:55
06/19/96	24	1	0	22	16	0	0	16	40	1	0	38	2	16:30	08:00
06/20/96	16	0	0	15	2	0	1	2	18	0	1	17	2	16:00	09:10
06/21/96	38	9	1	29	20	0	1	20	58	9	2	49	2	15:20	08:00
06/22/96	28	3	0	25	26	1	0	25	54	4	0	50	2	16:00	07:50
06/23/96	35	3	0	32	25	0	0	25	60	3	0	57	2	16:10	08:00
06/24/96	15	0	0	15	10	0	0	10	25	0	0	25	2	15:55	08:15
06/25/96	21	0	1	20	11	0	0	10	32	0	1	30	2	15:50	08:00
06/26/96	17	6	0	11	0	0	0	0	17	6	0	11	2	16:00	08:10
06/27/96	5	0	0	5	0	0	0	0	5	0	0	5	2	15:45	08:15
06/28/96	17	0	1	17	10	0	0	10	27	0	1	27	2	15:40	08:25
06/29/96	14	1	1	13	6	0	1	0	20	1	2	13	2	15:45	08:05
06/30/96	12	3	0	5	2	0	0	2	14	3	0	7	2	15:55	08:10
07/01/96	7	1	1	5	3	0	0	3	10	1	1	8	2	16:00	07:55
07/02/96	10	5	1	5	1	0	0	1	11	5	1	6	2	15:55	08:10
07/03/96	6	0	0	6	3	0	1	3	9	0	1	9	2	15:50	08:00
07/04/96	7	0	0	3	0	0	0	0	7	0	0	3	2	16:00	08:00
07/05/96	3	0	0	1	0	0	0	0	3	0	0	1	2	16:00	08:05
07/06/96	6	1	0	5	7	0	0	7	13	1	0	12	2	15:55	08:00
07/07/96	1	1	0	0	2	0	0	2	3	1	0	2	2	16:00	08:00
07/08/96	2	0	0	1	0	0	0	0	2	0	0	1	2	16:00	07:50
07/09/96	1	0	0	1	0	0	0	0	1	0	0	1	2	16:00	08:00
07/10/96	1	0	0	1	0	0	0	0	1	0	0	1	2	16:00	08:00
07/11/96	3	0	0	3	0	0	0	0	3	0	0	3	2	16:10	08:10
07/12/96	2	0	0	2	0	0	0	0	2	0	0	2	2	15:50	08:10
07/13/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:50	08:00

Appendix A. Daily trapping abundance of fall-run chinook salmon YOY: January -- July 1996.

	Nocturnal				Diurnal				Daily Totals				Trap Operations Data		
Date	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Captured	Mortality	Injury	CWT	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
07/14/96	1	0	0	1	0	0	0	0	1	0	0	1	2	16:00	08:15
07/15/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:45	08:10
07/16/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:50	08:20
07/17/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:40	08:10
07/18/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:40	08:10
07/19/96	0	0	0	0	0	0	0	0	0	0	0	0	2	16:00	08:10
07/20/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:40	08:25
07/21/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:45	08:10
07/22/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:50	08:10
07/23/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:50	08:20
07/24/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:40	08:20
07/25/96	1	0	0	1	0	0	0	0	1	0	0	1	2	15:55	08:20
07/26/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:40	08:15
07/27/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:45	08:15
07/28/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:45	08:15
07/29/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:45	08:10
07/30/96	0	0	0	0	0	0	0	0	0	0	0	0	2	15:50	08:10
07/31/96	0	0	0	0	0	0	0	0	0	0	0	0	2	16:00	
TOTALS	12318	1008	87	5161	2620	86	31	1890	14938	0 1094	0 118	0 7051			

Appendix B. Daily trapping abundance of steelhead: January -- July 1996.

	Nocturnal		Diurnal		Trap Operations Data		
Date	YOY	Age 1+	YOY	Age 1+	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
01/01/96							
01/02/96							
01/03/96							
01/04/96							
01/05/96							
01/06/96							
01/07/96							
01/08/96							
01/09/96							
01/10/96							
01/11/96							
01/12/96							
01/13/96							
01/14/96							
01/15/96	0	0	0	0	1		07:40
01/16/96	0	0	0	0	1	16:20	07:40
01/17/96	0	1	0	0	1	16:50	07:30
01/18/96	0	5	0	7	1	16:00	07:45
01/19/96	0	11	0	0	1	16:15	08:00
01/20/96	0	0	0	0	1	16:15	07:45
01/21/96	0	1	0	1	1	16:00	07:40
01/22/96	0	6	0	1	1	16:20	08:00
01/23/96	0	5	0	0	1	16:00	06:00
01/24/96	0	0	0	0	1	18:00	08:00
01/25/96	0	0	0	0	1	16:00	06:00
01/26/96	0	0	0	0	1	18:30	05:30
01/27/96	0	0	0	0	1	18:30	07:30
01/28/96	0	4	0	0	1	18:00	06:00
01/29/96	0	1	0	3	1	16:00	08:00
01/30/96	0	4	0	0	1	18:10	07:20
01/31/96	0	0	0	2	2	16:15	06:30
02/01/96	0	2	0	4	2	17:45	06:00
02/02/96	Winches stolen-no data available				0		
02/03/96	Winches stolen-no data available				0		
02/04/96	0	12	0	4	2	22:00	05:30
02/05/96	0	6	0	11	2	16:00	07:45
02/06/96	0	8	0	4	2	16:15	07:30
02/07/96	0	5	0	2	2	19:00	05:30
02/08/96	0	2	0	0	2	16:30	07:30
02/09/96	0	3	0	0	2	17:30	06:15
02/10/96	0	3	0	0	2	16:15	07:45
02/11/96	0	2	0	0	2	16:02	08:02
02/12/96	0	6	0	0	2	16:25	07:27
02/13/96	0	6	0	1	2	16:32	07:00
02/14/96	0	5	0	1	2	17:15	07:30
02/15/96	0	3	0	1	2	16:15	07:45
02/16/96	0	4	0	0	2	16:30	07:30
02/17/96	0	1	0	0	2	16:00	08:00
02/18/96	0	2	0	0	2	16:00	07:45
02/19/96	0	0	0	0	2	16:15	07:50
02/20/96	0	1	0	1	2	16:10	08:00
02/21/96	0	3	0	0	2	16:15	07:30

Appendix B. Daily trapping abundance of steelhead: January -- July 1996.

	Nocturnal		Diurnal		Trap Operations Data		
Date	YOY	Age 1+	YOY	Age 1+	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
02/22/96	0	1	0	1	2	16:15	07:30
02/23/96	0	1	0	0	2	16:45	07:30
02/24/96	0	0	0	0	2	16:45	07:30
02/25/96	0	3	0	0	2	16:30	07:30
02/26/96	0	0	0	0	2	16:15	07:45
02/27/96	0	4	0	0	2	16:15	07:45
02/28/96	0	2	0	0	2	16:15	07:45
02/29/96	0	2	0	0	2	16:00	07:40
03/01/96	0	0	0	0	2	16:20	08:00
03/02/96	0	3	0	0	2	16:00	07:30
03/03/96	0	1	0	1	2	16:10	08:00
03/04/96	0	2	0	0	2	16:15	07:47
03/05/96	0	2	0	0	2	16:25	07:45
03/06/96	0	4	0	0	2	16:22	08:00
03/07/96	0	1	0	0	2	16:00	07:45
03/08/96	0	4	0	0	2	16:15	07:37
03/09/96	0	0	0	0	2	16:22	07:45
03/10/96	0	1	0	0	2	16:15	07:45
03/11/96	0	2	0	0	2	16:45	07:15
03/12/96	0	0	0	0	2	16:00	08:00
03/13/96	0	2	0	0	2	16:00	08:00
03/14/96	0	0	0	1	2	16:00	07:27
03/15/96	0	2	0	0	2	16:47	07:30
03/16/96	0	0	0	0	2	16:15	07:45
03/17/96	0	0	0	0	2	16:15	08:00
03/18/96	0	0	0	0	2	16:07	07:52
03/19/96	0	1	0	0	2	16:15	07:45
03/20/96	0	2	0	0	2	16:15	07:45
03/21/96	0	0	0	0	2	16:15	07:30
03/22/96	0	0	0	0	2	16:15	08:00
03/23/96	0	1	0	0	2	16:15	07:15
03/24/96	0	0	0	0	2	16:20	07:50
03/25/96	0	0	0	0	2	16:10	07:40
03/26/96	0	0	0	0	2	16:20	07:40
03/27/96	0	0	0	0	2	16:45	07:25
03/28/96	0	2	0	0	2	16:35	07:45
03/29/96	0	0	0	2	2	16:00	07:45
03/30/96	0	3	0	1	2	16:30	09:35
03/31/96	0	2	0	0	2	14:10	09:30
04/01/96	0	0	0	0	2	14:45	07:45
04/02/96	0	1	0	0	1	16:30	07:30
04/03/96	0	2	0	0	1	16:15	07:45
04/04/96	0	0	0	0	2	16:15	07:45
04/05/96	0	2	0	0	1	16:15	
04/06/96	0	4	0	0	2	15:30	07:30
04/07/96	0	3	0	1	2	17:00	07:00
04/08/96	0	2	0	1	2	16:15	08:00
04/09/96	0	5	0	5	2	16:00	08:15
04/10/96	1	3	0	1	2	16:00	07:30
04/11/96	1	3	0	0	2	17:15	06:45
04/12/96	1	3	0	2	2	16:00	08:20
04/13/96	0	7	0	2	2	15:40	07:40

Appendix B. Daily trapping abundance of steelhead: January -- July 1996.

Date	Nocturnal YOY	Nocturnal Age 1+	Diurnal YOY	Diurnal Age 1+	Trap Operations Data Number Fished	Trap Operations Data Nocturnal (Hours)	Trap Operations Data Diurnal (Hours)
04/14/96	0	7	0	0	2	16:30	07:30
04/15/96	0	3	0	3	2	16:35	07:45
04/16/96	0	0	0	2	2	16:00	08:00
04/17/96	0	6	0	6	2	15:45	08:45
04/18/96	0	5	0	3	2	15:30	07:30
04/19/96	1	4	0	2	2	16:30	07:30
04/20/96	0	2	0	1	2	16:45	07:45
04/21/96	1	2	0	1	2	16:30	07:30
04/22/96	0	5	0	1	2	16:15	09:00
04/23/96	0	4	0	0	2	14:15	10:00
04/24/96	0	1	0	0	2	14:45	08:15
04/25/96	0	0	0	1	2	15:30	08:00
04/26/96	1	0	0	0	2	15:55	08:00
04/27/96	1	3	0	0	2	16:35	07:15
04/28/96	0	2	0	0	2	16:30	07:15
04/29/96	1	1	0	0	2	17:00	07:30
04/30/96	1	1	0	0	2	16:30	07:15
05/01/96	0	1	0	1	2	17:00	07:15
05/02/96	0	0	0	0	2	16:22	08:07
05/03/96	0	1	0	0	2	15:30	08:40
05/04/96	1	1	0	0	2	15:20	08:30
05/05/96	0	4	0	0	2	15:30	08:00
05/06/96	0	3	0	1	2	16:02	09:22
05/07/96	0	1	0	0	2	15:15	07:45
05/08/96	2	1	0	1	2	15:15	08:15
05/09/96	1	1	0	0	2	15:00	08:30
05/10/96	1	2	0	0	2	16:30	07:20
05/11/96	1	1	0	0	2	16:10	07:15
05/12/96	1	0	0	0	2	16:50	07:45
05/13/96	1	0	0	0	2	16:00	09:25
05/14/96	1	0	0	0	2	14:35	09:20
05/15/96	1	2	0	1	2	14:10	07:00
05/16/96	0	0	0	0	2	15:00	08:10
05/17/96	1	0	0	1	2	16:30	07:50
05/18/96	0	0	0	0	2	16:00	08:00
05/19/96	1	0	0	0	2	16:00	07:45
05/20/96	4	0	1	1	2	16:25	08:20
05/21/96	4	0	1	0	2	15:40	08:20
05/22/96	5	1	0	0	2	15:30	08:00
05/23/96	2	1	0	0	2	16:00	08:00
05/24/96	0	0	0	0	2	16:00	08:00
05/25/96	1	0	0	0	2	16:00	08:00
05/26/96	3	0	0	0	2	16:20	07:40
05/27/96	1	0	1	0	2	16:00	07:45
05/28/96	1	0	0	0	2	16:15	07:45
05/29/96	5	0	0	0	2	16:05	08:00
05/30/96	0	0	0	0	2	16:10	08:00
05/31/96	1	0	0	0	2	16:10	07:50
06/01/96	2	0	0	0	2	15:50	07:40
06/02/96	0	0	0	0	2	16:20	07:55
06/03/96	1	0	0	0	2	16:05	08:10
06/04/96	3	0	1	0	2	16:00	08:00

Appendix B. Daily trapping abundance of steelhead: January -- July 1996.

Date	Nocturnal		Diurnal		Trap Operations Data		
	YOY	Age 1+	YOY	Age 1+	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
06/05/96	3	0	2	0	2	16:10	08:45
06/06/96	1	0	0	0	2	15:10	07:35
06/07/96	0	0	0	0	2	16:20	07:50
06/08/96	1	0	0	0	2	16:05	08:05
06/09/96	0	1	1	0	2	15:58	08:08
06/10/96	1	0	0	0	2	16:00	08:25
06/11/96	1	0	0	0	2	15:45	08:10
06/12/96	0	0	0	0	2	15:35	08:50
06/13/96	0	0	0	0	2	14:55	09:12
06/14/96	0	0	0	0	2	15:07	08:20
06/15/96	1	0	1	0	2	15:50	07:50
06/16/96	0	0	1	0	2	16:05	07:55
06/17/96	0	0	0	0	2	16:40	07:15
06/18/96	0	0	0	0	2	16:05	06:55
06/19/96	0	0	0	0	2	16:30	08:00
06/20/96	0	0	0	0	2	16:00	09:10
06/21/96	0	0	0	0	2	15:20	08:00
06/22/96	0	0	0	0	2	16:00	07:50
06/23/96	0	0	0	0	2	16:10	08:00
06/24/96	0	0	0	0	2	15:55	08:15
06/25/96	1	0	1	0	2	15:50	08:00
06/26/96	0	0	0	2	2	16:00	08:10
06/27/96	0	0	0	0	2	15:45	08:15
06/28/96	1	6	0	2	2	15:40	08:25
06/29/96	1	0	0	0	2	15:45	08:05
06/30/96	2	1	0	0	2	15:55	08:10
07/01/96	0	0	0	0	2	16:00	07:55
07/02/96	1	0	0	0	2	15:55	08:10
07/03/96	0	0	0	0	2	15:50	08:00
07/04/96	3	0	0	0	2	16:00	08:00
07/05/96	0	0	0	1	2	16:00	08:05
07/06/96	0	0	0	0	2	15:55	08:00
07/07/96	1	0	1	1	2	16:00	08:00
07/08/96	0	1	0	0	2	16:00	07:50
07/09/96	0	0	0	2	2	16:00	08:00
07/10/96	0	1	0	1	2	16:00	08:00
07/11/96	1	0	0	0	2	16:10	08:10
07/12/96	1	0	0	1	2	15:50	08:10
07/13/96	0	0	0	0	2	15:50	08:00
07/14/96	0	0	0	0	2	16:00	08:15
07/15/96	0	0	0	0	2	15:45	08:10
07/16/96	0	0	0	0	2	15:50	08:20
07/17/96	0	0	0	0	2	15:40	08:10
07/18/96	0	0	0	0	2	15:40	08:10
07/19/96	2	0	0	0	2	16:00	08:10
07/20/96	0	0	0	0	2	15:40	08:25
07/21/96	0	0	0	0	2	15:45	08:10
07/22/96	0	0	0	0	2	15:50	08:10
07/23/96	0	0	0	0	2	15:50	08:20
07/24/96	0	0	0	0	2	15:40	08:20
07/25/96	1	0	0	0	2	15:55	08:20
07/26/96	0	0	0	0	2	15:40	08:15

Appendix B. Daily trapping abundance of steelhead: January -- July 1996.

Date	Nocturnal		Diurnal		Trap Operations Data		
	YOY	Age 1+	YOY	Age 1+	Number Fished	Nocturnal (Hours)	Diurnal (Hours)
07/27/96	0	0	0	0	2	15:45	08:15
07/28/96	0	0	0	0	2	15:45	08:15
07/29/96	0	0	0	0	2	15:45	08:10
07/30/96	1	1	0	0	2	15:50	08:10
07/31/96	0	0	0	0	2	16:00	
TOTALS	78	272	11	97			

Appendix C. Estimated daily abundance of downstream migrant fall-run chinook salmon: January -- July 1996.

Note: Differences in totals may be attributable to rounding.

Date	YOY# Day	YOY # Night	Trap Eff Day	Trap Eff Night	Est No. YOY Day	Est No. YOY Night	Est No. YOY Total
01/15/96	0	0			0	0	0
01/16/96	0	0			0	0	0
01/17/96	0	2			0	2	2
01/18/96	0	5			0	5	5
01/19/96	0	7			0	7	7
01/20/96	0	6			0	6	6
01/21/96	0	2			0	2	2
01/22/96	1	2			1	2	3
01/23/96	0	7			0	7	7
01/24/96	0	7			0	7	7
01/25/96	0	1			0	1	1
01/26/96	1	8			1	8	9
01/27/96	13	27			13	27	40
01/28/96	1	26			1	26	27
01/29/96	6	23			6	23	29
01/30/96	6	97			6	97	103
01/31/96	0	17			0	17	17
02/01/96	11	16	0.160	0.085	69	188	257
02/02/96							
02/03/96							
02/04/96	76	413	0.160	0.085	475	4859	5334
02/05/96	13	589	0.160	0.085	81	6929	7011
02/06/96	13	180	0.160	0.085	81	2118	2199
02/07/96	17	470	0.160	0.085	106	5529	5636
02/08/96	40	189	0.160	0.085	250	2224	2474
02/09/96	19	239	0.160	0.085	119	2812	2931
02/10/96	19	184	0.160	0.085	119	2165	2283
02/11/96	21	384	0.160	0.085	131	4518	4649
02/12/96	8	208	0.160	0.085	50	2447	2497
02/13/96	6	490	0.160	0.085	38	5765	5802
02/14/96	13	250	0.160	0.085	81	2941	3022
02/15/96	40	248	0.160	0.085	250	2918	3168
02/16/96	37	137	0.160	0.085	231	1612	1843
02/17/96	28	204	0.160	0.085	175	2400	2575
02/18/96	12	206	0.160	0.085	75	2424	2499
02/19/96	5	165	0.160	0.085	31	1941	1972
02/20/96	7	155	0.160	0.085	44	1824	1867
02/21/96	4	156	0.170	0.020	24	7800	7824
02/22/96	3	23	0.170	0.020	18	1150	1168
02/23/96	8	52	0.170	0.020	47	2600	2647
02/24/96	6	49	0.170	0.020	35	2450	2485
02/25/96	2	139	0.170	0.020	12	6950	6962
02/26/96	9	97	0.170	0.020	53	4850	4903
02/27/96	4	64	0.170	0.020	24	3200	3224
02/28/96	6	32	0.170	0.020	35	1600	1635

Appendix C. Estimated daily abundance of downstream migrant fall-run chinook salmon: January -- July 1996.

Note: Differences in totals may be attributable to rounding.

Date	YOY# Day	YOY # Night	Trap Eff Day	Trap Eff Night	Est No. YOY Day	Est No. YOY Night	Est No. YOY Total
02/29/96	0	24	0.170	0.020	0	1200	1200
03/01/96	2	12	0.170	0.020	12	600	612
03/02/96	5	42	0.170	0.020	29	2100	2129
03/03/96	0	15	0.170	0.020	0	750	750
03/04/96	2	11	0.170	0.020	12	550	562
03/05/96	0	27	0.170	0.020	0	1350	1350
03/06/96	1	51	0.170	0.020	6	2550	2556
03/07/96	1	5	0.170	0.020	6	250	256
03/08/96	4	12	0.170	0.020	24	600	624
03/09/96	2	20	0.170	0.020	12	1000	1012
03/10/96	1	12	0.170	0.020	6	600	606
03/11/96	0	4	0.170	0.020	0	200	200
03/12/96	1	8	0.170	0.020	6	400	406
03/13/96	4	5	0.170	0.020	24	250	274
03/14/96	2	6	0.170	0.020	12	300	312
03/15/96	1	5	0.170	0.020	6	250	256
03/16/96	0	0	0.170	0.020	0	0	0
03/17/96	0	7	0.170	0.020	0	350	350
03/18/96	0	4	0.170	0.020	0	200	200
03/19/96	0	2	0.170	0.020	0	100	100
03/20/96	0	2	0.105	0.045	0	44	44
03/21/96	0	4	0.105	0.045	0	89	89
03/22/96	0	3	0.105	0.045	0	67	67
03/23/96	1	1	0.105	0.045	10	22	32
03/24/96	0	4	0.105	0.045	0	89	89
03/25/96	0	3	0.105	0.045	0	67	67
03/26/96	1	5	0.105	0.045	10	111	121
03/27/96	0	2	0.105	0.045	0	44	44
03/28/96	4	2	0.105	0.045	38	44	83
03/29/96	5	38	0.105	0.045	48	844	892
03/30/96	0	12	0.105	0.045	0	267	267
03/31/96	2	8	0.105	0.045	19	178	197
04/01/96	1	8	0.105	0.045	10	178	187
04/02/96	2	13	0.105	0.045	19	289	308
04/03/96	0	12	0.105	0.045	0	267	267
04/04/96	2	23	0.150	0.115	13	200	213
04/05/96	0	20	0.150	0.115	0	174	174
04/06/96	19	35	0.150	0.115	127	304	431
04/07/96	9	142	0.150	0.115	60	1235	1295
04/08/96	30	87	0.150	0.115	200	757	957
04/09/96	24	99	0.150	0.115	160	861	1021
04/10/96	33	134	0.150	0.115	220	1165	1385
04/11/96	19	60	0.150	0.115	127	522	648
04/12/96	3	47	0.150	0.115	20	409	429
04/13/96	1	25	0.150	0.115	7	217	224

Appendix C. Estimated daily abundance of downstream migrant fall-run chinook salmon: January -- July 1996.

Note: Differences in totals may be attributable to rounding.

Date	YOY# Day	YOY # Night	Trap Eff Day	Trap Eff Night	Est No. YOY Day	Est No. YOY Night	Est No. YOY Total
04/14/96	3	58	0.150	0.115	20	504	524
04/15/96	23	32	0.150	0.115	153	278	432
04/16/96	16	31	0.150	0.115	107	270	376
04/17/96	4	92	0.150	0.115	27	800	827
04/18/96	30	97	0.150	0.115	200	843	1043
04/19/96	2	125	0.150	0.115	13	1087	1100
04/20/96	7	132	0.150	0.115	47	1148	1194
04/21/96	28	168	0.150	0.115	187	1461	1648
04/22/96	12	90	0.150	0.115	80	783	863
04/23/96	15	52	0.150	0.115	100	452	552
04/24/96	0	6	0.150	0.115	0	52	52
04/25/96	0	17	0.150	0.115	0	148	148
04/26/96	4	19	0.150	0.115	27	165	192
04/27/96	6	29	0.150	0.115	40	252	292
04/28/96	2	18	0.150	0.115	13	157	170
04/29/96	9	18	0.150	0.115	60	157	217
04/30/96	27	82	0.150	0.115	180	713	893
05/01/96	27	51	0.150	0.115	180	443	623
05/02/96	22	110	0.150	0.115	147	957	1103
05/03/96	17	95	0.150	0.115	113	826	939
05/04/96	75	103	0.150	0.115	500	896	1396
05/05/96	62	250	0.150	0.115	413	2174	2587
05/06/96	93	383	0.150	0.115	620	3330	3950
05/07/96	64	170	0.150	0.115	427	1478	1905
05/08/96	66	285	0.150	0.115	440	2478	2918
05/09/96	58	127	0.150	0.115	387	1104	1491
05/10/96	57	72	0.150	0.115	380	626	1006
05/11/96	68	93	0.150	0.115	453	809	1262
05/12/96	40	57	0.150	0.115	267	496	762
05/13/96	49	61	0.150	0.115	327	530	857
05/14/96	37	109	0.105	0.120	352	908	1261
05/15/96	71	109	0.105	0.120	676	908	1585
05/16/96	68	74	0.105	0.120	648	617	1264
05/17/96	24	187	0.105	0.120	229	1558	1787
05/18/96	28	101	0.105	0.120	267	842	1108
05/19/96	60	147	0.105	0.120	571	1225	1796
05/20/96	59	120	0.105	0.120	562	1000	1562
05/21/96	4	94	0.105	0.120	38	783	821
05/22/96	27	102	0.105	0.120	257	850	1107
05/23/96	40	72	0.105	0.120	381	600	981
05/24/96	20	74	0.105	0.120	190	617	807
05/25/96	28	78	0.105	0.120	267	650	917
05/26/96	18	84	0.105	0.120	171	700	871
05/27/96	18	57	0.105	0.120	171	475	646
05/28/96	12	60	0.105	0.120	114	500	614

Appendix C. Estimated daily abundance of downstream migrant fall-run chinook salmon: January -- July 1996.

Note: Differences in totals may be attributable to rounding.

Date	YOY# Day	YOY # Night	Trap Eff Day	Trap Eff Night	Est No. YOY Day	Est No. YOY Night	Est No. YOY Total
05/29/96	6	70	0.105	0.120	57	583	640
05/30/96	13	50	0.105	0.120	124	417	540
05/31/96	26	95	0.105	0.120	248	792	1039
06/01/96	24	84	0.105	0.120	229	700	929
06/02/96	8	34	0.105	0.120	76	283	360
06/03/96	22	53	0.105	0.120	210	442	651
06/04/96	13	45	0.105	0.120	124	375	499
06/05/96	21	22	0.105	0.120	200	183	383
06/06/96	18	33	0.105	0.120	171	275	446
06/07/96	16	65	0.105	0.120	152	542	694
06/08/96	22	66	0.105	0.120	210	550	760
06/09/96	21	71	0.105	0.120	200	592	792
06/10/96	18	47	0.105	0.120	171	392	563
06/11/96	66	31	0.105	0.120	629	258	887
06/12/96	31	28	0.105	0.120	295	233	529
06/13/96	11	30	0.105	0.120	105	250	355
06/14/96	7	69	0.105	0.120	67	575	642
06/15/96	25	20	0.105	0.120	238	167	405
06/16/96	17	30	0.105	0.120	162	250	412
06/17/96	37	22	0.105	0.120	352	183	536
06/18/96	17	32	0.105	0.120	162	267	429
06/19/96	16	24	0.030	0.050	533	480	1013
06/20/96	2	16	0.030	0.050	67	320	387
06/21/96	20	38	0.030	0.050	667	760	1427
06/22/96	26	28	0.030	0.050	867	560	1427
06/23/96	25	35	0.030	0.050	833	700	1533
06/24/96	10	15	0.030	0.050	333	300	633
06/25/96	11	21	0.030	0.050	367	420	787
06/26/96	0	17	0.030	0.050	0	340	340
06/27/96	0	5	0.030	0.050	0	100	100
06/28/96	10	17	0.030	0.050	333	340	673
06/29/96	6	14	0.030	0.050	200	280	480
06/30/96	2	12	0.030	0.050	67	240	307
07/01/96	3	7	0.030	0.050	100	140	240
07/02/96	1	10	0.030	0.050	33	200	233
07/03/96	3	6	0.030	0.050	100	120	220
07/04/96	0	7	0.030	0.050	0	140	140
07/05/96	0	3	0.030	0.050	0	60	60
07/06/96	7	6	0.030	0.050	233	120	353
07/07/96	2	1	0.030	0.050	67	20	87
07/08/96	0	2	0.030	0.050	0	40	40
07/09/96	0	1	0.030	0.050	0	20	20
07/10/96	0	1	0.030	0.050	0	20	20
07/11/96	0	3	0.030	0.050	0	60	60
07/12/96	0	2	0.030	0.050	0	40	40

Appendix C. Estimated daily abundance of downstream migrant fall-run chinook salmon: January -- July 1996.

Note: Differences in totals may be attributable to rounding.

Date	YOY# Day	YOY # Night	Trap Eff Day	Trap Eff Night	Est No. YOY Day	Est No. YOY Night	Est No. YOY Total
07/13/96	0	0	0.030	0.050	0	0	0
07/14/96	0	1	0.030	0.050	0	20	20
07/15/96	0	0	0.030	0.050	0	0	0
07/16/96	0	0	0.030	0.050	0	0	0
07/17/96	0	0	0.030	0.050	0	0	0
07/18/96	0	0	0.030	0.050	0	0	0
07/19/96	0	0	0.030	0.050	0	0	0
07/20/96	0	0	0.030	0.050	0	0	0
07/21/96	0	0	0.030	0.050	0	0	0
07/22/96	0	0	0.030	0.050	0	0	0
07/23/96	0	0	0.030	0.050	0	0	0
07/24/96	0	0	0.030	0.050	0	0	0
07/25/96	0	1	0.030	0.050	0	20	20
07/26/96	0	0	0.030	0.050	0	0	0
07/27/96	0	0	0.030	0.050	0	0	0
07/28/96	0	0	0.030	0.050	0	0	0
07/29/96	0	0	0.030	0.050	0	0	0
07/30/96	0	0	0.030	0.050	0	0	0
07/31/96	0	0	0.030	0.050	0	0	0
TOTAL:	2620	12318			23703	160311	184014

Appendix D. Daily average size of YOY fall-run chinook salmon captured at Woodbridge Dam - Traps 1 and 2: January -- July 1996

Date	Avg TL, mm	Avg FL, mm	Avg Wt, g	Avg K	Std TL	Std FL	Std Wt	Std K	Max TL, mm	Min TL, mm	Max Wt, g	Min Wt, g	N
01/01/96	No Trapping												
01/02/96	No Trapping												
01/03/96	No Trapping												
01/04/96	No Trapping												
01/05/96	No Trapping												
01/06/96	No Trapping												
01/07/96	No Trapping												
01/08/96	No Trapping												
01/09/96	No Trapping												
01/10/96	No Trapping												
01/11/96	No Trapping												
01/12/96	No Trapping												
01/13/96	No Trapping												
01/14/96	No Trapping												
01/15/96													0
01/16/96													0
01/17/96	39	37	0.3	5.26E-04	0.7	0.7	0.00	2.90E-05	39	38	0.3	0.3	2
01/18/96	37	36	0.3	6.33E-04	1.9	1.3	0.04	7.51E-05	39	35	0.4	0.3	5
01/19/96	36	35	0.4	7.69E-04	1.6	1.4	0.05	9.60E-05	39	35	0.4	0.3	7
01/20/96	37	36	0.3	6.08E-04	1.4	1.5	0.04	5.97E-05	39	36	0.4	0.3	6
01/21/96	36	35	0.4	7.45E-04	1.4	1.4	0.07	6.36E-05	37	35	0.4	0.3	2
01/22/96	38	37	0.3	5.91E-04	1.2	1.0	0.06	8.43E-05	39	37	0.4	0.3	3
01/23/96	37	36	0.4	6.81E-04	1.6	1.6	0.05	8.88E-05	40	36	0.4	0.3	7
01/24/96	38	37	0.3	6.32E-04	2.1	2.2	0.08	6.31E-05	41	35	0.5	0.3	7
01/25/96	37	36	0.3	5.92E-04					37	37	0.3	0.3	1
01/26/96	41	39	0.5	6.02E-04	8.8	7.4	0.42	3.95E-05	62	36	1.5	0.3	8
01/27/96	37	36	0.3	6.12E-04	1.5	1.3	0.06	1.18E-04	41	35	0.4	0.2	40
01/28/96	38	36	0.3	5.79E-04	1.3	1.1	0.05	8.43E-05	40	35	0.4	0.2	27
01/29/96	37	36	0.3	6.26E-04	1.4	1.4	0.05	1.04E-04	40	35	0.4	0.2	29
01/30/96	37	35	0.3	6.75E-04	1.8	1.7	0.07	1.30E-04	41	34	0.5	0.2	30
01/31/96	38	36	0.3	6.11E-04	1.5	1.3	0.06	1.12E-04	40	35	0.4	0.2	14
02/01/96	39	37	0.4	5.93E-04	1.9	1.6	0.06	6.40E-05	44	36	0.5	0.3	26
02/02/96	No Sampling - Traps Vandalized												
02/03/96	No Sampling - Traps Vandalized												
02/04/96	38	36	0.4	6.29E-04	1.4	1.3	0.06	8.46E-05	41	35	0.5	0.3	60
02/05/96	38	36	0.3	6.34E-04	1.7	1.5	0.06	9.12E-05	43	35	0.5	0.2	71
02/06/96	38	36	0.4	6.61E-04	3.1	2.6	0.16	1.08E-04	62	35	1.6	0.3	70
02/07/96	38	36	0.3	6.20E-04	1.7	1.7	0.08	1.20E-04	44	33	0.5	0.2	77
02/08/96	38	36	0.4	6.45E-04	1.6	1.5	0.07	1.26E-04	43	35	0.5	0.2	97
02/09/96	38	36	0.4	6.94E-04	1.7	1.6	0.08	1.13E-04	42	35	0.6	0.3	77
02/10/96	38	36	0.4	6.69E-04	1.7	1.5	0.07	1.16E-04	42	34	0.6	0.2	75
02/11/96	38	37	0.4	6.44E-04	1.6	1.5	0.07	1.35E-04	44	35	0.7	0.2	80
02/12/96	39	37	0.4	6.55E-04	1.9	1.8	0.07	1.05E-04	43	35	0.5	0.2	64
02/13/96	39	37	0.4	6.79E-04	1.8	1.7	0.06	1.04E-04	43	35	0.6	0.3	66
02/14/96	38	36	0.4	6.52E-04	1.7	1.6	0.08	1.47E-04	41	34	0.5	0.2	73
02/15/96	38	36	0.4	6.48E-04	1.8	1.6	0.07	1.11E-04	43	35	0.5	0.2	99
02/16/96	39	37	0.4	6.32E-04	1.7	1.6	0.07	1.11E-04	43	35	0.6	0.2	90
02/17/96	38	36	0.4	6.69E-04	2.1	2.3	0.09	1.18E-04	47	32	0.9	0.2	73
02/18/96	38	36	0.4	6.54E-04	1.5	1.4	0.07	1.10E-04	42	35	0.6	0.2	71
02/19/96	37	35	0.3	6.41E-04	1.6	1.6	0.07	1.22E-04	41	34	0.5	0.2	60
02/20/96	38	36	0.3	6.52E-04	1.8	1.8	0.06	9.10E-05	44	33	0.5	0.2	66
02/21/96	38	37	0.4	6.48E-04	2.3	2.1	0.09	8.00E-05	48	34	0.8	0.2	64
02/22/96	38	36	0.4	6.55E-04	2.7	2.6	0.08	8.38E-05	46	34	0.6	0.2	25
02/23/96	38	36	0.4	6.46E-04	2.8	2.7	0.11	1.08E-04	46	34	0.7	0.2	50
02/24/96	40	38	0.5	6.47E-04	6.7	5.8	0.40	9.96E-05	69	35	2.4	0.2	38
02/25/96	38	36	0.4	6.44E-04	3.7	3.4	0.18	1.48E-04	57	34	1.5	0.2	62
02/26/96	38	36	0.3	6.19E-04	2.4	2.3	0.08	1.15E-04	50	33	0.5	0.2	69
02/27/96	38	36	0.4	6.08E-04	3.2	2.9	0.15	8.55E-05	55	35	1.2	0.2	64
02/28/96	38	36	0.3	6.24E-04	1.6	1.3	0.06	7.70E-05	41	34	0.5	0.2	37
02/29/96	37	35	0.3	6.05E-04	1.9	1.8	0.08	1.04E-04	40	33	0.5	0.2	24
03/01/96	40	38	0.4	6.04E-04	2.7	2.4	0.08	8.22E-05	42	34	0.5	0.2	12
03/02/96	39	37	0.4	6.35E-04	3.7	3.5	0.15	1.20E-04	59	33	1.2	0.2	47

Appendix D. Daily average size of YOY fall-run chinook salmon captured at Woodbridge Dam - Traps 1 and 2: January -- July 1996

Date	Avg TL, mm	Avg FL, mm	Avg Wt, g	Avg K	Std TL	Std FL	Std Wt	Std K	Max TL, mm	Min TL, mm	Max Wt, g	Min Wt, g	N
03/03/96	38	36	0.4	6.25E-04	3.6	3.2	0.17	8.41E-05	49	34	0.9	0.2	15
03/04/96	39	37	0.4	6.55E-04	4.5	3.9	0.17	1.08E-04	53	34	0.9	0.3	13
03/05/96	38	36	0.4	6.62E-04	1.5	1.5	0.08	9.74E-05	41	34	0.5	0.2	27
03/06/96	42	39	0.5	7.03E-04	6.8	6.1	0.40	8.88E-05	74	35	2.5	0.3	44
03/07/96	46	43	0.7	6.81E-04	8.7	7.4	0.51	9.18E-05	61	40	1.6	0.4	5
03/08/96	45	42	0.8	6.92E-04	9.3	8.0	0.68	8.96E-05	66	38	2.5	0.3	13
03/09/96	41	39	0.5	6.18E-04	6.8	6.1	0.32	6.84E-05	61	35	1.4	0.3	20
03/10/96	39	37	0.4	6.40E-04	5.1	4.6	0.26	6.14E-05	53	32	1.2	0.2	12
03/11/96	38	36	0.3	5.92E-04	1.4	1.5	0.05	7.93E-05	39	36	0.4	0.3	4
03/12/96	42	39	0.5	6.60E-04	8.1	6.8	0.37	7.04E-05	63	36	1.5	0.3	9
03/13/96	44	42	0.7	6.27E-04	9.7	9.3	0.65	1.50E-04	60	38	1.7	0.3	7
03/14/96	48	46	0.9	6.51E-04	11.1	10.4	0.79	1.54E-04	63	37	2.0	0.3	8
03/15/96	35	34	0.3	6.15E-04	5.4	5.0	0.10	2.98E-05	41	25	0.4	0.1	6
03/16/96													0
03/17/96	37	35	0.4	7.85E-04	2.9	2.9	0.18	2.26E-04	39	32	0.7	0.2	5
03/18/96	51	48	1.5	7.70E-04	23.1	20.8	1.90	1.06E-04	82	32	4.3	0.3	4
03/19/96	58	53	2.1	7.00E-04	27.6	24.0	2.55	2.17E-04	77	38	3.9	0.3	2
03/20/96	65	61	2.1	7.50E-04	4.9	6.4	0.64	6.38E-05	68	61	2.5	1.6	2
03/21/96	70	65	3.1	7.51E-04	21.5	19.2	1.83	3.43E-05	82	38	4.3	0.4	4
03/22/96	59	56	1.8	8.71E-04	5.7	4.9	0.07	2.13E-04	63	55	1.8	1.7	2
03/23/96	64	60	2.1	7.30E-04	9.9	7.8	1.41	1.92E-04	71	57	3.1	1.1	2
03/24/96	74	70	3.5	8.22E-04	10.5	9.3	1.54	5.72E-05	86	64	5.5	2.3	4
03/25/96	70	65	3.1	9.01E-04	2.6	3.0	0.40	3.59E-05	72	67	3.5	2.7	3
03/26/96	68	64	2.8	7.28E-04	17.9	16.6	1.50	1.03E-04	79	37	4.0	0.3	5
03/27/96	67	62	2.9	7.84E-04	26.9	24.0	2.76	4.18E-05	86	48	4.8	0.9	2
03/28/96	77	71	3.6	7.64E-04	3.7	3.6	0.58	3.76E-05	81	71	4.0	2.5	6
03/29/96	76	71	3.6	7.64E-04	9.4	8.7	1.20	7.10E-05	94	39	6.5	0.4	43
03/30/96	80	74	4.2	7.98E-04	9.4	8.5	1.44	7.59E-05	100	67	7.7	2.8	12
03/31/96	75	69	3.5	7.94E-04	10.0	9.2	1.31	5.22E-05	90	61	5.7	1.8	10
04/01/96	63	59	2.3	7.54E-04	16.2	15.0	1.63	1.11E-04	80	38	4.3	0.4	9
04/02/96	88	81	5.5	7.79E-04	8.0	7.2	1.85	6.79E-05	102	74	9.4	2.9	14
04/03/96	82	76	4.5	7.97E-04	6.0	5.2	0.93	3.53E-05	93	73	6.2	3.3	7
04/04/96	86	79	5.4	8.50E-04	9.5	8.7	1.76	2.28E-04	105	71	10.0	2.0	25
04/05/96	87	79	5.5	8.10E-04	9.4	8.8	1.79	6.86E-05	102	72	8.5	2.6	20
04/06/96	89	82	5.8	7.83E-04	9.1	8.3	1.86	8.28E-05	106	65	9.6	2.1	54
04/07/96	90	83	5.9	7.76E-04	9.3	8.3	2.12	7.11E-05	115	72	12.2	2.7	52
04/08/96	91	84	6.0	7.84E-04	8.0	7.5	1.70	1.02E-04	115	76	11.8	3.0	80
04/09/96	91	84	6.0	7.69E-04	9.1	8.6	1.81	5.34E-05	116	68	12.3	2.7	79
04/10/96	92	84	6.3	7.80E-04	10.7	9.3	2.44	8.63E-05	121	65	14.7	1.4	93
04/11/96	91	83	6.0	7.91E-04	8.3	7.5	1.49	4.86E-05	112	64	11.0	2.2	74
04/12/96	93	85	6.1	7.53E-04	6.4	6.0	1.27	5.72E-05	108	79	8.9	3.6	45
04/13/96	96	87	6.5	7.21E-04	8.0	7.1	1.59	3.81E-05	113	67	10.6	2.0	26
04/14/96	98	89	7.1	7.46E-04	6.4	6.1	1.48	4.60E-05	119	83	11.9	4.2	45
04/15/96	97	89	6.9	7.39E-04	5.8	5.2	1.36	7.35E-05	110	85	10.8	4.2	48
04/16/96	97	88	6.7	7.31E-04	7.9	7.2	1.43	9.14E-05	110	66	9.7	2.7	47
04/17/96	98	89	6.9	7.27E-04	7.1	6.5	1.66	4.26E-05	123	81	13.1	4.6	58
04/18/96	98	89	7.1	7.45E-04	6.1	5.8	1.39	4.38E-05	113	82	10.8	4.4	85
04/19/96	96	86	6.5	7.37E-04	6.4	5.9	1.26	3.73E-05	109	74	9.4	2.8	46
04/20/96	96	88	6.9	7.85E-04	9.2	8.6	1.64	2.80E-04	116	53	12.6	4.0	50
04/21/96	97	89	6.7	7.34E-04	5.6	4.8	1.21	5.37E-05	110	79	9.7	4.0	66
04/22/96	98	90	7.1	7.47E-04	5.4	5.0	1.17	4.25E-05	109	82	9.7	4.6	65
04/23/96	98	90	7.2	7.52E-04	7.9	7.4	1.78	6.52E-05	116	62	12.2	1.7	59
04/24/96	98	92	7.2	7.56E-04	4.6	4.1	1.10	1.70E-05	105	94	8.8	6.2	6
04/25/96	97	88	6.5	7.04E-04	7.6	6.9	1.55	5.12E-05	106	81	8.8	4.0	17
04/26/96	99	90	7.1	7.33E-04	5.7	4.9	1.17	3.37E-05	110	89	9.3	5.2	23
04/27/96	102	93	8.2	7.56E-04	5.4	5.3	1.44	5.44E-05	117	93	12.6	5.8	35
04/28/96	103	94	8.5	7.67E-04	6.1	5.5	1.68	4.96E-05	113	92	11.5	5.6	20
04/29/96	103	95	8.8	7.90E-04	6.2	5.6	1.72	4.26E-05	116	91	13.0	5.8	20
04/30/96	105	96	8.9	7.69E-04	7.1	6.6	1.93	6.49E-05	121	82	14.2	4.3	76
05/01/96	104	96	8.8	7.68E-04	6.4	6.0	1.76	4.85E-05	119	85	13.5	4.5	75
05/02/96	104	95	8.7	7.67E-04	6.6	6.2	1.81	5.20E-05	129	91	16.2	5.6	81
05/03/96	104	95	8.7	7.58E-04	6.8	6.4	1.83	4.32E-05	126	86	15.4	4.7	73

Appendix D. Daily average size of YOY fall-run chinook salmon captured at Woodbridge Dam - Traps 1 and 2: January -- July 1996

Date	Avg TL, mm	Avg FL, mm	Avg Wt, g	Avg K	Std TL	Std FL	Std Wt	Std K	Max TL, mm	Min TL, mm	Max Wt, g	Min Wt, g	N
05/04/96	106	96	9.0	7.53E-04	7.2	6.8	2.01	4.97E-05	127	91	15.2	5.3	120
05/05/96	104	94	8.7	7.70E-04	6.8	6.3	1.81	4.62E-05	122	87	14.0	5.1	110
05/06/96	106	96	9.2	7.62E-04	7.0	6.6	2.01	4.59E-05	125	90	16.0	5.7	120
05/07/96	106	96	9.1	7.58E-04	6.9	6.4	2.06	5.84E-05	127	92	16.8	5.4	120
05/08/96	106	97	9.3	7.57E-04	7.0	6.5	2.17	5.42E-05	127	90	18.1	5.4	113
05/09/96	106	96	9.3	7.80E-04	7.0	6.6	2.08	7.03E-05	127	93	16.6	5.7	135
05/10/96	107	97	9.5	7.59E-04	7.6	7.0	2.39	6.04E-05	127	91	17.5	5.8	115
05/11/96	107	97	9.4	7.63E-04	6.6	6.2	2.00	5.36E-05	125	91	14.5	5.8	112
05/12/96	109	99	11.0	8.32E-04	7.9	7.3	10.63	7.54E-04	127	92	101.0	5.5	78
05/13/96	111	101	10.3	7.47E-04	7.3	6.7	2.15	5.42E-05	131	92	16.1	5.8	98
05/14/96	109	98	9.9	7.64E-04	7.7	6.9	2.26	4.79E-05	126	94	16.2	6.0	97
05/15/96	113	102	11.5	7.97E-04	7.5	7.0	2.57	6.13E-05	130	90	19.0	5.7	106
05/16/96	111	101	11.2	7.98E-04	7.0	6.6	2.32	7.39E-05	134	96	21.6	7.1	121
05/17/96	113	103	11.2	7.73E-04	5.8	5.5	1.99	7.26E-05	126	100	15.7	7.4	84
05/18/96	110	100	10.4	7.69E-04	7.3	6.8	2.11	5.32E-05	131	94	15.2	6.2	58
05/19/96	108	98	10.0	7.67E-04	7.7	6.9	2.13	8.75E-05	128	63	17.4	6.3	113
05/20/96	108	99	9.8	7.61E-04	7.1	6.5	2.12	5.24E-05	128	84	16.0	4.6	116
05/21/96	110	100	10.4	7.75E-04	7.3	7.1	2.24	3.61E-05	128	95	16.4	6.1	64
05/22/96	112	101	10.7	7.55E-04	7.1	6.7	2.57	6.01E-05	135	97	20.2	6.7	87
05/23/96	111	101	10.6	7.65E-04	7.2	6.4	2.22	6.96E-05	133	90	17.6	5.4	98
05/24/96	109	99	10.2	7.65E-04	6.9	6.4	2.25	5.28E-05	126	96	17.3	6.5	80
05/25/96	109	99	9.9	7.53E-04	7.0	6.4	2.10	6.48E-05	124	86	15.7	5.0	88
05/26/96	113	102	11.3	7.80E-04	7.3	6.9	2.59	5.50E-05	131	95	18.8	6.5	78
05/27/96	112	102	11.3	7.97E-04	7.3	6.9	2.73	6.46E-05	143	100	26.0	5.7	65
05/28/96	112	103	11.3	7.89E-04	5.4	5.2	1.87	4.50E-05	124	101	16.5	7.9	58
05/29/96	111	101	10.9	7.86E-04	7.6	7.1	2.53	5.08E-05	136	95	22.1	6.5	59
05/30/96	113	103	11.1	7.60E-04	7.2	6.7	2.33	5.04E-05	130	99	16.5	7.2	47
05/31/96	112	102	11.1	7.76E-04	7.5	6.8	2.66	6.17E-05	130	97	18.1	6.8	85
06/01/96	111	101	10.9	7.92E-04	9.5	8.7	2.84	1.11E-04	129	69	18.7	4.4	83
06/02/96	112	101	11.1	7.84E-04	8.0	7.6	2.69	4.83E-05	131	95	19.3	7.0	40
06/03/96	113	104	12.0	8.07E-04	7.3	7.0	2.63	6.49E-05	129	96	19.3	7.0	73
06/04/96	110	100	10.8	8.07E-04	7.9	7.2	2.42	7.35E-05	127	85	17.1	6.2	57
06/05/96	111	102	11.3	8.10E-04	6.9	5.8	2.21	4.91E-05	125	90	17.1	5.2	42
06/06/96	110	101	11.0	8.09E-04	7.6	6.6	2.23	5.98E-05	123	90	15.1	6.3	49
06/07/96	112	102	11.4	8.11E-04	7.7	7.0	2.50	5.59E-05	127	95	17.8	6.6	76
06/08/96	112	101	11.3	8.05E-04	7.5	7.1	2.52	8.09E-05	132	91	21.6	6.0	81
06/09/96	111	101	11.1	8.03E-04	7.1	6.6	2.35	6.60E-05	125	91	16.9	5.8	77
06/10/96	110	100	10.6	7.92E-04	6.5	5.3	1.92	5.85E-05	127	91	17.7	5.8	64
06/11/96	112	102	11.0	7.79E-04	7.1	6.2	2.20	5.51E-05	129	89	17.1	5.1	88
06/12/96	114	104	12.0	8.07E-04	7.4	7.0	2.77	8.01E-05	134	90	22.5	5.1	88
06/13/96	117	106	13.0	7.90E-04	9.4	8.5	3.85	4.50E-05	138	100	22.9	8.3	11
06/14/96	113	103	11.7	8.00E-04	7.2	6.7	2.43	5.98E-05	129	97	17.6	7.6	50
06/15/96	111	102	11.1	7.99E-04	8.9	7.7	2.88	5.70E-05	138	94	21.8	6.5	44
06/16/96	107	98	9.6	7.76E-04	7.5	7.2	1.91	1.21E-04	125	75	15.5	5.3	42
06/17/96	108	99	10.1	8.01E-04	7.0	6.2	2.13	4.94E-05	126	92	16.8	6.5	59
06/18/96	110	101	10.9	8.07E-04	6.1	5.6	1.92	4.86E-05	121	98	14.9	6.8	47
06/19/96	110	101	11.3	8.28E-04	11.1	9.8	3.24	5.46E-05	131	68	18.5	2.6	39
06/20/96	109	100	10.6	8.15E-04	8.4	7.1	2.52	4.81E-05	132	89	18.4	6.0	18
06/21/96	110	101	10.6	7.88E-04	6.9	6.1	2.18	8.99E-05	120	91	16.4	7.2	49
06/22/96	112	103	11.6	8.13E-04	6.9	6.3	2.30	5.52E-05	125	95	16.4	6.4	50
06/23/96	112	103	11.4	7.99E-04	6.8	6.0	2.46	5.36E-05	132	101	18.7	7.6	57
06/24/96	111	101	11.2	8.06E-04	7.9	7.3	2.87	4.95E-05	130	99	18.3	7.1	25
06/25/96	115	105	12.6	8.12E-04	7.1	6.2	2.63	5.92E-05	130	99	19.4	7.9	30
06/26/96	111	103	11.2	7.97E-04	6.3	5.9	2.70	7.39E-05	124	103	17.1	8.5	11
06/27/96	111	102	11.0	7.84E-04	9.5	9.8	2.81	1.39E-05	122	98	14.4	7.4	5
06/28/96	115	105	12.3	8.01E-04	7.6	7.2	2.62	5.79E-05	133	97	17.4	7.2	27
06/29/96	112	103	11.5	7.96E-04	10.9	10.0	3.27	5.75E-05	135	89	19.0	5.9	19
06/30/96	113	103	12.4	8.40E-04	6.4	6.4	2.19	5.55E-05	122	103	15.7	9.0	11
07/01/96	108	100	11.1	8.06E-04	19.3	17.3	4.57	4.65E-05	126	60	17.3	1.7	9
07/02/96	118	108	13.6	8.13E-04	10.7	11.4	4.03	2.42E-05	132	105	19.6	9.5	5
07/03/96	115	106	12.6	8.19E-04	6.4	6.2	2.34	6.92E-05	126	107	16.0	9.5	9
07/04/96	118	108	13.7	8.00E-04	15.3	17.0	6.37	5.31E-05	135	106	21.0	9.5	3

Appendix D. Daily average size of YOY fall-run chinook salmon captured at Woodbridge Dam - Traps 1 and 2: January -- July 1996

Date	Avg TL, mm	Avg FL, mm	Avg Wt, g	Avg K	Std TL	Std FL	Std Wt	Std K	Max TL, mm	Min TL, mm	Max Wt, g	Min Wt, g	N
07/05/96	114	104	11.0	7.42E-04					114	114	11.0	11.0	1
07/06/96	115	105	12.8	8.20E-04	8.1	6.3	2.71	7.19E-05	128	102	16.0	8.5	12
07/07/96	120	106	11.8	6.88E-04	0.7	4.2	0.35	8.50E-06	120	119	12.0	11.5	2
07/08/96	109	100	9.0	6.95E-04					109	109	9.0	9.0	1
07/09/96	115	105	13.0	8.55E-04					115	115	13.0	13.0	1
07/10/96	140	132	23.0	8.38E-04					140	140	23.0	23.0	1
07/11/96	122	113	16.8	8.49E-04	20.3	20.1	9.25	9.88E-05	140	100	26.0	7.5	3
07/12/96	116	107	12.8	8.12E-04	19.8	17.0	4.60	1.18E-04	130	102	16.0	9.5	2
07/13/96													0
07/14/96	102	95	9.5	8.95E-04					102	102	9.5	9.5	1
07/15/96													0
07/16/96													0
07/17/96													0
07/18/96													0
07/19/96													0
07/20/96													0
07/21/96													0
07/22/96													0
07/23/96													0
07/24/96													0
07/25/96	137	125	25.5	9.92E-04					137	137	25.5	25.5	1
07/26/96													0
07/27/96													0
07/28/96													0
07/29/96													0
07/30/96													0
07/31/96													0

Appendix E. Daily environmental conditions at Woodbridge Dam: January -- July 1996.

Date	Avg River Q	WID Canal Q	Water Temp (F) Avg	Max	Min	Secchi Depth, cm AM	PM	Avg	Woodbridge Rainfall	Camanche Dam Rainfall	Woodbridge Barometer	Moon Age	Sunrise	Sunset
01/01/96	210								0.00	0.02	30.11	11	724	1659
01/02/96	208								0.00	0.02	30.08	12	724	1656
01/03/96	210								0.00	0.00	30.02	13	724	1657
01/04/96	211								0.00	0.00	30.01	14	724	1658
01/05/96	208								0.00	0.00	30.14	15	725	1659
01/06/96	204								0.00	0.00	30.22	16	725	1659
01/07/96	204								0.00	0.00	30.15	17	725	1700
01/08/96	206								0.00	0.00	30.09	18	724	1701
01/09/96	208								0.00	0.04	30.14	19	724	1702
01/10/96	206								0.00	0.02	30.24	20	724	1703
01/11/96	206		52.81	53.24	52.34				0.00	0.00	30.26	21	724	1704
01/12/96	206		52.11	52.70	51.80				0.00	0.00	30.15	22	724	1705
01/13/96	205		51.47	51.80	51.26				0.00	0.00	30.10	23	724	1706
01/14/96	204		50.92	51.26	50.54				0.01	0.00	30.17	24	723	1707
01/15/96	207		50.53	50.90	50.36	150	150	150.0	0.18	0.00	30.18	25	723	1708
01/16/96	269		51.03	51.26	50.90	70	70	70.0	0.88	0.64	29.83	26	723	1709
01/17/96	242		51.49	51.98	50.90	80	65	72.5	0.00	0.00	30.02	27	722	1710
01/18/96	222		51.19	51.98	50.72	60	70	65.0	0.62	0.25	29.95	28	722	1711
01/19/96	218		51.43	52.16	50.72	70	120	95.0	0.00	0.19	30.11	29	722	1712
01/20/96	209		51.65	52.16	50.90	100	115	107.5	0.17	0.01	30.14	0	721	1713
01/21/96	225		51.92	52.34	51.44	80	90	85.0	0.13	0.34	29.99	1	721	1715
01/22/96	210		51.44	51.98	50.72	110	140	125.0	0.03	0.00	30.12	2	720	1716
01/23/96	206		49.09	50.54	48.38	90	140	115.0	0.07		30.25	3	719	1717
01/24/96	225		48.65	49.46	48.20	130	110	120.0	0.67	0.26	30.09	4	718	1718
01/25/96	272		50.19	51.08	49.46	70	70	70.0	0.01	0.30	30.08	5	717	1719
01/26/96	237		49.78	50.72	49.46	60	60	60.0	0.00	T	30.12	6	717	1720
01/27/96	253		49.51	50.18	48.74	80	70	75.0	0.69	0.39	29.91	7	716	1721
01/28/96	282		50.68	51.62	49.82	70	45	57.5	0.00	0.28	30.07	8	715	1722
01/29/96	235		50.02	50.72	49.64	30	40	35.0	0.00	0.00	30.04	9	715	1723
01/30/96	330		50.60	51.62	49.82	90	70	80.0	0.20	0.00	29.86	10	714	1725
01/31/96	619		51.76	52.16	51.26	50	50	50.0	0.70	0.55	29.67	11	713	1726
02/01/96	959		52.11	52.70	51.62	30	40	35.0	0.00		29.78	12	712	1727
02/02/96	1120		52.42	52.70	51.98	None taken			0.00	0.00	29.94	13	711	1728
02/03/96	1140		52.30	52.52	51.98	None taken			0.10	0.07	30.01	14	710	1729
02/04/96	1210		52.98	53.42	52.52	50	50	50.0	0.80	0.35	30.07	15	710	1730
02/05/96	1230		54.28	55.22	53.60	50	60	55.0	0.10	0.29	30.27	16	709	1731
02/06/96	1200		53.75	54.32	53.06	80	80	80.0	0.00	0.00	30.28	17	708	1732
02/07/96	1480		52.69	53.06	51.98	50	50	50.0	0.00	0.00	30.16	18	707	1733
02/08/96	1690		52.42	52.88	51.98	60	50	55.0	0.00	0.00	29.97	19	706	1737
02/09/96	1730		52.48	52.88	51.98	60	70	65.0	0.00	0.00	29.89	20	705	1738
02/10/96	1670		52.70	53.06	52.16	70	90	80.0	0.00	0.00	30.00	21	704	1739
02/11/96	1660		52.60	53.06	51.98	90	80	85.0	0.00	0.00	30.07	22	702	1740
02/12/96	1660		52.24	52.70	51.62	90	90	90.0	0.00	0.00	30.02	23	701	1741
02/13/97	1660		52.43	52.88	51.98	90	110	100.0	0.00	0.00	30.08	24	700	1742
02/14/96	1670		52.40	52.88	51.98	80	90	85.0	0.00	0.00	30.08	25	659	1743

Appendix E. Daily environmental conditions at Woodbridge Dam: January -- July 1996.

Date	Avg River Q	WID Canal Q	Water Temp (F) Avg	Water Temp (F) Max	Water Temp (F) Min	Secchi Depth, cm AM	Secchi Depth, cm PM	Secchi Depth, cm Avg	Woodbridge Rainfall	Camanche Dam Rainfall	Woodbridge Barometer	Moon Age	Sunrise	Sunset
02/15/96	1680		52.57	53.06	52.16	80	90	85.0	0.00	0.00	30.06	26	658	1744
02/16/96	1890		52.10	52.52	51.44	70	60	65.0	0.00	0.18	30.08	27	657	1745
02/17/96	2020		52.56	53.42	51.80	70	70	70.0	0.00	0.00	30.04	28	656	1746
02/18/96	2040		52.71	53.42	51.98	80	80	80.0	0.10	0.00	29.94	0	654	1747
02/19/96	2100		52.27	52.70	51.62	80	85	82.5	1.10	0.31	29.69	1	653	1749
02/20/96	2140		52.53	52.88	51.98	60	80	70.0	0.30	0.85	29.76	2	652	1750
02/21/96	2590		52.55	53.06	51.80	50	60	55.0	0.50	0.56	29.79	3	651	1751
02/22/96	2840		53.00	53.78	52.52	60	60	60.0	0.10	0.15	30.10	4	649	1752
02/23/96	2840		52.56	53.42	51.80	50	60	55.0	0.00	0.00	30.11	5	648	1753
02/24/96	2850		52.30	52.88	51.44	70	80	75.0	0.20	0.09	29.86	6	647	1754
02/25/96	2850		52.28	52.70	51.62	70	70	70.0	0.00	0.00	29.79	7	645	1755
02/26/96	2840		51.60	52.16	50.90	80	80	80.0	0.00	0.04	29.90	8	644	1756
02/27/96	2850		51.40	51.98	50.54	90	90	90.0	0.00	0.01	29.90	9	643	1757
02/28/96	2870		50.88	51.62	50.18	100	90	95.0	0.00	0.00	29.94	10	641	1758
02/29/96	2870		52.26	52.88	51.62	80	80	80.0	0.04	0.03	30.10	11	640	1759
03/01/96	2860		52.75	53.06	52.16	90	90	90.0	0.00	0.02	30.23	12	639	1800
03/02/96	2860		52.86	53.60	52.16	90	90	90.0	0.00	0.00	30.07	13	637	1801
03/03/96	2850		52.39	53.06	51.44	80	90	85.0	0.10	0.00	29.88	14	636	1802
03/04/96	2890		51.78	52.70	51.26	100	100	100.0	0.65	0.26	29.74	15	634	1803
03/05/96	2980		51.48	51.80	51.26	50	70	60.0	0.26	1.28	29.99	16	633	1804
03/06/96	2930		51.79	52.34	51.26	80	90	85.0	0.01	0.02	30.20	17	631	1805
03/07/96	2880		51.24	51.98	50.18	90	90	90.0	0.00	0.00	30.19	18	630	1806
03/08/96	2870		51.97	52.70	51.08	90	90	90.0	0.00	0.00	30.04	19	629	1807
03/09/96	2860		51.79	52.34	50.90	90	100	95.0	0.00	0.00	29.98	20	627	1808
03/10/96	2850		51.91	52.34	51.08	90	90	90.0	0.01	0.00	30.11	21	626	1809
03/11/96	2870		51.55	52.16	50.72	100	50	75.0	0.37	0.20	30.10	22	623	1810
03/12/96	2950		51.50	51.98	51.08	80	90	85.0	1.26	0.57	29.80	23	622	1811
03/13/96	2900		51.07	51.62	50.72	90	80	85.0	0.00	0.17	29.73	24	620	1811
03/14/96	2850		50.96	51.98	50.00	80	100	90.0	0.00	0.00	30.01	25	619	1812
03/15/96	2820		51.37	52.16	50.36	90	90	90.0	0.00	0.00	30.13	26	617	1813
03/16/96	2760		51.79	52.70	50.72	90	100	95.0	0.00	0.00	30.07	27	616	1814
03/17/96	2710		51.65	52.16	50.54	100	95	97.5	0.00	0.00	30.00	28	614	1815
03/18/96	2660		51.78	52.70	50.54	95	110	102.5	0.00	0.00	29.96	29	613	1816
03/19/96	2610		52.12	53.06	50.90	110	95	102.5	0.00	0.00	29.96	0	611	1818
03/20/96	2570		52.03	52.70	50.90	90	110	100.0	0.00	0.00	29.96	1	610	1819
03/21/96	2520		52.05	52.88	50.90	95	95	95.0	0.00	0.00	29.86	2	608	1820
03/22/96	2470		52.11	52.88	51.08	100	100	100.0	0.00	0.00	29.86	3	606	1821
03/23/96	2430		51.68	52.34	50.90	100	100	100.0	0.00	0.00	29.91	4	605	1822
03/24/96	2380		51.26	52.16	50.00	100	100	100.0	0.00	0.00	29.96	5	603	1823
03/25/96	2330		51.90	52.70	50.90	110	110	110.0	0.00	0.00	29.99	6	602	1824
03/26/96	2290		51.55	52.52	50.90	110	110	110.0	0.00	0.00	29.99	7	600	1825
03/27/96	2240		51.60	52.52	50.36	120	110	115.0	0.03	0.03	29.93	8	559	1826
03/28/96	2190		52.15	52.70	51.44	110	120	115.0	0.00	0.04	29.85	9	557	1826
03/29/96	2130		52.40	53.06	51.62	120	110	115.0	0.00	0.00	30.00	10	556	1827
03/30/96	2080		52.08	52.88	50.90	110	100	105.0	0.00	0.00	30.00	11	554	1828

Appendix E. Daily environmental conditions at Woodbridge Dam: January -- July 1996.

Date	Avg River Q	WID Canal Q	Water Temp (F) Avg	Water Temp (F) Max	Water Temp (F) Min	Secchi Depth, cm AM	Secchi Depth, cm PM	Secchi Depth, cm Avg	Woodbridge Rainfall	Camanche Dam Rainfall	Woodbridge Barometer	Moon Age	Sunrise	Sunset
03/31/96	2030		52.60	53.24	51.44	120	100	110.0	0.00	0.00	29.84	12	552	1829
04/01/96	1840		52.84	53.60	51.62	110	100	105.0	0.69	0.15	29.74	13	550	1830
04/02/96	1800		52.50	53.78	51.98	120	130	125.0	0.00	0.37	29.96	14	549	1831
04/03/96	1660		52.64	53.60	51.62	100	140	120.0	0.00	0.01	30.03	15	547	1832
04/04/96	1470		53.46	54.32	52.88	120	130	125.0	0.00	0.00	30.07	16	546	1834
04/05/96	1290		54.10	54.68	53.60	110		110.0	0.00	0.00	30.07	17	544	1835
04/06/96	1250		54.66	55.40	54.14	140	140	140.0	0.00	0.00	29.98	18	543	1836
04/07/96	1230		55.14	55.76	54.50	140	200	170.0	0.00	0.00	29.82	19	641	1937
04/08/96	1200		55.46	56.12	54.86	170	140	155.0	0.00	0.00	29.91	20	640	1937
04/09/96	1220		55.62	56.12	55.22	150	150	150.0	0.00	0.00	30.03	21	638	1938
04/10/96	1200	44	54.54	55.22	53.42	170		170.0	0.00	0.00	30.03	22	637	1939
04/11/96	1150	44	53.94	55.22	52.88	155	135	145.0	0.00	0.00	30.08	23	636	1940
04/12/96	1170	54	54.73	55.40	54.14	140	160	150.0	0.00	0.00	30.06	24	634	1941
04/13/96	1130	69	54.82	55.40	54.32	150	200	175.0	0.00	0.00	30.03	25	633	1942
04/14/96	1140	75	54.69	55.04	54.32	200	220	210.0	0.00	0.00	29.99	26	631	1943
04/15/96	1130	75	55.16	55.76	54.50	180	210	195.0	0.00	0.00	29.88	27	630	1944
04/16/96	1130	81	55.42	55.94	55.04	260	220	240.0	0.09	0.07	29.79	28	629	1945
04/17/96	1100	97	55.21	55.76	54.86	230	230	230.0	0.51	0.22	29.85	0	627	1946
04/18/96	1130	99	54.63	55.22	54.14	180	220	200.0	0.01	0.62	30.15	1	626	1947
04/19/96	1110	94	54.67	55.76	53.78	220	230	225.0	0.12	0.01	30.20	2	624	1948
04/20/96	1110	94	54.57	55.22	53.96	230	230	230.0	0.01	0.11	30.11	3	623	1948
04/21/96	1110	93	53.85	54.14	53.60	230	230	230.0	0.00	0.00	30.05	4	622	1949
04/22/96	1110	101	54.52	55.58	53.24	200	230	215.0	0.00	0.00	30.11	5	620	1950
04/23/96	1080	107	56.11	56.66	55.40	180	220	200.0	0.00	0.00	30.09	6	619	1951
04/24/96	1090	110	56.43	56.84	55.76	210	230	220.0	0.00	0.00	30.08	7	618	1952
04/25/96	1090	112	56.54	57.02	56.30	230	240	235.0	0.00	0.00	30.06	8	617	1953
04/26/96	1080	114	56.53	57.38	55.76	200	210	205.0	0.00	0.00	30.00	9	615	1954
04/27/96	1070	115	57.26	57.56	56.84	190	220	205.0	0.00	0.00	29.93	10	614	1955
04/28/96	1070	114	56.98	57.38	56.66	210	220	215.0	0.00	0.00	29.94	11	613	1956
04/29/96	1060	125	56.53	57.02	55.94	210	210	210.0	0.00	0.00	30.00	12	612	1957
04/30/96	1040	132	57.25	57.74	56.48	200	220	210.0	0.00	0.00	29.92	13	611	1958
05/01/96	1010	139	58.02	58.46	57.38	230	230	230.0	0.00	0.00	0.00	14	609	1959
05/02/96	1040	145	58.56	59.00	58.10	220	210	215.0	0.00	0.00	0.00	15	608	1959
05/03/96	1040	143	58.60	59.00	58.28	200	200	200.0	0.00	0.00	0.00	16	605	2000
05/04/96	1040	140	58.12	58.64	57.38	160	170	165.0	0.00	0.00	0.00	17	604	2001
05/05/96	1040	136	57.42	57.92	56.84	170	210	190.0	0.00	0.00	30.00	18	603	2002
05/06/96	1040	139	57.58	58.28	57.02	210	180	195.0	0.00	0.00	29.94	19	602	2003
05/07/96	1040	137	57.48	57.92	57.02	200	210	205.0	0.00	0.00	29.92	20	601	2004
05/08/96	1010	157	57.69	58.28	57.02	200	210	205.0	0.00	0.00	29.94	21	600	2005
05/09/96	1030	165	57.34	57.74	56.84	230	140	185.0	0.00	0.00	29.98	22	559	2006
05/10/96	1030	166	56.52	57.02	56.12	200	220	210.0	0.00	0.00	30.04	23	558	2007
05/11/96	1020	172	56.44	56.84	55.94	240	250	245.0	0.00	0.00	29.93	24	557	2008
05/12/96	1020	174	56.95	57.38	56.48	170	200	185.0	0.00	0.00	29.81	25	556	2008
05/13/96	1000	178	57.46	57.92	56.84	170	220	195.0	0.00	0.00	29.82	26	555	2009
05/14/96	927	182	57.77	58.28	57.38	160	180	170.0	0.00	0.00	29.84	27	554	2011

Appendix E. Daily environmental conditions at Woodbridge Dam: January -- July 1996.

Date	Avg River Q	WID Canal Q	Water Temp (F) Avg	Water Temp (F) Max	Water Temp (F) Min	Secchi Depth, cm AM	Secchi Depth, cm PM	Secchi Depth, cm Avg	Woodbridge Rainfall	Camanche Dam Rainfall	Woodbridge Barometer	Moon Age	Sunrise	Sunset
05/15/96	876	175	57.72	58.64	57.02	210	200	205.0	0.78	0.13	29.80	28	553	2012
05/16/96	862	151	56.77	57.38	56.12	70	150	110.0	0.42	2.05	29.77	29	553	2013
05/17/96	761	146	56.69	57.02	56.30	70	150	110.0	0.18	0.02	29.87	0	552	2014
05/18/96	742	147	56.12	56.48	55.22	220	210	215.0	0.06	0.03	29.96	1	551	2015
05/19/96	733	147	55.60	56.66	54.68	200	170	185.0	0.03	0.00	29.99	2	550	2015
05/20/96	735	146	56.80	58.10	55.76	200	240	220.0	0.01	0.03	29.93	3	550	2016
05/21/96	740	141	57.72	59.36	56.66	200	190	195.0	0.01	0.00	29.90	4	549	2017
05/22/96	739	140	55.72	57.02	54.86	200	170	185.0	0.01	0.06	29.95	5	548	2018
05/23/96	735	140	56.78	58.10	55.76	170	210	190.0	0.00	0.00	29.90	6	548	2019
05/24/96	733	136	57.36	58.82	56.12	170	200	185.0	0.00	0.00	29.75	7	547	2019
05/25/96	729	133	58.54	60.62	57.02	210	210	210.0	0.00	0.00	29.70	8	546	2020
05/26/96	728	133	59.56	61.52	58.28	220	190	205.0	0.00	0.00	29.83	9	546	2021
05/27/96	729	132	59.26	60.98	58.10	220	200	210.0	0.00	0.00	29.84	10	545	2022
05/28/96	723	137	58.84	60.44	57.56	150	200	175.0	0.00	0.00	29.82	11	545	2022
05/29/96	723	144	58.60	60.26	57.56	200	200	200.0	0.00	0.00	29.82	12	544	2023
05/30/96	707	150	58.77	60.62	57.38	190	200	195.0	0.00	0.00	29.88	13	544	2024
05/31/96	691	151	59.15	60.98	57.74	200	190	195.0	0.00	0.00	29.94	14	544	2025
06/01/96	672	149	59.78	61.70	58.28	190	200	195.0	0.00	0.00	29.94	15	543	2025
06/02/96	666	146	60.51	62.60	59.00	190	220	205.0	0.00	0.00	29.94	16	543	2026
06/03/96	679	149	60.94	62.96	59.36	200	220	210.0	0.00	0.00	29.90	17	543	2026
06/04/96	668	159	61.18	62.95	59.72	190	200	195.0	0.00	0.00	29.81	18	542	2027
06/05/96	676	153	61.27	62.96	59.72	150	160	155.0	0.00	0.00	29.77	19	542	2028
06/06/96	669	152	61.34	63.14	59.72	160	200	180.0	0.00	0.00	29.77	20	542	2028
06/07/96	662	161	61.49	63.14	59.90	200	200	200.0	0.00	0.00	29.78	21	542	2029
06/08/96	652	165	61.39	63.14	59.90	160	170	165.0	0.00	0.00	29.83	22	541	2029
06/09/96	652	165	61.28	63.14	59.90	180	200	190.0	0.00	0.00	29.85	23	541	2030
06/10/96	670	173	60.83	62.60	59.36	170	190	180.0	0.00	0.00	29.88	24	541	2030
06/11/96	879	198	59.83	60.62	59.18	150	160	155.0	0.00	0.00	29.78	25	541	2031
06/12/96	920	207	59.68	60.80	59.00	170	200	185.0	0.00	0.00	29.75	26	541	2031
06/13/96	926	211	59.37	60.26	58.82	170	170	170.0	0.00	0.00	29.83	27	541	2032
06/14/96	918	220	59.14	59.90	58.46	170	190	180.0	0.00	0.00	29.82	28	541	2032
06/15/96	911	225	59.39	60.44	58.64	170	180	175.0	0.00	0.00	29.78	0	541	2032
06/16/96	906	226	59.26	60.26	58.64	170	180	175.0	0.00	0.00	29.82	1	541	2033
06/17/96	911	224	58.97	59.72	58.46	170	170	170.0	0.00	0.00	29.93	2	541	2033
06/18/96	917	222	59.19	60.26	58.64	190	200	195.0	0.00	0.00	29.84	3	542	2034
06/19/96	922	221	59.32	60.26	58.82	180	180	180.0	0.00	0.00	29.74	4	542	2034
06/20/96	925	220	59.23	59.90	58.82	170	160	165.0	0.00	0.00	29.77	5	542	2034
06/21/96	934	220	59.24	59.90	58.82	140	170	155.0	0.00	0.00	29.74	6	542	2034
06/22/96	934	218	59.30	59.90	58.64	170	180	175.0	0.00	0.00	29.77	7	542	2034
06/23/96	919	217	59.83	60.80	59.18	200	180	190.0	0.00	0.00	29.78	8	543	2035
06/24/96	933	211	59.20	59.90	57.92	170	180	175.0	0.00	0.00	29.85	9	543	2035
06/25/96	956	204	58.10	58.82	57.56	200	180	190.0	0.00	0.00	29.77	10	543	2035
06/26/96	969	198	58.29	59.00	57.20	190	230	210.0	0.00	0.01	29.75	11	544	2035
06/27/96	961	201	57.58	58.64	56.84	180	200	190.0	0.00	0.32	29.92	12	544	2035
06/28/96	961	199	59.06	59.72	58.28	210	210	210.0	0.00	0.00	29.98	13	544	2035

Appendix E. Daily environmental conditions at Woodbridge Dam: January -- July 1996.

Date	Avg River Q	WID Canal Q	Water Temp (F) Avg	Water Temp (F) Max	Water Temp (F) Min	Secchi Depth, cm AM	Secchi Depth, cm PM	Secchi Depth, cm Avg	Woodbridge Rainfall	Camanche Dam Rainfall	Woodbridge Barometer	Moon Age	Sunrise	Sunset
06/29/96	957	201	59.98	60.98	59.18	200	190	195.0	0.00	0.00	29.88	14	545	2035
06/30/96	952	203	60.44	61.52	59.72	180	200	190.0	0.00	0.00	29.80	15	545	2035
07/01/96	959	203	60.79	61.88	59.90	190	200	195.0	0.00	0.00	29.76	16	546	2034
07/02/96	945	209	60.92	61.70	60.44	200	200	200.0	0.00	0.00	29.70	17	546	2034
07/03/96	944	210	60.80	61.52	60.26	200	190	195.0	0.00	0.00	29.77	18	547	2034
07/04/96	947	210	60.63	61.34	59.90	180	180	180.0	0.00	0.00	29.83	19	547	2034
07/05/96	936	217	60.26	61.16	59.54	190	180	185.0	0.00	0.00	29.81	20	548	2034
07/06/96	932	226	60.63	61.70	59.72	180	180	180.0	0.00	0.00	29.77	21	548	2034
07/07/96	925	229	60.95	61.88	60.26	190	200	195.0	0.00	0.00	29.71	22	549	2033
07/08/96	921	236	60.87	61.70	60.26	180	190	185.0	0.00	0.00	29.67	23	549	2033
07/09/96	904	241	60.93	61.88	60.26	190	200	195.0	0.00	0.00	29.71	24	550	2033
07/10/96	895	251	61.00	61.88	60.44	190	220	205.0	0.00	0.00	29.83	25	551	2032
07/11/96	902	254	60.86	61.88	60.26	190	200	195.0	0.00	0.00	29.87	26	551	2031
07/12/96	904	257	60.82	61.88	59.90	190	180	185.0	0.00	0.00	29.82	27	552	2031
07/13/96	894	255	61.03	62.06	60.26	190	190	190.0	0.00	0.00	29.82	28	553	2031
07/14/96	896	246	61.26	62.24	60.62	190	190	190.0	0.00	0.00	29.75	29	553	2030
07/15/96	924	240	61.06	61.88	60.44	170	190	180.0	0.00	0.00	29.80	0	554	2030
07/16/96	930	231	60.66	61.70	59.90	170	170	170.0	0.00	0.00	29.80	1	555	2029
07/17/96	935	217	60.64	61.70	59.90	170	160	165.0	0.00	0.00	29.83	2	556	2029
07/18/96	934	216	60.64	61.34	59.90	170	180	175.0	0.00	0.00	29.94	3	556	2028
07/19/96	917	225	60.59	61.34	59.90	170	180	175.0	0.00	0.00	29.91	4	557	2028
07/20/96	913	226	60.73	61.70	59.90	200	210	205.0	0.00	0.00	29.81	5	558	2027
07/21/96	892	231	61.24	62.60	60.44	180	190	185.0	0.00	0.00	29.81	6	559	2026
07/22/96	879	242	61.08	62.06	60.44	190	180	185.0	0.00	0.00	29.90	7	559	2025
07/23/96	886	247	60.96	62.06	60.26	170	170	170.0	0.00	0.00	29.90	8	600	2025
07/24/96	850	270	61.21	62.24	60.62	170	170	170.0	0.00	0.00	29.83	9	601	2024
07/25/96	839	298	61.39	62.60	60.62	170	170	170.0	0.00	0.00	29.77	10	602	2022
07/26/96	853	300	61.48	62.60	60.80	170	170	170.0	0.00	0.00	29.79	11	603	2021
07/27/96	852	292	60.99	62.06	60.26	190	200	195.0	0.00	0.00	29.84	12	603	2020
07/28/96	854	291	61.09	62.24	60.26	170	190	180.0	0.00	0.00	29.87	13	604	2020
07/29/96	891	269	61.89	62.96	61.16	170	180	175.0	0.00	0.00	29.87	14	605	2019
07/30/96	874	267	62.08	63.14	61.34	180	180	180.0	0.00	0.00	29.81	15	606	2018
07/31/96	870	267	62.05	63.14	61.34	170		170.0	0.00	0.00	29.78	16	607	2017

Notes:
Mokelumne River flow data from U.S.G.S. gaging station #11325500 at Woodbridge, CA and WID Canal diversion data from U.S.G.S. gaging station #11325000.
Water temperatures were recorded hourly with a Ryan TM2000 submersible thermograph installed in pool #8a of low-stage fishway or pool 15 of high-stage fishway.
Secchi depth measured twice daily in pool #9a of low-stage fishway, or from screw trap platform located about mid-channel from Woodbridge Dam, or immediately upstream of spill bay #1 in Lake Lodi.
Barometric pressure measured hourly and average daily value computed by EBMUD meteorological datalogging station at Woodbridge, CA.
Lunar and solar data compiled from tables in the Old Farmer's Almanac, 1996 edition, Yankee Publishing, Dublin, NH.

Appendix F. Delta outflow (in cfs): January -- July 1996

January 1996

Date	Sacramento River at Freeport	Sacramento Treatment Plant	San Joaquin River Near Vernalis	Tracy Pump	Contra Costa Pump	Clifton Court Forebay Inflow	Byron-Bethany Irrigation District	Delta Outflow Index
1	28,763	227	2,775	4,186	99	689	0	19,800
2	29,373	227	2,617	4,184	96	877	0	25,460
3	27,186	227	2,455	4,176	103	5,681	0	21,110
4	24,916	227	2,356	4,165	114	6,585	0	17,890
5	23,013	227	2,259	4,168	120	5,856	0	16,280
6	21,725	227	2,202	4,192	117	6,087	0	14,050
7	20,706	227	2,170	4,201	118	6,410	0	12,410
8	20,129	227	2,134	4,201	121	7,194	0	10,560
9	19,510	227	2,133	4,266	115	6,483	0	10,650
10	19,008	227	2,095	4,335	113	5,165	0	11,310
11	18,442	227	2,099	4,404	102	5,800	0	10,120
12	17,900	227	2,071	4,364	103	6,778	0	8,610
13	17,400	227	2,047	4,282	112	3,438	0	11,500
14	17,583	227	2,036	4,257	97	5,420	0	9,040
15	17,186	227	2,037	4,251	92	6,543	0	8,140
16	17,136	227	2,092	4,291	4	7,314	0	7,040
17	21,473	227	2,213	4,295	0	6,075	0	10,900
18	32,201	227	2,664	4,272	36	7,155	0	15,580
19	39,212	227	2,643	4,292	111	7,112	0	26,240
20	42,731	227	2,731	4,253	130	7,280	0	33,970
21	45,967	227	2,919	4,284	118	7,166	0	37,420
22	49,175	227	2,725	4,278	118	7,041	0	41,080
23	50,725	227	2,821	4,392	118	7,315	0	42,670
24	49,616	227	2,645	4,217	117	6,728	0	45,120
25	49,777	227	2,694	4,333	116	7,263	0	45,060
26	51,023	227	3,586	4,327	118	5,510	0	52,430
27	51,244	227	3,855	4,329	116	5,396	0	50,120
28	54,316	227	3,570	4,322	114	5,134	0	54,230
29	57,785	227	4,459	4,337	110	5,040	0	56,570
30	61,731	227	4,025	4,445	104	3,354	0	61,670
31	64,943	227	4,071	4,351	79	3,324	0	66,180
TOTAL	1,061,895	7,037	83,199	132,652	3,028	177,214	0	853,210
AVERAGE	34,255	227	2,684	4,279	101	5,717	0	27,523

Appendix F. Delta outflow (in cfs): January -- July 1996

February 1996

Date	Sacramento River at Freeport	Sacramento Treatment Plant	San Joaquin River Near Vernalis	Tracy Pump	Contra Costa Pump	Clifton Court Forebay Inflow	Byron-Bethany Irrigation District	Delta Outflow Index
1	65,083	238	5,304	4344	98	2813	0	73,740
2	64,410	238	6,241	4340	94	131	0	77,060
3	63,248	238	6,371	4361	87	65	0	74,270
4	63,261	238	6,449	4,333	87	5,734	0	64,890
5	75,684	238	7,114	4,326	87	3,787	0	76,420
6	87,883	238	8,913	4,357	23	684	0	106,250
7	91,604	238	8,851	4,329	31	1,048	0	151,730
8	88,601	238	9,365	4,343	82	1,396	0	166,620
9	84,055	238	9,846	4,353	85	3,206	0	155,720
10	81,054	238	10,111	4,328	97	3,865	0	135,320
11	77,190	238	10,501	4,308	104	4,682	0	114,270
12	74,328	238	10,832	2,382	104	3,534	0	99,490
13	73,172	238	10,754	3,320	110	3,347	0	92,320
14	72,868	238	10,500	4,436	118	3,853	0	88,230
15	72,038	238	10,443	4,437	115	3,730	0	85,670
16	71,608	238	10,417	4,431	112	4,531	0	82,240
17	72,814	238	10,424	4,445	60	3,276	0	83,900
18	74,451	238	10,525	4,381	102	2,846	0	87,470
19	78,346	238	10,717	4,333	101	4,385	0	93,100
20	85,353	238	11,062	4,286	101	4,080	0	109,620
21	89,929	238	12,316	4,273	79	3,944	0	142,460
22	91,513	238	13,294	2,449	75	2,630	0	181,360
23	90,352	238	13,951	1,851	68	2,799	0	202,890
24	87,538	238	14,024	1,922	76	2,492	0	206,160
25	85,145	238	14,434	1,933	70	2,772	0	199,180
26	82,239	238	14,576	1,921	72	2,264	0	188,080
27	78,880	238	14,461	1,911	70	2,704	0	174,120
28	76,459	238	14,241	1,901	62	4,037	0	158,160
29	74,631	238	14,130	1,923	55	1,815	0	144,280
TOTAL	2,080,996	6,902	310,167	104,257	2,424	86,451	0	3,615,020
AVERAGE	80,038	223	10,005	3,363	78	2,789	0	116,614

Appendix F. Delta outflow (in cfs): January -- July 1996

March 1996

Date	Sacramento River at Freeport	Sacramento Treatment Plant	San Joaquin River Near Vernalis	Tracy Pump	Contra Costa Pump	Clifton Court Forebay Inflow	Byron-Bethany Irrigation District	Delta Outflow Index
1	73,001	225	14,034	1,914	63	1,937	0	138,770
2	73,230	225	13,972	1,918	59	2,361	0	130,980
3	72,177	225	13,917	1,914	66	5,325	0	124,870
4	71,500	225	14,145	520	0	3,588	0	124,720
5	71,104	225	14,443	0	0	3,011	0	122,680
6	71,003	225	15,093	0	0	2,089	0	127,840
7	70,030	225	15,850	0	0	1,757	0	122,410
8	68,768	225	16,255	0	56	538	0	118,650
9	68,111	225	16,601	0	94	0	0	111,040
10	67,287	225	16,832	0	91	322	0	104,980
11	66,906	225	16,726	0	85	1,962	0	98,830
12	68,190	225	16,626	0	81	5,301	0	93,040
13	68,957	225	16,531	0	82	3,952	0	99,810
14	68,197	225	16,136	1,558	84	2,253	0	102,950
15	67,312	225	15,445	1,720	84	2,363	0	99,130
16	66,627	225	14,885	1,723	78	2,054	0	94,220
17	65,840	225	14,691	1,715	85	1,813	0	89,500
18	64,448	225	14,781	1,717	92	1,486	0	85,850
19	61,935	225	14,937	509	108	1,893	0	82,740
20	58,716	225	14,999	0	109	2,216	0	78,940
21	55,553	225	15,169	236	96	2,064	0	75,640
22	51,966	225	15,205	0	94	2,008	0	72,800
23	48,512	225	14,750	0	91	3,556	0	67,750
24	44,558	225	13,916	570	94	4,144	0	62,540
25	41,551	225	12,995	894	96	1,114	0	60,010
26	38,964	225	12,122	945	90	3,243	0	53,960
27	36,371	225	12,046	1,020	102	2,834	0	50,410
28	34,888	225	11,810	1,020	105	4,714	0	45,530
29	34,182	225	11,702	1,018	104	4,595	0	43,230
30	34,122	225	11,384	1,020	97	4,801	0	42,220
31	33,944	225	10,507	1,019	98	5,627	0	40,760
TOTAL	1,817,950	6,975	448,505	22,949	2,323	84,920	0	2,766,800
AVERAGE	58,644	225	14,468	740	77	2,739	0	89,252

Appendix F. Delta outflow (in cfs): January -- July 1996

April 1996

Date	Sacramento River at Freeport	Sacramento Treatment Plant	San Joaquin River Near Vernalis	Tracy Pump	Contra Costa Pump	Clifton Court Forebay Inflow	Byron-Bethany Irrigation District	Delta Outflow Index
1	34,905	201	9,869	1,022	97	6,246	0	38,890
2	39,624	201	9,604	3,219	91	2,621	0	41,850
3	45,059	201	9,789	4,355	87	2,267	0	47,390
4	47,170	201	9,373	4,450	85	2,259	0	53,240
5	45,185	201	8,712	4,279	88	2,165	0	53,610
6	42,935	201	8,046	4,357	87	2,583	0	49,660
7	40,881	201	7,680	4,182	84	2,777	0	45,510
8	38,988	201	7,421	4,348	84	2,670	7	42,960
9	38,239	201	7,145	4,339	107	1,363	25	41,620
10	36,993	201	6,969	4,326	108	1,482	24	40,570
11	36,214	201	6,909	4,337	109	2,036	29	38,500
12	36,030	201	6,685	4,335	104	3,179	20	36,470
13	35,806	201	6,595	4,308	111	4,982	20	34,180
14	35,462	201	6,434	4,312	111	5,674	13	33,020
15	34,763	201	6,397	1,888	115	610	20	39,960
16	36,801	201	6,377	1,010	120	579	0	40,030
17	39,197	201	6,392	1,005	107	591	0	42,240
18	41,908	201	6,536	1,005	107	590	0	45,250
19	43,777	201	6,791	951	109	634	0	48,740
20	44,605	201	6,958	1,004	112	634	0	50,460
21	42,788	201	7,053	1,007	112	745	0	51,290
22	39,866	201	7,066	882	106	893	15	49,490
23	36,832	201	6,952	824	56	942	51	46,650
24	35,086	201	6,532	841	77	876	25	43,650
25	32,697	201	6,292	858	103	793	30	41,430
26	30,195	201	6,406	852	116	791	76	38,670
27	29,575	201	6,437	875	127	743	76	35,970
28	28,804	201	6,397	872	126	841	76	35,260
29	28,504	201	6,400	871	146	713	74	34,480
30	27,990	201	6,334	874	156	856	70	33,920
TOTAL	1,126,879	6,030	216,551	71,790	3,049	54,136	652	1,274,960
AVERAGE	37,563	201	7,218	2,393	105	1,805	22	42,499

Appendix F. Delta outflow (in cfs): January -- July 1996

May 1996

Date	Sacramento River at Freeport	Sacramento Treatment Plant	San Joaquin River Near Vernalis	Tracy Pump	Contra Costa Pump	Clifton Court Forebay Inflow	Byron-Bethany Irrigation District	Delta Outflow Index
1	27,117	197	6,279	881	150	713	109	33,480
2	25,977	197	6,356	885	168	701	73	32,450
3	25,566	197	6,178	917	158	834	141	31,330
4	26,974	197	6,200	907	171	763	101	30,720
5	27,142	197	6,272	909	173	582	91	32,290
6	25,783	197	6,497	927	176	780	137	32,280
7	23,055	197	6,299	891	172	791	94	31,100
8	20,939	197	6,074	875	173	687	120	28,220
9	19,573	197	6,192	879	174	632	90	25,970
10	18,096	197	6,376	886	175	809	96	24,380
11	16,867	197	6,616	888	170	823	101	23,070
12	16,636	197	6,690	925	188	879	101	21,900
13	17,034	197	6,706	701	181	1,032	93	21,820
14	17,360	197	6,614	717	176	1,031	85	22,160
15	18,270	197	7,011	909	151	795	64	22,330
16	25,913	197	8,089	910	142	2,228	57	22,370
17	58,420	197	8,619	919	106	2,132	9	34,650
18	69,960	197	9,036	916	84	2,196	51	66,320
19	81,500	197	10,126	914	112	2,153	25	77,770
20	80,158	197	10,941	907	118	2,210	31	89,820
21	76,136	197	11,105	3,324	141	4,059	55	84,620
22	71,988	197	11,296	4,362	127	4,056	55	79,500
23	68,291	197	11,594	4,353	146	4,076	78	75,500
24	66,842	197	11,657	4,346	159	4,003	62	71,330
25	66,016	197	11,688	4,350	160	6,008	63	67,840
26	61,983	197	11,353	4,337	157	6,004	51	66,890
27	55,618	197	11,009	4,337	147	5,999	51	62,520
28	49,084	197	10,422	4,330	151	5,989	71	55,710
29	44,685	197	9,763	4,328	157	6,104	97	48,530
30	40,860	197	8,698	4,308	160	6,071	62	43,320
31	38,002	197	7,231	4,376	169	6,139	70	38,230
TOTAL	1,281,845	6,107	258,987	64,417	4,640	81,278	2,383	1,398,420
AVERAGE	41,350	197	8,354	2,078	155	2,622	77	45,110

Appendix F. Delta outflow (in cfs): January -- July 1996

June 1996

Date	Sacramento River at Freeport	Sacramento Treatment Plant	San Joaquin River Near Vernalis	Tracy Pump	Contra Costa Pump	Clifton Court Forebay Inflow	Byron-Bethany Irrigation District	Delta Outflow Index
1	36,035	197	5,975	4,385	173	5,981	0	33,810
2	34,046	197	5,841	4,554	173	5,989	60	30,420
3	32,755	196	5,594	4,391	155	5,972	97	28,490
4	32,623	196	5,477	4,416	34	5,910	115	27,290
5	31,236	195	4,901	4,431	0	6,323	99	26,380
6	30,735	195	4,531	4,444	110	6,451	90	24,160
7	29,965	194	4,146	4,483	187	4,889	91	24,630
8	29,291	194	3,955	4,521	190	6,672	91	21,530
9	28,640	193	4,054	4,548	207	6,303	91	20,940
10	27,878	193	4,341	4,548	212	6,661	85	19,990
11	27,202	193	4,334	4,489	207	526	143	25,860
12	26,251	193	4,056	4,462	92	0	66	25,760
13	24,885	193	5,367	4,306	218	5,136	191	19,470
14	24,251	193	3,706	4,608	227	6,560	117	17,490
15	22,667	193	3,769	4,380	234	6,564	101	15,310
16	20,810	193	3,782	4,381	233	6,193	101	14,120
17	20,928	193	3,786	4,420	235	5,955	161	12,530
18	20,611	193	3,571	4,147	240	6,586	151	12,240
19	20,350	193	3,460	4,438	237	4,167	177	13,730
20	19,842	193	3,284	4,396	243	5,194	146	12,210
21	18,462	193	3,162	4,359	235	5,532	103	11,150
22	18,316	193	3,090	4,413	238	5,096	101	10,010
23	18,306	193	3,173	4,397	228	5,099	101	9,690
24	18,294	193	3,163	4,416	72	5,085	53	9,920
25	18,792	193	3,067	4,376	178	4,527	141	10,430
26	18,380	193	3,071	4,376	214	3,123	128	12,160
27	18,667	193	3,085	4,409	215	5,594	92	9,200
28	18,185	193	3,169	4,378	215	4,054	62	11,120
29	18,547	193	3,148	4,356	217	2,981	63	11,750
30	19,738	193	3,136	4,238	224	4,417	63	10,620
TOTAL	726,688	5,810	119,194	128,081	5,643	153,540	3,080	532,410
AVERAGE	24,223	194	3,973	4,417	188	5,118	103	17,747

Appendix F. Delta outflow (in cfs): January -- July 1996

July 1996

Date	Sacramento River at Freeport	Sacramento Treatment Plant	San Joaquin River Near Vernalis	Tracy Pump	Contra Costa Pump	Clifton Court Forebay Inflow	Byron-Bethany Irrigation District	Delta Outflow Index
1	20,618	193	3,117	4,303	207	4,072	76	12,100
2	21,576	193	2,953	4,371	49	4,890	60	11,970
3	21,936	194	2,833	4,466	1	4,474	66	13,340
4	22,180	195	2,778	4,442	112	2,197	66	15,830
5	22,071	196	2,656	4,475	239	6,299	66	11,820
6	21,530	196	2,520	4,470	241	6,157	66	11,610
7	20,434	197	2,501	4,512	243	6,596	101	10,440
8	20,481	198	2,569	4,489	243	6,575	80	9,360
9	21,040	199	2,459	4,462	241	6,551	103	9,530
10	21,006	199	2,366	4,462	245	5,849	104	10,690
11	20,736	199	2,345	4,336	241	6,372	96	10,120
12	20,717	199	2,301	4,273	243	6,541	87	9,730
13	20,787	199	2,258	4,433	238	6,468	95	9,600
14	20,729	199	2,329	4,489	238	6,583	88	9,380
15	20,812	199	2,444	4,393	240	6,957	101	9,190
16	20,753	199	2,386	4,508	239	6,513	80	9,720
17	20,237	199	2,451	4,519	239	6,197	80	9,980
18	20,348	199	2,414	4,534	242	6,213	85	9,510
19	20,041	199	2,442	4,497	239	6,098	109	9,720
20	19,876	199	2,421	4,440	237	6,338	101	9,200
21	19,513	199	2,552	4,498	233	5,171	94	10,170
22	20,020	199	2,600	4,469	223	6,470	92	8,680
23	20,403	199	2,396	4,460	210	6,564	95	9,110
24	20,250	199	2,283	4,473	221	6,580	81	9,230
25	20,232	199	2,159	4,490	215	6,739	127	8,840
26	20,077	199	2,174	4,486	212	6,666	114	8,800
27	20,105	199	2,333	4,452	214	6,451	101	8,890
28	19,985	199	2,313	4,434	203	6,494	101	9,060
29	19,907	199	2,543	4,404	30	6,611	116	9,050
30	20,239	199	2,435	4,364	83	6,450	124	9,420
31	21,250	199	2,408	4,500	243	6,493	120	9,270
TOTAL	639,889	6,139	76,739	133,601	6,304	188,629	2,875	313,360
AVERAGE	20,642	198	2,475	4,453	203	6,085	93	10,108

Appendix G. Juvenile fall-run chinook salmon smolt physiology database, field measurements: January - July 1996.

Location	Date	Fish No.	FL, mm	TL, mm	WT, g.	K	Total ATPase
UPSHAB	03/09/96	1	45	48	0.8	7.23E-04	1.37
UPSHAB	03/09/96	2	50	53	1.4	9.40E-04	1.12
UPSHAB	03/09/96	3	42	45	0.6	6.58E-04	2.08
UPSHAB	03/09/96	4	39	41	0.5	7.25E-04	0.45
UPSHAB	03/09/96	5	57	62	2.2	9.23E-04	1.88
UPSHAB	03/09/96	6	41	44	0.6	7.04E-04	3.90
UPSHAB	03/09/96	7	38	40	0.4	6.25E-04	0.32
WIDD	03/09/96	1	57	61	1.4	6.17E-04	0.70
WIDD	03/09/96	2	35	37	0.3	5.92E-04	4.59
WIDD	03/09/96	3	39	41	0.4	5.80E-04	2.74
WIDD	03/09/96	4	38	40	0.4	6.25E-04	2.56
WIDD	03/09/96	5	38	39	0.4	6.74E-04	1.70
WIDD	03/09/96	6	33	35	0.3	7.00E-04	0.70
UPSHAB	03/18/96	1	39	40	0.5	7.81E-04	4.55
UPSHAB	03/18/96	2	31	32	0.3	9.16E-04	1.25
UPSHAB	03/18/96	3	64	69	2.4	7.31E-04	1.06
UPSHAB	03/18/96	4	54	57	1.4	7.56E-04	4.16
UPSHAB	03/18/96	5	41	43	0.5	6.29E-04	2.12
UPSHAB	03/18/96	6	35	36	0.4	8.57E-04	1.29
WIDD	03/18/96	1	33	35	0.3	7.00E-04	0.38
WIDD	03/18/96	2	52	56	1.2	6.83E-04	2.46
WIDD	03/18/96	3	30	32	0.3	9.16E-04	0.49
WIDD	03/18/96	4	75	82	4.3	7.80E-04	1.57
WIDD	03/18/96	5	77	70	3.9	1.14E-03	2.74
WIDD	03/18/96	6	38	36	0.3	6.43E-04	5.08
UPSHAB	04/04/96	1	41	44	0.6	7.04E-04	5.15
UPSHAB	04/04/96	2	61	66	2.2	7.65E-04	6.74
UPSHAB	04/04/96	3	62	68	2.5	7.95E-04	2.74
UPSHAB	04/04/96	4	65	70	2.7	7.87E-04	1.86
UPSHAB	04/04/96	5	68	73	3.1	7.97E-04	2.68
UPSHAB	04/04/96	6	55	59	1.6	7.79E-04	3.05
UPSHAB	04/04/96	7	55	60	1.5	6.94E-04	3.81
UPSHAB	04/04/96	8	41	45	0.6	6.58E-04	1.50
UPSHAB	04/04/96	9	60	65	2.3	8.38E-04	3.77
UPSHAB	04/04/96	10	41	44	0.6	7.04E-04	4.60
UPSHAB	04/04/96	11	46	49	0.8	6.80E-04	0.53
WIDD	04/04/96	1	69	75	3.1	7.35E-04	1.00
WIDD	04/04/96	2	73	79	3.4	6.90E-04	2.43
WIDD	04/04/96	3	68	74	3	7.40E-04	4.56
WIDD	04/04/96	4	69	76	3.1	7.06E-04	3.80
WIDD	04/04/96	5	75	82	4.1	7.44E-04	3.89
WIDD	04/04/96	6	79	86	5.1	8.02E-04	2.08
WIDD	04/04/96	7	100	109	10.2	7.88E-04	2.99
WIDD	04/04/96	8	76	84	4.1	6.92E-04	2.72
WIDD	04/04/96	9	84	92	6.1	7.83E-04	1.85
WIDD	04/04/96	10	82	90	5.3	7.27E-04	2.51
UPSHAB	04/18/96	1	85	94	6.1	7.34E-04	7.21
UPSHAB	04/18/96	2	65	70	2.7	7.87E-04	4.27
UPSHAB	04/18/96	3	76	81	4.1	7.71E-04	4.38
UPSHAB	04/18/96	4	77	83	4.4	7.70E-04	6.04
UPSHAB	04/18/96	5	81	89	4.2	5.96E-04	5.00

Appendix G. Juvenile fall-run chinook salmon smolt physiology database, field measurements: January - July 1996.

Location	Date	Fish No.	FL, mm	TL, mm	WT, g.	K	Total ATPase
UPSHAB	04/18/96	6	59	65	2.4	8.74E-04	4.32
UPSHAB	04/18/96	7	62	67	2.4	7.98E-04	3.18
UPSHAB	04/18/96	8	68	74	5.1	1.26E-03	3.78
UPSHAB	04/18/96	9	76	83	4.1	7.17E-04	4.41
UPSHAB	04/18/96	10	79	86	4.7	7.39E-04	3.83
WIDD	04/18/96	1	95	104	7.8	6.93E-04	3.20
WIDD	04/18/96	2	89	100	6.9	6.90E-04	7.46
WIDD	04/18/96	3	93	102	8	7.54E-04	7.21
WIDD	04/18/96	4	86	96	5.9	6.67E-04	6.49
WIDD	04/18/96	5	88	97	6.8	7.45E-04	6.20
WIDD	04/18/96	6	91	100	7.6	7.60E-04	6.54
WIDD	04/18/96	7	86	96	6.5	7.35E-04	9.14
WIDD	04/18/96	8	86	95	6	7.00E-04	7.79
WIDD	04/18/96	9	92	102	8.3	7.82E-04	7.24
WIDD	04/18/96	10	86	94	6.8	8.19E-04	7.50
UPSHAB	05/09/96	1	73	80	4	7.81E-04	
WIDD	05/08/96	1	103	94	8.6	1.04E-03	5.13
WIDD	05/08/96	2	105	115	11.8	7.76E-04	3.98
WIDD	05/08/96	3	83	91	6.2	8.23E-04	4.62
WIDD	05/08/96	4	98	110	9.5	7.14E-04	1.69
WIDD	05/08/96	5	106	95	8.5	9.91E-04	2.79
WIDD	05/08/96	6	102	112	11.2	7.97E-04	3.05
WIDD	05/08/96	7	101	112	11	7.83E-04	3.83
WIDD	05/08/96	8	100	111	10.7	7.82E-04	2.75
WIDD	05/08/96	9	94	104	9	8.00E-04	3.48
WIDD	05/08/96	10	88	97	6.9	7.56E-04	5.19
WIDD	05/22/96	1	98	110	8.8	6.61E-04	1.61
WIDD	05/22/96	2	99	110	10.3	7.74E-04	3.86
WIDD	05/22/96	3	105	117	11.4	7.12E-04	6.76
WIDD	05/22/96	4	94	104	8.3	7.38E-04	12.71
WIDD	05/22/96	5	99	110	10.1	7.59E-04	7.64
WIDD	05/22/96	6	113	123	13.7	7.36E-04	3.20
WIDD	05/22/96	7	113	124	14.2	7.45E-04	7.72
WIDD	05/22/96	8	104	114	10.8	7.29E-04	8.02
WIDD	05/22/96	9	100	110	10.1	7.59E-04	8.42
WIDD	05/22/96	10	103	112	11.2	7.97E-04	6.95
UPSHAB	05/26/96	1					
UPSHAB	05/26/96	2	94	103	9.1	8.33E-04	3.58
UPSHAB	05/26/96	3	69	77	3.8	8.32E-04	2.37
UPSHAB	05/26/96	4	95	105	9.2	7.95E-04	2.35
UPSHAB	05/26/96	5	100	112	11.6	8.26E-04	5.35
UPSHAB	05/26/96	6	95	105	10.1	8.72E-04	7.57
UPSHAB	05/26/96	7	96	105	9.6	8.29E-04	6.06
UPSHAB	05/26/96	8	87	96	7.1	8.02E-04	7.60
UPSHAB	05/26/96	9	97	108	10.3	8.18E-04	6.69
UPSHAB	05/26/96	10	89	98	7.6	8.07E-04	2.61
UPSHAB	05/26/96	11					
UPSHAB	05/26/96	12					
UPSHAB	05/26/96	13					
UPSHAB	05/26/96	14					
UPSHAB	05/26/96	15	90	99	8.4	8.66E-04	4.29

Appendix G. Juvenile fall-run chinook salmon smolt physiology database, field measurements: January - July 1996.

Location	Date	Fish No.	FL, mm	TL, mm	WT, g.	K	Total ATPase
UPSHAB	05/26/96	16	94	104	9.4	8.36E-04	6.15
UPSHAB	05/26/96	17	92	102	8.8	8.29E-04	7.39
UPSHAB	05/26/96	18	95	105	9.8	8.47E-04	5.18
WIDD	06/16/96	1	104	115	11.7	7.69E-04	4.49
WIDD	06/16/96	2	101	111	11	8.04E-04	9.71
WIDD	06/16/96	3	106	115	13	8.55E-04	7.32
WIDD	06/16/96	4	114	129	16.7	7.78E-04	12.36
WIDD	06/16/96	5	98	108	9.8	7.78E-04	7.42
WIDD	06/16/96	6	89	98	7.6	8.07E-04	9.12
WIDD	06/16/96	7	104	94	10.1	1.22E-03	13.04
WIDD	06/16/96	8	105	97	9	9.86E-04	13.25
WIDD	06/16/96	9	104	114	12.1	8.17E-04	10.75
WIDD	06/16/96	10	97	107	9.8	8.00E-04	10.92
UPSHAB	06/17/96	1	104	114	12.4	8.37E-04	8.28
WIDD	06/30/96	1	109	119	12.9	7.66E-04	10.09
WIDD	06/30/96	2	98	110	11.9	8.94E-04	11.49
WIDD	06/30/96	3	95	103	9	8.24E-04	4.72
WIDD	06/30/96	4	109	121	15.7	8.86E-04	8.56
WIDD	06/30/96	5	98	106	10.4	8.73E-04	4.97
WIDD	06/30/96	6	108	118	10.6	6.45E-04	11.8
WIDD	06/30/96	7	122	135	17.7	7.19E-04	10.19
WIDD	06/30/96	8	93	103	7.9	7.23E-04	12.38
WIDD	06/30/96	9	100	107	10	8.16E-04	9.52
WIDD	06/30/96	10	97	105	9.5	8.21E-04	7.1
UPSHAB	07/01/96	1	98	108	11.2	8.89E-04	7.88