YUBA RIVER JUVENILE CHINOOK SALMON, *ONCORHYNCHUS TSHAWYTSHA*, AND JUVENILE CENTRAL VALLEY STEELHEAD TROUT, *ONCORHYNCHUS MYKISS*, LIFE HISTORY SURVEY, ANNUAL DATA REPORT 2004-2005

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Table of Contents

Introduction

The Yuba River, a tributary of the Feather River, drains a watershed of 2,154 square kilometers, originating in the higher elevations of the west slope of the Sierra Nevada. The North, Middle and South Yuba rivers converge near, and are impounded by the U.S. Army Corps of Engineers' Englebright Dam (approximately 39 river kilometers east of the city of Marysville), which represents the upper limits of anadromous fish migration. The lower Yuba River below Englebright Dam provides spawning and rearing habitat for adult and juvenile spring-, fall-, and late fall-run Chinook salmon (*Oncorhynchus tshawytscha*), as well as Central Valley steelhead trout (*Oncorhynchus mykiss*) (Drury, 2003). The river supports other anadromous species including American shad and striped bass below Daguerre Point Dam (approximately 19 river kilometers below Englebright Dam).

Historically, the spring-run Chinook salmon was considered the most abundant run of salmon in the Central Valley of California, with yearly escapements in the Sacramento River estimated to have reached 600,000 spawners. Historically spring-run was also a major component of the Yuba River fishery. Currently, spring-run Chinook salmon are listed as Threatened under both the Federal and State Endangered Species acts, while Central Valley steelhead trout are listed as Threatened under the Federal Endangered Species Act. Limited life history information on juvenile salmonids (spring-, fall-, and late fall-run Chinook salmon and Central Valley steelhead trout) in the lower Yuba River exists, and additional studies are needed to manage for these species. This study was conducted to continue development of baseline information for the Central Valley Project Improvement Act's (CVPIA), Anadromous Fish Restoration Program (AFRP) for juvenile salmon and steelhead trout life history strategies on the lower Yuba River. Data were collected to determine and document the timing of downstream movement, the duration of downstream movement, to determine abundance and/or relative abundance, and to monitor the condition and size of downstream migrants. Emigrating juvenile salmon were coded-wire tagged (CWT) in an effort to enumerate and determine the relative contribution to the adult escapement on the Yuba River by differing life history strategies employed by juvenile Chinook salmon.

Methods

Trap Location

Juvenile Chinook salmon and steelhead trout were captured using two rotary screw traps (RST) equipped with an eight-foot diameter cone, manufactured by E.G. Solutions in Corvallis, Oregon. Both RSTs were located on the Yuba River, approximately 10 kilometers east of the city of Marysville, adjacent to the south end of Hallwood Boulevard. The sampling site was downstream of most available salmon and steelhead spawning habitat. The RSTs were tethered by an earth anchor situated at the downstream terminus of a large gravel bar. The site allowed for a wide range of flexibility in the RSTs' orientation to, and their location in the river channel for optimum sampling during all flows. Except during extraordinarily high water flows or during periods of excessive debris, RST 1 was fished 24-hours-per-day, seven-days-a-week from October 21, 2004 through June 27, 2005. RST 2 was fished in tandom with RST 1 from April 26, 2005 through June 20, 2005.

Data Collection

All fish were netted daily from each RST live box and immediately placed in five-gallon buckets equipped with portable aerators and fresh river water. Juvenile Chinook salmon and steelhead trout were separated from other species and transferred with small aquarium nets into additional five-gallon buckets equipped with portable aerators and held for processing. A sub-sample containing a minimum of 100 juvenile Chinook salmon, or 10% of the total captured (whichever number was greatest) was anesthetized in a shallow tub containing a weak solution (2/3 gram per liter of water) of tricaine methanesulfonate (MS-222). Upon immobilization, each fish was measured to the nearest millimeter (mm) in fork length (FL), weighed to the nearest tenth of a gram, and assigned to race. Chinook salmon race was classified by size-at-capture criteria (Fisher, 1992). Although the Fisher size-at-capture criteria do not apply to all Central Valley streams, they appear to provide a good measure for Chinook salmon on the Yuba River during some periods of emigration. All remaining salmon were individually counted. If the number of salmon remaining was too great to efficiently count individually (> 8,000 fish), then volumetric estimation was used in lieu of an exact enumeration. This was accomplished by filling a standardized container to the half-full mark with water and adding a documented number of fish until a complete volume was reached without the loss of any water. This process was repeated three times to produce an average number of fish for the known volume. Following RST work up, all juvenile Chinook salmon were held in holding pens placed in the river channel until such a number had been accrued to facilitate coded-wire tagging.

In order to obtain a relative measure of trapping efficiency, bi-monthly calibrations were conducted using a sub-sample of no less than 300 Chinook salmon. The sub-sample was marked using a solution of Bismark brown and fresh river water (8 grams Bismark brown per 380 liters of water). The marked salmon were held for 24-hours to insure all marked fish exhibited normal behavior and to assess any mortality that may have been caused by the staining process. The marked group was then released approximately 0.5 kilometers upstream from the trapping location, and was spread across a cross-section of the river to allow for random dispersement. The number of Chinook salmon recaptured in subsequent sampling was recorded on a daily basis and was used to develop trap efficiencies for differing flow regimes and salmon size classes for each trap. Additional calibration tests were conducted in addition to the bi-monthly tests if the flows or average fish size was determined to have changed substantially between the normal calibration frequency.

All juvenile steelhead trout were individually measured using the same protocol employed for juvenile Chinook salmon. In addition, a juvenile steelhead trout life-stage rating protocol (smolt index) based on ontogenetic characteristics was utilized to provide information on smolt development over time and space (Table 1) (Snider and Titus, 1995). In this rating system, each individual steelhead trout was given a numeric code that represented a particular smolting stage. All steelhead trout were released approximately 100 meters (m) downstream of the rotary screw traps.

Table 1. Juvenile Steelhead trout life-stage descriptive index based on ontogenetic characteristics observed at date of capture.

Numeric Code	Abbreviation	Description
1	YSF	Yolk Sac Fry - newly emerged with visible yolk sac.
2	FRY	Fry - recently emerged with yolk sac absorbed, pigmentation undeveloped.
3	PAR	Parr - darkly pigmented with distinct parr marks, no silvery coloration, and scales firmly set.
4	SPR	Silvery Parr - parr marks visible but faded, intermediate degree of silvering.
5	SMT	Smolt - parr marks highly faded or absent, bright silver or nearly white coloration, and scales easily shed (deciduous).

Coded-Wire Tagging

Captured salmon were transported via aerated buckets to the tagging facility located immediately downstream of the RST. Fish were tagged using three Northwest Marine Technology Tag Injectors, Model MKIV and Model MKIV Quality Control Devices (QCD). Injectors were initially fitted with a 1,100-fish/lb head mold and were changed periodically to accommodate for growth later in the season. Fish were anaesthetized in a weak solution (2/3 gram per liter of water) of MS-222, adipose-fin clipped, then tagged with a half-length (0.5 mm) decimal coded tag in the rostrum. All tagged fish were held for observation for 24 hours. A sub-sample (10% or greater) of the held fish were re-run through the QCD to obtain a 24-hour tag shedding rate and then released approximately 100 meters downstream of the RST. Tag codes were changed every 14 days or after use of an entire CWT spool, whichever was more frequent.

Abiotic Measurements

Ambient river water temperature was monitored using an Onset Model WTA032 temperature data logger. The Onset data logger was placed inside the RST live box within a short section of perforated steel pipe and suspended by a steel cable. Data loggers were set for 15-minute interval readings and were downloaded monthly.

Water velocities were measured at the anterior end of the RST, directly in front of the rotating cone with a Marsh-McBirney Flo-Mate, Model 2000. The velocity probe was attached to a graduated aluminum staff and was submerged to a depth of 0.61m below the water surface. Each velocity measurement was taken at a preset averaged period of ten seconds, and was recorded as the velocity reading for the entire 24-hr period.

Turbidity was recorded daily using a Hach, Model 2100P, portable turbidity meter. A representative sample of water was collected directly adjacent to the RST. All turbidity measurements were recorded in Nephelometric Turbidity Units (ntu).

RST cone revolutions were recorded through the use of a Reddington Counters Inc., Model 1-2936 mechanical counter. Total revolutions for the 24-hr period were recorded and the counter was reset each day.

Flows were monitored at the Marysville gage through the California Department of Water Resources' (DWR) online California Data Exchange Center (CDEC).

Results

RST 1 was installed on October 21, 2004. The trap was fished continuously from October 21, 2004 to June 27, 2005 unless periods of high flow and/or heavy debris required field crews to cease operations until flows and debris loading returned to lower levels. RST 1 was not fished from December 9, 2004 to December 10, 2004, from December 31, 2004 to January 1, 2005, and from May 19, 2005 to May 26, 2005 due to high flows and debris loading.

RST 2 was installed adjacent to RST 1 on April 26, 2005. RST 2 was fished in tandem with RST 1 from April 26, 2005 to June 20, 2005 to increase captures of smolt-sized Chinook salmon for coded-wire tagging. RST 2 was not fished from May 19, 2005 to May 26, 2005 due to unseasonably high flows and debris loading during this period.

Twenty-two species of fish were captured during the sampling period (Table 2), including a total of 285,034 juvenile Chinook salmon. Bi-weekly summaries of the 2004-2005 Chinook salmon catch are reported in Appendix A. For comparison, 307,397 juvenile Chinook salmon were captured utilizing a single trap during the 2003-2004 sampling season. Steelhead trout were captured significantly less frequently in both traps and totaled 614 fish during the October 2004 – June 2005 trapping period. Bi-weekly summaries of steelhead trout catch are reported in Appendix B. In comparison, during the 2003-2004 sampling season 590 juvenile steelhead trout were captured with one RST.

Total monthly juvenile Chinook salmon captures for January, February and March 2005 were 66,882, 115,052, and 67,774, respectively. Peak captures of Chinook salmon fry this season were observed later in the calendar year than in the previous 2003-2004 season, but modeled observations from earlier monitoring efforts (1999-2002). Monitoring conducted at the same site from 1999 through 2002 revealed that peak catches occur between January and March of each year (Drury, 2003). Current observations of emigrating fry captured in the RST were similar to those described by Drury (2003) (Appendix A, Figures A-5, A-6).

RST calibrations were conducted to assess trap efficiency under varying flows. Fry were utilized primarily, as smolt-sized Chinook salmon were not captured in sufficient numbers. Twelve calibrations were completed between November 29, 2004 and June 6, 2005 (Table 3). The majority of marked releases were recaptured on day one following the release, and recaptures would infrequently be observed as late as day three or four. Interestingly, no recaptures were recovered from RST 2. Only two calibrations were conducted during the period that RST 2 was fishing due to low overall Chinook salmon catch totals and due to the unseasonably high flows in May that forced field crews to cease trapping operations for eight days. Aside from the difficulties surrounding the late-season efficiencies, the calibrations have still provided a relative measure to assess the number of emigrating juvenile salmon moving downstream at the RST site. RST efficiency during the calibration period (November 2004 – June 2005) ranged from 0.94% to 7.62%, with the majority of calibration values falling between 1.97% and

6.65%. Calibration values observed during the 2003-2004 sampling season (1.42% - 7.36%) were similar to those observed during the 2004-2005 study. Calibration values changed with varying average daily flows for the capture period. RST efficiency values indicated that the peak captures of juvenile Chinook salmon observed from late January 2005 through early March 2005 corresponded with the lowest RST efficiencies observed during the same period, indicating that captures during this period represented a much smaller fraction of the total emigrating juvenile salmon at the RST site.

Table 2. Common and scientific names of species captured during the 2004-2005 season.

Common Name	Species
American shad	*Alosa sapidissima*
Bluegill sunfish	*Lepomis macrochirus*
Brown bullhead	*Ameiurus nebulosus*
California roach	*Lavinia symmetricus*
Chinook salmon	*Oncorhynchus tshawytscha*
Golden shiner	*Notemigonus crysoleucas*
Green sunfish	*Lepomis cyanellus*
Hardhead	*Mylopharodon conocephalus*
Largemouth bass	*Micropterus salmoides*
Mosquitofish	*Gambusia affinis*
Pacific lamprey	*Lampetra tridentatus*
Prickly sculpin	*Cottus asper*
Steelhead trout	*Oncorhynchus mykiss*
Riffle sculpin	*Cottus gulosus*
River lamprey	*Lampetra ayresi*
Sacramento pikeminnow	*Ptychocheilus grandis*
Sacramento sucker	*Catostomus occidentalis*
Smallmouth bass	*Micropterus dolomieui*
Speckled dace	*Rhinichthys osculus*
Tule perch	*Hysterocarpus traski*
White catfish	*Ameiurus catus*
White crappie	*Pomoxis annularis*

Table 3. Summary of RST efficiency calibrations from November 29, 2004 to June 6, 2005.

Date of Release	Release Number	Recaptures				Total Recaptures	Trap Efficiency
		Day 1	Day2	Day 3	Day 4		
11/29/2004	333	20	2	0	0	22	6.59%
12/10/2004	672	28	1	0	0	29	4.27%
12/20/2004	375	25	0	0	0	25	6.65%
1/3/2005	758	15	0	0	0	15	1.97%
1/20/2005	323	22	1	1	1	25	7.62%
2/10/2005	479	13	0	0	1	14	2.90%
2/28/2005	395	0	4	0	0	4	1.00%
3/16/2005	499	13	1	0	0	14	2.80%
3/22/2005	416	0	0	0	0	0	0.00%
3/29/2005	315	3	0	0	0	3	0.94%
4/26/2005	319	4	3	0	0	7	2.16%
6/6/2005	270	12	1	0	0	13	4.59%

Three runs of Chinook salmon (spring-, fall-, and late-fall run) were identified through analysis and identification of modal distributions of captures at the RST (Appendix A). Length-at-date capture criteria developed for run identification on the Sacramento River at Red Bluff were referenced to provide real-time monitoring of incidental take of threatened spring-run Chinook salmon, as the capture criteria generally fit the modal distributions of the three runs reasonable well (Fisher, 1992). Ongoing Chinook salmon monitoring projects (redd surveys, escapement surveys, juvenile monitoring and real-time adult passage monitoring at Daguerre Dam) further suggest that three runs exist on the lower Yuba River. Juvenile Chinook salmon were first observed on November 12, 2004. These early emigrating fish are presumably spring-run due to timing and a general agreement with size-at-date capture criteria; however, no true demarcation can be made between spring- and fall-run Chinook salmon emigrations due to overlaps in spawning, rearing and emigration periods. In contrast, a distinction can be made between fall and late- fall run Chinook salmon, as the latter are marked by a distinct and separate modal peak during the month of April (Appendix A, Figure A-14); and were represented in daily sampling until project commencement in late June. Fall-run Chinook salmon represented the majority of juveniles captured in the lower Yuba River, whereas the spring- and late-fall runs were captured less frequently. This pattern of catch during the 2004-2005 sampling season resembles closely that observed during the 2003-2004 season. .

Coded-wire tagging operations ran from November 29, 2004 through June 7, 2005. This tagging period was similar to the 2003-2004 effort that ran from November 26, 2003 to June 15, 2004. The majority of juvenile Chinook salmon were tagged between early January 2005 and late February 2005. Of the 285,034 total juvenile Chinook salmon captured in the RST, 247,889 were injected with a CWT and adipose-fin-clipped for later identification. Of that total, 242,774 juvenile Chinook salmon were successfully tagged and released (Appendix E, Table E-1) The remaining 5,115 tagged fish either shed their tag (3,337) or perished (1,778) during the tagging process. For comparison, 185,515 juvenile Chinook salmon were injected with a CWT during the 2003-2004 season and 183,305 were successfully tagged and released for that period.

Water temperature data were recorded from November 20, 2004 to June 27, 2005 (Appendix C, Figure C-1). Data were unrecoverable from December 8, 2004 to December 17, 2004 and from March 28, 2005 to May 15, 2005 due to the loss of in-river data loggers from storm flows. Average daily temperatures observed remained between 8^{o}C and 13^{o}C during the winter months. Maximum daily temperatures slightly exceeded the accepted optimum thermal limit of 15^{o}C on several occasions from March 11, 2005 through the end of monitoring activities in June 2005 (Hinze, 1959; Boles, 1988; CDFG, 1998; Ward, 2004).

Water velocities measured at the RST 1 cone ranged from 1.6 ft/s to 5.5 ft/s with a mean value of 2.9 ft/s (Appendix F, Table F-1). Daily turbidity measured at the RST ranged from 0.81 ntu to 70.2 ntu around a mean value of 2.81 ntu (Appendix G, Figure G-1).

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Appendix A:

Chinook Salmon (*Oncorhynchus tshawytscha*) Bi-weekly Captures 2004-2005

Table A-1. Bi-weekly summary of Chinook salmon captures on the Yuba River near Hallwood Blvd., October 1, 2004 to June 27, 2005.

Trapping Period		Mean FL (mm)	Range FL (mm)		Total Captured
10/01/04	10/15/04	n/a	n/a	n/a	0
10/16/04	10/31/04	n/a	n/a	n/a	0
11/01/04	11/15/04	36	32	78	6
11/16/04	11/30/04	36	30	132	1,856
12/1/04	12/15/04	36	25	134	2,909
12/16/04	12/31/04	37	28	50	18,804
01/01/05	01/15/05	40	30	51	21,210
01/16/05	01/31/05	38	28	56	45,672
02/01/05	02/15/05	38	29	70	55,478
02/16/05	02/28/05	40	29	55	59,574
03/01/05	03/15/05	40	30	130	60,678
03/16/05	03/31/05	45	29	91	7,066
04/01/05	04/15/05	50	30	87	2,338
*04/16/05	04/30/05	59	32	94	2,359
*05/01/05	05/15/05	64	33	90	3,026
*05/16/05	05/31/05	69	35	95	681
*06/01/05	06/15/05	70	38	96	2,958
*06/16/05	06/27/05	71	49	81	419

* includes captures from RST 1 and RST 2.

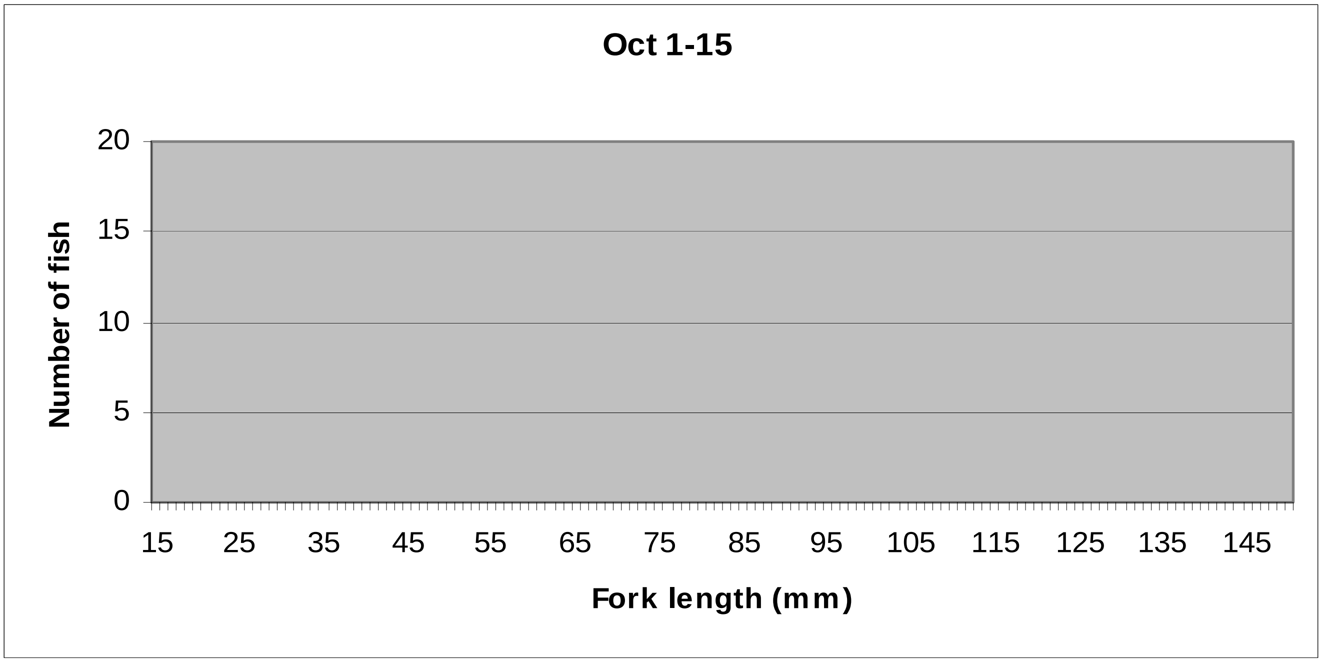

Figure A-1. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, October 1-15, 2004.

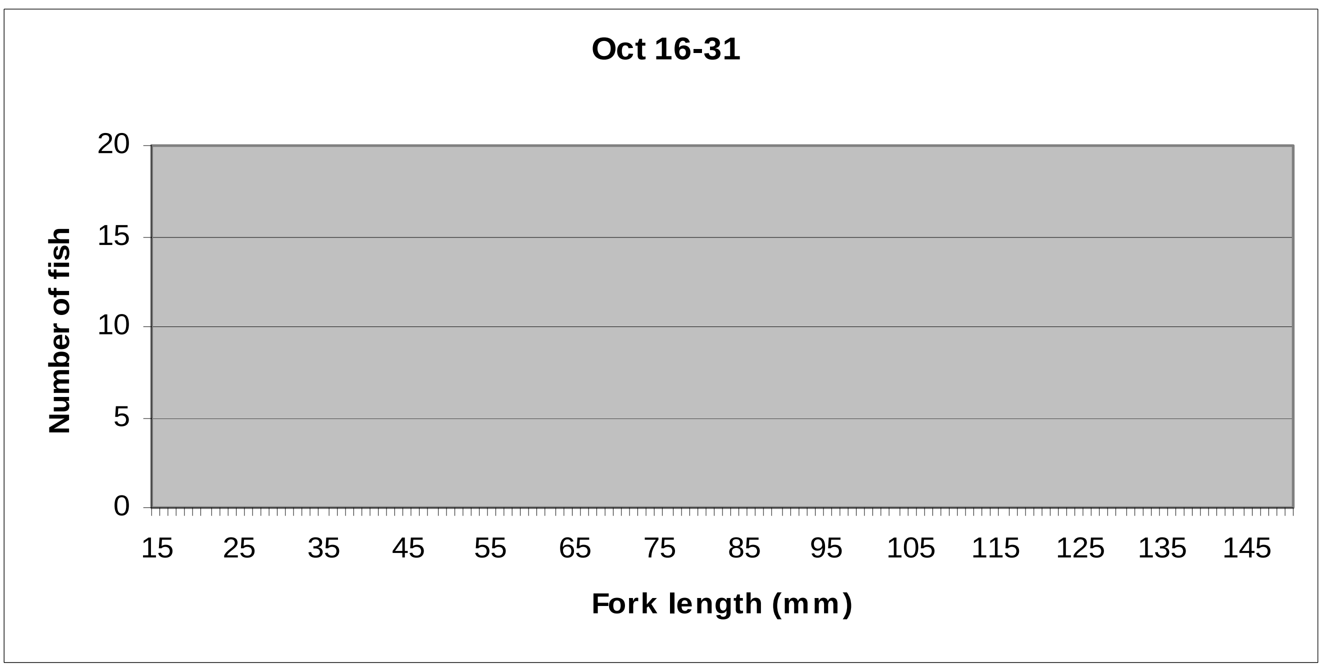

Figure A-2. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, October 16 -31, 2004.

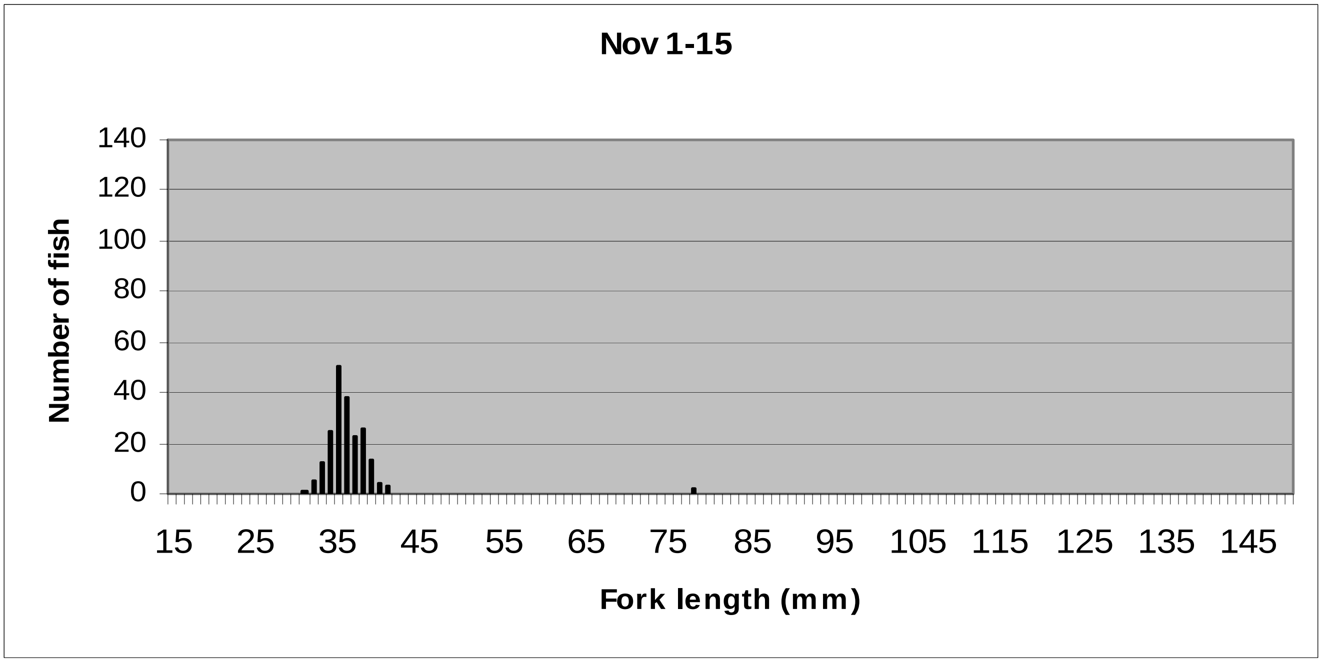

Figure A-3. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, November 1 – 15, 2004.

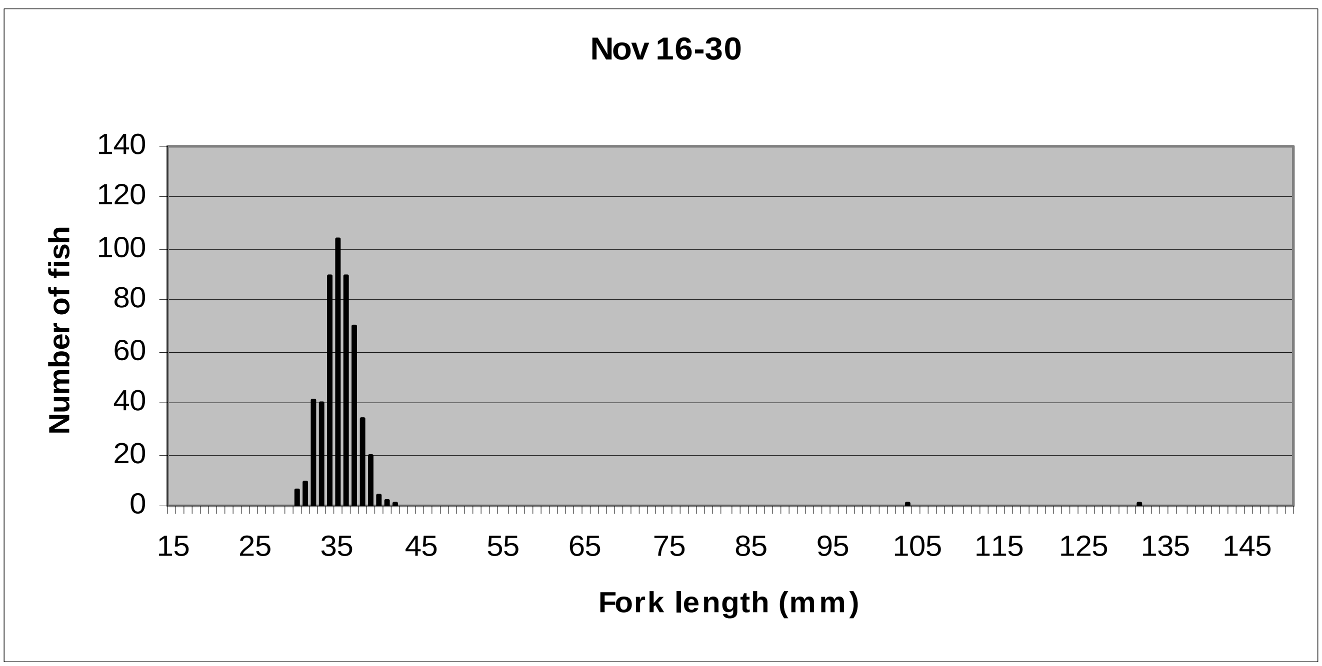

Figure A-4. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, November 16 – 30, 2004.

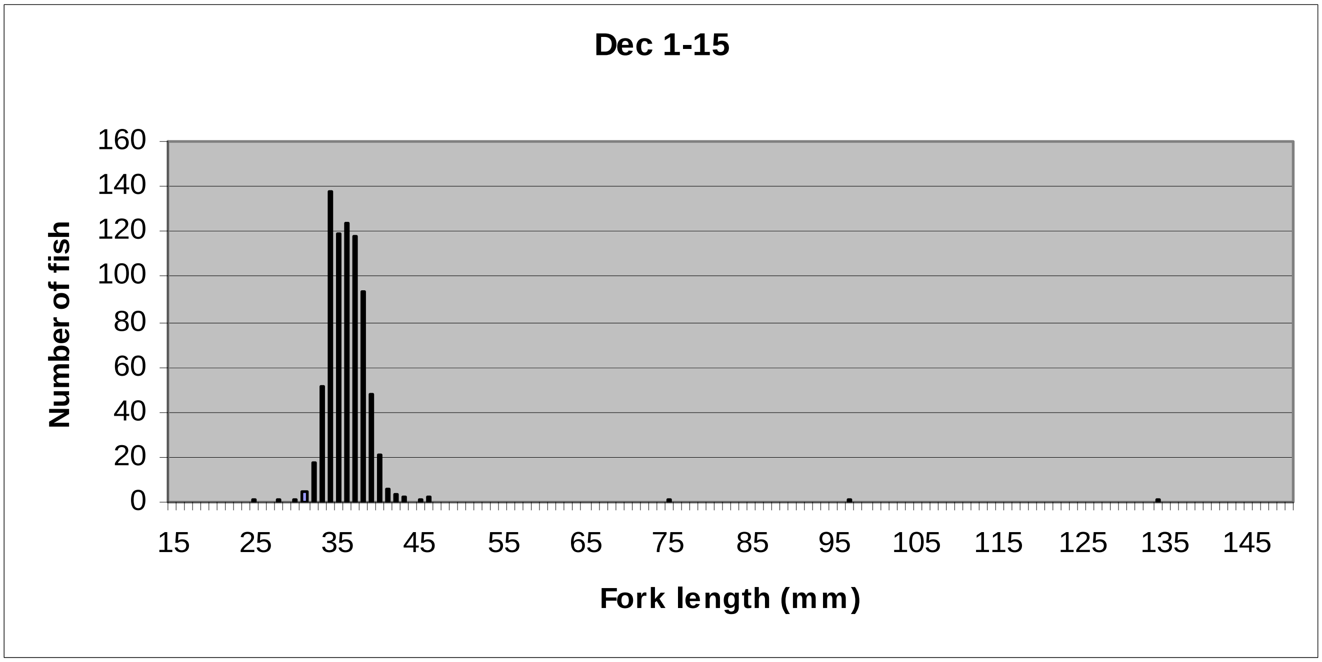

Figure A-5. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, December 1 – 15, 2004.

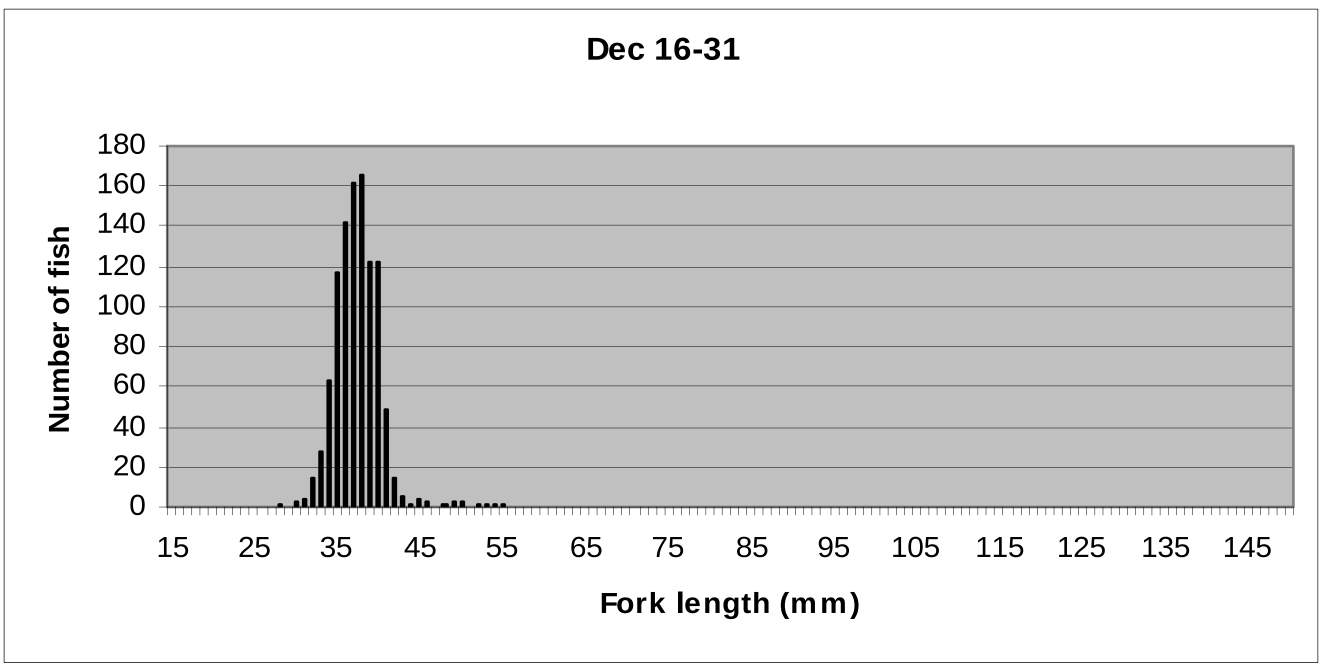

Figure A-6. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, December 16 – 31, 2004.

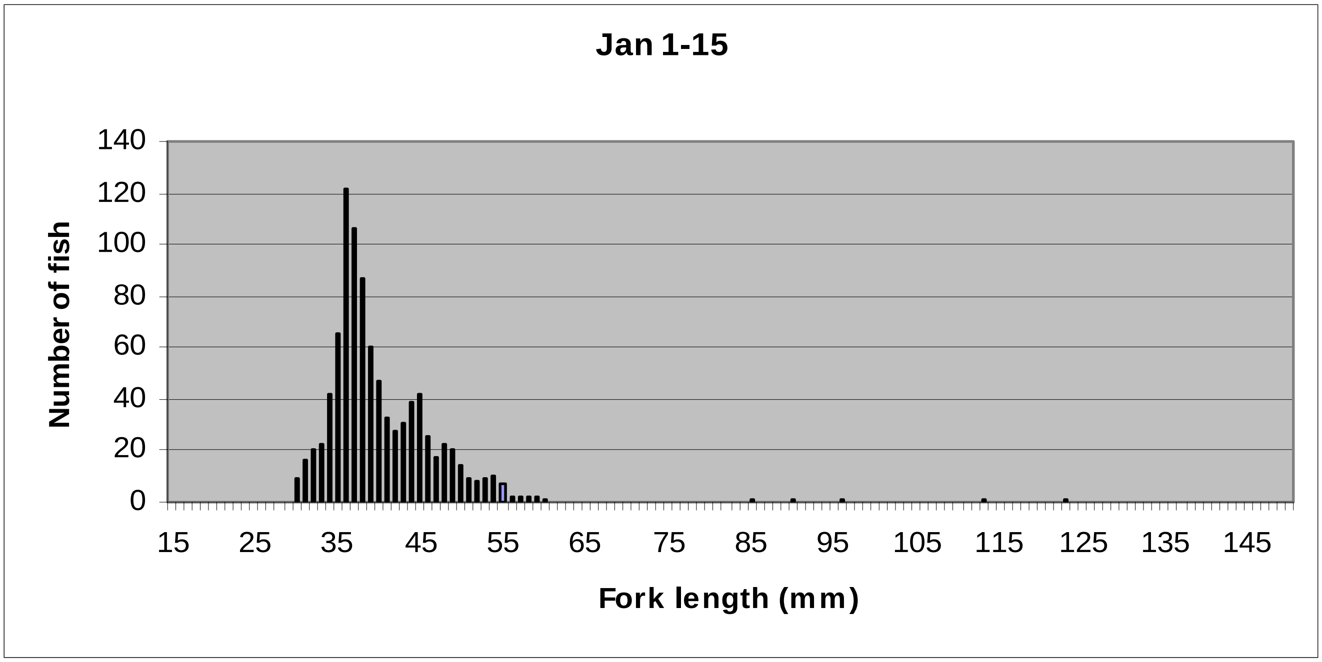

Figure A-7. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, January 1 – 15, 2005.

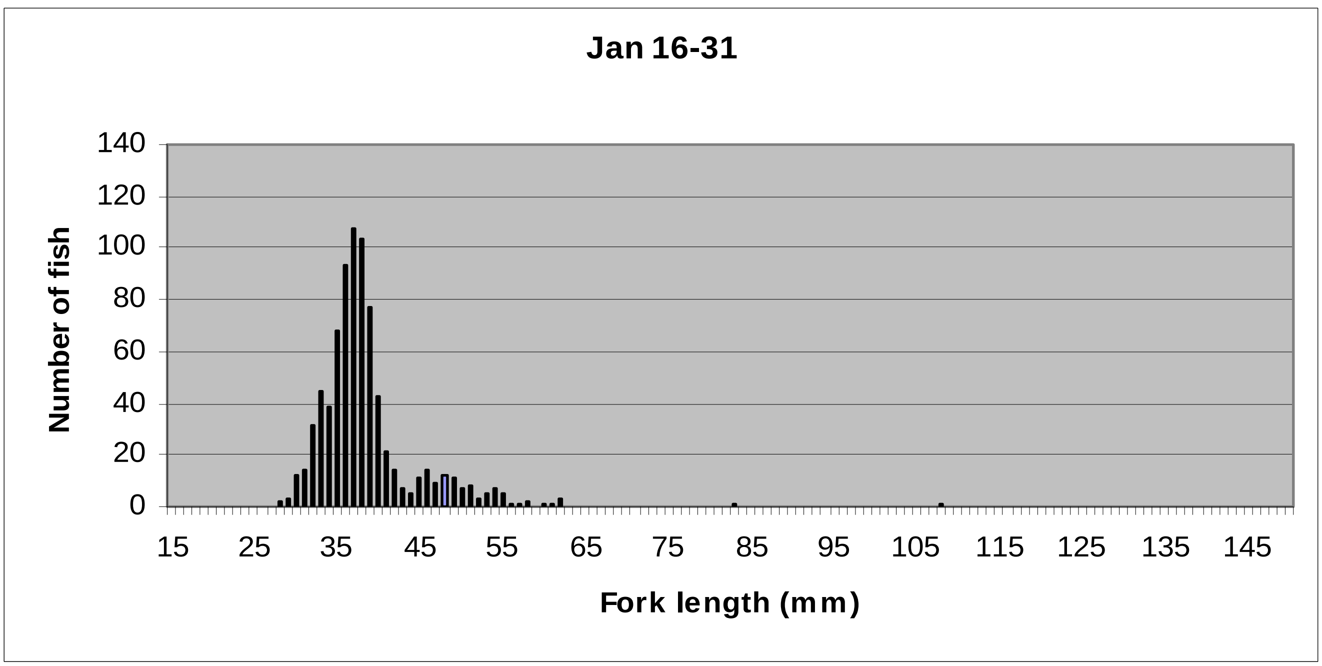

Figure A-8. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, January 16 – 31, 2005.

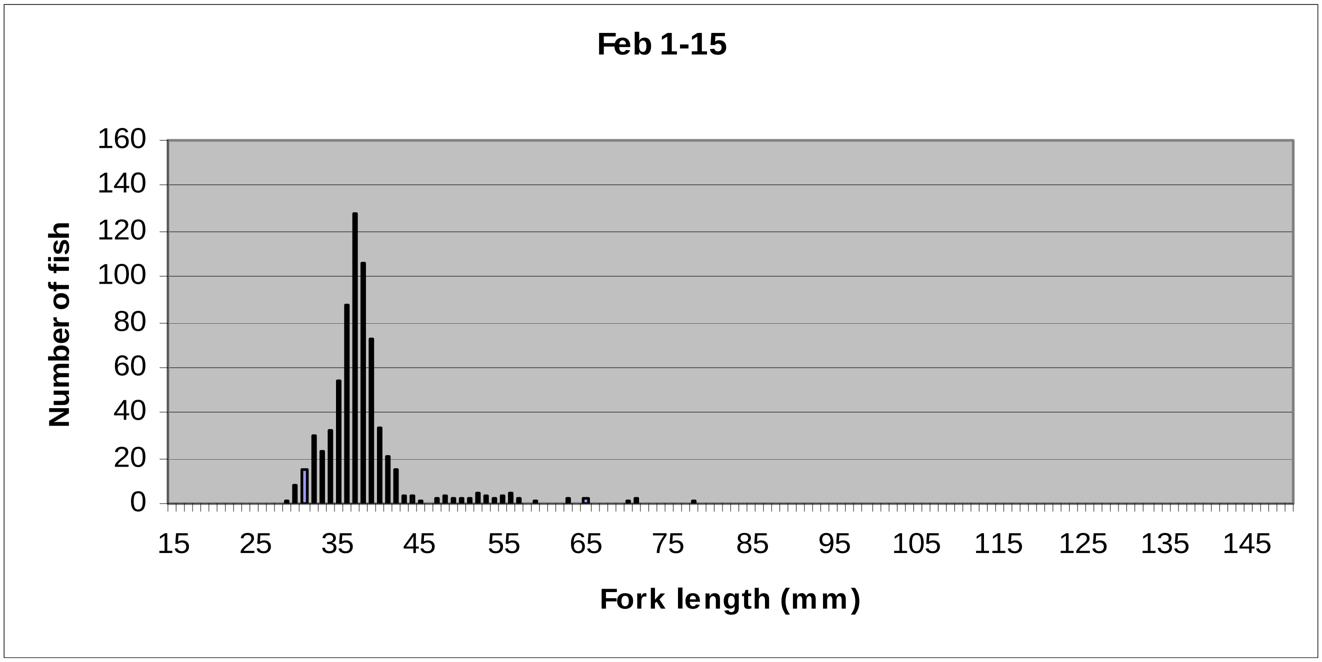

Figure A-9. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, February 1 – 15, 2005.

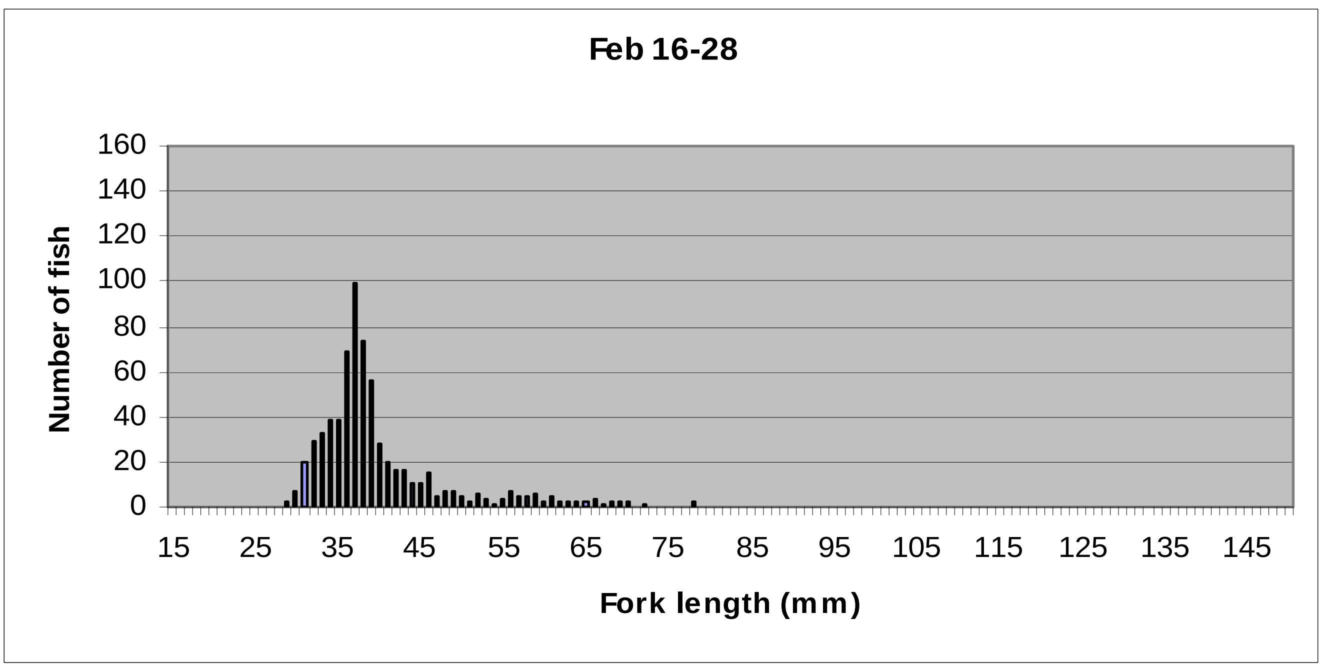

Figure A-10. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, February 16 – 28, 2005.

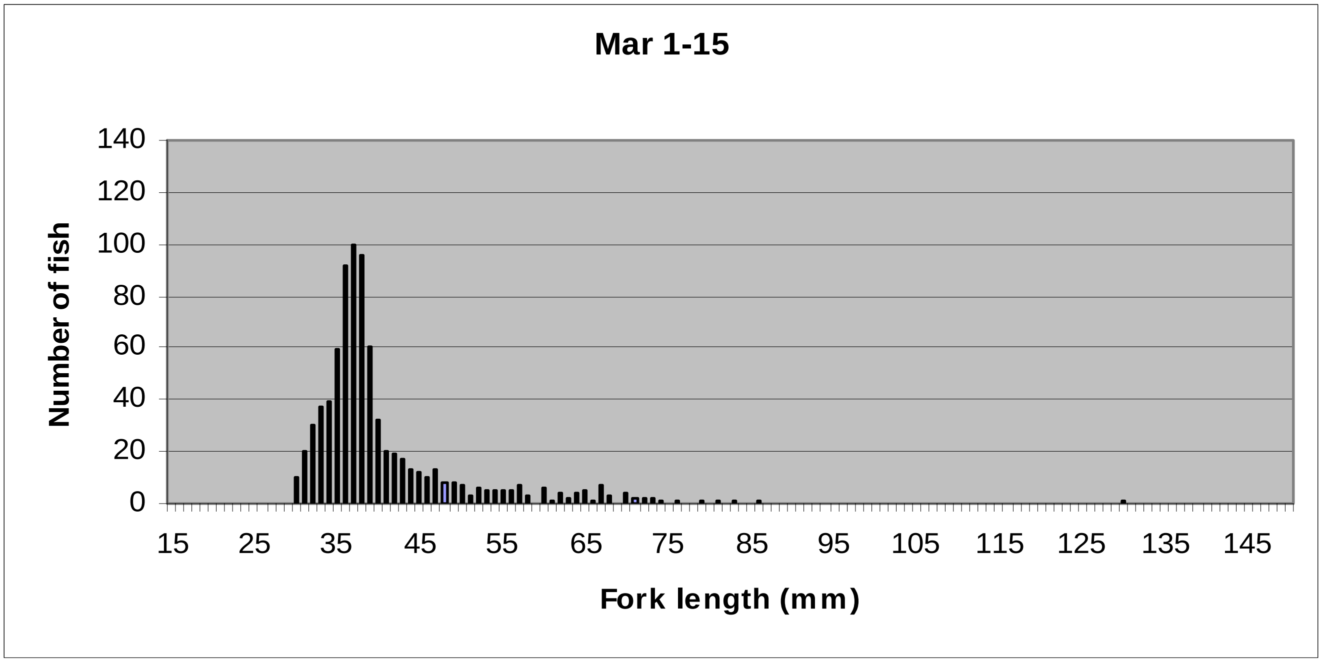

Figure A-11. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, March 1 – 15, 2005.

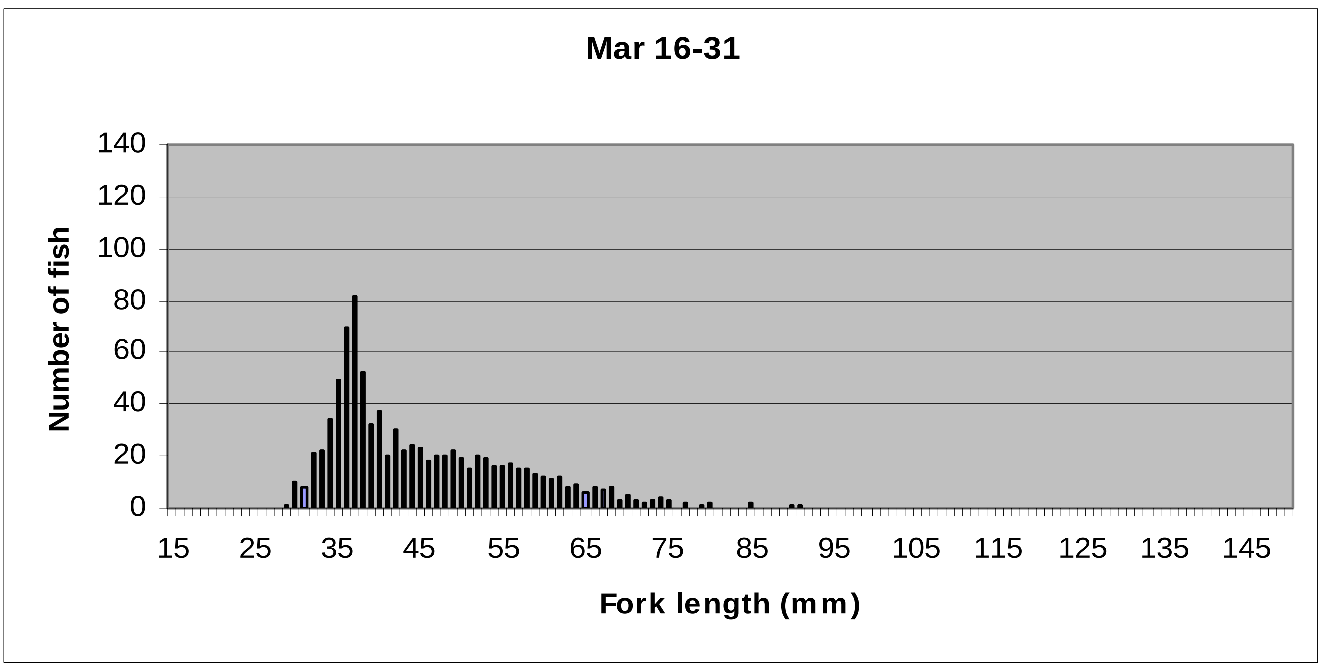

Figure A-12. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, March 16 – 31, 2005.

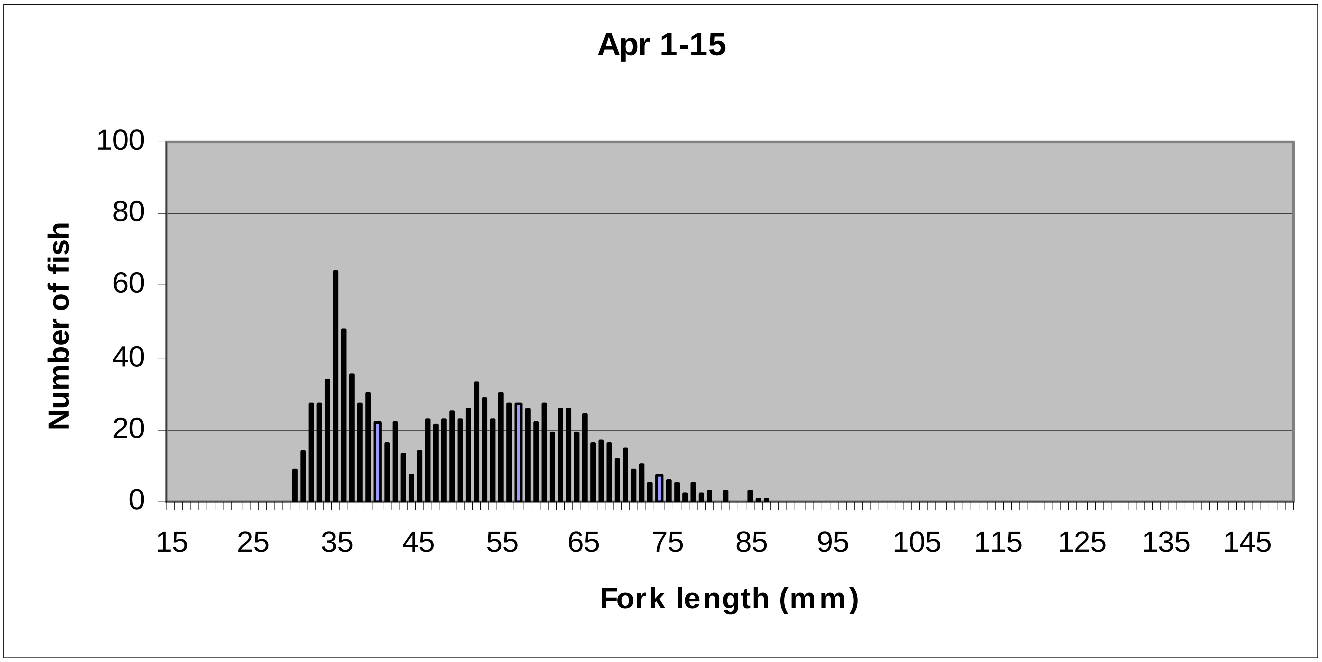

Figure A-13. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, April 1 – 15, 2005.

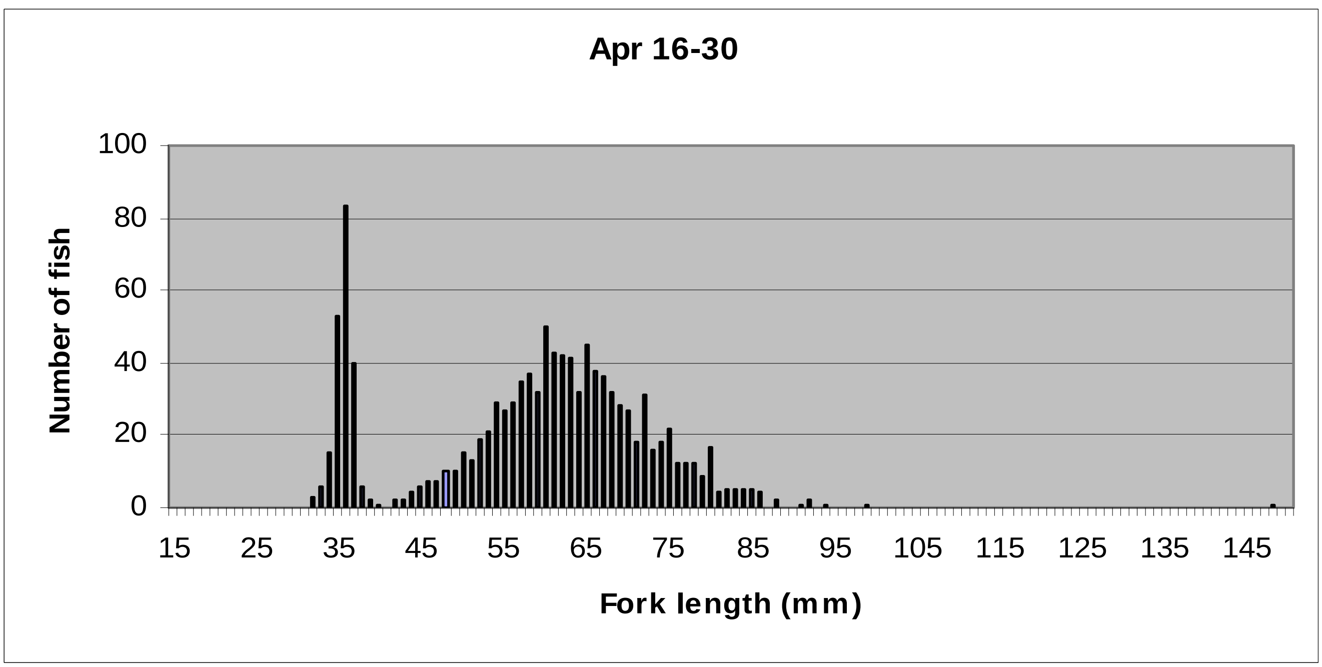

Figure A-14. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, April 16 – 30, 2005.

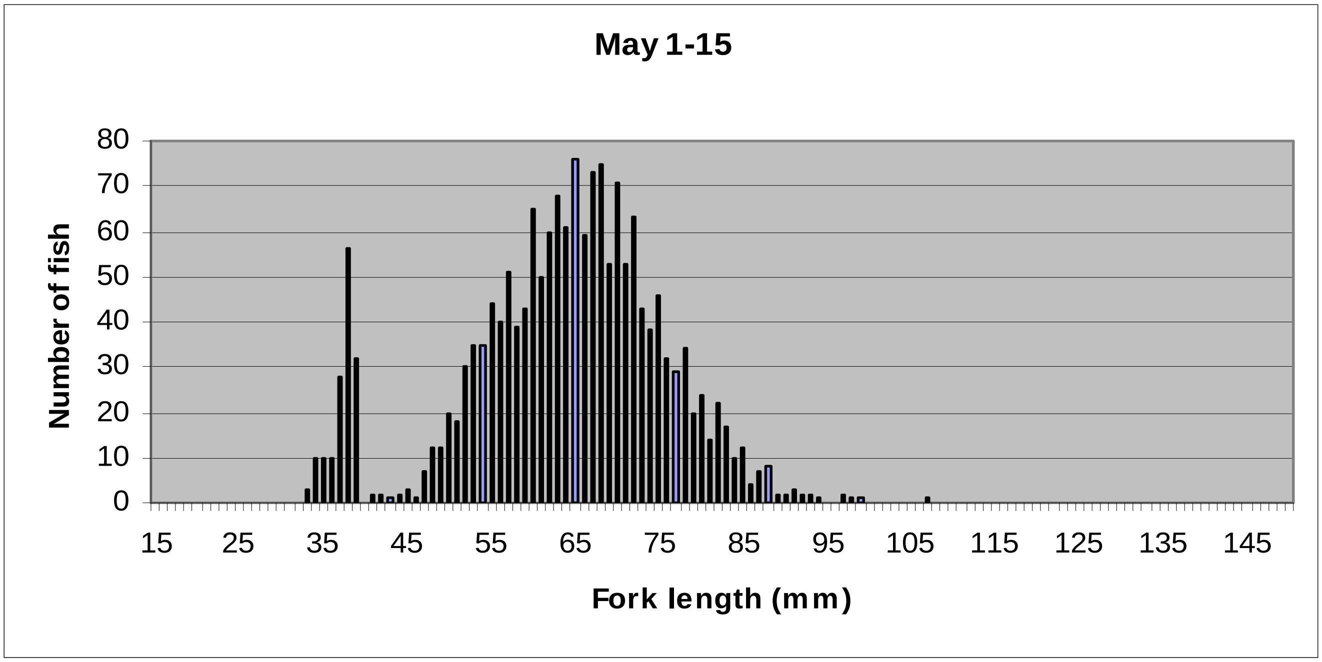

Figure A-15. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, May 1 – 15, 2005.

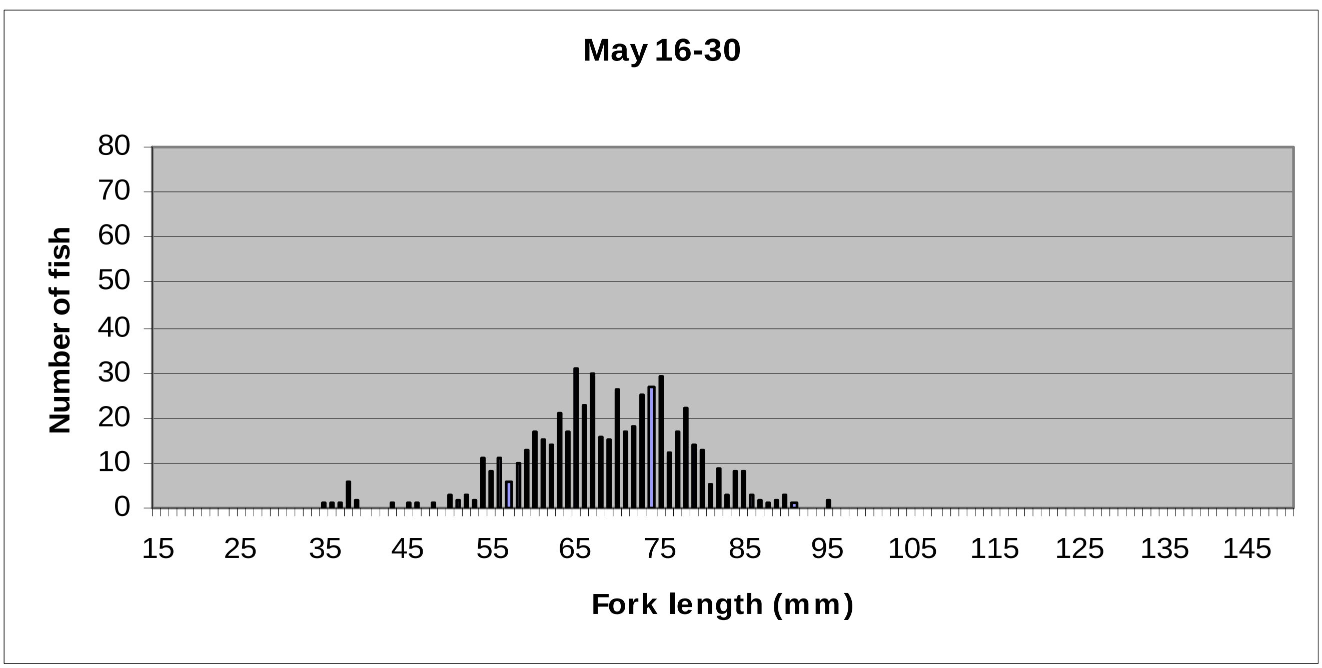

Figure A-16. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, May 16 – 30, 2005.

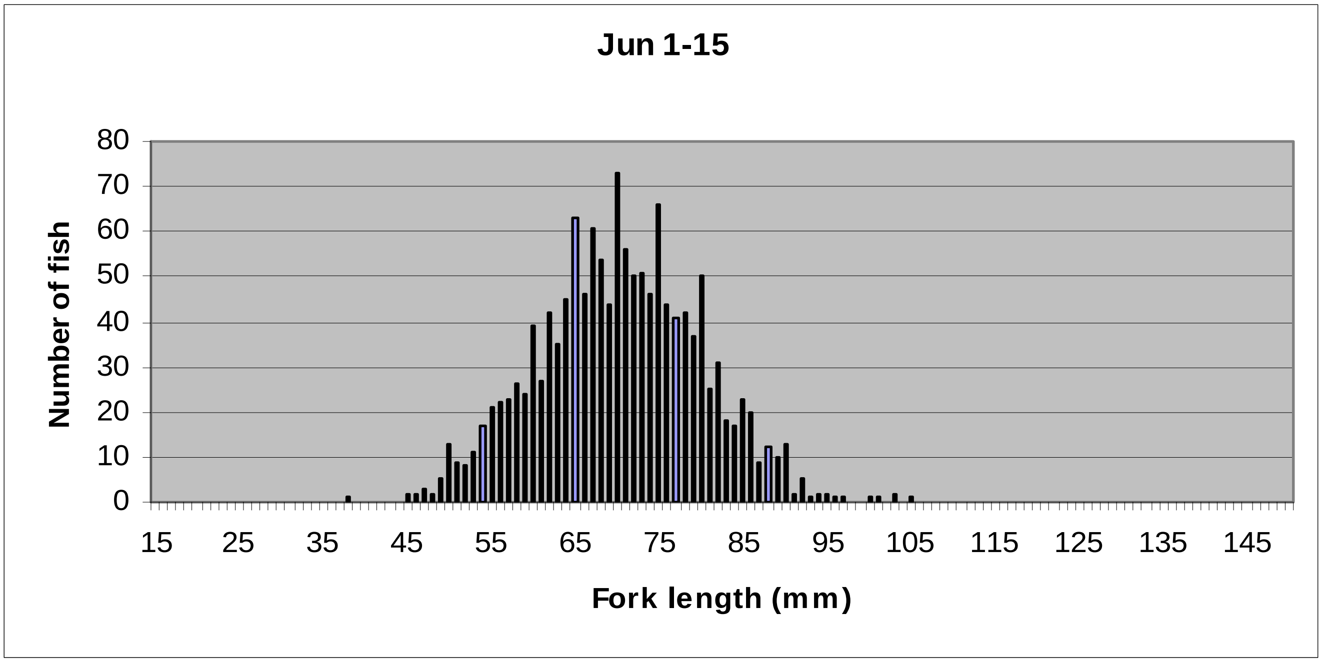

Figure A-17. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, June 1 – 15, 2005.

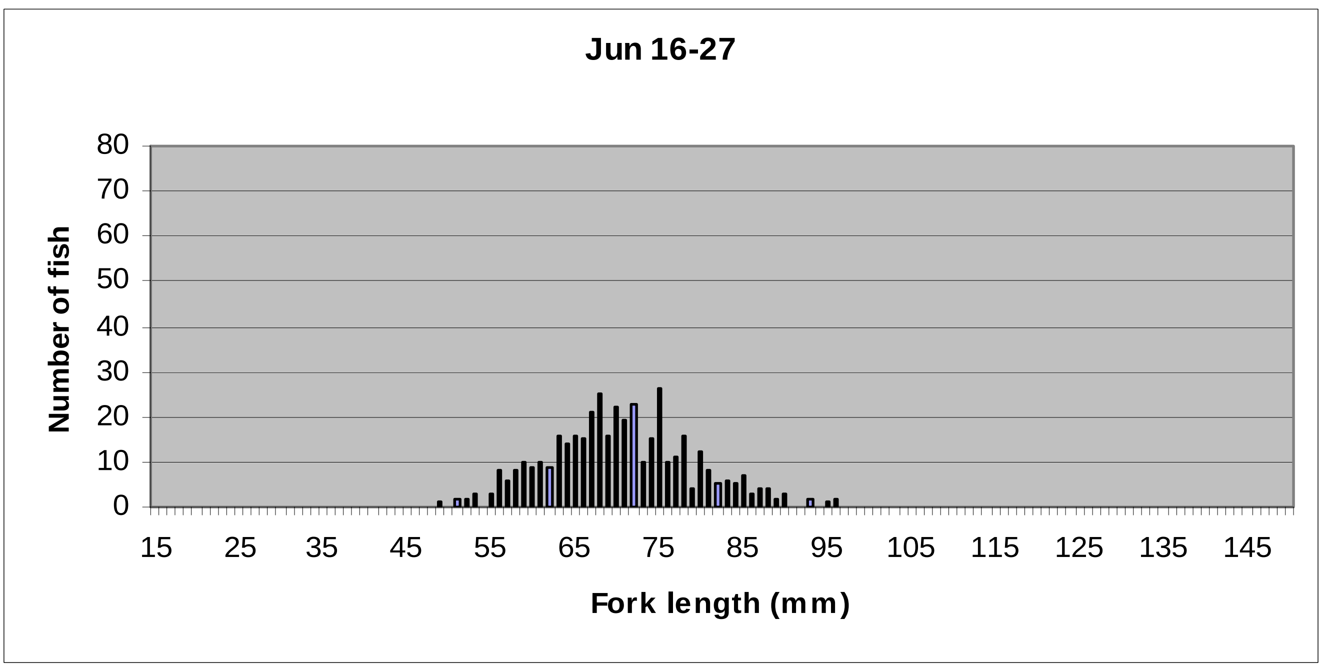

Figure A-18. Bi-weekly length frequency distributions of juvenile Chinook salmon at the Yuba River RST, June 16 – 27, 2005.

Appendix B:

Steelhead Trout (*Oncorhynchus mykiss*) Bi-weekly Captures 2004-2005

Table B-1. Bi-weekly summary of steelhead trout captures on the Yuba River near Hallwood Blvd., October 1, 2004 to June 27, 2005.

Trapping Period		Mean FL (mm)	Range FL (mm)		Total Captured
10/01/04	10/15/04	n/a	n/a	n/a	0
10/16/04	10/31/04	93	57	258	12
11/01/04	11/15/04	79	58	109	10
11/16/04	11/30/04	99	58	220	18
12/1/04	12/15/04	82	48	155	65
12/16/04	12/31/04	92	58	143	18
01/01/05	01/15/05	86	52	162	50
01/16/05	01/31/05	92	62	148	22
02/01/05	02/15/05	86	61	166	8
02/16/05	02/28/05	88	57	209	20
03/01/05	03/15/05	88	65	199	42
03/16/05	03/31/05	92	48	202	60
04/01/05	04/15/05	97	72	238	29
*04/16/05	04/30/05	66	37	98	5
*05/01/05	05/15/05	61	41	99	44
*05/16/05	05/31/05	70	37	183	15
*06/01/05	06/15/05	67	38	355	149
*06/16/05	06/27/05	71	45	246	57

* includes captures from RST 1 and RST 2.

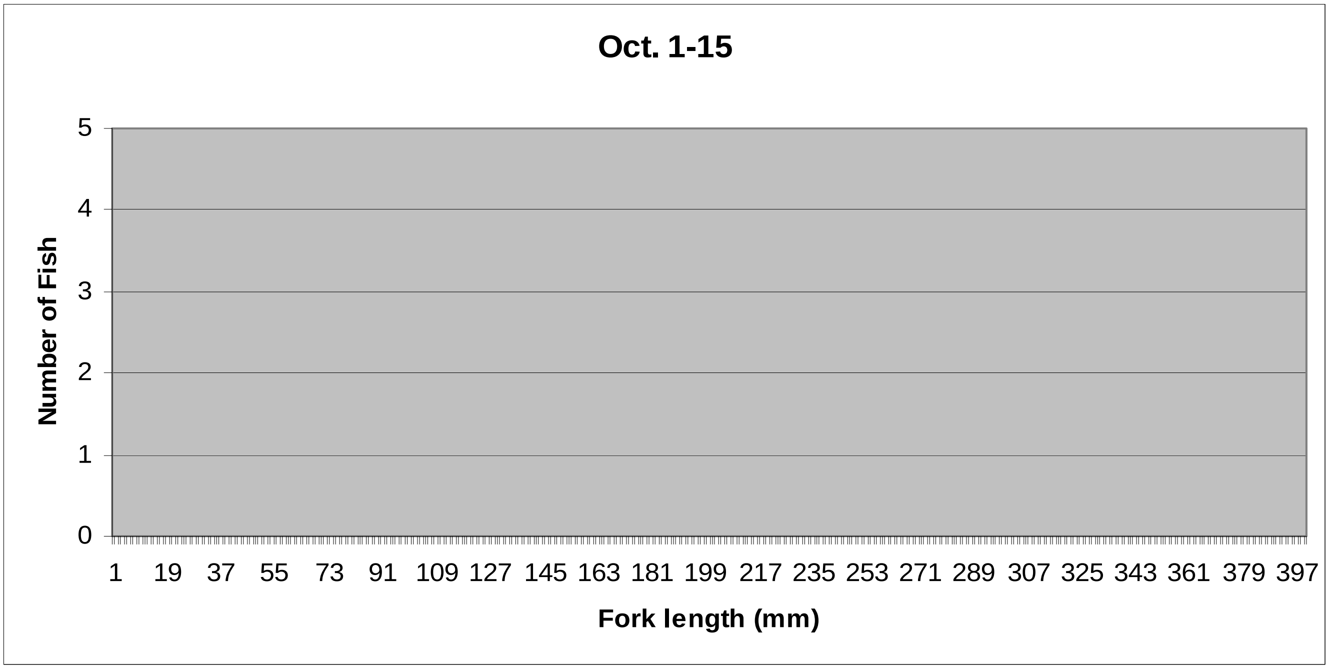

Figure B-1. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, Oct 1 – 15, 2004.

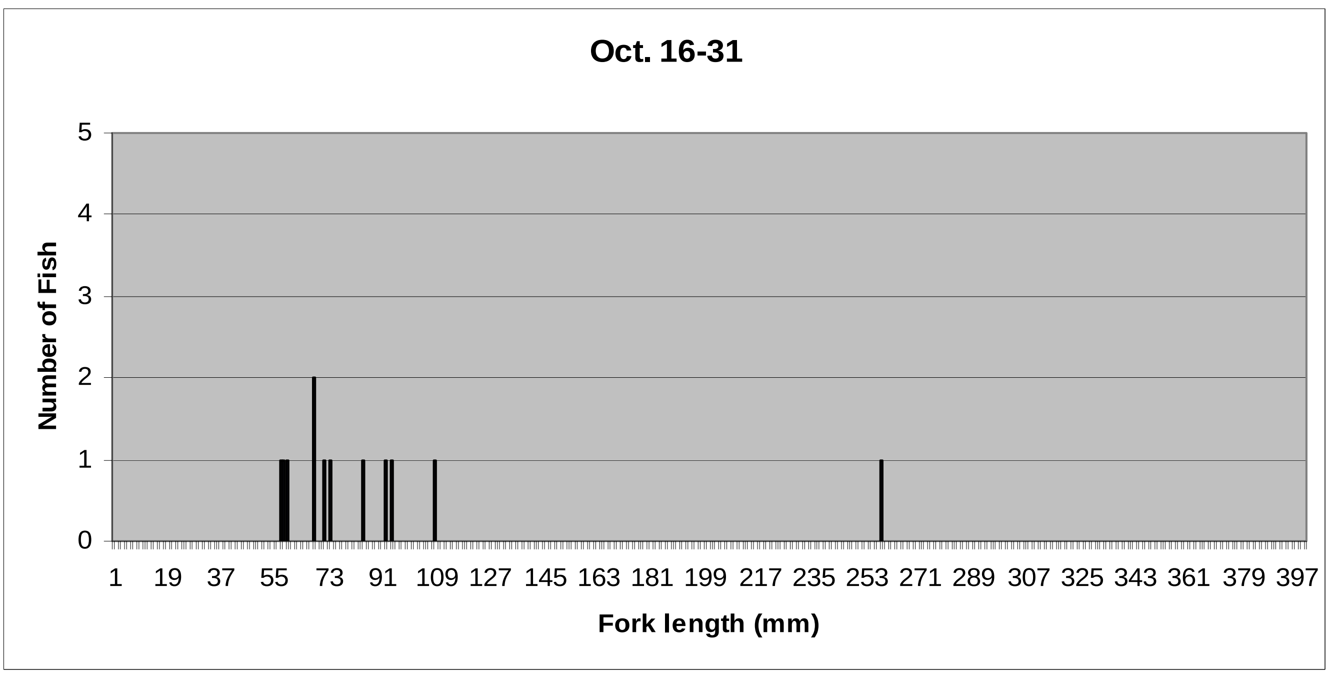

Figure B-2. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, Oct 16 – 31, 2004.

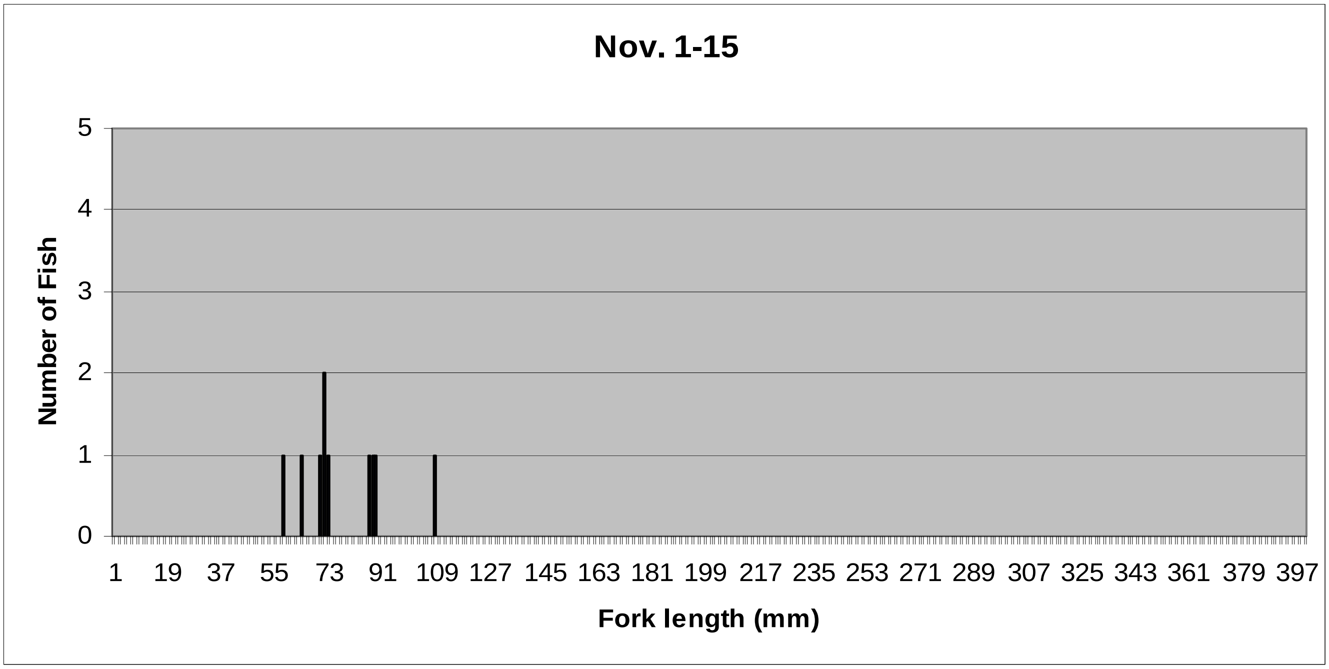

Figure B-3. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, November 1 – 15, 2004.

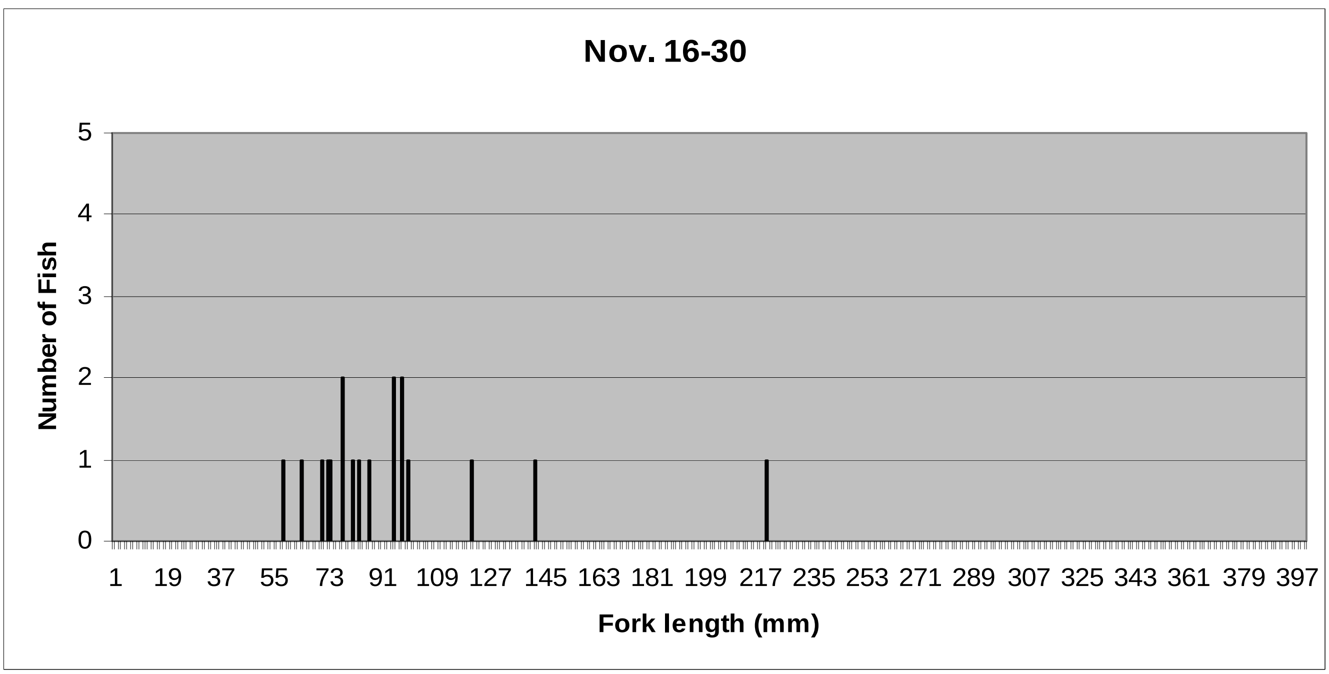

Figure B-4. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, November 16 – 30, 2004.

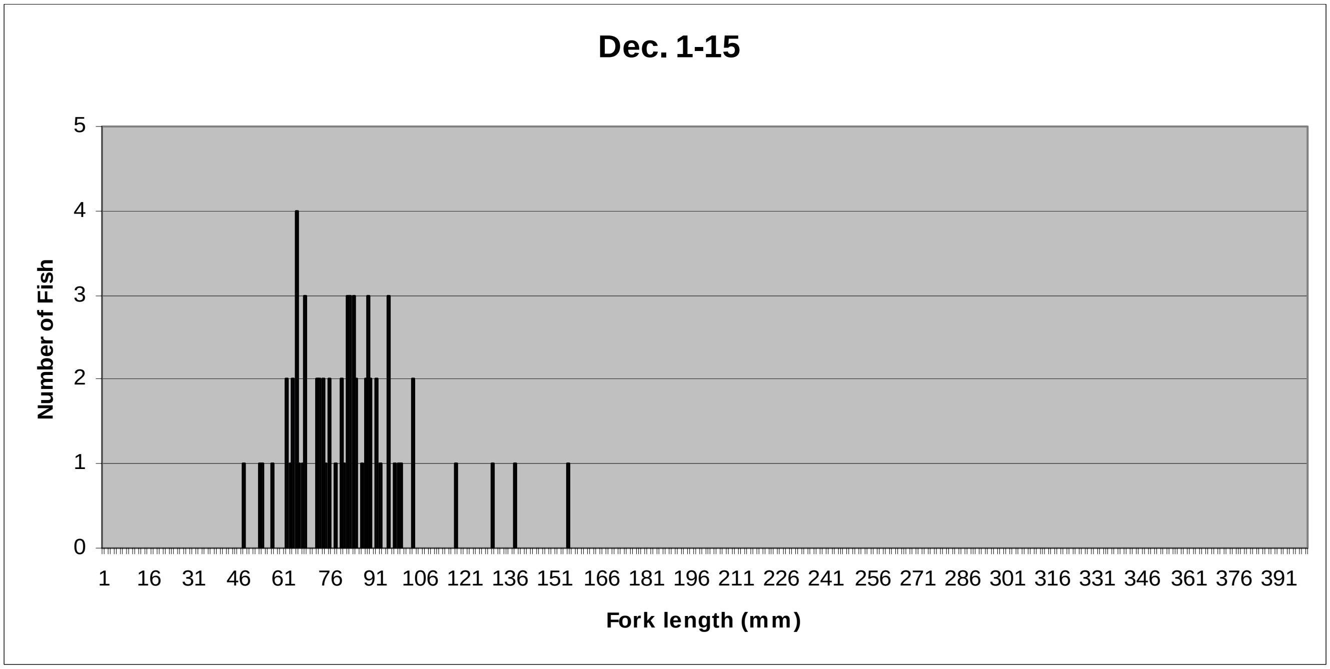

Figure B-5. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, December 1 -15, 2004.

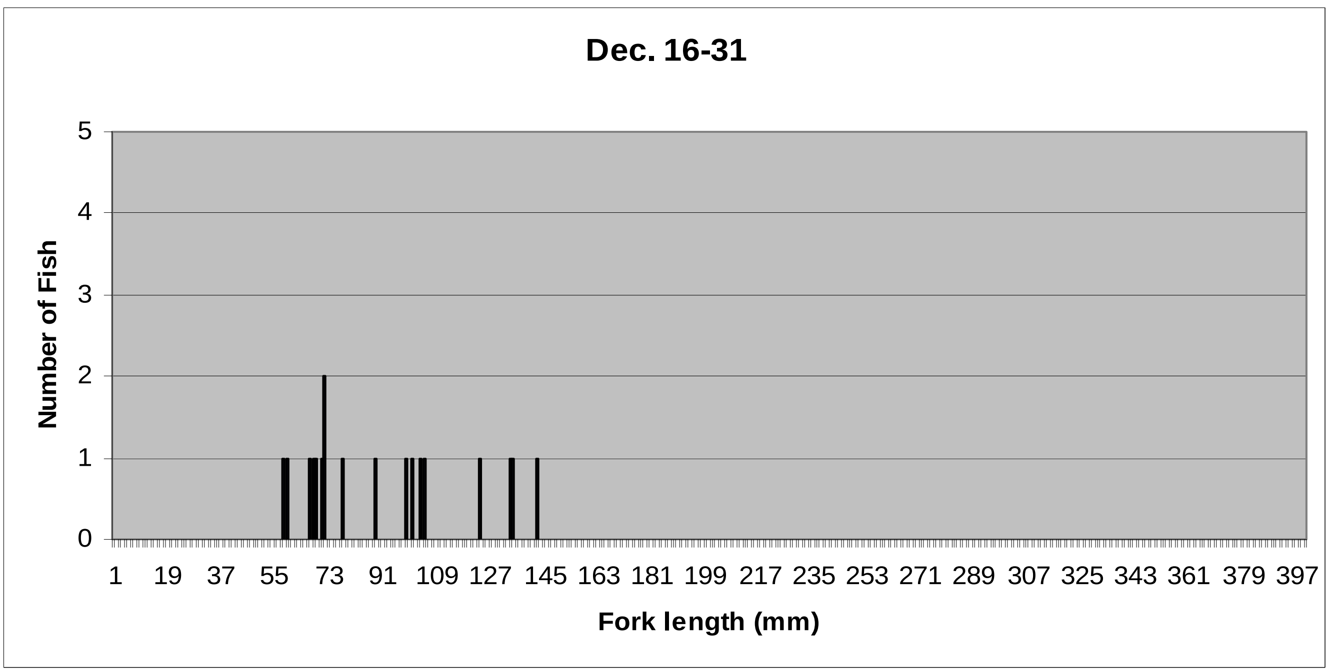

Figure B-6. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, December 16 – 31, 2004.

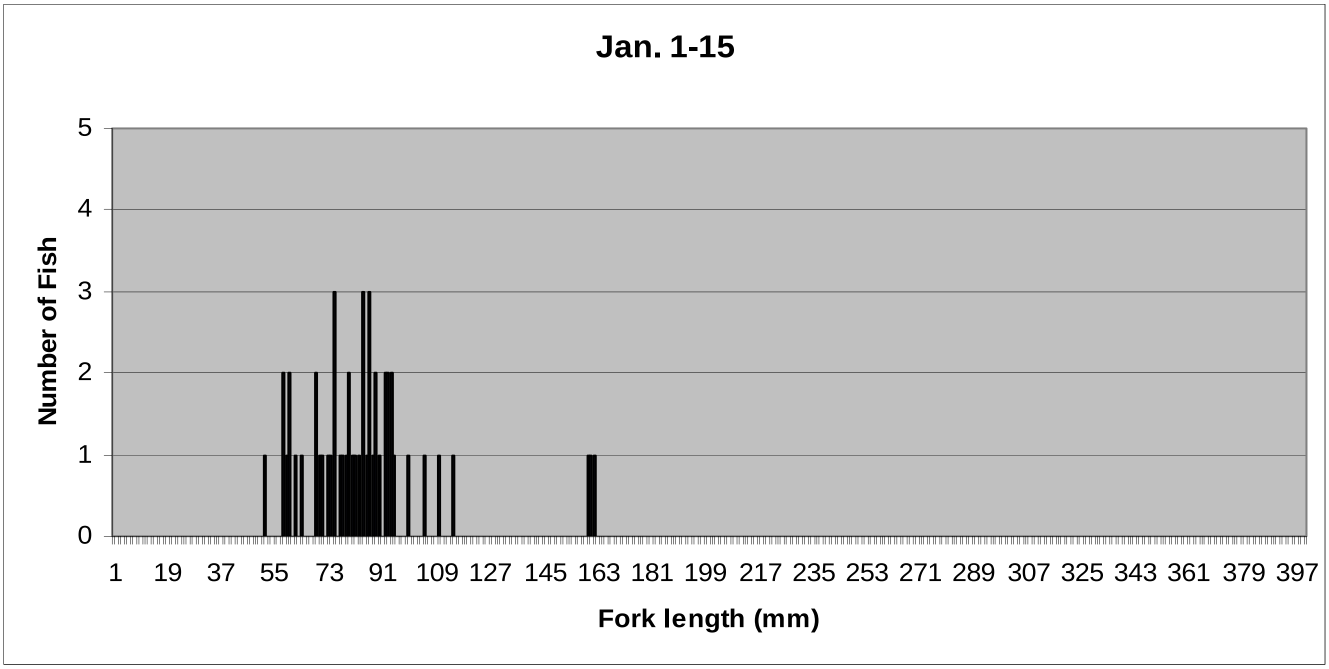

Figure B-7. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, January 1 – 15, 2005.

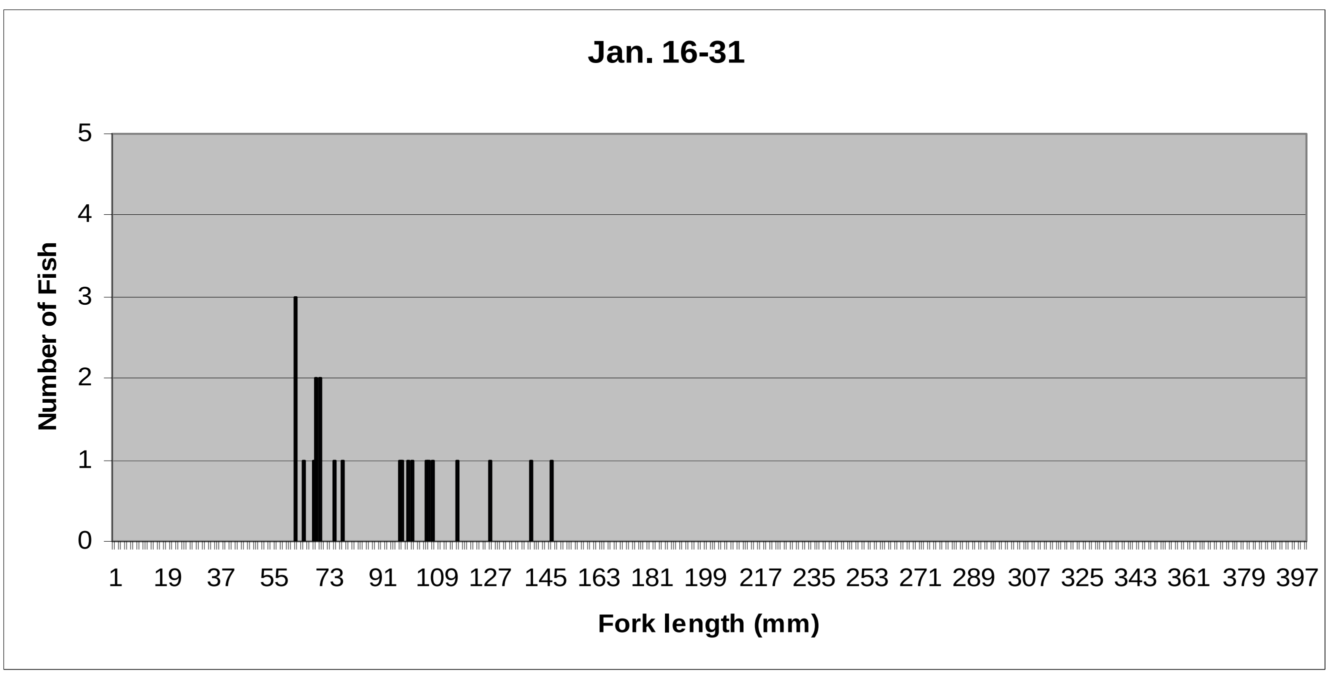

Figure B-8. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, January 16 – 31, 2005.

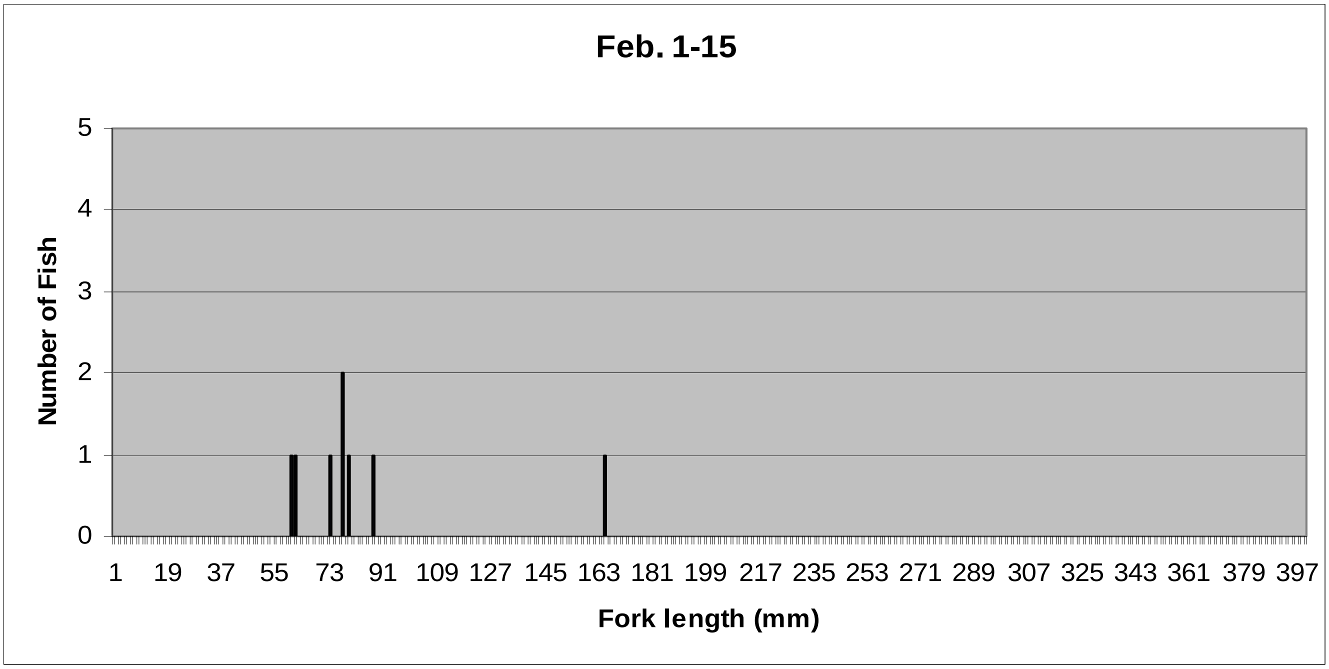

Figure B-9. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, February 1 – 15, 2005.

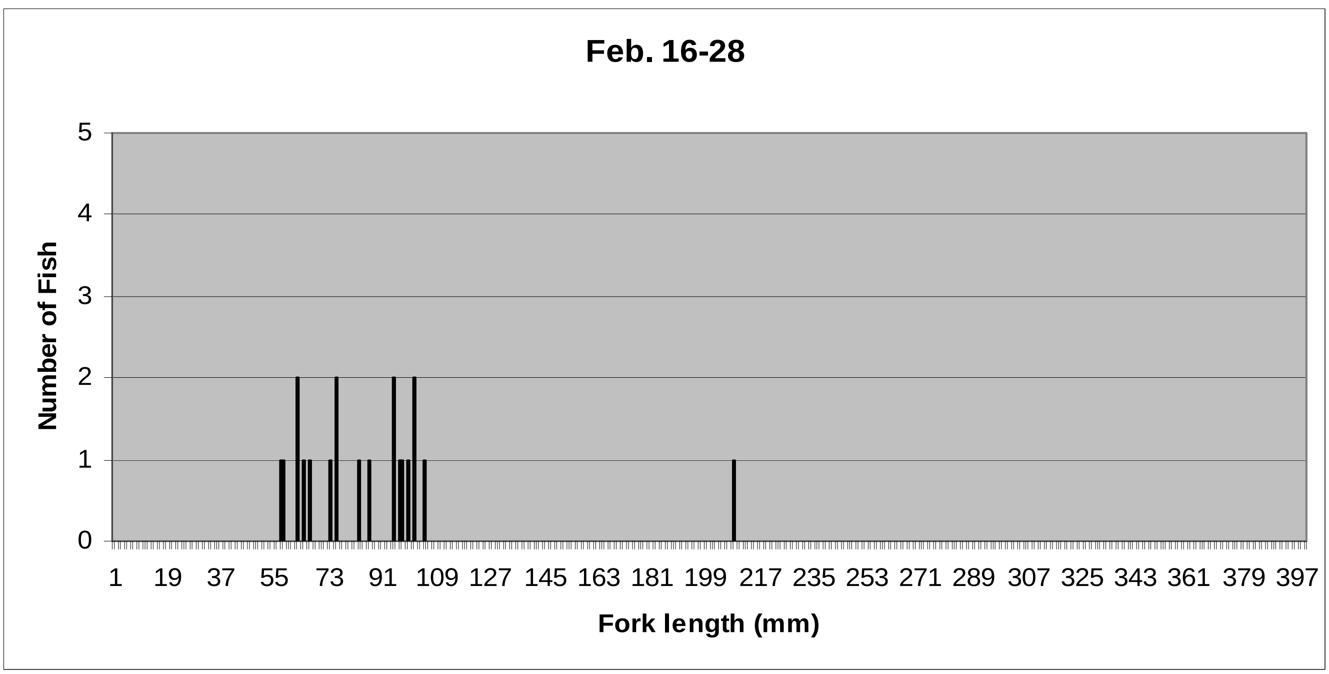

Figure B-10. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, February 16 – 28, 2005.

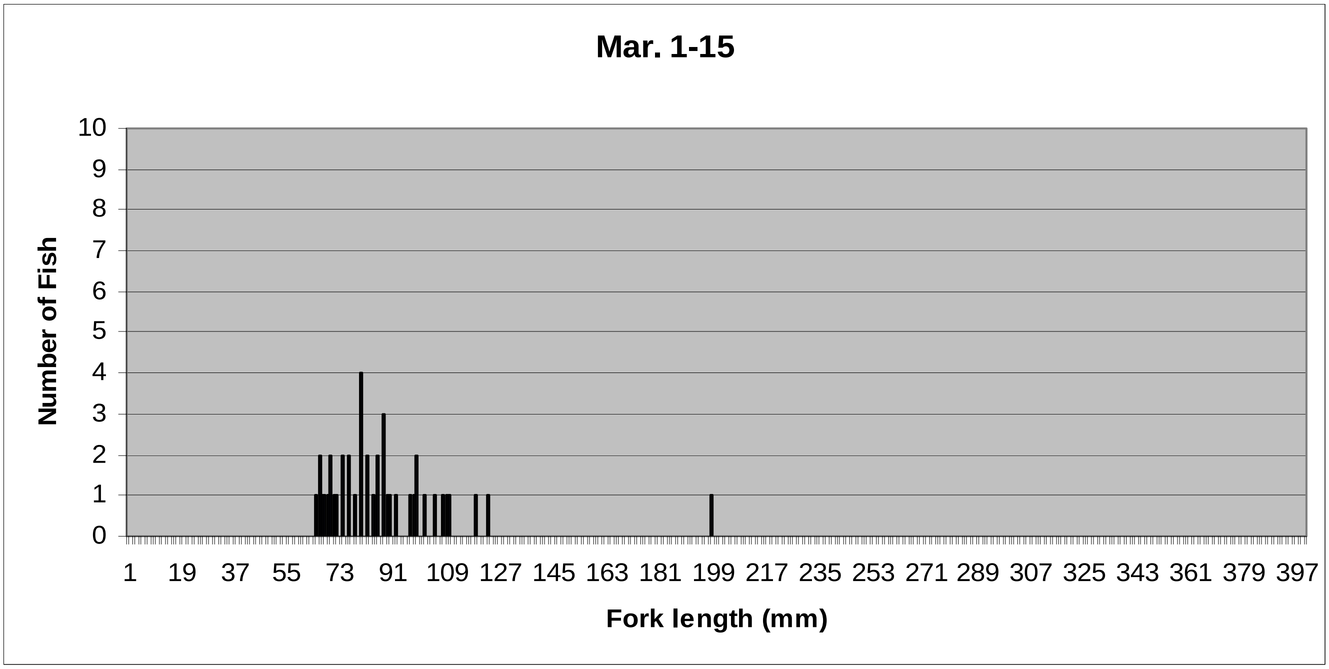

Figure B-11. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, March 1 – 15, 2005.

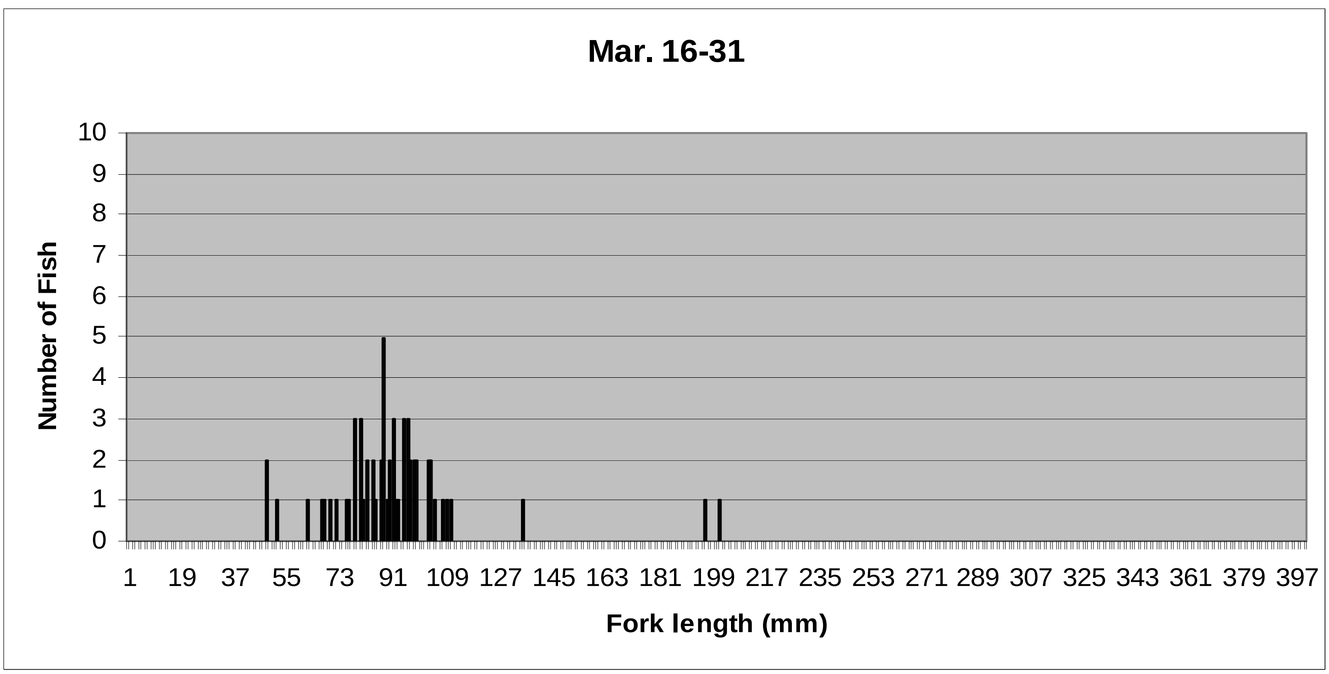

Figure B-12. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, March 16 – 31, 2005.

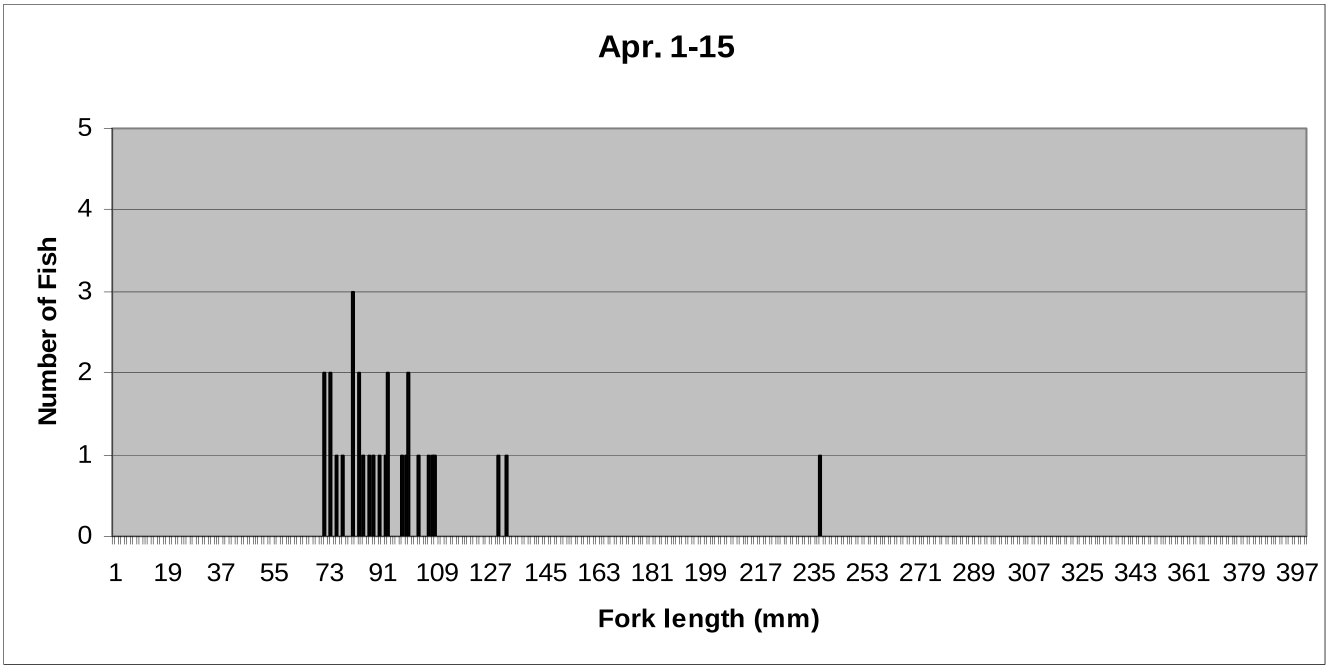

Figure B-13. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, April 1 – 15, 2005.

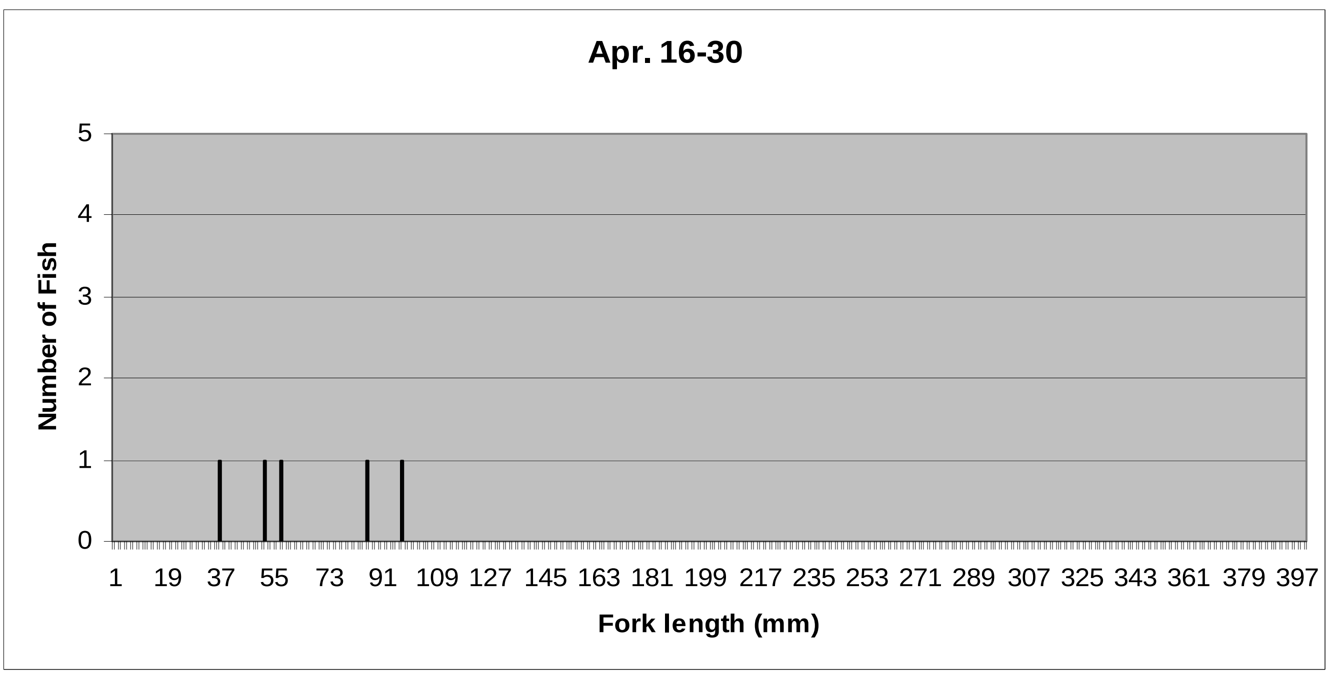

Figure B-14. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, April 16 – 30, 2005.

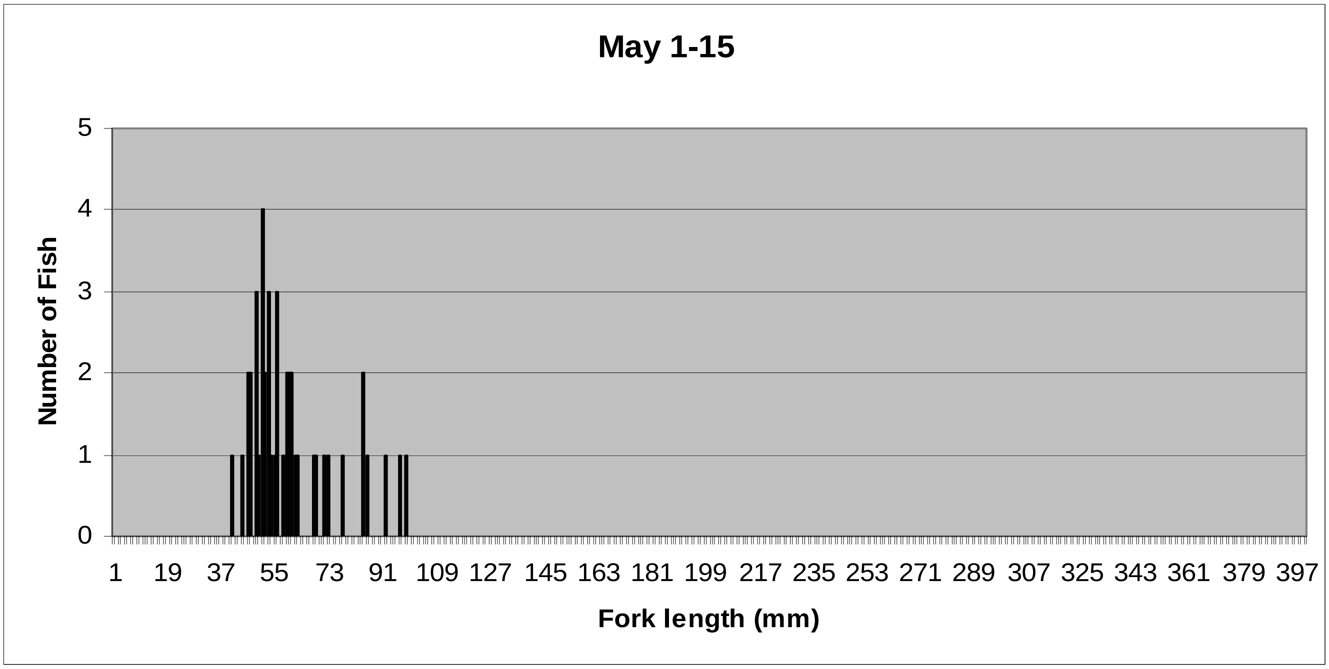

Figure B-15. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, May 1 – 15, 2005.

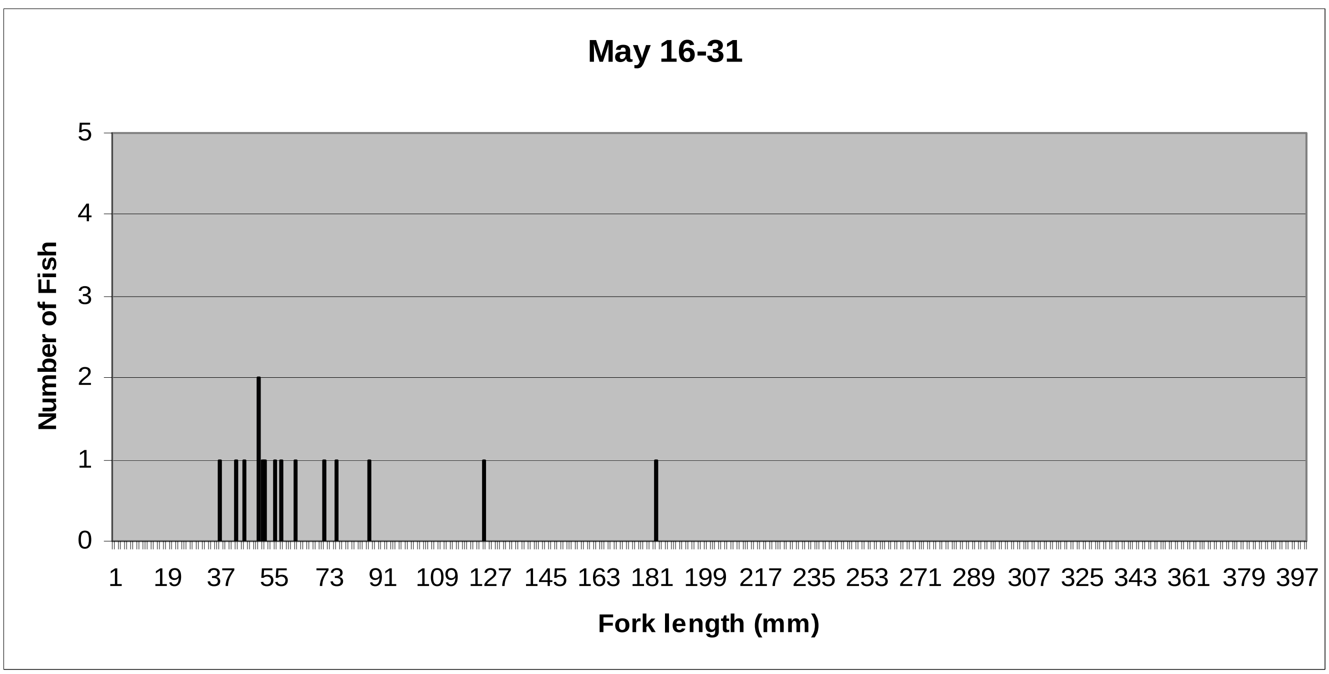

Figure B-16. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, May 16 – 31, 2005.

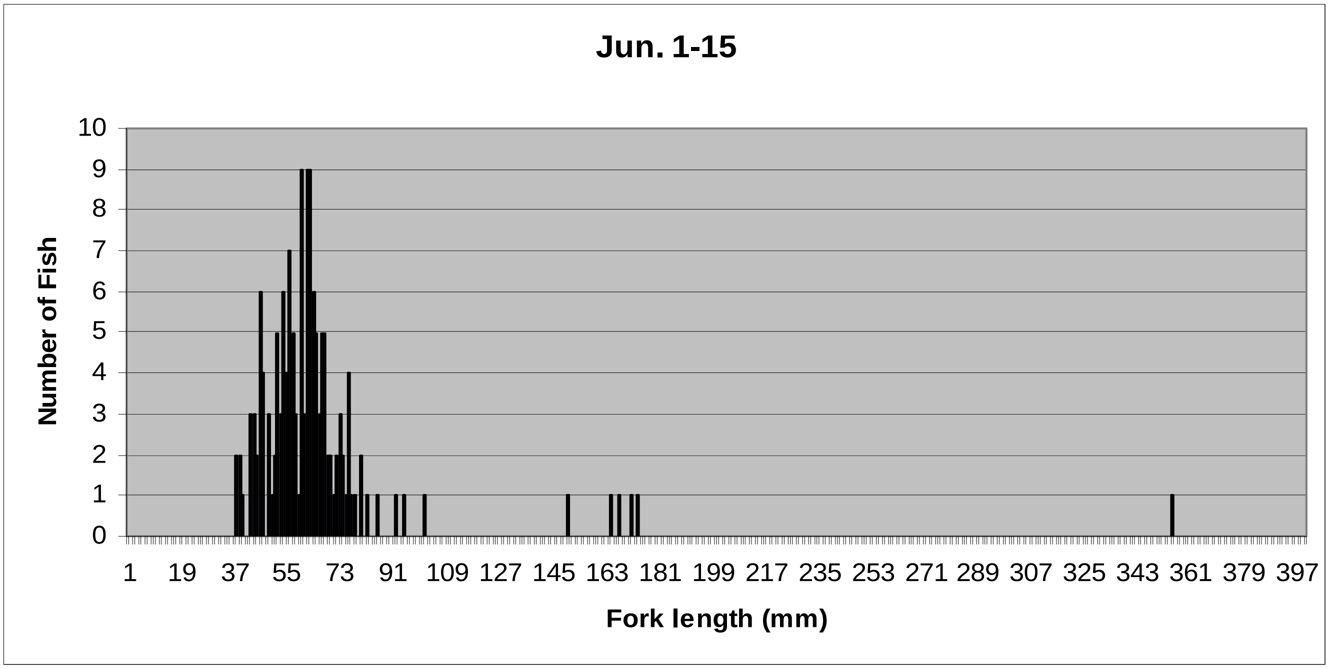

Figure B-17. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, June 1 – 15, 2005.

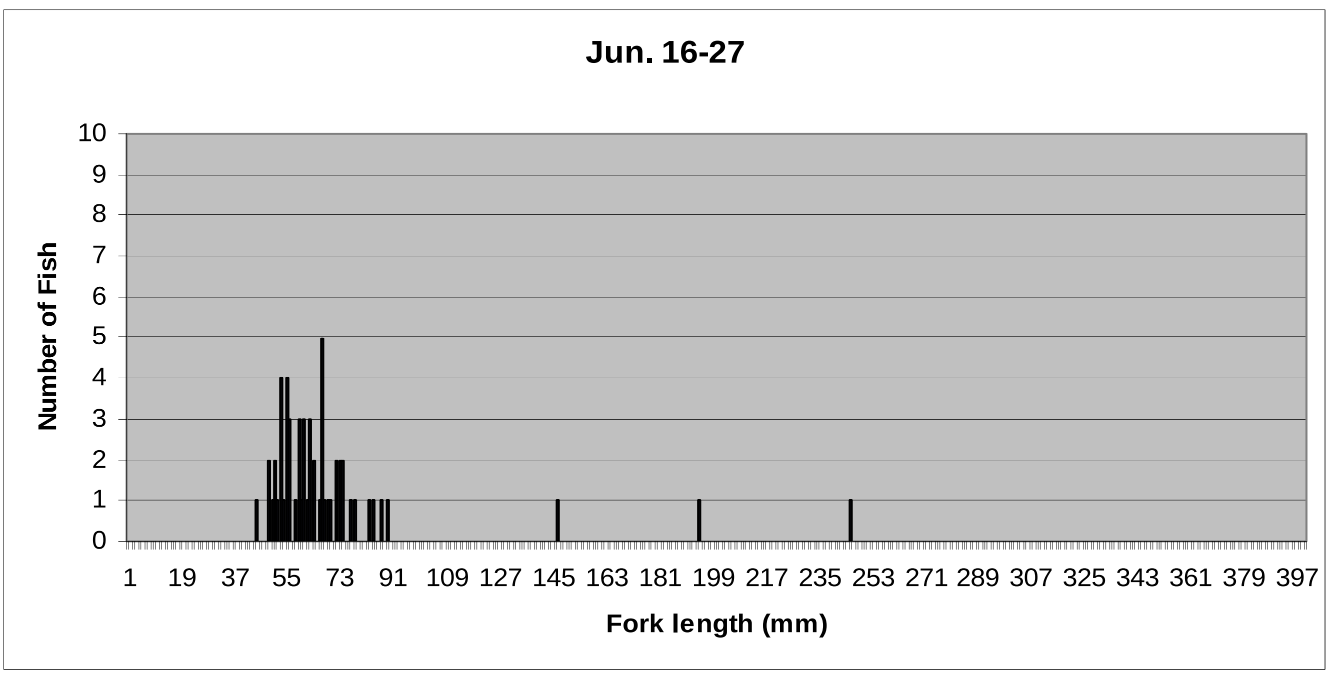

Figure B-18. Bi-weekly length frequency distributions of juvenile steelhead trout at the Yuba River RST, June 16 – 27, 2005.

Appendix C:

Lower Yuba River Temperatures at the Hallwood Rotary Screw Trap

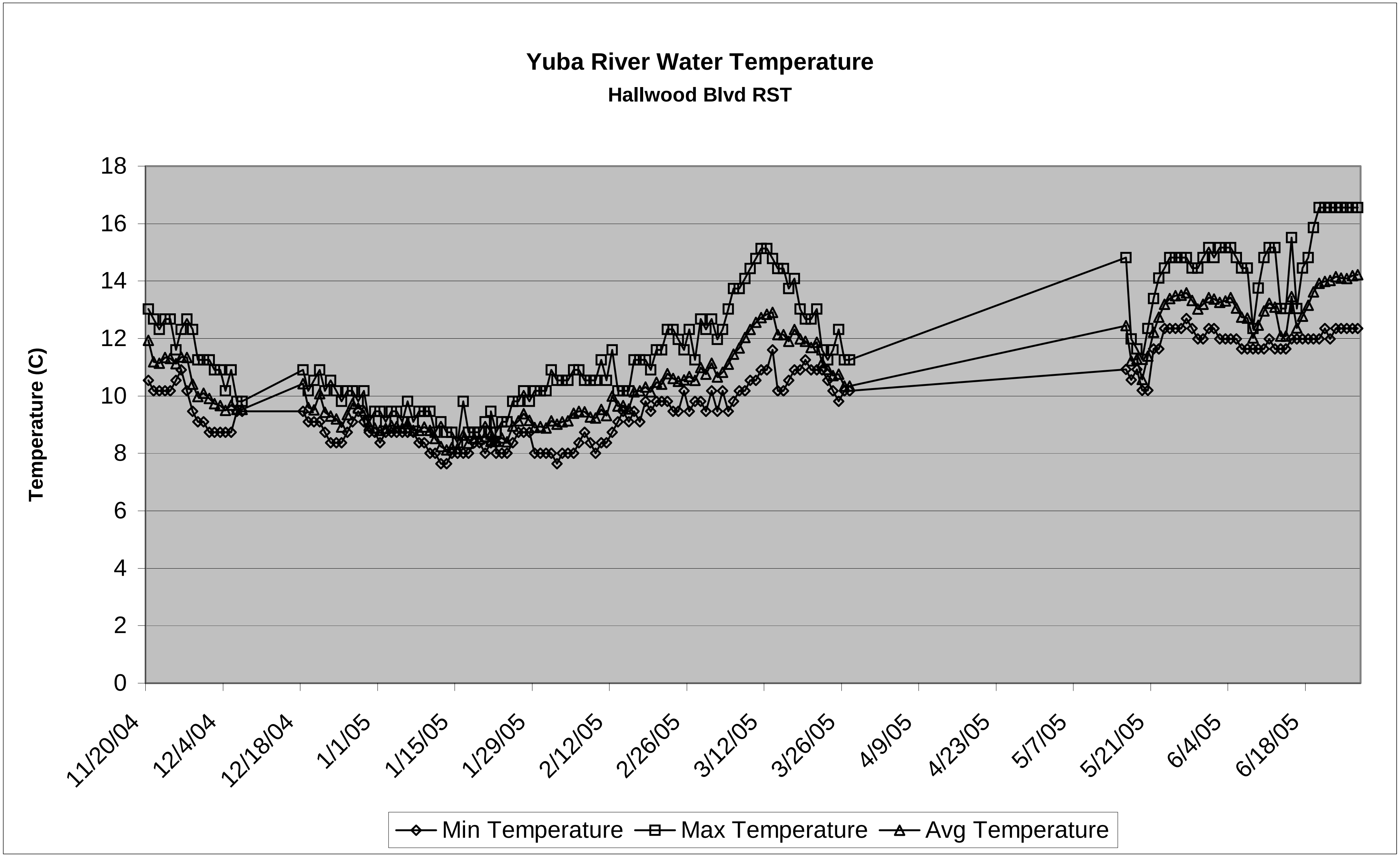

Figure C-1. Water temperatures in the RST, November 20, 2004 to June 27, 2005.

Appendix D:

Lower Yuba River Flows at Marysville Gage

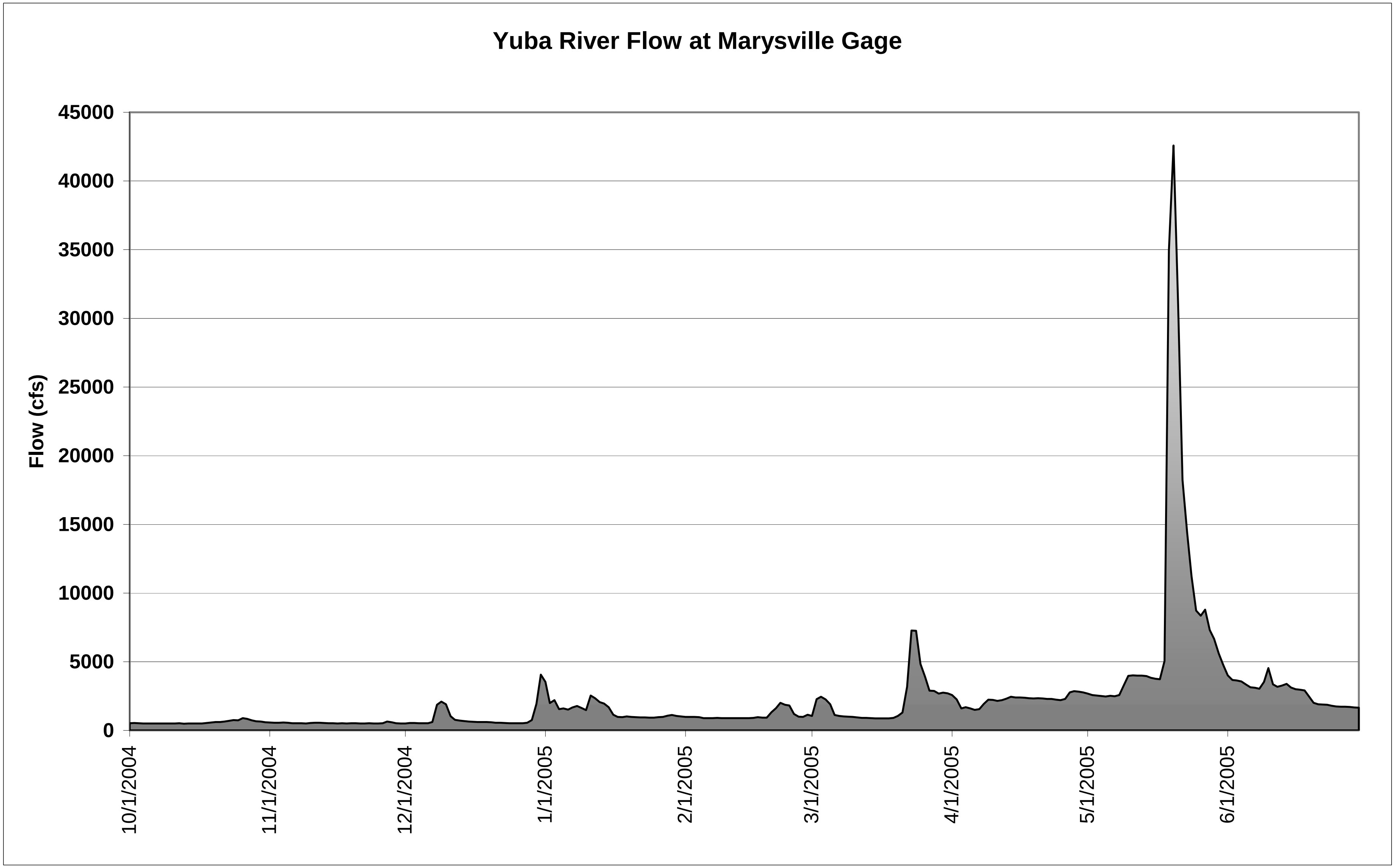

Figure D-1. Average daily Yuba River flows as measured at the Marysville Gage located approximately two kilometers downstream of the RST at Hallwood Blvd., October 1, 2004 to June 30, 2005.

Appendix E:

Coded-Wire Tagged Chinook Salmon Released to the Lower Yuba River

Table E-1. Summary of coded-wire tagged Chinook salmon released to the lower Yuba River near Hallwood, November 26, 2003 to June 15, 2004.

Tag Code	Dates Tagged		Mean FL (mm)	Total Released	Shed Rate (%)
06-01-03-03-04	11/19/2004	12/17/2004	37	2059	3.23%
06-01-03-03-05	3/3/2005	3/3/2005	37	2652	1.54%
06-01-03-03-06	4/5/2005	5/17/2005	79	267	4.30%
06-01-03-03-09	5/4/2005	5/10/2005	62	1485	3.59%
06-01-03-04-00	12/17/2004	12/21/2004	37	1312	7.40%
06-01-03-04-01	12/17/2004	12/24/2004	37	2482	7.25%
06-01-03-04-02	12/24/2004	3/3/2005	37	2277	3.37%
06-01-03-04-03	12/23/2004	12/28/2004	37	3118	4.02%
06-01-03-04-04	2/22/2005	2/24/2005	37	11256	1.03%
06-01-03-04-05	2/23/2005	3/3/2005	37	11037	1.00%
06-01-03-04-06	2/24/2005	3/3/2005	37	11197	1.34%
06-01-03-04-07	2/29/2005	3/4/2005	37	10913	1.49%
06-01-03-04-08	2/2/2005	2/11/2005	37	17098	0.26%
06-01-03-04-09	2/8/2005	2/11/2005	37	16968	0.70%
06-01-03-05-00	1/21/2005	1/31/2005	37	15626	0.49%
06-01-03-05-01	1/31/2005	2/2/2005	37	17432	0.62%
06-01-03-05-02	12/31/2004	1/21/2005	37	16635	2.06%
06-01-03-05-03	12/12/2004	1/18/2005	37	16874	2.21%
06-01-03-05-04	2/16/2005	2/29/2005	37	17270	0.59%
06-01-03-05-05	2/12/2005	2/23/2005	37	17099	0.54%
06-01-03-05-06	2/2/2005	2/3/2005	37	10648	0.60%
06-01-03-05-07	2/3/2005	2/11/2005	37	11026	0.30%
06-01-03-05-08	3/4/2005	3/4/2005	37	3060	1.66%
06-01-03-05-09	3/4/2005	3/15/2005	37	3592	1.87%
06-01-03-06-00	3/4/2005	3/4/2005	37	3042	1.67%
06-01-03-06-01	3/30/2005	4/19/2005	58	2136	10.12%
06-01-03-06-02	3/4/2005	3/15/2005	37	3053	1.76%
06-01-03-06-03	3/15/2005	5/18/2005	38	5356	1.96%
06-01-03-06-04	3/15/2005	3/15/2005	37	2039	2.05%
06-01-03-06-05	6/8/2005	6/8/2005	76	1152	0.77%
06-01-03-07-00	5/4/2005	5/17/2005	62	2613	1.72%

Appendix F:

Flow Velocities Measured at the Lower Yuba River RST at Hallwood

Table F-1. Water velocities as measured at the head of the RST, October 21, 2004 to June 27, 2005.

Date	ft/s	Date	ft/s	Date	ft/s	Date	ft/s	Date	ft/s	Date	ft/s
10/2/2003	2.31	11/18/2003	2.75	12/24/2003	1.38	2/11/2004	2.71	3/26/2004	2.73	5/2/2004	1.96
10/15/2003	2.61	11/19/2003	2.57	12/25/2003	3.4	2/12/2004	2.65	3/27/2004	2.76	5/3/2004	2.93
10/16/2003	2.55	11/20/2003	2.34	12/26/2003	3.29	2/13/2004	2.98	3/28/2004	2.66	5/4/2004	1.78
10/17/2003	2.97	11/21/2003	2.68	12/27/2003	3.5	2/14/2004	2.28	3/29/2004	2.53	5/5/2004	2.17
10/18/2003	3.74	11/22/2003	2.6	12/28/2003	2.47	2/15/2004	2.5	3/30/2004	3.12	5/6/2004	1.74
10/19/2003	3.47	11/23/2003	2.38	12/29/2003	2.25	2/16/2004	2.2	3/31/2004	2.79	5/7/2004	2.64
10/20/2003	3.02	11/24/2003	3.24	12/30/2003	3.5	2/17/2004	2.9	4/1/2004	2.72	5/8/2004	1.96
10/21/2003	2.78	11/25/2003	2.92	12/31/2003	3.41	2/25/2004	3.81	4/2/2004	2.95	5/9/2004	1.82
10/22/2003	3.16	11/26/2003	2.35	1/1/2004	3.91	2/26/2004	3.6	4/3/2004	2.93	5/10/2004	1.73
10/23/2003	3.92	11/27/2003	2.39	1/8/2004	3.2	2/27/2004	2.77	4/4/2004	2.93	5/11/2004	1.66
10/24/2003	2.44	11/28/2003	2.3	1/9/2004	3.58	2/28/2004	3.56	4/5/2004	2.53	5/12/2004	3.04
10/25/2003	2.25	11/29/2003	2.38	1/10/2004	3.11	2/29/2004	3.43	4/6/2004	2.73	5/15/2004	2.23
10/27/2003	2.68	11/30/2003	2.52	1/11/2004	3.03	3/1/2004	3.33	4/7/2004	2.53	5/17/2004	2.65
10/28/2003	3.12	12/1/2003	2.44	1/12/2004	2.42	3/2/2004	3.8	4/8/2004	2.35	5/22/2004	1.62
10/29/2003	2.93	12/2/2003	2.4	1/13/2004	2.53	3/5/2004	3.49	4/9/2004	2.62	5/23/2004	1.57
10/30/2003	3.49	12/3/2003	2.99	1/14/2004	3.05	3/6/2004	3.31	4/10/2004	2.09	5/24/2004	1.79
10/31/2003	4.12	12/4/2003	2.56	1/24/2004	2.68	3/7/2004	2.63	4/13/2004	2.14	5/25/2004	1.5
11/1/2003	3.06	12/5/2003	2.24	1/25/2004	2.75	3/8/2004	2.75	4/14/2004	1.55	5/26/2004	2.85
11/2/2003	2.31	12/6/2003	3.33	1/26/2004	2.71	3/9/2004	2.77	4/15/2004	1.87	6/1/2004	2.58
11/2/2003	2.3	12/7/2003	3.92	1/27/2004	2.65	3/10/2004	2.93	4/16/2004	2.87	6/2/2004	1.47
11/3/2003	2.63	12/8/2003	3.6	1/28/2004	2.51	3/11/2004	2.65	4/17/2004	2.48	6/3/2004	2.64
11/4/2003	2.52	12/10/2003	4.96	1/29/2004	3	3/12/2004	2.91	4/18/2004	2.69	6/5/2004	2.38
11/5/2003	2.7	12/11/2003	4	1/30/2004	3.03	3/13/2004	3.78	4/19/2004	2.65	6/7/2004	5.31
11/6/2003	3.01	12/12/2003	4.16	1/31/2004	3.14	3/14/2004	3.04	4/20/2004	2.31	6/8/2004	4.73
11/7/2003	3.18	12/14/2003	3.28	2/1/2004	2.46	3/15/2004	3.11	4/21/2004	4.13	6/9/2004	6.2
11/9/2003	4.61	12/15/2003	3.02	2/2/2004	2.97	3/16/2004	2.65	4/22/2004	2.47	6/10/2004	4.4
11/10/2003	2.36	12/16/2003	2.44	2/3/2004	3.2	3/18/2004	3.37	4/23/2004	3.23	6/11/2004	4.15
11/11/2003	3.14	12/17/2003	1.51	2/4/2004	3.35	3/19/2004	3.64	4/24/2004	2.18	6/12/2004	3.89
11/12/2003	5.23	12/18/2003	1.28	2/5/2004	3.05	3/20/2004	3.54	4/25/2004	2.42	6/14/2004	3.85
11/13/2003	2.75	12/19/2003	1.1	2/6/2004	3.92	3/21/2004	3.36	4/26/2004	2.57	6/15/2004	4.13
11/14/2003	2.78	12/20/2003	4.72	2/7/2004	3.58	3/22/2004	2.59	4/27/2004	2.54	6/16/2004	3.88
11/15/2003	2.53	12/21/2003	4.85	2/8/2004	2.75	3/23/2004	2.72	4/28/2004	3.03	6/17/2004	3.2
11/16/2003	2.76	12/22/2003	4.94	2/9/2004	3.96	3/24/2004	2.64	4/30/2004	2.25		
11/17/2003	2.59	12/23/2003	4.75	2/10/2004	4.17	3/25/2004	2.86	5/1/2004	1.93		

Appendix G:

Turbidity Measured at the Lower Yuba River RST at Hallwood

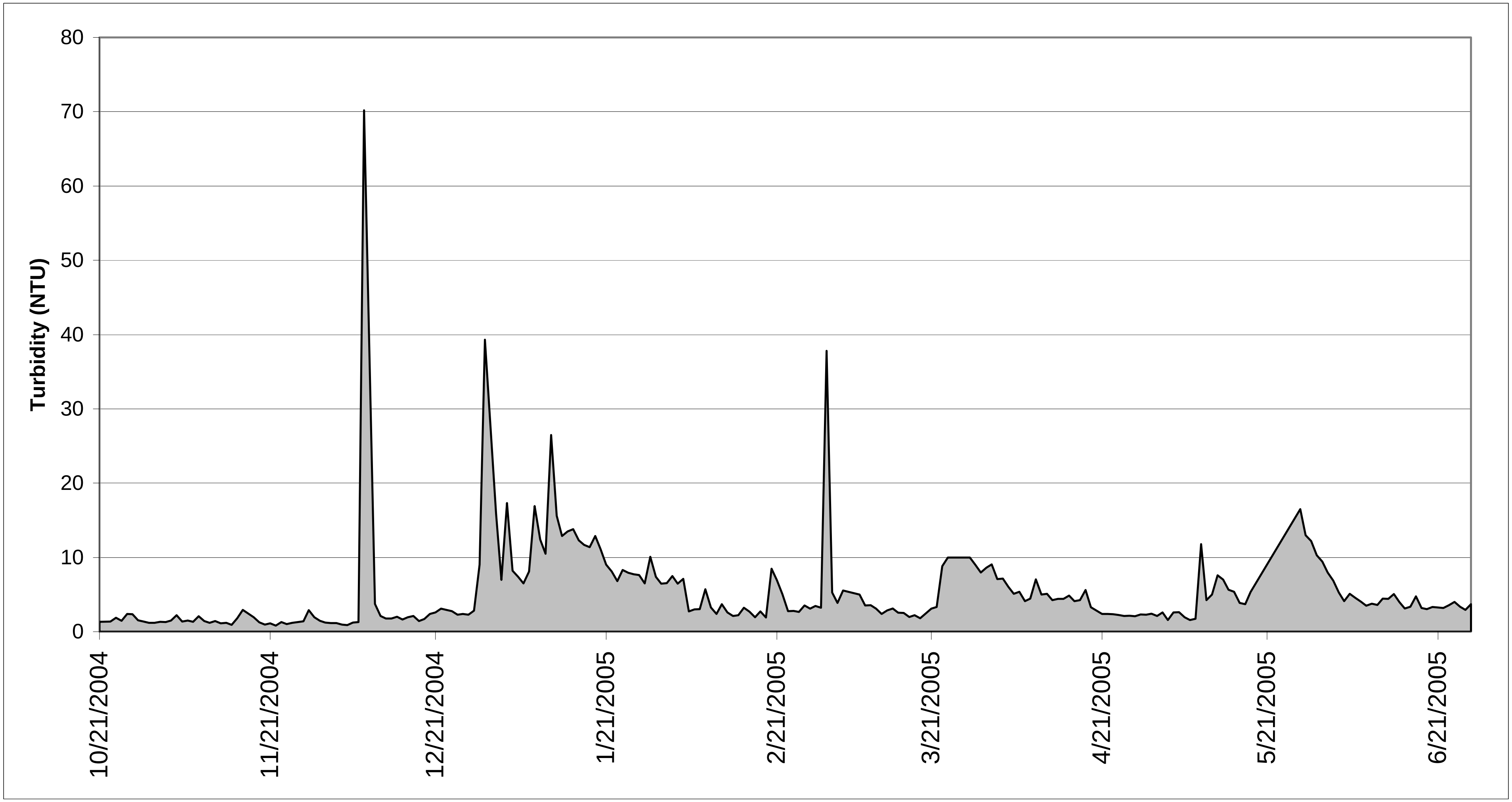

Figure G-1. Turbidity measured at the RST, October 21, 2004 to June 27, 2005.