STEELHEAD SUPPLEMENTATION STUDIES IN IDAHO RIVERS
1994 ANNUAL REPORT

To evaluate the feasibility of using artificial production to increase natural steelhead populations and to collect baseline life history, genetic, and disease data from natural steelhead populations.

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ABSTRACT

The steelhead *Oncorhynchus mykiss* supplementation study was designed to evaluate the feasibility of using artificial production to increase natural steelhead populations and to collect baseline life history, genetic, and disease data from natural steelhead populations. The scope of the study was expanded as it entered its second year in 1994. Because of the low escapement of wild steelhead, our primary objective of comparing wild and hatchery broodstocks for supplementation was not done. Hatchery adult steelhead from Sawtooth Fish Hatchery were stocked in Frenchman and Beaver creeks. I plan to evaluate the adult outplant as a case study to see if the Sawtooth stock could be used to reestablish naturally-spawning steelhead in the upper Salmon River drainage The second of four yearly outplants of 50,000 hatchery fingerling steelhead was made in the South Fork Red River on October 27, 1994. I estimated a nearly five-fold increase in the population of steelhead parr in the South Fork Red River from last year. I estimated that 7.7% of the fingerlings stocked in September 1993 survived to June 1994. We increased our snorkeling and Passive Integrated Transponder (PIT) tagging in wild steelhead streams in 1994. The age 1 + parr density in Fish Creek, a stream that can serve as an indicator of wild B-run steelhead, was 22.89 fish/100 m^2, an increase from 15.36 fish/100 m^2 in 1993. Idaho Department of Fish and Game research crews PIT-tagged 6,314 wild steelhead juveniles at 12 locations in the Clearwater and Salmon river drainages. Seven hundred ninety-five PIT-tagged smolts were detected at Lower Granite, Little Goose, Lower Monumental, and McNary dams in the spring of 1994.

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INTRODUCTION

The goal of supplementation is to increase natural fish production using artificial propagation without a negative effect on the productivity and abundance of existing natural populations. Supplementation has been identified to generate much of the planned anadromous fish run increases in the Columbia River Basin (NPPC 1987, RASP 1992). Although a sustainable benefit from supplementation is unlikely without an improvement in passage conditions through the federal hydropower system in the Snake and Columbia rivers, supplementation may help rebuild Idaho steelhead *Oncorhynchus mykiss* populations.

The goal of supplementation -- an increase in natural production without negative impacts on the natural target and non-target populations -- is a departure from previous hatchery management. The major supplementation question that needs to be resolved is whether it is possible to integrate artificial and natural production without an unacceptable risk to natural populations. Potential supplementation risks include: reducing natural productivity below sustainable levels through genetic introgression with a less-fit supplementation stock; displacement of naturally-produced fish through behavioral interactions with supplementation fish; transmission of diseases; excessive straying of returning hatchery adults; and inadvertent selection or domestication of donor stocks brought into the hatchery. These risks should be addressed before the implementation of large-scale supplementation programs.

In this study, we incorporated the Regional Assessment of Supplementation Projects (RASP) planning guidelines (RASP 1992) of describing the present and desired future condition of the stream and stock to design strategies to reach the desired future condition. Our research investigates four performance standards identified by RASP to evaluate supplementation: post-release survival, reproductive success, long-term fitness, and ecological interactions. We are investigating the potential benefits and risks of supplementation with small-scale experiments. Knowledge from this research will be used to guide future steelhead supplementation decisions in Idaho.

OBJECTIVES

There were seven objectives in the Experimental Design for this research project (Byrne 1994). We began work on three objectives in 1993 and planned to phase in the other four within two years. Because of budget reductions, we were unable to expand our list of objectives in 1994. This year, we focused our research on the three objectives we began last year. In 1994, we continued the manipulative experiments we began in 1993 (Byrne 1995) to evaluate long-term fitness and reproductive success. We also broadened our collection of life history data from wild steelhead populations.

The objectives and major questions we are studying are:

1. Assess the performance of hatchery and wild brood sources to reestablish steelhead in streams where extirpated.

Questions: Which brood source has the highest survival rate from:

a) egg-to-smolt in the hatchery environment,
b) smolt-to-adult (post-release) in the natural environment,
c) egg-to-age 1 in the natural environment, and
d) egg-to-smolt in the natural environment?

2. Evaluate the ability of returning adults from hatchery smolt and fingerling releases to produce progeny in natural streams.

Question,: Which group of adults that returns to spawn naturally from a smolt or fingerling stocking produces the most progeny?

3. Assess the abundance, habitat, and life history characteristics of existing wild and natural steelhead populations in the Salmon and Clearwater river drainages.

Questions: For our natural and wild steelhead populations:

a) What were the historical stream and stock characteristics?
b) What are the status, trend, and performance attributes of steelhead stocks within Idaho?
c) Are habitat and survival adequate for supplementation to be successful?
d) How do we best match donor to recipient stocks and habitat requirements for supplementation?
e) Can kelts or residualized steelhead be used as a donor source for supplementation purposes?

This objective was listed as Objective 5 in the Experimental Design (Byrne 1994) and the 1993 Annual Report (Byrne 1995).

The following four objectives were included in the original Study Plan (Byrne 1994), but were not implemented:

1. Estimate recovery rates and the frequency of supplementation required to establish viable steelhead populations in restoration rivers.

2. Evaluate broodstock management at existing weirs in relation to natural production objectives.

3. Assess the behavioral and ecological effects of supplementation on natural chinook salmon O. *tshawytscha,* steelhead, and resident trout populations.

4. Evaluate post-release survival of fish raised by alternative hatchery techniques in comparison to conventional hatchery practices.

STUDY AREA

The Steelhead Supplementation Study (SSS) is conducted in the Clearwater and Salmon river drainages of Idaho (Figures 1 and 2). Our research is coordinated with other Idaho Department of Fish and Game (IDFG) projects including: Idaho Chinook Supplementation

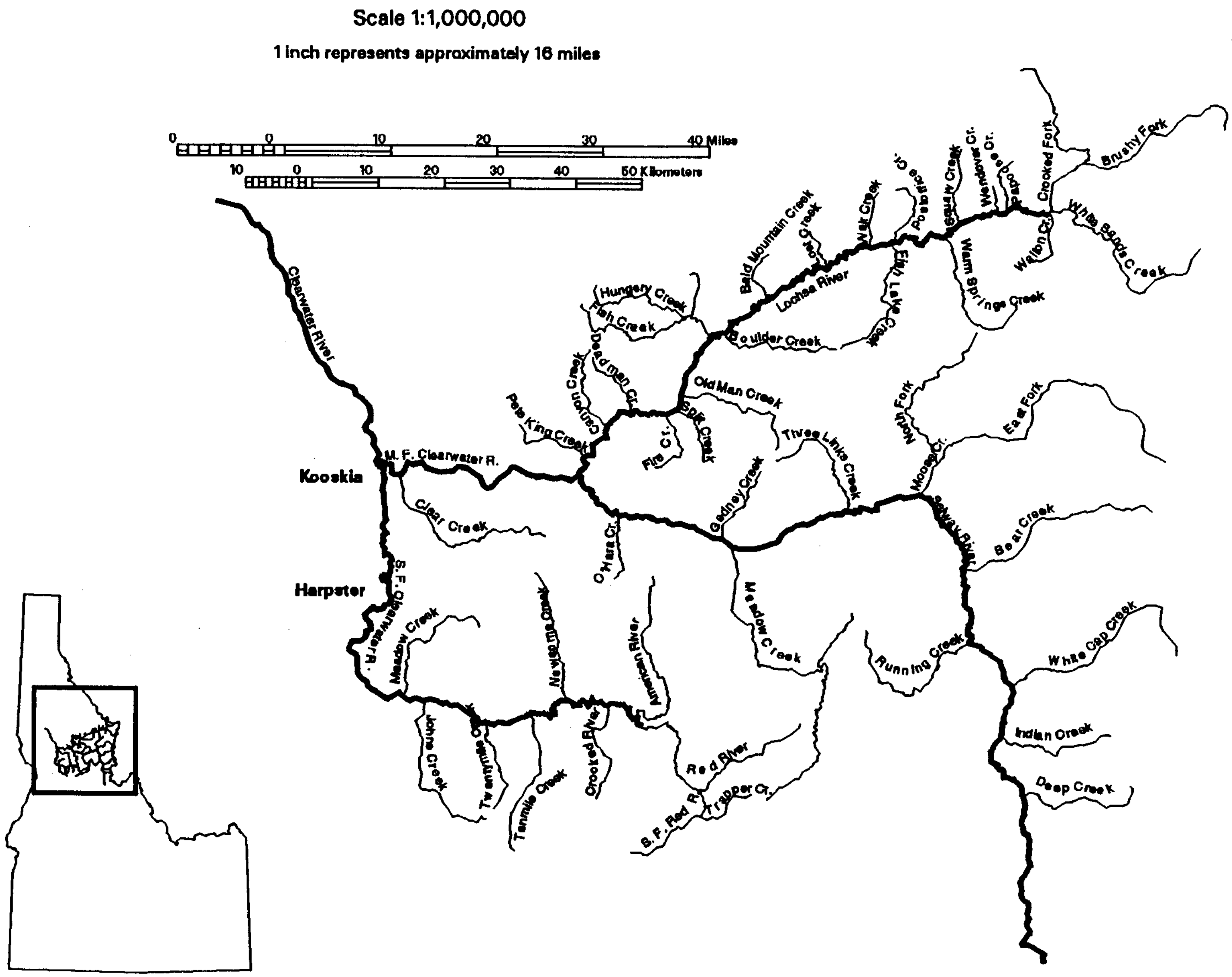


Figure 1. Location of the study streams in the Clearwater River drainage.

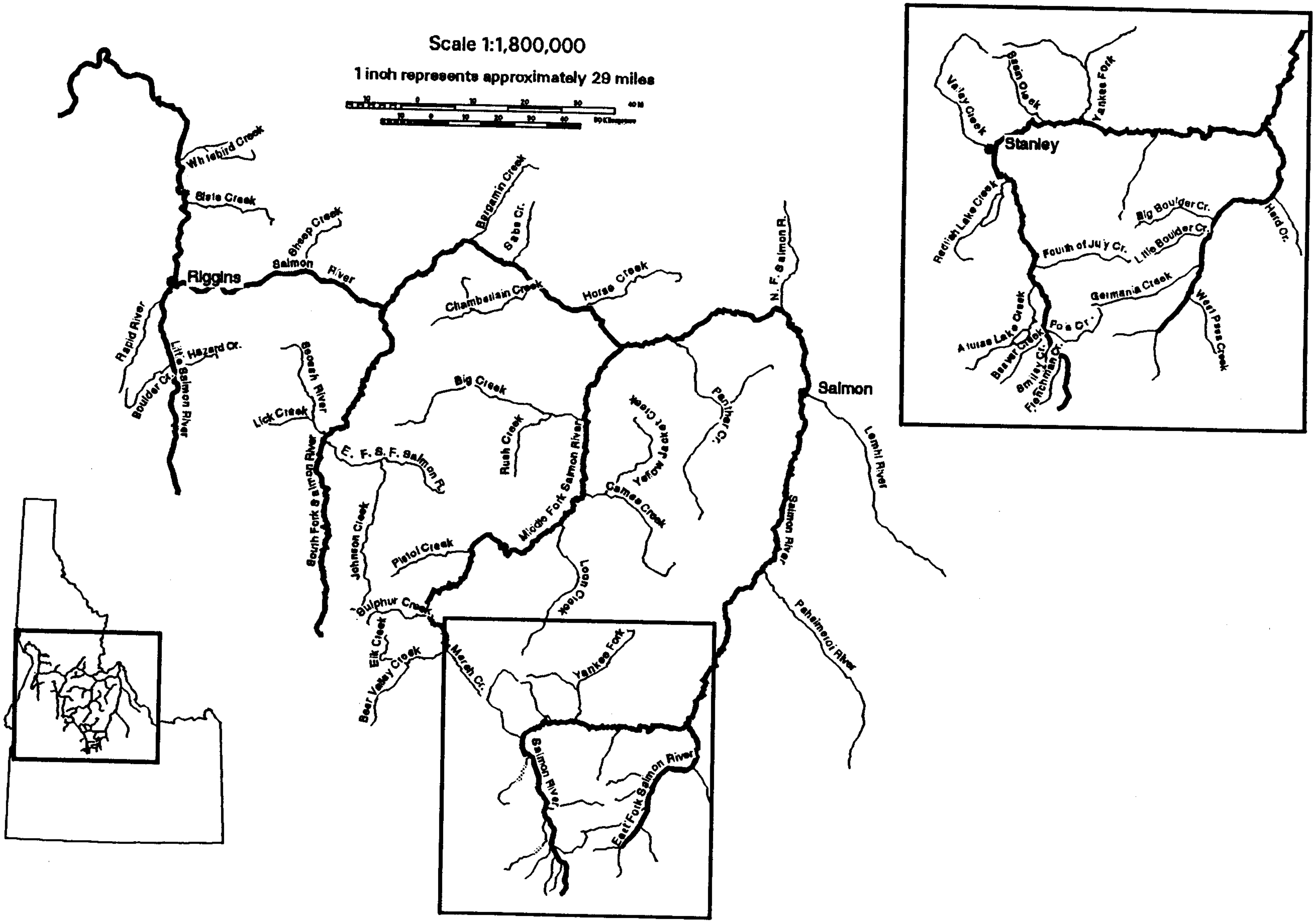


Figure 2. Location of the study streams in the Salmon River drainage.

Studies (ISS) (Bonneville Power Administration (BPA] project 89-093); Intensive Smolt Monitoring (ISM) (BPA project 91-073); and General Parr Monitoring (GPM) (BPA project 91-073).

In 1994, SSS crews snorkeled three streams in the Clearwater River drainage and eight streams in the Salmon River drainage. I recorded temperatures at 36 sites in 30 streams. IDFG crews Passive Integrated Transponder (PIT)-tagged wild juvenile steelhead at traps on Red River, Marsh Creek, Crooked Fork Creek, Fish Creek, Rapid River, Pahsimeroi River, and the South Fork Salmon River. I obtained juvenile steelhead PIT tag data from the U.S. Fish and Wildlife Service's screw trap in Clear Creek and the Shoshone-Bannock Tribes' screw trap in the East Fork Salmon River. We continued our Objective 1 and Objective 2 field experiments in Beaver Creek, Frenchman Creek, and the South Fork Red River.

METHODS

Objective 1

Collecting and Outplanting Adult Steelhead

IDFG personnel stocked hatchery adult steelhead that returned to Sawtooth Fish Hatchery in Beaver and Frenchman creeks to evaluate the reproductive success and long-term fitness of the stock for supplementation, following the procedures outlined by Byrne (1995). Hatchery adults were randomly sorted from fish that returned to the Sawtooth Fish Hatchery between April 22 and May 6. Because of the low escapement of wild steelhead into Idaho in 1994, we did not collect any for outplanting in study streams.

We installed a temporary picket weir at the upstream and downstream boundary of a stream section (about 1 km in length) before stocking the adults. The outplant sites were the same areas we used in 1993. The adults were sexed, measured to the nearest cm, placed in a hatchery truck, and distributed throughout the two study sites. IDFG personnel stocked 10 pair of adults in Frenchman Creek on April 25. IDFG personnel stocked a total of 8 females and 14 males in Beaver Creek on April 26, May 6, and May 8. We made three stockings in Beaver Creek because there were not enough females entering the hatchery trap after April 25 to make one outplant. Nine of the 14 males stocked in Beaver Creek were spawned once in the hatchery. Personnel monitored the fish daily, marked all redds, and removed the weirs after all the fish had spawned. I classified the redds as full (surface area 20.75 m^2) or partial (<0.75 m^2). I did not disturb the gravel to verify egg deposition.

The fork lengths of female steelhead spawned at Sawtooth Fish Hatchery were measured to the nearest cm. Their eggs were incubated in individual egg trays and enumerated with an egg counter. I used regression analysis to develop a relation between fork length and fecundity. I used this relation to estimate the maximum egg deposition in Beaver and Frenchman creeks.

Evaluation of Spawner Success

Because wild adult steelhead were not stocked, I cannot evaluate the relative performance of the Sawtooth Fish Hatchery stock to a wild stock as planned. Instead, this experiment is viewed as a case study to determine if the Sawtooth Fish Hatchery stock can be used to reestablish steelhead in vacant habitat in the upper Salmon River drainage.

The stream temperature in both creeks was recorded with Hobo™ temperature recorders (Onset Instruments, Pocasset, Massachusetts). I used the last day that a redd was built in each stream to predict the fry emergence date. I summed the daily mean temperature to calculate the number of temperature units (TUs) in °C in each stream. I assumed that fry emergence began when 556 TUs were accumulated and was 95% complete after 722 TUs were accumulated (Russ Thurow, U.S. Forest Service, Intermountain Research Station, Boise, Idaho, unpublished data).

I used age 1 juvenile steelhead abundance (fish/100 m^2), based on snorkel surveys following the procedures outlined in the Objective 3, juvenile fish densities section, as an index of reproductive success. I assumed that all age 1 steelhead in Beaver and Frenchman creeks were the progeny of the 1993 hatchery adult outplants. In spring 1993, Sawtooth Fish Hatchery personnel stocked 149 female and 456 male steelhead in the Salmon River upstream of the hatchery weir. Some of these adults were outplanted and then spawned in the Salmon River between Beaver Creek and Frenchman Creek. Progeny from those adults could have immigrated into Beaver and Frenchman creeks.

Objective 2

Fingerling Stocking

We released about 51,000 steelhead fingerlings (reared at Clearwater Fish Hatchery) at five locations in the South Fork Red River on October 27, 1994 (Figure 3). Because of the late stocking date, we did not monitor fish movement after they were released. An IDFG marking crew PIT-tagged about 5,000 fish and Coded Wire-Tagged (CWT) 46,000 fish on September 7-9. The adipose fin was not clipped on any fish to prevent angler harvest on returning adults. All PIT-tagged fish were measured for fork length to the nearest 1 mm and a random sample of 300 fish was weighed to the nearest 0.1 g. The condition factor (K) of steelhead was calculated as:

$$K = \frac{W\ (100{,}000)}{L^3} \qquad (1)$$

where W = weight in grams and
L = fork length in mm.

This was the second of four yearly fall fingerling releases (1993-1996) in the South Fork Red River.

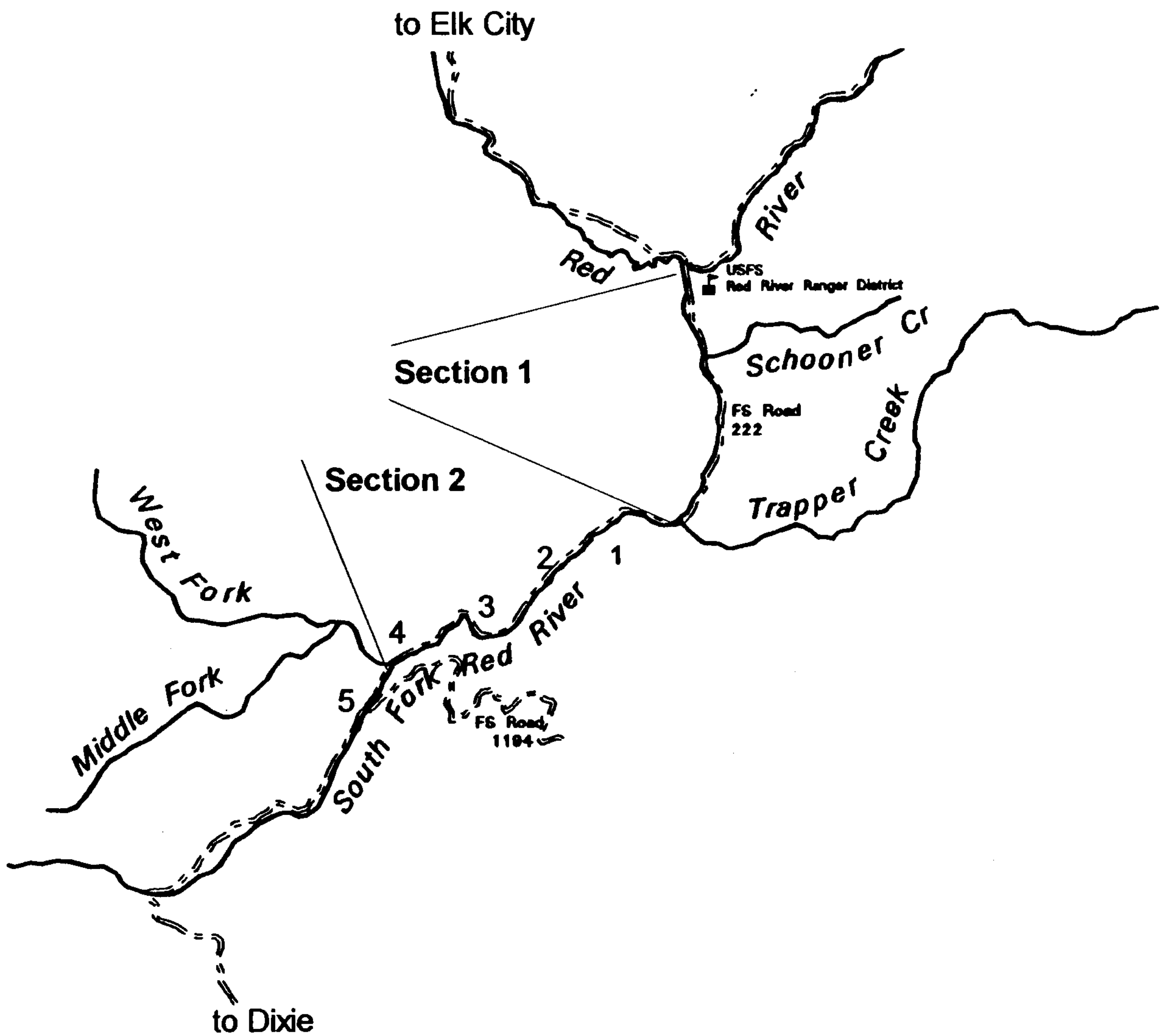


Figure 3. Map of South Fork Red River drainage showing location of five fingerling stocking sites and stream section snorkel boundaries.

Smolt Stocking

IDFG will begin releasing about 4,000 hatchery smolts (reared at Clearwater Fish Hatchery) in Red River upstream of the South Fork Red River beginning in spring 1996 and continuing yearly until 2000. The lag between fingerling and smolt stockings was planned so that most of the steelhead released as fingerling smolts would migrate to the ocean during the years that hatchery smolts are released.

Objective 3

Habitat Survey

IDFG personnel walked Fish, Gedney, West Fork Gedney, and Marsh creeks and classified the predominant stream habitat every 10 m into pool, run, riffle, and pocketwater (Shepard 1983). Based on the survey, I divided streams into sections that reflected gradient, habitat, or stream order differences. The survey was not repeated in Frenchman, Beaver, and West Pass creeks and the South Fork Red River, as these streams were surveyed in 1993. I was unable to complete the habitat survey in Gedney Creek upstream of West Fork Gedney Creek because of time constraints. IDFG personnel did not do a habitat survey in Basin, Capehorn, East Fork Valley, Valley, and Germania creeks, although we did snorkel them.

Juvenile Fish Densities

Steelhead supplementation crews snorkeled eight streams in the Salmon River drainage and three in the Clearwater River drainage to estimate juvenile steelhead abundance. Each snorkel site consisted of a distinct habitat type and was chosen randomly throughout the stream section we surveyed. The number of snorkel sites for each habitat type was allocated proportional to the type's abundance in the stream section. Depending on stream size, one to four snorkelers counted fish in each snorkel site. Each snorkel site was separated by at least one distinct habitat type change from a prior site. Snorkelers estimated the size of all fish except chinook salmon parr, dace *Rhinichthys sp.,* and sculpin *Cottus sp.* to the nearest inch. After the site was snorkeled, we measured the length and three to six widths of the site to calculate surface area.

Chinook salmon parr and steelhead parr were aged based on observed size. Chinook salmon parr were counted and classified as age 0 (brood year 1993, 100 mm) or age 1 (brood year 1992, >100 mm). Steelhead parr were classified as: age 1, length 3 in to 5 in (76 mm to 127 mm); and age 2+, length >5 in (127 mm). Because steelhead fry (age 0, 75 mm) are indistinguishable from cutthroat trout *Oncorhynchus clarki* fry, we classified both as trout fry. We did not partition cutthroat trout, bull trout *Salvelinus confluentus,* brook trout S. *fontinalis,* and mountain whitefish *Prosopium williamsoni* into age classes.

Mean densities (fish per 100 m^2) by habitat type in each stream section were calculated for trout fry, the two age classes of steelhead, chinook salmon, resident trout, and mountain whitefish. I calculated a weighted mean density (w_t) for each class of fish in stream sections that were habitat surveyed as:

$$w_t = \sum p_{it} d_{it} \qquad 12)$$

where p_{it} = proportion of habitat *i* in stream section *t,*
d_{it} = mean density of habitat *i* in stream section *t,*
i = pool, riffle, run, pocketwater, and
t = stream section.

The weighted mean density of each class of fish for the entire stream (w_3) was found by**:**

$$\overline{w_s} = \sum \overline{w_t} A_t \qquad (3)$$

where A_t = proportion of the stream surface area in section t.

Population Totals

The total age 1 and age 2 + steelhead population was estimated for each stream section

$$N_S = \sum_{i=1}^{4} A_i \overline{d_i} \qquad (4)$$

where N, = population total for section s,
A, = total surface area, in section s, of habitat type i,
Đ$_t$= mean steelhead density, in section s, of habitat i, and
i = pool, riffle, run, pocket water.

The total surface area ($A_;$) of each habitat type in the stream section was calculated as:

$$A_i = L_s p_i w_i \qquad (5)$$

where L, = length of stream section s,
p_i = proportion of habitat i in stream section s, and
w_i = mean width of habitat i in section s.

An approximate 95% confidence interval (CI_5) on the population estimates in the stream section was calculated as:

$$CI_s = 2\sqrt{\sum_{i=1}^{h} A_i^2 \left(\frac{A_i - a_i}{A_i}\right)\left(\frac{s_i^2}{n_i}\right)} \qquad (6)$$

where A_i = total surface area of habitat i,
s^2 = the sample variance of mean steelhead density in habitat i,
a_i = total surface area of habitat i snorkeled in the section,
n_i = number of habitat i sites snorkeled in the section, and
i = pool, run, pocketwater, or riffle habitat.

We treated A_i and a_i as constants when calculating CI and assumed that the variance was due to differences of densities in each snorkel site, not area measurements. The estimated total abundance of each age class for the entire stream was found by summing the estimates of all sections.

Stream Temperature

Temperature recorders (Onset Instruments, Pocasset, Massachusetts) were located at 36 sites in 30 streams (Table 1). I began recording temperatures at 20 new sites in 1994. The water temperature was recorded every 1.0 h to 1.6 h from early spring until late October. The recorders were reset to measure stream temperature every 2.4 h or 3.2 h, depending on location and access, throughout the winter. The daily mean, maximum, and minimum temperatures were calculated for each stream. We computed the number of TUs in °C accrued in each stream from May 1 to October 15 by summing the daily mean temperature. The elevation of each recorder was determined from 7.5 min U.S. Geological Survey topographic maps. I used regression analysis to determine the relation between elevation and TUs accrued between May 1 and October 15. I compared the number of TUs accrued between June 15 and September 15 this year with the same period in 1993 to determine the percent change in water temperature between years in streams where the data was available.

PIT Tagging

Personnel operating screw traps on the East Fork Salmon River, Clear Creek, Fish Creek, Red River, Crooked Fork Creek, Marsh Creek, Pahsimeroi River, and South Fork Salmon River PIT-tagged wild steelhead captured during the spring (March 3 to June 15). During the fall (August 15 to November 15), we operated screw traps and tagged steelhead at all spring sites except Clear Creek. During the fall we tagged steelhead that were captured by a weir designed to trap bull trout in Rapid River. We tagged steelhead >70 mm and measured fork length to the nearest mm and weight to the nearest 0.1 g. The traps were checked daily and the number of steelhead captured was recorded. Each fish was scanned prior to tagging to verify that it had not been tagged previously. We followed PIT tagging procedures outlined for chinook salmon in Kiefer and Forester (1991) and the PIT Tag Steering Committee (1993).

Table 1. Location of temperature recorders and date temperature recording began.

Stream	Date	Location
Salmon River drainage		
Basin Creek	9/22/94	200 m upstream of hot springs
Beaver Creek	6/7/93	3 km upstream of mouth
Big Boulder Creek	9/22/94	200 m upstream of mouth
Capehorn Creek	9/22/94	30 m upstream of Highway 21 bridge
East Fork Salmon River 1	1/29/94	100 m upstream of mouth
East Fork Salmon River 2	1/29/94	at hatchery weir
East Fork Salmon River 3	10/19/94	100 m downstream of Fisher Creek
East Fork Salmon River 4	6/8/93	Upstream of Bowery Hot Springs
Frenchman Creek	6/7/93	3 km upstream of mouth
Fourth of July Creek	6/21/94	50 m upstream of USFS boundary
Germania Creek	6/8/93	20 m upstream of irrigation diversion
Marsh Creek	6/7/93	20 m downstream of adult weir site
Pole Creek	6/21/94	2 km upstream of irrigation diversion
Redfish Lake Creek	5/5/94	at weir site
Salmon River 1	1/29/94	200 m upstream of EF Salmon River
Salmon River 2	3/29/94	at Sawtooth Hatchery
South Fork Salmon River	3/8/94	at hatchery weir site
Smiley Creek	6/7/93	4 km upstream of mouth
Valley Creek	6/8/93	70 m upstream of Meadow Creek
West Pass Creek	6/8/93	20 m upstream of irrigation diversion
Clearwater River drainage		
Bald Mountain Creek	10/2/94	20 m downstream of Highway 12 bridge
Canyon Creek	6/10/93	300 m upstream of mouth
Crooked Fork Creek	6/9/93	70 m upstream of Brushy Fork Creek
Fish Creek 1	6/9/93	1 km upstream of mouth
Fish Creek 2	7/12/94	50 m upstream of Pagoda Creek
Gedney Creek	9/9/94	200 m upstream of mouth
Lost Creek	10/2/94	20 m downstream of Highway 12 bridge
Post Office Creek	6/9/93	100 m upstream of mouth
Red River	6/10/93	1 km upstream of SF Red River
South Fork Red River 1	6/10/93	50 m upstream of Schooner Creek
South Fork Red River 2	10/27/94	1.5 km upstream of Trapper Creek
Trapper Creek	6/29/94	100 m upstream of mouth
Walton Creek	6/9/93	50 m upstream of hatchery intake
Weir Creek	6/9/93	300 m upstream of mouth
Wendover Creek	7/13/94	200 m upstream of Highway 12 bridge
West Fork Gedney Creek	7/24/94	20 m upstream of mouth

A maximum of 20 juveniles were anesthetized with MS-222 at one time. PIT tagging equipment was sterilized with a 70% ethanol solution to reduce disease transfer between fish. Tagged juveniles were held 4 h to 24 h to observe mortality and tag rejection, then released.

Steelhead supplementation crews PIT-tagged juvenile steelhead in Beaver, Gedney, Johnson, and Fish creeks in July, August, and September. We captured the fish by fly-fishing with size 16 barbless flies in Fish and Gedney creeks. Crews collected steelhead from Beaver Creek with seines and electrofishing. In Johnson Creek, crews used baited minnow traps to collect the steelhead parr. Steelhead were released throughout the area where they were captured after a 1 h to 4 h recovery period.

Fish were grouped into 5 mm length classes (class 70=fish 70 mm to 74 mm, class 75 = fish 75 mm to 79 mm, etc.) and the length frequency of the PIT-tagged fish was plotted. Condition factor (Equation 1) was calculated for all fish that were weighed and measured. The cumulative distribution of the number of fish caught was plotted for the spring and fall trapping periods. Analysis of variance (ANOVA) for unbalanced designs was used to test for differences in length and condition factor among streams. When significant differences were detected, the Tukey-Kramer HSD test was used for all pairwise comparisons among the streams (Systat, 1992).

Smolt Detections

I obtained the number, date of tagging, length, and weight at tagging of smolts that were detected at Lower Granite, Little Goose, Lower Monumental, and McNary dams in 1994 for each release site. I put the detected smolts into a fall 1993 (tagged August 15 to November 15, 1993) or a spring 1994 (tagged March 15 to June 15, 1994) group and used a t-test to test for differences in length and condition factor. Smolts that were detected and tagged prior to August 15, 1993 were excluded from the analysis because of the small number of observations. ANOVA for unbalanced designs was used to test for differences in length and condition factor among release sites within the two tag groups. If a significant difference was obtained, I used the Tukey-Kramer HSD test for pairwise comparisons among the streams.

Smolt Travel Time to Lower Granite Dam

Smolt travel time from release site to Lower Granite Dam (LGR) was calculated for all sites where fish were tagged during spring 1994. The detected fish, arrival date at LGR, and travel time (in days) to LGR were downloaded from the Pacific States Marine Fisheries Commission's Columbia River Basin PIT Tag Information System (PTAGIS) database. Travel time was converted to km traveled per day from the release site to LGR. The median arrival date and the cumulative distribution function of arrival date at LGR was calculated for each release site and for fish that were tagged in fall 1993 and spring 1994. I used the Smirnov test (Conover 1980) to test whether the cumulative distribution of arrival time at LGR differed between smolts that were tagged in fall 1993 and spring 1994. For each stream I calculated the median travel time to LGR and the CI with confidence z90%. CI for streams with <25 detections at LGR were determined using the binomial distribution. If there were >25 detections at LGR, I used the normal approximation to a binomial distribution (Zar 1984, Steinhorst et al. 1988) to calculate CI.

Adult and Juvenile Steelhead Scale Samples

Scales, fork length, and sex were obtained from naturally-produced adult steelhead trapped in the Salmon River at Sawtooth Fish Hatchery and Clear Creek during the spring. We collected scales and fork lengths of age 1 + juveniles from Fish Creek, Gedney Creek, Johnson Creek, South Fork Salmon River, and Whitecap Creek. Scales were taken from both sides of the fish from the preferred area (MacLellan 1987). This area is located just above the lateral line, posterior of a vertical line drawn from the posterior end of the dorsal fin. All scales were mounted on gummed paper, pressed in acetate, and aged.

RESULTS

Objective 1

Collecting and Outplanting Adult Steelhead

On April 25, IDFG personnel stocked 10 pair of adult steelhead in Frenchman Creek. The mean length of the females and males were 69 cm and 66 cm, respectively (Table 2). Spawning was completed in Frenchman Creek by May 5 and the weirs were removed. A total of 12 redds were counted. Of these, 6 were classified full redds and 6 partial redds. River otters entered the study section and preyed on the adult steelhead while they were spawning. We verified otter kills of 7 females, 5 males, and 1 unknown sex steelhead between April 26 and May 5. Several of the females were killed before they completed spawning.

IDFG personnel stocked two females and three males on April 28, four females and seven males on May 6, and two females and four males on May 9 in Beaver Creek (Table 2). The mean length of the females and males were 63 cm and 66 cm, respectively. We counted

Table 2. Number, date, and mean length of hatchery steelhead outplanted in Beaver and Frenchman creeks to spawn during spring 1994. Standard deviation of mean in parentheses. NR = not recorded.

	Date	Number of		Mean length		Number of redds
		Males	Females	Males	Females	
Beaver Creek	4/28	3	2	66 (5)	68(0)	--
	5/6	7	4	63 (7)	72(7)	--
	5/9		2	58 (6)	69(4)	--
	Total	14	8	63 (7)	65(6)	6
Frenchman Creek	4/25	10	10	66 (9)	69(4)	14
Sawtooth Hatchery	4/14-4/21	--	44	--	67(4)	--

six redds in Beaver Creek by May 10. After May 10, the water was too high and turbid to see the creek bottom and to make accurate redd counts. The increasing flow knocked over the downstream weir on May 14. We removed it and the upstream weir on May 15. We did not observe any otters or find any dead steelhead in this outplant section during the time adults were spawning.

successfully, then the maximum egg deposition was 38,888 (± 3,016) and 48,610 (± 3,770) in

The mean fecundity of females spawned at Sawtooth Fish Hatchery between April 14 and April 21 was 4,861 (n=45, 95% CI ±377) and ranged from 1,413 to 7,394. The regression of fecundity on length (Figure 4) was not significant ($p = 0.242$). Because there was no relation between female length and fecundity, I used the mean fecundity to estimate egg deposition in Beaver and Frenchman creeks. If all the females that were stocked spawned Beaver and Frenchman creeks, respectively. Because of otter predation on the adults in Frenchman Creek, egg deposition was less than the maximum in that stream. We recovered one female in Beaver Creek after spawning and found no eggs retained. We were unable to recover the other females stocked in Beaver Creek due to high water.

Evaluation of Spawner Success

I used May 1 and May 9 as the starting dates for calculating TUs to predict fry emergence in Frenchman and Beaver Creeks, respectively. In Frenchman Creek, the predicted initial emergence date was July 7, with 95% emergence by July 20. In Beaver Creek, the predicted initial emergence date was July 16, with 95% emergence by July 28 (Figure 5). We snorkeled Beaver and Frenchman creeks on August 4 and 5. Fry densities in the outplant sections were 22.21 (95% CI, ± 14.71) and 35.17 (95% CI, ± 14.29) fry/100 m^2 in Beaver and Frenchman creeks, respectively.

Hatchery adult steelhead were stocked in Frenchman and Beaver creeks in 1993. The weighted mean age 1 density in the supplementation sections (section 1 in Frenchman Creek and section 2 in Beaver Creek) were 10.74 fish/100 m^2 (95% CI, ± 7.61) and 3.88 fish/100 m^2 (95% CI, ± 3.31) in Beaver and Frenchman creeks, respectively.

Although fewer adults spawned in Beaver Creek in 1993, it had a higher population of juvenile steelhead (1,364 ±467) than Frenchman Creek (433 ±232). Although the age 1 abundance in Frenchman Creek increased 87% compared with 1993, the combined age 1 and age 2+ population declined about 12% compared with 1993 (Figure 6). In Beaver Creek the combined age 1 and age 2+ population and age 1 population rose 182% and 361%, respectively, compared with 1993.

We PIT-tagged 245 juvenile steelhead in Beaver Creek on August 8-10. We collected 94 fish by electroshocking and 151 with beach seines. The mean length of the steelhead was 90 mm (± 3 mm) and the median length was 84 mm. The mean condition factor of the fish was 1.0261 (± 0.0102, n=232).

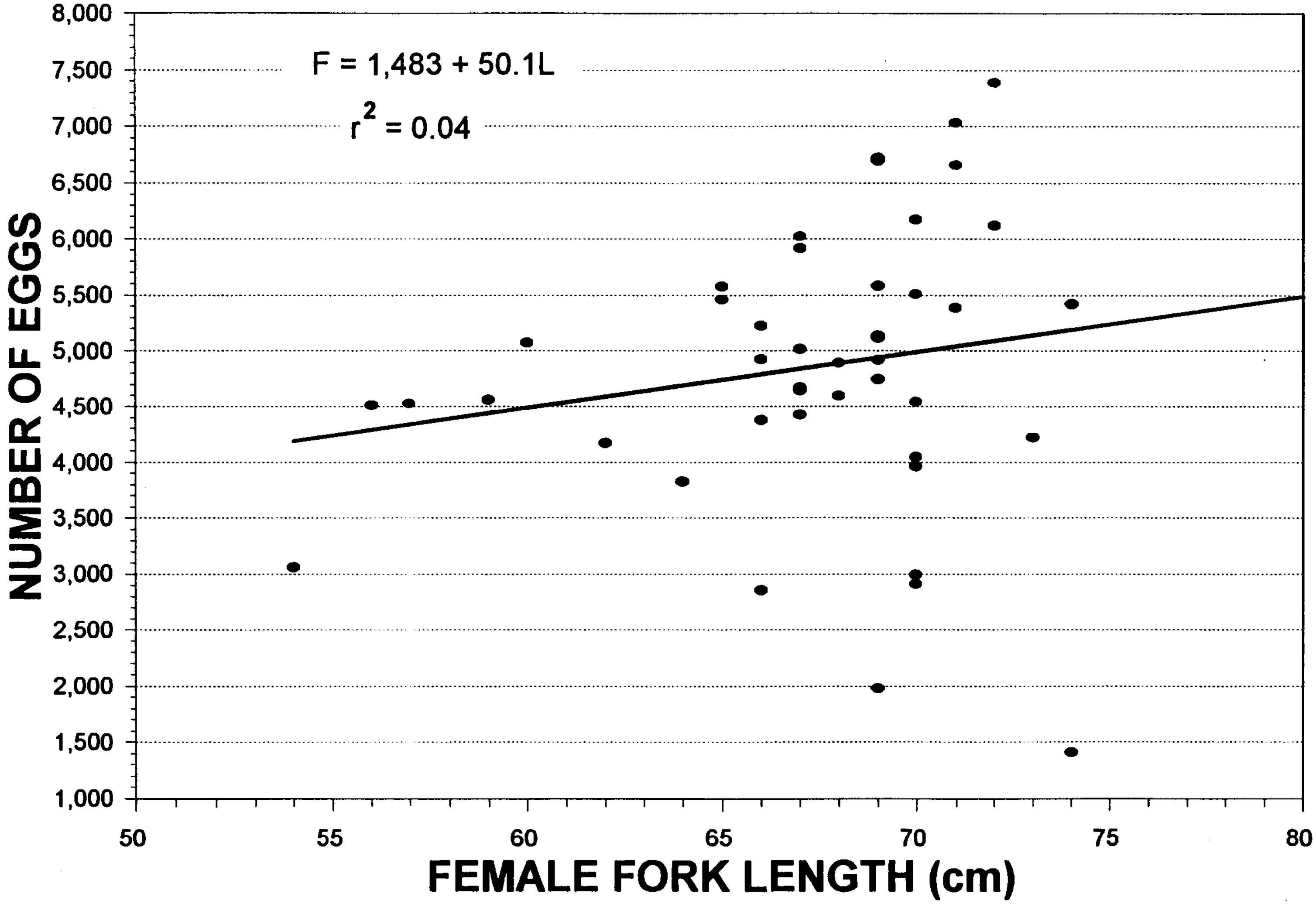


Figure 4. Relation between female fork length (L) and fecundity (F) of hatchery steelhead spawned at Sawtooth Fish Hatchery.

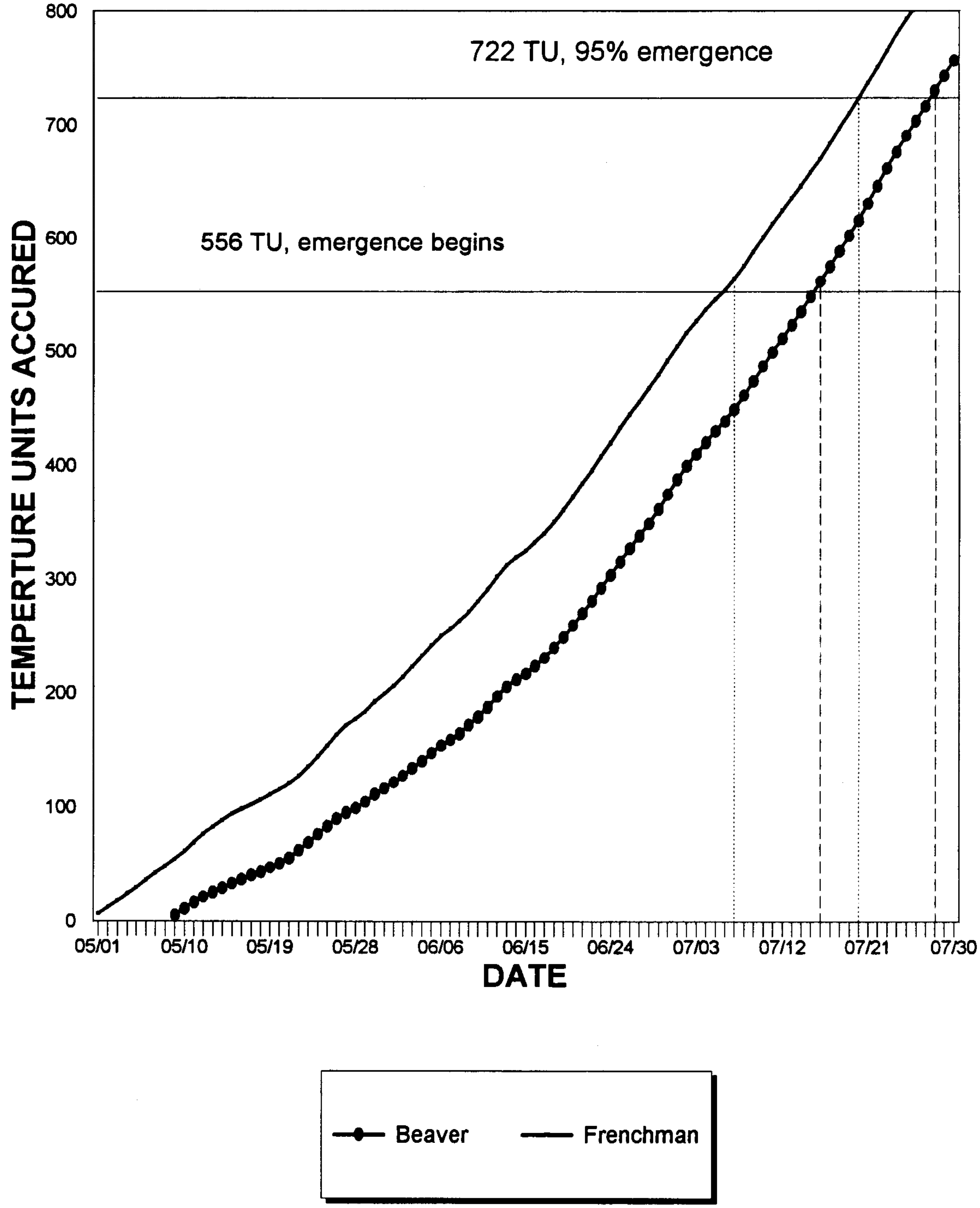


Figure 5. Amount of TUs (°C) accrued in Beaver and Frenchman creeks from estimated steelhead spawning date.

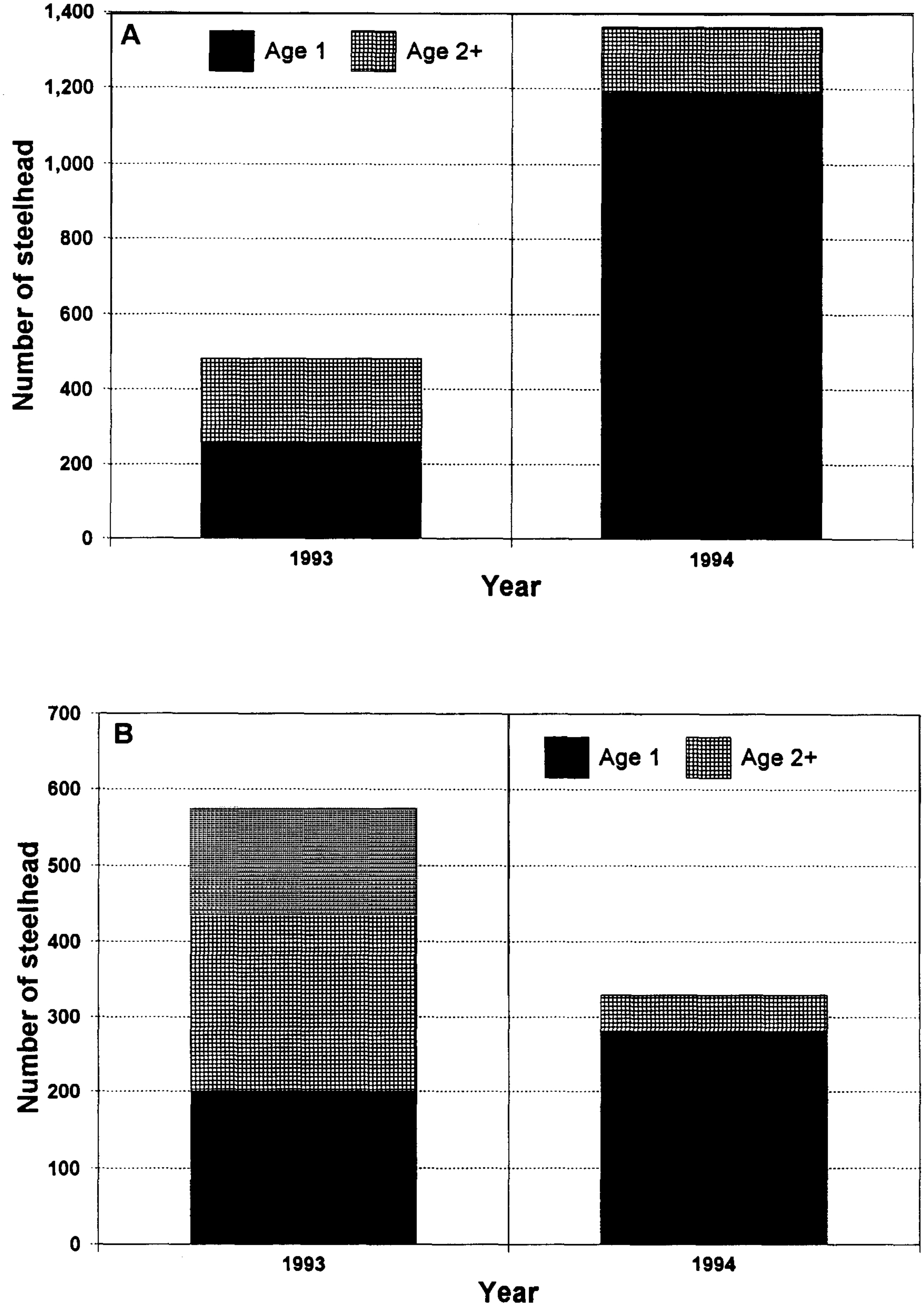


Figure 6. Population estimates for age 1 and age 2+ steelhead in 1993 and 1994. (A) = Beaver Creek. (B) = Frenchman Creek.

Objective 2

Fingerling Stocking

We stocked about 50,800 steelhead parr (4,790 PIT-tagged and 46,010 CWT) in the South Fork Red River on October 27. The mean water temperature that day was 5.1 °C. On November 2, the mean water temperature was 0°C and it remained at or near 0°C for the rest of the year (Appendix 30). The mean length was 76 mm (±0.3, n = 942), mean weight was 5.3 g (±0.1, n=306), and mean condition factor was 1.1229 (±0.0189, n = 306) at the time of tagging. An outbreak of columnaris after the fish were tagged prevented us from stocking them on the scheduled date of September 15. The fish were put on chilled water and treated with TM-100 medicated feed for 21 days at Clearwater Fish Hatchery.

There were eight detections at the dams on the Snake and Columbia rivers of hatchery fingerlings we stocked in the South Fork Red River in September 1993. The mean length of the detected fish in late August 1993 was 74 mm (s = 4). The detection rate from the 1993 stocking was 0.16%. Since only a subsample of the stocked fingerlings were PIT-tagged, I estimate that 80 of the nearly 50,000 fingerlings stocked in fall 1993 smolted in the spring of 1994.

Smolt Stocking

No smolts were released this year. The first smolt stocking is planned for spring 1996.

Objective 3

Habitat Survey

Pocketwater habitat accounted for >50% of the stream length in Gedney and West Fork Gedney creeks and 44% of the stream length in Fish Creek (Table 3). In Marsh Creek, pocketwater was found in only 6.4% of the stream length surveyed. The dominant habitat types in Marsh Creek were riffles (48.9%) and runs (42.3%). I partitioned Gedney Creek into two sections that reflected a stream order difference - section 1 from the mouth to the confluence of West Fork Gedney Creek and section 2 from West Fork Gedney Creek to Canteen Creek. I did not partition Marsh Creek, Fish Creek, and West Fork Gedney Creek, as the habitat, gradient, and stream order were similar in the area that was snorkeled (Table 4).

Juvenile Steelhead Densities

Within each stream section, most of the combined age 1 and age 2+ steelhead densities by habitat type in the Salmon River tributaries were <4 fish/100 m^2 (Table 5). Beaver and

Table 3. Percentage of each habitat in stream sections based on 10-pace survey. Stream length measured in km.

Stream	Date	Section	Pool	Run	PW	Riffle	Length
CLEARWATER RIVER DRAINAGE							
South Fork Red River	07/09/93	1. Mouth-Trapper Creek	4.1	39.6	20.1	36.2	4.70
		2. Trapper Creek-WF SF Red River	10.0	45.2	14.1	30.7	6.90
Fish Creek	09/25/94	1. Mouth-Hungery Creek	6.8	31.2	44.2	17.8	7.47
Gedney Creek	07/25/94	1. Mouth-WF Gedney Creek	7.4	19.3	59.0	14.3	5.02
West Fork Gedney Creek	07/22/94	1. Mouth-waterfall 2 km upstream	20.6	19.1	54.5	5.7	2.09
SALMON RIVER DRAINAGE							
Beaver Creek	07/20/93	1. Mouth-water diversion pump	5.4	73.1	0.0	21.5	1.90
		2. Diversion-top supplementation section	8.8	56.1	5.3	29.8	2.90
		3. Supplementation site-upstream	32.3	47.9	2.1	17.7	8.40
Frenchman Creek	07/20/93	1. Mouth-top supplementation site	7.1	75.5	2.3	15.1	3.10
		2. Supplementation site-upstream	24.4	65.1	1.0	9.5	3.10
West Pass Creek	06/26/93	1. Mouth-Roaring Creek	3.4	19.7	10.3	66.5	2.30
		2. Roaring Creek-Cougar Canyon	4.7	32.8	9.4	53.0	4.70
Germania Creek	06/27/93	2. Upper meadow-Chamberlain Creek	5.4	24.3	25.3	44.8	3.00
Marsh Creek	08/23/94	1. Mouth-Capehorn Creek	2.5	42.3	6.4	48.9	9.76

Table 4. Streams snorkeled in 1994 and their section boundaries. In streams with more than one section, downstream boundary of sections 2 and 3 begins at upstream boundary of previous section.

		Boundary	
Stream	Section	Downstream	Upstream
Fish Creek	1	mouth	Hungery Creek
Gedney Creek	1	mouth	West Fork Gedney Creek
	2		Canteen Creek
West Fork Gedney Creek	1	mouth	Waterfall upstream about 2 km
South Fork Red River	1	mouth	Trapper Creek
	2		West Fork Red River
West Fork Red River	1	mouth	Upstream 1.5 km
Banner Creek	1	mouth	Upstream 2 km
Basin Creek	1	mouth	East Fork Basin Creek
Beaver Creek	1[a]	mouth	Irrigation pump about 0.5 km upstream of Highway 75
	2		Jeep trail crossing about 3 km upstream of irrigation pump
	3[b]		Upstream about 5 km
Capehorn Creek	1	mouth	Banner Creek
	2		Upstream 2 km
Frenchman Creek	1	mouth	Just upstream of first meadow, about 3 km upstream of Highway 75
	2		Upstream 3 km
Germania Creek	1	mouth	First meadow about 6 km upstream of mouth
	2		Chamberlain Creek
Marsh Creek	1	mouth	Capehorn Creek
Valley Creek	1	USFS road 029 bridge	Upstream 7 km
West Pass Creek	1	mouth	Roaring Creek
	2		Cougar Canyon Creek

[a] This section dry during summer.
[b] Creek dry 5 km upstream of jeep trail crossing.

Table 5. Mean fish densities (fish/100 m^2) by habitat type in Salmon River tributaries obtained from snorkel surveys in 1994. S = stream section; Area =total surface area of all sites in m^2; N = number of sites snorkeled of each habitat type; Fry = all trout <76 mm; SH1 = juvenile steelhead 76 mm to 127 mm; SH2 + = juvenile steelhead > 127 mm; CHO = age 0 chinook salmon; Cutt = all cutthroat trout; Bull = all bull trout; Brook = all brook trout; White = all mountain whitefish; Total = total salmonid density.

Stream	Tvoe	S	Area	N	Date	Fry	SH1	SH2+	CHO	CH1	Cutt	Bull	Brook	White	Total
Banner Creek	Pool	1	106	2	8/23	0.00	0.00	0.00	74.95	0.00	0.00	0.00	2.92	0.00	77.88
Banner Creek	Riffle	1	40	1		0.00	0.00	0.00	7.52	0.00	0.00	0.00	0.00	0.00	7.52
Banner Creek	Run	1	190	2		0.00	0.00	0.00	17.03	0.00	0.00	0.00	0.46	0.00	17.48
Basin Creek	Pool	1	300	3	8/21	3.61	3.04	1.15	43.88	0.00	0.00	0.00	0.00	0.37	52.05
Basin Creek	PW	1	88	1		3.39	3.39	1.13	6.78	0.00	0.00	1.13	0.00	1.13	16.95
Basin Creek	Riffle	1	949	10		5.29	4.15	0.87	10.75	0.00	0.00	0.00	0.00	0.84	21.91
Basin Creek	Run	1	1,577	14		4.32	3.20	1.97	29.93	0.00	0.00	0.29	0.00	2.89	42.59
East Basin Creek	Run	1	36	2		0.00	0.00	0.00	86.12	0.00	0.00	0.00	0.00	0.00	86.12
Beaver Creek[a]	Pool	2	137	4	8/4	13.03	21.37	3.23	57.42	6.79	0.00	0.00	15.52	0.00	117.36
Beaver Creek	PW	2	129	2		24.70	4.29	0.92	2.02	0.00	0.00	0.00	1.35	0.00	33.27
Beaver Creek	Riffle	2	371	7		19.87	6.47	0.00	1.74	0.00	0.00	0.00	5.05	0.00	33.13
Beaver Creek	Run	2	815	19		24.65	11.95	0.90	19.93	0.25	0.00	0.11	11.64	0.00	69.41
Beaver Creek	Pool	3	460	10	8/5	0.00	0.00	0.00	6.18	0.00	0.00	0.00	25.56	0.00	31.74
Beaver Creek	Riffle	3	208	3		0.00	0.38	0.00	26.93	0.00	0.00	0.00	4.50	0.00	31.81
Beaver Creek	Run	3	766	13		0.19	0.44	0.05	25.02	0.00	0.00	0.00	21.22	0.00	46.92
Capehorn Creek	Pool	1	545	5	8/23	0.00	0.16	0.00	138.32	0.00	0.00	0.66	2.85	0.00	141.98
Capehorn Creek	Riffle	1	1,061	9		0.00	0.76	0.06	28.01	0.00	0.00	0.00	0.85	0.00	29.68
Capehorn Creek	Run	1	1,583	11		0.00	0.04	0.04	87.00	0.00	0.00	0.13	0.54	0.00	87.76
Capehorn Creek	Pool	2	58	3	8/23	0.00	0.00	0.00	6.27	0.00	0.00	0.00	3.76	0.00	10.03
Capehorn Creek	PW	2	20	1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Capehorn Creek	Riffle	2	74	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.90	0.00	0.90
Capehorn Creek	Run	2	235	7		0.00	0.50	0.00	0.24	0.00	0.00	0.00	0.99	0.00	1.73
Frenchman Creek '	Pool	1	136	6	8/4	31.23	10.43	5.51	74.02	0.59	0.00	0.00	59.40	0.00	181.19
Frenchman Creek	PW	1	111	4		15.94	2.99	0.00	12.07	0.00	0.00	0.00	23.68	0.00	54.67
Frenchman Creek	Riffle	1	188	7		21.98	3.06	0.00	17.18	0.00	0.00	0.00	12.39	0.00	54.61
Frenchman Creek	Run	1	639	23		38.76	3.46	0.21	37.22	0.00	0.00	0.00	51.44	0.00	131.09
Frenchman Creek	Pool	2	205	3	8/4	0.00	0.00	0.00	14.67	0.00	0.00	0.00	27.80	0.00	42.47
Frenchman Creek	PW	2	20	1		0.00	0.00	0.00	69.81	0.00	0.00	0.00	19.95	0.00	89.76

Table 5. Continued.

Stream	Type	S	Area	N	Date	Fry	SH 1	SH2 +	CHO	CH 1	Cutt	Bull	Brook	White	Total
Frenchman Creek	Riffle	2	115	5		0.00	1.79	0.00	47.91	0.00	0.00	0.00	33.82	0.00	83.52
Frenchman Creek	Run	2	522	14		3.02	0.73	0.00	74.54	0.00	0.00	0.00	96.71	0.00	75.00
Germania Creek	Pool	1	177	4	8/9	0.00	0.76	6.03	0.00	0.00	3.24	8.60	0.00	0.00	18.62
Germania Creek	PW	1	126	1		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Germania Creek	Riffle	1	336	4		0.00	0.00	0.42	0.00	0.00	0.00	1.42	0.00	0.00	1.84
Germania Creek	Run	1	1,082	12		0.00	0.64	1.69	1.95	0.00	0.09	2.20	0.00	0.00	6.56
Germania Creek	Pool	2	271	5	8/9	0.00	0.00	0.00	0.00	0.00	0.30	12.31	0.00	0.00	12.61
Germania Creek	PW	2	262	4		0.00	0.00	0.00	0.00	0.00	0.00	5.68	0.00	0.00	5.68
Germania Creek	Riffle	2	827	10		0.00	0.00	0.00	0.00	0.00	0.00	1.99	0.00	0.00	1.99
Germania Creek	Run	2	747	11		0.00	0.00	0.00	0.00	0.00	0.00	5.86	0.00	0.00	5.86
Marsh Creek	Pool	1	2,380	7	8/18-20	0.79	0.81	3.32	77.98	0.16	0.63	0.08	0.07	8.37	92.22
Marsh Creek	PW	1	1,479	4		0.76	4.21	3.30	6.20	0.06	0.10	0.06	0.00	1.30	15.99
Marsh Creek	Riffle	1	5,628	17		1.81	2.53	1.35	10.99	0.03	0.01	0.05	0.05	1.49	18.32
Marsh Creek	Run	1	8,774	21		0.90	1.37	1.62	42.76	0.04	0.25	0.19	0.07	2.66	49.86
Valley Creek	Pool	1	648	11	8/22	0.00	0.00	0.00	26.39	0.00	0.00	0.00	38.47	1.01	65.87
Valley Creek	Riffle	1	689	12		0.00	0.00	0.00	11.56	0.00	0.00	0.51	6.92	0.34	19.34
Valley Creek	Run	1	1,424	19		0.00	0.00	0.00	21.92	0.08	0.00	0.29	23.93	1.34	47.55
West Pass Creek	Pool	1	41	1	8/7	0.00	4.91	2.45	0.00	0.00	0.00	4.91	0.00	0.00	12.26
West Pass Creek	PW	1	150	2		0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
West Pass Creek	Riffle	1	314	3		0.00	0.00	0.65	0.00	0.00	0.21	0.00	0.00	0.00	0.85
West Pass Creek	Run	1	246	4		0.00	1.07	2.63	0.00	0.00	0.00	1.11	0.00	0.00	4.81
West Pass Creek	Pool	2	289	6	8/8	0.00	0.00	0.00	0.00	0.00	0.00	3.70	0.00	0.00	3.70
West Pass Creek	PW	2	324	4		0.00	0.00	0.00	0.00	0.00	0.00	1.23	0.00	0.00	1.23
West Pass Creek	Riffle	2	1,590	20		0.00	0.00	0.00	0.00	0.00	0.00	1.85	0.00	0.00	1.85
West Pass Creek	Run	2	729	12		0.00	0.00	0.00	0.00	0.00	0.00	3.42	0.00	0.00	3.42

[a] Beaver Creek section 2 and Frenchman Creek section 1 were stocked with hatchery adult steelhead in spring 1993 and 1994.

Frenchman creeks had higher densities, but these streams were supplemented with hatchery adult steelhead in 1993. In Banner, Capehorn, Valley, and the non-supplemented sections of Beaver and Frenchman creeks, the combined age 1 and age 2+ steelhead densities were <1 fish/100 m^2 in all habitat types. The highest density we observed in the Salmon River drainage, excluding the supplemented sections of Frenchman and Beaver creeks, was 7.51 fish/100 m^2 in Marsh Creek pocketwater habitat. In Germania and West Pass creeks, both tributaries of the East Fork Salmon River, we only saw steelhead from the mouth upstream 1 km.

Steelhead densities by habitat type were much higher in Clearwater River tributaries. The combined age 1 and age 2+ densities exceeded 20 fish/100 m^2 in all habitat types in Fish, West Fork Gedney, and Gedney creeks, except pocketwater in Gedney Creek (Table 6). In the South Fork Red River, which was stocked with 50,000 hatchery fingerlings in September 1993, densities in each habitat ranged from 4.32 to 11.07 fish/100 m^2. The highest density we observed was 55.74 fish/100 m^2 in pool habitat in section 2 of Gedney Creek.

The weighted mean age 1 and age 2+ density for the streams were highest in Clearwater River tributaries and ranged from 27.88 fish/100 m^2 in West Fork Gedney Creek to 0.49 fish/100 m^2 in West Pass Creek (Table 7).

Population Totals

Fish Creek and the Gedney Creek drainage, both wild steelhead streams in pristine condition, had the largest steelhead populations of the streams we sampled. The estimated combined population age 1 and age 2+ abundance ranged from 21,687 (t 1,189) in Fish Creek to a low of 171 (t 126) in West Pass Creek (Table 8).

The South Fork Red River was stocked with about 50,000 hatchery steelhead fingerlings (mean length 74 mm) on September 1, 1993. Our estimate of 4,421 (± 1,387) includes naturally-produced steelhead and the hatchery steelhead we stocked. This is a 204% increase from the 1993 population estimate of 1,453 age 1 and age 2+ steelhead.

Stream Temperature

By the end of 1994, I was recording stream temperatures at 20 sites in 16 streams of the Salmon River drainage and 16 sites in 14 streams of the Clearwater River drainage. For the regression of TUs on elevation, I used 7 sites from the Clearwater River drainage and 12 sites from the Salmon River drainage (Table 9). The regression of TUs on elevation (Figure 7) was not significant ($p = 0.114$, $r^2 = 0.14$). If the regression is done by drainage, then there is a significant relationship between TUs and elevation for Salmon River streams ($p = 0.04$, $r^2 = 0.3$), but not Clearwater River streams ($p = 0.288$, $r^2 = 0.06$).

During the summer of 1994, between June 15 and September 15, Salmon River streams accumulated an average 36.84% more TUs (range 16% to 56%) than in 1993. There was an average increase of 19.5% (range 15% to 26%) in TUs in Clearwater River streams during this time period.

Table 6. Mean fish densities (fish/100 m^2) by habitat type in Clearwater River tributaries obtained from snorkel surveys in 1994. S = stream section; Area =total surface area of all sites in m^2; N = number of sites snorkeled of each habitat type; Fry = all trout <76 mm; SH1 =juvenile steelhead 76 mm to 127 mm; SH2 + = juvenile steelhead > 127 mm; CHO = age 0 chinook salmon; Cutt = all cutthroat trout; Bull = all bull trout; Brook = all brook trout; White = all mountain whitefish; Total = total salmonid density.

Stream	Tvoe	S	Area	N	Date	Fry	SH1	SH2+	CHO	CH1	Cutt	Bull	Brook	White	Total
Fish Creek	Pool	1	978	6	7/8-12	3.66	26.51	10.21	0.00	0.00	0.52	0.00	0.00	0.00	40.90
Fish Creek	PW	1	11,716	27		2.14	15.06	5.18	0.00	0.00	0.29	0.00	0.00	0.00	22.67
Fish Creek	Run	1	3,888	14		4.77	17.66	7.49	0.00	0.00	0.41	0.00	0.00	0.00	30.33
Gedney Creek	Pool	1	750	6	7/22-26	7.21	15.68	9.34	33.01	0.25	0.71	0.23	0.00	1.30	67.73
Gedney Creek	PW	1	6,075	21		8.51	8.74	4.70	13.79	0.06	0.31	0.00	0.00	0.17	36.28
Gedney Creek	Run	1	1,555	11		15.52	13.02	10.04	14.81	0.16	1.59	0.00	0.00	0.34	55.48
Gedney Creek	Pool	2	223	4	7/21-22	6.93	37.45	18.29	0.31	0.00	0.78	0.31	0.00	0.00	64.07
Gedney Creek	PW	2	1,208	8		4.77	12.34	5.18	0.00	0.12	0.11	0.00	0.00	0.00	22.53
Gedney Creek	Run	2	248	4		5.94	14.61	12.10	0.00	0.00	0.00	0.00	0.00	0.00	32.65
WF Gedney Creek	Pool	1	468	5	7/21-22	16.26	31.91	16.47	0.00	0.00	0.24	0.00	0.00	0.34	65.22
WF Gedney Creek	PW	1	1,207	7		8.41	13.32	8.09	0.00	0.00	0.08	0.00	0.00	0.00	29.90
WF Gedney Creek	Run	1	648	5		15.09	17.69	7.98	0.00	0.15	0.12	0.00	0.00	0.00	41.03
SF Red River	Pool	1	215	3	6/28-29	1.01	9.38	4.80	3.72	0.00	2.02	0.00	0.53	1.28	22.74
SF Red River	PW	1	1,015	6		2.15	5.26	0.92	0.11	0.00	2.21	0.00	0.29	0.33	11.27
SF Red River	Riffle	1	1,312	10		2.89	3.04	0.54	3.42	0.00	0.40	0.00	0.23	0.00	10.52
SF Red River	Run	1	1,287	10		0.52	6.77	2.30	16.02	0.00	1.44	0.14	0.35	0.00	27.54
SF Red River[a]	Pool	2	114	3	6/28-30	0.00	8.27	0.00	0.00	0.00	7.74	0.00	0.98	0.00	16.99
SF Red River	PW	2	172	2		0.00	11.07	0.00	0.00	0.00	0.52	0.00	0.66	0.00	12.25
SF Red River	Riffle	2	1,679	18		0.03	4.29	0.10	0.00	0.00	0.58	0.12	0.13	0.00	5.25
SF Red River	Run	2	1,438	16		0.16	6.44	0.48	0.00	0.00	1.78	0.19	0.00	0.06	9.11
WF Red River	Pool	1	21	1	6/29	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
WF Red River	Riffle	1	113	2		0.00	0.00	0.00	0.00	0.00	5.08	0.00	0.72	0.00	5.80
WF Red River	Run	1	145	3		0.00	0.00	0.00	0.00	0.00	6.03	0.00	0.00	0.00	6.03

[a]South Fork Red River section 2 stocked with hatchery fingerling steelhead in fall 1993 and 1994.

Table 7. Weighted mean densities of stream sections snorkeled in 1994.

Stream	Section	Fry	SH 1	SH2 +	CHO	CHI	Cutt	Bull	Brook	White	Total
Clearwater River drainage											
Fish Creek	1	3.06	16.65	6.24	0.00	0.00	0.34	0.00	0.00	0.00	26.30
Gedney Creek	1	9.77	10.08	6.07	15.41	0.09	0.59	0.02	0.00	0.29	42.31
WF Gedney Creek	1	11.33	18.05	9.83	0.00	0.03	0.12	0.00	0.00	0.07	39.44
South Fork Red River	1	1.73	5.22	1.49	7.76	0.00	1.24	0.06	0.30	0.12	17.92
	2	0.08	6.62	0.25	0.00	0.00	1.83	0.12	0.23	0.03	9.16
	All	0.89	5.93	0.86	3.81	0.00	1.54	0.09	0.27	0.07	13.46
WF Red River	1	0.00	0.00	0.00	0.00	0.00	5.16	0.00	0.27	0.00	5.43
Salmon River drainage											
Beaver Creek	2	22.21	10.74	0.84	16.86	0.74	0.00	0.06	9.47	0.00	60.90
	3	0.09	0.28	0.02	19.18	0.00	0.00	0.00	19.58	0.00	39.16
	All	7.40	3.74	0.29	18.41	0.24	0.00	0.02	16.23	0.00	46.33
Frenchman Creek	1	35.17	3.88	0.55	36.23	0.04	0.00	0.00	45.47	0.00	121.34-
	2	1.97	0.65	0.00	57.35	0.00	0.00	0.00	73.15	0.00	133.12
	All	16.68	2.08	0.24	47.99	0.02	0.00	0.00	60.88	0.00	127.90
Germania Creek	2	0.00	0.00	0.00	0.00	0.00	0.02	4.42	0.00	0.00	4.43
Marsh Creek	1	1.33	2.10	1.64	25.87	0.04	0.13	0.11	0.06	2.15	33.45
West Pass Creek	1	0.00	0.38	1.03	0.00	0.00	0.14	0.39	0.00	0.00	1.93
	2	0.00	0.00	0.00	0.00	0.00	0.00	2.39	0.00	0.00	2.39
	All	0.00	0.13	0.36	0.00	0.00	0.05	1.68	0.00	0.00	2.23`

Table 8. Population estimates for age 1 and age 2+ steelhead and 95% bound on population estimates (in parentheses).

Stream	Section	Age 1		Age 2 +		All ages	
Salmon River drainage							
		0		0		0	
Beaver Creek	2	1,134	(282)	169	(124)	1,303	(406)
Beaver Creek	3	56	(52)	5	(9)	61	(61)
Beaver Creek	All	1,190	(334)	174	(133)	1,364	(467)
Frenchman Creek	1	322	(131)	49	(48)	371	(179)
Frenchman Creek	2	52	(53)	0		52	(53)
Frenchman Creek	All	374	(184)	49	(48)	423	(232)
Marsh Creek"	1	2,631	(555)	2,116	(855)	4,747	(1,410)
West Pass Creek	1	44	(29)	127	(97)	171	(126)
West Pass Creek	2	0		0		0	
West Pass Creek	All	44	(29)	127	(97)	171	(126)
Clearwater River drainage							
Fish Creek	1	15,804	(1,189)	5,883	(848)	21,687	(2,037)
Gedney Creek	1	5,369	(1,011)	3,185	(503)	8,554	(1,514)
West Fork Gedney Creek	1	2,949	(635)	1,527	(331)	4,476	(966)
South Fork Red River	1	1,783	(493)	505	(184)	2,288	(677)
South Fork Red River	2	2,061	(647)	72	(63)	2,133	(710)
South Fork Red River	All	3,844	(1,140)	577	(247)	4,421	(1,387)

Table 9. TUs (°C) accumulated during summer 1993 and 1994 in streams of Salmon and Clearwater river drainages. Percent increase in TUs in 1994 compared to 1993 is for period of June 15 to September 15. Elevation measured in m.

Stream	TUs accumulated from 6/15-	6/15-9/15/94	5/1-10/15/94	Elevation	Percent Increase
Salmon River drainage					
Beaver Creek	749.7	1,060.6	1,485.2	2,213	41.5
East Fork Salmon @ Bowery	702.4	1,046.9	1,573.7	2,060	49.0
Frenchman Creek	663.3	1,037.9	1,531.3	2,268	56.5
Germania Creek	687.7	881.9	1,325.0	1,945	28.2
Marsh Creek	930.1	1,080.9	1,642.7	1,987	16.2
Smiley Creek	897.6	1,245.4	1,782.2	2,219	38.7
West Pass Creek	610.2	860.1	1,256.3	2,060	41.0
Valley Creek	938.2	1,160.0	1,811.7	1,999	23.6
East Fork Salmon @ mouth			2,015.4	1,638	
Salmon River @ East Fork			2,062.7	1,640	
Salmon River @ Sawtooth			2,033.8	1,975	
South Fork Salmon @ Knox Bridge			1,911.4	1,560	
Clearwater River drainage					
Fish Creek	1,227.9	1,454.7	2,153.0	634	18.5
Red River	1,040.3	1,303.3	1,894.3	1,335	25.3
South Fork Red River	915.4	1,156.0	1,688.5	1,344	26.3
Post Office Creek	975.0	1,123.2	1,694.6	878	15.2
Walton Creek	850.9	974.8	1,456.3	1,097	14.6
Weir Creek	995.3	1,166.6	1,789.9	878	17.2
Crooked Fork Creek	1,033.9		1,720.8	1,195	

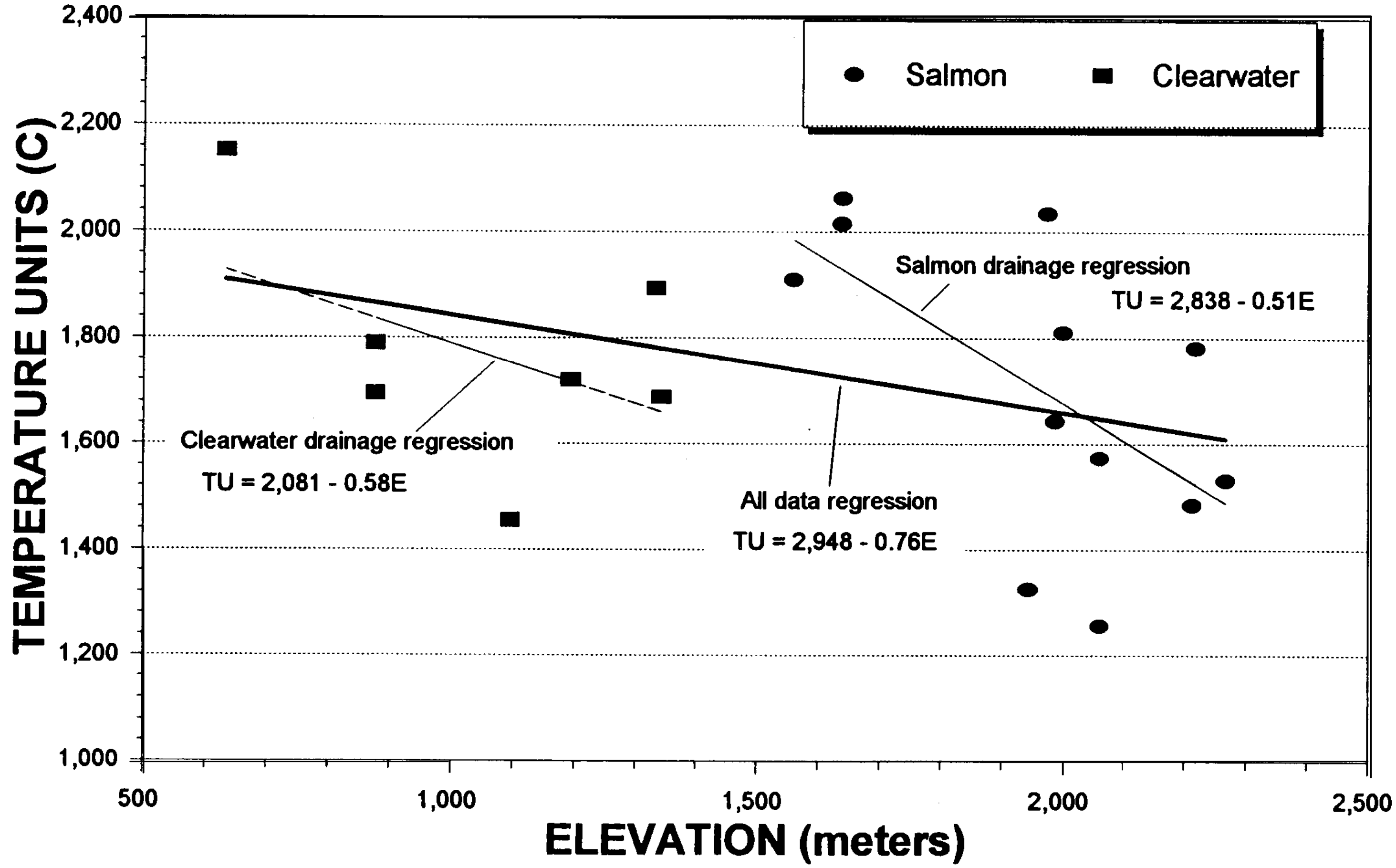


Figure 7. Relation between elevation (E) and TUs accrued from May 1 to October 15 in tributaries of Salmon and Clearwater drainages. Regressions of all data points ($p=0.114$, $r^2=0.14$) and Clearwater tributaries were not significant ($p=0.288$, $r^2=0.22$). Regression of Salmon tributaries was significant ($p=0.039$, $r^2=0.36$).

PIT Tagging

We PIT-tagged 1,636 of the 3,094 steelhead juveniles and smolts collected at the eight screw traps during the spring. The number of steelhead collected at each site ranged from a low of 69 at the East Fork Salmon River up to 1,029 at the South Fork Salmon River (Table 10, Figures 8a-15a). There was a significant difference in length among the streams (ANOVA, $p < 0.001$). The mean length of the PIT-tagged fish ranged from 151 mm in Crooked Fork Creek to 109 mm at the South Fork Salmon River. Tukey's pairwise HSD test revealed that Crooked Fork Creek fish were significantly larger than fish from all other streams and Pahsimeroi River fish differed from all streams except the East Fork Salmon River. In addition, Fish Creek differed from Red River and the East Fork Salmon River; and the South Fork Salmon River differed from Red River (Table 11).

There was a significant difference in condition factor among the streams during the spring trapping period (ANOVA, $p < 0.0001$). The mean condition factor ranged from 1.0818 in Fish Creek to 0.8882 in Marsh Creek. Tukey's HSD pairwise test revealed differences between Fish Creek and all other streams except South Fork Salmon River, Marsh Creek and all other streams except the East Fork Salmon, and Crooked Fork Creek and all streams except the East Fork and South Fork Salmon River. In addition, there were differences between the East Fork Salmon River and Red River, Pahsimeroi River, Clear Creek, and the South Fork Salmon River (Table 12).

During the spring trapping period, most streams had a similar pattern of migration past the screw traps (Table 13, Figure 16). The date that migrants trapped reached 50% was between April 20 and 30 at all sites except Clear Creek (May 19) and Fish Creek (June 4). In both Clear Creek and Fish Creek >70% of the migrants were trapped after May 12. In all the other streams 75% of the migrants were trapped by that date, except Marsh Creek, where 68% had been trapped. All streams, except the Pahsimeroi River, had at least one migration spike lasting seven days or less, accounting for 20% of the total number of fish that were trapped (Figure 16).

During the summer, crews collected and PIT-tagged 344 parr on July 9 and 10 and 763 parr on August 31 and September 1 in Fish Creek (Table 10, Figure 17a). The mean length and condition factor of the Fish Creek July parr were 141 mm ($n=344$, $s=28$) and 1.1238 ($n=344$, $s = 0.078$), respectively. The Fish Creek parr we tagged on the later dates were significantly smaller (133 mm, $n=731$, $s=27$) and had a lower condition factor (0.8695, $n= 731$, $s = 0.08267$) than the fish we collected in July (t-tests, $p < 0.0001$). Crews collected and tagged 835 steelhead parr in Gedney Creek during the summer (Table 10, Figure 17b). In Gedney Creek, there was a significant difference (t-test, $p=0.033$) in length of the fish we collected in July (132 mm, $n=267$, $s=25$) and September (136 mm, $n=374$, $s=25$). The condition factor in Gedney Creek was not significantly different (t-test, $p=0.83$) on the two collection dates. We also PIT-tagged 245 steelhead parr in Beaver Creek that averaged 90 mm in length ($s = 22$) and 70 parr from Johnson Creek that averaged 82 mm in length Is = 18).

During the fall, we operated seven screw traps and a weir in Rapid River. Because we used a weir designed to trap bull trout in Rapid River, we probably selected for larger steelhead juveniles at this site. We tagged 2,516 of the 4,067 steelhead we trapped in the fall (Table 10). The number of fish trapped at each location ranged from a low of 28 at the East Fork Salmon River up to 2,511 at Fish Creek (Table 10, Figures 8b-15b). There was a significant

Table 10. Number of juvenile steelhead captured and PIT-tagged in 1994. Lengths (forks) measured to nearest mm. Sample size (N) for length and condition factor (K) is given. Standard deviation from mean in parentheses.

Site	Dates	Number Collected	Number PIT-Tagged	Mean Length	Median Length	Mean K	N Length	N K
Spring screw traps								
Clear Creek	4/15-6/10	98	98	115 (27)	105	1.0016 (0.1116)	98	98
Fish Creek [a]	3/18-6/13	659	443	110 (21)	112	1.0818 (0.0833)	443	443
Red River	3/29-5/24	130	122	124 (43)	144	1.0088 (0.1369)	122	118
Crooked Fork Creek	3/16-6/1	492	437	151 (42)	168	0.9570 (0.1324)	437	434
East Fork Salmon River	3/16-5/11	69	69	128 (37)	135	0.9110 (0.0974)	61	61
Marsh Creek	3/16-6/1	370	134	119 (49)	111	0.8882 (0.2258)	124	104
Pahsimeroi River	3/3-6/1	247	238	137 (36)	128	1.0021 (0.1123)	236	236
South Fork Salmon River	3/16-6/1	1,029	98	109 (25)	103	1.0214 (0.1424)	97	18
Summer								
Beaver Creek	8/6-8/7	245	245	90 (22)	84	1.0261 (0.0787)	245	232
Fish Creek	7/9-7/10	350	350	141 (28)	146	1.1238 (0.0780)	344	344
Fish Creek	8/31-9/1	763	760	133 (27)	129	0.8695 (0.0827)	731	731
Gedney Creek	7/24-7/25	356	356	132 (25)	133	0.9388 (0.2991)	267	267
Gedney Creek	9/8	379	379	136 (25)	134	0.9428 (0.1044)	374	374
Johnson Creek	8/12-8/16	70	70	82 (18)	81	NA	70	0
Fall screw traps								
Crooked Fork Creek	8/24-11/4	524	117	84 (34)	70	NA	117	0
Fish Creek	9/22-11/7	2,511	1,516	124 (22)	121	0.9363 (0.0551)	1,516	1,460
Red River	8/26-10/12	42	33	138 (35)	134	1.0341 (0.0710)	28	28
East Fork Salmon River	8/15-11/13	28	28	116 (45)	123	0.9990 (0.0115)	26	26
Marsh Creek	8/19-11/2	177	165	112 (22)	106	1.0120 (0.0912)	143	143
Pahsimeroi River	9/9-12/8	136	136	127 (20)	124	0.9883 (0.0720)	135	135
Rapid River	7/26-10/28	446	381	178 (23)	180	0.9974 (0.0947)	378	378
South Fork Salmon River	8/30-10/25	191	139	138 (36)	142	1.0295 (0.0895)	90	90

[a]PIT tagging began on April 24.

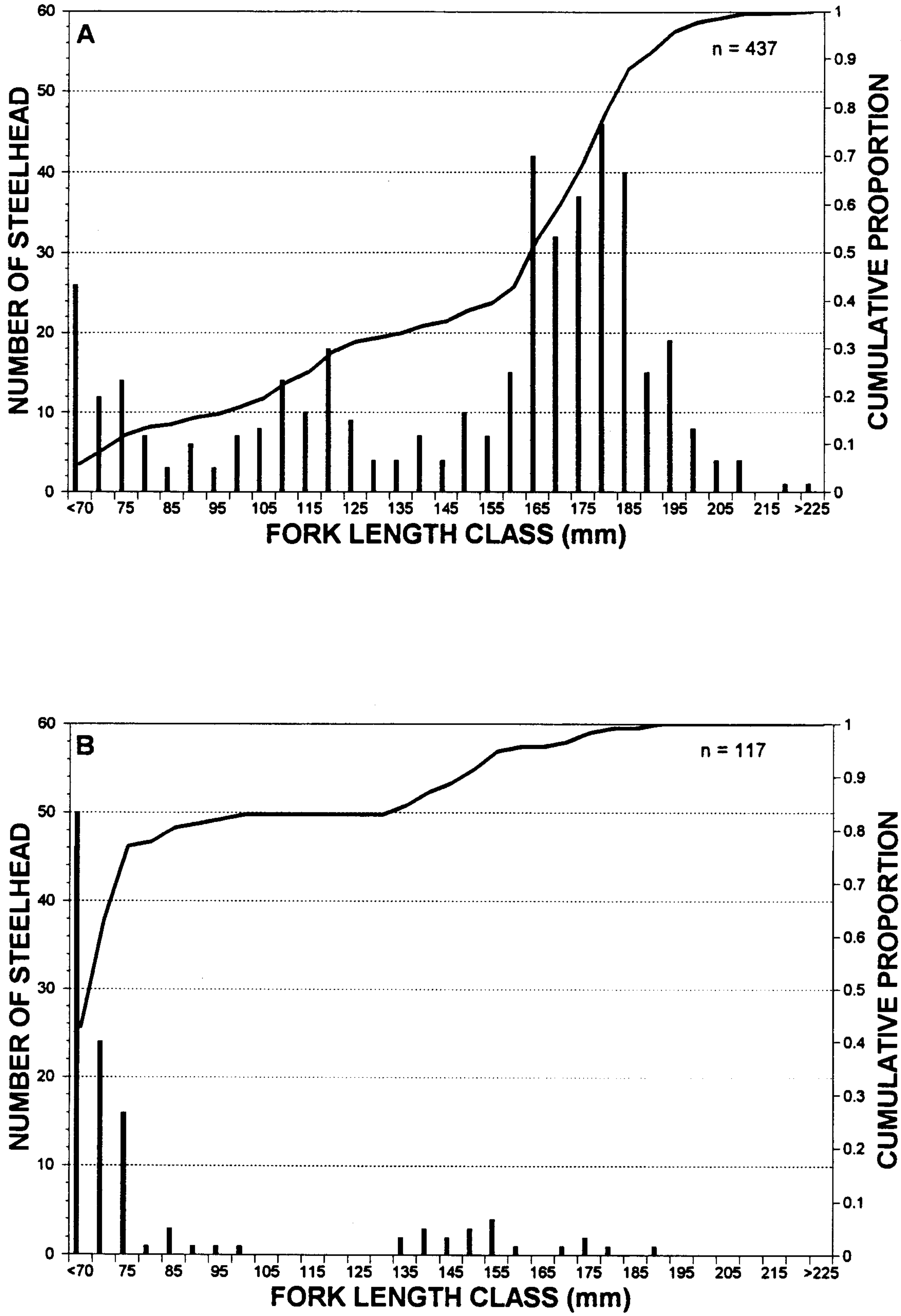


Figure 8. Length frequency of PIT-tagged steelhead caught in Crooked Fork Creek screw trap (bars) and cumulative distribution (line) of length. (A) = March 29 to June 1. (B) = August 24 to November 4.

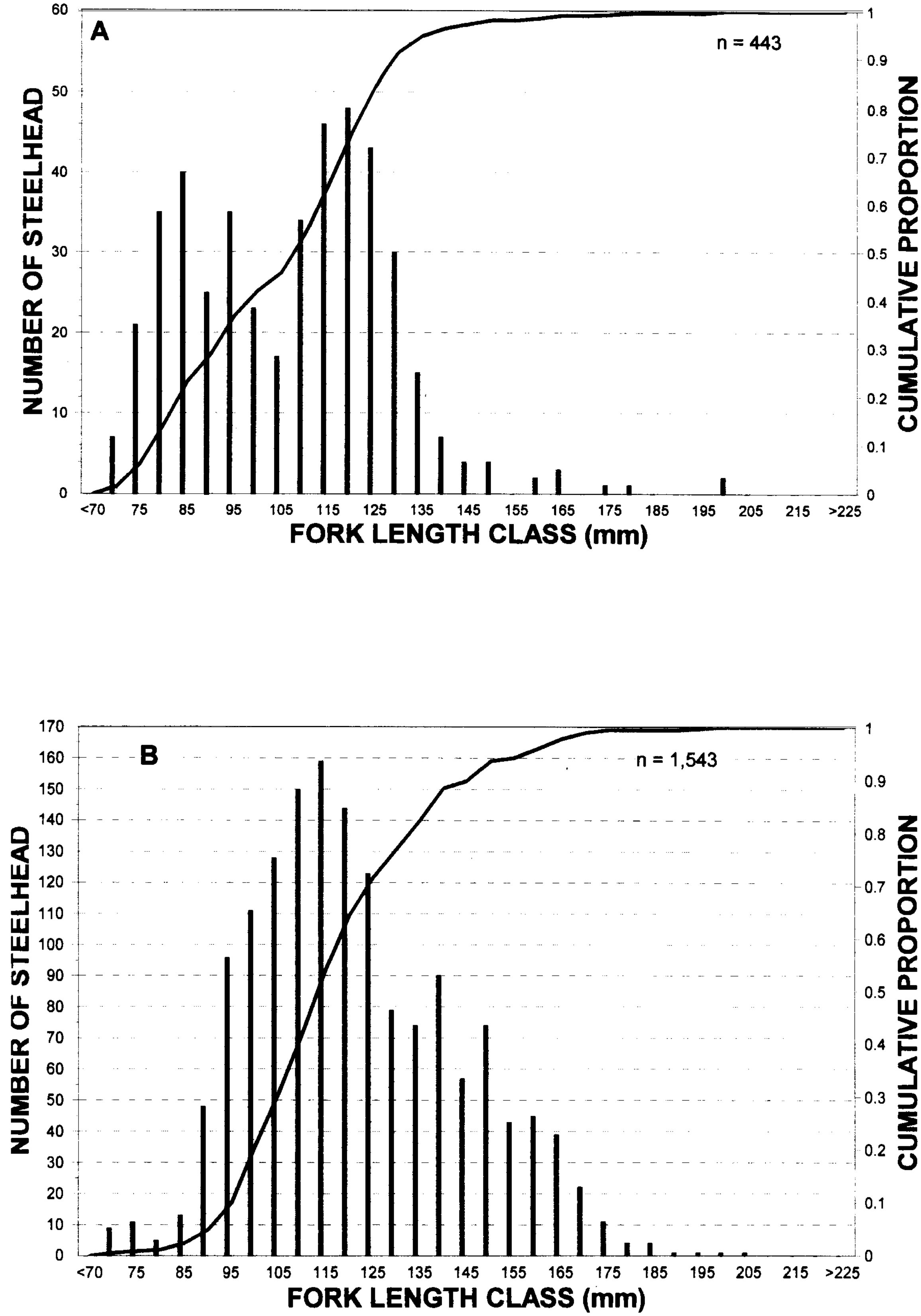
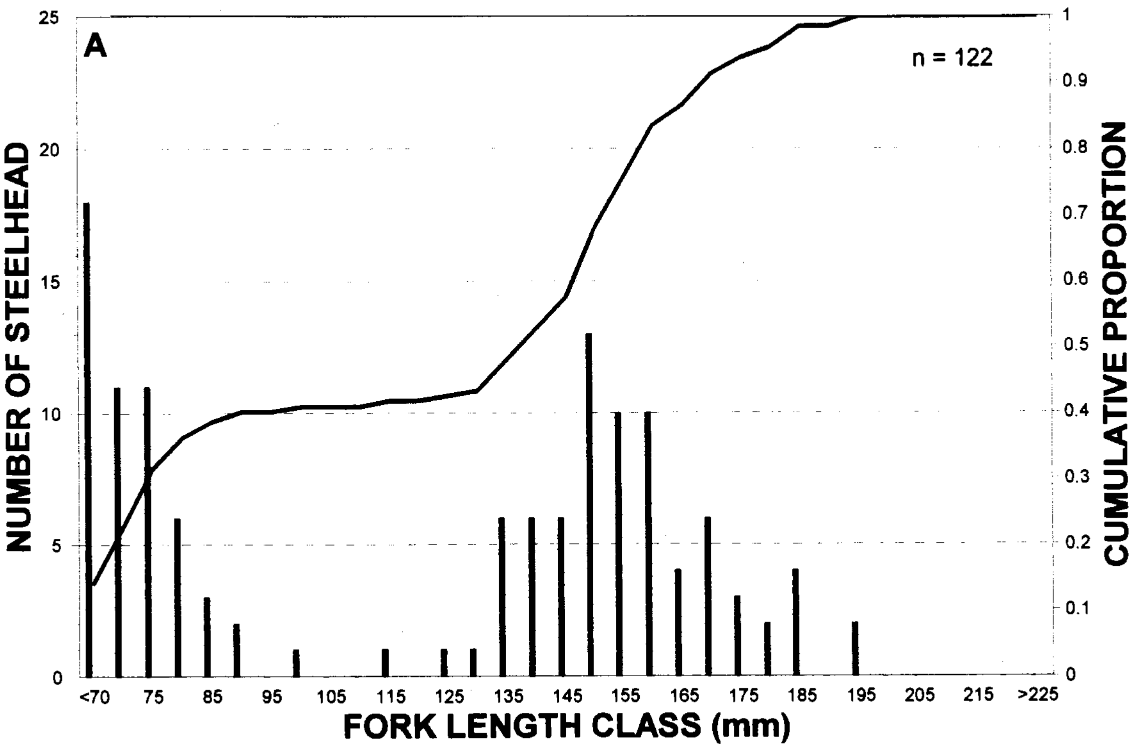


Figure 9. Length frequency of PIT-tagged steelhead caught in Fish Creek screw trap (bars) and cumulative distribution (line) of length. (A) = April 24 to June 13. (B) = September 22 to November 7. Data includes 27 fish tagged in July and August.



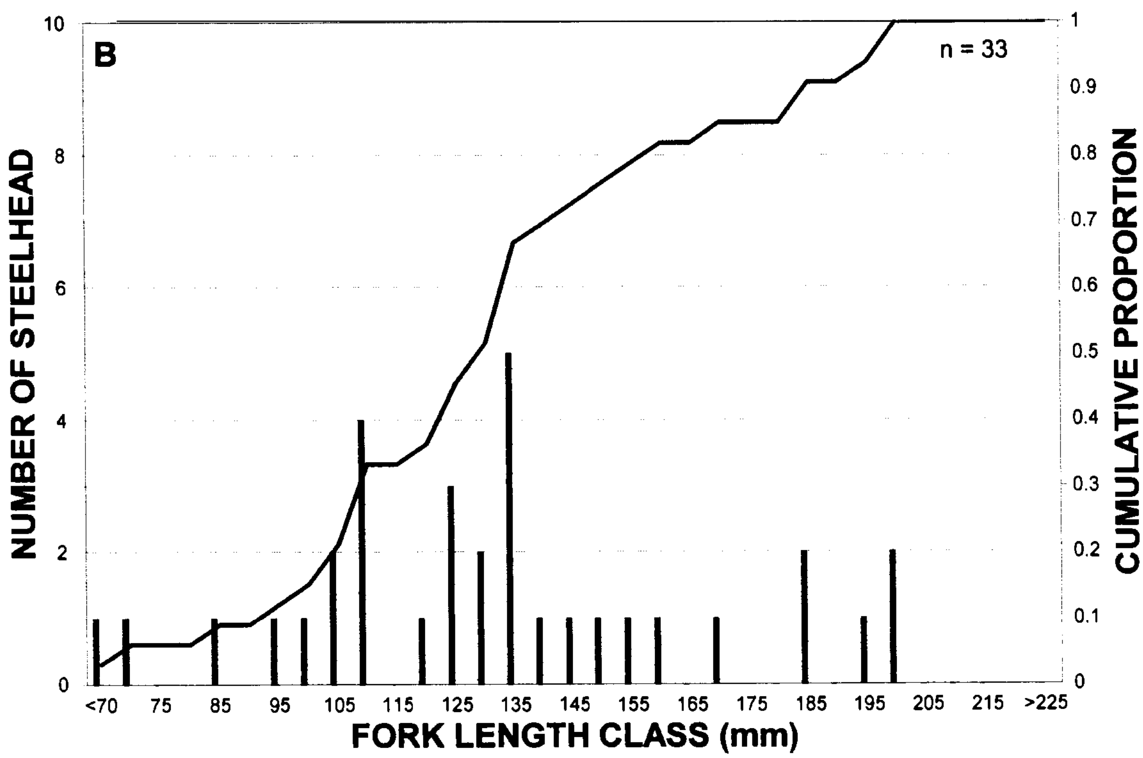
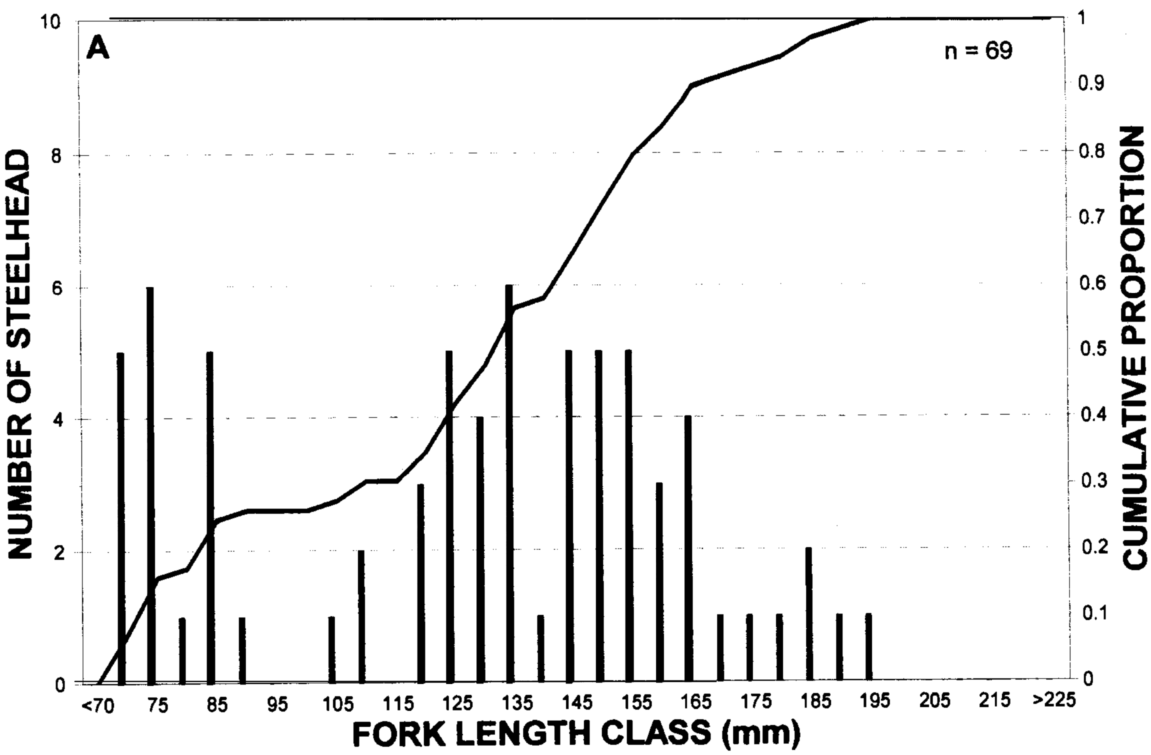


Figure 10. Length frequency of PIT-tagged steelhead caught in Red River screw trap (bars) and cumulative distribution (line) of length. (A) = March 29 to May 18. (B) = August 26 to October 5.



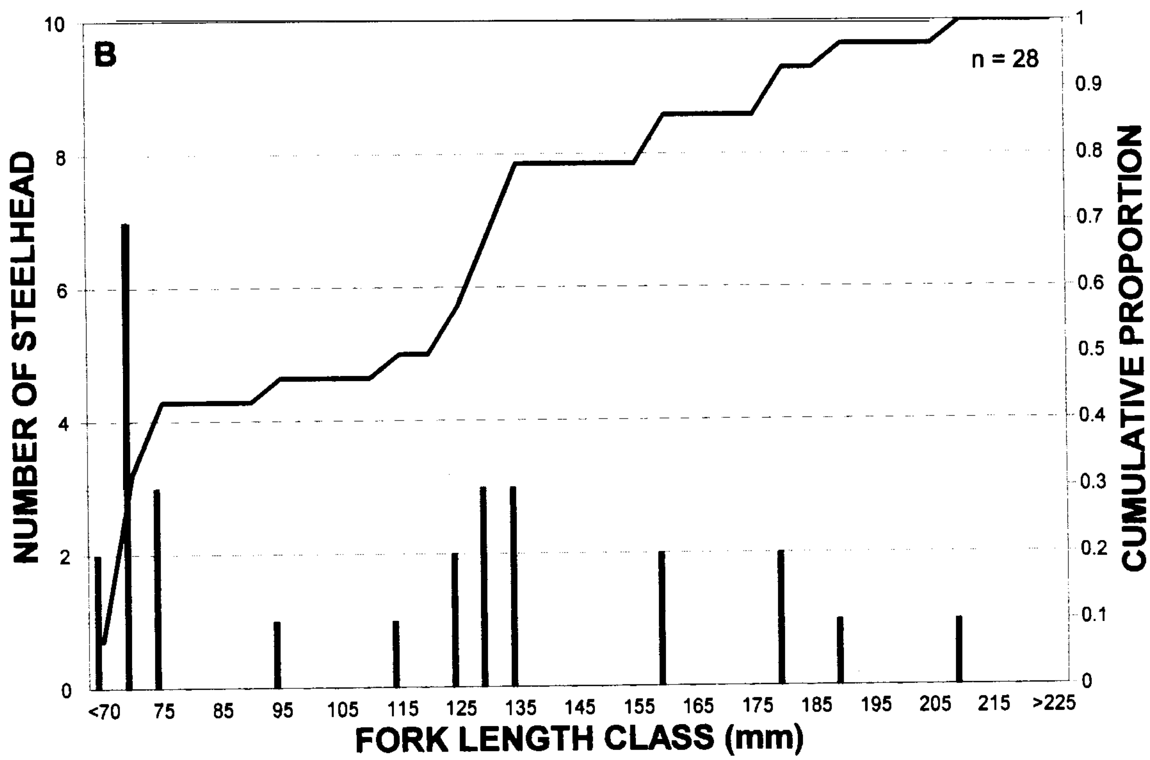


Figure 11. Length frequency of PIT-tagged steelhead caught in East Fork Salmon River screw trap (bars) and cumulative distribution (line) of length. (A) = March 16 to May 23. (B) = August 31 to November 13.

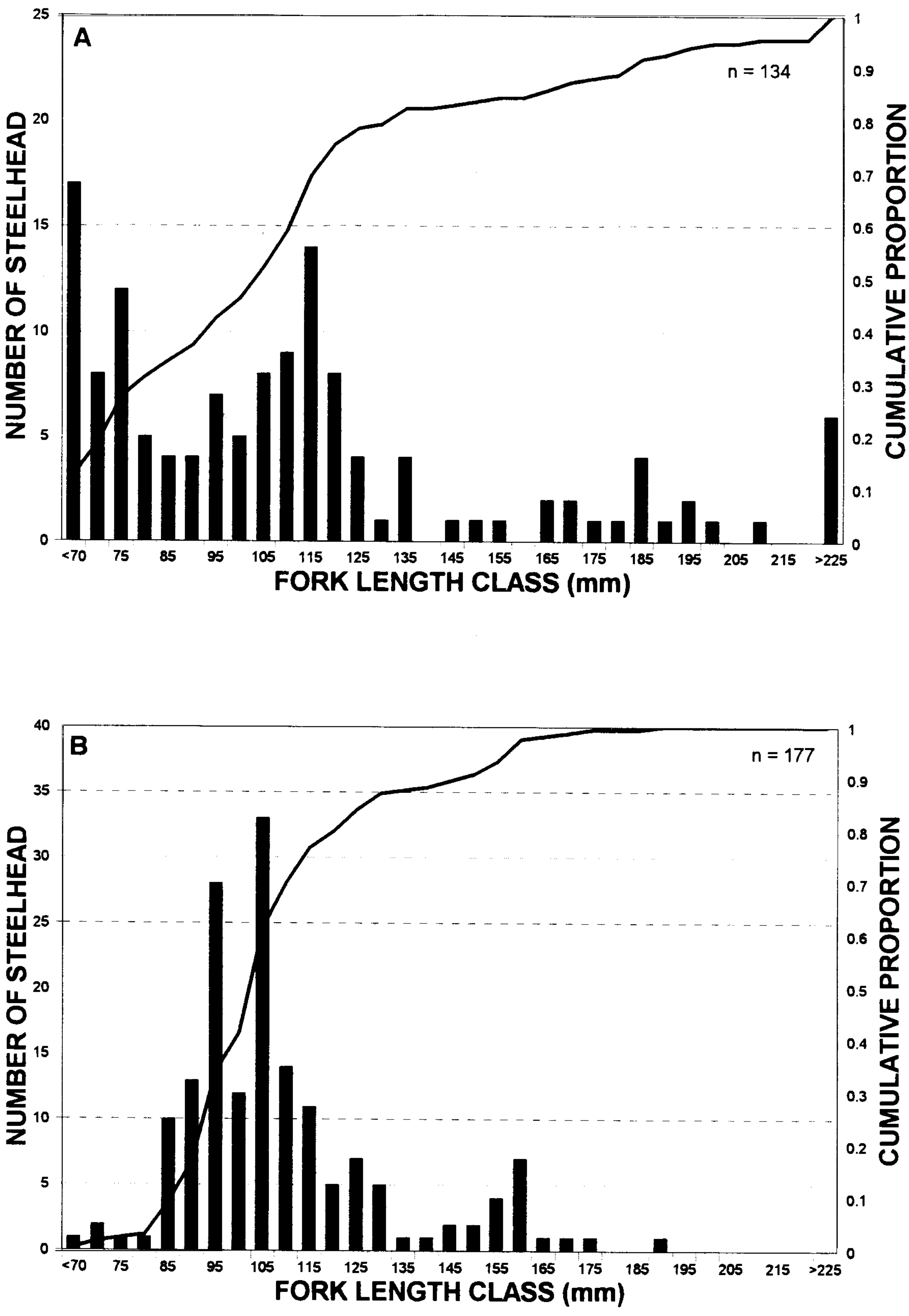


Figure 12. Length frequency of PIT-tagged steelhead caught in Marsh Creek screw trap (bars) and cumulative distribution (line) of length. (A) = April 7 to June 1. (B) = August 20 to October 31.

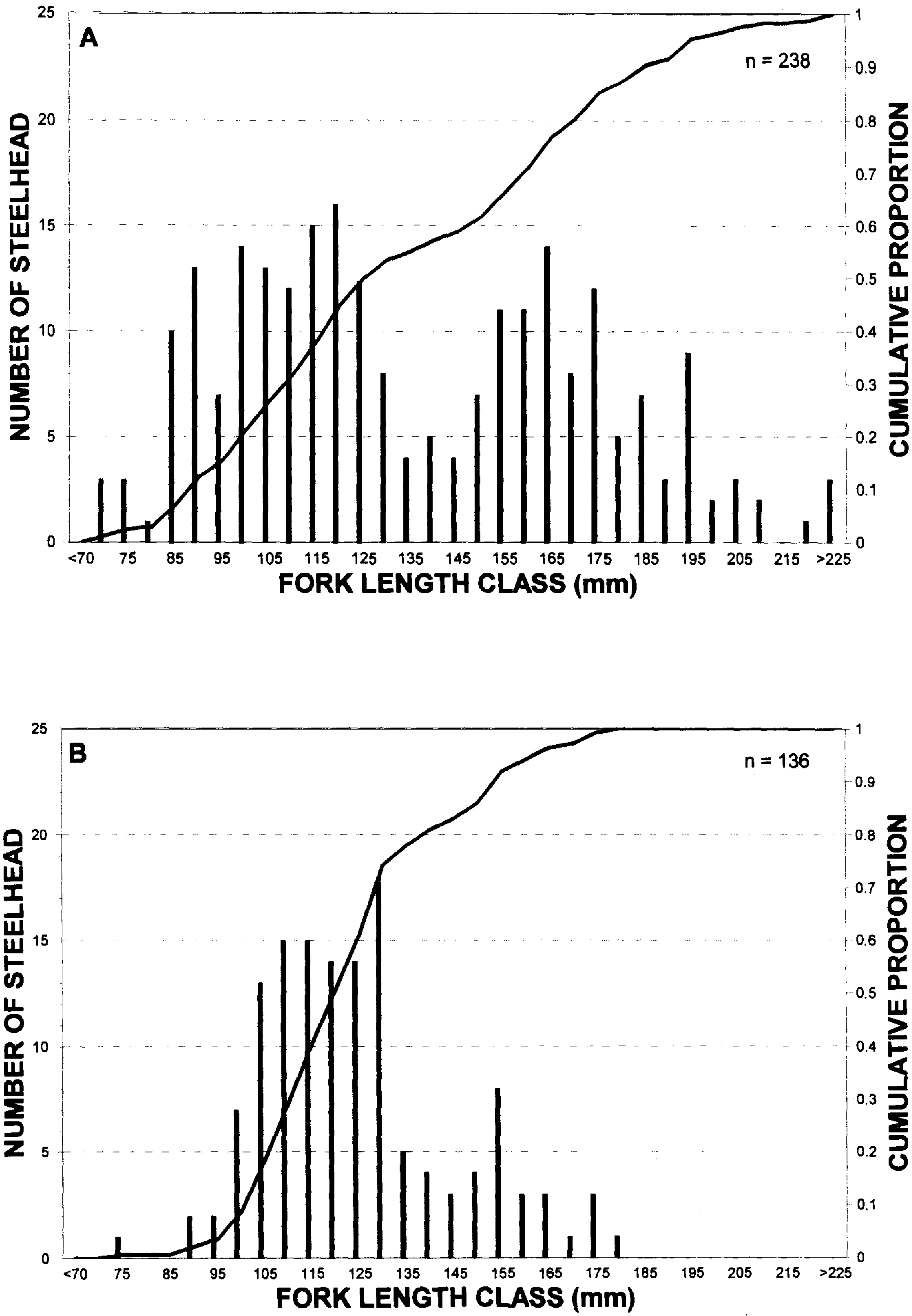


Figure 13. Length frequency of PIT-tagged steelhead caught in Pahsimeroi River screw trap (bars) and cumulative distribution (line) of length. (A) = March 3 to May 31. (B) = September 10 to December 10.

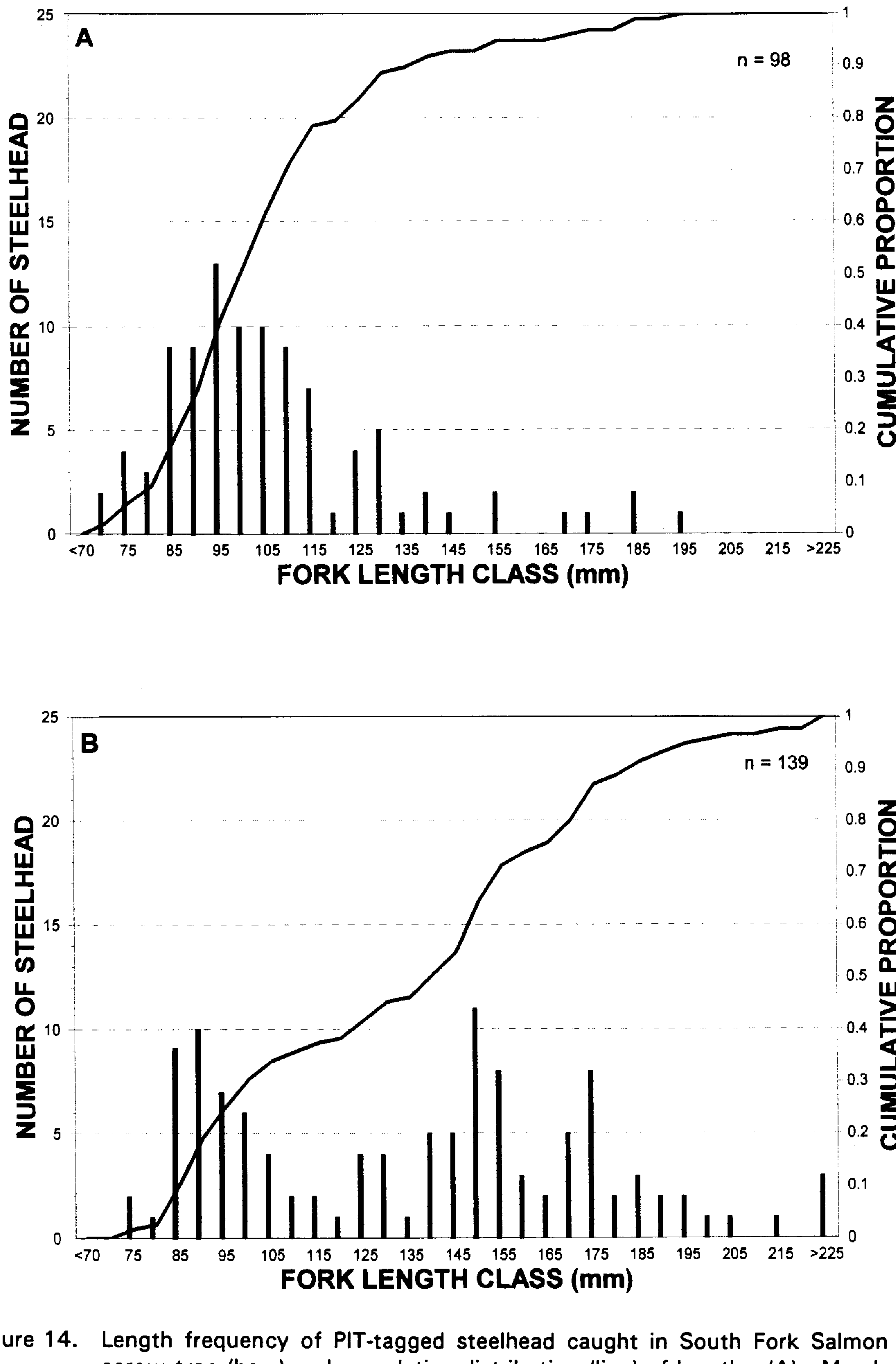
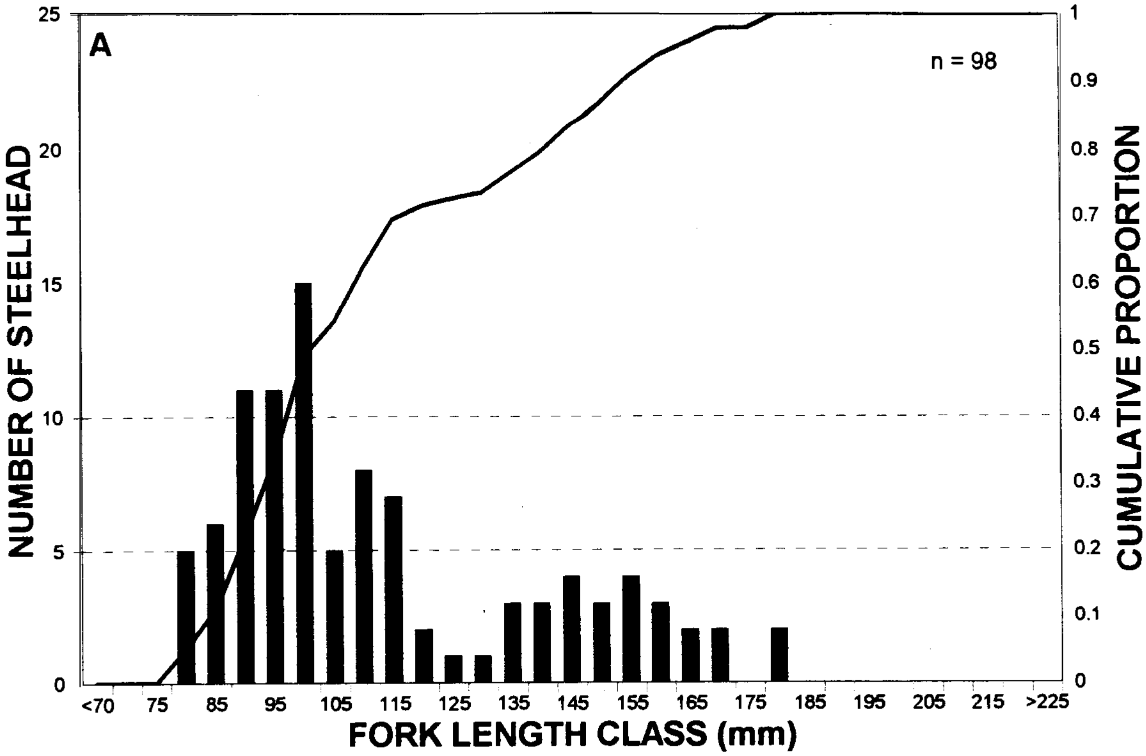


Figure 14. Length frequency of PIT-tagged steelhead caught in South Fork Salmon River screw trap (bars) and cumulative distribution (line) of length. (A) = March 20 to June 1. (B) = August 31 to October 7.



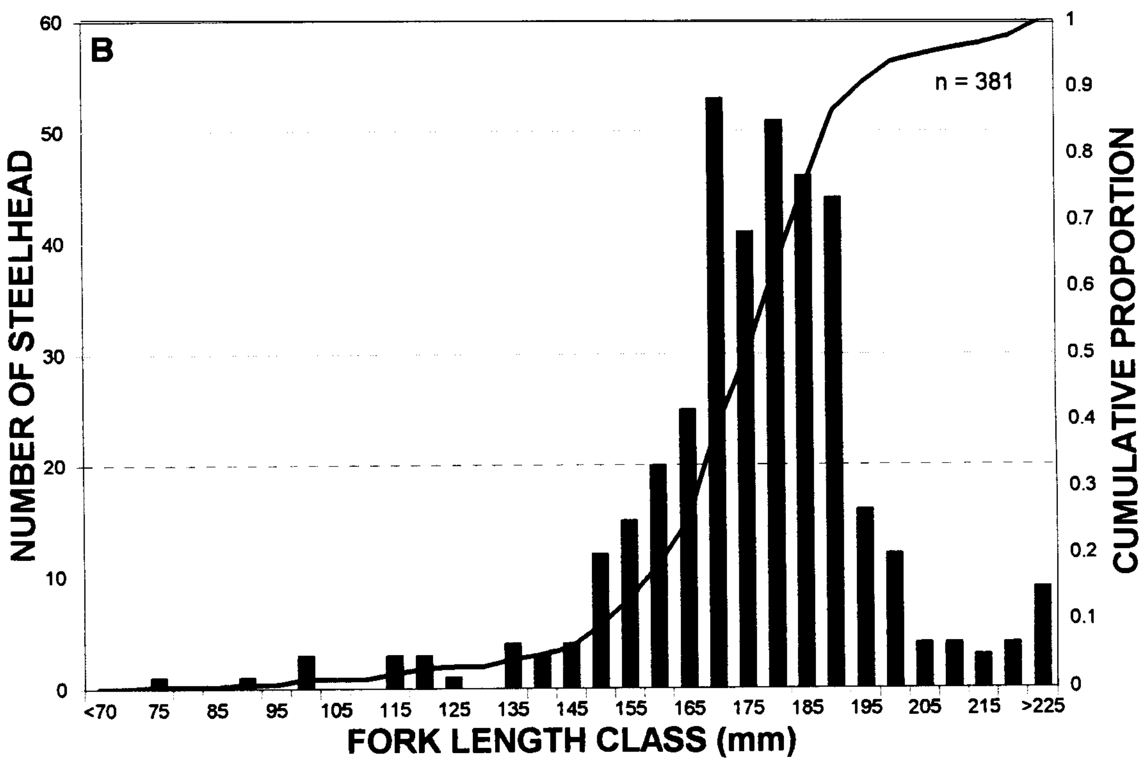


Figure 15. Length frequency of PIT-tagged steelhead (bars) and cumulative distribution (line) of length. (A) = Clear Creek screw trap, April 15 to June 10. (B) = Rapid River bull trout weir, August 1 to October 28.

Table 11. Matrix of pairwise probabilities obtained from Tukey's HSD multiple comparisons of wild steelhead fork length between streams for spring and fall trapping periods.

Stream	Spring 1994						
	Crooked Fork Creek	Clear Creek	Fish Creek	Marsh Creek	Pahsimeroi River	Red River	East Fork Salmon River
Crooked Fork Creek							
Clear Creek	<0.001						
Fish Creek	<0.001	0.821					
Marsh Creek	<0.001	0.996	0.160				
Pahsimeroi River	<0.001	<0.001	<0.001	<0.001			
Red River	<0.001	0.659	0.002	0.960	0.009		
East Fork Salmon River	<0.001	0.144	<0.001	0.414	0.755	0.939	
South Fork Salmon River	<0.001	0.896	1.000	0.411	<0.001	0.039	0.003

Stream	Fall 1994						
	Crooked Fork Creek	Fish Creek	Marsh Creek	Pahsimeroi River	Rapid River	Red River	East Fork Salmon River
Crooked Fork Creek							
Fish Creek	<0.001						
Marsh Creek	<0.001	<0.001					
Pahsimeroi River	<0.001	0.999	<0.001				
Rapid River	<0.001	<0.001	<0.001	<0.001			
Red River	<0.001	0.351	<0.001	0.680	<0.001		
East Fork Salmon River	<0.001	0.609	0.972	0.526	<0.001	0.082	
South Fork Salmon River	<0.001	0.992	<0.001	1.000	<0.001	0.735	0.465

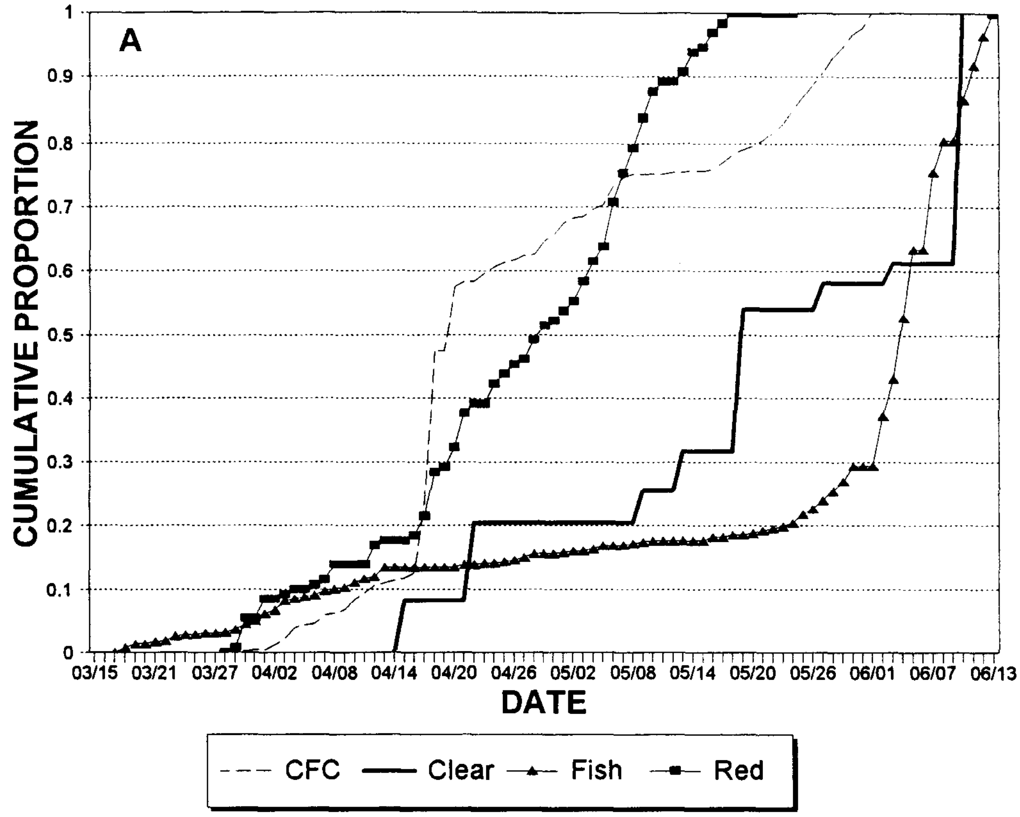
Table 12. Matrix of pairwise probabilities obtained from Tukey's HSD multiple comparisons of wild steelhead condition factor between streams for spring and fall trapping periods.

	Spring 1994						
Stream	Crooked Fork Creek	Clear Creek	Fish Creek	Marsh Creek	Pahsimeroi River	Red River	East Fork Salmon River
Crooked Fork Creek							
Clear Creek	0.029						
Fish Creek	<0.001	<0.001					
Marsh Creek	<0.001	<0.001	<0.001				
Pahsimeroi River	<0.001	1.000	<0.001	<0.001			
Red River	<0.002	0.999	<0.001	<0.001	0.999		
East Fork Salmon River	0.120	<0.001	<0.001	0.948	<0.001	<0.001	
South Fork Salmon River	0.381	0.999	0.469	<0.001	0.998	0.999	0.021

	Fall 1994					
Stream	Fish Creek	Marsh Creek	Pahsimeroi River	Rapid River	Red River	East Fork Salmon River
Fish Creek						
Marsh Creek	0.029					
Pahsimeroi River	<0.001	0.066				
Rapid River	<0.001	0.324	0.850			
Red River	<0.001	0.714	0.024	0.095		
East Fork Salmon River	0.001	0.976	0.991	1.000	0.503	
South Fork Salmon River	<0.001	0.491	0.002	0.001	0.999	0.426

Table 13. Date 10%, 25%, 50%, 75%, and 90% of total steelhead juveniles were captured at screw traps during spring and fall trapping periods.

Site	Dates	Number Collected	Date Quantile Attained 10%	25%	50%	75%	90%
Spring screw traps							
Crooked Fork Creek	3/16-6/1	492	4/12	4/18	4/20	5/8	5/27
Clear Creek	4/15-6/10	98	4/22	5/9	5/19	6/10	6/10
Fish Creek	3/18-6/13	659	4/8	5/28	6/4	6/7	6/11
Red River	3/29-5/24	130	4/4	4/18	4/29	5/7	5/13
East Fork Salmon River	3/16-5/11	69	3/23	4/9	4/19	5/11	5/11
Marsh Creek	3/16-6/1	370	4/16	4/21	4/29	5/19	5/26
Pahsimeroi River	3/3-6/1	247	3/22	4/4	4/30	5/8	5/15
South Fork Salmon River	3/16-6/1	1,029	4/16	4/19	4/21	5/11	5/27
Fall screw traps							
Crooked Fork Creek	8/24-11/4	524	8/29	9/4	10/3	10/24	10/30
Fish Creek	9/22-11/7	2,511	10/13	10/20	10/22	10/24	10/30
Red River	8/26-10/12	42	8/29	8/30	9/6	9/12	9/20
East Fork Salmon River	8/15-11/13	28	8/26	9/4	10/6	10/23	10/31
Marsh Creek	8/19-11 /2	177	9/5	9/16	9/22	10/10	10/29
Pahsimeroi River	9/9-12/8	136	9/30	10/5	10/28	11/17	11/26
Rapid River	7/26-10/28	446	9/3	9/7	9/16	10/5	10/24
South Fork Salmon River	8/30-10/25	191	8/31	9/3	9/9	9/23	10/14



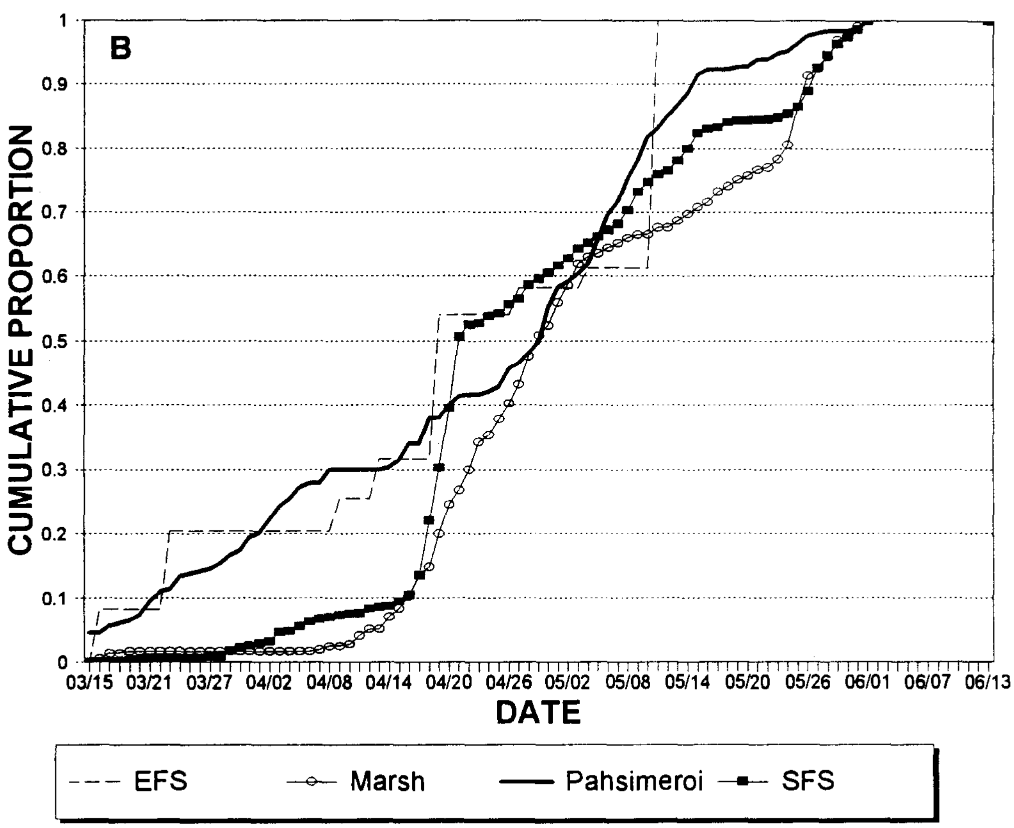
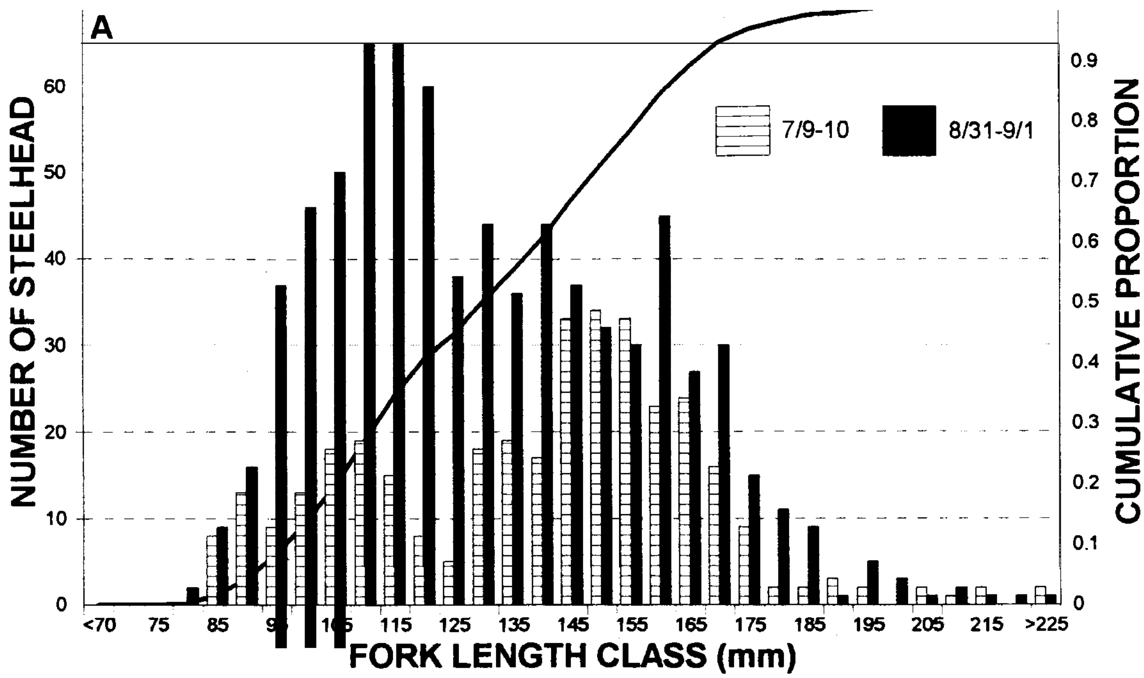


Figure 16. Cumulative distribution of number of steelhead captured during spring trapping season. (A) = Clearwater River drainage, CFC = Crooked Fork Creek. (B) = Salmon River drainage, EFS = East Fork Salmon River, SFS = South Fork Salmon River.



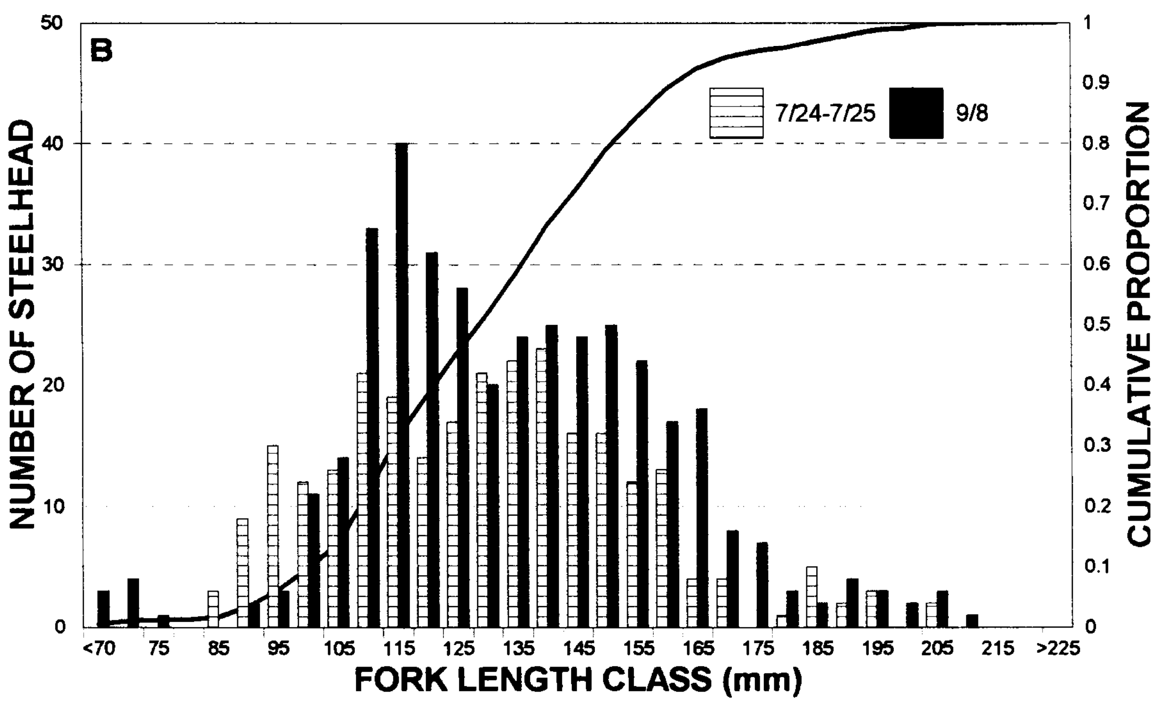


Figure 17. Length frequency of PIT-tagged steelhead (bars) caught by fly fishing on two occasions about six weeks apart. Cumulative distribution of length (line) is for both tagging dates combined. (A) = Fish Creek. (B) = Gedney Creek.

difference in length of the tagged fish among the streams (ANOVA, $p<0.001$). The mean length ranged from 178 mm in Rapid River to 84 mm in Crooked Fork Creek. Tukey's HSD pairwise comparisons revealed that length significantly differed between Crooked Fork Creek and all other streams and Marsh Creek and all other streams except the East Fork Salmon River (Table 13).

There was a significant difference in condition factor among the streams during the fall (ANOVA, $p <0.001$). The mean condition factor ranged from 1.0341 in Red River to 0.9363 in Fish Creek. Tukey's HSD pairwise comparisons revealed significant differences between Fish Creek and all streams except the East Fork Salmon and South Fork Salmon rivers, the South Fork Salmon River and the Pahsimeroi and Rapid rivers, and between Red River and the Pahsimeroi River (Tables 10 and 11).

During the fall, there was much variation in the starting and ending dates of screw trap operation (Table 10). In addition, we trapped <45 steelhead at the Red River and East Fork Salmon River screw traps. For these reasons, it is difficult to compare the fall migration pattern among all streams. In the Clearwater River drainage, comparisons among streams were not made. In Crooked Fork Creek, 40% of the fish were trapped in the first two weeks of operation (August 24 to September 7) and another 40% were trapped from October 24 to November 4, the last 15 days of operation (Figure 18a). We trapped 2,511 steelhead in Fish Creek, the most at any location in 1994. Forty-three percent (1,081) were captured on October 23 and 24. Within the Salmon River drainage, South Fork Salmon River and Rapid River fish had a similar migration pattern (Figure 18b). Marsh Creek migration mimicked that of the South Fork Salmon River and Rapid River, but the 10%, 25%, and 50% quantiles were attained about 10 days later (Table 13). After the 70% quantile was reached, Marsh Creek and Rapid River had a similar migration pattern. Pahsimeroi River fish migrated much later than those in the other Salmon River streams; however, the trap was installed later and operated a month longer than the other traps.

Smolt Detections at Dams

There were 795 smolt detections at Lower Granite, Little Goose, Lower Monumental, and McNary dams during the spring of 1994. Five hundred nine detections were of steelhead tagged in fall 1993, 271 were tagged in spring 1994, and 15 were tagged in spring 1993 (Table 14). If we assume that only fish 140 mm in length at the time of tagging were smolts, then 47% and 45% of the spring 1994 and fall 1993 tagged fish 140 mm were detected, respectively. There was a significant difference in length (t-test, $p<0.001$, df = 776) and condition factor ($p< 0.001$, df = 592) between detected smolts tagged in fall 1993 and spring 1994. The mean length at the time of tagging of the spring 1994 fish was 175 mm, compared with 168 mm for the fall 1993 fish. The mean condition factor at the time of tagging was 0.9098 and 1.0147 for detected smolts tagged in spring 1994 and fall 1993, respectively.

There was a significant difference in smolt length (ANOVA, $p<0.001$) among the six streams where fish were tagged in fall 1993. The mean length ranged from 176 mm in Crooked Fork Creek to 154 mm in Red River (Table 15). Tukey's HSD pairwise comparisons revealed that there were significant differences between Red River and Crooked Fork Creek, Rapid River, and the South Fork Salmon River and between Fish Creek and Crooked Fork Creek and the South Fork Salmon River.

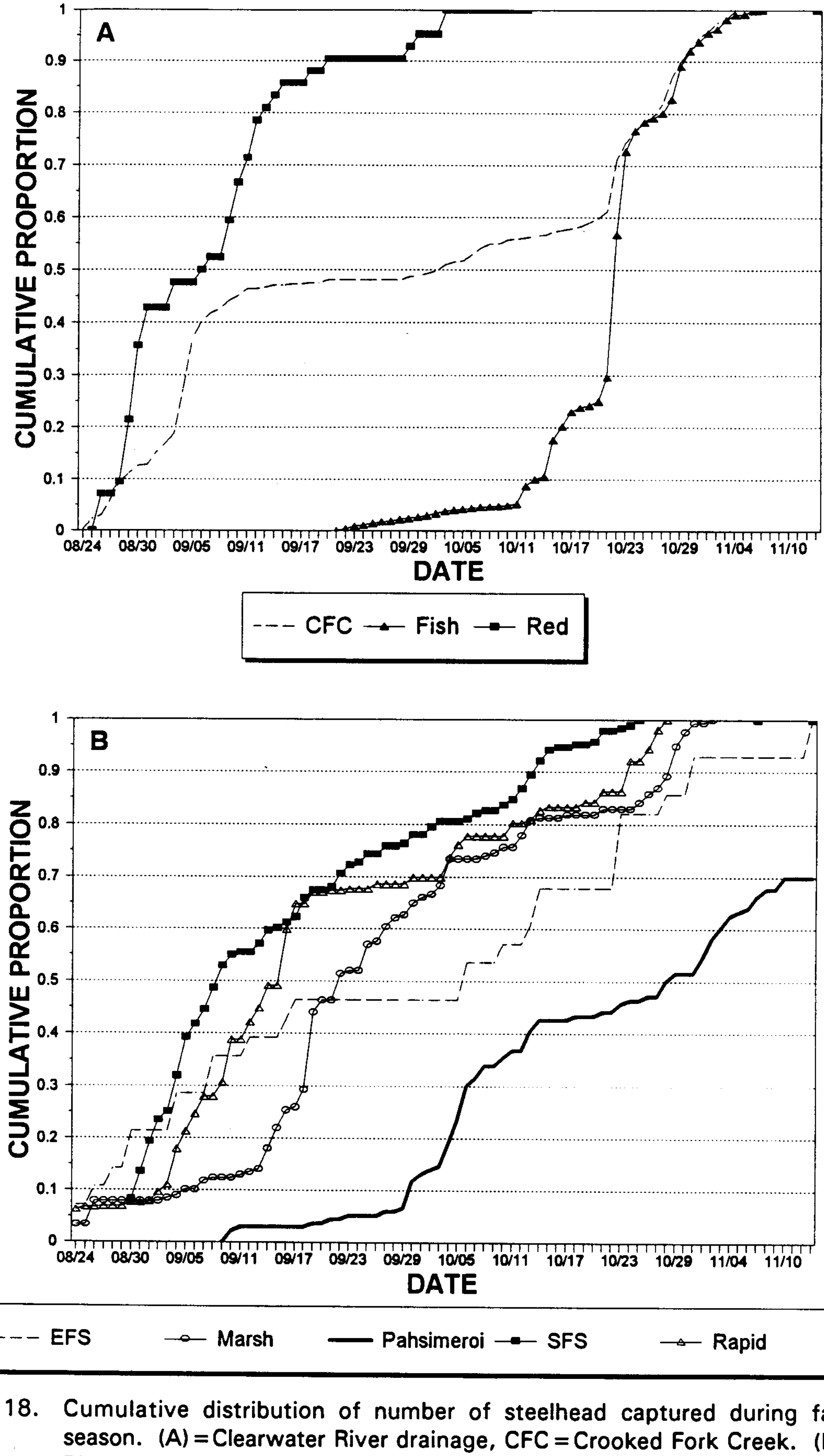


Figure 18. Cumulative distribution of number of steelhead captured during fall trapping season. (A) = Clearwater River drainage, CFC = Crooked Fork Creek. (B) = Salmon River drainage, EFS = East Fork Salmon River; SFS = South Fork Salmon River.

Table 14. Number of smolts detected in 1994 at Lower Granite, Little Goose, Lower Monumental, and McNary dams and number of steelhead juveniles < 140 mm and 2140 mm fork lengths that were PIT-tagged. Numbers in detection columns in parentheses are minimum and maximum lengths at time of PIT tagging of smolts detected in 1994.

		Number tagged in:				Number of detections of fish tagged in:		
	Number	Fall 1993		Spring 1994				
Site	Detected	<140 mm	2140 mm	<140 mm	2140 mm	Spring 93	Fall 93	Spring 94
Crooked Fork Creek	307	274	228	142	292	4 (93-145)	130 (142-217)	173 (147-220)
Clear Creek	13	0	0	98	23	0	0	13 (138-182)
Fish Creek	128	211	184	443	24	0	119 (124-197)	9 (130-200)
Red River	83	165	118	122	64	0	47 (70-186)	361 (137-198)
Marsh Creek	15	193	50	134	24	1 (152)	13 (151-188)	1 (168)
EF Salmon River	8	0	0	69	30	0	0	8 (138-197)
Pahsimeroi River	27	0	0	238	107	0	0	27 (123-233)
Rapid River	124	284	275	0	0	0	124 (123-250)	0
SF Salmon River	90	536	271	98	10	10 (111-153)	76 (117-210)	4 (142-157)
Total	**795**	**1,663**	**1,126**	**1,344**	**574**	**15 (93-153)**	**509 (70-250)**	**271 (123-233)**

Table 15. Fork length and condition factor (K) statistics of wild steelhead smolts detected at all dams in 1994. Standard deviation of mean in parentheses.

Stream	Mean Length (mm)	Mean K	Median Length	Median K	Number Length	Number K
Fall 1993 tagged						
Crooked Fork Creek	176 (16)		174		130	0
Fish Creek	155 (15)	0.9755 (0.0608)	154	0.9776	117	117
Red River	154 (19)	0.9992 (0.1275)	151	0.9854	47	35
Marsh Creek	168 (12)	0.9900 (0.0426)	170	0.9971	13	8
Rapid River	174 (16)	1.0615 (0.1159)	174	1.0630	124	119
South Fork Salmon River	172 (21)	1.0105 (0.1054)	176	0.9980	76	56
Spring 1994 tagged						
Crooked Fork Creek	180 (13)	0.8831 (0.0600)	180	0.8771	173	171
Clear Creek	159 (14)	0.9914 (0.0692)	159	0.9820	13	13
Fish Creek	163 (20)	0.9276 (0.0676)	164	0.9127	9	9
Red River	165 (15)	0.9748 (0.0998)	164	0.9872	36	35
Pahsimeroi River	178 (24)	0.9561 (0.0795)	**175**	0.9553	27	25
East Fork Salmon River	169 (20)	0.8947 (0.0686)	169	0.8909	8	6
South Fork Salmon River	147(7)		145		4	0

Weights were not taken at Crooked Fork Creek during fall 1993, hence condition factor was not calculated for that stream. There was a significant difference in condition factor among the streams (ANOVA, $p<0.001$) for smolts tagged in fall 1993. The mean condition factor at the time of tagging ranged from 1.0615 in Rapid River to 0.9755 in Fish Creek. Tukey's HSD test revealed significant differences between Rapid River and Fish Creek, Red River, and South Fork Salmon River (Tables 10 and 12).

I deleted fish tagged during spring 1994 in Marsh Creek, South Fork Salmon River, East Fork Salmon River, Fish Creek, and Clear Creek for the smolt length ANOVA because of the small number of detections (n13 for each stream). There was a significant difference in length among Crooked Fork Creek, Pahsimeroi River, and Red River (ANOVA, $p <0.001$). Tukey's HSD test revealed significant differences between Red River and Crooked Fork Creek and the Pahsimeroi River. The mean length at the time of tagging was 180 mm in Crooked Fork Creek, 178 mm in the Pahsimeroi River, and 165 mm in Red River.

Because of the small number of detections (n13), I deleted Clear Creek, Fish Creek, Marsh Creek, East Fork Salmon River, and the South Fork Salmon River from the smolt condition factor ANOVA for spring 1994 tagging. There was a significant difference in condition factor among Crooked Fork Creek, Pahsimeroi River, and Red River smolts tagged in spring 1994 (ANOVA, $p <0.001$). Tukey's HSD test revealed significant differences between Crooked Fork Creek and the Pahsimeroi River and Red River. The mean condition factor was 0.9748 in Red River, 0.9561 in the Pahsimeroi River, and 0.8831 in Crooked Fork Creek.

Smolt Travel Time

The median smolt arrival dates at Lower Granite Dam were April 26 and May 1 for all fish tagged in fall 1993 and spring 1994, respectively (Figure 19, Table 16). On a stream basis, the earliest median arrival date of spring-tagged fish was April 29 for Crooked Fork Creek, and the latest median arrival date was May 10 from Red River (Table 16). Of the eight sites where we tagged fish in spring 1994, only Crooked Fork Creek had >30 smolt detections at Lower Granite Dam (Table 16). Because of the small sample size, all travel time statistics, with the exception of Crooked Fork Creek, should be viewed with caution. The median travel time ranged from 15.4 km/d (n=4) from the South Fork Salmon River to 49.8 km/d (n=18) from the Pahsimeroi River (Table 16, Figure 20). In Crooked Fork Creek, the median travel time In= 112) was 26 km/d. The lower and upper bound *(90%* CI) was 16.1 km/d and 27.3 km/d, respectively.

Adult and Juvenile Steelhead Aging

We collected scales from 7 and 47 adult steelhead from the upper Salmon River and Clear Creek, respectively. We collected scales from age 1 + steelhead in Fish Creek (189), Gedney Creek (90), Whitecap Creek (67), South Fork Salmon River (38), and Johnson Creek (29) during the summer and fall. We have not had time to analyze the scales. We plan to develop a length distribution for the different age classes of juveniles in each stream with this data.

DISCUSSION

We were unable to implement much of the Experimental Design, as planned for 1994, because of budget cutbacks and the low escapement of wild steelhead into Idaho. In our Experimental Design we identified seven objectives to investigate (Byrne 1994), but only worked on the three identified in this report this year. We outplanted adult hatchery steelhead in Beaver and Frenchman creeks, stocked hatchery fingerlings in the South Fork Red River, and expanded our collection of life-history traits from wild populations.

Our primary objective of this study was to compare the performance of wild and hatchery stocks for supplementation. IDFG personnel stocked Beaver and Frenchman creeks with hatchery adult steelhead for the second year in 1994. Because of the low wild steelhead escapement into Idaho in 1994, we did not attempt to capture any for use in Objective 1 experiments. In Frenchman Creek, river otters killed 12 of the 20 adults we stocked. We did not document any otter kills in Beaver Creek. Frenchman Creek is less than 4 m wide and 1 m deep in the outplant section, making adults very vulnerable to predation. Although we observed 12 redds in Frenchman Creek, many females were killed before they had finished spawning. Because of heavy predation by otters, fry and parr production in Frenchman Creek from this stocking may be low. The age 1 steelhead densities increased in both streams compared to 1993, but we observed a larger increase in Beaver Creek (Figure 5). The outplant section of Beaver Creek has abundant large substrate with interstitial spaces, whereas the

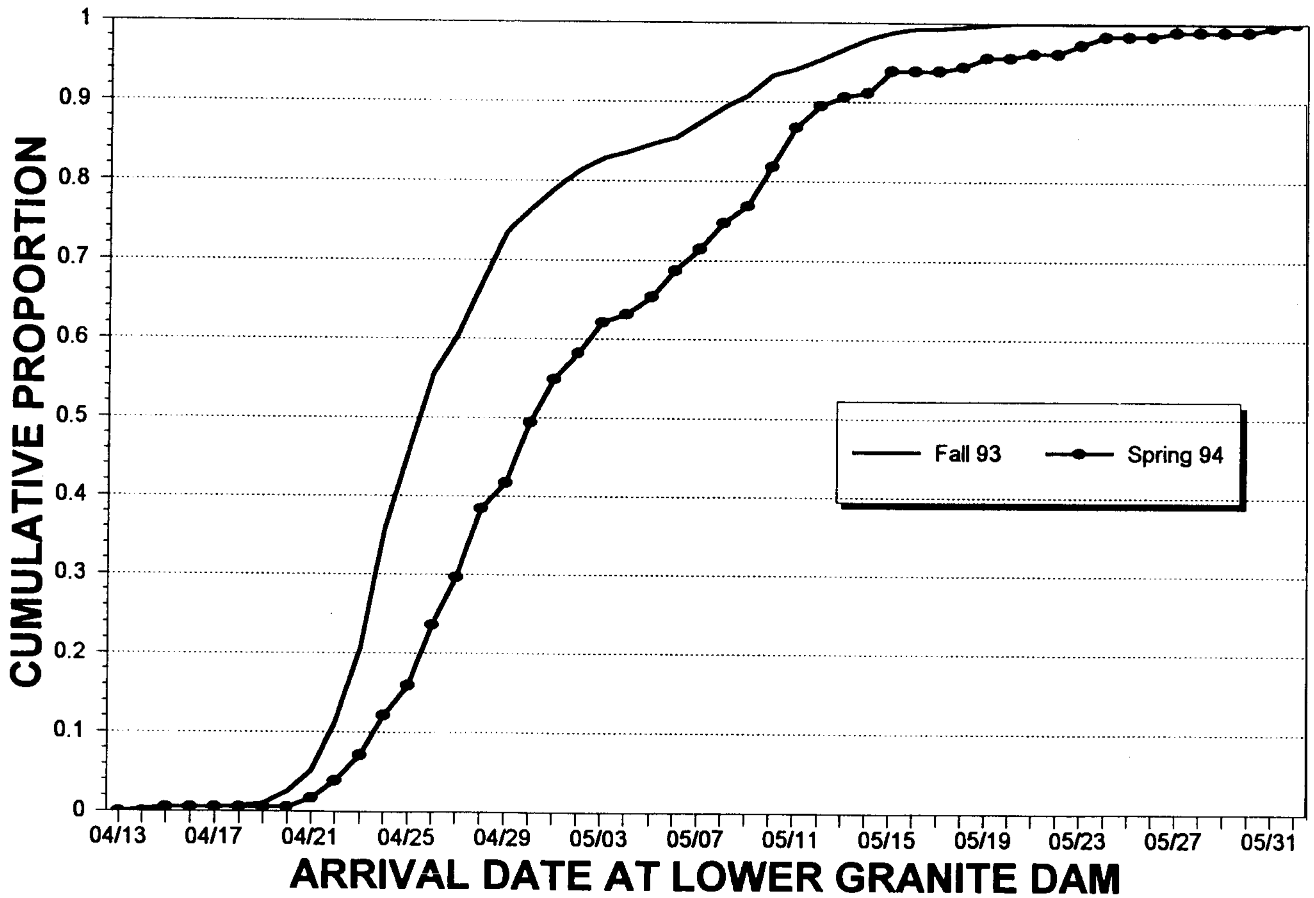


Figure 19. Cumulative distribution of arrival date at Lower Granite Dam of steelhead smolts tagged in fall 1993 and spring 1994.

Table 16. Travel time statistics of smolts PIT-tagged at screw traps during spring 1994 that were detected at Lower Granite Dam. Number tagged column contains total steelhead tagged and number of fish > 140 mm in length when tagged during spring 1994. Median travel time and 90% CI are in km/d. Travel time CI not calculated for sites with <10 detections. Mean, maximum (Max), and minimum (Min) length at tagging are for detected smolts only.

	Detections at	Number Taaged		Median		90% C.I.		Length at Tagging		
Site	Lower Granite Dam	Total	≥140 mm	Arrival	Travel	Lower	Upper	Min	Max	Mean
Crooked Fork Creek	112	434	292	4/29	27.6	16.1	27.31	147	220	180
Clear Creek	11	98	23	4/27	25.1	22.0	35.20	138	182	160
Fish Creek[a]	7	443	24	5/7	35.6	--	--	130	200	163
Red River	26	122	64	5/10	20.3	16.1	27.30	137	198	166
Marsh Creek	0	134	24	--	--	--	--	--	--	--
East Fork Salmon River	4	69	30	5/1	26.3	--	--	151	197	170
Pahsimeroi River	18	238	107	5/6	49.8	31.1	56.50	154	233	181
South Fork Salmon River	4	98	10	5/3	15.4	--	--	142	157	147
All spring 1994 tagged fish	**182**	**1,636**	**574**	**5/1**	**26.1**	**--**	**--**	**130**	**233**	**175**
All fall 1993 tagged fish	**392**	**1,847**	**1,126**	**4/26**	**NA**	**--**	**--**	**70**	**250**	**168**

[a]Tagging began on April 24, 1994.

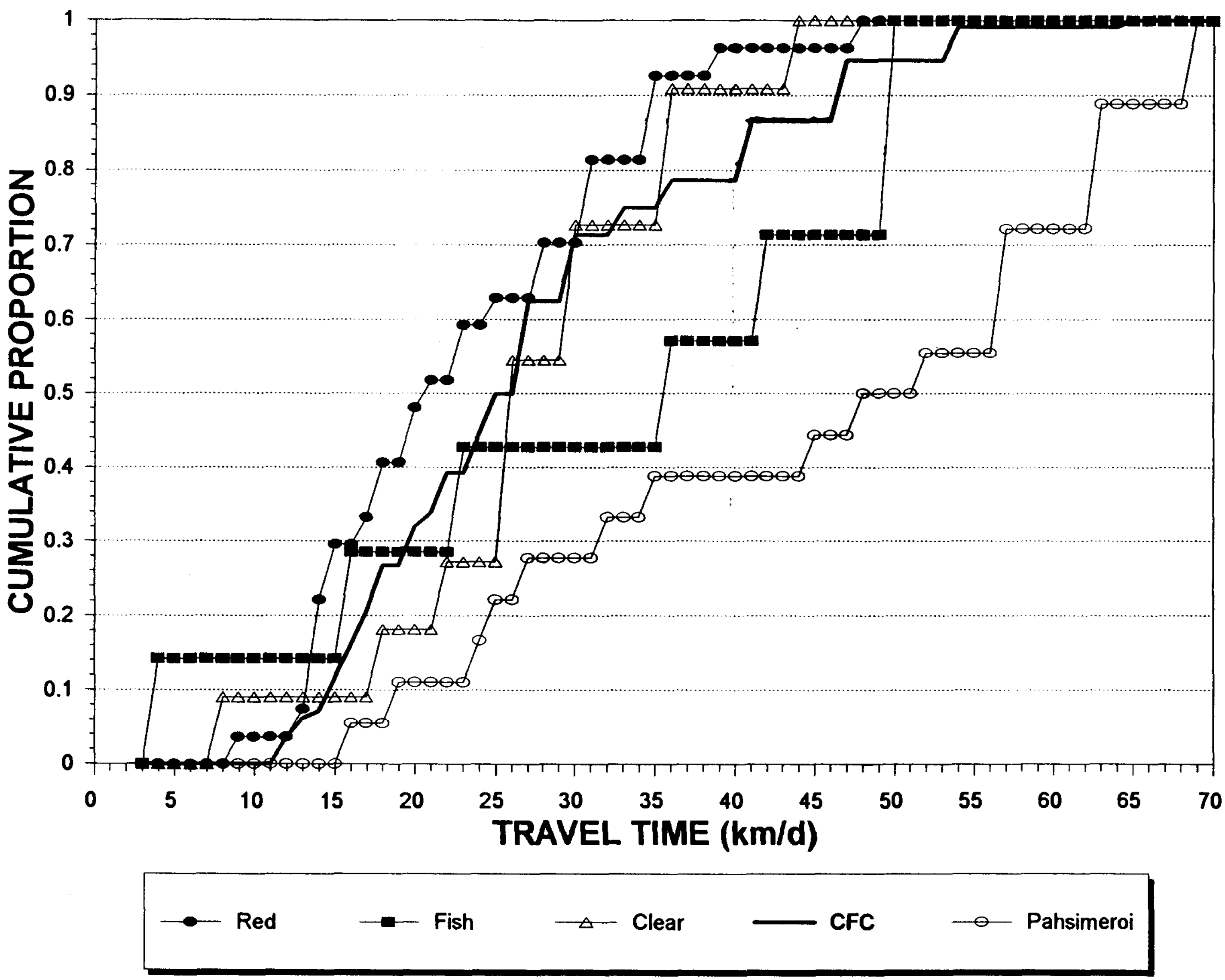


Figure 20. Cumulative distribution of travel time (km/d from tagging site to Lower Granite Dam of smolts tagged in spring. CFC = Crooked Fork Creek.

substrate in the Frenchman Creek site is primarily sand and small gravel. Large woody debris is common in the Beaver Creek outplant site, but is absent in the Frenchman Creek site. Brook trout are nearly five times more abundant in Frenchman Creek than Beaver Creek. The combination of abundant brook trout, a sand and gravel bottom, and little in-stream cover could make steelhead parr more prone to predation by brook trout in Frenchman Creek and explain the higher age 1 densities in Beaver Creek.

There was no significant relation between female length and fecundity for the Sawtooth stock this year. Most of the females were between 65 cm and 74 cm, yet the number of eggs per fish ranged from 1,400 to nearly 6,800 (Figure 4). The low egg counts were from females that entered the hatchery partially spawned out. Had these females retained all their eggs, the relation may have been significant.

The second objective was to compare juvenile production from naturally-spawning adults stocked as fingerlings or smolts. We stocked a second group of 50,000 fingerlings in the South Fork Red River. In late June, the estimated age 1 steelhead population was 3,844, a 491% increase from the 1993 estimate of 740 fish. If we assume all age 1 fish were from the September 1993 fingerling stocking, then the survival rate was 7.7%. If we assume all fish we stocked in September 1993 will become smolts in spring 1995 and that 50% of the fish survive another winter, then 1,925 smolts (3.85% fingerling-to-smolt survival rate) will be produced. The estimated survival of smolts stocked in the South Fork Clearwater River to returning adults is about 0.6% (Bill Miller, U.S. Fish and Wildlife Service, Idaho Fisheries Resource Office, Ahsahka). If the smolts produced from the fingerling stocking survive at the same rate, then 11 to 12 adults should return to spawn (0.024% fingerling-to-adult survival rate). Our experiment was designed to return 26 adults from each stocking (a fingerling-to-adult survival equal to 0.052%). If my projections are correct, then the fingerling-to-adult survival rate I used when designing this experiment was nearly double the actual rate. We detected eight fish (0.16% of the tagged fish) at the Snake River dams in spring 1994 that were stocked in September 1993. This was unexpected as the mean length of detected fish at tagging on August 25-27, 1993 was 74 mm. Most of the wild smolts we detect at the dams are >139 mm and it is doubtful the fingerlings we stocked in September 1993 grew to that size.

We devoted much of our effort this year on Objective 3, collecting life-history data from wild steelhead populations. Gedney Creek, a tributary of the Selway River, was intensively snorkeled and juvenile steelhead were PIT-tagged. We found high densities of juvenile steelhead in this stream. Gedney and Fish creeks have the largest density of steelhead of all streams that have been snorkeled by this project, and we will focus much effort in these two streams to collect life-history data in the future. We PIT-tagged 6,314 juvenile steelhead at 12 locations in 1994, more than doubling the number we tagged in 1993. Many of the steelhead we tagged were <139 mm and will spend an additional summer rearing in streams before smolting.

The majority of smolt detections in 1994 were tagged in the fall of 1993. Of the 795 detections, only 271 (34%) were tagged in spring 1994, 509 (64%) were tagged in fall 1993, and 15 (2%) in spring 1993. Although there were 183 detections of spring-tagged smolts at Lower Granite Dam, only Red River (n=26) and Crooked Fork Creek (n=112) had >20 detections. Because of the small sample size at other tagging sites, travel statistics should be viewed with caution and comparisons among the sites cannot be made.

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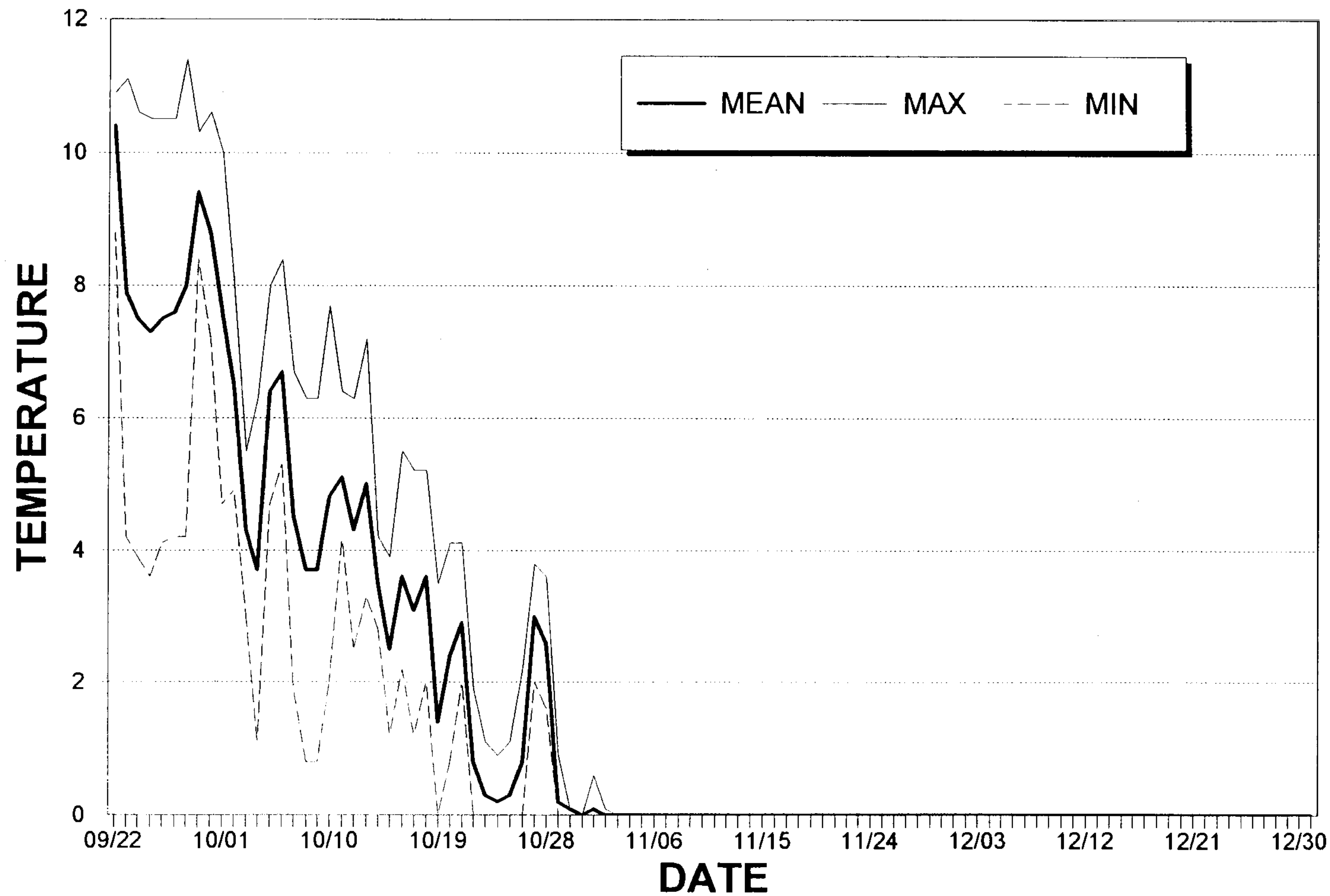
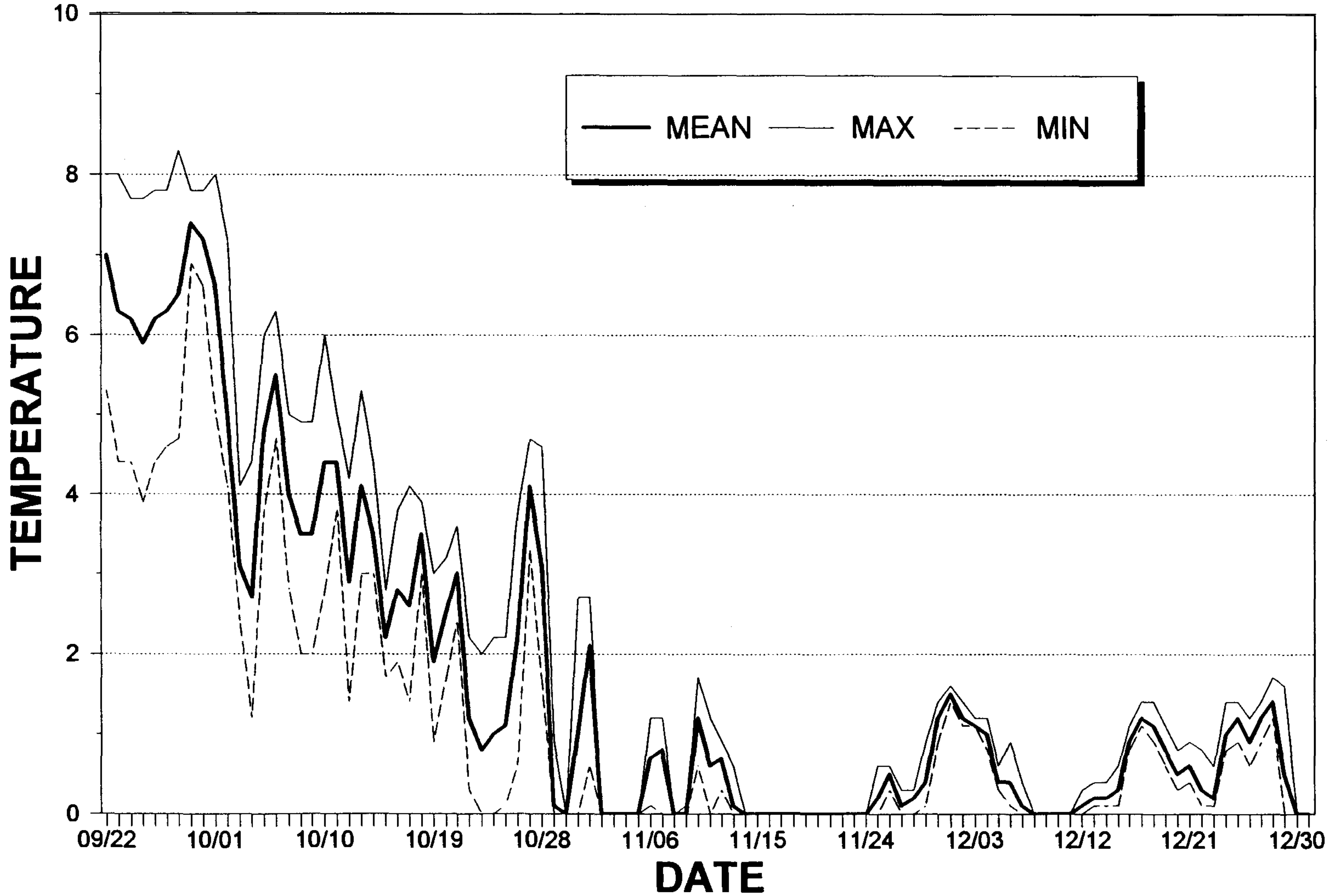
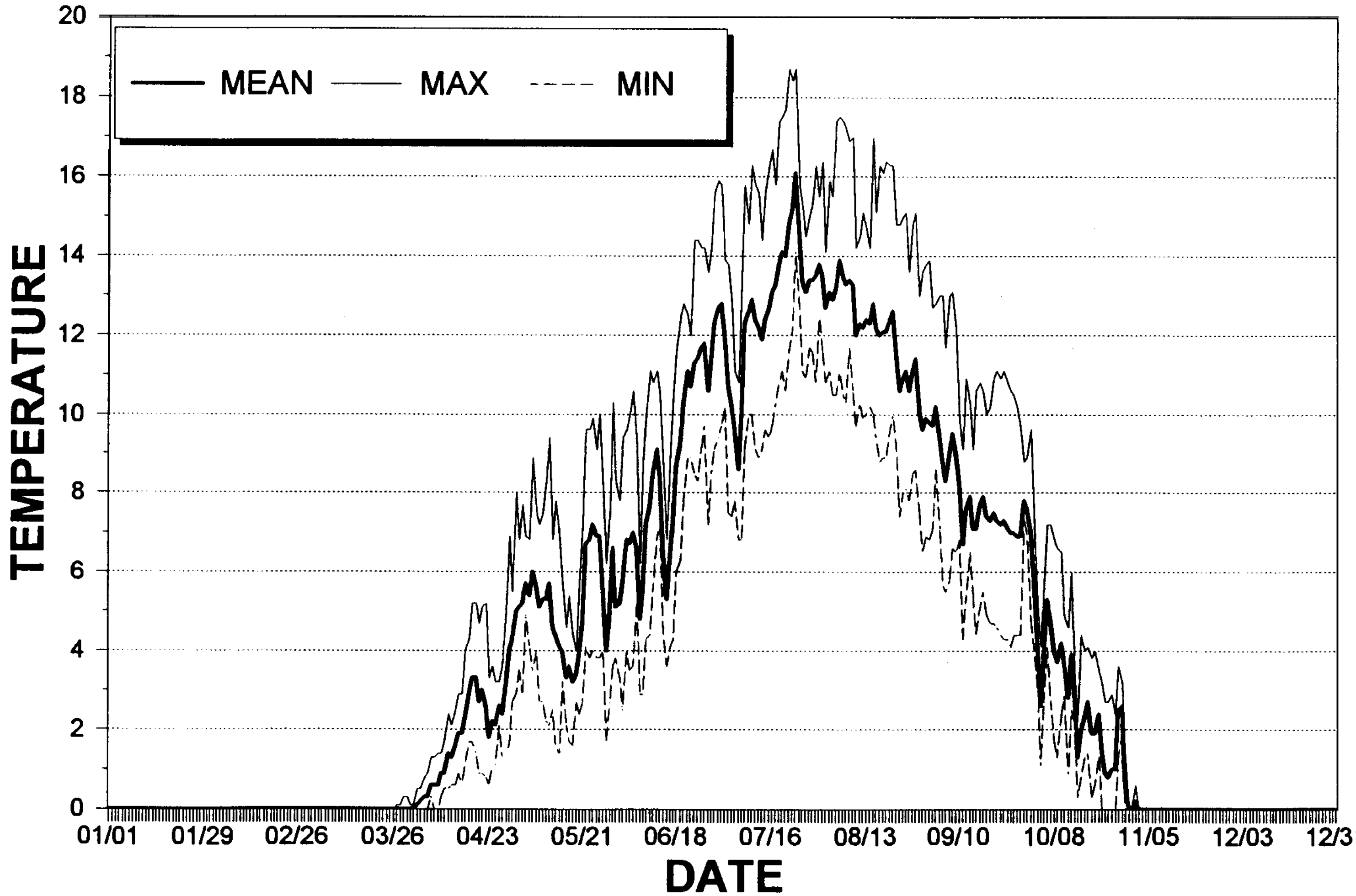
APPENDICES



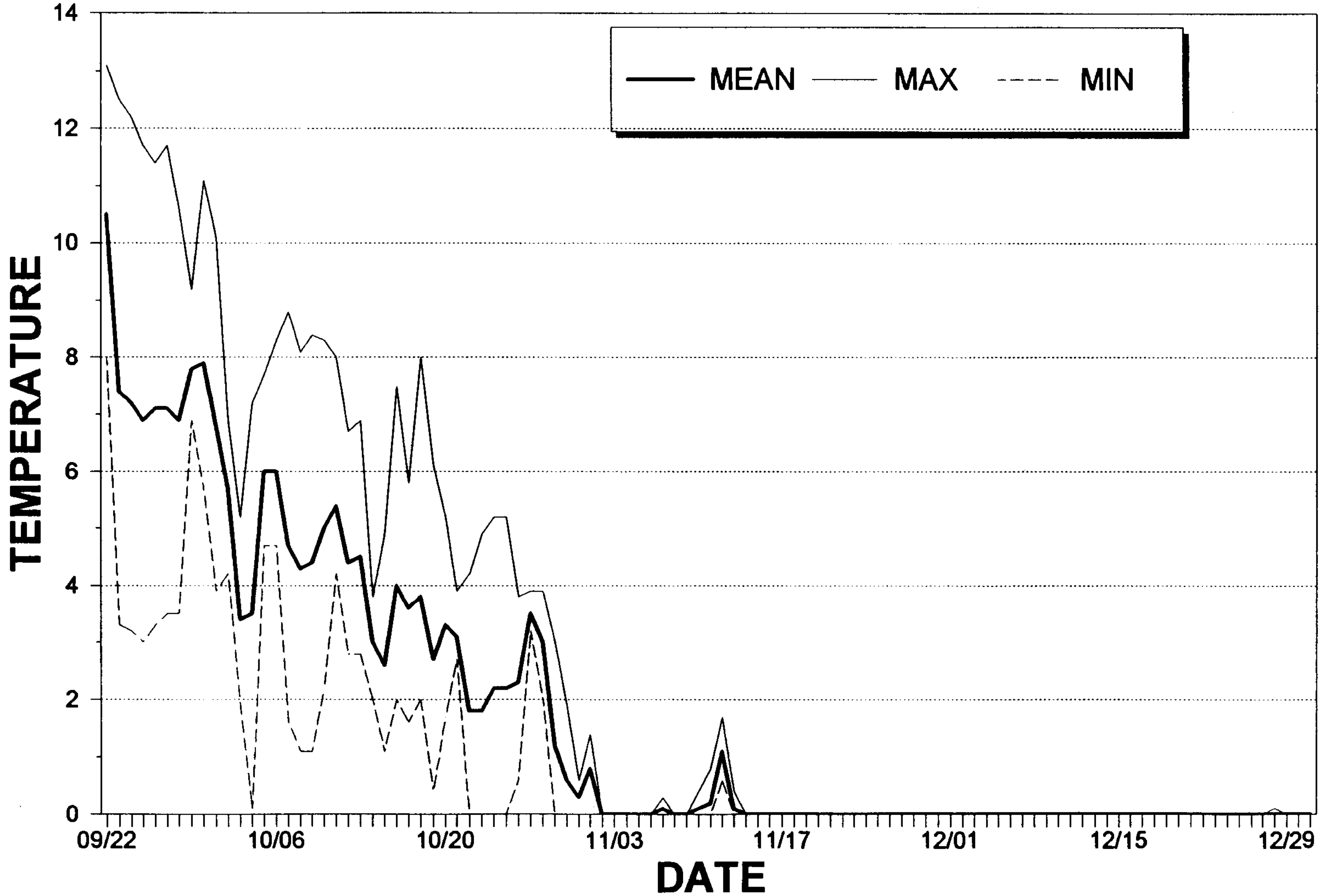
Appendix 1. Daily mean, maximum, and minimum water temperatures (°C) in Basin Creek from September 22 to December 31, 1994.



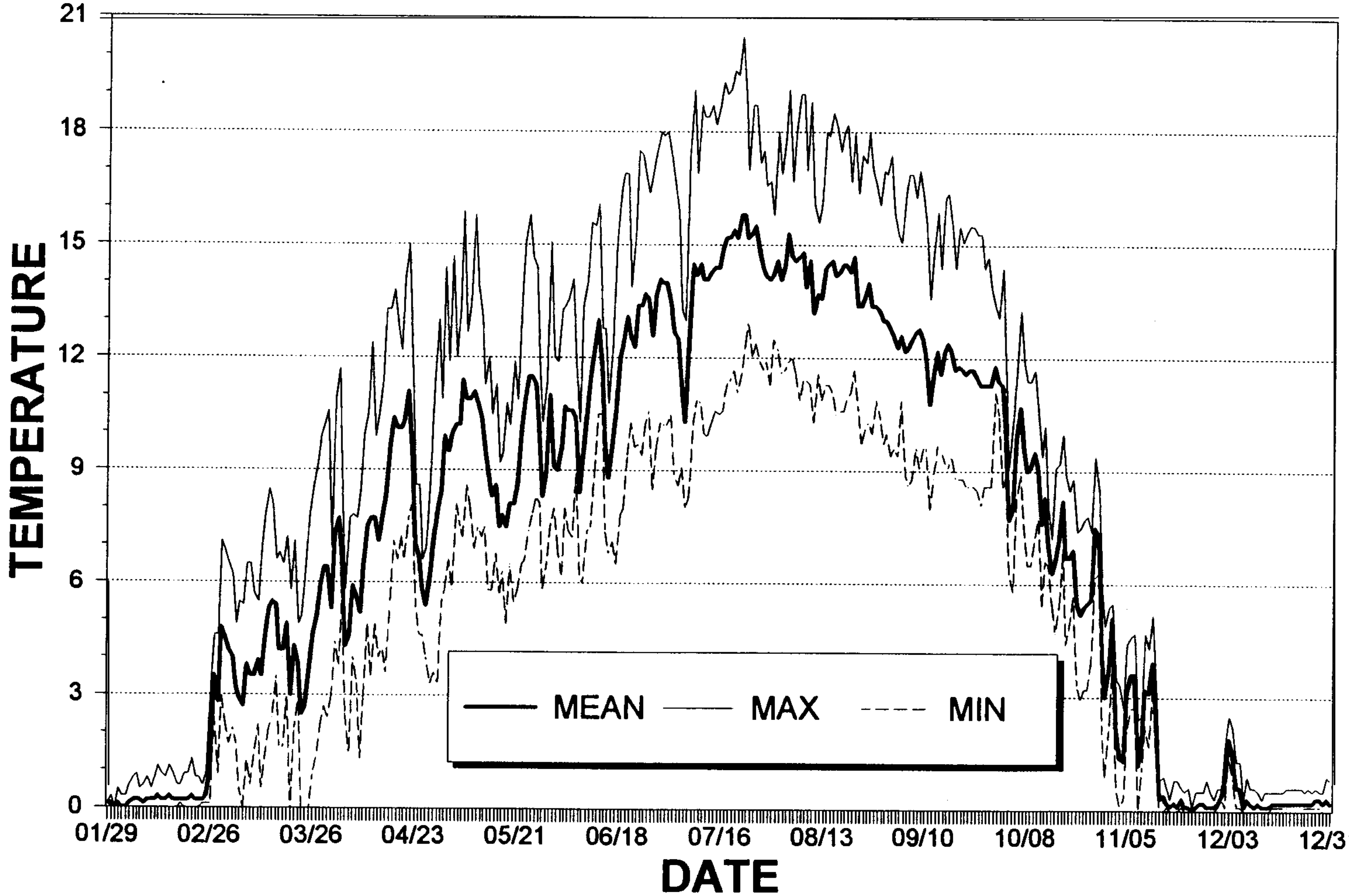
Appendix 2. Daily mean, maximum, and minimum water temperatures (°C) in Big Boulder Creek from September 22 to December 31, 1994.



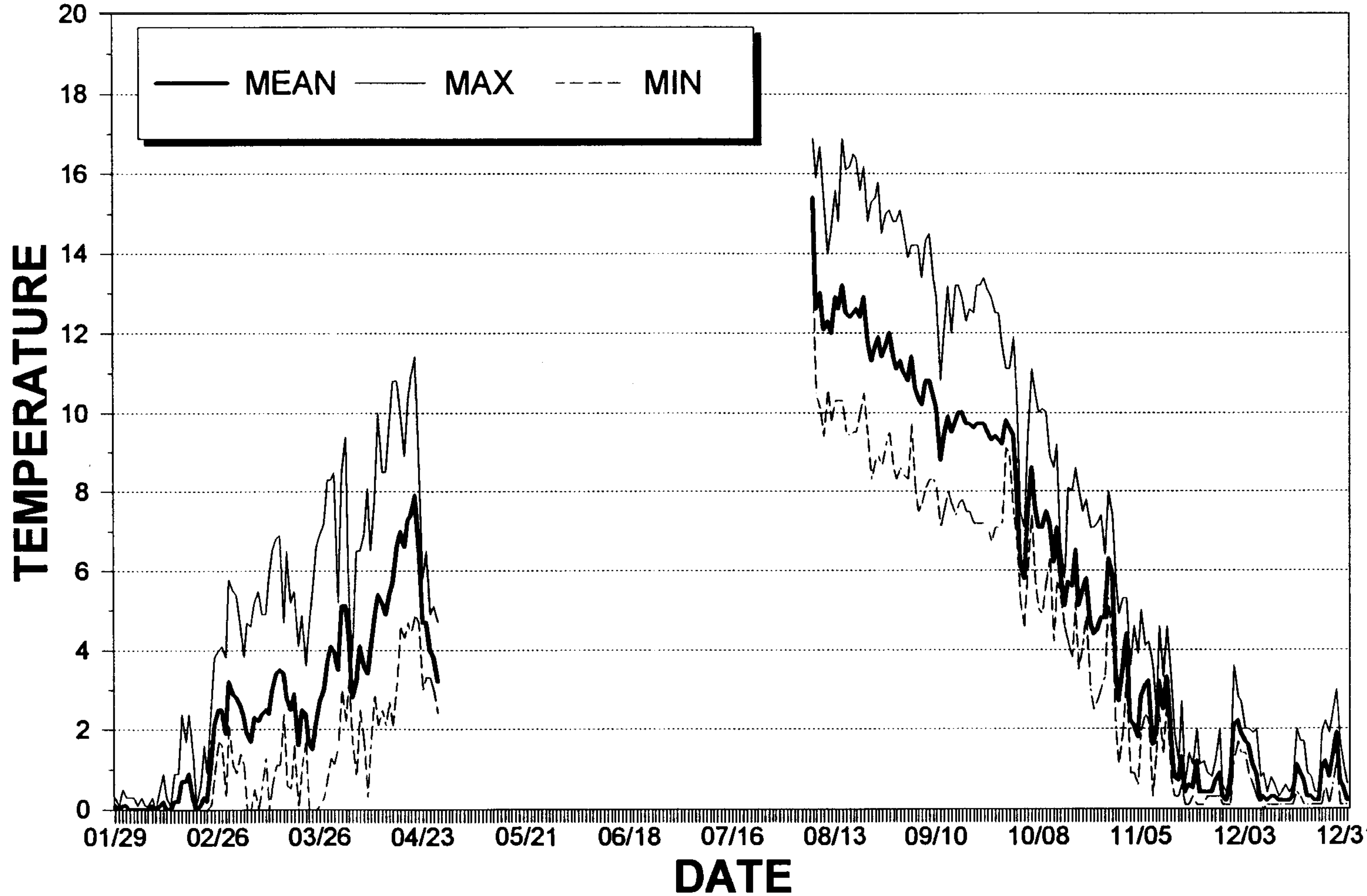
Appendix 3. Daily mean, maximum, and minimum water temperatures (°C) in Beaver Creek from January 1 to December 31, 1994.



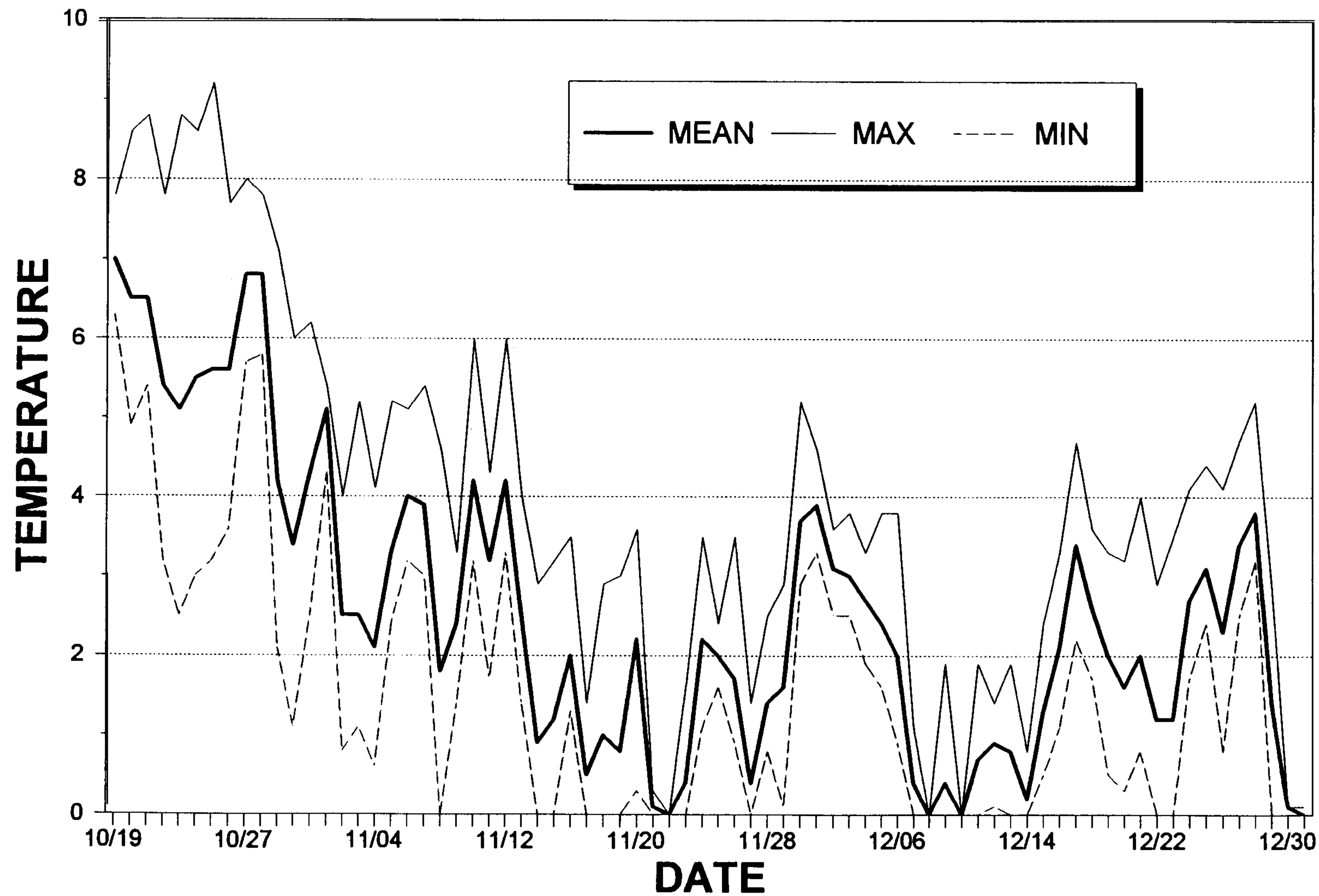
Appendix 4. Daily mean, maximum, and minimum water temperatures (°C) in Capehorn Creek from September 22 to December 31, 1994.



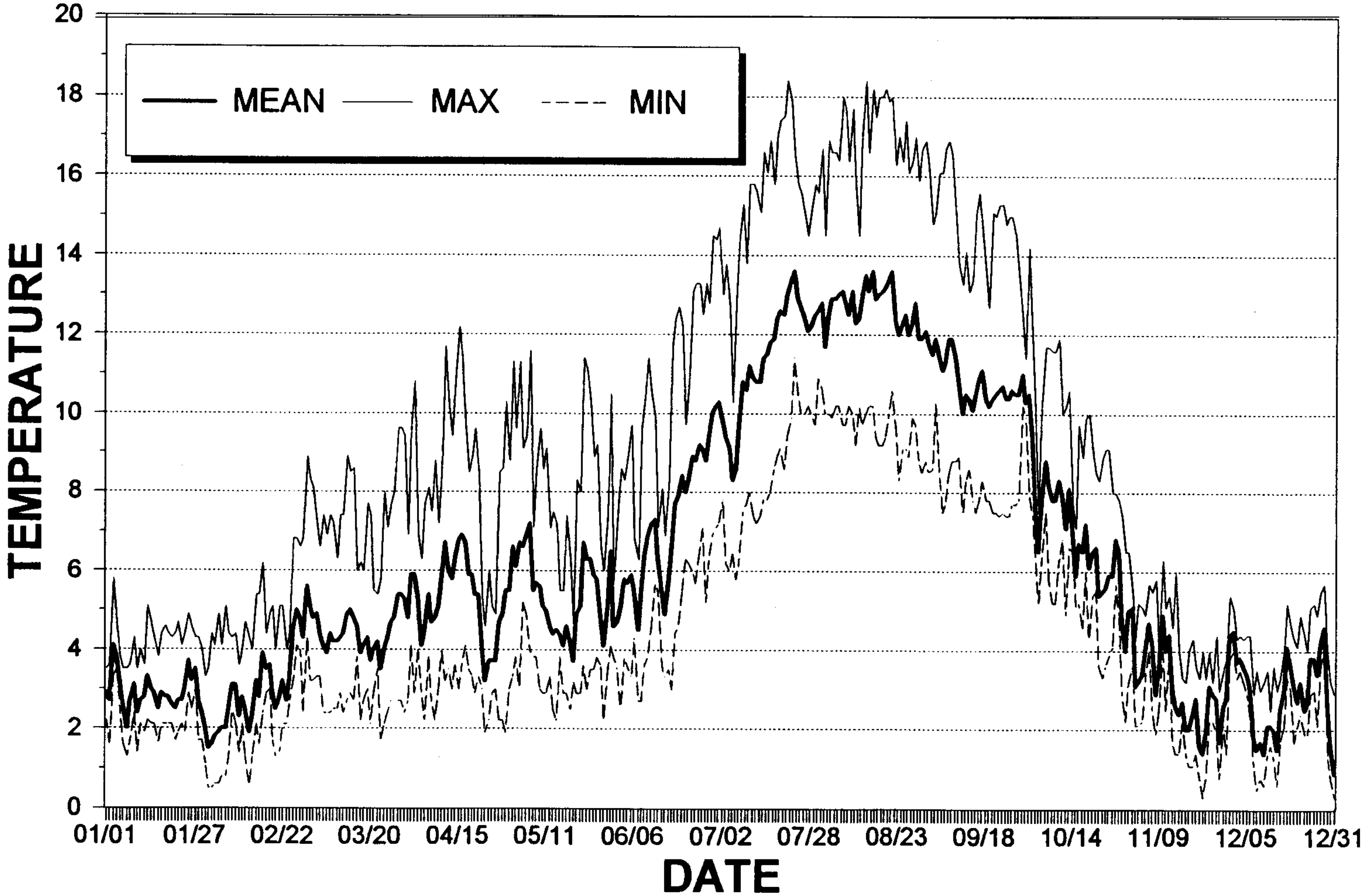
Appendix 5. Daily mean, maximum, and minimum water temperatures (°C) in the East Fork Salmon River, 200 m upstream from its mouth, from January 29 to December 31, 1994.



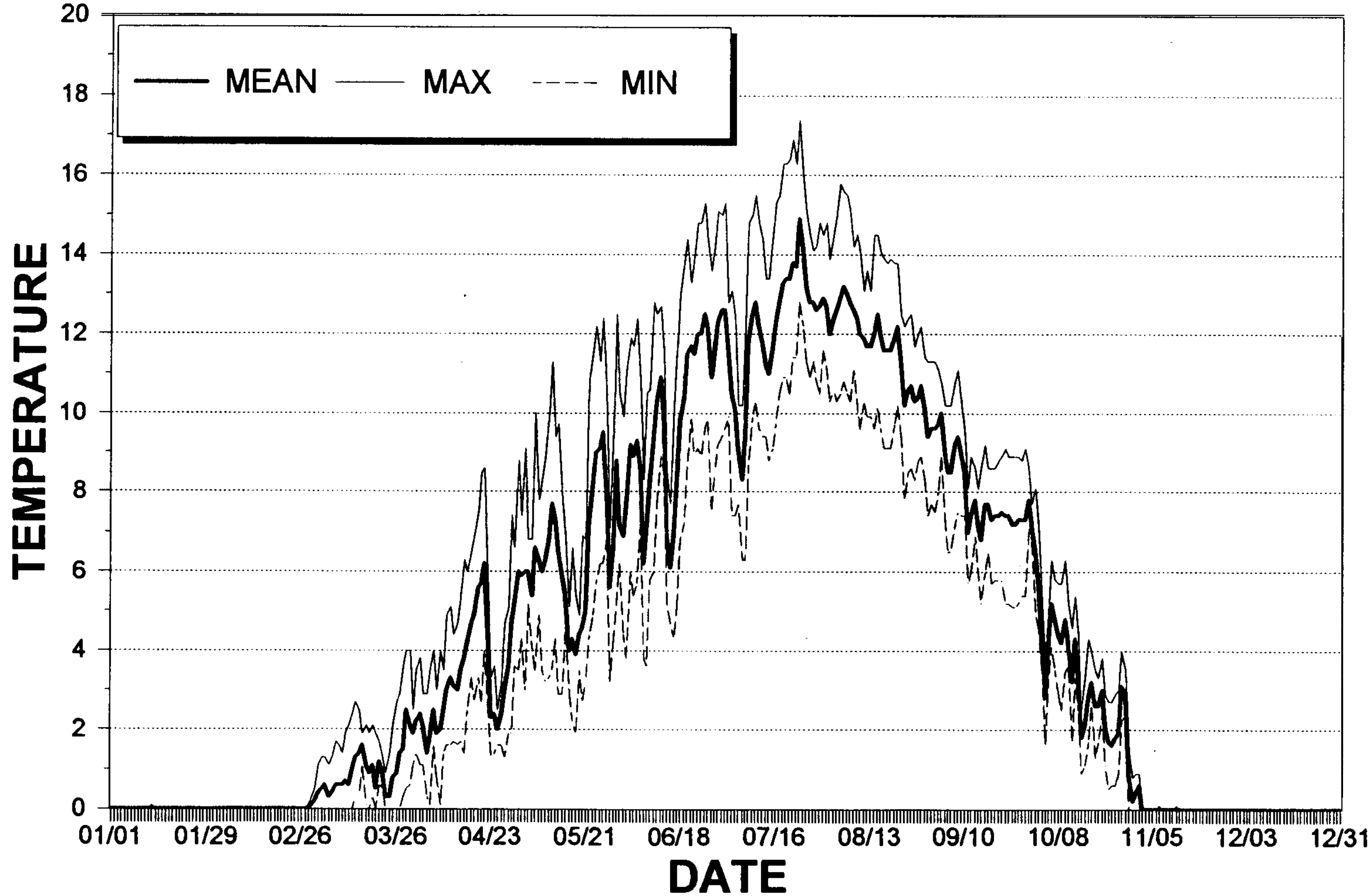
Appendix 6. Daily mean, maximum, and minimum water temperatures (°C) in the East Fork Salmon River at the hatchery weir from January 29 to December 31, 1994.



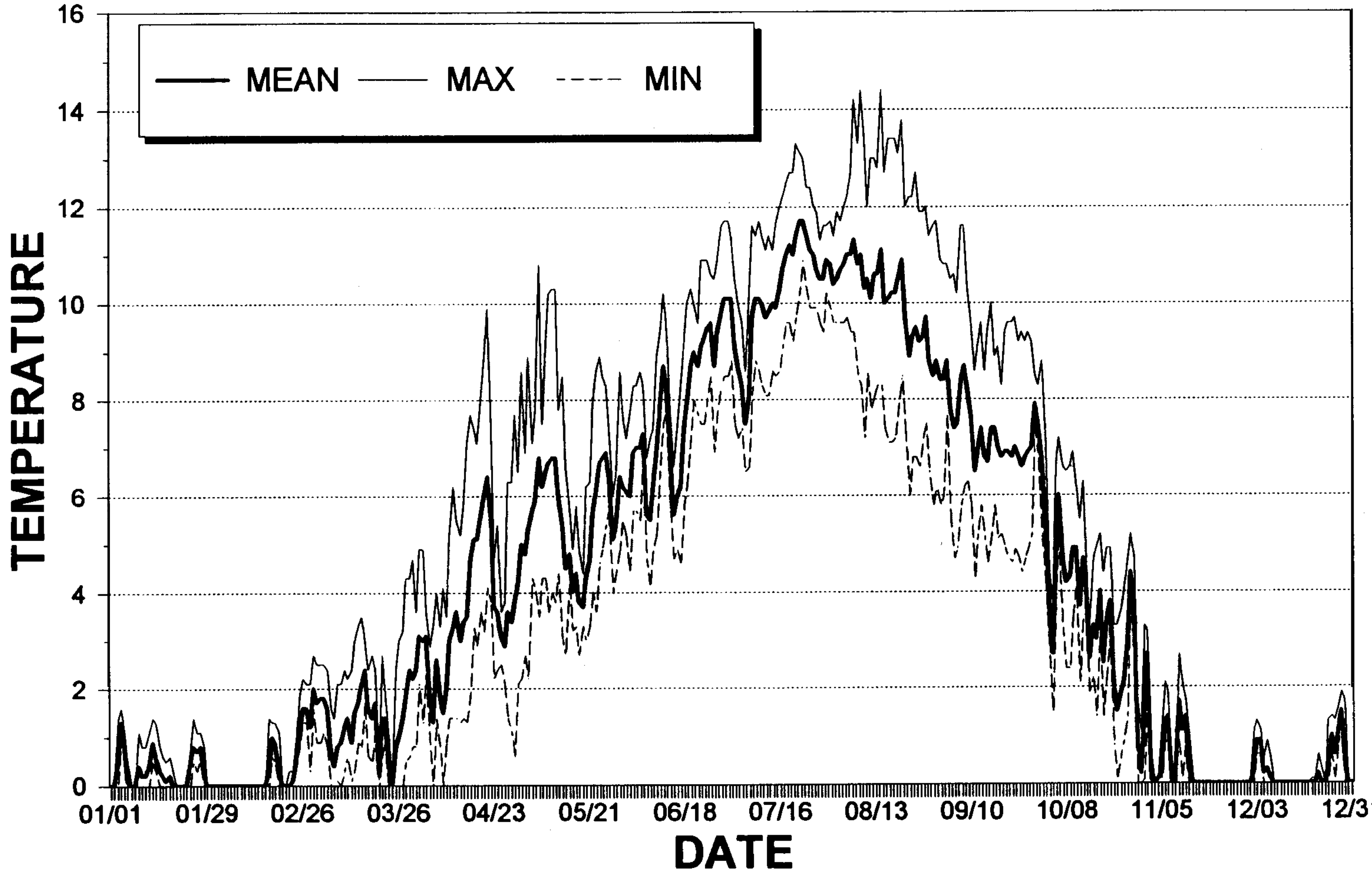
Appendix 7. Daily mean, maximum, and minimum water temperatures (°C) in the East Fork Salmon River near Fisher Creek from October 19 to December 31, 1994.



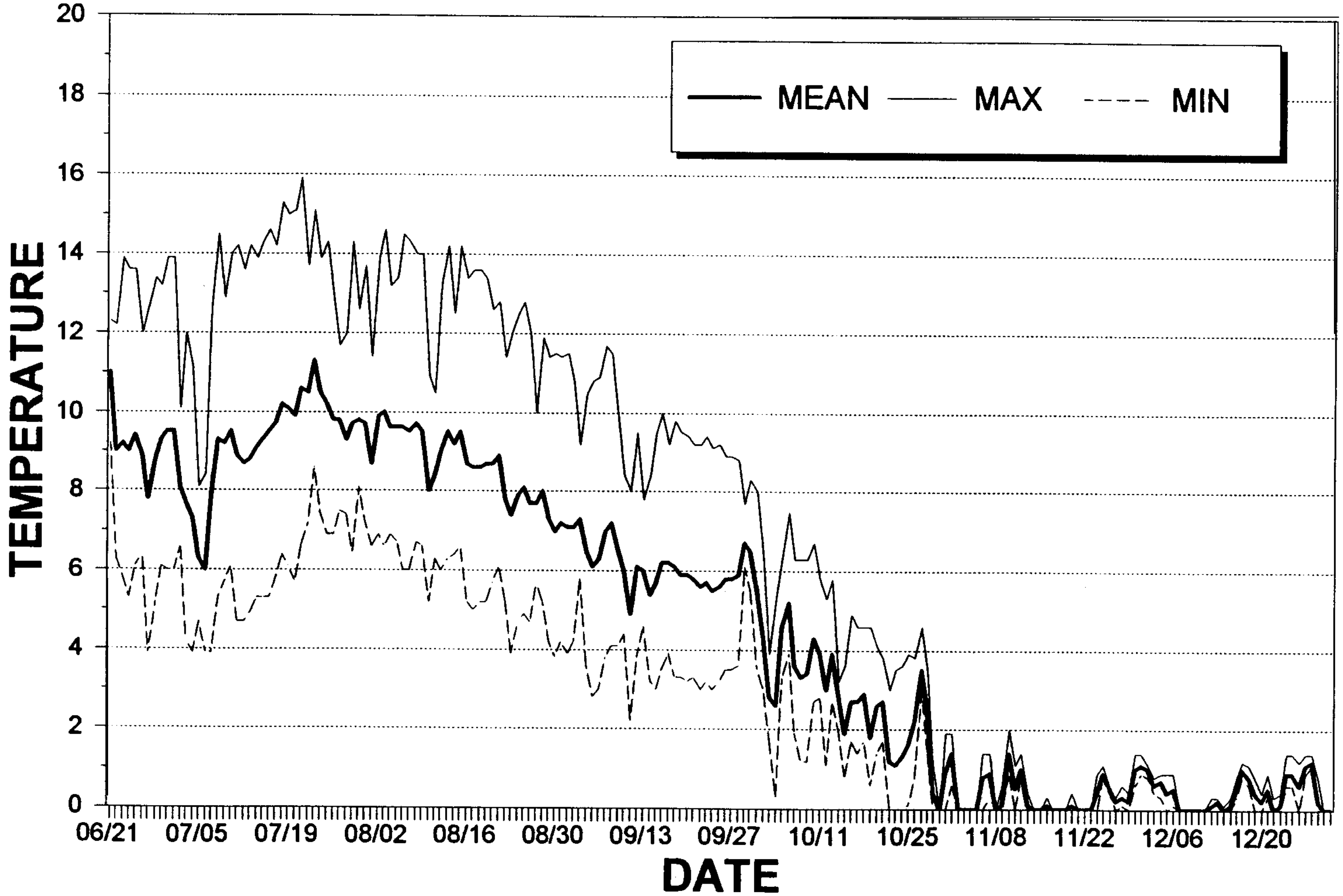
Appendix 8. Daily mean, maximum, and minimum water temperatures (°C) in the East Fork Salmon River upstream of Bowery Hot Springs from January 1 to December 31, 1994.



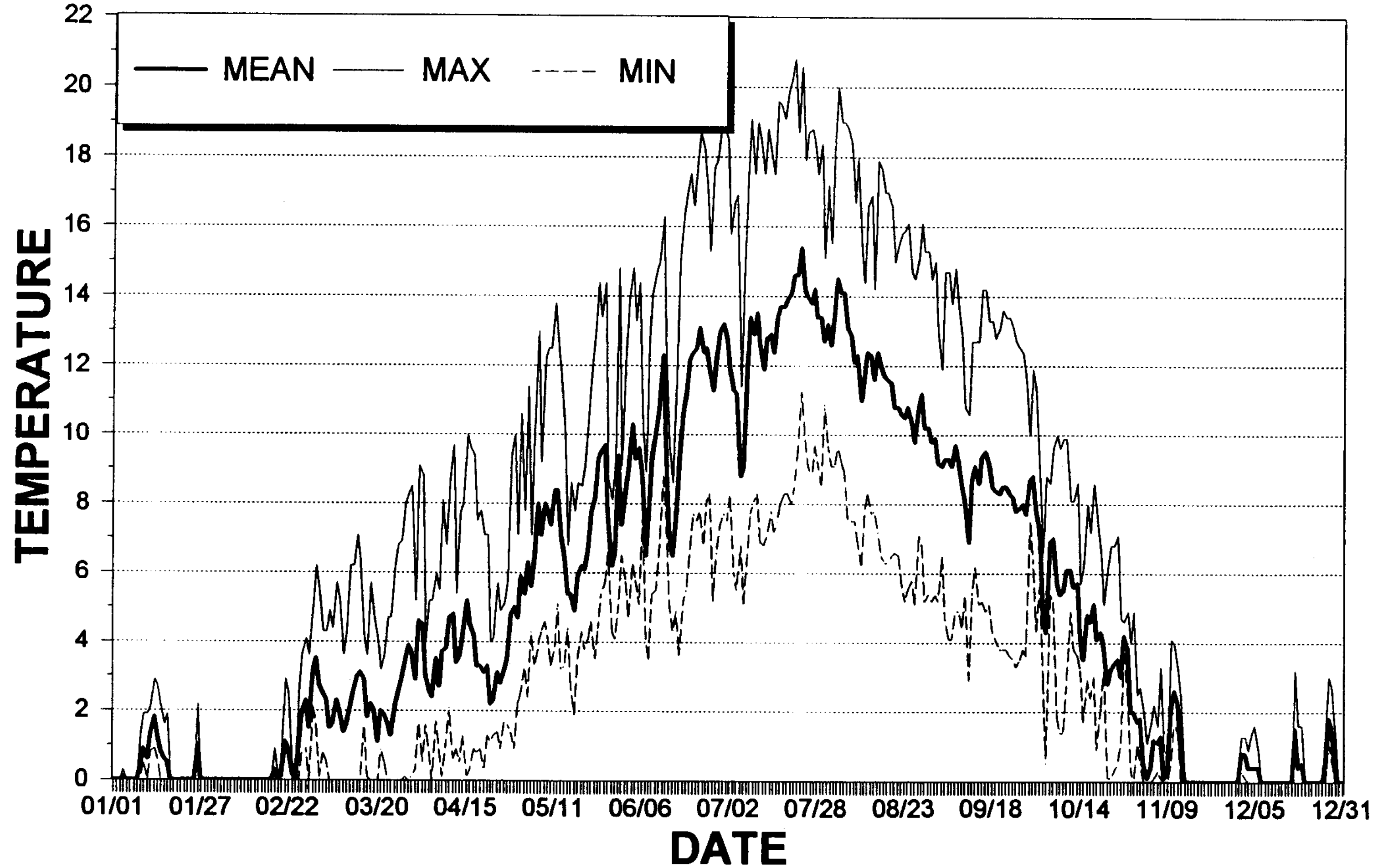
Appendix 9. Daily mean, maximum, and minimum water temperatures (°C) in Frenchman Creek from January 1 to December 31, 1994.



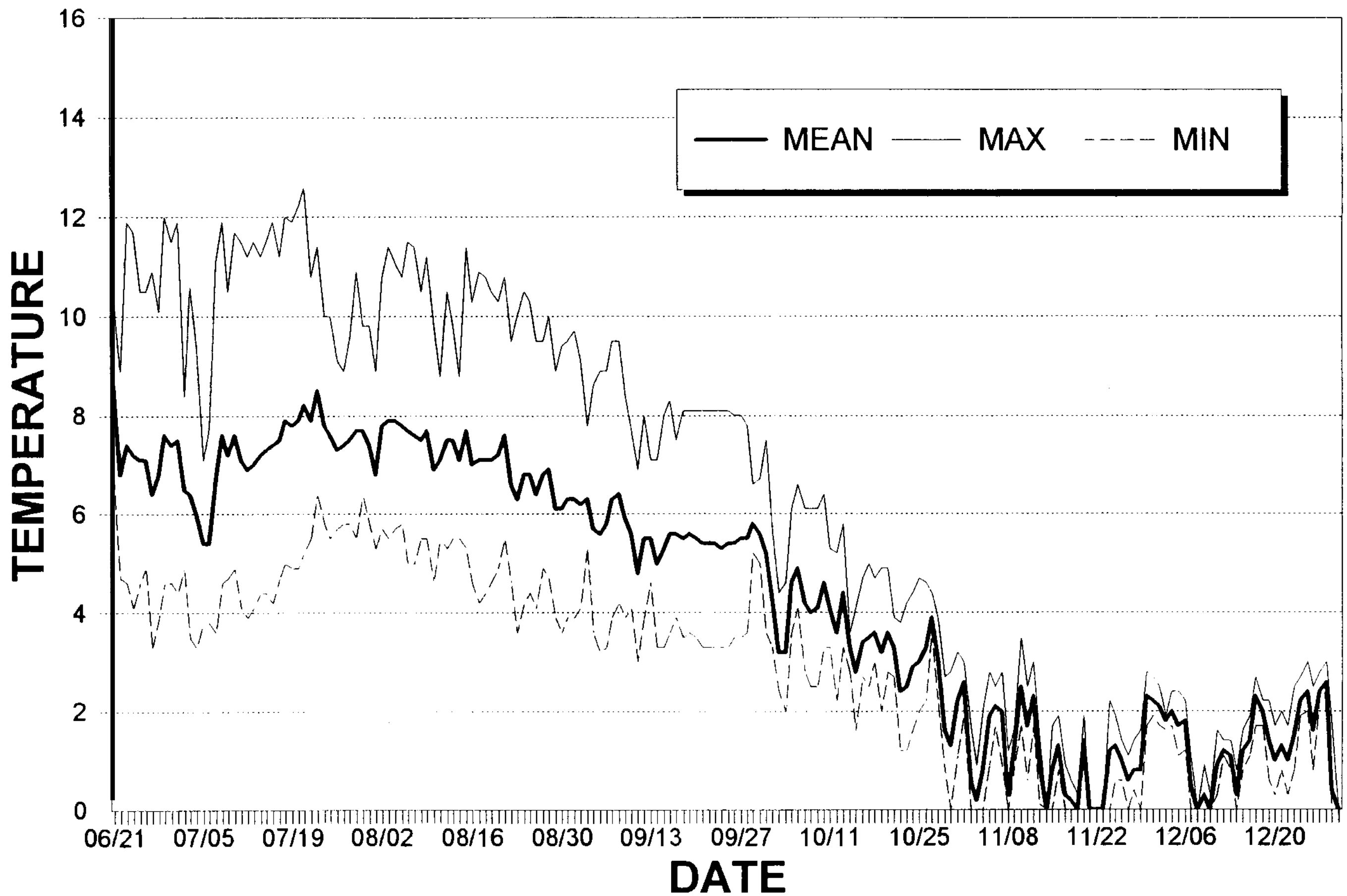
Appendix 10. Daily mean, maximum, and minimum water temperatures (°C) in Germania Creek from January 1 to December 31, 1994.



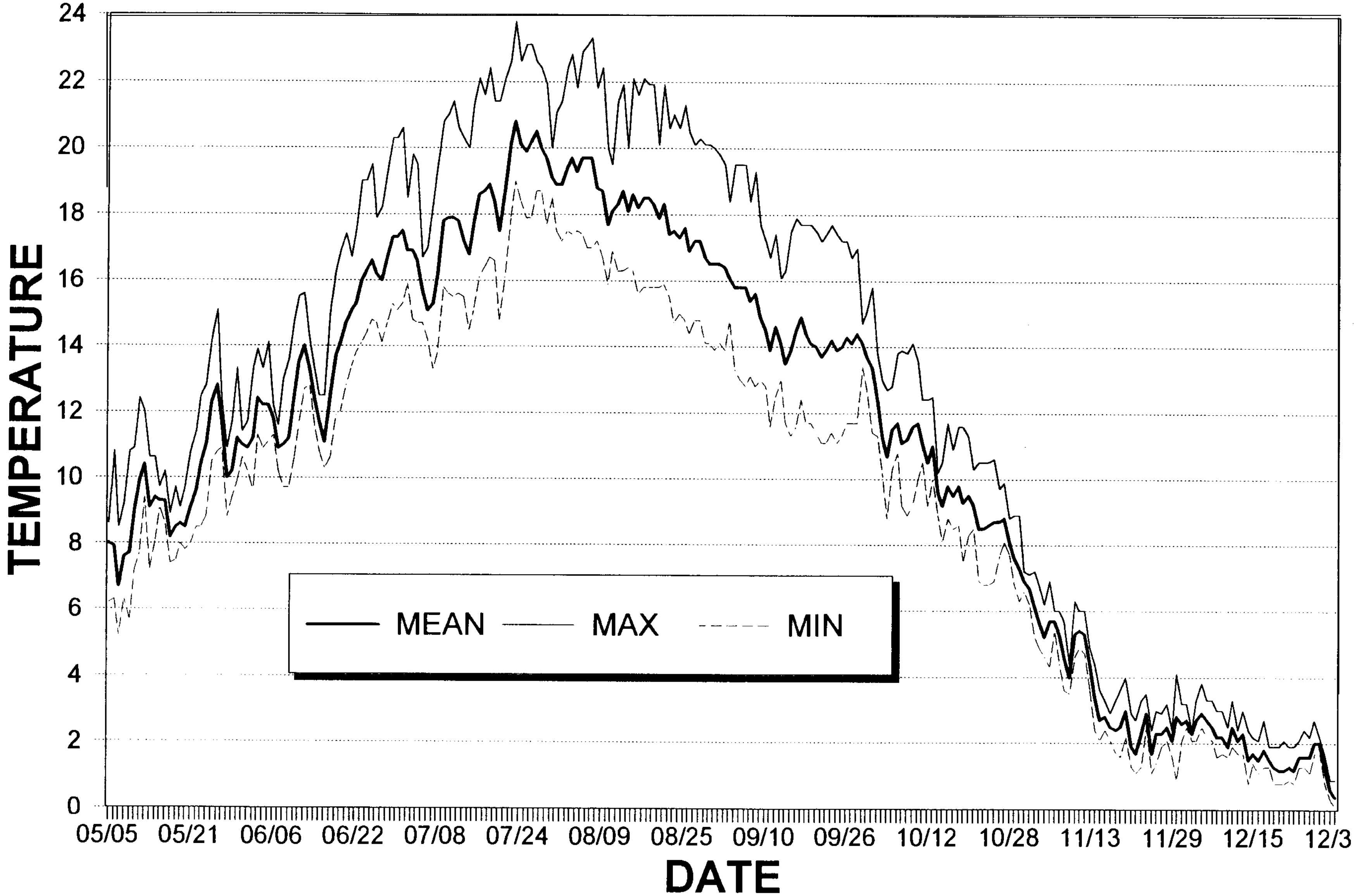
Appendix 11. Daily mean, maximum, and minimum water temperatures (°C) in Fourth of July Creek from June 21 to December 31, 1994.



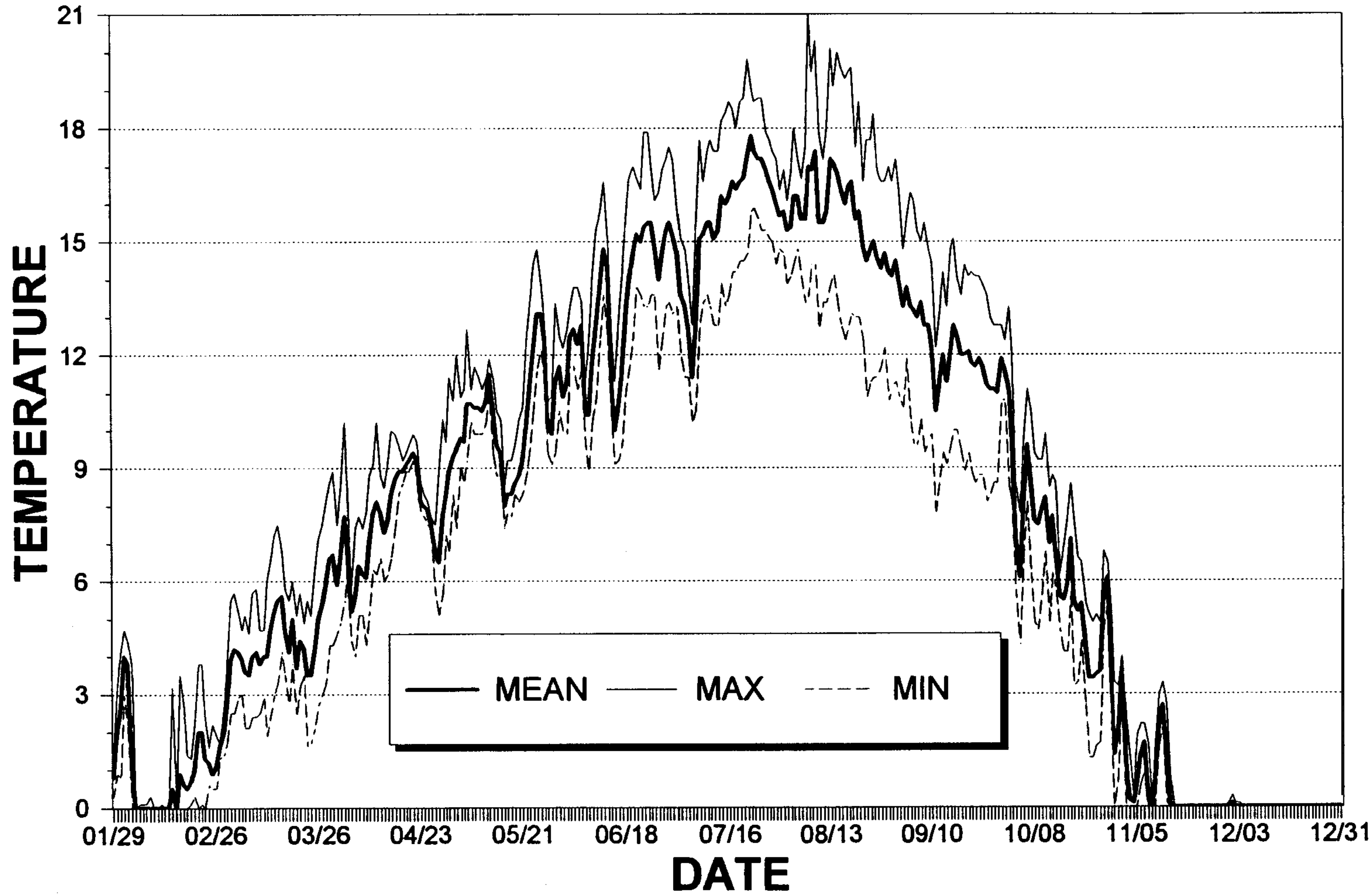
Appendix 12. Daily mean, maximum, and minimum water temperatures (°C) in Marsh Creek from January 1 to December 31, 1994.



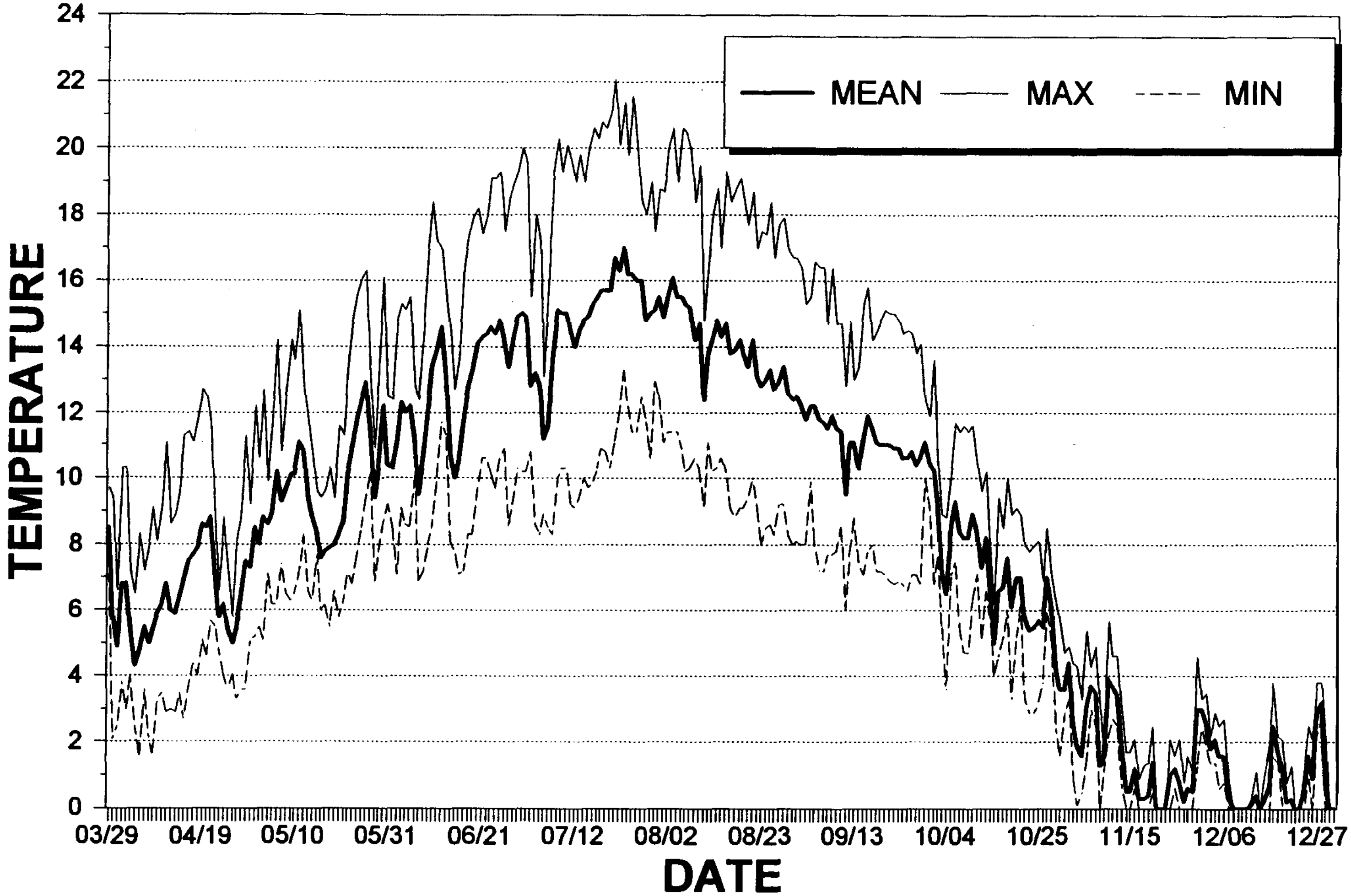
Appendix 13. Daily mean, maximum, and minimum water temperatures (°C) in Pole Creek from June 21 to December 31, 1994.



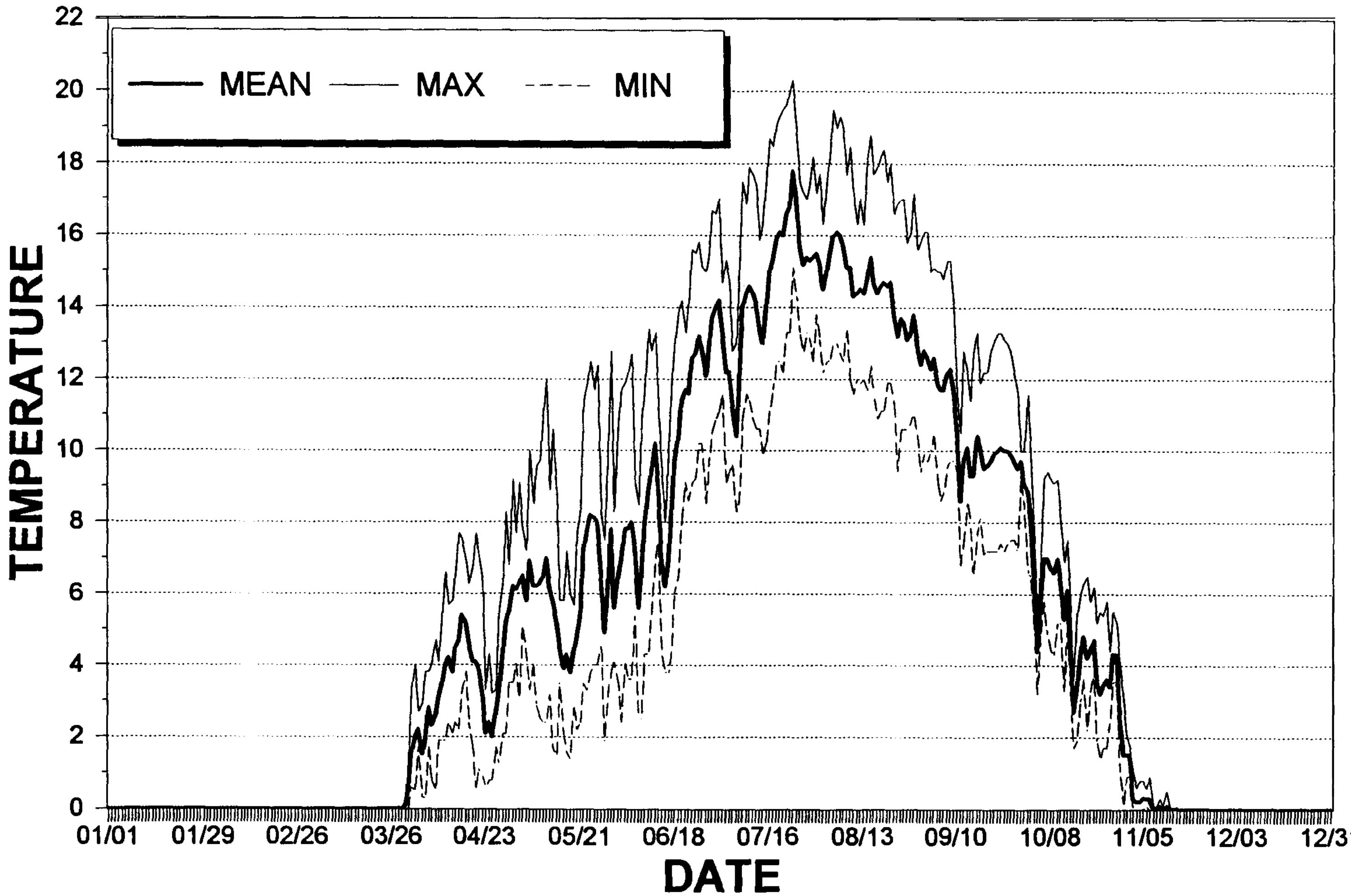
Appendix 14. Daily mean, maximum, and minimum water temperatures (°C) in Redfish Lake Creek from May 5 to December 31, 1994.



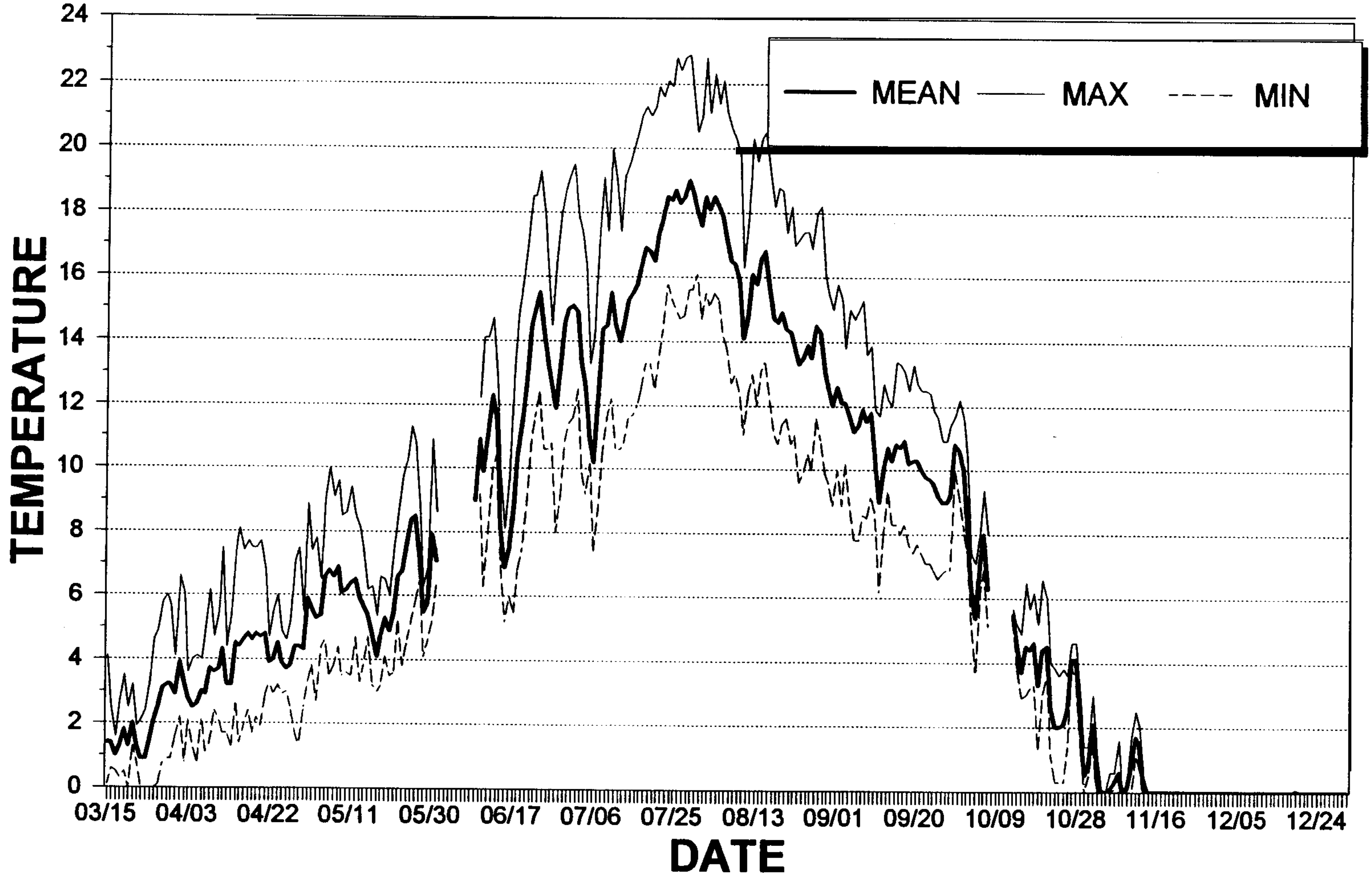
Appendix 15. Daily mean, maximum, and minimum water temperatures (°C) in the Salmon River, just upstream from the East Fork Salmon River, from January 29 to December 31, 1994.



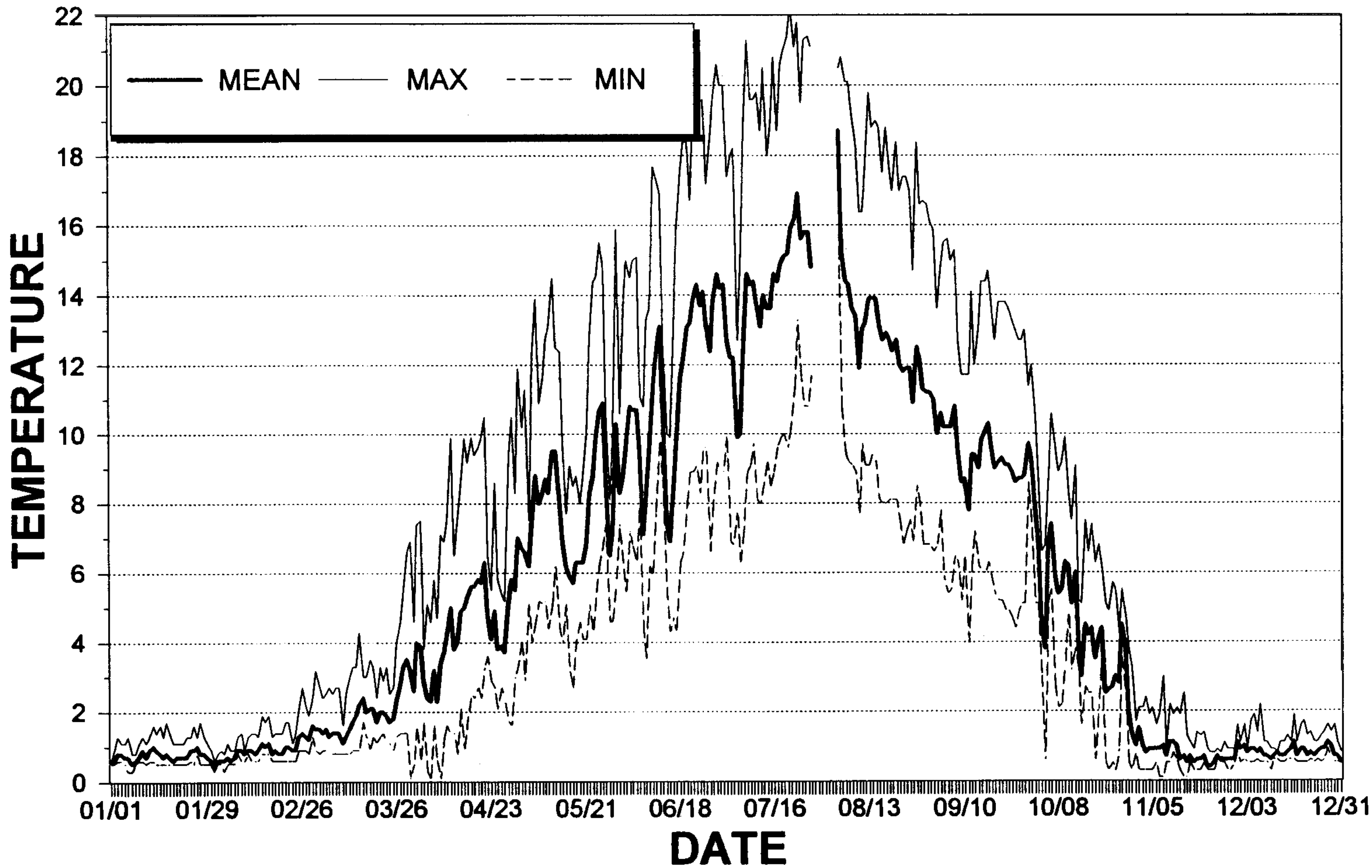
Appendix 16. Daily mean, maximum, and minimum water temperatures (°C) in the Salmon River at Sawtooth Hatchery from March 29 to December 31, 1994.



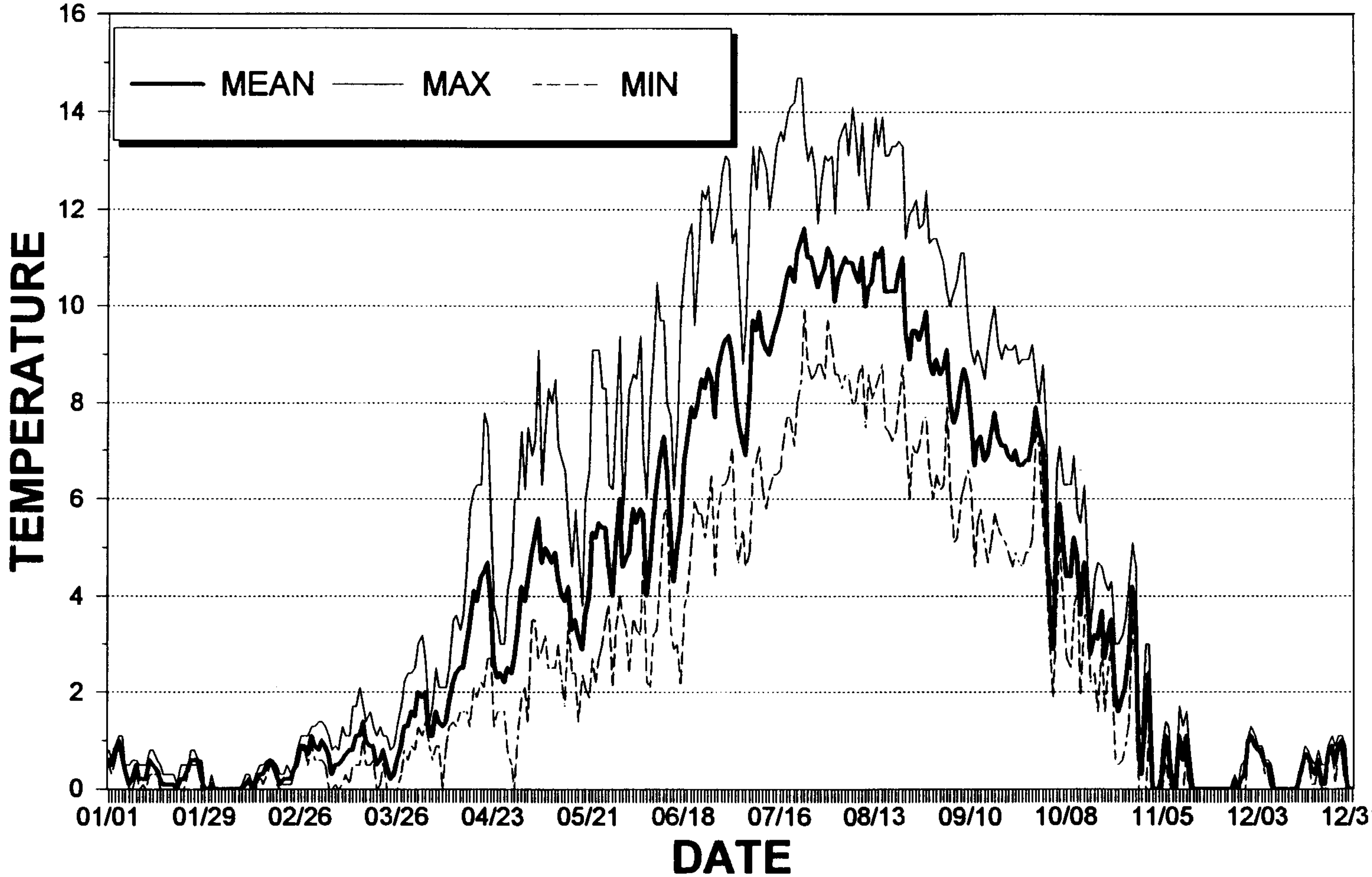
Appendix 17. Daily mean, maximum, and minimum water temperatures (°C) in Smiley Creek from January 1 to December 31, 1994.



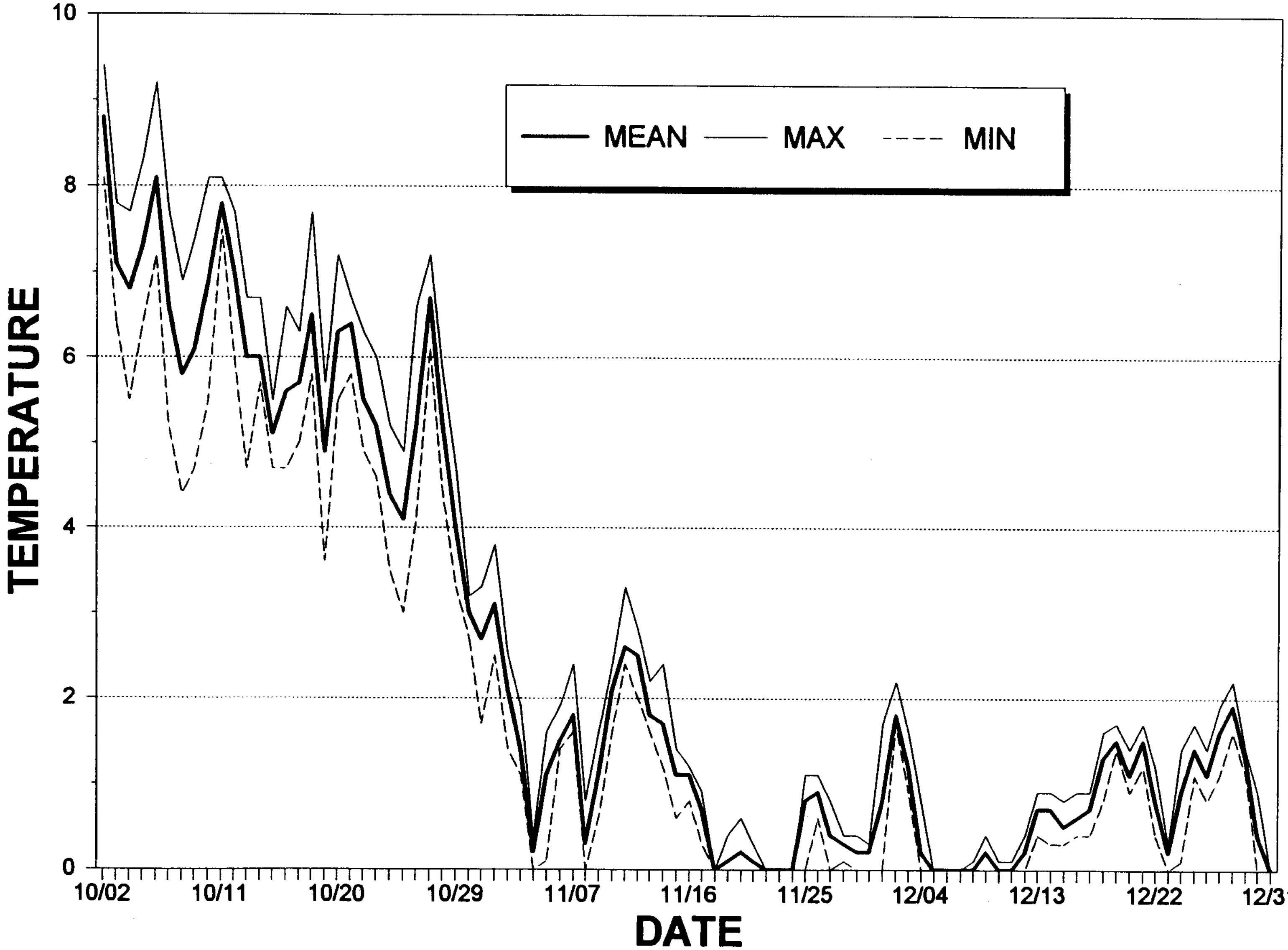
Appendix 18. Daily mean, maximum, and minimum water temperatures (°C) in the South Fork Salmon River at the hatchery weir from March 15 to December 31, 1994.



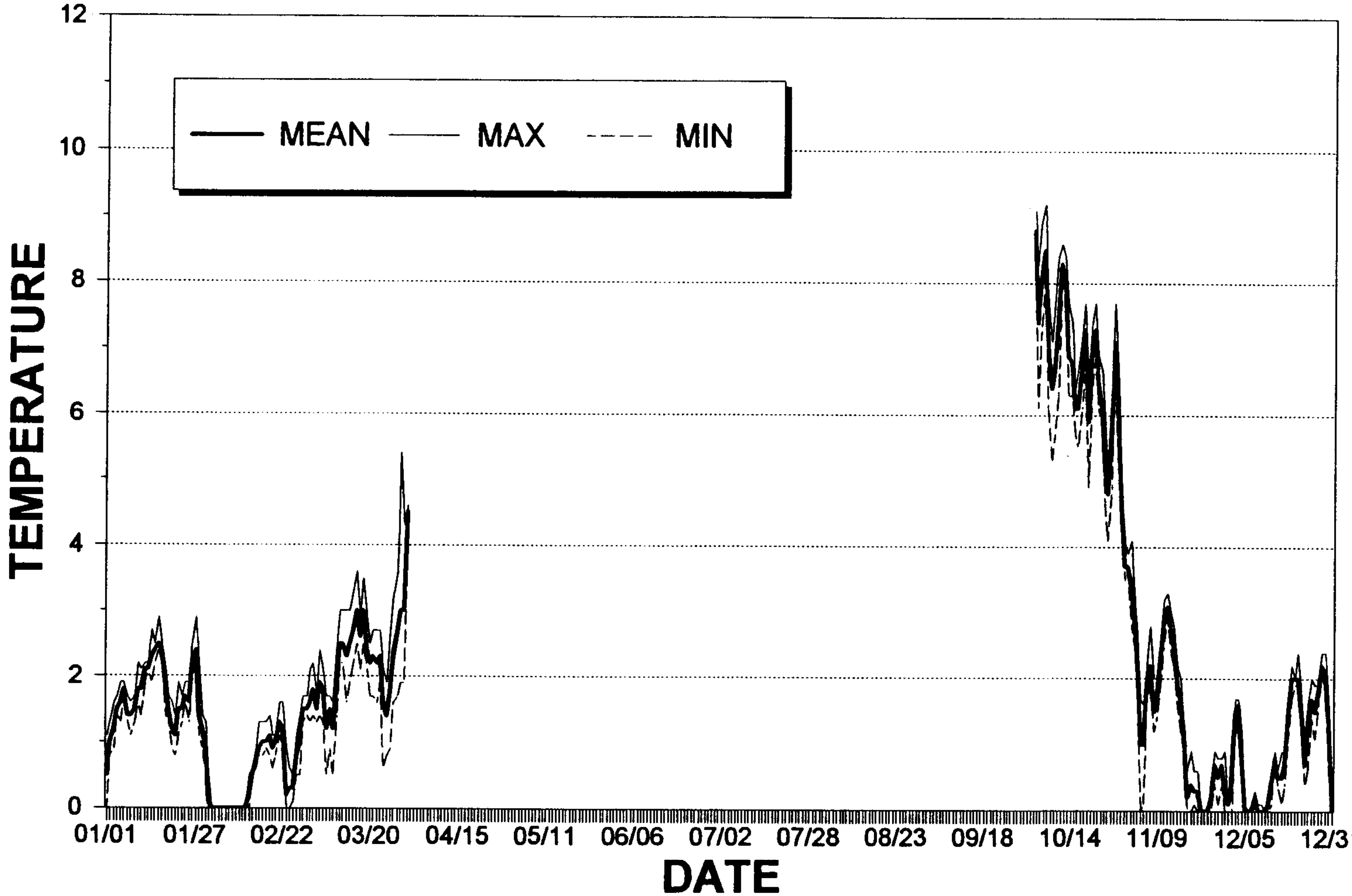
Appendix 19. Daily mean, maximum, and minimum water temperatures (°C) in Valley Creek from January 1 to December 31, 1994.



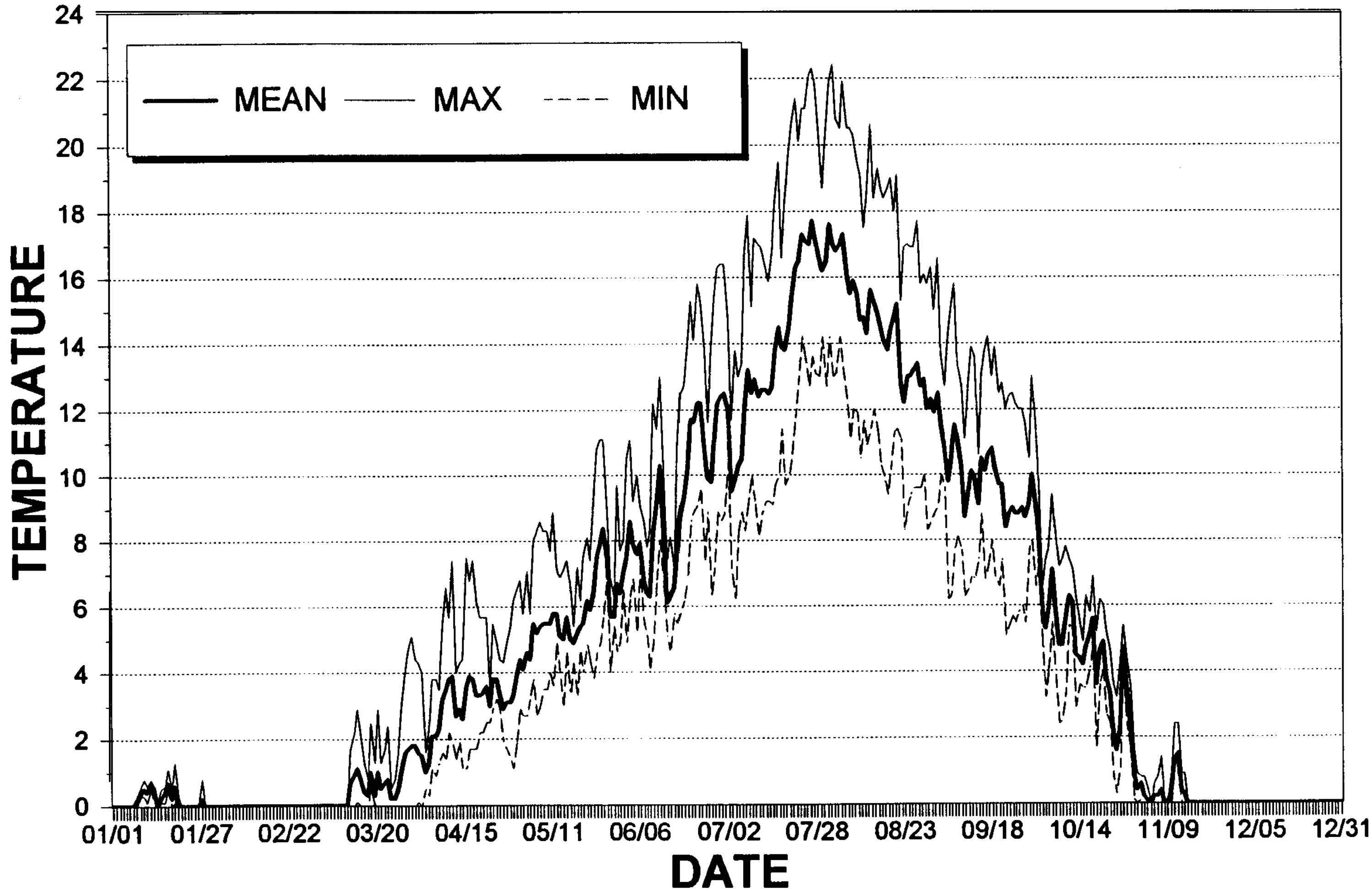
Appendix 20. Daily mean, maximum, and minimum water temperatures (°C) in West Pass Creek from January 1 to December 31, 1994.



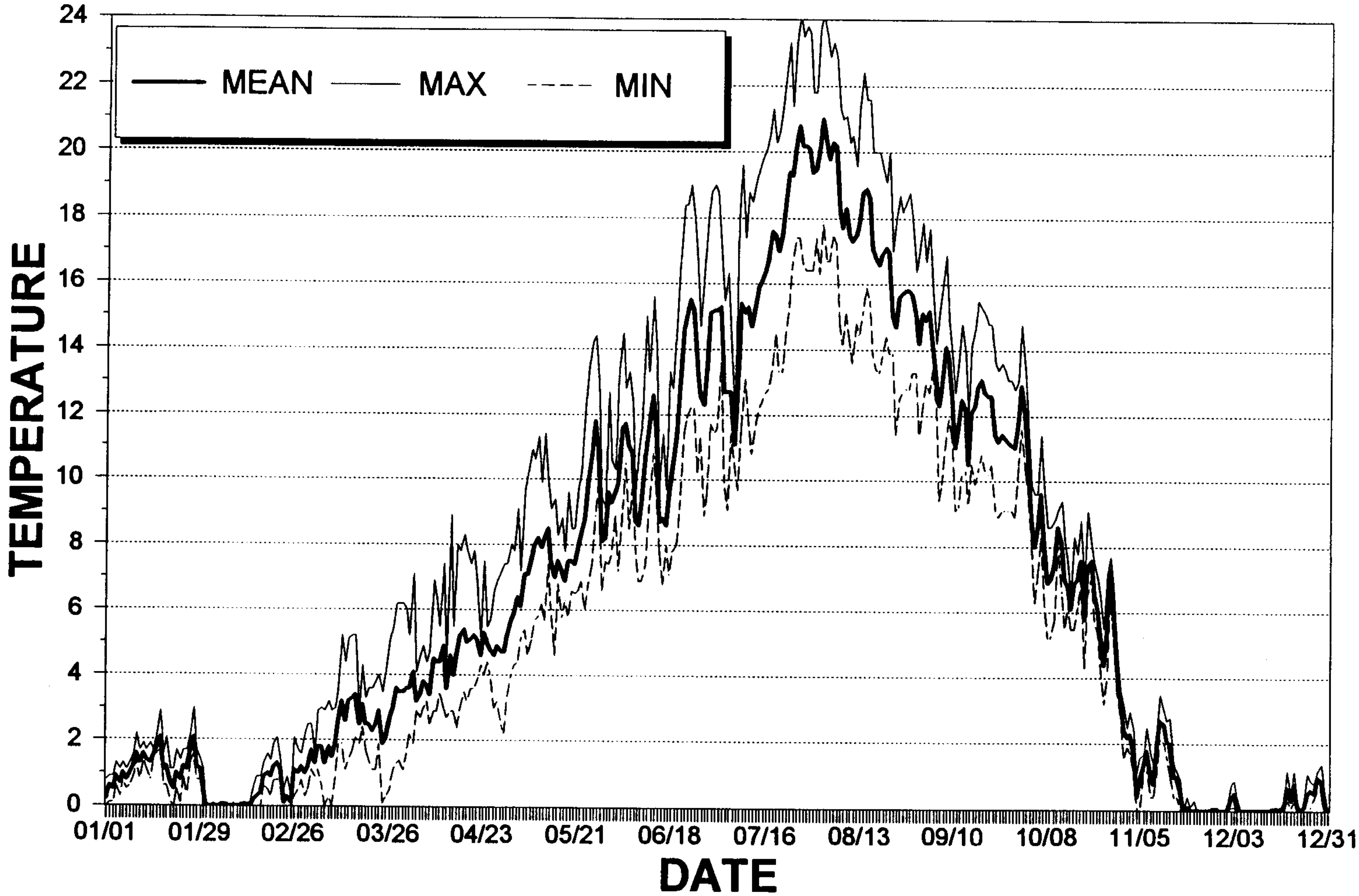
Appendix 21. Daily mean, maximum, and minimum water temperatures (°C) in Bald Mountain Creek from October 2 to December 31, 1994.



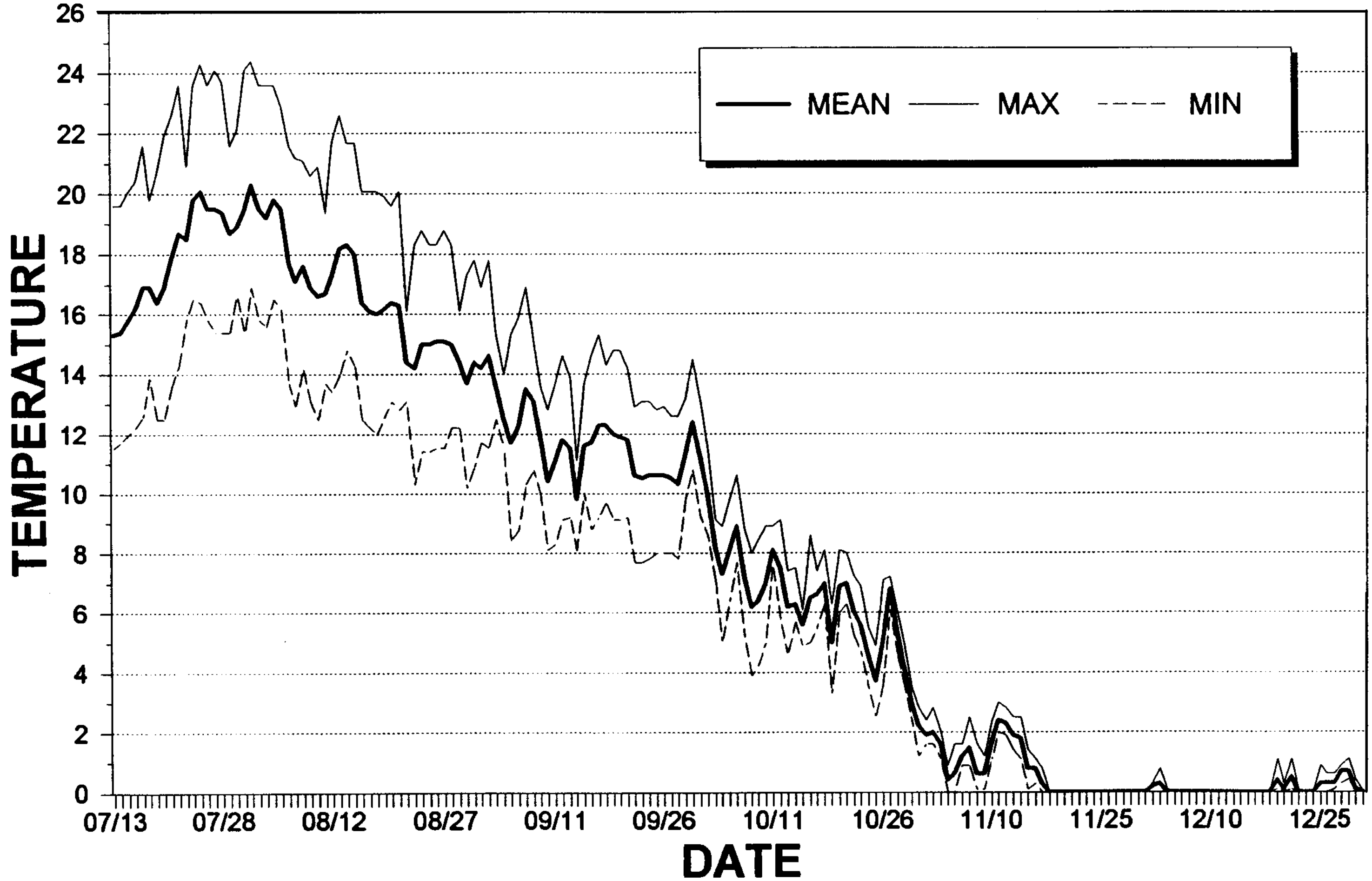
Appendix 22. Daily mean, maximum, and minimum water temperatures (°C) in Canyon Creek from January 1 to December 31, 1994.



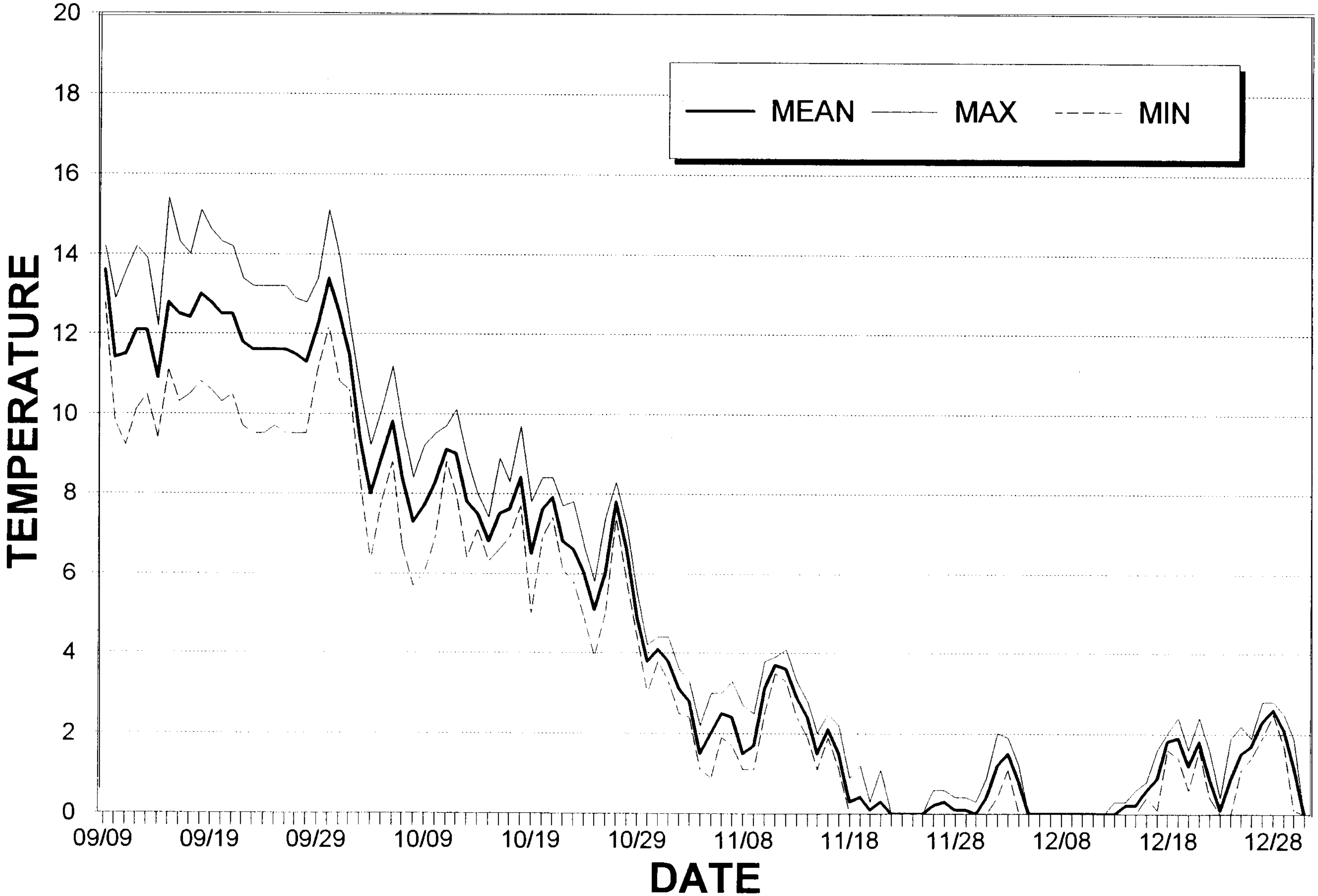
Appendix 23. Daily mean, maximum, and minimum water temperatures (°C) in Crooked Fork Creek from January 1 to December 31, 1994.



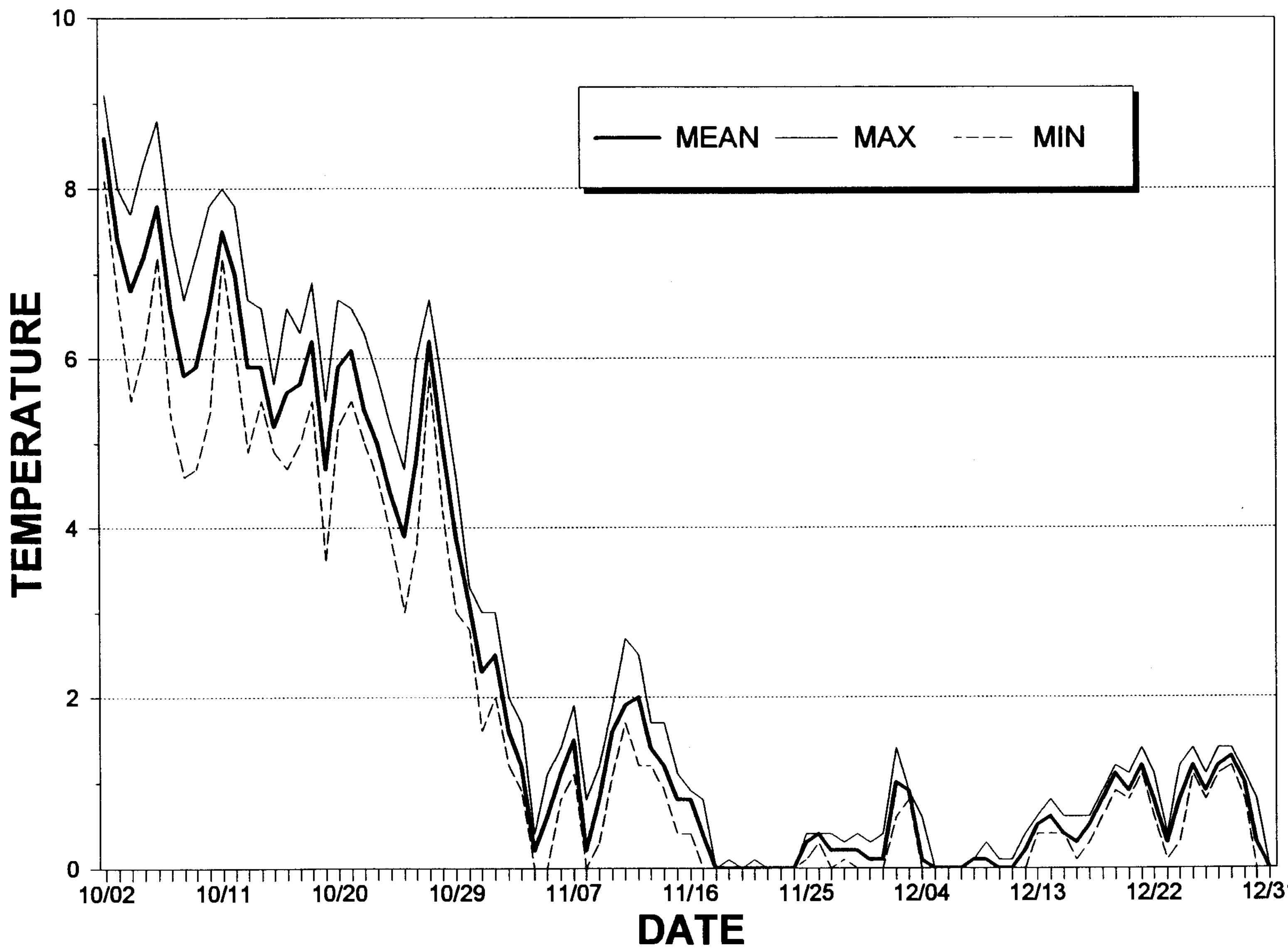
Appendix 24. Daily mean, maximum, and minimum water temperatures (°C) in Fish Creek, about 1 km upstream of its mouth, from January 1 to December 31, 1994.



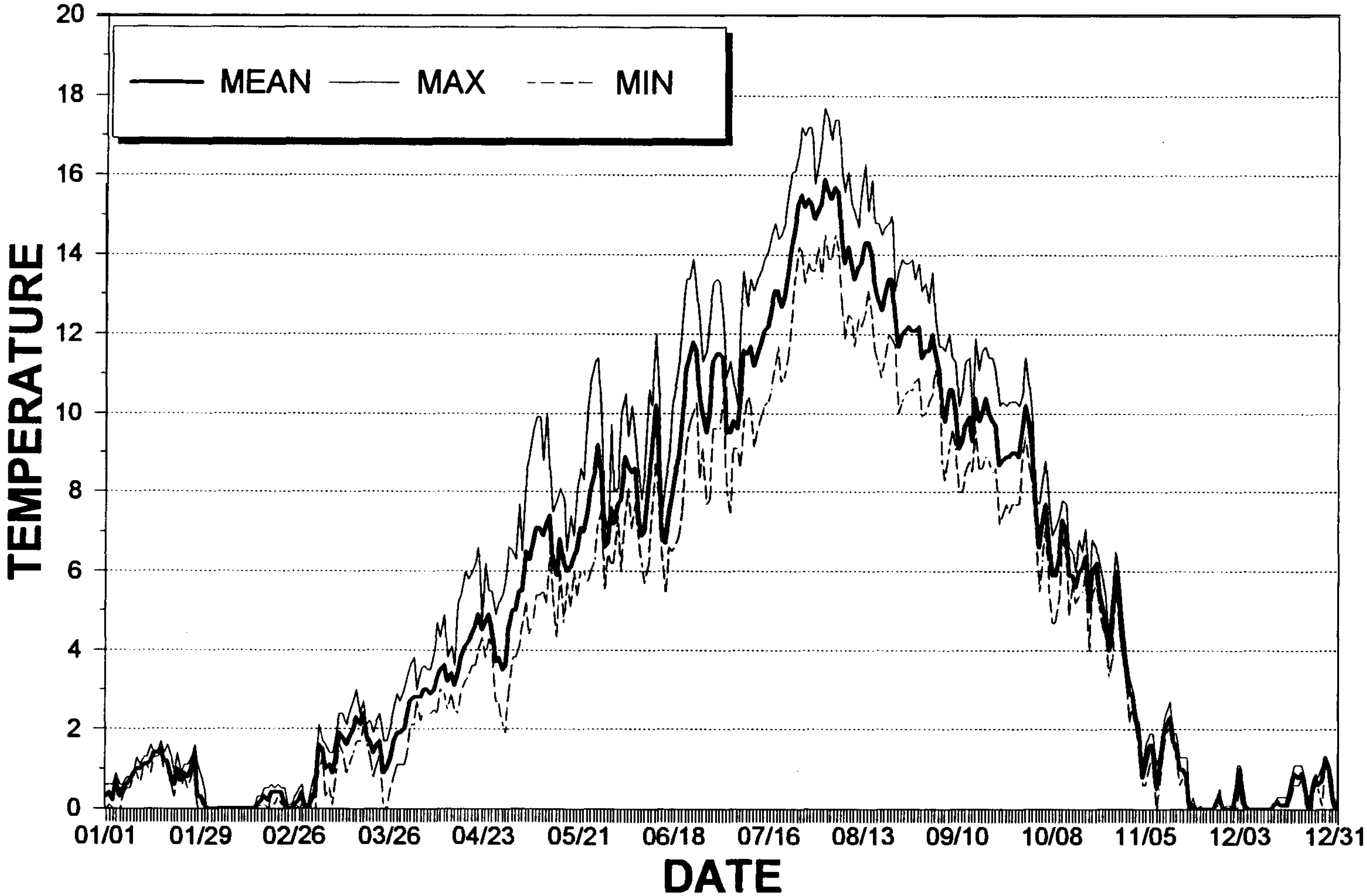
Appendix 25. Daily mean, maximum, and minimum water temperatures (°C) in Fish Creek, just upstream of Pagoda Creek, from July 13 to December 31, 1994.



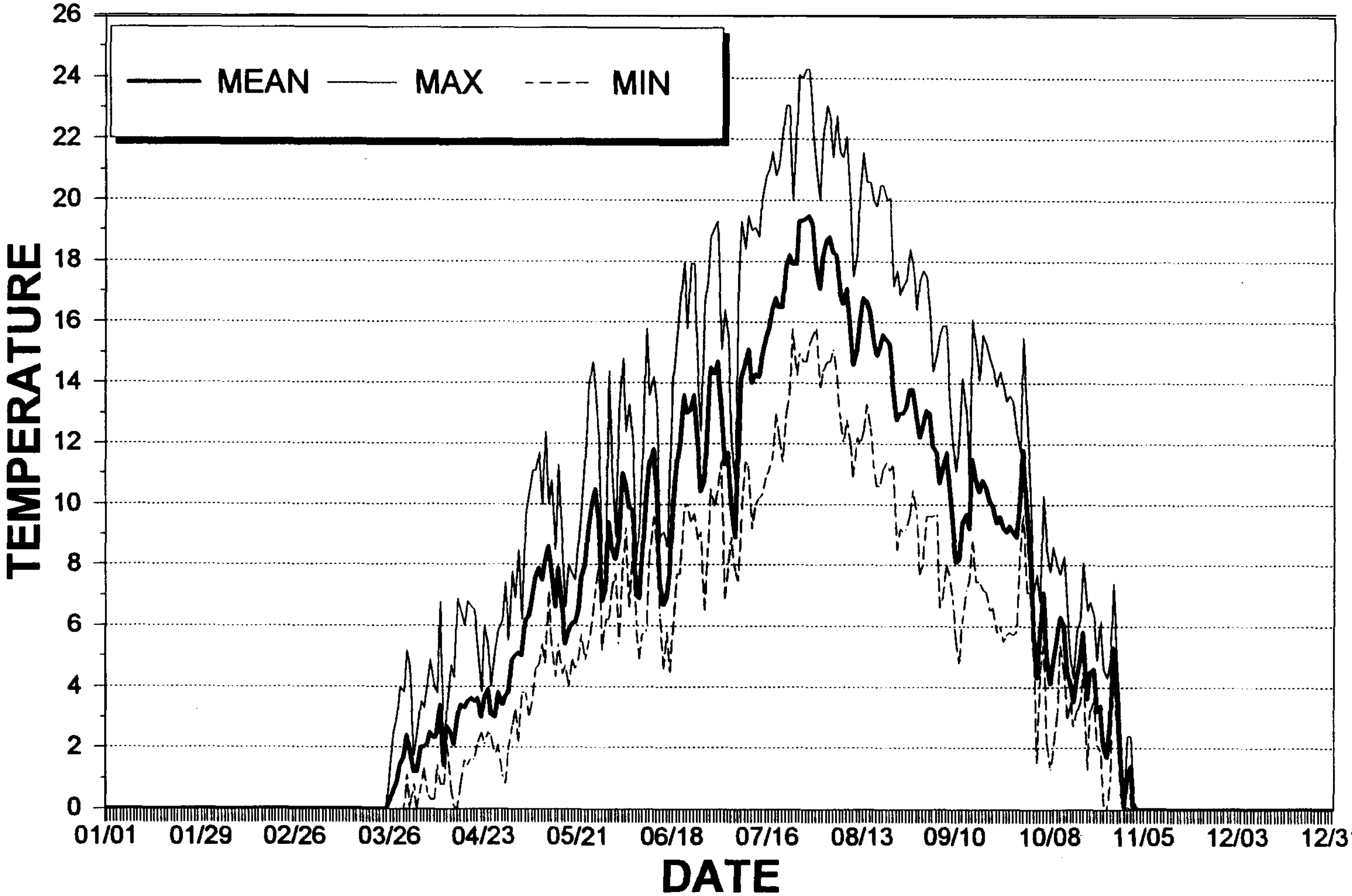
Appendix 26. Daily mean, maximum, and minimum water temperatures (°C) in Gedney Creek from September 9 to December 31, 1994.



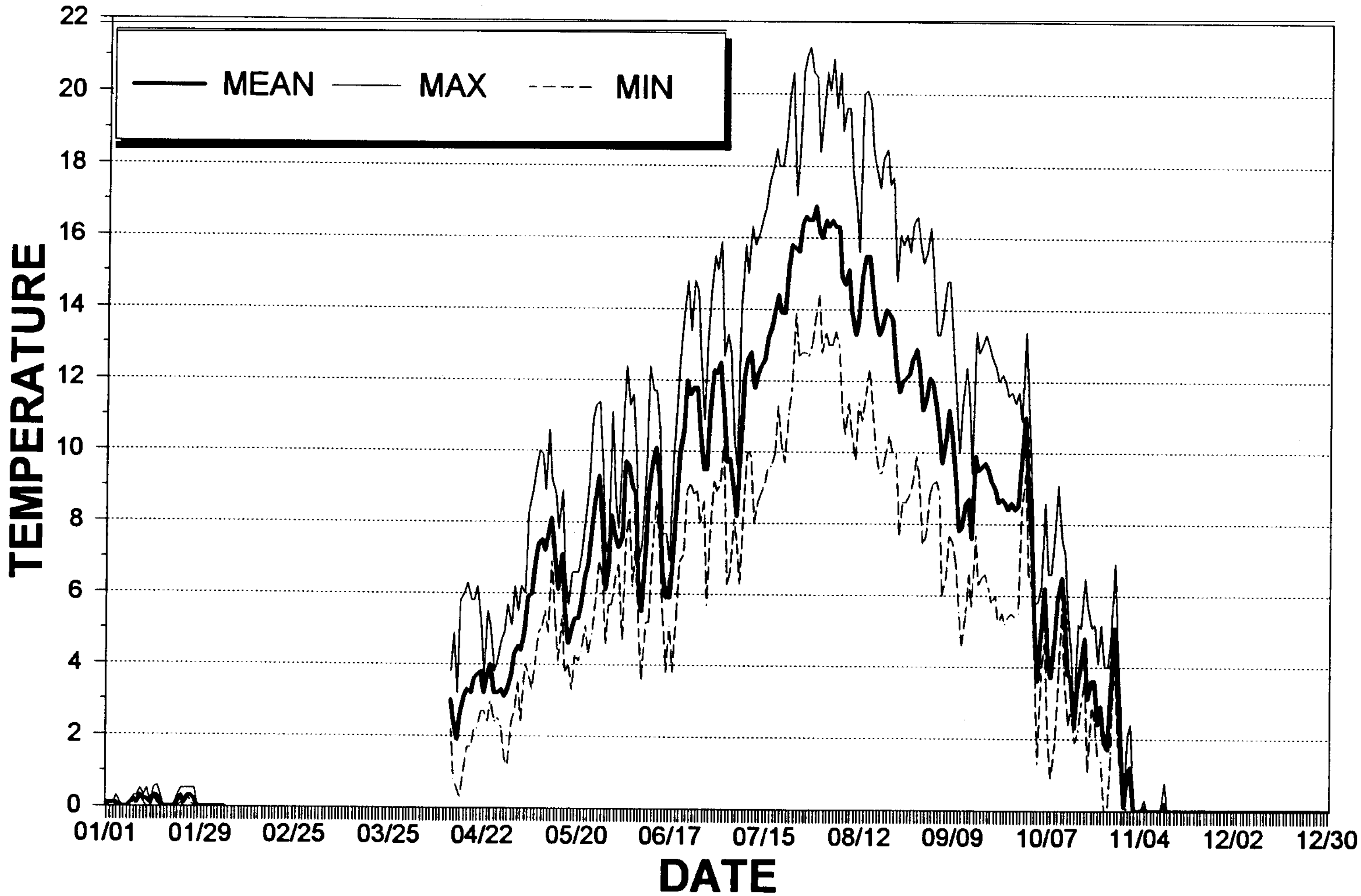
Appendix 27. Daily mean, maximum, and minimum water temperatures (°C) in Lost Creek from October 2 to December 31, 1994.



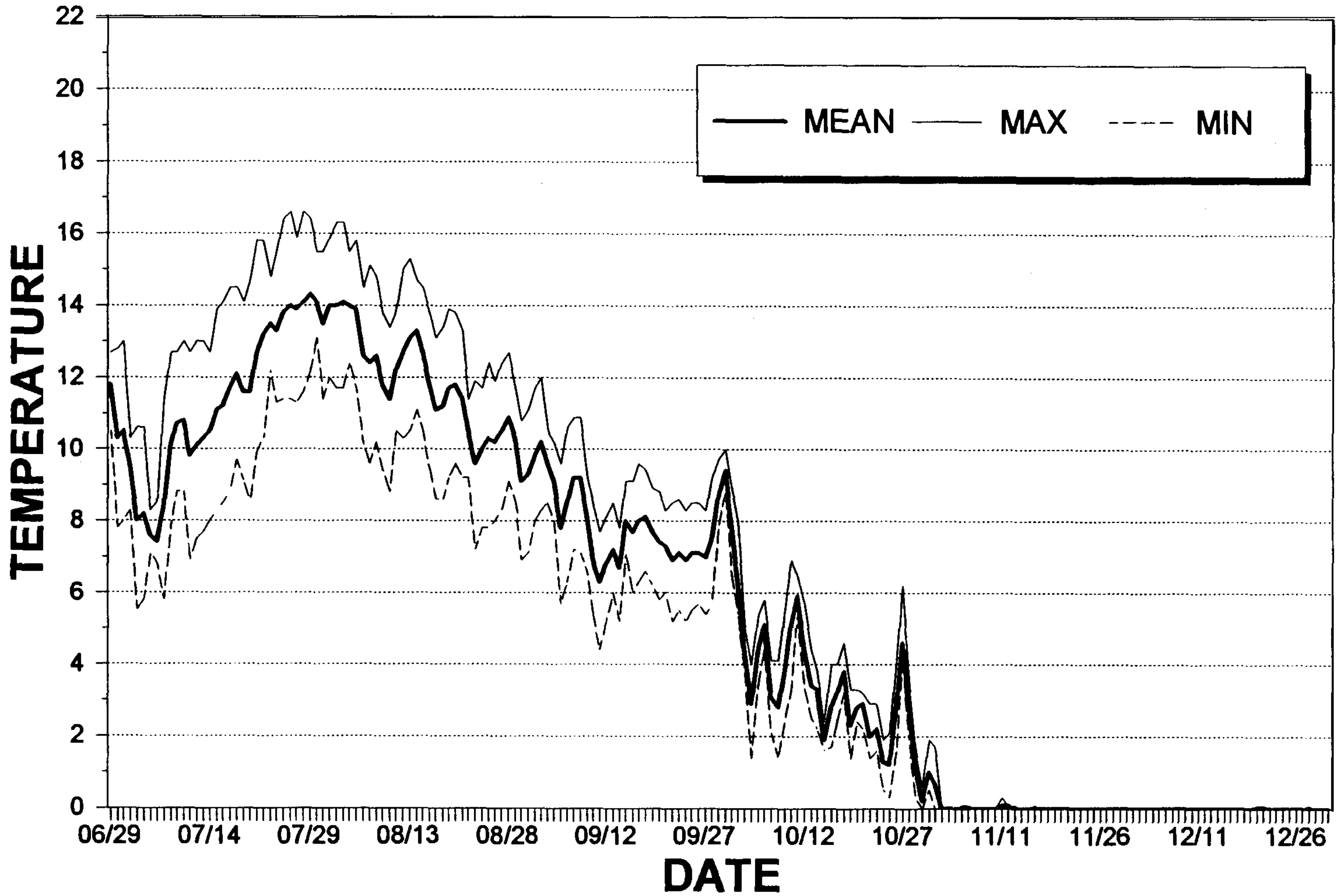
Appendix 28. Daily mean, maximum, and minimum water temperatures (°C) in Post Office Creek from January 1 to December 31, 1994.



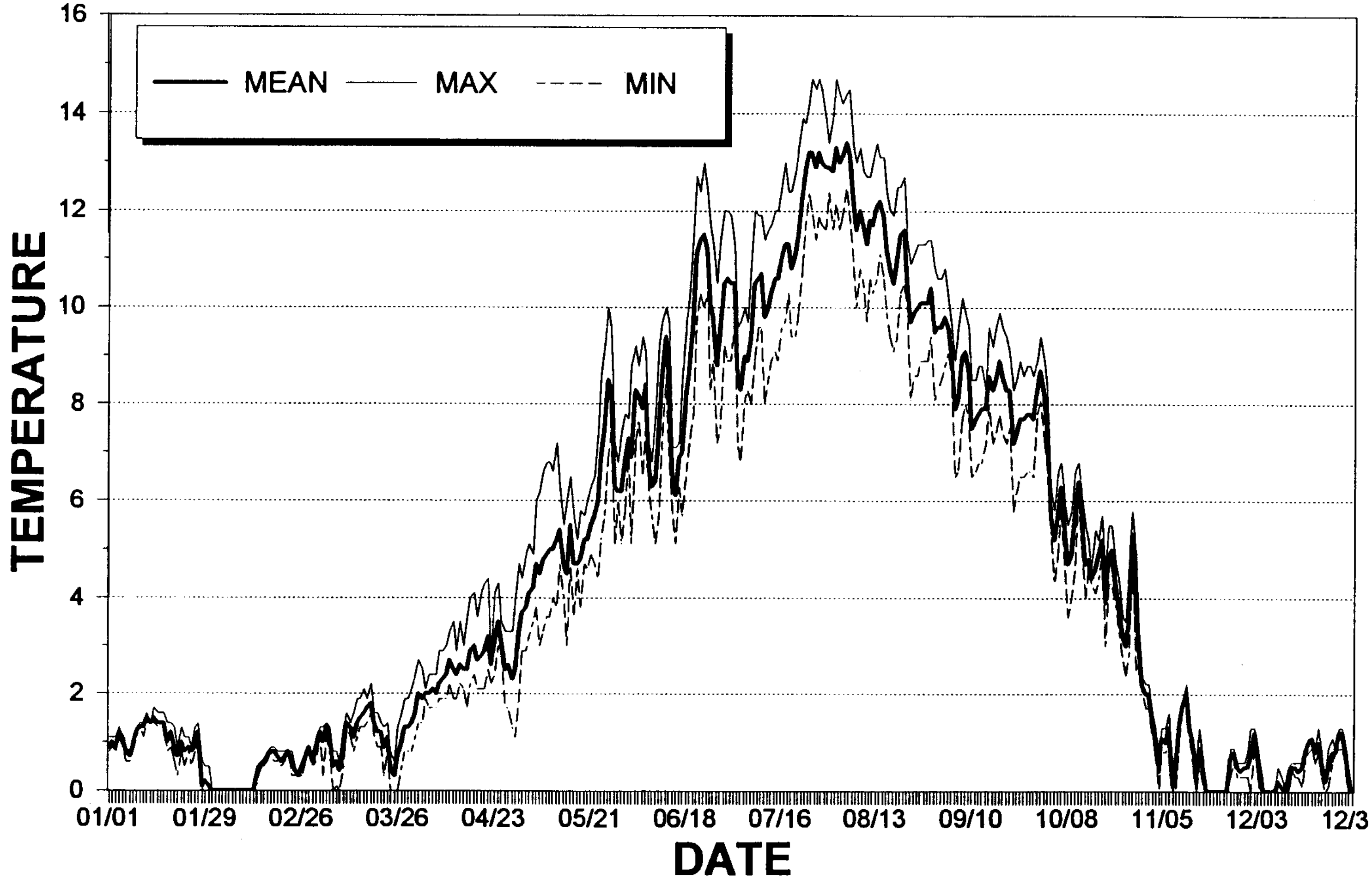
Appendix 29. Daily mean, maximum, and minimum water temperatures (°C) in Red River from January 1 to December 31, 1994.



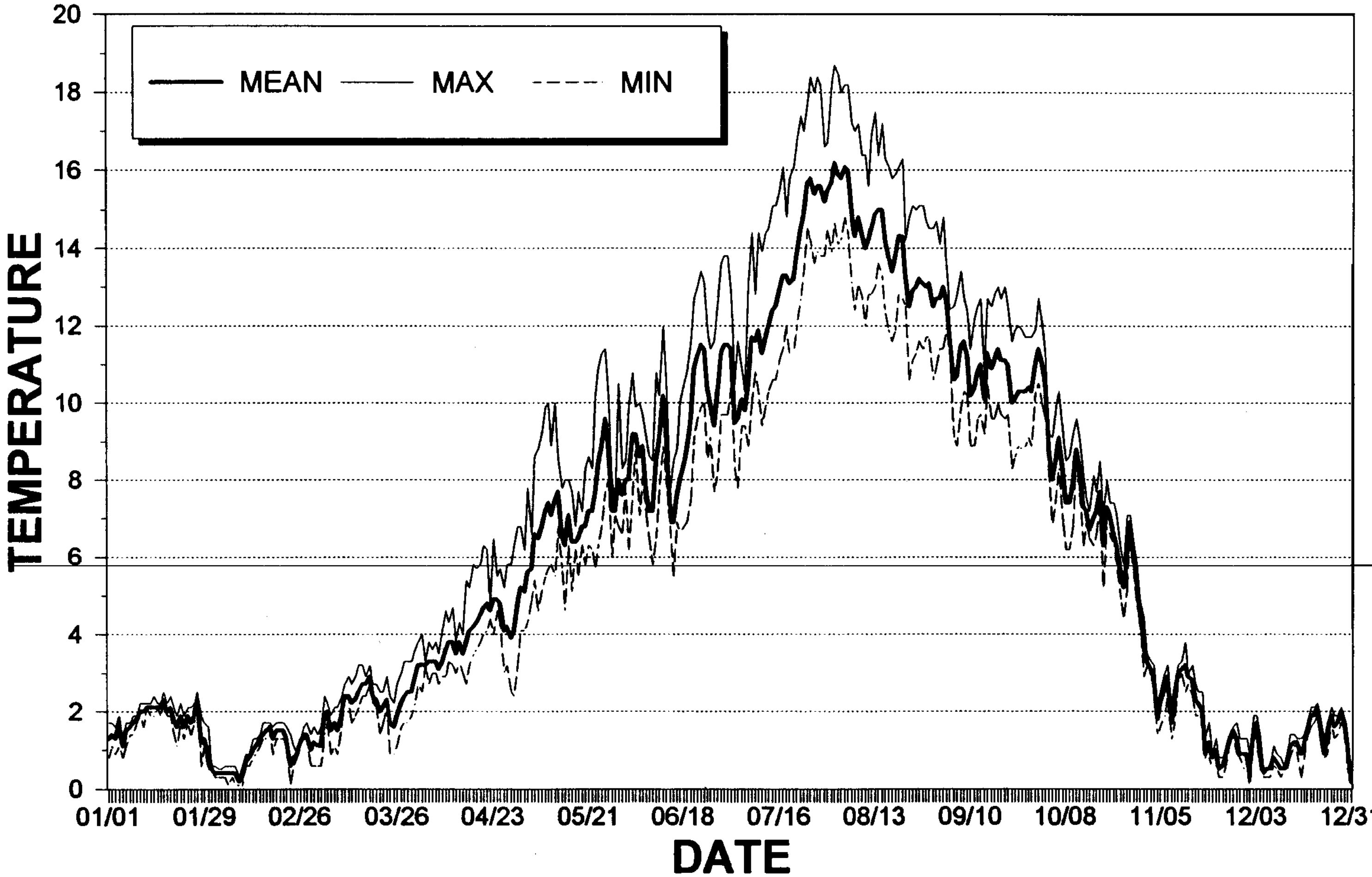
Appendix 30. Daily mean, maximum, and minimum water temperatures (°C) in the South Fork Red River from January 1 to December 31, 1994.



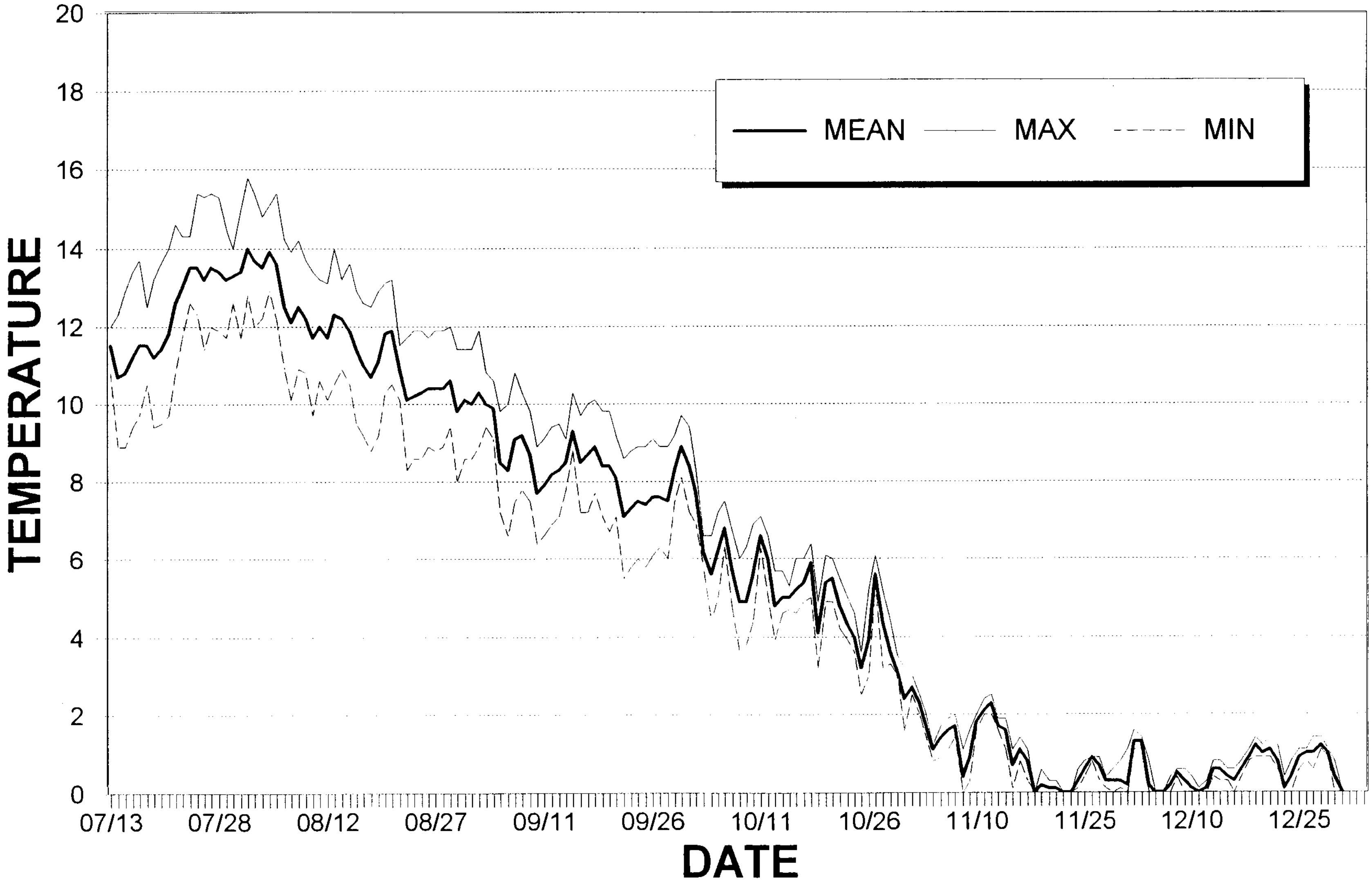
Appendix 31. Daily mean, maximum, and minimum water temperatures (°C) in Trapper Creek from June 29 to December 31, 1994.



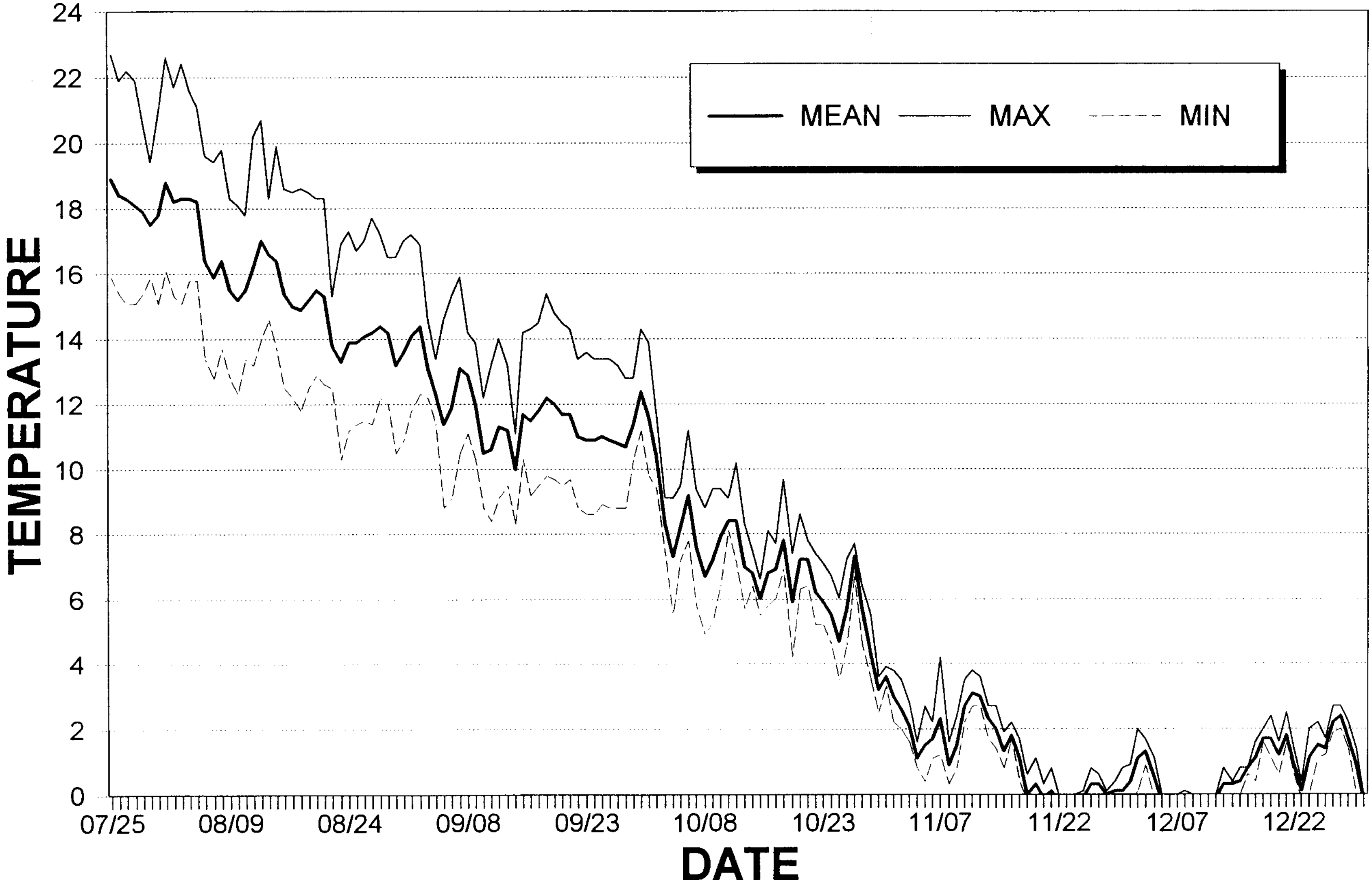
Appendix 32. Daily mean, maximum, and minimum water temperatures (°C) in Walton Creek from January 1 to December 31, 1994.



Appendix 33. Daily mean, maximum, and minimum water temperatures (°C) in Weir Creek from January 1 to December 31, 1994.



Appendix 34. Daily mean, maximum, and minimum water temperatures (°C) in Wendover Creek from July 13 to December 31, 1994.



Appendix 35. Daily mean, maximum, and minimum water temperatures (°C) in West Fork Gedney Creek from July 25 to December 31, 1994.

Submitted by:

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Approved by:

IDAHO DEPARTMENT OF FISH AND GAME

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