SECTION D
RIPARIAN FUNCTION

INTRODUCTION

Mendocino Redwood Company conducted an assessment of riparian function in the Big River Watershed Analysis Unit (WAU) during the summer of 2000. This assessment is divided into two groups: 1) the potential of the riparian stand to recruit large woody debris (LWD) to the stream channel and 2) a canopy closure and stream temperature assessment. The LWD potential assessment evaluates short-term (the next 2-3 decades) LWD recruitment. It shows the current condition of the riparian stands for generating LWD for stream habitat or stream channel stability. Field observations of current LWD levels in the stream channels and the riparian stand's ability to recruit LWD are presented in relation to channel sensitivity to LWD in order to determine current in-stream needs. The canopy closure and stream temperature assessment presents current canopy closure conditions and results of stream temperature monitoring for the Big River WAU. The goal of these evaluations is to provide baseline information on the current riparian stand functions in the Big River WAU.

Historical Context of Instream Large Woody Debris

Big River had historically been dammed in many places in order to move logs down to the mill in Mendocino during spring freshets. It has been stated that there were more logging dams on Big River than on any other stream in the redwood region (Jackson, 1991). Current evidence suggests 27 permanent type dams were present in the Big River watershed from 1852 to 1938 (Jackson, 1991). Almost all of these were present in what is now under MRC ownership. Although the affect of these on LWD isn't entirely clear, this log-moving technique undoubtedly affected fish habitat.

In the 1980s and 1990s, California Department of Fish and Game contracted various groups to conduct LWD jam removal projects in Russell Brook, Ramon Creek, Daugherty Creek, Halfway House Gulch, Mettick Creek, Tramway Gulch, and East Branch North Fork Big River. The purpose of these projects was to improve fish passage through LWD choked streams. Personal accounts from L-P foresters indicate that these jam removal projects did improve fish passage. They may or may not have negatively affected habitat value in these streams.

LARGE WOODY DERBIS RECRUITMENT POTENTIAL AND INSTREAM DEMAND METHODS

Short-term LWD recruitment potential (next 20-30 years) was evaluated in designated stream segments within the Big River WAU. Stream segments were designated in the stream channel condition assessment and are shown on map E-1 (Stream Channel Condition Module). Generally, stream segments were assessed on any watercourse with less than a 20 percent gradient. In this assessment, vegetation type, size and density is assumed to influence LWD recruitment with the best riparian vegetation being large conifer trees.

To determine the LWD recruitment potential, riparian stands were classified using year 2000 aerial photographs and field observations from the summer of 2000. The riparian stands were evaluated for a distance of approximately one tree height on either side of the watercourse. Riparian stands were

evaluated separately for each side of the watercourse. The following vegetation classification scheme for the Mendocino Redwood Company (MRC) timber inventory was used to classify the riparian stands:

Vegetation Classes

RW- greater than 75% of the stand basal area in coast redwood.
RD- combination of Douglas-fir and coast redwood basal area exceeds 75% of the stand, but neither species alone has 75% of the basal area.
MH- mix of hardwood basal area exceeds 75% of the stand, but no one hardwood species has 75% of the basal area.
CH- mix of conifer and hardwood basal area exceeds 75% of the stand, but no one hardwood or conifer species has 75% of the basal area.
Br- Brush

Vegetation Size Classes

1 - <8inches dbh
2 - 8 to 15.9 inches dbh
3 - 16 to 23.9 inches dbh
4 - 24 to 31.9 inches dbh
5 - >32 inches dbh

The size class is determined by looking at the diameters of the trees in the riparian stand. The size class which exceeds 50% of the total basal area is the size class assigned to the stand.

Vegetation Density

O - 5-20% tree canopy cover range
L - 20-40% tree canopy cover range
M - 40-60% tree canopy cover range
D - 60-80% tree canopy cover range
E - >80% tree canopy cover

The codes for vegetation classification of riparian stand condition are based on the three classes listed above. The vegetation code is a string of the classes with the vegetation class first, the size class second, and the vegetation density last. For example, the vegetation code for a redwood stand with greater than 50% of the basal area with 16-23.9 inch dbh or larger and 60-80% canopy cover would be classified RW3D.

In this assessment, vegetation type, size and density is assumed to affect LWD recruitment to the stream channel with the best riparian vegetation being large conifer trees. The LWD recruitment potential ratings reflect this. The following table presents the vegetation classification codes for the different LWD recruitment potential ratings (Table D-1).

Table D-1. Description of LWD Recruitment Potential Rating by Riparian Stand Classification for the Big River WAU.

Vegetation Type	Size and Density Classes					
	Size Classes 1-2 (Young)		Size Class 3 (Mature)		Size classes 4-5 (Old)	
	Sparse (O, L)	Dense (M, D, E)	Sparse (O, L, M)	Dense (D, E)	Sparse (O, L, M)	Dense (D, E)
RW	Low	Low	Low	Moderate	Moderate	High
RD	Low	Low	Low	Moderate	Moderate	High
CH	Low	Low	Low	Moderate	Low	High
MH	Low	Low	Low	Low	Low	Moderate

LWD was inventoried in watercourses during the stream channel assessment. All "functional" LWD was tallied within the active channel and the bankfull channel for each sampled stream segment. Functional LWD was that LWD greater than 4 inch and diameter and 6 feet in length which is providing some habitat or morphologic function in the stream channel (i.e. pool formation, scour, debris dam, bank stabilization, or gravel storage). LWD is classified by tree species class, either redwood, fir (Douglas-fir, hemlock, grand fir), hardwood (alder, tan oak, etc.), or unknown (if tree species is indeterminable). Length and diameter were recorded for each piece so that volume could be calculated.

LWD associated with an accumulation of 3 pieces or more was recorded and the number of LWD accumulations in the stream survey reach was tallied. LWD pieces were also assigned attributes if they fall into certain categories. These categories are: if the LWD piece was part of a living tree, root associated (i.e. does it have a rootwad attached to it), was part of the piece buried within stream gravel or the bank, or associated with a restoration structure. By assigning these attributes, the number of pieces in a segment which, for example, have a rootwad associated with the piece can be noted. This is important as these types of pieces can be more stable or have ecological benefits above that which a LWD piece alone may have.

Pieces that were partially buried were noted, as calculated volume for these LWD pieces represents a minimum dimension. There may likely be a significant amount of volume that is buried that we cannot measure. Also, these pieces may be more stable in the channel during high flows. The percentage of total pieces which are partially buried was calculated for each stream segment. Some consideration was given as to what percentage (0-25%, 25-50%, 50-75% and 75-100%) of the LWD pieces in the stream were recently contributed (<10 years). The LWD is further classified as a key LWD piece if it meets or exceeds size requirements (Table D-2).

Table D-2. Key LWD Piece Size Requirements (adapted from Bilby and Ward, 1989)

Bankfull Width (ft)	Diameter (in)	Length (ft)
0-20	12	20
20-30	18	30
30-40	22	40
40-60	24	60

Debris jams (>10 pieces) were noted and total dimensions of the jam recorded. This volume was calculated assuming 50% porosity of the jam. In other words, 50% of a debris jam was considered to be "air space" and subtracted out of the LWD volume. Total number of pieces and number of key pieces

were noted. Species and dimensions were not recorded for individual pieces contained in debris jams. All volume estimates and piece counts were separated in two groups, one not considering jams and one considering all LWD pieces in the segment, debris jams included. The percentage of total volume and total pieces per segment which was contained in debris jams was also calculated.

The quantity of LWD observed was normalized by distance, for comparison through time or to other similar areas, and was presented as a number of LWD pieces per 100 meters (328 feet). This normalized quantity, by distance, was performed for functional and key LWD pieces within the bankfull channel. The key piece quantity (per 100 meters of channel) is compared to the target for what would be an appropriate key piece loading. The target for appropriate key piece loading was derived from Bilby and Ward (1989) and Gregory and Davis (1992) and presented in Table D-3.

Table D-3. Target for Number of Key Large Woody Debris Pieces in Watercourses of the Big River WAU.

	# Key Pieces		
Bankfull Width (ft)	**Per 100 meters**	**Per 1000 feet**	**Per Mile**
<15	6.6	20	106
15-35	4.9	15	79
35-45	3.9	12	63
>45	3.3	10	53

An in-stream LWD demand is identified in addition to the riparian stand recruitment potential, discussed previously. The in-stream LWD demand is an indication of what level of concern there is for in-stream LWD for stream channel morphology and fish habitat associations within the Big River WAU. The in-stream LWD demand is determined by stream segment considering the overall LWD recruitment, the stream segment LWD sensitivity rating (as determined in the Stream Channel and Fish Habitat Assessment for stream geomorphic units), and the level of LWD currently in the stream segment (on target or off target). Table D-4 shows how these three factors are used to determine the in-stream LWD demand.

Table D-4. In-stream LWD Demand

Recruitment Potential Rating	LWD On Target / LWD Off Target	Channel LWD Sensitivity Rating: LOW	MODERATE	HIGH
	LOW	LOW	MODERATE	HIGH
		MODERATE	HIGH	HIGH
	MODERATE	LOW	MODERATE	MODERATE
		MODERATE	HIGH	HIGH
	HIGH	LOW	MODERATE	MODERATE
		LOW	HIGH	HIGH

Low In-stream LWD Demand - this classification suggests that current riparian LWD recruitment conditions and in-stream LWD are at levels which are sufficient for LWD function in these stream channel types.

Moderate In-stream LWD Demand - this classification suggests that current riparian LWD recruitment conditions and in-stream LWD are at levels which are moderately sufficient for fish habitat and stream channel morphology requirements. Consideration must be given to these areas to improve the LWD recruitment potential of the riparian stand. These areas may also be considered for supplemental LWD or stream structures placed in the stream channel.

High In-stream LWD Demand - this classification suggests that current riparian LWD recruitment conditions and in-stream LWD are at levels which are not sufficient for LWD function in these stream channel types. These areas must consider improvement of the LWD recruitment potential of the riparian stand. These areas should be the highest priority for supplemental LWD or stream structures placed in the stream channel.

Major streams and stretches of river within each Calwater Planning Watershed were further evaluated for meeting target conditions. Within each hydrologic watershed of the stream segment analyzed, the percentage of watercourses with low or moderate LWD demand and the percentage of watercourses with an appropriate number of key LWD pieces determine the overall quality rating of watercourse LWD in each stream or stream segment of a Calwater planning watershed. Under this scheme, LWD quality falls into the following categories:

ON TARGET – >80% of watercourses have low or moderate LWD demand, and >80% of stream segments have appropriate number of key LWD pieces.

MARGINAL – 50-80% of watercourses have low or moderate LWD demand, and stream segments have significant functional LWD and are approaching the number of key LWD pieces desired

DEFICIENT – <50% of watercourses have low or moderate LWD demand, and little functional or key LWD.

The percentages that define the break between each of the LWD quality ratings have the intent of realizing that streams and watersheds are dynamic. LWD loadings are naturally found to be variable. Therefore a target of 100% of stream segment meeting LWD quality demand would be inappropriate. However, it seems that if less than half of the watercourses (50%) do not meet LWD demand than a LWD deficiency is assumed.

We consider key LWD for determination of both instream LWD demand and overall LWD quality to help ensure that enough key LWD exists at both small (i.e., stream segment) and large (i.e., planning watershed) spatial scales.

LARGE WOODY DEBRIS RECRUITMENT POTENTIAL AND INSTREAM DEMAND RESULTS

The large woody debris recruitment potential and in-stream LWD demand for the Big River WAU is illustrated in Map D-1. The large woody debris recruitment potential and in-stream LWD demand provides baseline information on the structure and composition of the riparian stand and the level of concern about current LWD conditions in the stream. This map provides a tool for prioritizing riparian and stream management for improving LWD recruitment and instream LWD. These areas must be monitored over time to ensure that the recruitment potential is improving and that large woody debris is providing the proper function to the watercourses.

Current LWD loading is shown in Table D-5 a, b, and c. Only six of forty-four segments surveyed in the Big River WAU met the target for key LWD. However, many of the streams in the WAU have reasonably good levels of functional LWD. Generally, LWD loading in streams in the Big River WAU needs improvement.

Debris jams, though very scarce in the Big River WAU, were shown to contain a significant portion of the total piece count and volume when they occurred. In the Big River WAU, debris jams occurred in seven segments and contained approximately 40-50% of the total pieces and at times a considerable amount of the total volume (see Table D-5 a and b). In a few streams, debris jams actually affected whether or not the segment met the key LWD target. Although there obviously can be a significant amount of LWD trapped in debris jams, the ecological function may not be accurately represented by numbers alone. All of the pieces in a debris jam may actually have more habitat value if they were spread out in the stream as opposed to being piled up in one spot.

The percent of volume contained in debris accumulations (>3 pieces) varied widely in segments in the Big River WAU. A considerable amount of LWD in any given segment was at least partially buried. This indicates that we are unable to quantify a significant portion of the LWD volume which may eventually be useful to the stream.

LWD species composition was largely redwood dominated (Table D-6 b). This analysis was limited to pieces not contained within debris jams. Redwood contained 77% of the LWD volume in all surveys in the Big River WAU and in a few streams all pieces were redwood. This may not be surprising as these

streams flow through a redwood forest but it does show that the LWD currently found in streams within the Big River WAU is more stable as redwood breaks down more slowly in streams than hardwood species.

Nearly all segments in the Big River WAU contained LWD that largely was not recently contributed to the stream. All but two of the segments fell into the 0-25% category for LWD recently recruited LWD (<10 yrs). It did not appear that many of the LWD pieces had been contributed within the last 10 years. One exception is segment BS 24, Johnson Creek, where a blowdown had occurred and many large trees had fallen from the riparian area into the stream channel. The lack of recently contributed LWD may be a result of past riparian harvest. More LWD must be contributed to the stream channel in future years.

As shown in tables D-5 a and b and Map D-1, there is a need for LWD in channel segments of the Big River WAU. Channel segments with very low LWD loading will need to be the priority for monitoring future recruitment and restoration work. Even the few segments that met the target need LWD levels to be maintained to ensure LWD is providing fish habitat and morphological function in the stream channels.

Riparian recruitment potential is, in general, quite poor in the Big River WAU (see map D-1). Exceptions are the East Branch North Fork of Big River and Two Log Creek where the majority of riparian stands fall into the high and moderate recruitment potential rating. Provided this is maintained, good future LWD recruitment potential from the riparian stands will be present in these streams. Here, as in most of the Big River WAU, class II and III channels have especially poor riparian stands. Russell Brook, South Fork Big River, upper Daughtery Creek and especially Ramon Creek are noteworthy for their exceptionally low riparian recruitment potential. Past harvesting activities in riparian areas have resulted in small-sized, open stands which are composed of mixed conifer hardwood species. These areas should receive special treatment in regards to riparian harvest.

Due primarily to the low LWD recruitment potential of riparian stands, nearly every major channel in the Big River WAU falls into the high instream LWD demand category. The entire mainstem Big River, South Fork Big River, North Fork Big River, and East Branch North Fork Big River are badly in need of LWD. The same is true of nearly all the major tributaries. Many of the smaller Class II channels are only in moderate need of LWD input, though this is only due to these channels having a low sensitivity to LWD. This issue needs to be addressed if stream channel habitat is to improve in the future.

Table D-5 a. Large Woody Debris Pieces in Streams of the Big River Watershed Analysis Unit, 2000.

Stream Segment Name	Stream ID#	Functional LWD w/o Debris Jams	Functional LWD Pieces w/ Jams	Total # of Debris Jams	Total # of Debris Accumulations	Functional LWD (#/328ft.) w/o Jams	Functional LWD (#/328ft.) w/ Jams	Key LWD Pieces w/o Jams	Key LWD Pieces w/ Jams	Key LWD Pieces/100m w/o Jams	Key LWD Pieces/100m w/ Jams	% of Pieces in Jams
EAST BRANCH NF BIG RIVER	BE1	35	35	0	2	12.4	12.4	0	0	0.0	0.0	0%
EAST BRANCH NF BIG RIVER	BE2	10	10	0	1	6.0	6.0	4	4	2.4	2.4	0%
BULL TEAM GULCH	BE8	20	35	1	4	30.1	52.7	3	6	4.5	9.0	43%
FRYKMAN GULCH	BE14	15	15	0	0	21.0	21.0	2	2	2.8	2.8	0%
BIG RIVER	BI1	7	7	0	0	2.8	2.8	0	0	0.0	0.0	0%
NORTH FORK BIG RIVER	BL1	13	13	0	0	4.8	4.8	0	0	0.0	0.0	0%
NORTH FORK BIG RIVER	BL3	6	6	0	0	2.1	2.1	0	0	0.0	0.0	0%
STEAM DONKEY GULCH	BL7	11	11	0	1	22.7	22.7	1	1	2.1	2.1	0%
DUNLAP GULCH	BL12	49	81	2	4	48.9	80.8	17	27	16.9	26.9	40%
SOUTH FORK BIG RIVER	BM1	4	4	0	0	1.4	1.4	0	0	0.0	0.0	0%
SOUTH FORK BIG RIVER	BM3	10	10	0	0	3.4	3.4	0	0	0.0	0.0	0%
SOUTH FORK BIG RIVER	BM5	8	8	0	0	2.8	2.8	0	0	0.0	0.0	0%
RAMON CREEK	BM25	7	7	0	0	6.8	6.8	2	2	1.9	1.9	0%
RAMON CREEK	BM26	11	23	1	2	7.1	14.8	4	7	2.6	4.5	52%
RAMON CREEK	BM27	24	24	0	1	19.3	19.3	1	1	0.8	0.8	0%
NORTH FORK RAMON CREEK	BM31	13	13	0	3	8.6	8.6	0	0	0.0	0.0	0%
NORTH FORK RAMON CREEK	BM31(2)	21	36	1	1	22.5	38.6	3	5	3.2	5.4	42%
METTICK CREEK	BM54	7	7	0	0	6.2	6.2	0	0	0.0	0.0	0%
METTICK CREEK	BM55	17	17	0	1	12.7	12.7	1	1	0.7	0.7	0%
BOARDMAN GULCH	BM59	10	10	0	0	16.3	16.3	0	0	0.0	0.0	0%
HALFWAY HOUSE GULCH	BM64	19	33	1	1	14.9	25.9	5	9	3.9	7.1	42%
UNNAMED TRIB TO South Fork	BM76	7	7	0	0	13.0	13.0	0	0	0.0	0.0	0%
BIG RIVER	BR1	20	20	0	1	5.9	5.9	3	3	0.9	0.9	0%
BIG RIVER	BR2	18	34	1	1	5.3	10.0	1	3	0.3	0.9	47%
BIG RIVER	BR4	7	7	0	0	2.8	2.8	0	0	0.0	0.0	0%
RUSSEL BROOK	BR5	45	45	0	4	26.1	26.1	1	1	0.6	0.6	0%
RUSSEL BROOK	BR6	65	65	0	2	46.3	46.3	7	7	5.0	5.0	0%
RUSSEL BROOK	BR7	56	56	0	4	58.9	58.9	10	10	10.5	10.5	0%
WILDHORSE GULCH	BR9	21	21	0	0	17.2	17.2	1	1	0.8	0.8	0%
PIGPEN GULCH	BR29	20	20	0	3	33.3	33.3	2	2	3.3	3.3	0%
DAUGHERTY CREEK	BS1	13	13	0	0	4.9	4.9	1	1	0.4	0.4	0%
DAUGHERTY CREEK	BS3	11	11	0	0	5.8	5.8	5	5	2.6	2.6	0%
DAUGHERTY CREEK	BS5	16	16	0	0	16.9	16.9	6	6	6.3	6.3	0%
SODA CREEK	BS15	17	17	0	0	14.3	14.3	7	7	5.9	5.9	0%
GATES CREEK	BS23	19	19	0	0	11.5	11.5	4	4	2.4	2.4	0%
JOHNSON CREEK	BS24	43	43	0	2	27.2	27.2	9	9	5.7	5.7	0%
SNUFFINS CREEK	BS49	48	48	0	3	47.6	47.6	10	10	9.9	9.9	0%
BIG RIVER	BT1	21	21	0	0	3.9	3.9	0	0	0.0	0.0	0%
BIG RIVER	BT2	21	21	0	0	4.2	4.2	0	0	0.0	0.0	0%
TWO LOG CREEK	BT4	14	14	0	0	9.6	9.6	1	1	0.7	0.7	0%
TWO LOG CREEK	BT4(2)	14	14	0	0	9.3	9.3	2	2	1.3	1.3	0%
BEAVER POND GULCH	BT5	31	49	1	1	45.4	71.8	2	7	2.9	10.3	37%
TRAMWAY GULCH	BT12	9	9	0	0	13.5	13.5	1	1	1.5	1.5	0%
DIETZ GULCH	BT26	5	5	0	0	5.0	5.0	0	0	0.0	0.0	0%

Table D-5b. Large Woody Debris Volume in Streams of the Big River Watershed Analysis Unit, 2000.

Stream Segment Name	Stream ID#	Total Volume w/o Jams (yd^3)	Total Volume w/ Jams (yd^3)	Total Volume/328 ft w/o Jams (yd^3)	Total Volume/328 ft w/ Jams (yd^3)	% Volume in Jams	% Volume Key Pieces w/o Jams	% Volume by Species w/o Jams				
								Redwood	Fir	Alder	Hardwood	Unknown
EAST BRANCH NF BIG RIVER	BE1	26.3	26.3	9.3	9.3	0%	0%	84%	6%	0%	0%	9%
EAST BRANCH NF BIG RIVER	BE2	12.8	12.8	7.7	7.7	0%	93%	97%	0%	2%	1%	0%
BULL TEAM GULCH	BE8	21.0	22.9	31.7	34.4	8%	75%	99%	0%	0%	0%	1%
FRYKMAN GULCH	BE14	15.8	15.8	22.2	22.2	0%	91%	95%	2%	0%	3%	0%
BIG RIVER	BI1	3.3	3.3	1.3	1.3	0%	0%	93%	3%	2%	2%	0%
NORTH FORK BIG RIVER	BL1	11.4	11.4	4.2	4.2	0%	0%	96%	0%	4%	0%	0%
NORTH FORK BIG RIVER	BL3	6.3	6.3	2.2	2.2	0%	0%	76%	0%	0%	20%	5%
STEAM DONKEY GULCH	BL7	4.8	4.8	9.9	9.9	0%	12%	77%	12%	1%	3%	7%
DUNLAP GULCH	BL12	46.1	142.4	45.9	141.9	68%	66%	97%	1%	0%	3%	0%
SOUTH FORK BIG RIVER	BM1	1.2	1.2	0.4	0.4	0%	0%	12%	0%	0%	29%	59%
SOUTH FORK BIG RIVER	BM3	6.0	6.0	2.0	2.0	0%	0%	51%	0%	12%	27%	10%
SOUTH FORK BIG RIVER	BM5	4.3	4.3	1.5	1.5	0%	0%	14%	23%	9%	32%	21%
RAMON CREEK	BM25	8.6	8.6	8.3	8.3	0%	52%	60%	37%	0%	0%	3%
RAMON CREEK	BM26	8.3	16.6	5.3	10.6	50%	76%	32%	68%	0%	0%	0%
RAMON CREEK	BM27	12.6	12.6	10.1	10.1	0%	18%	87%	7%	0%	6%	0%
NORTH FORK RAMON CREEK	BM31	3.4	3.4	2.3	2.3	0%	0%	96%	0%	0%	4%	0%
NORTH FORK RAMON CREEK	BM31(2)	11.4	23.2	12.2	24.9	51%	79%	71%	0%	0%	29%	0%
METTICK CREEK	BM54	1.3	1.3	1.1	1.1	0%	0%	32%	25%	0%	0%	42%
METTICK CREEK	BM55	6.9	6.9	5.1	5.1	0%	13%	89%	11%	0%	0%	0%
BOARDMAN GULCH	BM59	1.3	1.3	2.1	2.1	0%	0%	100%	0%	0%	0%	0%
HALFWAY HOUSE GULCH	BM64	30.0	42.5	23.5	33.3	29%	65%	99%	0%	0%	1%	0%
UNNAMED TRIB TO South Fork	BM76	0.7	0.7	1.2	1.2	0%	0%	100%	0%	0%	0%	0%
BIG RIVER	BR1	47.0	47.0	14.0	14.0	0%	61%	91%	0%	0%	9%	0%
BIG RIVER	BR2	16.6	83.2	4.9	24.4	80%	38%	69%	17%	11%	1%	2%
BIG RIVER	BR4	4.0	4.0	1.6	1.6	0%	0%	42%	58%	0%	0%	0%
RUSSEL BROOK	BR5	23.4	23.4	13.6	13.6	0%	25%	85%	11%	0%	3%	1%
RUSSEL BROOK	BR6	43.5	43.5	31.0	31.0	0%	73%	83%	15%	0%	2%	0%
RUSSEL BROOK	BR7	53.0	53.0	55.7	55.7	0%	72%	99%	0%	0%	1%	0%
WILDHORSE GULCH	BR9	10.2	10.2	8.4	8.4	0%	8%	88%	0%	6%	4%	2%
PIGPEN GULCH	BR29	5.9	5.9	9.8	9.8	0%	30%	90%	0%	0%	10%	0%
DAUGHERTY CREEK	BS1	10.5	10.5	3.9	3.9	0%	28%	93%	5%	0%	0%	2%
DAUGHERTY CREEK	BS3	6.8	6.8	3.6	3.6	0%	66%	67%	25%	0%	8%	0%
DAUGHERTY CREEK	BS5	12.9	12.9	13.6	13.6	0%	73%	91%	0%	0%	5%	4%
SODA CREEK	BS15	12.8	12.8	10.8	10.8	0%	58%	79%	21%	0%	0%	0%
GATES CREEK	BS23	10.3	10.3	6.2	6.2	0%	28%	75%	18%	0%	7%	0%
JOHNSON CREEK	BS24	29.2	29.2	18.4	18.4	0%	66%	55%	45%	0%	1%	0%
SNUFFINS CREEK	BS49	31.1	31.1	30.8	30.8	0%	64%	98%	1%	0%	0%	1%
BIG RIVER	BT1	35.3	35.3	6.6	6.6	0%	0%	62%	7%	0%	7%	25%
BIG RIVER	BT2	9.0	9.0	1.8	1.8	0%	0%	61%	10%	9%	6%	14%
TWO LOG CREEK	BT4	10.6	10.6	7.2	7.2	0%	44%	66%	11%	0%	9%	14%
TWO LOG CREEK	BT4(2)	17.3	17.3	11.5	11.5	0%	79%	73%	27%	0%	1%	0%
BEAVER POND GULCH	BT5	13.2	33.2	19.3	48.6	60%	57%	97%	0%	0%	2%	2%
TRAMWAY GULCH	BT12	7.3	7.3	10.9	10.9	0%	77%	93%	0%	0%	1%	7%
DIETZ GULCH	BT26	1.2	1.2	1.2	1.2	0%	0%	73%	27%	0%	0%	0%

Table D-5c. Percentage of Large Woody Debris in Streams of Big River Watershed Analysis that are Root Associated, Buried and Alive, 2000.

Stream Segment Name	Stream ID#	Piece Count						Volume					
		Root Associated		Buried		Alive		Root Associated		Buried		Alive	
		#	%	#	%	#	%	Yd^3	%	Yd^3	%	Yd^3	%
EAST BRANCH NF BIG RIVER	BE1	15	43%	7	20%	5	14%	16.2	62%	5.2	20%	9.5	36%
EAST BRANCH NF BIG RIVER	BE2	7	70%	2	20%	2	20%	9.6	76%	1.3	10%	7.0	55%
BULL TEAM GULCH	BE8	3	15%	3	15%	3	15%	11.8	56%	1.7	8%	11.8	56%
FRYKMAN GULCH	BE14	4	27%	1	7%	1	7%	11.2	71%	3.5	22%	0.0	0%
BIG RIVER	BI1	2	29%	1	14%	3	43%	3.0	90%	0.2	5%	0.1	2%
NORTH FORK BIG RIVER	BL1	9	69%	1	8%	5	38%	5.8	51%	0.2	2%	0.3	3%
NORTH FORK BIG RIVER	BL3	4	67%	1	17%	0	0%	5.2	84%	0.0	0%	0.0	0%
STEAM DONKEY GULCH	BL7	1	9%	0	0%	0	0%	0.0	1%	0.0	0%	0.0	0%
DUNLAP GULCH	BL12	6	12%	5	10%	1	2%	7.1	15%	7.2	16%	0.7	2%
SOUTH FORK BIG RIVER	BM1	4	100%	0	0%	0	0%	1.2	100%	0.0	0%	0.0	0%
SOUTH FORK BIG RIVER	BM3	2	20%	2	20%	0	0%	1.0	16%	1.2	20%	0.0	0%
SOUTH FORK BIG RIVER	BM5	1	13%	3	38%	0	0%	0.5	12%	2.0	46%	0.0	0%
RAMON CREEK	BM25	4	57%	0	0%	0	0%	5.7	66%	0.0	0%	0.0	0%
RAMON CREEK	BM26	1	9%	1	9%	0	0%	2.8	34%	0.6	7%	0.0	0%
RAMON CREEK	BM27	3	13%	3	13%	1	4%	2.8	22%	1.0	8%	0.1	1%
NORTH FORK RAMON CREEK	BM31	6	46%	1	8%	0	0%	1.2	36%	0.0	0%	0.0	0%
NORTH FORK RAMON CREEK	BM31(2)	5	24%	0	0%	1	5%	0.2	2%	0.0	0%	0.4	4%
METTICK CREEK	BM54	4	57%	0	0%	0	0%	0.6	50%	0.0	0%	0.0	0%
METTICK CREEK	BM55	8	47%	7	41%	1	6%	3.7	53%	2.8	41%	0.1	2%
BOARDMAN GULCH	BM59	2	20%	1	10%	0	0%	0.6	47%	0.1	10%	0.0	0%
HALFWAY HOUSE GULCH	BM64	0	0%	2	11%	0	0%	0.0	0%	0.3	1%	0.0	0%
UNNAMED TRIB TO South Fork	BM76	5	71%	0	0%	0	0%	0.3	41%	0.0	0%	0.0	0%
BIG RIVER	BR1	9	45%	3	15%	1	5%	33.7	72%	1.9	4%	2.0	4%
BIG RIVER	BR2	9	50%	1	6%	1	6%	13.3	80%	0.8	5%	1.0	6%
BIG RIVER	BR4	3	43%	1	14%	0	0%	1.7	41%	0.3	7%	0.0	0%
RUSSEL BROOK	BR5	5	11%	0	0%	2	4%	4.2	18%	0.0	0%	0.9	4%
RUSSEL BROOK	BR6	18	28%	45	69%	0	0%	7.2	17%	28.3	65%	0.0	0%
RUSSEL BROOK	BR7	14	25%	5	9%	1	2%	17.4	33%	1.7	3%	0.5	1%
WILDHORSE GULCH	BR9	9	43%	0	0%	2	10%	6.6	64%	0.0	0%	0.2	2%
PIGPEN GULCH	BR29	2	10%	2	10%	1	5%	1.3	22%	1.4	24%	0.7	12%
DAUGHERTY CREEK	BS1	1	8%	1	8%	0	0%	0.0	0%	0.8	8%	0.0	0%
DAUGHERTY CREEK	BS3	1	9%	0	0%	0	0%	0.6	8%	0.0	0%	0.0	0%
DAUGHERTY CREEK	BS5	4	25%	5	31%	0	0%	4.2	33%	3.9	30%	0.0	0%
SODA CREEK	BS15	4	24%	1	6%	0	0%	2.9	23%	0.7	5%	0.0	0%
GATES CREEK	BS23	1	5%	0	0%	1	5%	0.6	6%	0.0	0%	1.0	10%
JOHNSON CREEK	BS24	17	40%	2	5%	4	9%	14.1	48%	0.2	1%	3.9	13%
SNUFFINS CREEK	BS49	10	21%	13	27%	0	0%	3.7	12%	9.3	30%	0.0	0%
BIG RIVER	BT1	8	38%	3	14%	4	19%	15.2	43%	4.6	13%	0.3	1%
BIG RIVER	BT2	11	52%	2	10%	1	5%	5.6	62%	0.1	1%	0.6	7%
TWO LOG CREEK	BT4	7	50%	1	7%	1	7%	7.2	68%	0.2	2%	4.7	44%
TWO LOG CREEK	BT4(2)	8	57%	1	7%	0	0%	12.0	70%	0.4	3%	0.0	0%
BEAVER POND GULCH	BT5	19	61%	3	10%	1	3%	3.5	27%	4.0	30%	0.1	1%
TRAMWAY GULCH	BT12	3	33%	4	44%	1	11%	5.7	79%	1.0	13%	0.0	1%
DIETZ GULCH	BT26	2	40%	1	20%	1	20%	0.3	28%	0.0	0%	0.3	27%

Table D-6 shows the instream LWD quality rating for major streams and sections of stream or river in individual Calwater planning watersheds. This quality rating will provide a tool to monitor the quality of the LWD in major streams over time. Currently the major streams within the Big River WAU have a mix of marginal and deficient LWD quality ratings. None of the major streams in the Big River WAU received an on target rating.

Table D-6. Instream LWD Quality Ratings for Major Streams and Sections of Streams or Rivers in Calwater Planning Watersheds for the Gualala WAU.

Stream	Calwater Planning Watershed	Instream LWD Quality Rating
Big River (Two Log PWS)	Two Log Creek	Deficient
Big River (Russell Brook PWS)	Russell Brook	Deficient
Big River (Rice Crk PWS)	Rice Creek	Deficient
Russell Brook	Russell Brook	Marginal
North Fork Big River	Lower North Fork Big River	Deficient
East Branch North Fork Big River	East Branch North Fork Big River	Marginal
Two Log Creek	Two Log Creek	Deficient
Tramway Gulch	Two Log Creek	Marginal
South Fork Big River	Mettick Creek	Deficient
Ramon Creek	Mettick Creek	Marginal
Mettick Creek	Mettick Creek	Deficient
Anderson Gulch	Mettick Creek	Deficient
Boardman Gulch	Mettick Creek	Deficient
Halfway House Gulch	Mettick Creek	Marginal
Daugherty Creek	South Daugherty	Marginal
Soda Creek	South Daugherty	Marginal
Gates Creek	South Daugherty	Marginal
Snuffins Creek	South Daugherty	Marginal

CANOPY CLOSURE AND STREAM TEMPERATURE
METHODS

Canopy closure, over watercourses, was estimated from aerial photographs (2000) and field observations during the summer of 2000. Field measurements of canopy closure over select stream channels were taken during the stream channel assessments in the Big River WAU. The field measurements consisted of estimating canopy closure over a watercourse using a spherical densiometer. The densiometer estimates were taken at approximately 3-5 evenly spaced intervals along a channel sample segment, typically at a length of 20-30 bankfull widths. The results of the densiometer readings were averaged across the channel to represent the percentage of canopy closure for the channel segment. Based on the field observations and aerial photograph observations four canopy closure classes were determined using aerial photographs (Map D-2). These classes as well as the criteria for an aerial photograph interpretation are shown in Table D-7.

Table D-7. Canopy Closure Classes and Criteria for Interpretation from Aerial Photographs.

Characteristics Observed on Aerial Photograph	Canopy Closure Class
Stream surface not visible	>90%
Stream surface visible in patches	70-90%
Stream surface visible but banks not visible	40-70%
Stream surface visible and banks visible at times	20-40%
Stream surface and banks visible	0-20%

Stream temperature has been monitored in Class I watercourses in the Big River WAU as early as 1992. In summer 2001 this was expanded to include Class II stream temperatures as part of a herpetological study. Although Class II streams by definition do not support fish, they do flow into Class I streams and therefore affect temperature of fish bearing streams. Stream temperature monitoring was conducted by electronic temperature recorders (Stowaway, Onset Instruments) with continuous readings at 2 hour intervals. Stream temperatures are monitored during the summer months when the water temperatures are highest. The stream temperature recorders were typically placed in shallow pools (<2 ft. in depth) directly downstream of riffles. Map D-2 shows the temperature monitoring locations and Table D-8 describes the temperature monitoring locations.

Table D-8. Stream Temperature Monitoring Locations and Year, Big River WAU (see map D-2).

Stream Monitoring ID#	Stream Segment #	Name	Years Monitored
74-1	BR1	Big River	‘92, '93, '94, '00, ’01, ‘02
74-2	BR5	Russell Brook	‘94, '95, '00, ‘01, ’02, ‘03
74-3	BR4	Big River	‘94, '95, '99, ‘01, ‘02, ‘03
75-1	BE1	East Branch NF Big River	‘93, '95, '97, '99, '00, ‘01, ‘02, ‘03
75-3	BL1	East Branch NF Big River	‘97, ‘01, ‘02, ‘03
75-4	BL1	North Fork Big River	‘93, ‘02, ‘03
76-1	BT2	Big River	‘93, '94, '99, ‘01, ‘03
76-2	BT4	Two Log Creek	‘00, ‘01, ‘02, ‘03
79-1	BM1	South Fork Big River	‘96, '97, '99, '00, ‘01, ‘02
79-2	BM25	Ramon Creek	‘96, '97, '99, ‘02, ‘03
79-4	BS1	Daugherty Creek	‘94, '95, '97, '99, '00, ‘01, ‘02, ‘03
79-5	BS4	Daugherty Creek	‘97, ‘02, ‘03
79-8	BM31	NF Ramon Creek	‘00, ‘02, ‘03
79-9	BS23	Gates Creek	‘97, ‘01, ‘02, ‘03
79-10	BM27	Ramon Creek	‘02, ‘03
79-11	BM3	South Fork Big River	‘02, ‘03
79-12	BM5	South Fork Big River	‘02, ‘03
79-13	BS24	Johnson Creek	‘02, ‘03
76-20 (Class II)	BT5	Beaver Pond Gulch	‘01
75-20 (Class II)	BE7	Quail Gulch	‘01
75-22 (Class II)	BE14	Frykman Gulch	‘01
79-20 (Class II)	BM19	No Name Gulch	‘01
74-20 (Class II)	BR13	Johnston Gulch	‘01
74-21 (Class II)	BR9	Wildhorse Gulch	‘01
79-21 (Class II)	BM76	20 mile Trib to SF Big River	‘01
79-22 (restorable Class I)	BM23	Donkey House Gulch	‘01

Maximum and mean daily temperatures were calculated for each temperature monitoring site and year and are presented in graphical form in Appendix D. Maximum weekly average temperatures (MWATs) and maximum weekly maximum temperatures were calculated for the stream temperatures by taking a seven day average of the mean daily stream temperatures and the daily maximum temperatures.

A stream shade quality rating was derived for major tributaries or river segments within a Calwater planning watershed. The percentage of perennial watercourses in a stream segment's hydrologic watershed ranked as having "on-target" effective shade determines the overall quality of the stream's shade canopy. For streams of rivers that flow through several Calwater planning watersheds, the percentage of perennial watercourses in stream segments of that planning watershed ranked as having "on-target" effective shade determines the overall quality of the stream or river's shade canopy.

The percentage of effective shade required for an "on-target" rating varies by bankfull width of the watercourse:

- for watercourses with bankfull widths <30 feet, >90% effective shade.
- for watercourses with bankfull widths of 30-100 feet, >70% effective shade.
- for watercourses with bankfull widths of 100-150 feet, >40% effective shade.

We use the following categories of watercourse-shade rating to determine overall shade quality in each major stream or river/stream segment of a planning watershed:

ON TARGET – >90% of perennial watercourses that contribute to the stream have "on-target" effective shade

MARGINAL – 70-90% of perennial watercourses that contribute to the stream have "on-target" effective shade, or >70% of stream with greater than 70% canopy.

DEFICIENT – <70% of perennial watercourses that contribute to the stream have "on-target" effective shade or <70% canopy.

CANOPY CLOSURE AND STREAM TEMPERATURE
RESULTS AND DISCUSSION

Canopy closure over watercourses in the Big River WAU ranges from poor to good (Map D-2 and Table D-9). Big River, North Fork Big River and South Fork Big River have less than ideal canopy cover values but this is to be expected from larger river channels. East Branch North Fork Big River, Daugherty Creek and Two Log Creek are areas that have reasonably good canopy cover.

Table D-9. Year 2000 Field Observations of Stream Canopy Closure for Select Stream Channel Segments in the Big River WAU.

Stream Name	Segment Number	Mean Shade Canopy
EAST BRANCH NF BIG RIVER	BE1	82
EAST BRANCH NF BIG RIVER	BE2	76
BULL TEAM GULCH	BE8	78
FRYKMAN GULCH	BE14	94
BIG RIVER	BI1	59
NORTH FORK BIG RIVER	BL1	58
NORTH FORK BIG RIVER	BL3	55
STEAM DONKEY GULCH	BL7	98
DUNLAP GULCH	BL12	98
SOUTH FORK BIG RIVER	BM1	40
SOUTH FORK BIG RIVER	BM3	70
SOUTH FORK BIG RIVER	BM5	69
RAMON CREEK	BM25	49
RAMON CREEK	BM26	62
RAMON CREEK	BM27	48
NORTH FORK RAMON CREEK	BM31	78
NORTH FORK RAMON CREEK	BM31(2)	85
METTICK CREEK	BM54	92
METTICK CREEK	BM55	94
BOARDMAN GULCH	BM59	65
HALFWAY HOUSE GULCH	BM64	92
UNNAMED TRIB TO SF BIG RIVER	BM76	92
BIG RIVER	BR1	53
BIG RIVER	BR2	78
BIG RIVER	BR4	55
RUSSEL BROOK	BR5	93
RUSSEL BROOK	BR6	68
RUSSEL BROOK	BR7	96
WILDHORSE GULCH	BR9	97
PIGPEN GULCH	BR29	94
DAUGHERTY CREEK	BS1	69
DAUGHERTY CREEK	BS3	87
DAUGHERTY CREEK	BS5	97
SODA CREEK	BS15	90
GATES CREEK	BS23	81
JOHNSON CREEK	BS24	81
SNUFFINS CREEK	BS49	94
BIG RIVER	BT1	43
BIG RIVER	BT2	38
TWO LOG CREEK	BT4	92
TWO LOG CREEK	BT4(2)	90
BEAVER POND GULCH	BT5	90
TRAMWAY GULCH	BT12	99
DIETZ GULCH	BT26	92

Stream temperatures in the Big River WAU are commonly above levels that are stressful to salmonids. At times, maximum daily temperatures at many sites in the Big River WAU exceed the maximum lethal temperatures of coho salmon (23 C^o). Temperatures for some of the streams exceed the MWAT threshold maximums for coho salmon (17-18 C^o) (Brett, 1952 and Becker and Genoway, 1979). These high temperature levels are of concern for rearing habitat quality in the Big River WAU, though are not entirely related to canopy cover issues. See Tables D-10, D-11 and D-12.

Table D-10. Maximum Daily Temperatures for the Big River WAU (degrees Celsius).

Station No.	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
74-1	23.5	22.5	21.5	**	**	**	**	**	22.9	23.8	23.6	**
74-2	**	**	17.0	19.0	**	**	**	**	18.1	17.5	17.9	18.3
74-3	**	**	22.6	21.4	**	**	**	22.1	**	22.1	21.7	21.3
75-1	**	22.4	**	21.4	**	20.5	**	20.1	19.5	19.0	18.3	19.4
75-3	**	**	**	**	**	21.4	**	**	**	19.4	20.2	20.2
75-4	**	21.0	**	**	**	**	**	**	**	**	19.4	20.9
75-5	**	**	**	**	**	**	**	**	**	**	16.4	17.1
76-1	**	23.0	23.0	**	**	**	**	22.7	**	**	**	23.4
76-2	**	**	**	**	**	**	**	**	17.8	17.1	17.9	16.4
79-1	**	**	**	**	23.6	23.0	**	22.8	23.2	22.5	22.1	22.7
79-2	**	**	**	**	22.6	21.7	**	22.0	**	**	21.5	21.7
79-4	**	**	21.9	22.8	**	21.9	**	21.6	21.8	21.5	21.2	22.2
79-5	**	**	**	**	**	20.9	**	**	**	**	20.5	21.0
79-8	**	**	**	**	**	**	**	**	17.2	**	16.4	18.7
79-9	**	**	**	**	**	21.6	**	**	**	19.6	20.2	21.3
79-10	**	**	**	**	**	**	**	**	**	**	22.9	21.3
79-11	**	**	**	**	**	**	**	**	**	**	22.3	22.5
79-12	**	**	**	**	**	**	**	**	**	**	20.4	22.5
79-22	**	**	**	**	**	**	**	**	**	14.5	**	19.0

Table D-11. Maximum Weekly Average Temperature (MWAT) for the Big River WAU (Celsius).

Station No.	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
74-1	20.1	19.0	19.0	**	**	**	**	**	19.3	19.9	19.4	**
74-2	**	**	15.2	16.6	**	**	**	**	16.0	14.9	15.7	16.6
74-3	**	**	18.8	18.1	**	**	**	18.8	**	18.8	19.0	18.9
75-1	**	18.4	**	18.1	**	17.9	**	17.1	17.1	16.4	16.6	17.4
75-3	**	**	**	**	**	17.9	**	**	**	16.3	17.0	17.7
75-4	**	19.2	**	**	**	**	**	**	**	**	17.4	19.0
75-5	**	**	**	**	**	**	**	**	**	**	13.5	15.3
76-1	**	19.7	19.3	**	**	**	**	19.4	**	**	**	20.6
76-2	**	**	**	**	**	**	**	**	15.8	14.8	15.3	15.5
79-1	**	**	**	**	20.6	20.5	**	20.0	20.4	19.5	19.7	20.3
79-2	**	**	**	**	18.7	18.4	**	18.7	**	**	18.2	18.5
79-4	**	**	18.7	19.3	**	18.4	**	18.2	19.0	18.4	18.5	19.1
79-5	**	**	**	**	**	18.7	**	**	**	**	17.8	18.3
79-8	**	**	**	**	**	**	**	**	15.1	**	14.5	16.6
79-9	**	**	**	**	**	18.2	**	**	**	16.5	17.7	18.8
79-10	**	**	**	**	**	**	**	**	**	**	18.0	18.3
79-11	**	**	**	**	**	**	**	**	**	**	19.1	19.7
79-12	**	**	**	**	**	**	**	**	**	**	18.4	19.0
79-22	**	**	**	**	**	**	**	**	**	13.2	**	17.4

**Data not collected

Table D-12. 7-Day Moving Average of the Daily Maximum (MWMT) for the Big River WAU (Celsius).

Station No.	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002	2003
74-1	22.9	21.9	21.1	**	**	**	**	**	21.8	22.8	22.5	**
74-2	**	**	16.9	17.9	**	**	**	**	17.3	16.8	17.4	17.8
74-3	**	**	21.1	20.4	**	**	**	21.1	**	20.9	20.8	20.5
75-1	**	21.3	**	20.2	**	20.1	**	19.2	18.8	18.1	17.8	18.6
75-3	**	**	**	**	**	20.7	**	**	**	18.5	19.4	19.5
75-4	**	20.6	**	**	**	**	**	**	**	**	18.8	20.3
75-5	**	**	**	**	**	**	**	**	**	**	15.6	16.8
76-1	**	21.9	22.6	**	**	**	**	21.9	**	**	**	22.6
76-2	**	**	**	**	**	**	**	**	17.3	16.4	17.1	15.9
79-1	**	**	**	**	22.5	22.4	**	21.8	22.4	21.7	21.3	21.9
79-2	**	**	**	**	21.8	21.2	**	20.8	**	**	20.7	20.7
79-4	**	**	21.5	21.7	**	20.9	**	20.4	20.7	20.4	20.4	21.2
79-5	**	**	**	**	**	20.6	**	**	**	**	19.6	20.0
79-8	**	**	**	**	**	**	**	**	16.4	**	15.7	18.1
79-9	**	**	**	**	**	20.2	**	**	**	18.1	19.2	20.5
79-10	**	**	**	**	**	**	**	**	**	**	22.1	20.4
79-11	**	**	**	**	**	**	**	**	**	**	21.1	21.5
79-12	**	**	**	**	**	**	**	**	**	**	19.3	21.6
79-22	**	**	**	**	**	**	**	**	**	12.9	**	18.5

**Data not collected

Table D-13. Class II Stream Temperature Data for the Big River WAU (degrees Celsius).

Stream Name	Station Number	Maximum	MWAT	MWMT
Beaver Pond Gulch	76-20	14.1	13.4	13.8
Quail Gulch	75-20	12.9	12.1	12.5
Frykman Gulch	75-22	14.1	13.6	13.8
No Name Gulch	79-20	16.0	14.0	15.4
Johnston Gulch	74-20	14.9	14.2	14.6
Wildhorse Gulch	74-21	15.6	14.7	15.1
20 mile trib. To SF Big River	79-22	14.5	13.8	14.0
Steam Donkey Gulch	75-23	14.5	13.2	13.8

The Big River WAU is located in area of high summer air temperatures presenting challenges for maintenance of high quality rearing habitat for salmonids due to corresponding high water temperatures. This increased risk for high water temperatures needs to a focus for management practices that improve stream shading particularly where canopy levels are unnaturally low. Currently the majority of stream segments have marginal stream shade quality ratings, with a few being deficient. There are no “on target” stream shade quality ratings in the Big River WAU (Table D-14).

Table D-14. Stream Shade Quality Ratings for Major Streams and River/Stream Segments in Calwater Planning Watersheds for the Big River WAU.

Stream	Calwater Planning Watershed	Stream Shade Quality Rating
Big River (Two Log PWS)	Two Log Creek	Marginal
Big River (Russell Brook PWS)	Russell Brook	Deficient
Big River (Rice Crk PWS)	Rice Creek	Marginal
Russell Brook	Russell Brook	Marginal
North Fork Big River	Lower North Fork Big River	Marginal
East Branch North Fork Big River	East Branch North Fork Big River	Marginal
Two Log Creek	Two Log Creek	Marginal
Tramway Gulch	Two Log Creek	Marginal
South Fork Big River	Mettick Creek	Deficient
Ramon Creek	Mettick Creek	Marginal
Mettick Creek	Mettick Creek	Marginal
Anderson Gulch	Mettick Creek	Marginal
Boardman Gulch	Mettick Creek	Deficient
Halfway House Gulch	Mettick Creek	Marginal
Daugherty Creek	South Daugherty	Marginal
Soda Creek	South Daugherty	Marginal
Gates Creek	South Daugherty	Marginal
Snuffins Creek	South Daugherty	Marginal

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Big River Watershed Analysis Unit

Map D-1
Large Woody Debris Recruitment Potential and Demand

This map presents the large woody debris recruitment potential and in-stream large woody debris (LWD) demand for the streams MRC lands in the Big River WAU. This map provides baseline information on the structure and composition of the riparian stand and the level of concern about current LWD conditions in the stream. It is based on the streamside stand characteristics, amount of LWD in the stream and the sensitivity of the stream channel to LWD from aerial photograph interpretation of 2000 photographs and field observations in 2001. This map provides a tool for prioritizing riparian and stream management for improving LWD recruitment and in-stream LWD.

LWD Recruitment Potential Classes
- High
- Moderate
- Low

Instream LWD Demand
- High
- Moderate
- Low

- MRC Ownership
- Planning Watershed Boundary
- Big River Watershed Boundary

Flow Class
- Class I
- Class II
- Class III

Sheet 1

0 1/2 1 Mile

September 2003

Big River Watershed Analysis Unit

Map D-1
Large Woody Debris Recruitment Potential and Demand

This map presents the large woody debris recruitment potential and in-stream large woody debris (LWD) demand for the streams MRC lands in the Big River WAU. This map provides baseline information on the structure and composition of the riparian stand and the level of concern about current LWD conditions in the stream. It is based on the streamside stand characteristics, amount of LWD in the stream and the sensitivity of the stream channel to LWD from aerial photograph interpretation of 2000 photographs and field observations in 2001. This map provides a tool for prioritizing riparian and stream management for improving LWD recruitment and in-stream LWD.

LWD Recruitment Potential Classes
- High
- Moderate
- Low

Instream LWD Demand
- High
- Moderate
- Low

- MRC Ownership
- Planning Watershed Boundary
- Big River Watershed Boundary

Flow Class
- Class I
- Class II
- Class III

Sheet 2

0 1/2 1 Mile

September 2003

Big River Watershed Analysis Unit

Map D-2
Stream Canopy Classification and Temperature Monitoring Locations

This map presents the canopy closure, over watercourses, for streams and rivers within the MRC ownership in the Big River WAU. The canopy was estimated for five canopy closure classes from 2000 aerial photographs and 2001 field observations. The location of stream temperature monitoring locations is also presented, these locations are monitored each year during summer.

Stream Canopy Classes
- > 90%
- 70-90%
- 40-70%
- 20-40%
- 0-20%
- Temperature Monitoring Locations
- MRC Ownership
- Planning Watershed Boundary
- Big River Watershed Boundary

Flow Class
- Class I
- Class II
- Class III

Sheet 1

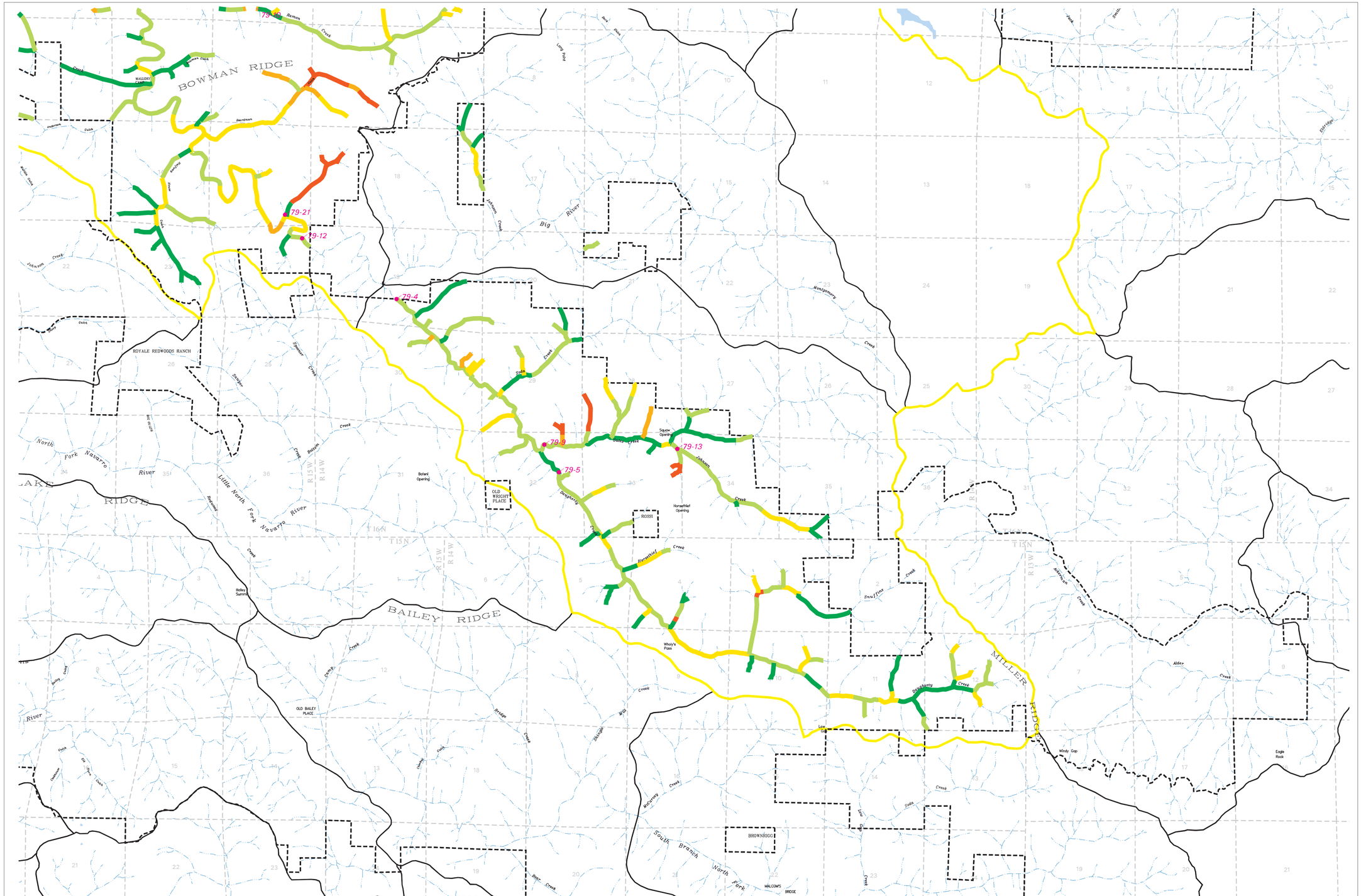
0 1/2 1 Mile

September 2003

Big River Watershed Analysis Unit

Map D-2
Stream Canopy Classification and Temperature Monitoring Locations

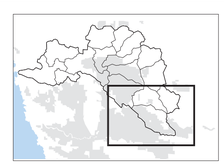
This map presents the canopy closure, over watercourses, for streams and rivers within the MRC ownership in the Big River WAU. The canopy was estimated for five canopy closure classes from 2000 aerial photographs and 2001 field observations. The location of stream temperature monitoring locations is also presented, these locations are monitored each year during summer.



Stream Canopy Classes
- > 90%
- 70-90%
- 40-70%
- 20-40%
- 0-20%
- Temperature Monitoring Locations
- MRC Ownership
- Planning Watershed Boundary
- Big River Watershed Boundary

Flow Class
- Class I
- Class II
- Class III

Sheet 2



0 1/2 1 Mile

September 2003

APPENDIX D
Riparian Function

Figure T74-02. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Russell Brook Creek (Site T74-02), Mendocino County, California.

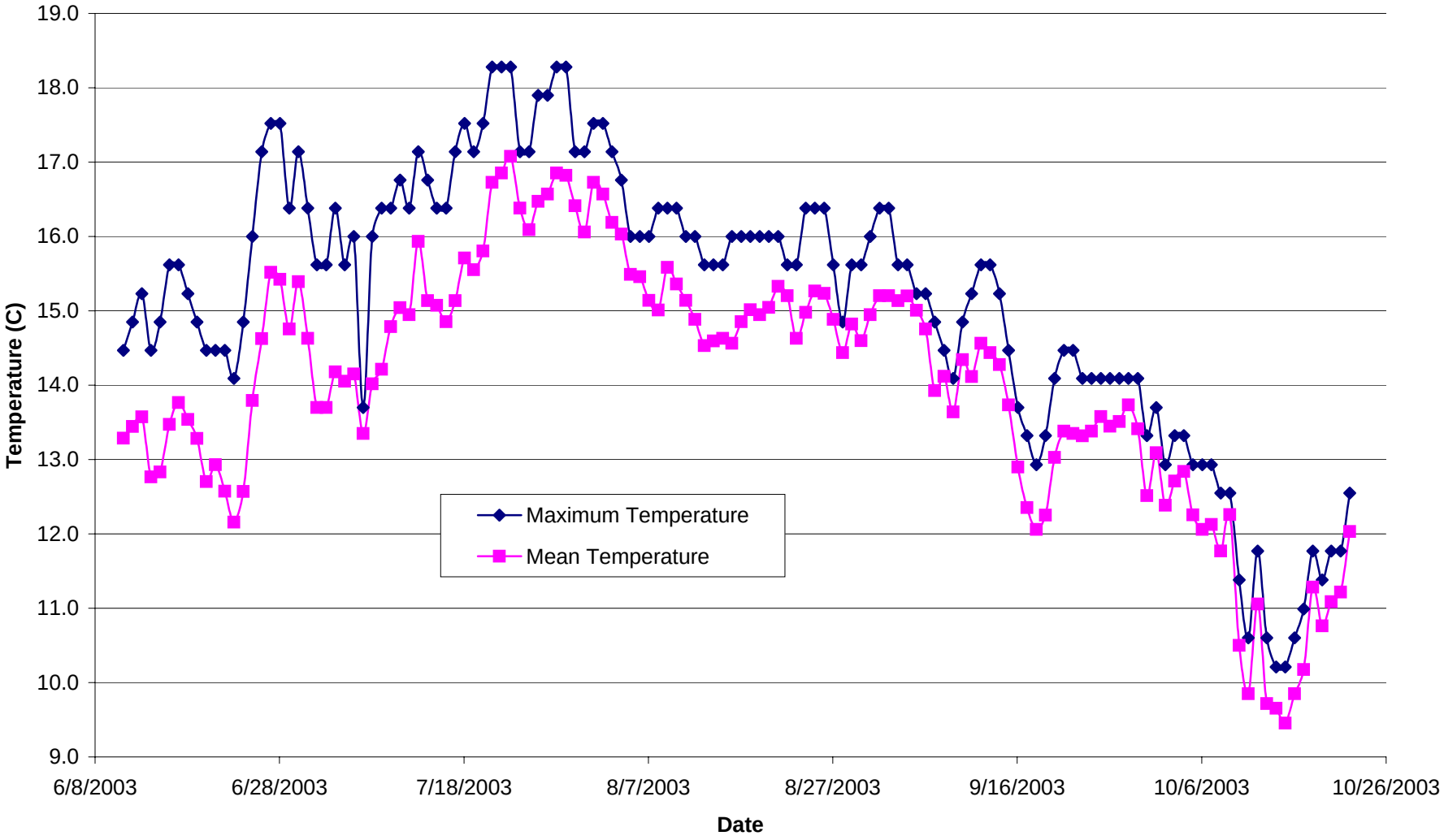


Figure T74-03. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Big River (Site T74-03), Mendocino County, California.

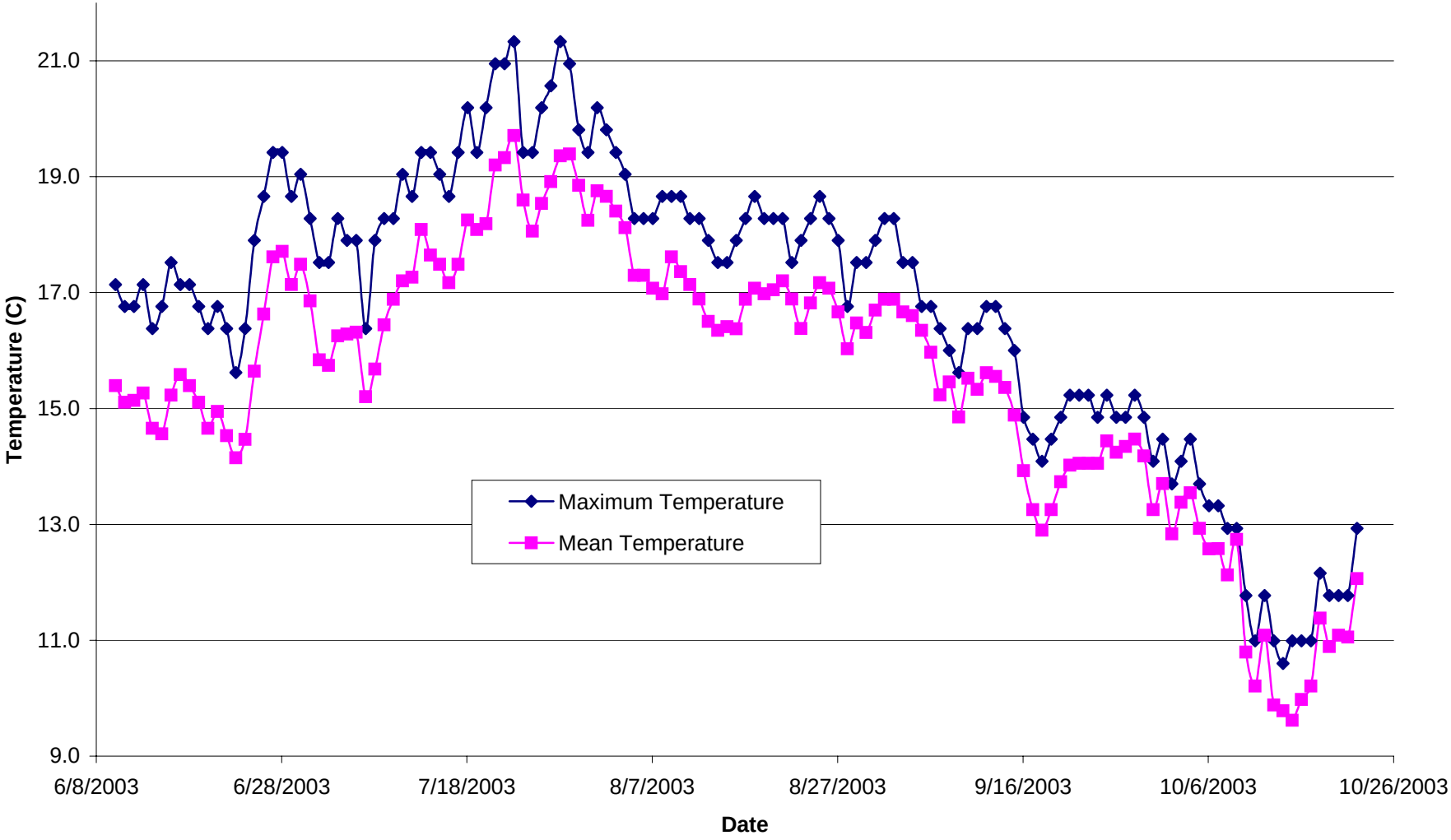


Figure T75-01. Mean and Maximum Daily Stream Temperatures During Summer 2003 at East Branch North Fork Big River (Site T75-01), Mendocino County, California.

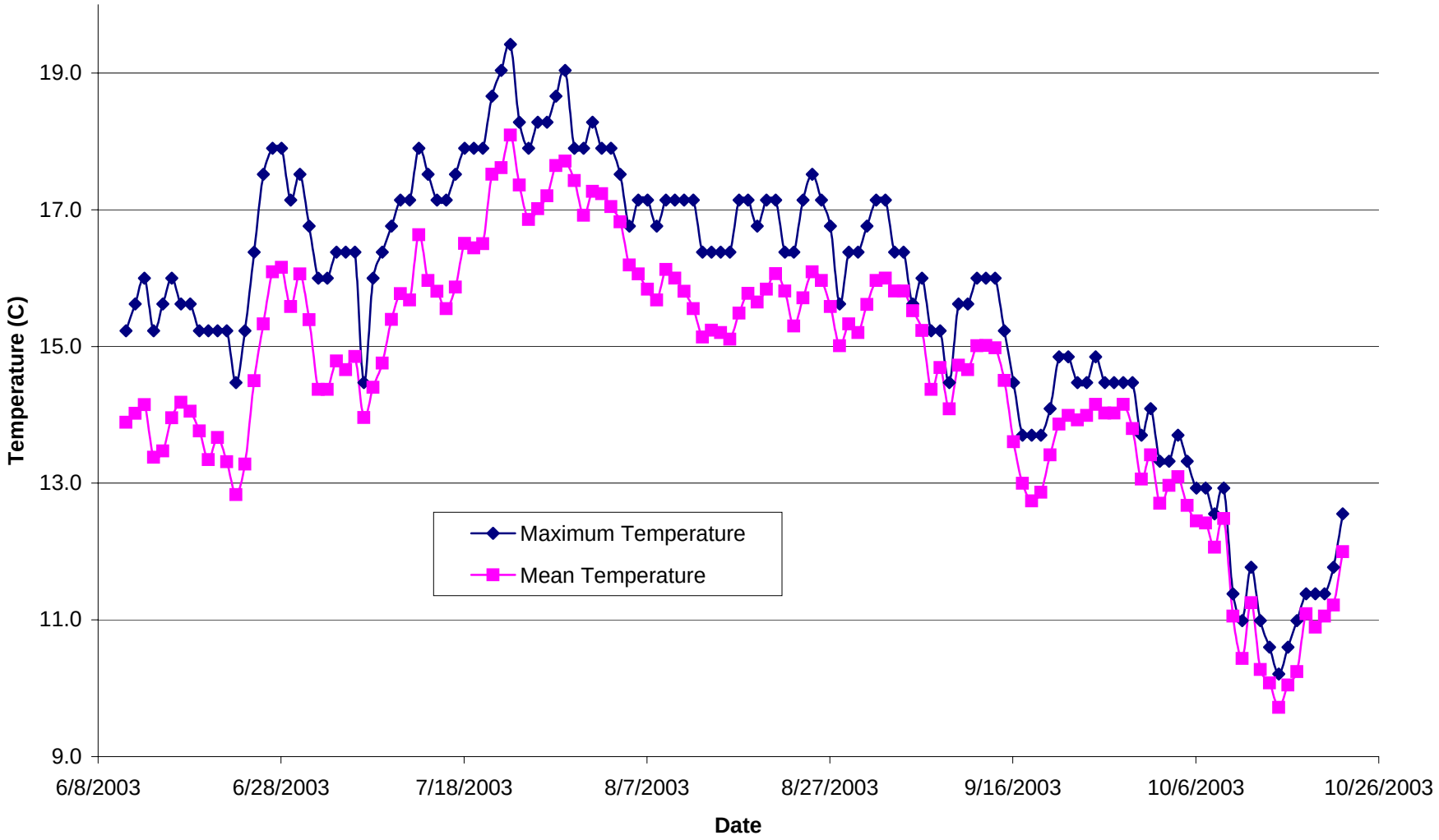


Figure T75-03. Mean and Maximum Daily Stream Temperatures During Summer 2003 at East Branch North Fork Big River (Site T75-03), Mendocino County, California.

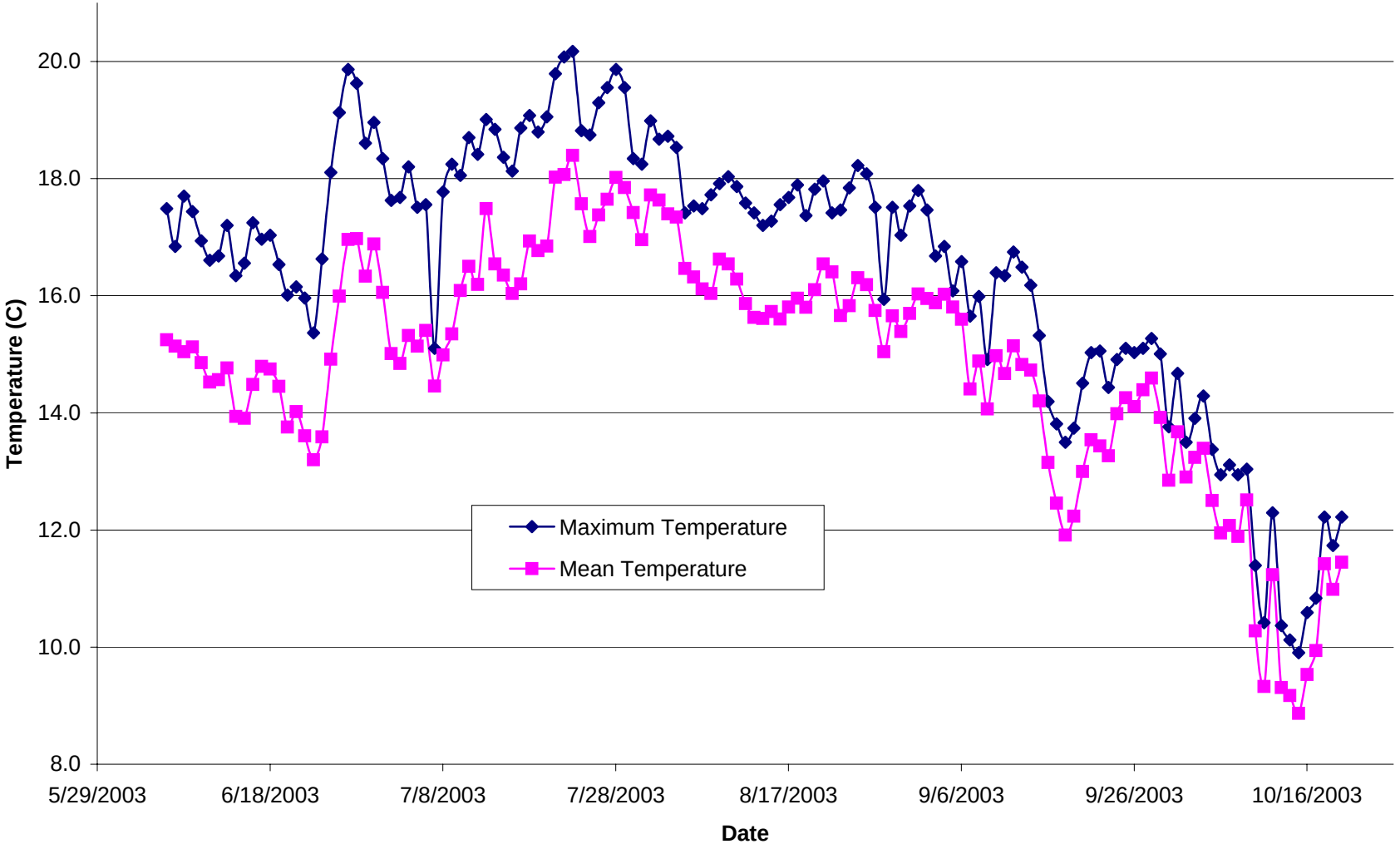


Figure T75-04. Mean and Maximum Daily Stream Temperatures During Summer 2003 at North Fork Big River (Site T75-04), Mendocino County, California.

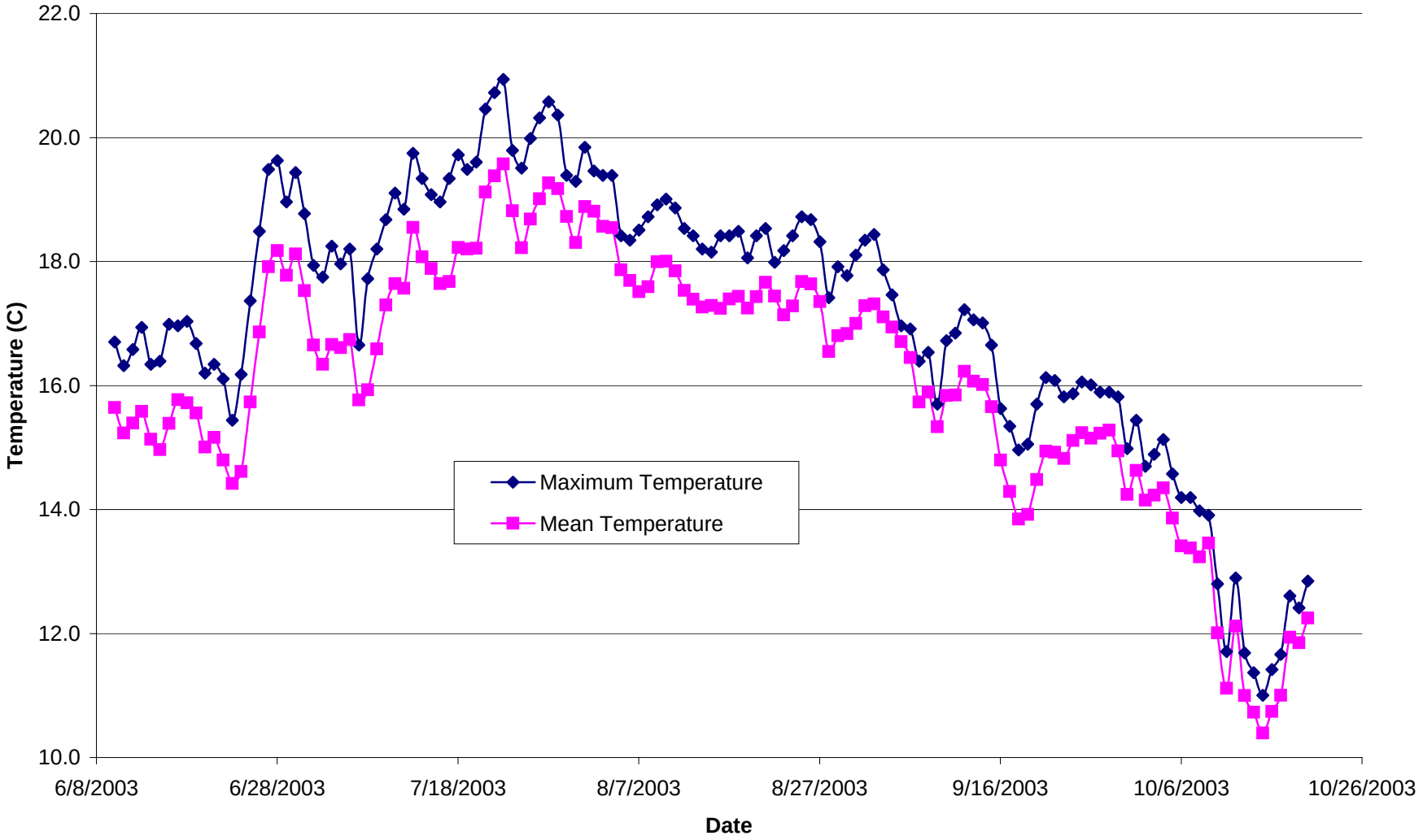


Figure T75-05. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Bull Team Gulch (Site T75-05), Mendocino County, California.
*****Data recorder was buried under a thick mat of algae upon retrieval.**

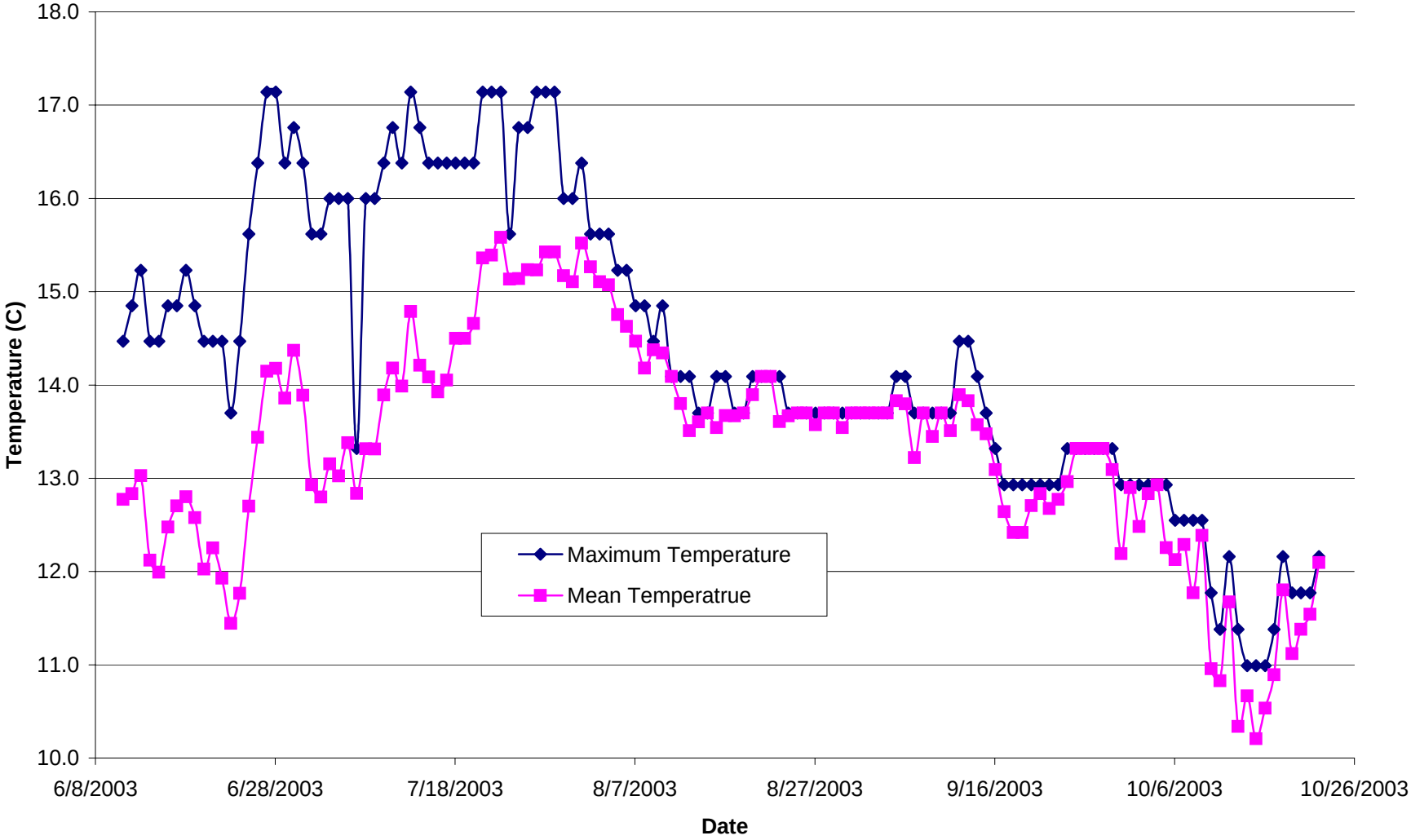


Figure T76-01. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Big River (Site T76-01), Mendocino County, California.

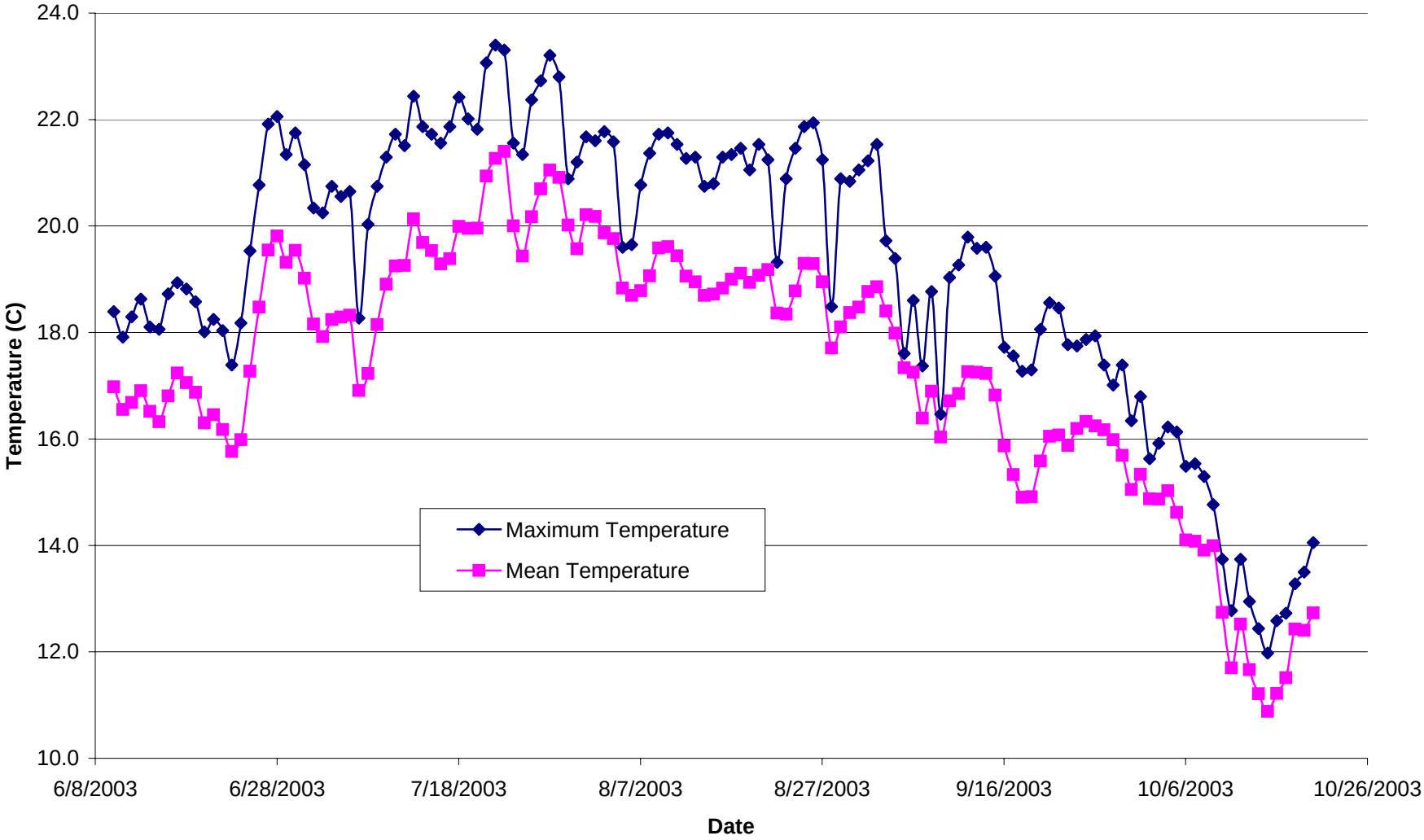


Figure T76-02. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Two Log Creek (Site T76-02), Mendocino County, California.

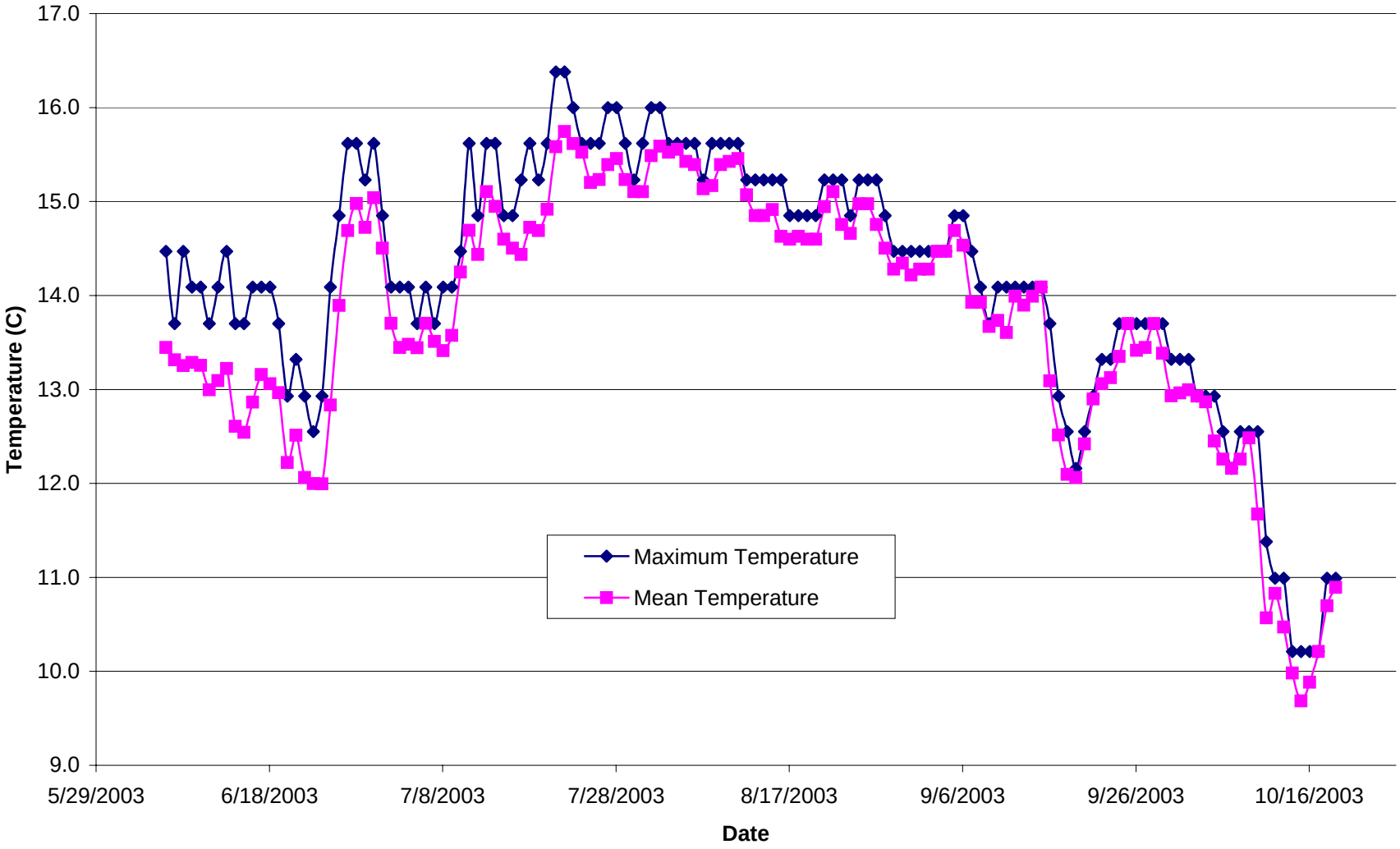


Figure T79-01. Mean and Maximum Daily Stream Temperatures During Summer 2003 at South Fork Big River (Site T79-01), Mendocino County, California.

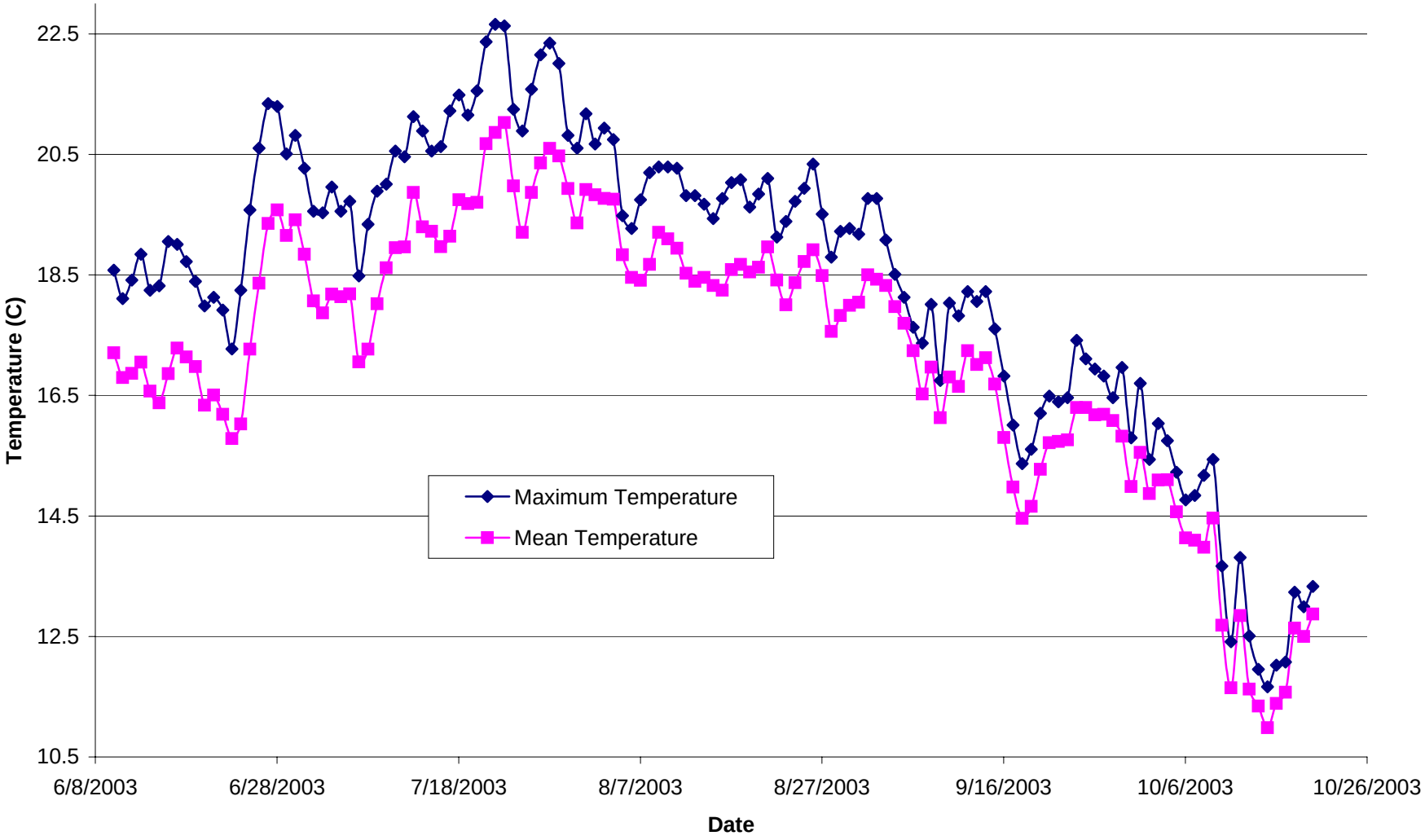


Figure T79-02. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Ramon Creek (Site T79-02), Mendocino County, California.

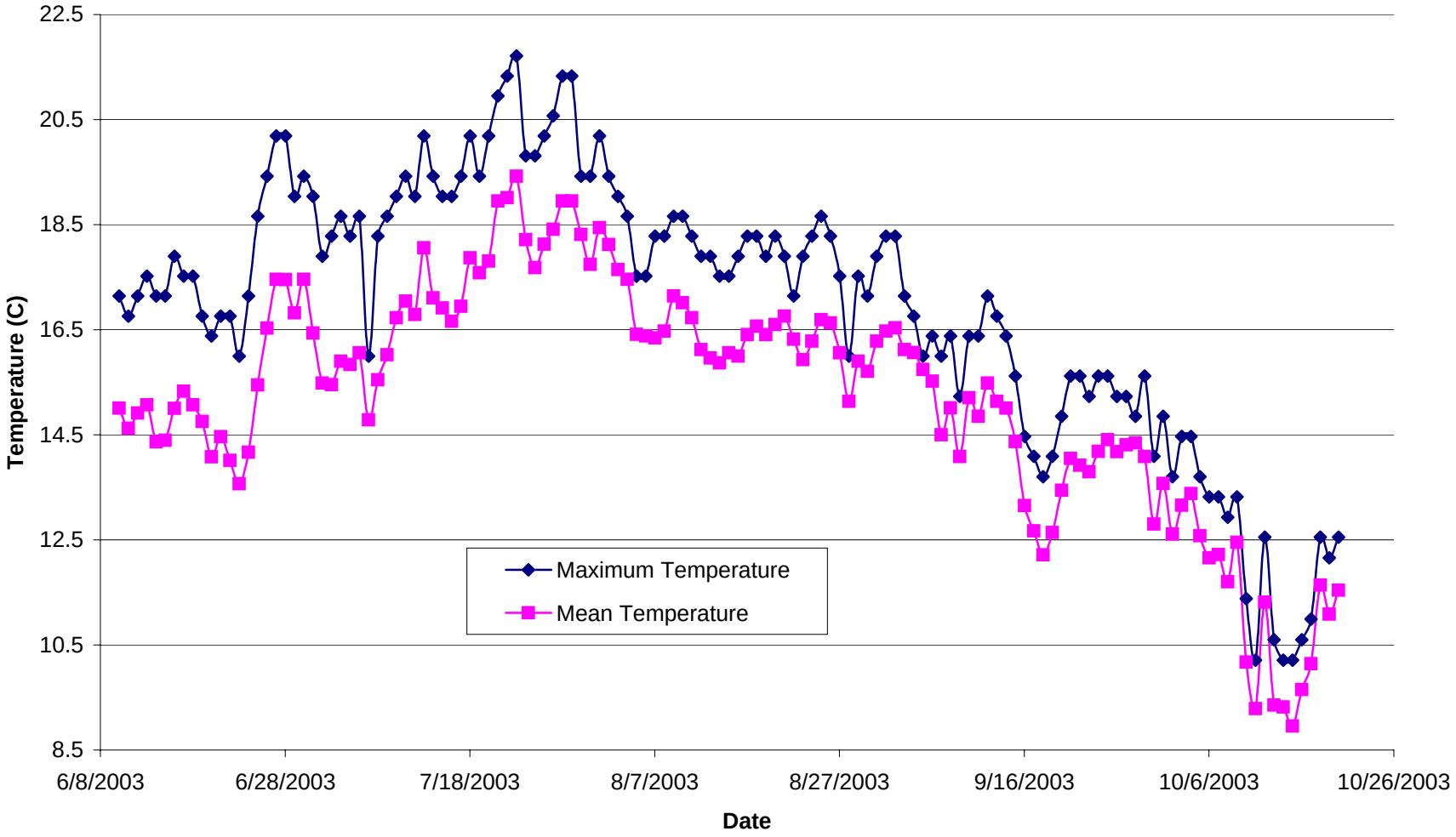


Figure T79-04. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2003 at Daugherty Creek (Site T79-04 and T79-4a), Mendocino County, California.

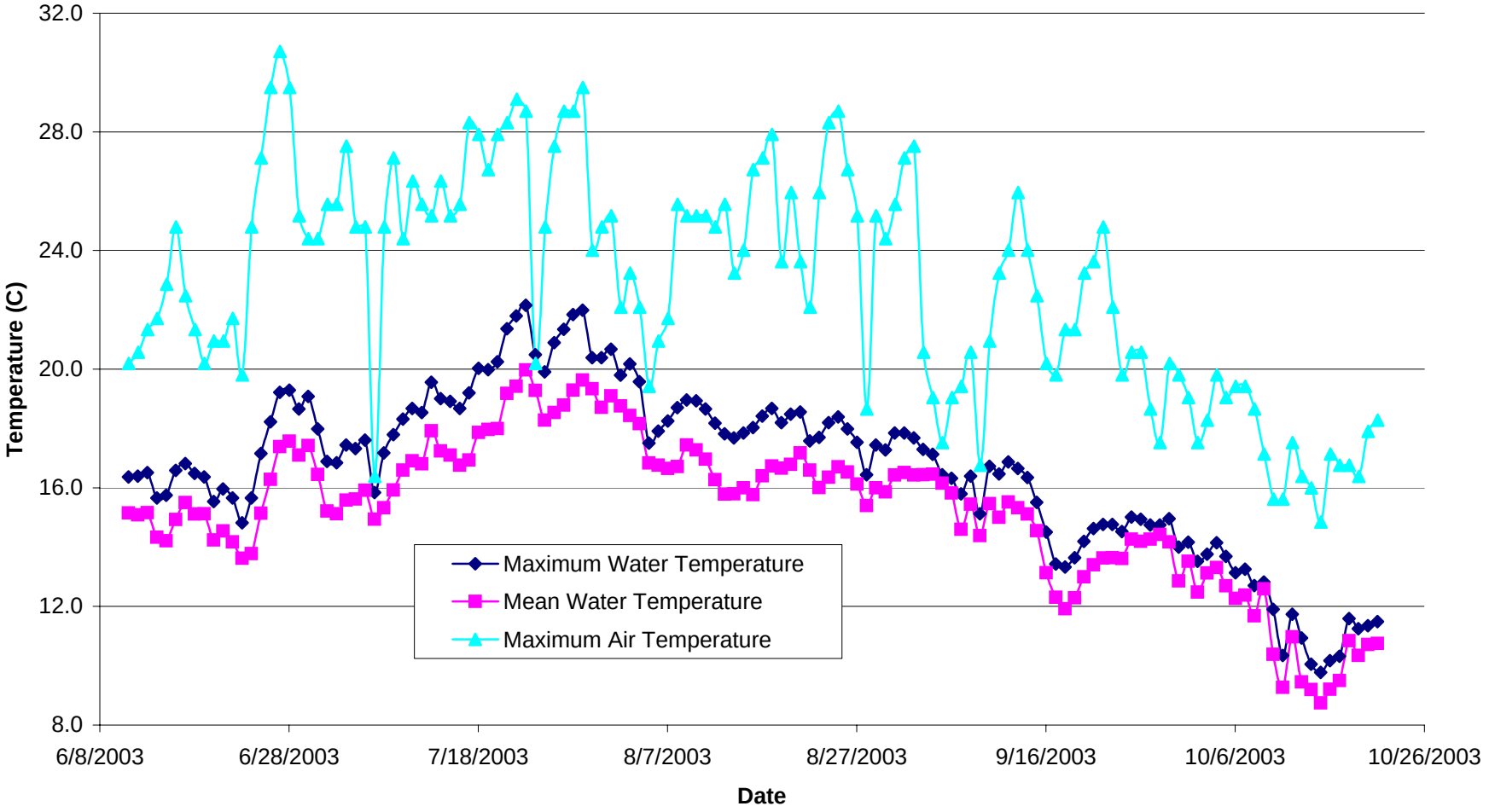


Figure T79-05. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Daugherty Creek (Site T79-05), Mendocino County, California.

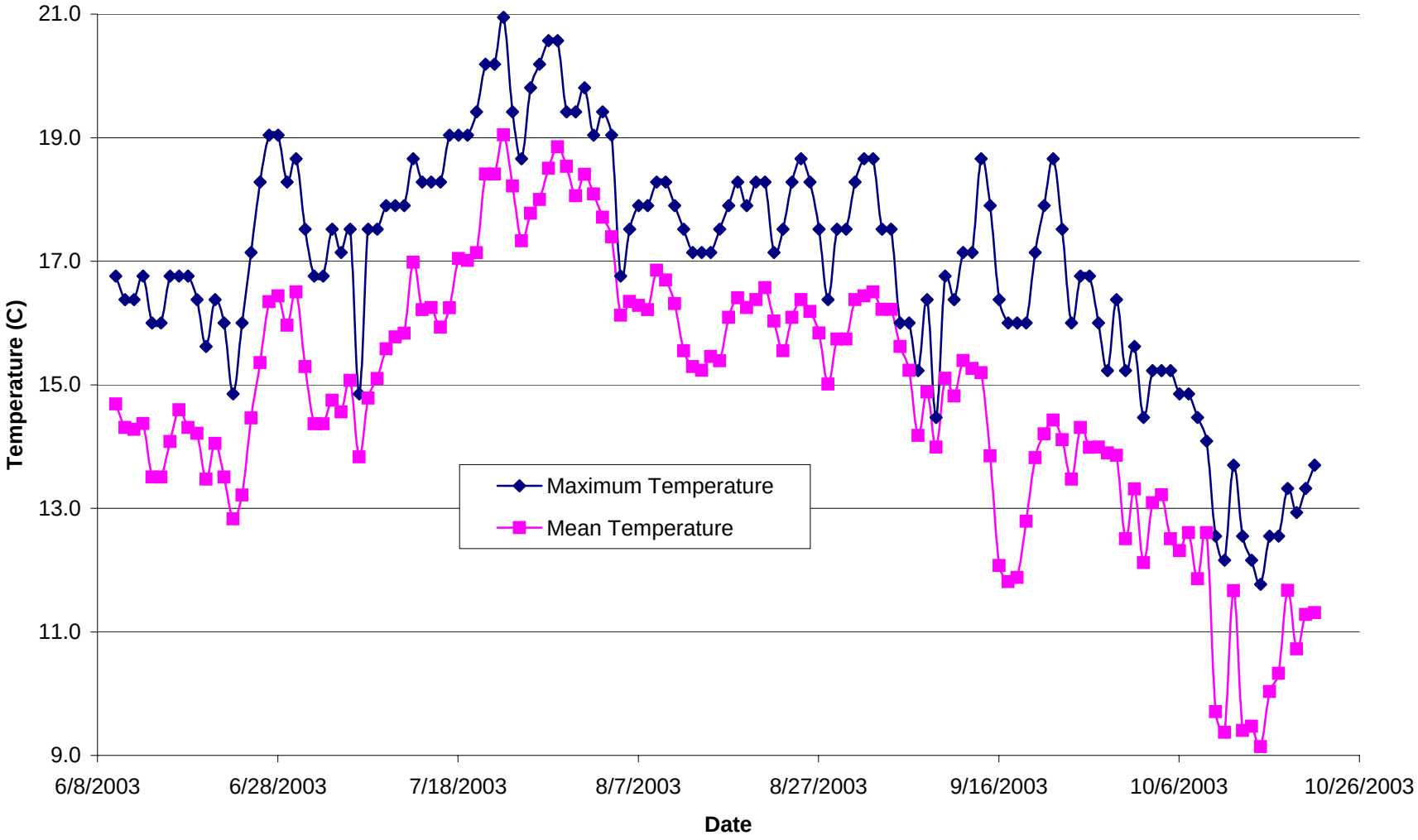


Figure T79-08. Mean and Maximum Daily Stream Temperatures During Summer 2003 at North Fork Ramon Creek (Site T79-08), Mendocino County, California.

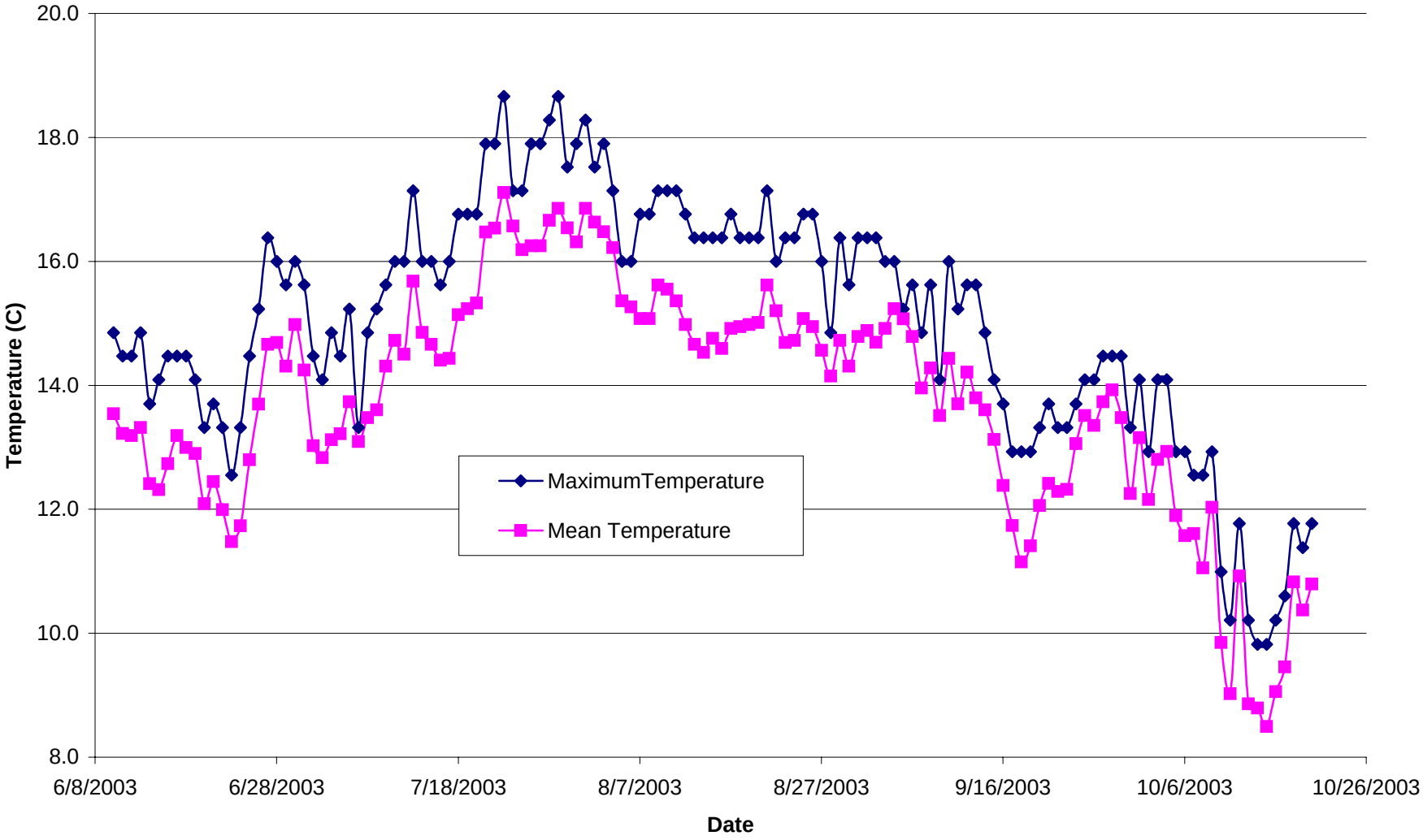


Figure T79-09. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Gates Creek (Site T79-09), Mendocino County, California.

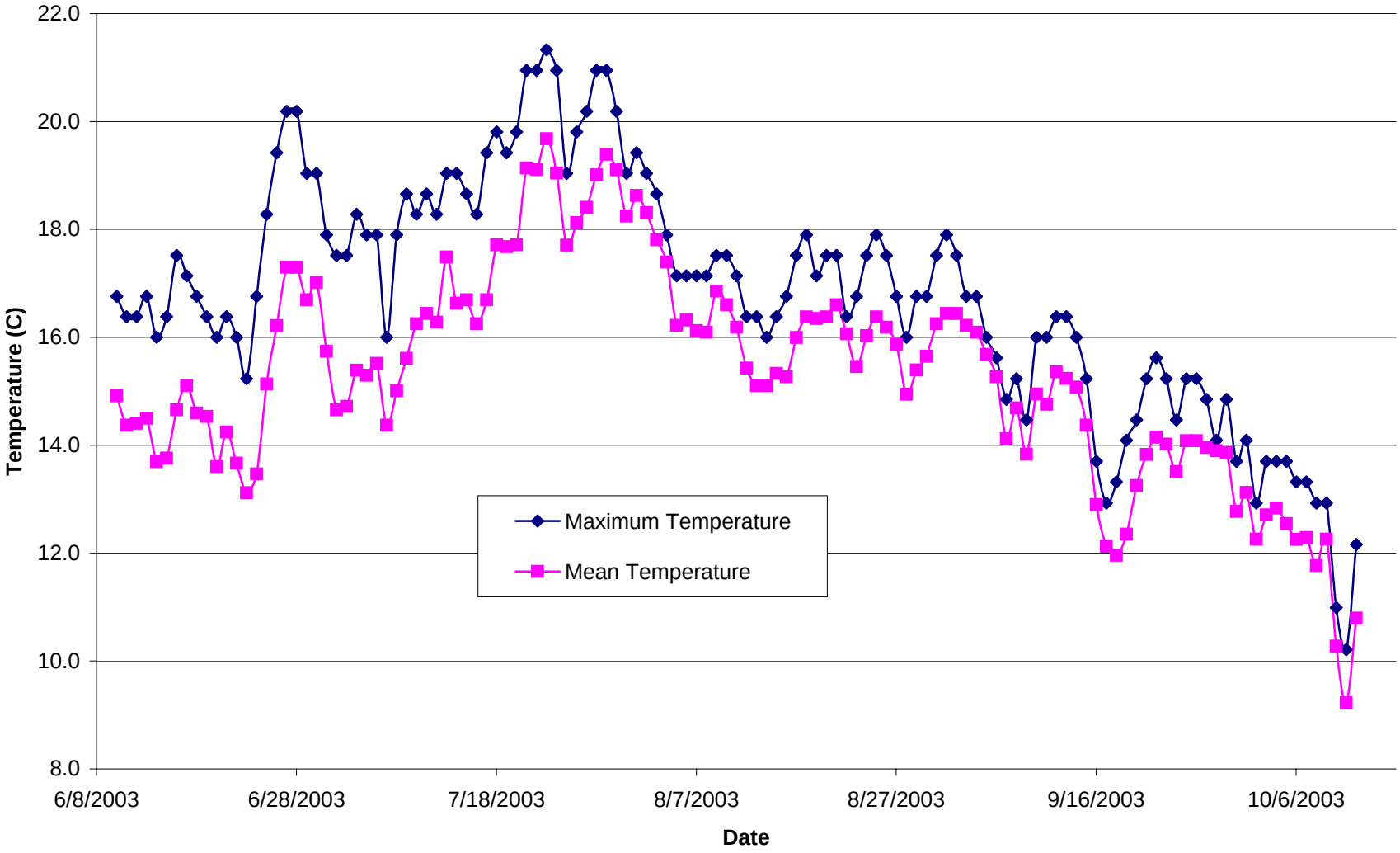


Figure T79-10. Maximum Air and Mean and Maximum Daily Stream Temperatures During Summer 2003 at Ramon Creek (Site T79-10 and T79-10A), Mendocino County, California.

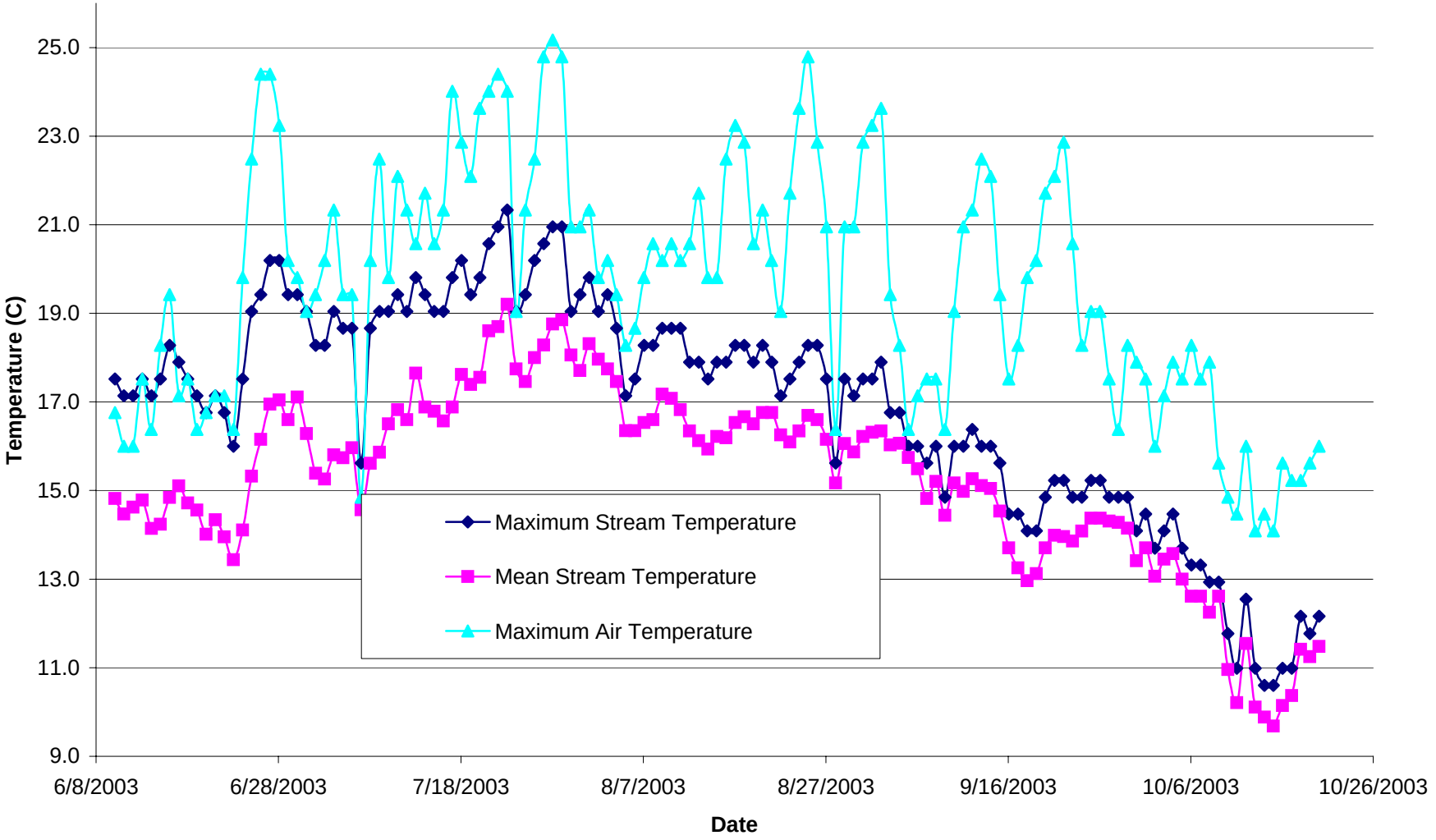


Figure T79-11. Mean and Maximum Daily Stream Temperatures During Summer 2003 at South Fork Big River (Site T79-11), Mendocino County, California.

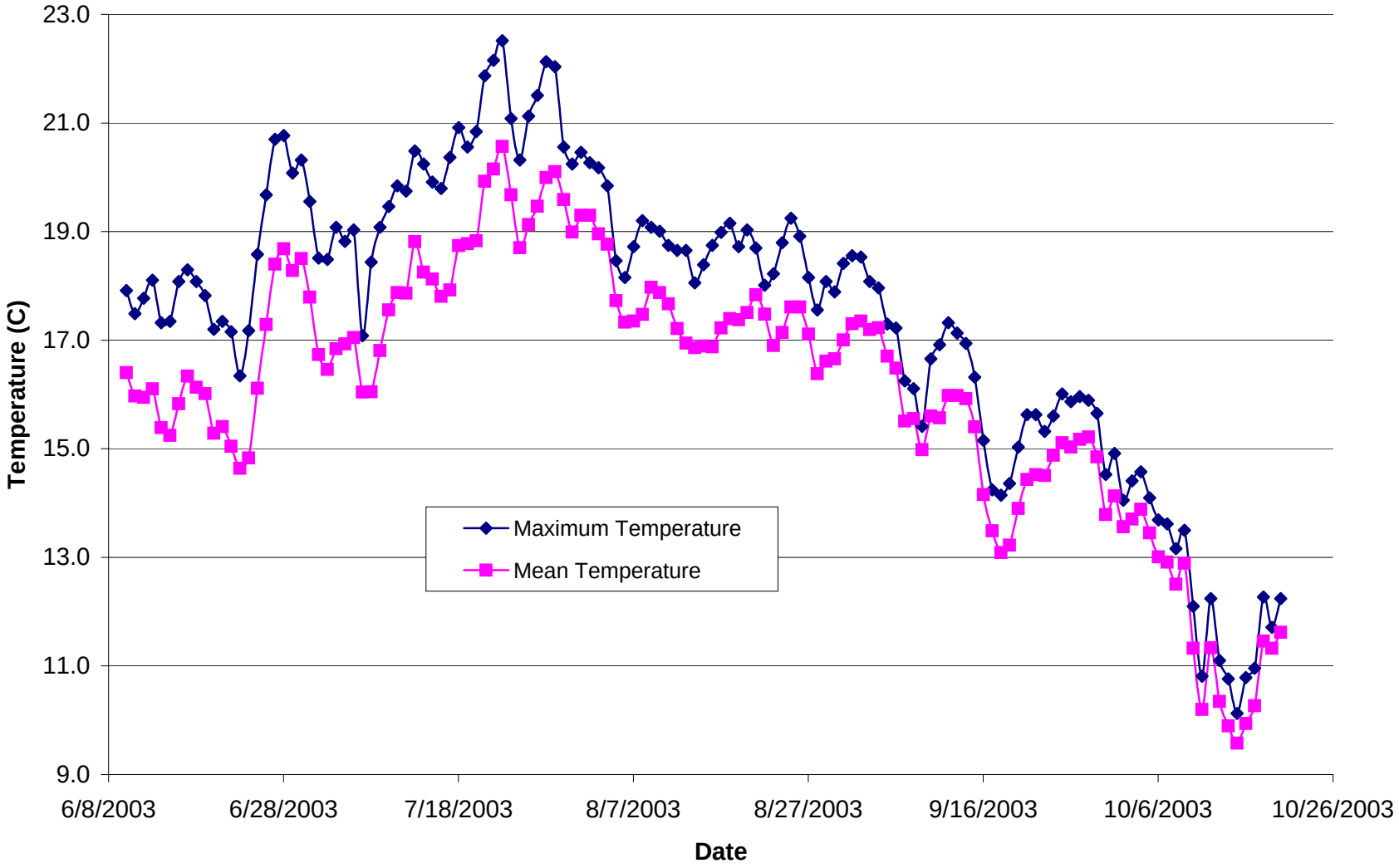


Figure T79-12. Mean and Maximum Daily Stream Temperatures During Summer 2003 at South Fork Big River (Site T79-12), Mendocino County, California.

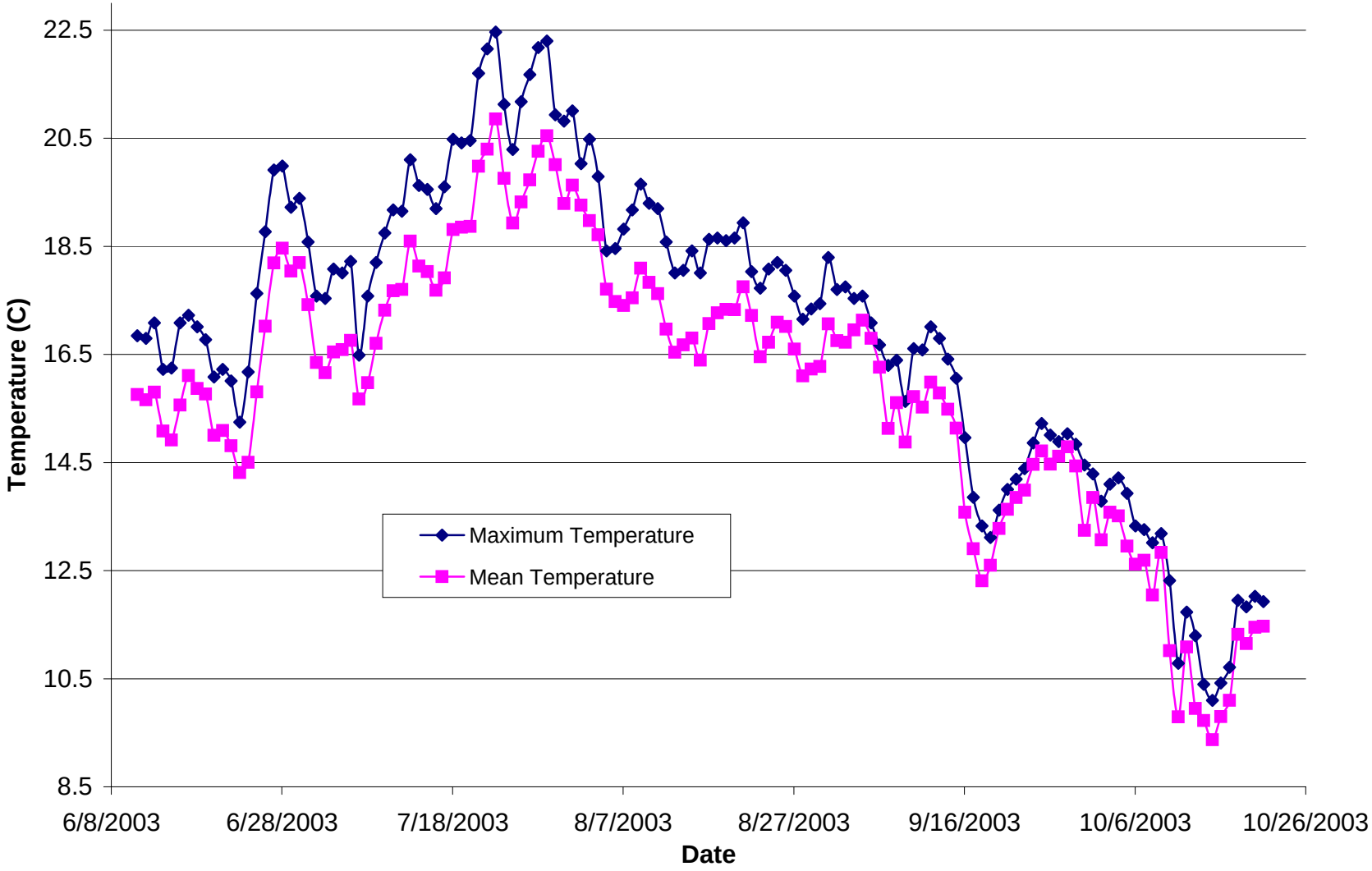


Figure T79-13. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Johnson Creek (Site T79-13), Mendocino County, California.

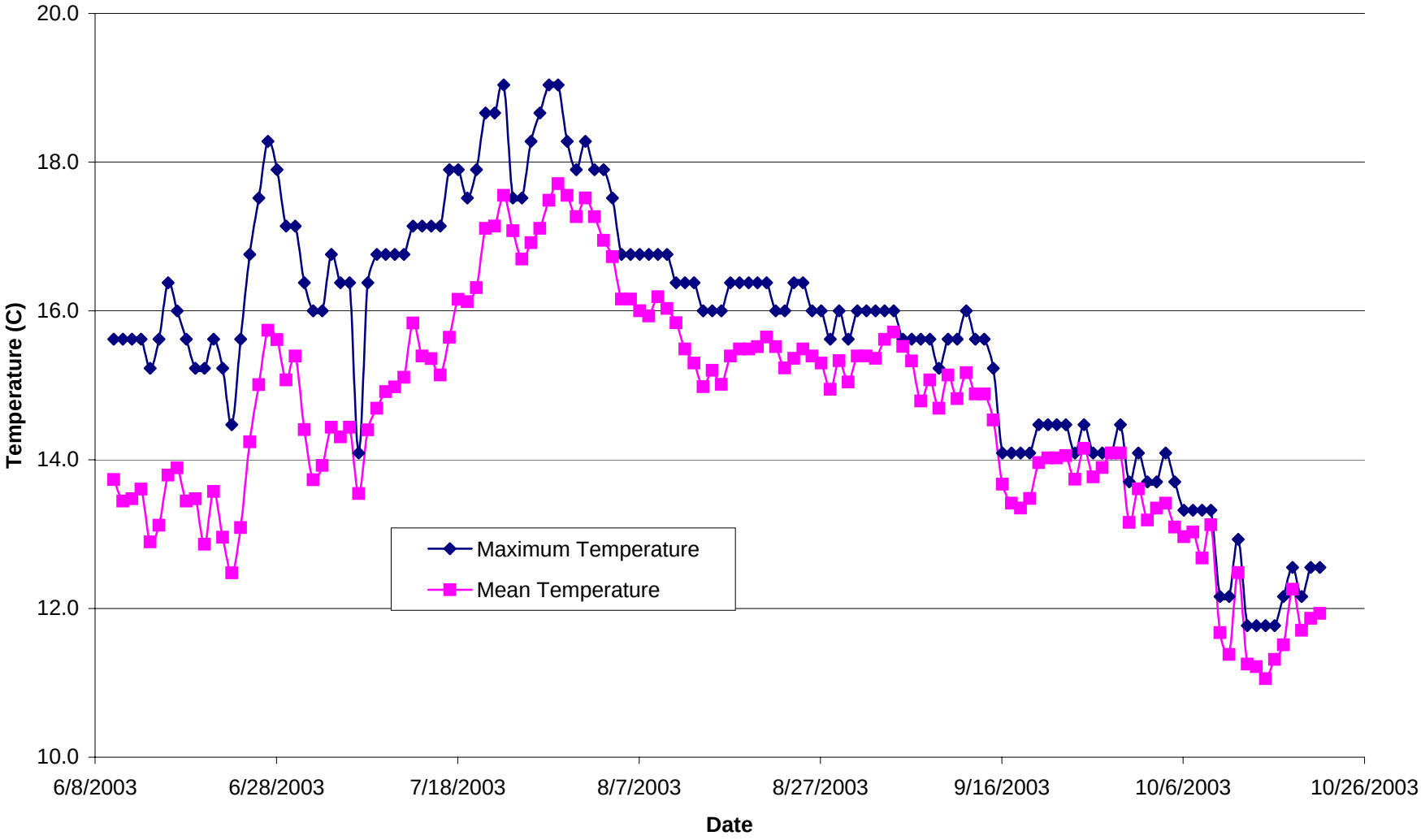


Figure T74-03. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Big River (Site T74-03), Mendocino County, California.

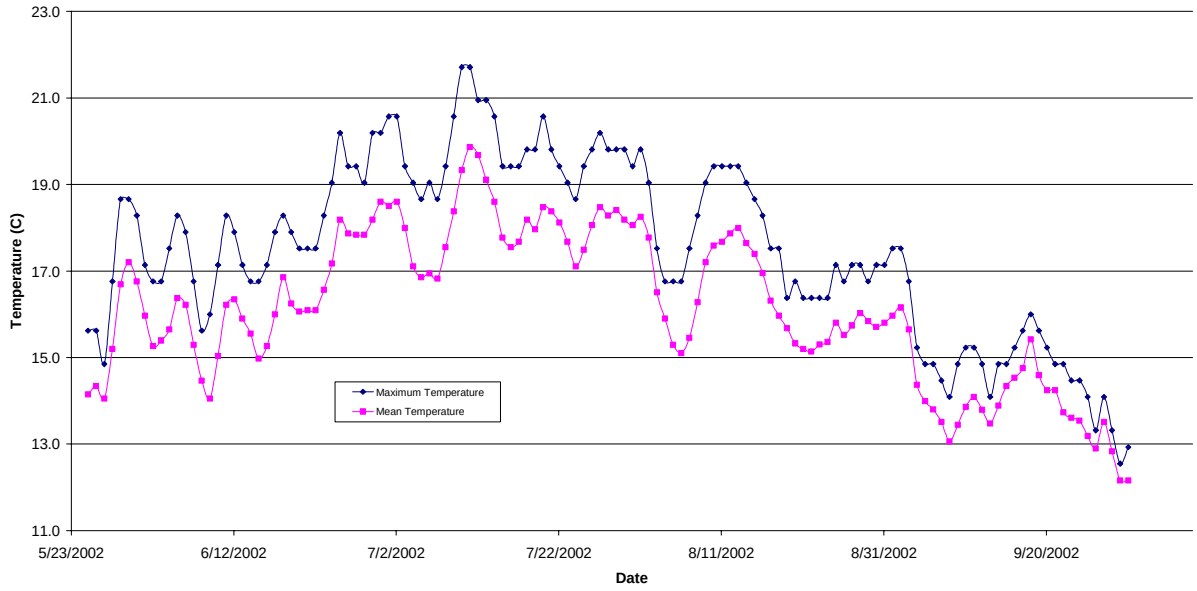


Figure T74-01. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Big River (Site T74-01), Mendocino County, California.

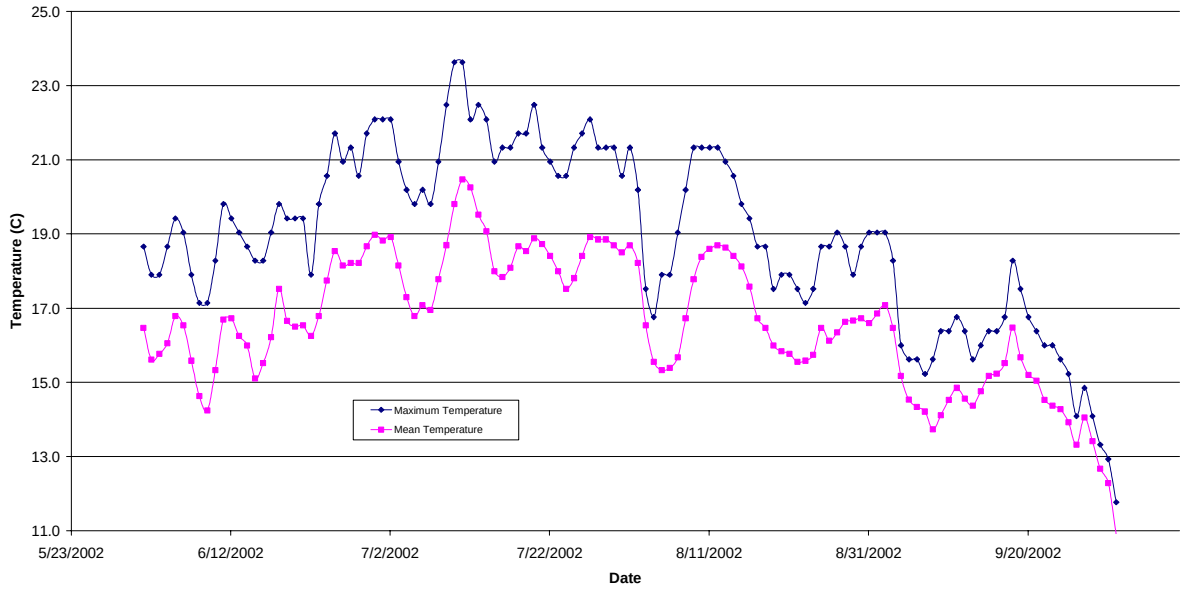


Figure T75-05. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Bull Team Gulch (Site T75-05), Mendocino County, California.
*****Data recorder was buried under a thick mat of algae upon retrieval.**

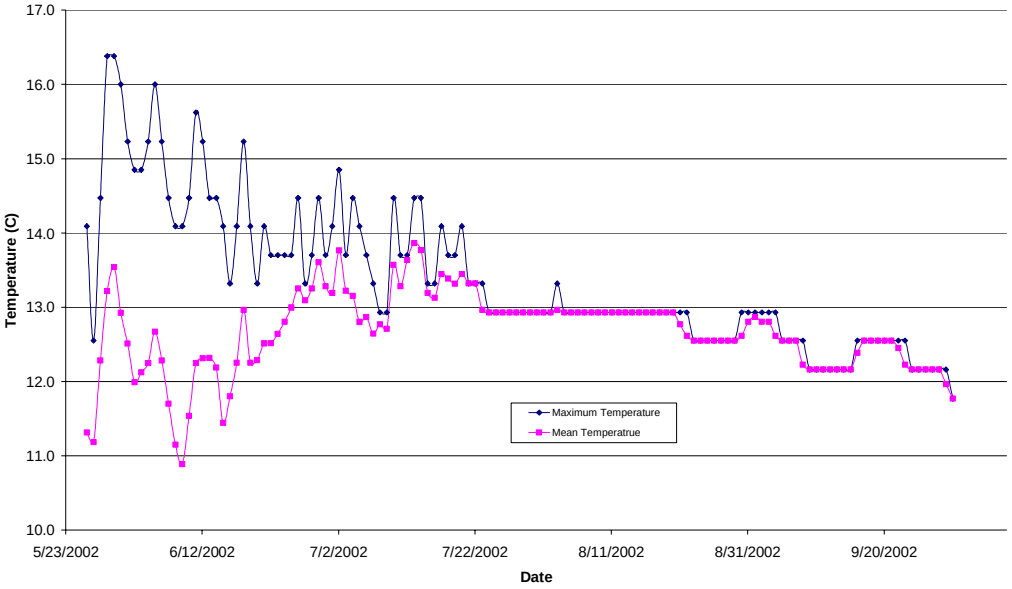


Figure T79-05. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Daugherty Creek (Site T79-05), Mendocino County, California.

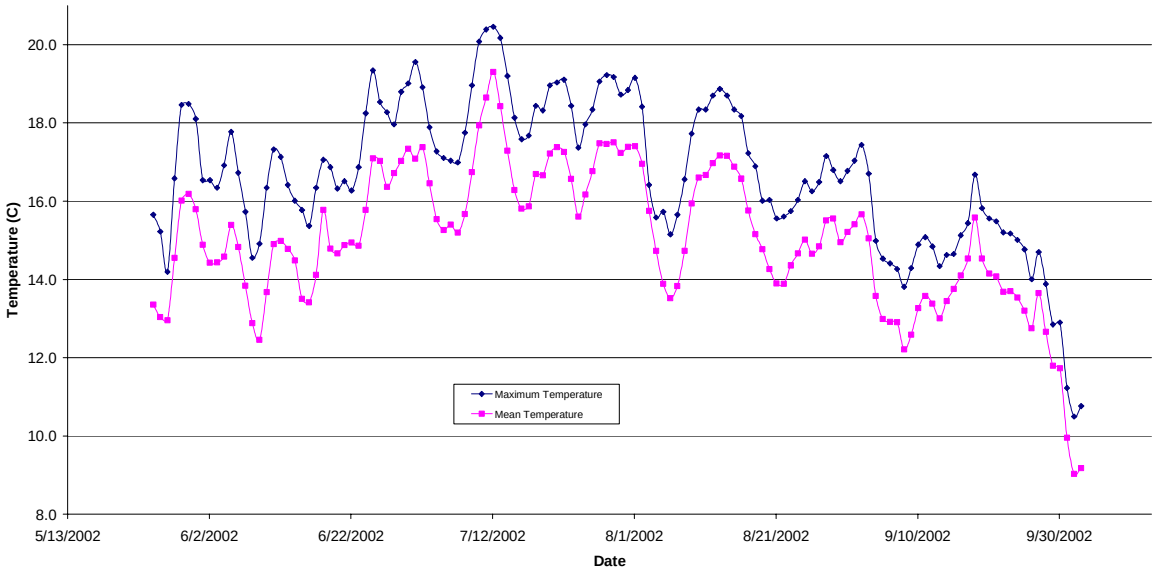


Figure T79-04. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2002 at Daugherty Creek (Site T79-04), Mendocino County, California.

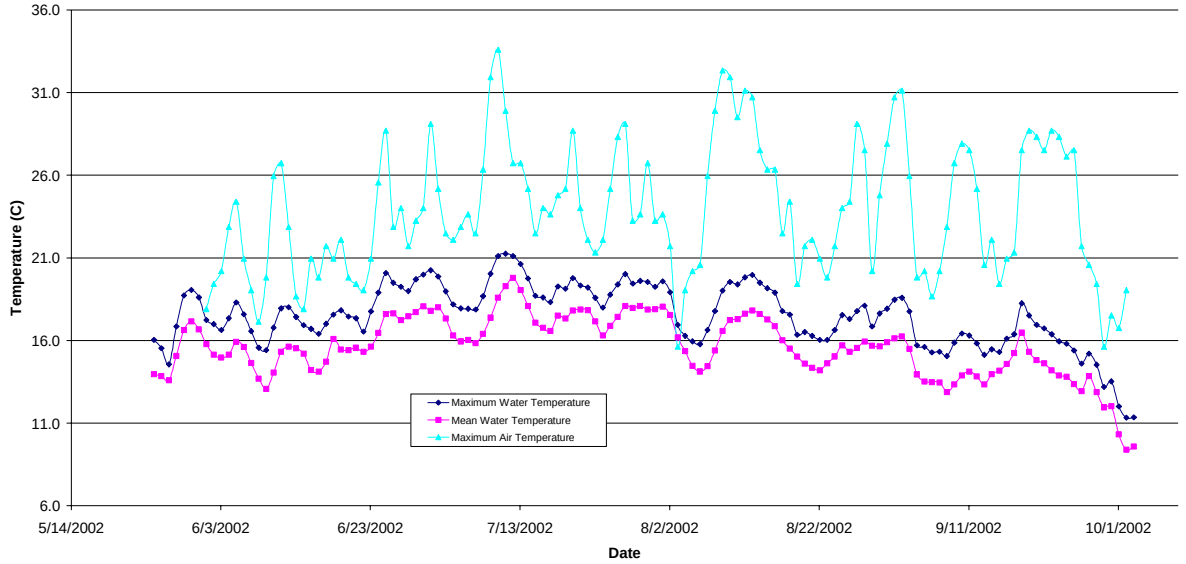


Figure T75-03. Mean and Maximum Daily Stream Temperatures During Summer 2002 at East Branch North Fork Big River (Site T75-03), Mendocino County, California.

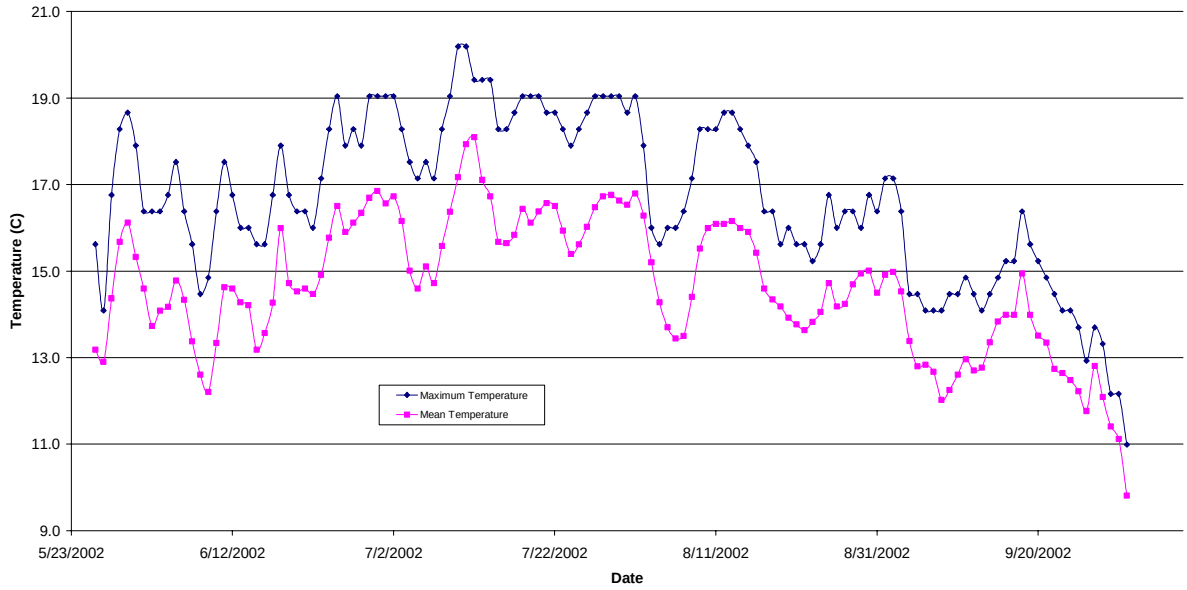


Figure T75-01. Mean and Maximum Daily Stream Temperatures During Summer 2002 at East Branch North Fork Big River (Site T75-01), Mendocino County, California.

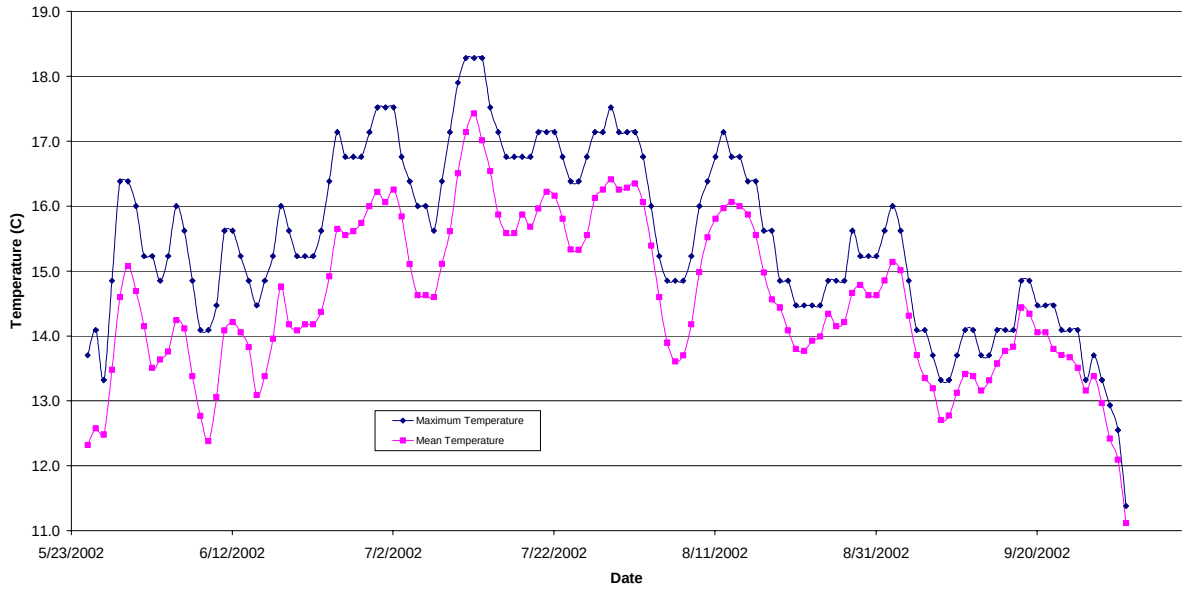


Figure T79-09. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Gates Creek (Site T79-09), Mendocino County, California.

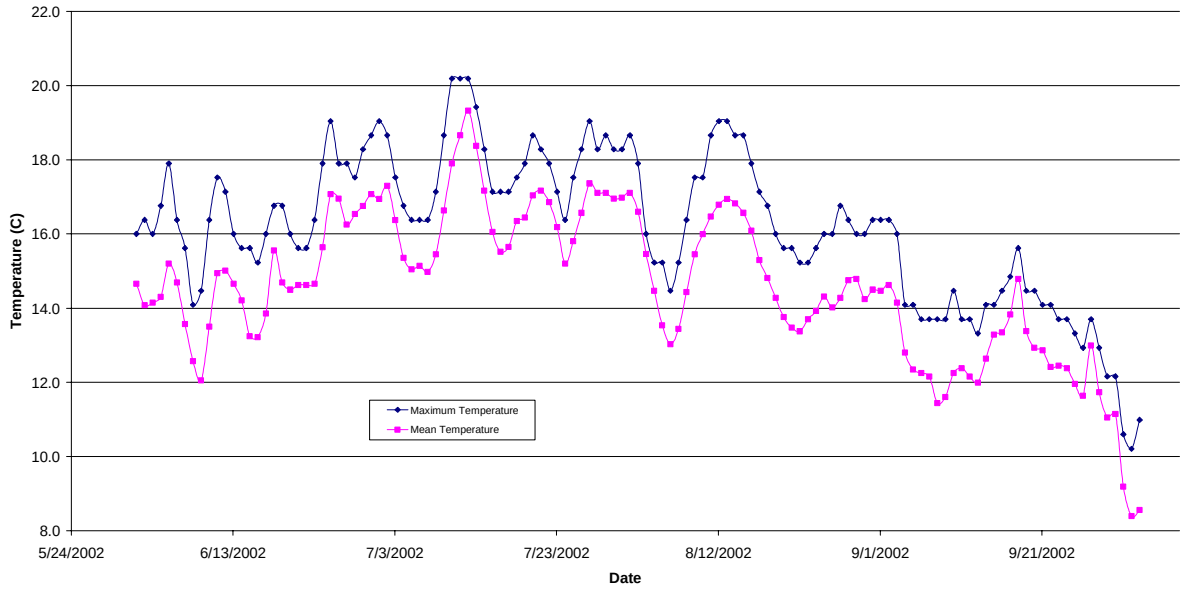


Figure T79-13. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Johnson Creek (Site T79-13), Mendocino County, California.

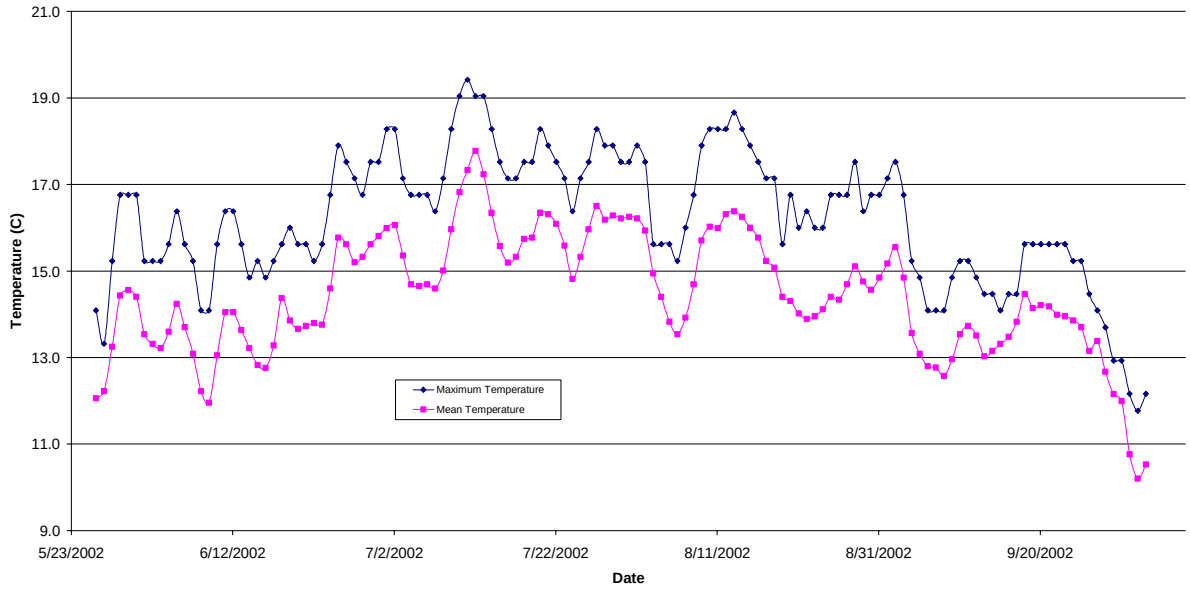


Figure T75-04. Mean and Maximum Daily Stream Temperatures During Summer 2002 at North Fork Big River (Site T75-04), Mendocino County, California.

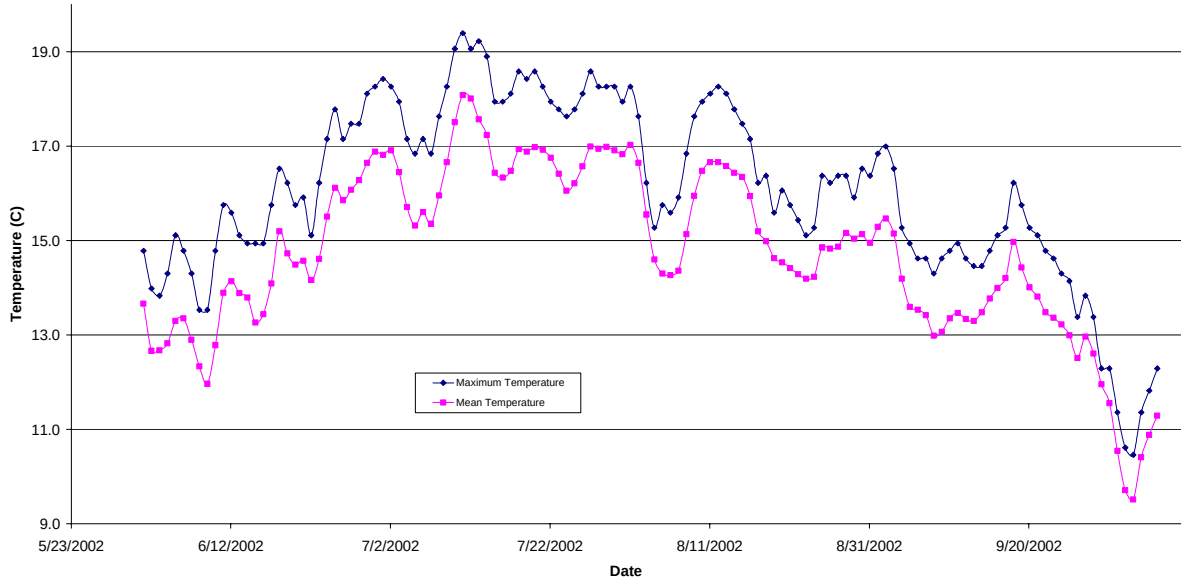


Figure T79-08. Mean and Maximum Daily Stream Temperatures During Summer 2002 at North Fork Ramon Creek (Site T79-08), Mendocino County, California.

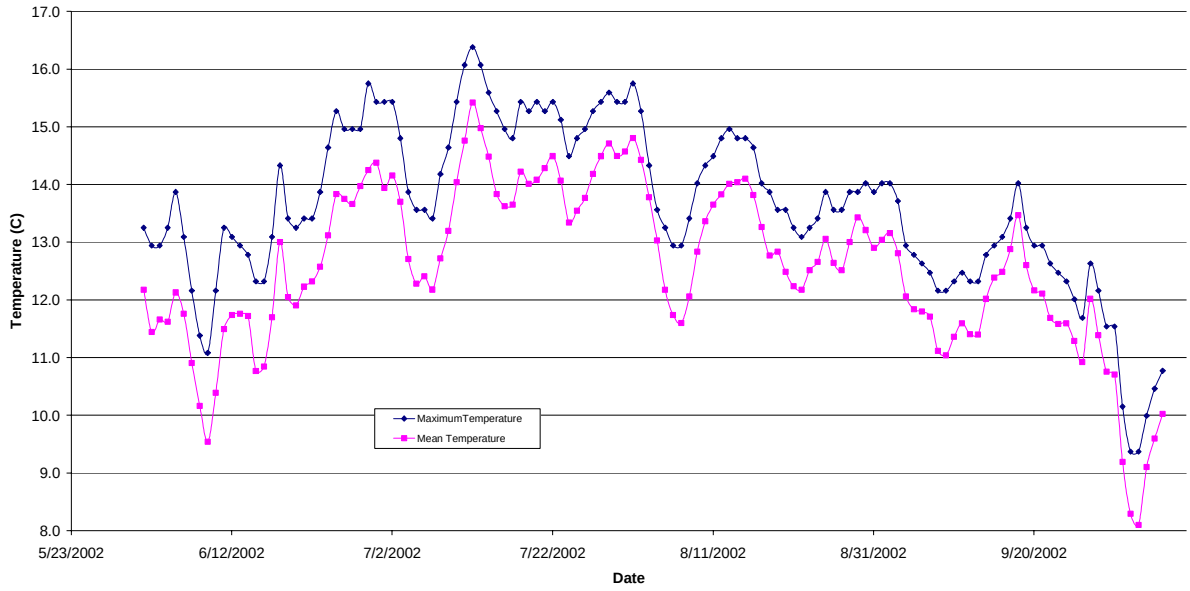


Figure T79-10. Maximum Air and Mean and Maximum Daily Stream Temperatures During Summer 2002 at Ramon Creek (Site T79-10 and T79-10A), Mendocino County, California.
*****Air temperature data recorder was not in the original location upon retrieval.**

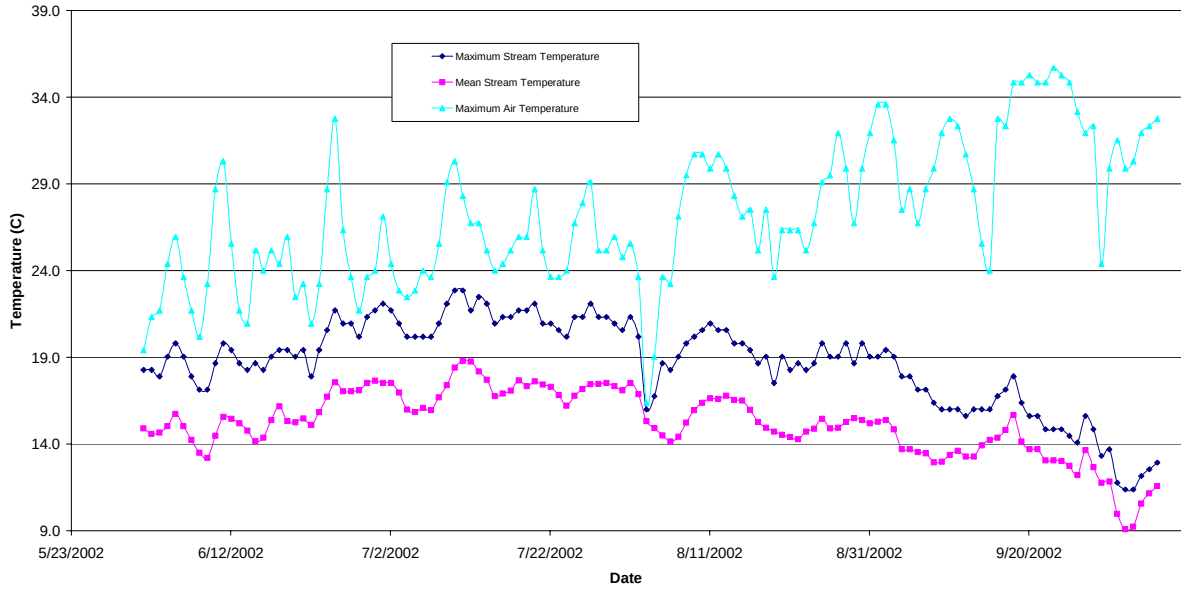


Figure T79-02. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Ramon Creek (Site T79-02), Mendocino County, California.

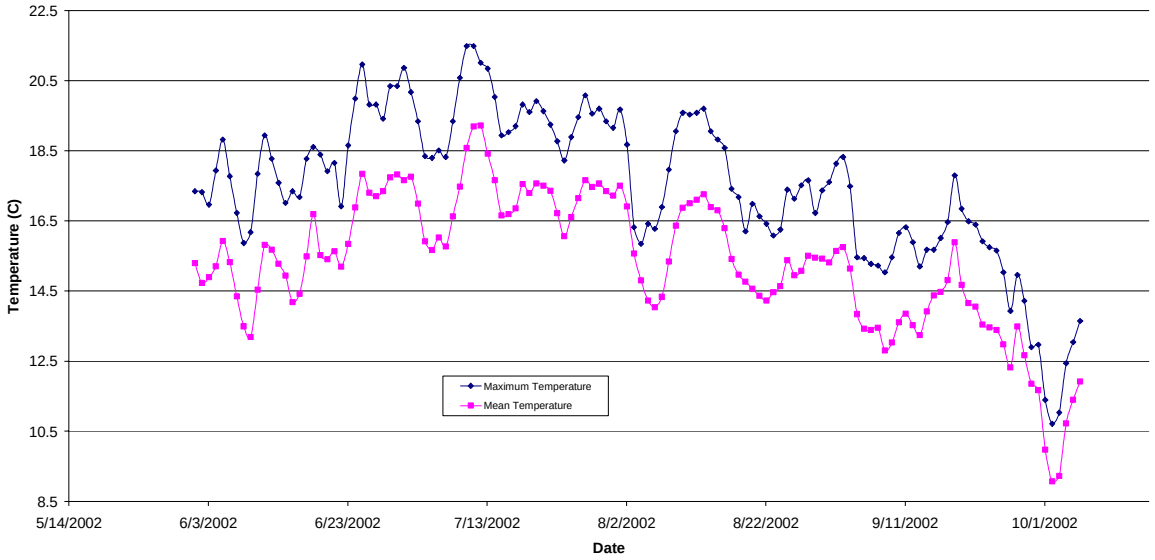


Figure T74-02. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Russell Brook Creek (Site T74-02), Mendocino County, California.

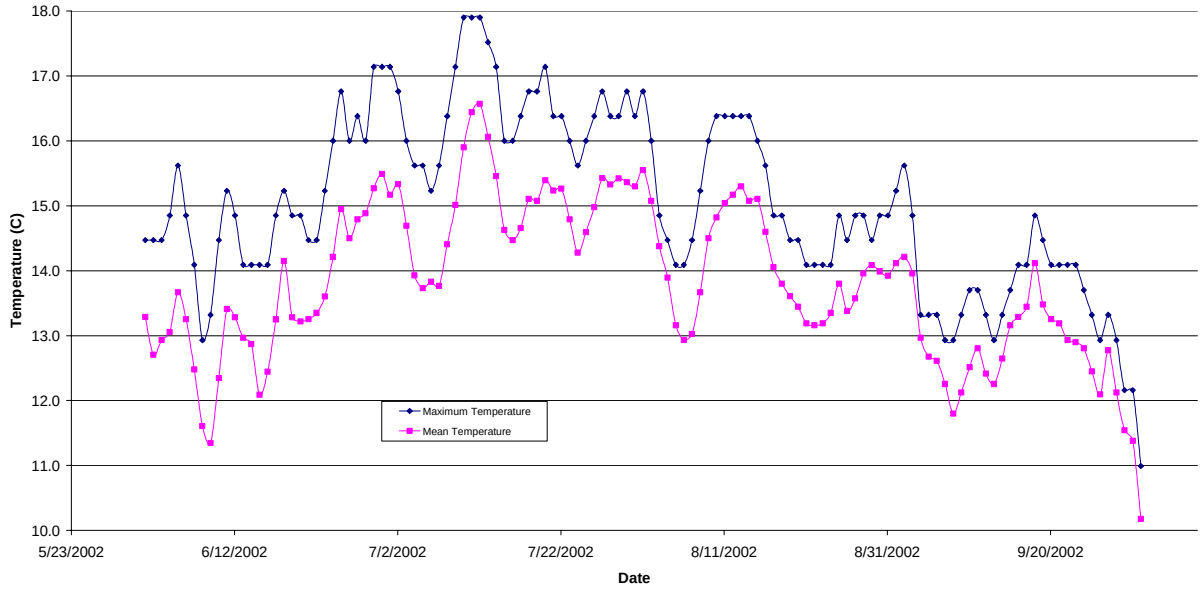


Figure T79-01. Mean and Maximum Daily Stream Temperatures During Summer 2002 at South Fork Big River (Site T79-01), Mendocino County, California.

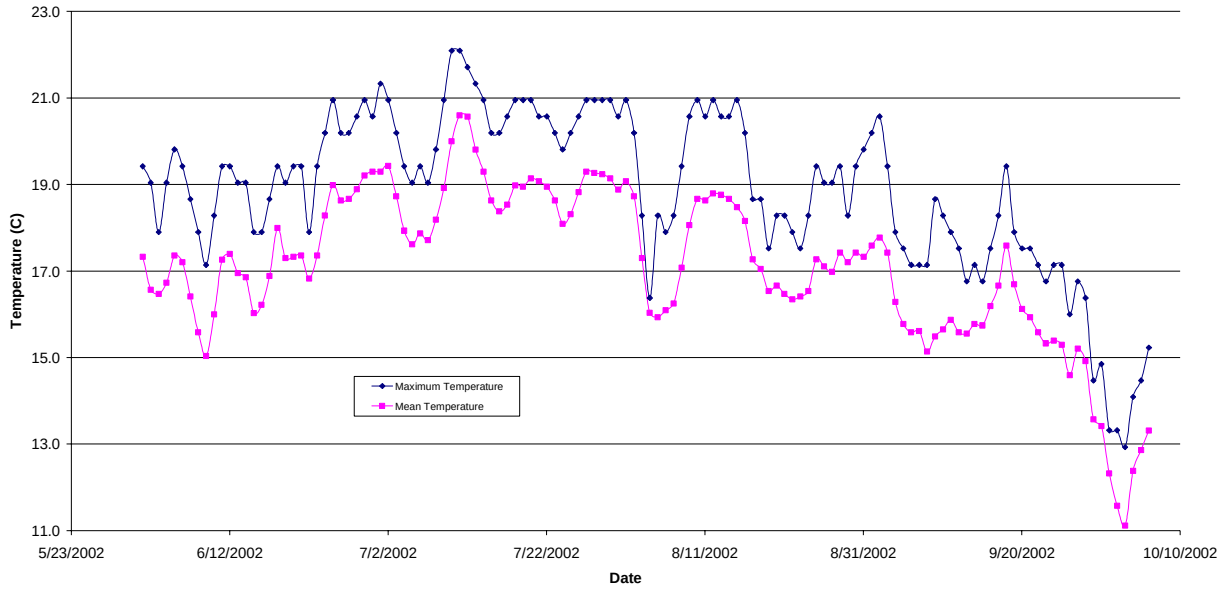


Figure T79-12. Mean and Maximum Daily Stream Temperatures During Summer 2002 at South Fork Big River (Site T79-12), Mendocino County, California.

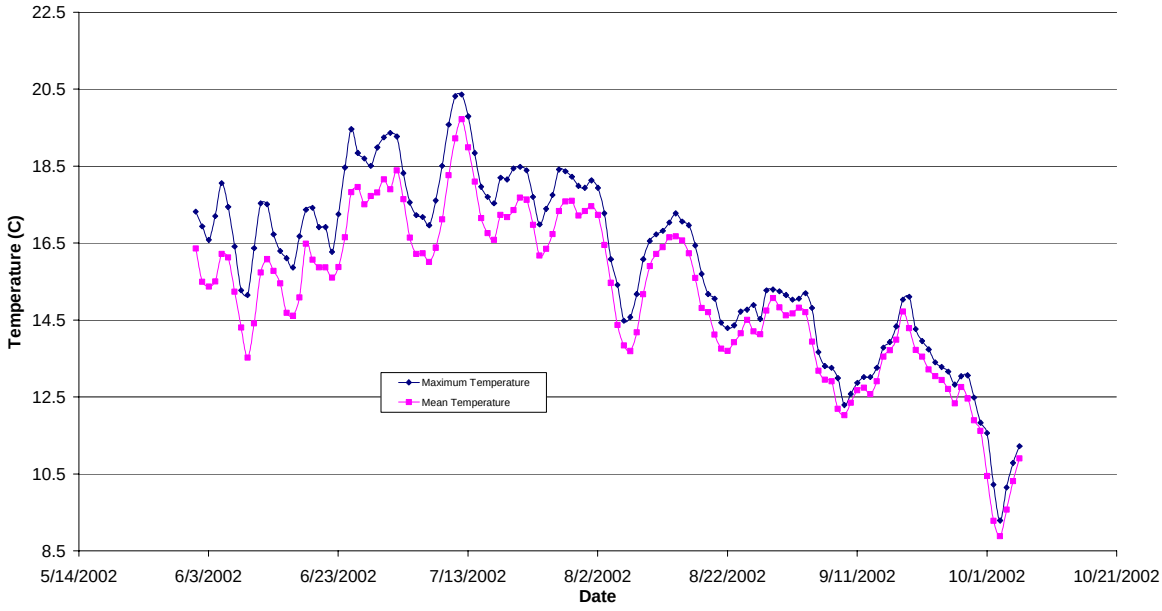


Figure T79-11. Mean and Maximum Daily Stream Temperatures During Summer 2002 at South Fork Big River (Site T79-11), Mendocino County, California.

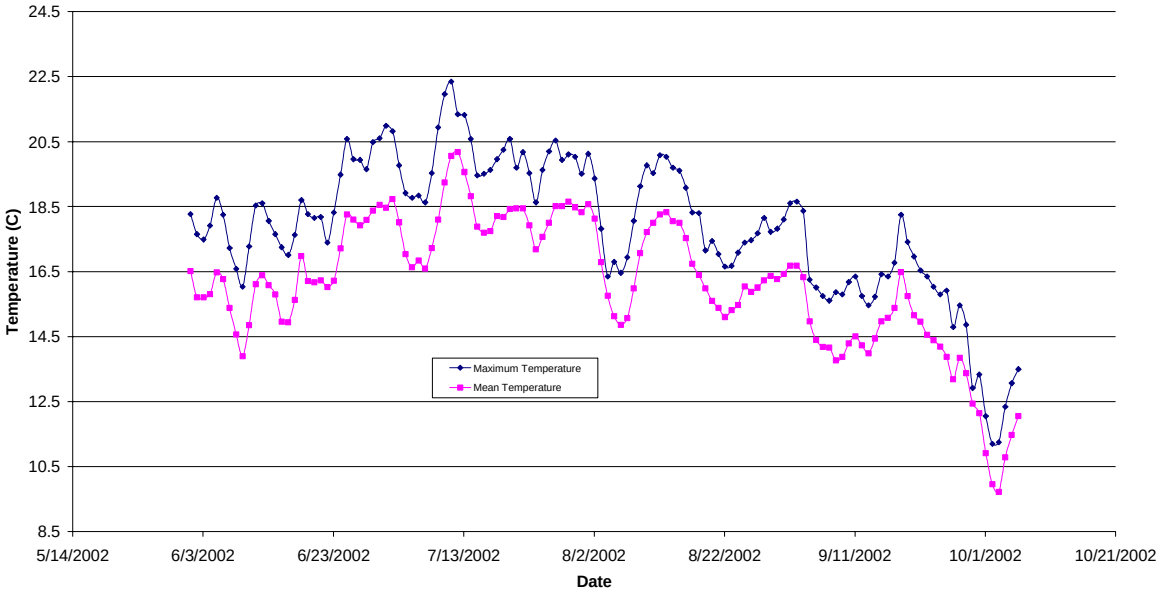


Figure T76-02. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Two Log Creek (Site T76-02), Mendocino County, California.

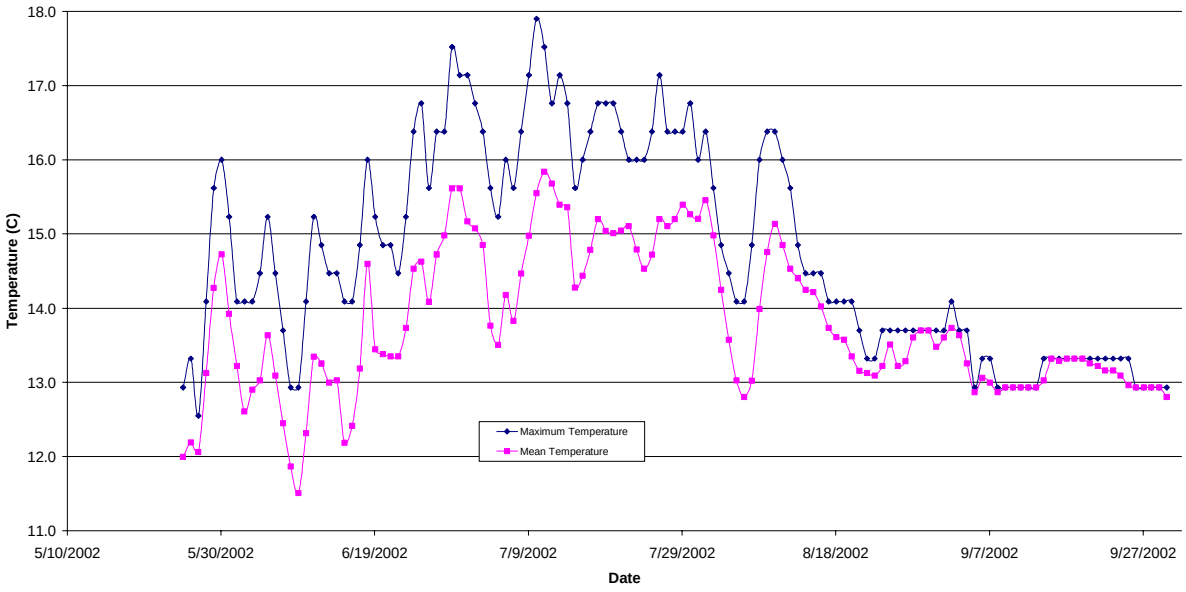


Figure 48. Mean and Maximum Daily Stream Temperature During Summer 2001 at Big River (Site 74-3), Mendocino County, Calfornia.

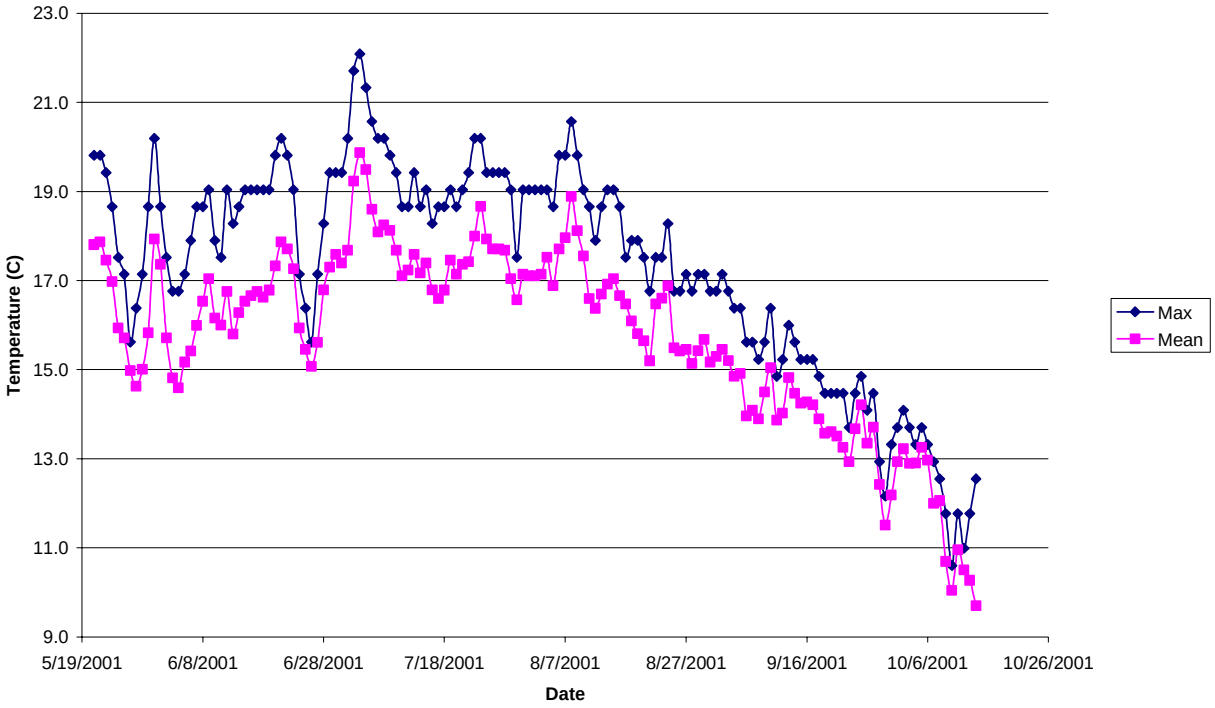


Figure 46. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Big River (Site 74-1), Mendocino County, California

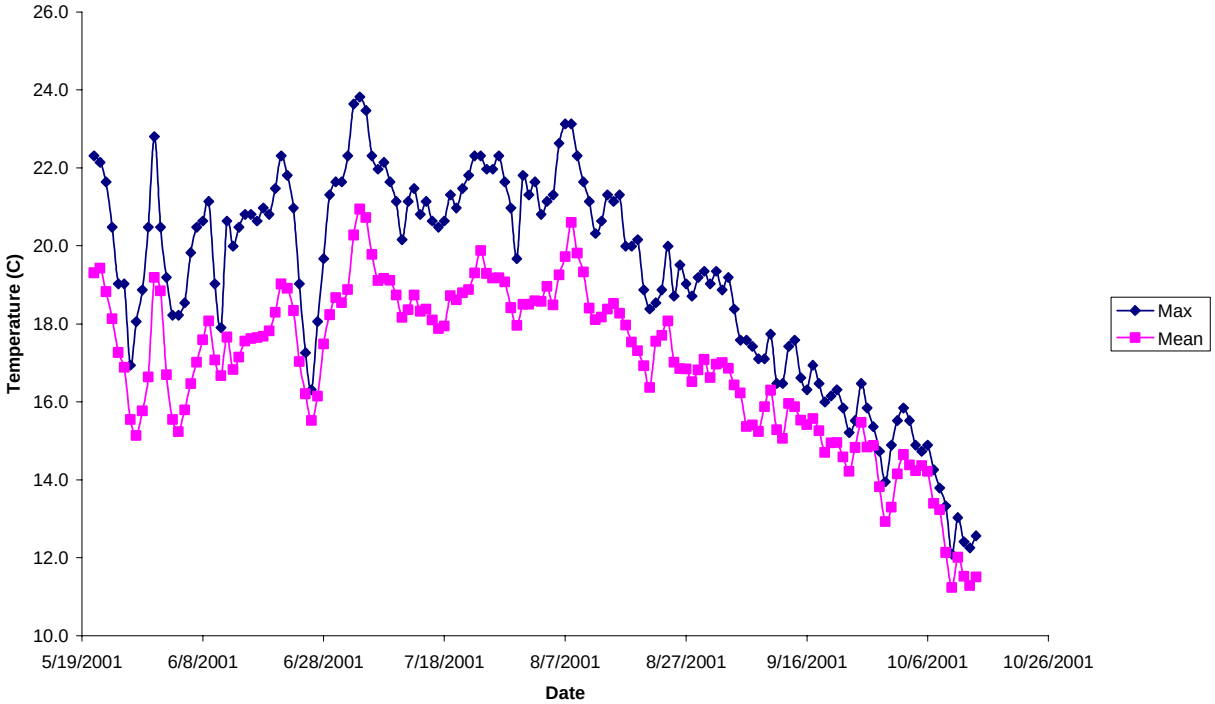


Figure 59. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Daugherty Creek (Site 79-4), Mendocino County, California.

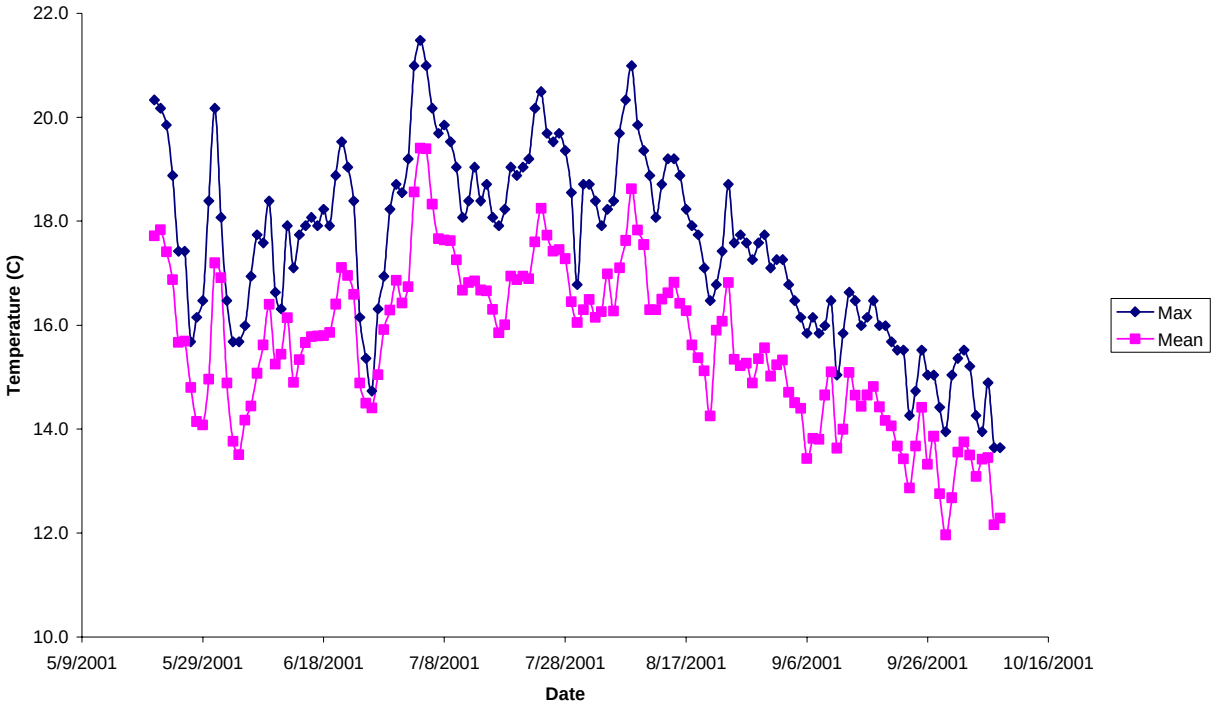


Figure 52. Mean and Maximum Daily Stream Temperatures During Summer 2001 at East Branch North Fork Big River (Site75-3), Mendocino County, California.

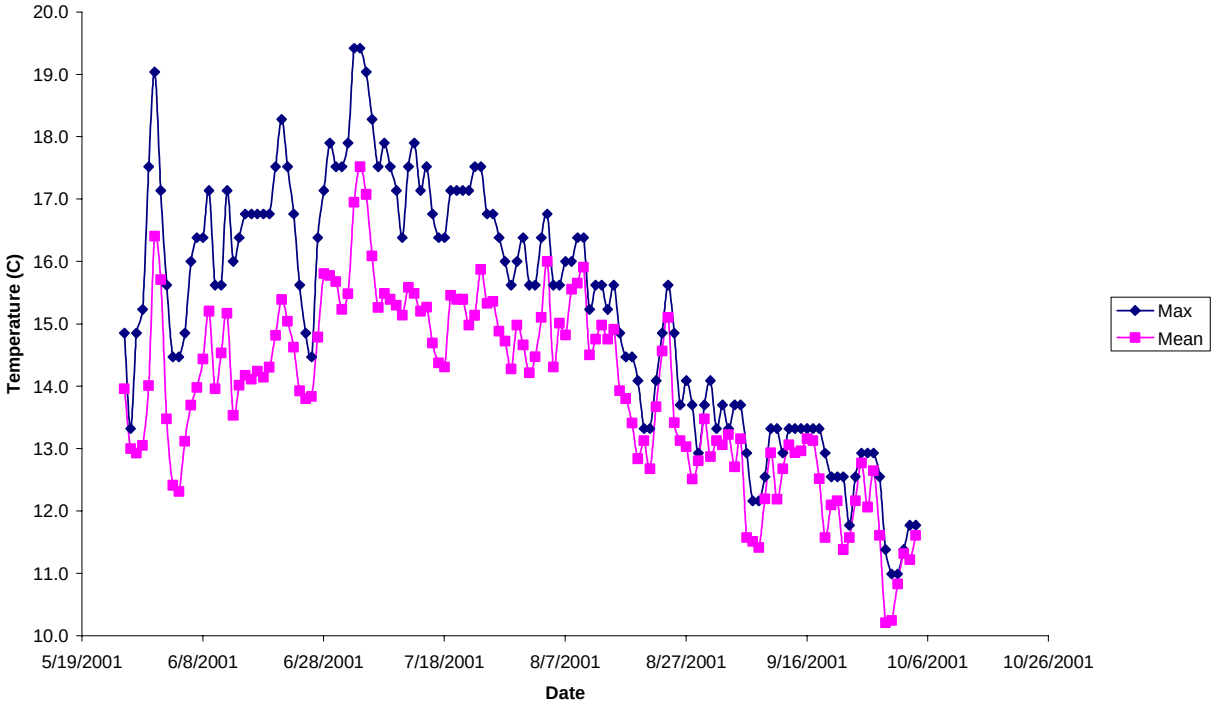


Figure 51. Mean and Maximum Daily Stream Temperatures During Summer 2001 at East Branch North Fork Big River (Site 75-1), Mendocino County, California.

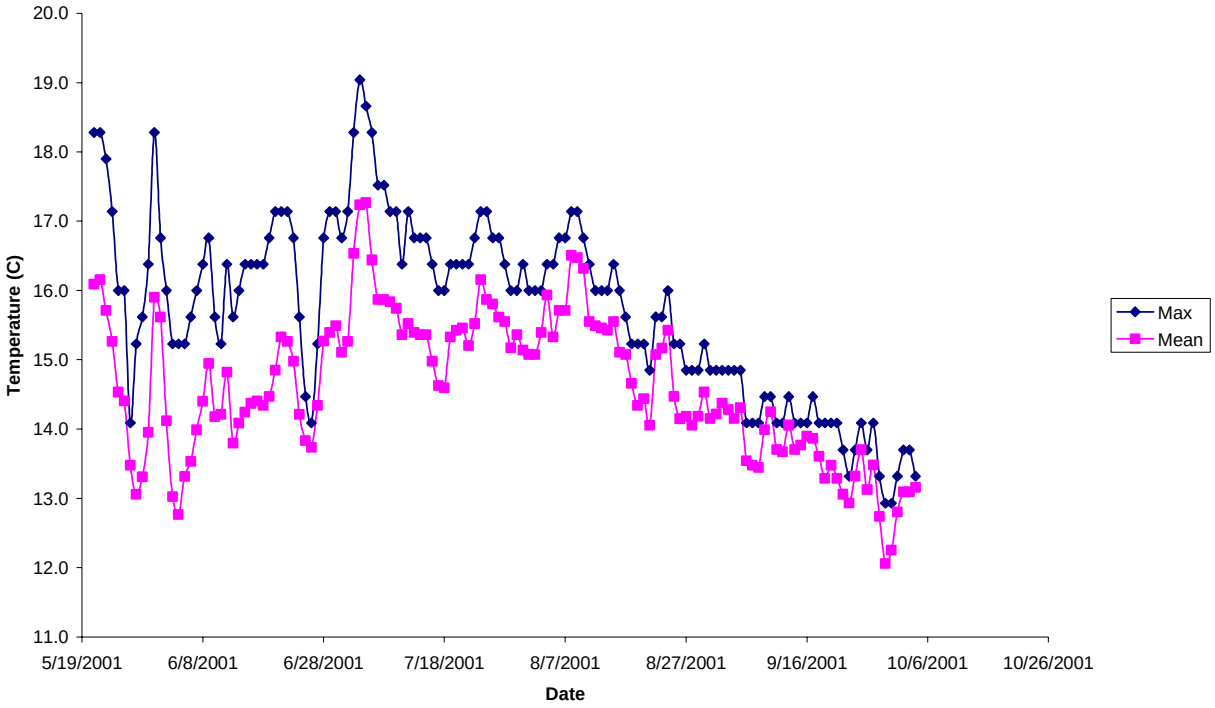


Figure 60. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Gates Creek (Site 79-9), Mendocino County, California.

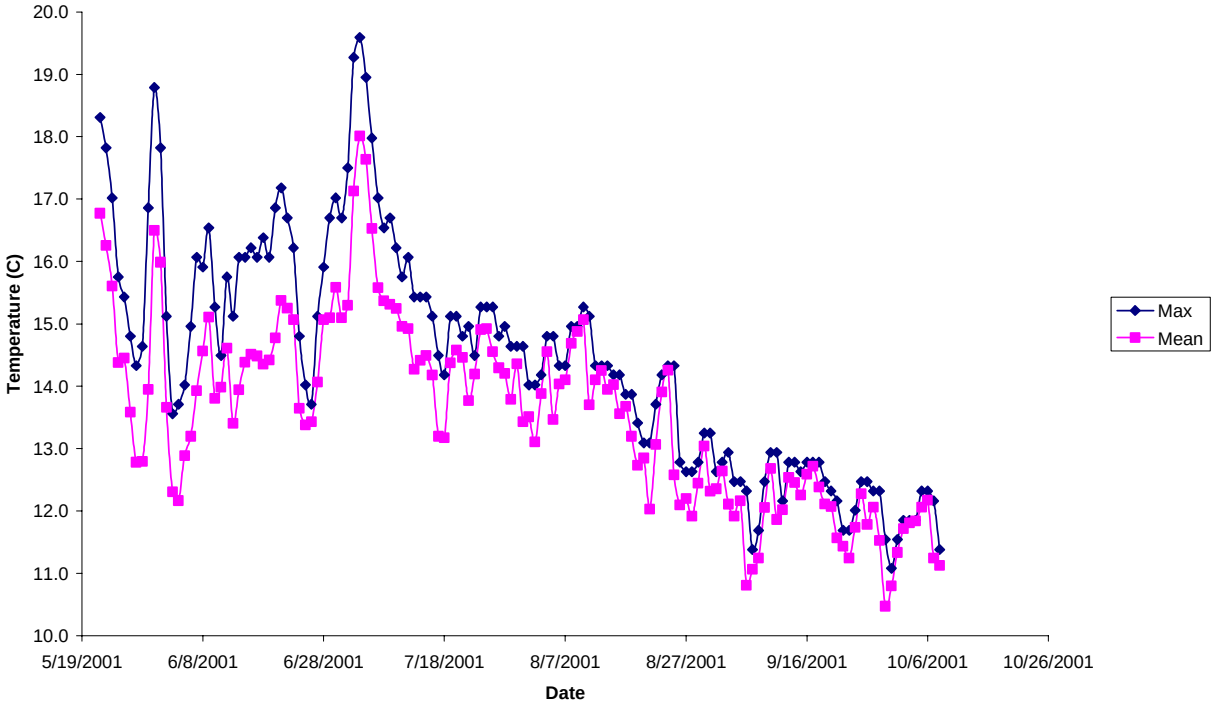


Figure 47. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Russel Brook (Site 74-2), Mendocino County, California.

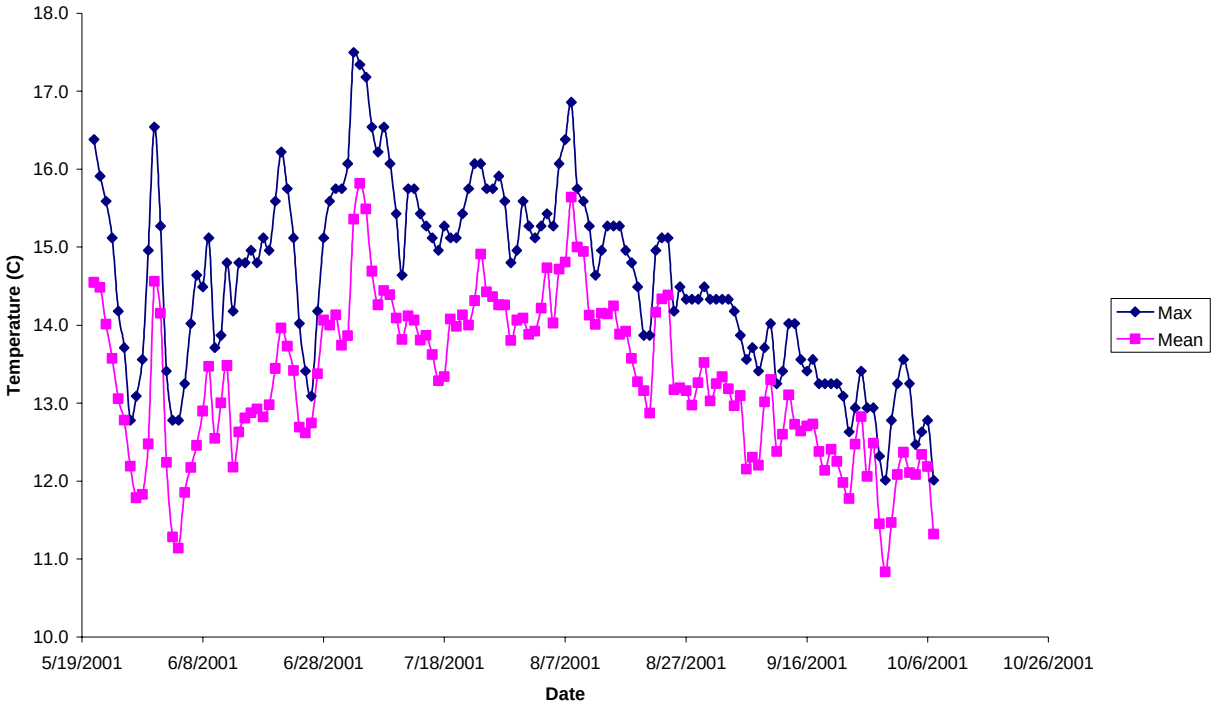


Figure 58. Mean and Maximum Daily Stream Temperatures During Summer 2001 at South Fork Big River (Site79-1), Mendocino County, California.

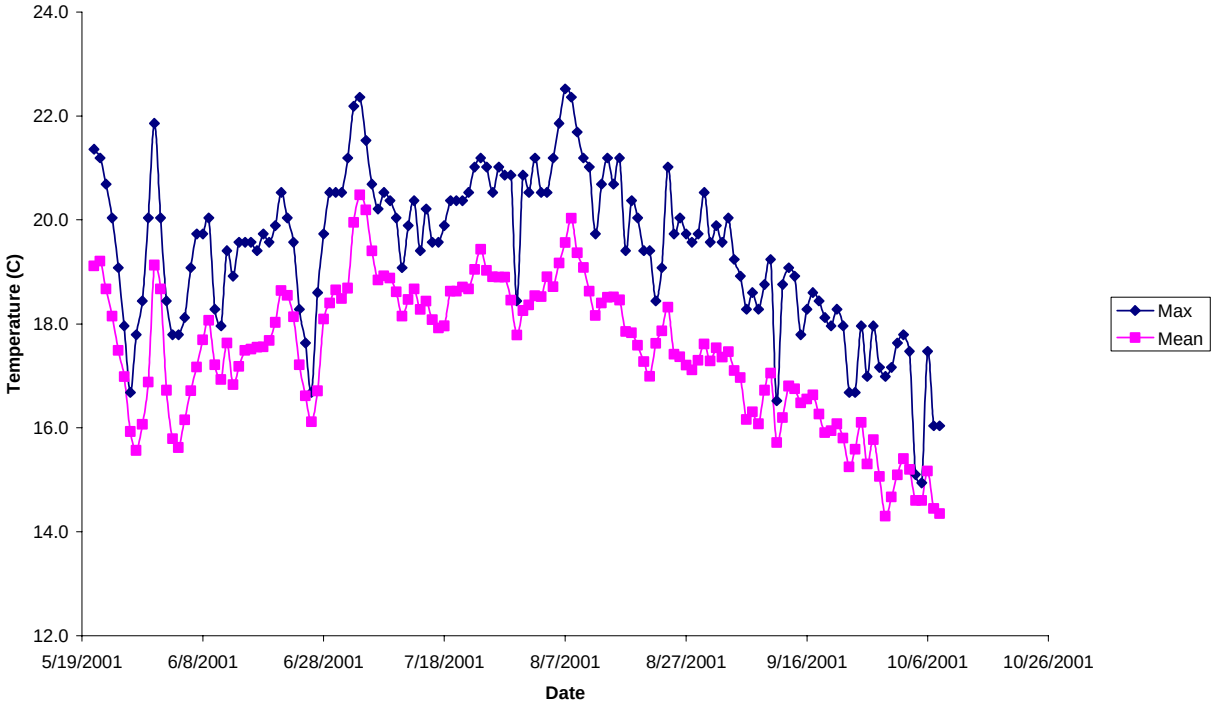


Figure 56. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Two Log Creek Site (76-2), Mendocino County, California.

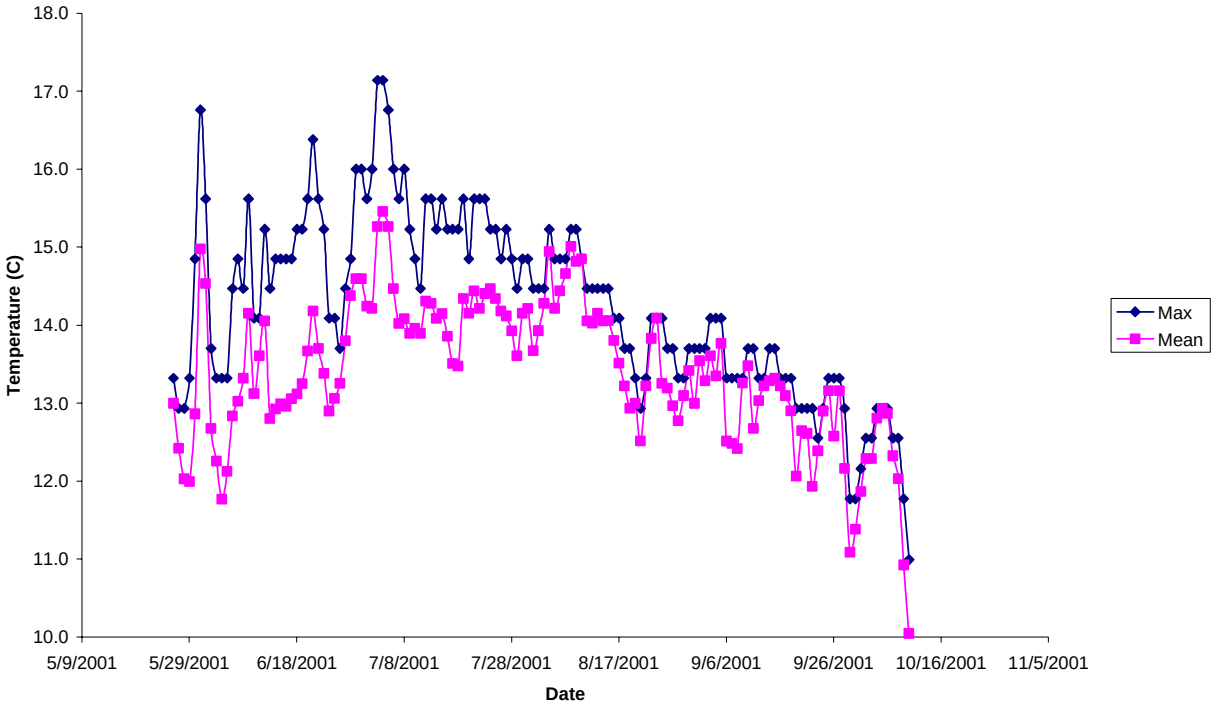


Figure 62. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Goddard Gulch (79-21), Mendocino County, California.

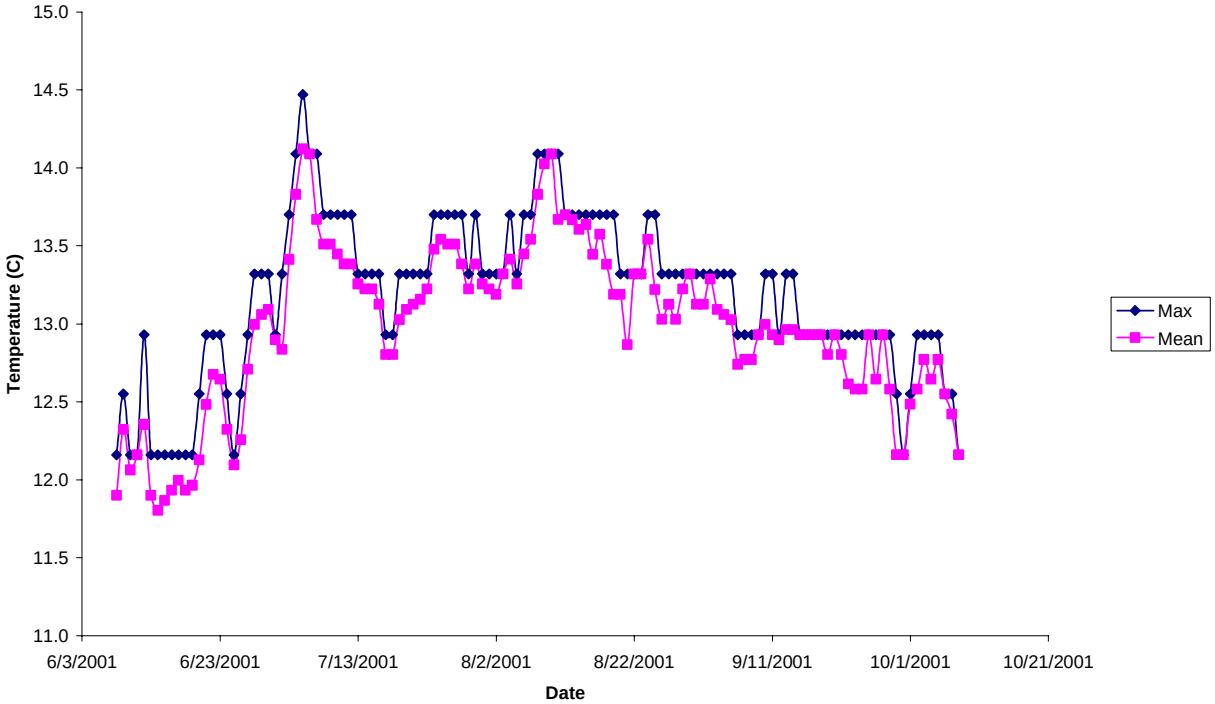


Figure 57. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Beaver Pond Gulch (76-20), Mendocino County, California.

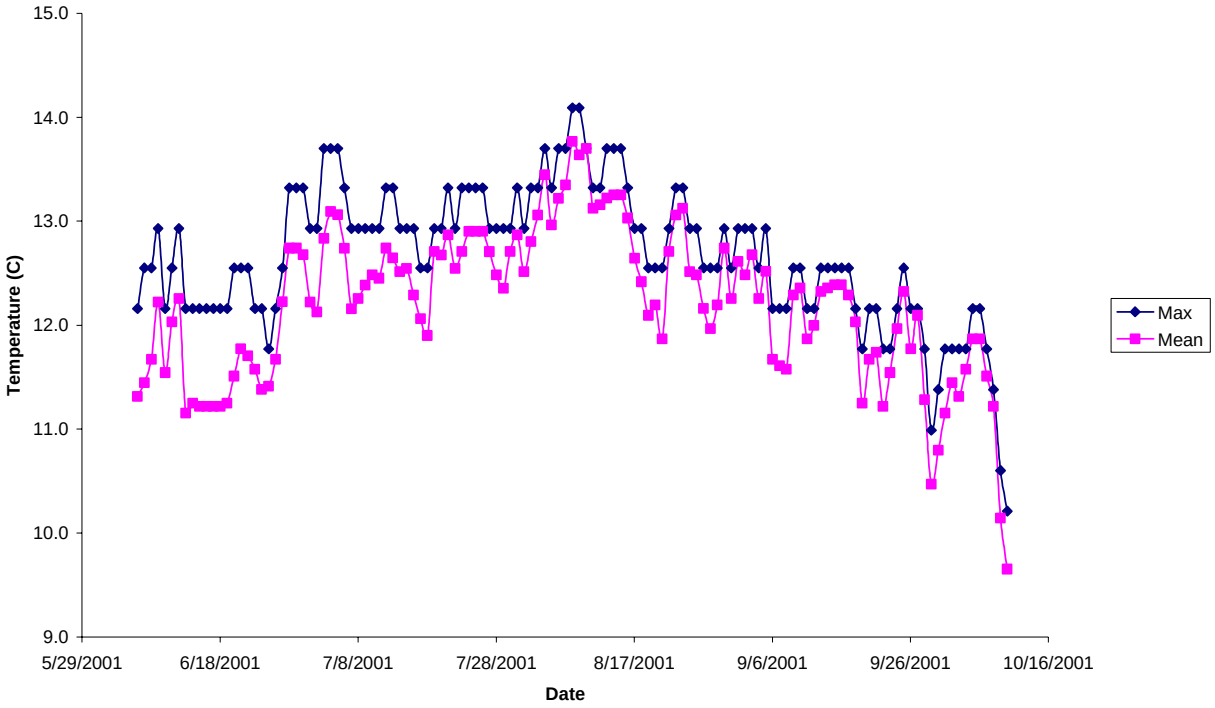
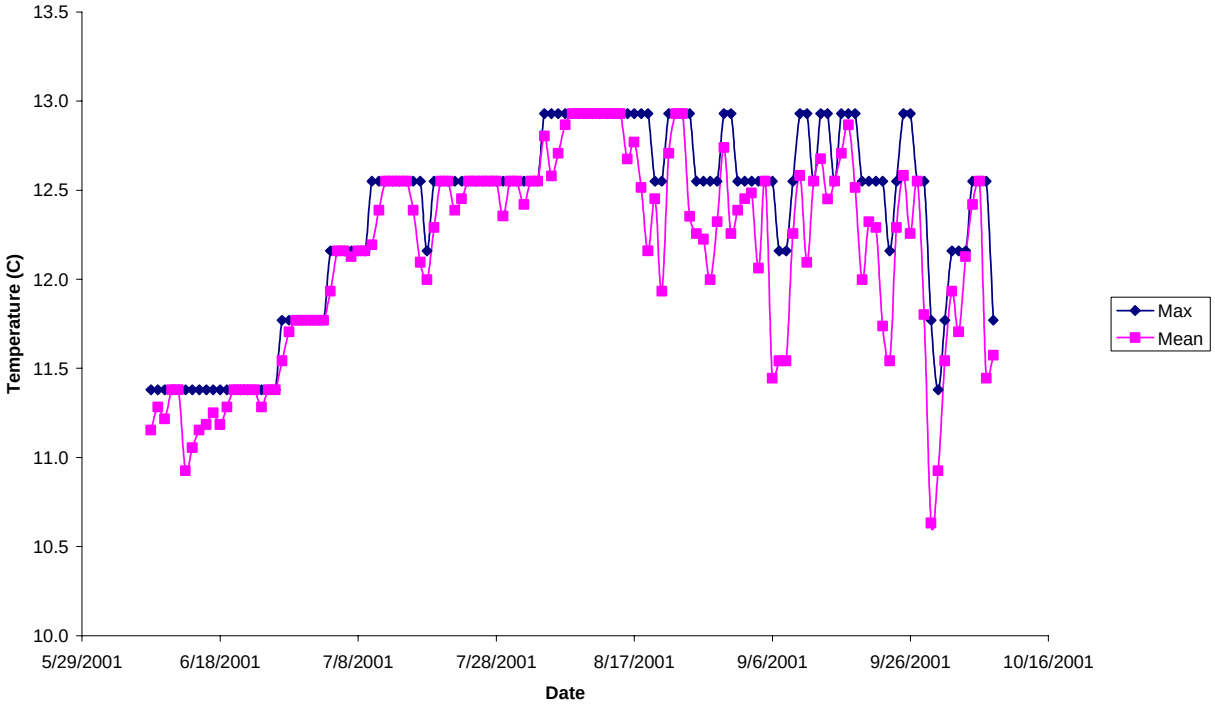


Figure 63. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Donkey House Gulch (79-22), Mendocino County, California.



Mean and Maximum Daily Stream Temperatures During Summer 2001 at Dunlap Gulch (CII), Mendocino County, California.

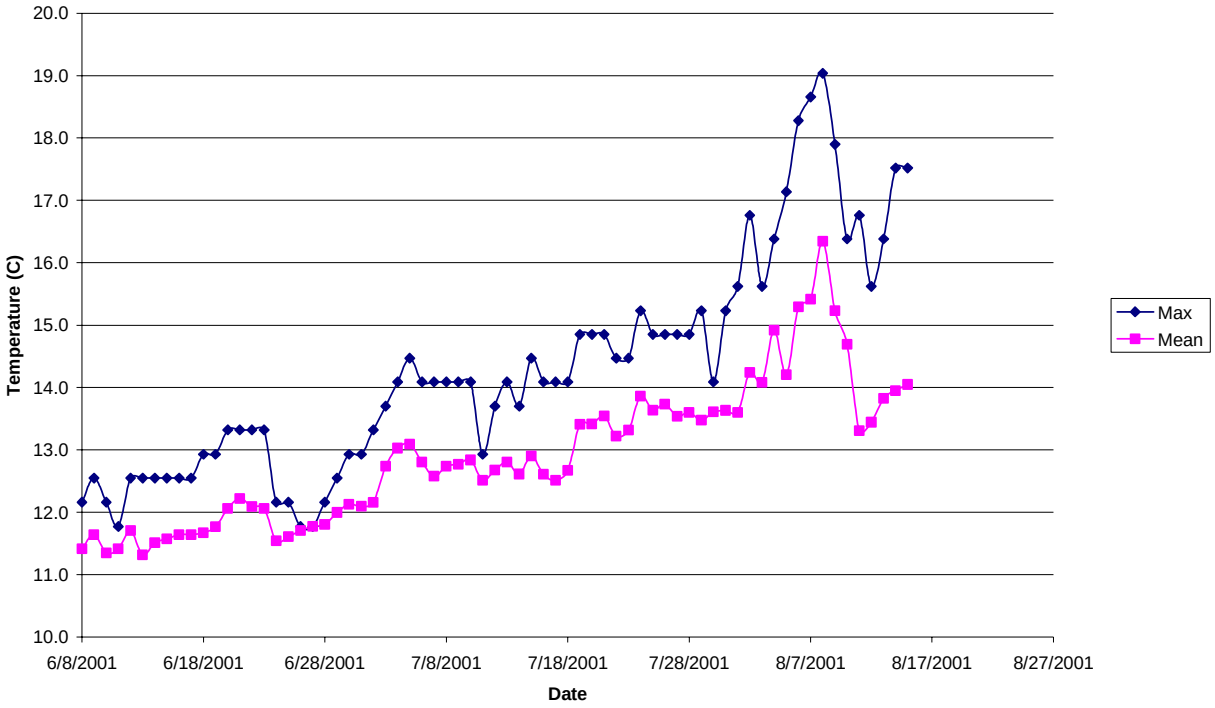


Figure 54. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Frykman Gulch (75-22), Mendocino County, California.

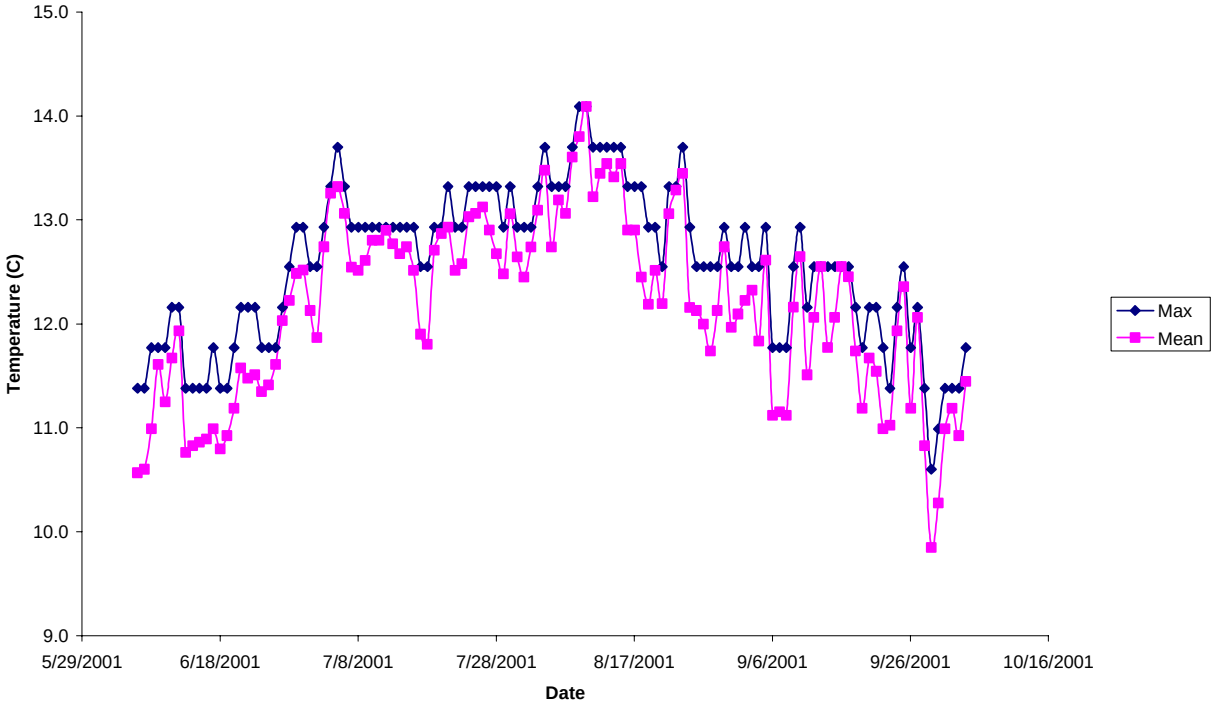


Figure 49. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Johnston Gulch (74-20), Mendocino County, California.

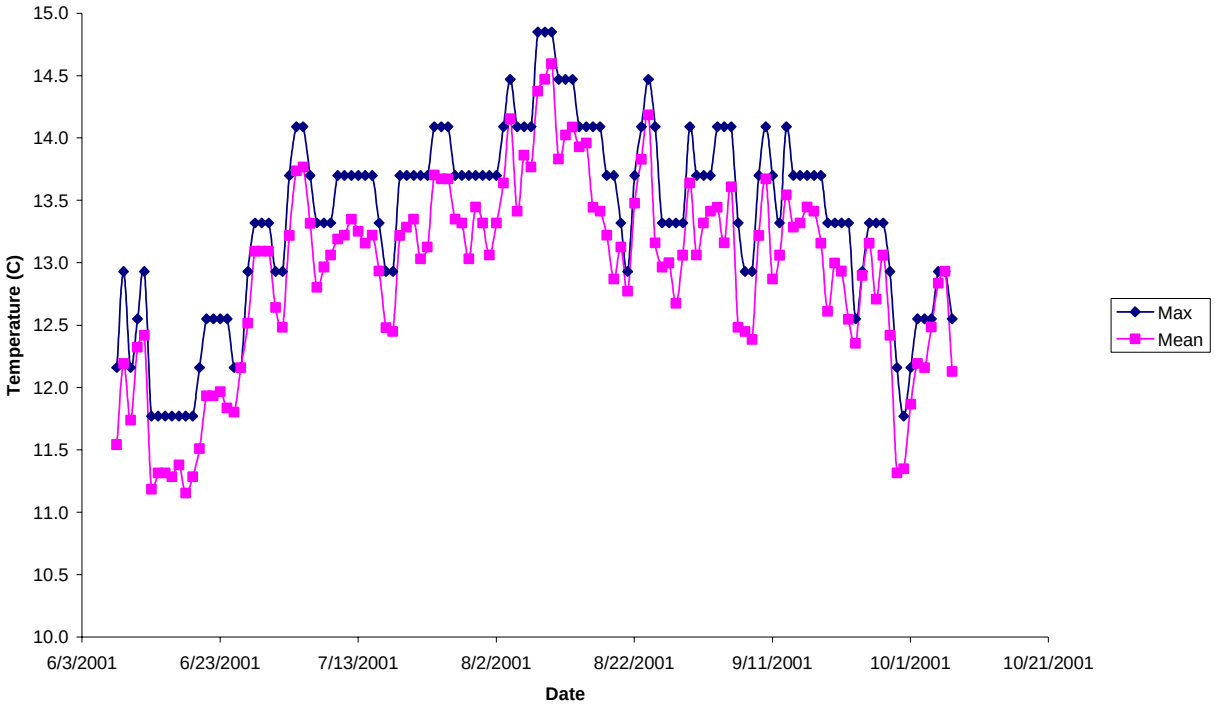


Figure 61. Mean and Maximum Daily Stream Temperatures During Summer 2001 at No Name Gulch (79-20), Mendocino County, California.

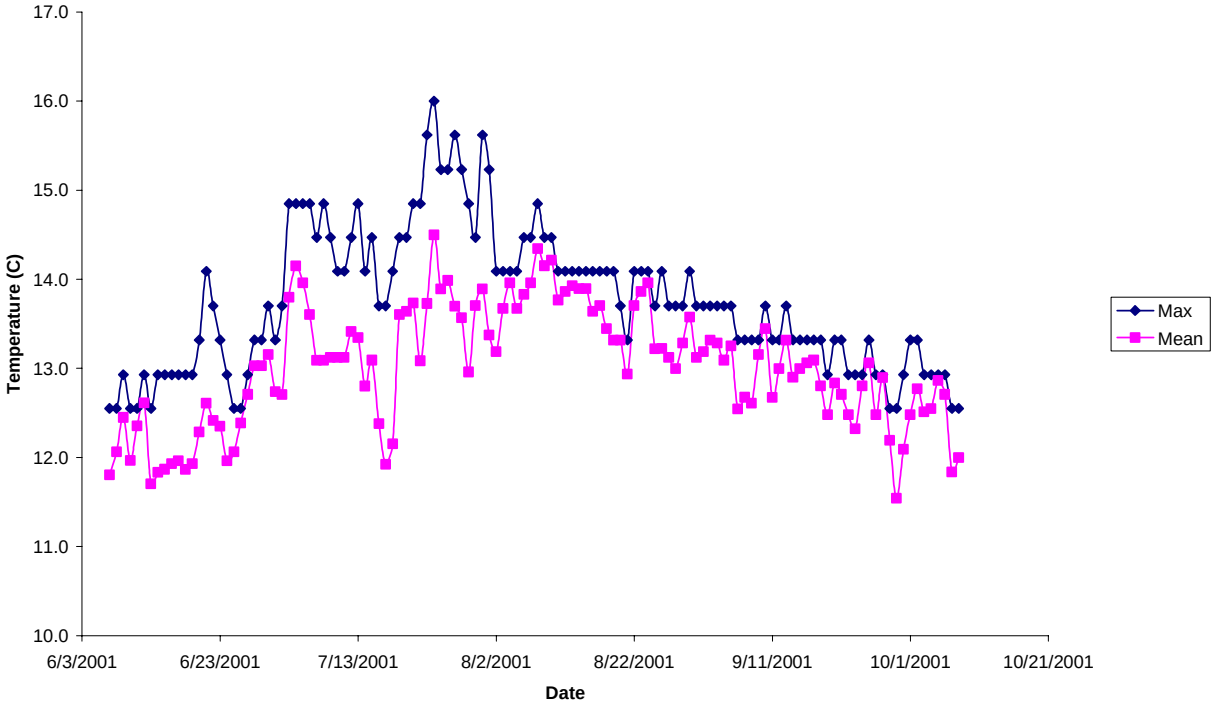


Figure 53. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Quail Gulch (75-20), Mendocino County, California.

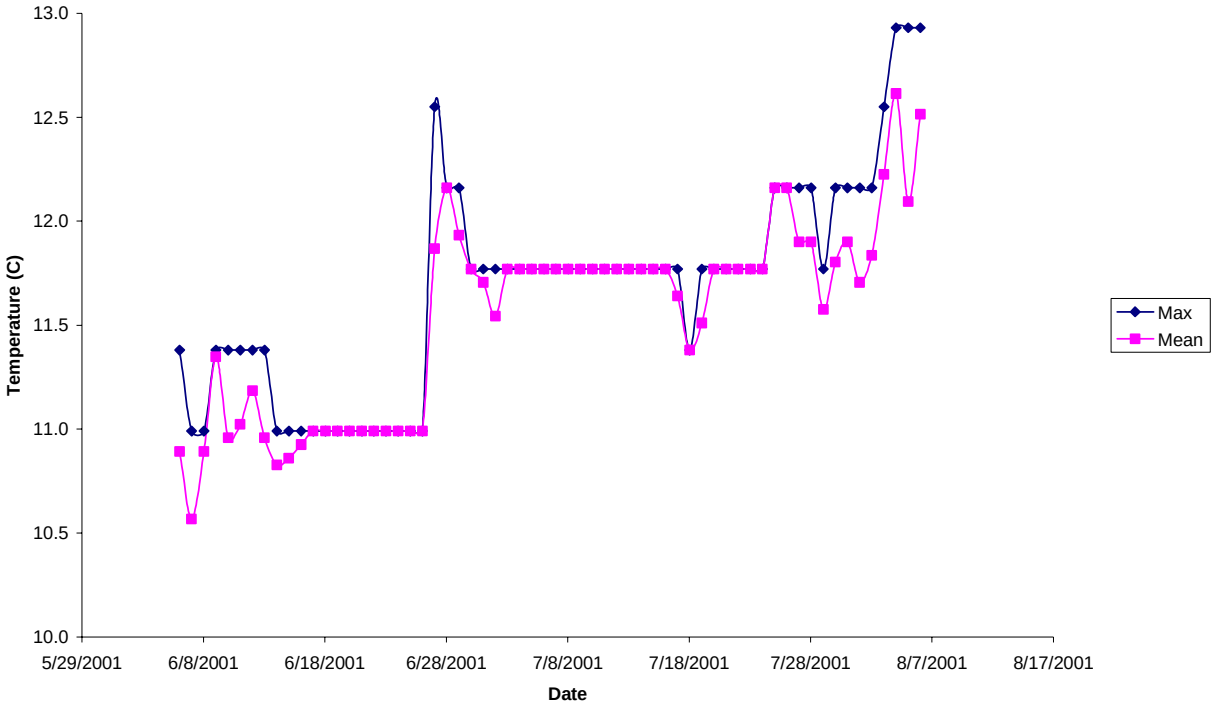


Figure 55. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Steam Donkey Gulch (75-23), Mendocino County, California.

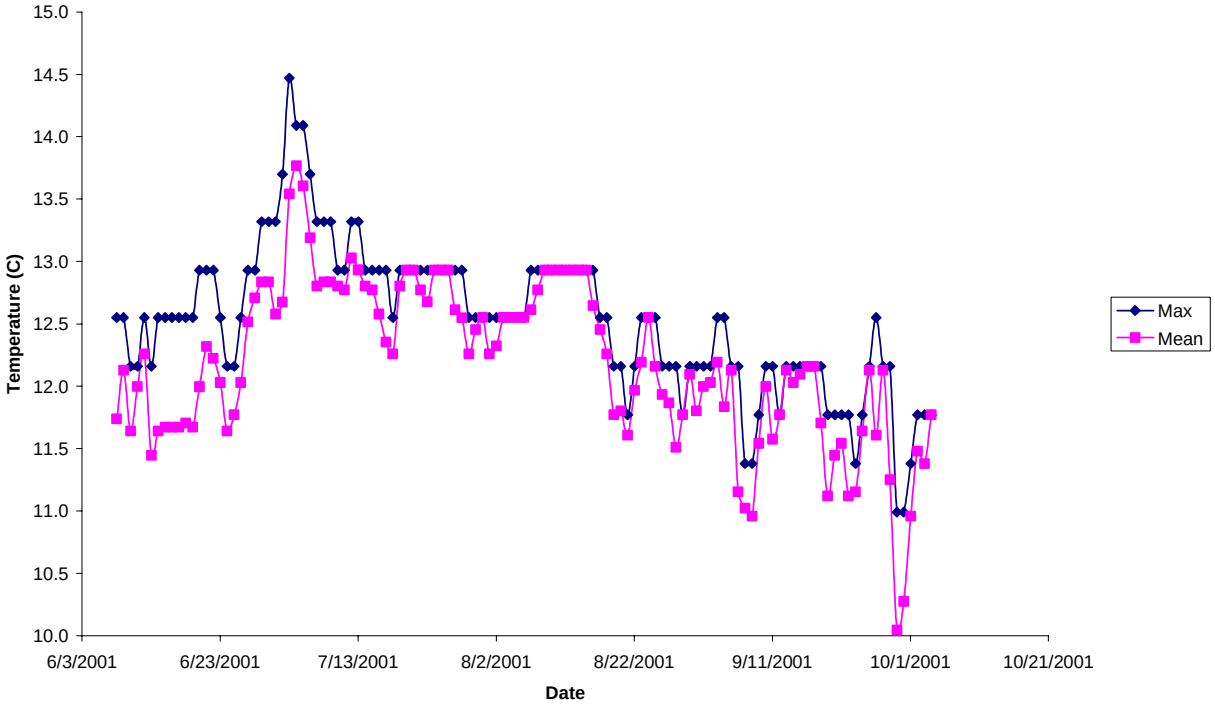


Figure 50. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Wildhorse Gulch (74-21), Mendocino County, California.

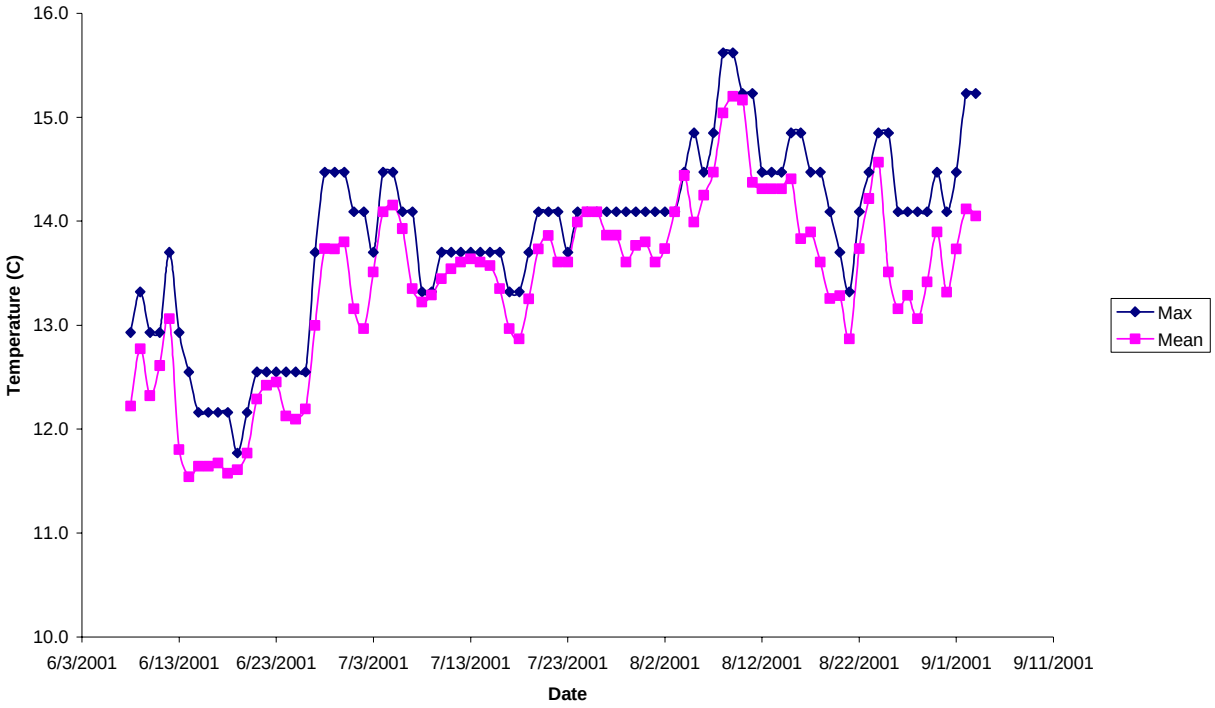


Figure 54. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Big River (Site 74-1), Mendocino County, California.

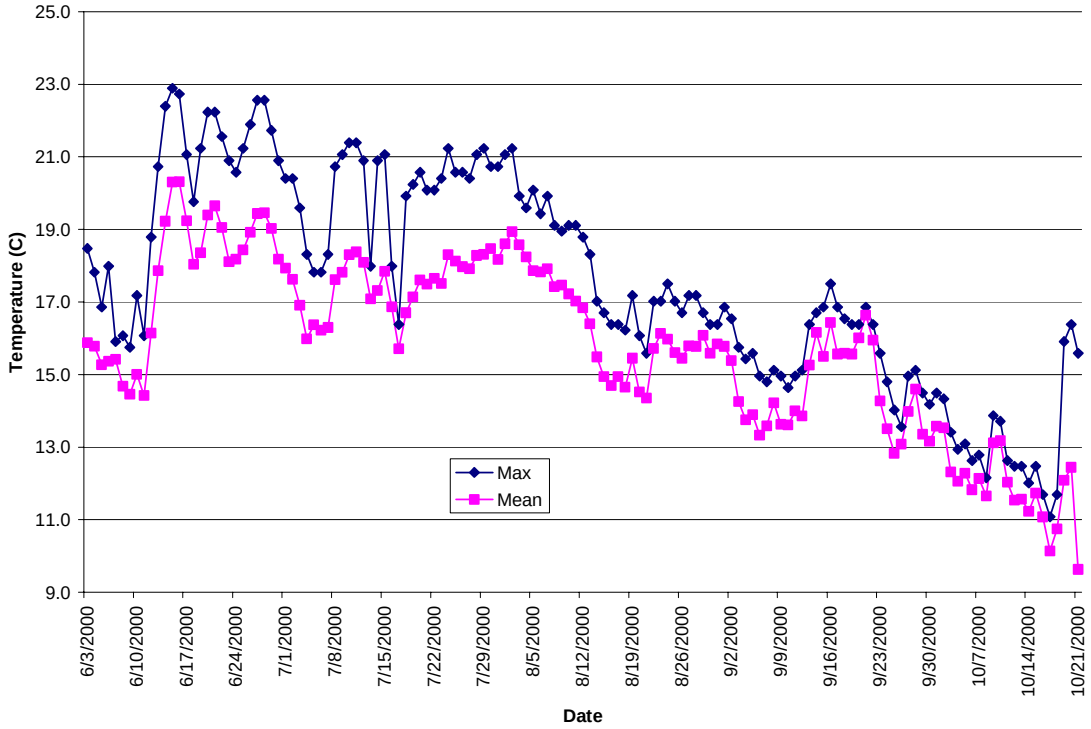


Figure 59. Mean and Maximum Daily Stream Temperatures During Summer 2000 at East Branch North Fork Big River (Site 75-1), Mendocino County, California.

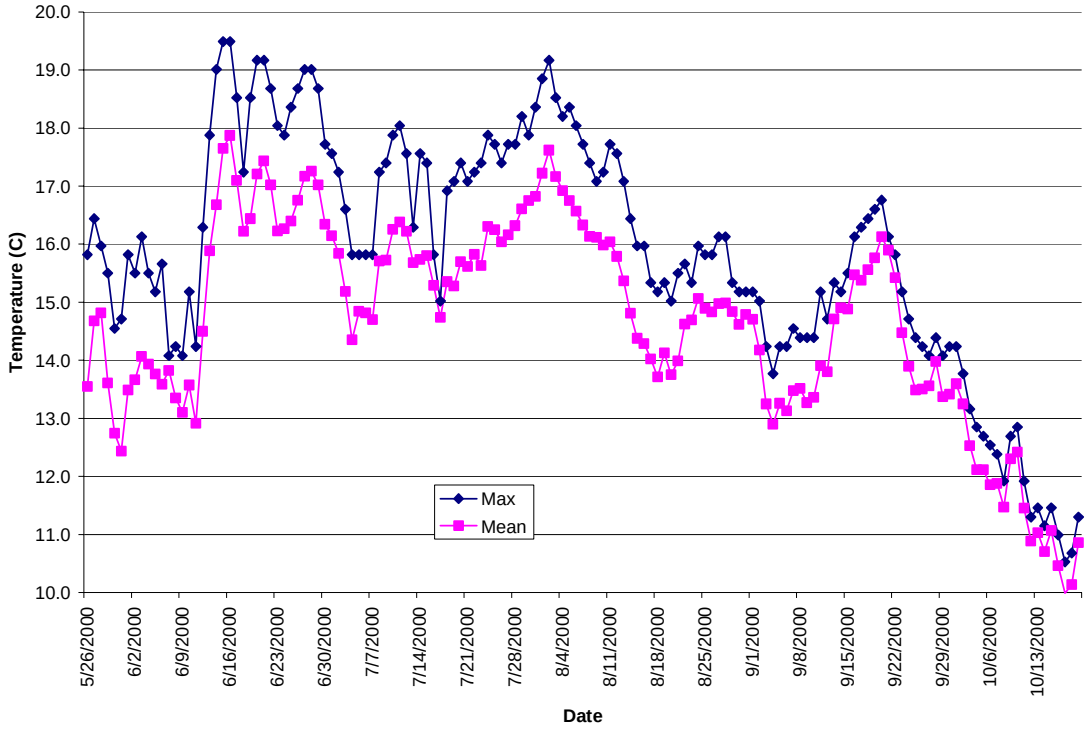


Figure 72. Mean and Maximum Daily Stream Temperatures During Summer 2000 at North Fork Ramon Creek (Site 79-8), Mendocino County, California.

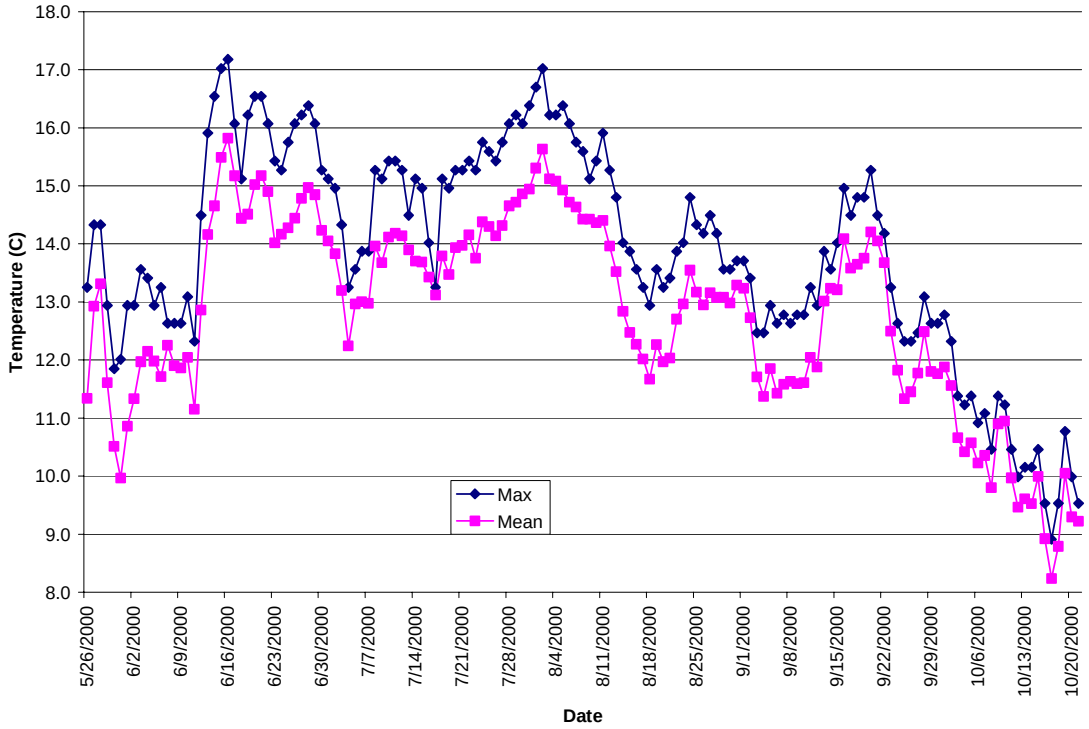


Figure 55. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Russel Brook (Site 74-2), Mendocino County, California.

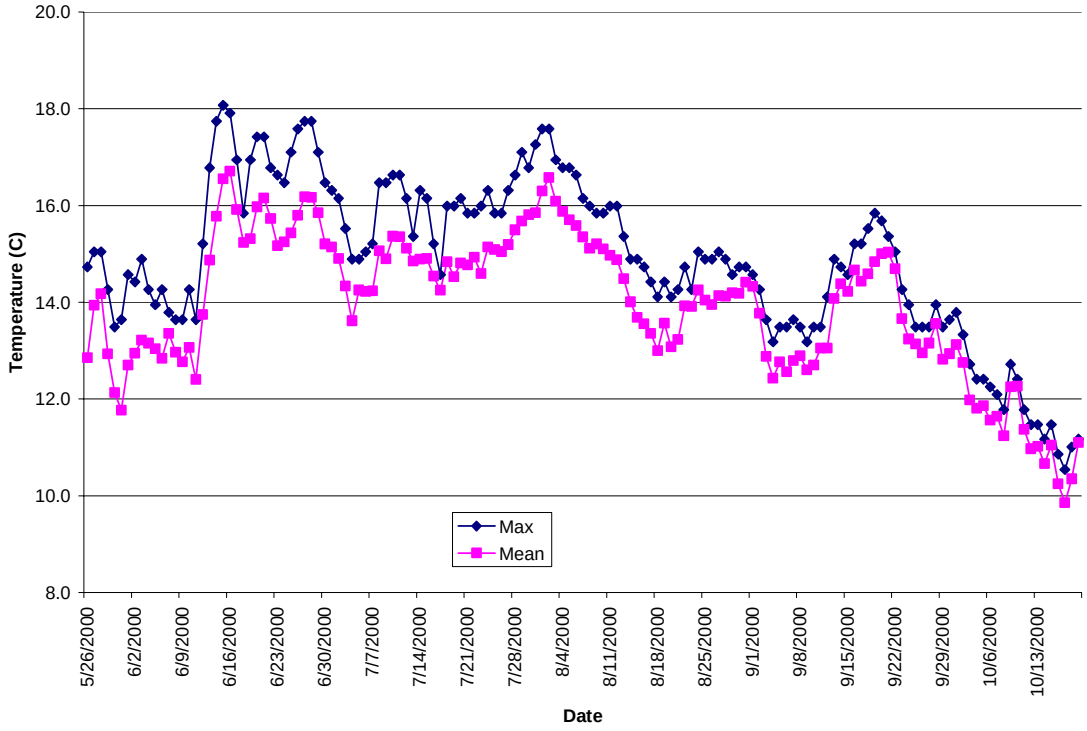


Figure 70. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Daugherty Creek (Site 79-4), Mendocino County, California.

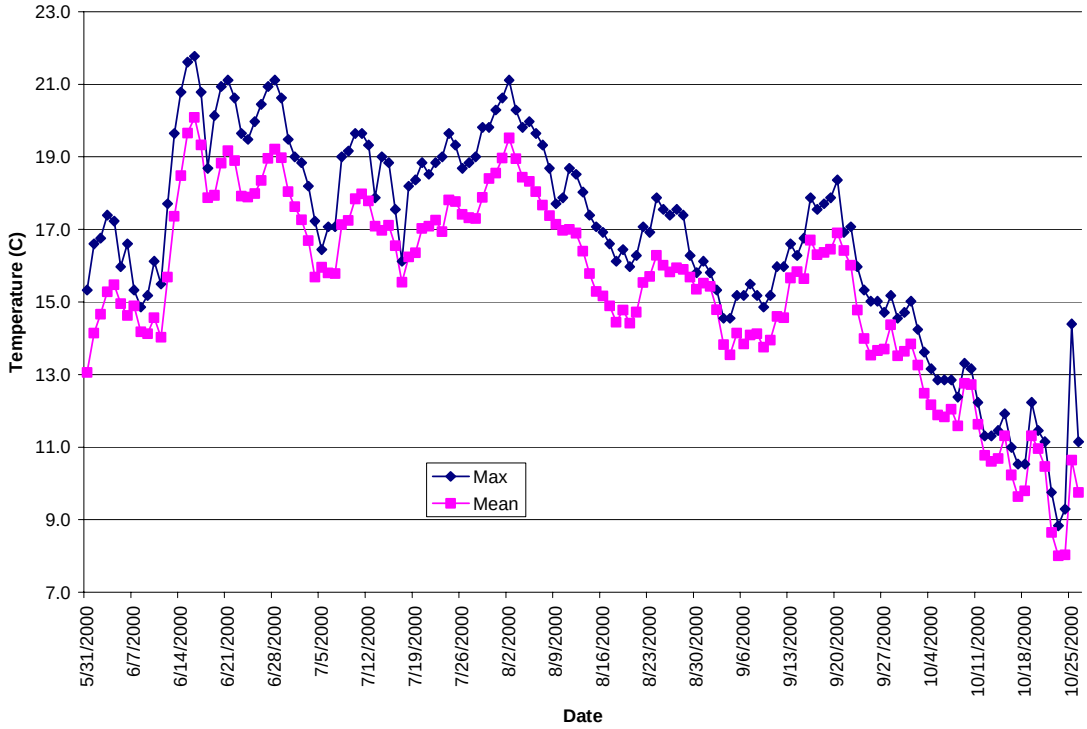


Figure 65. Mean and Maximum Daily Stream Temperatures During Summer 2000 at South Fork Big River (Site 79-1), Mendocino County, California.

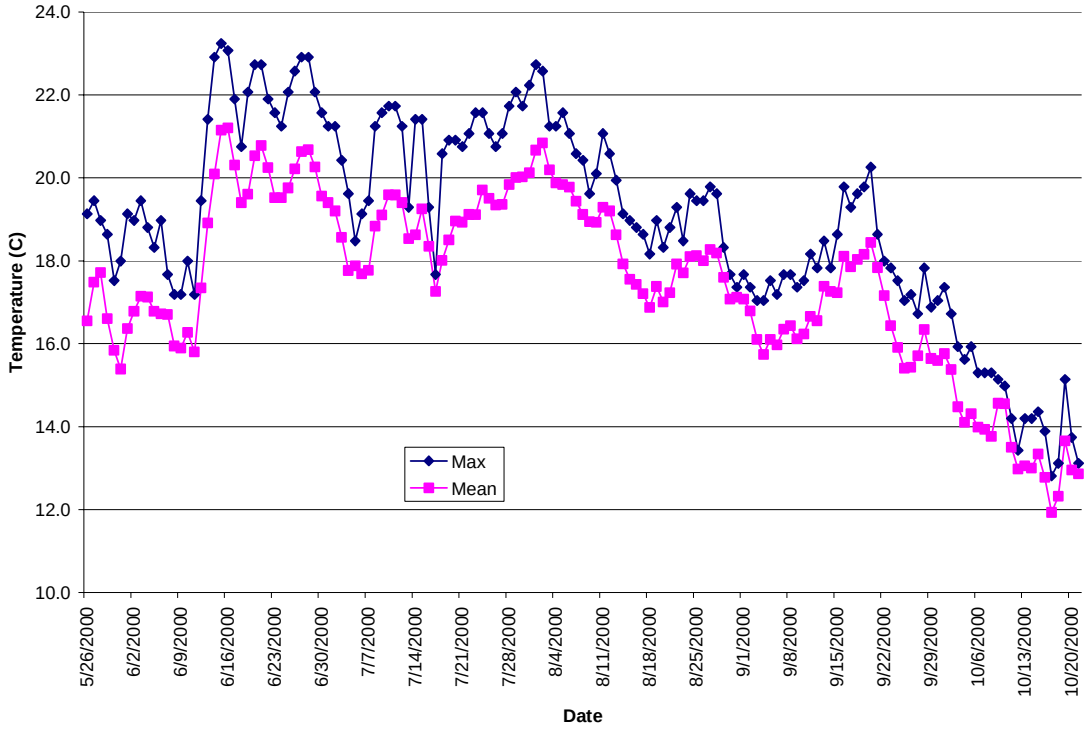


Figure 62. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Two Log Creek (Site 76-2), Mendocino County, California.

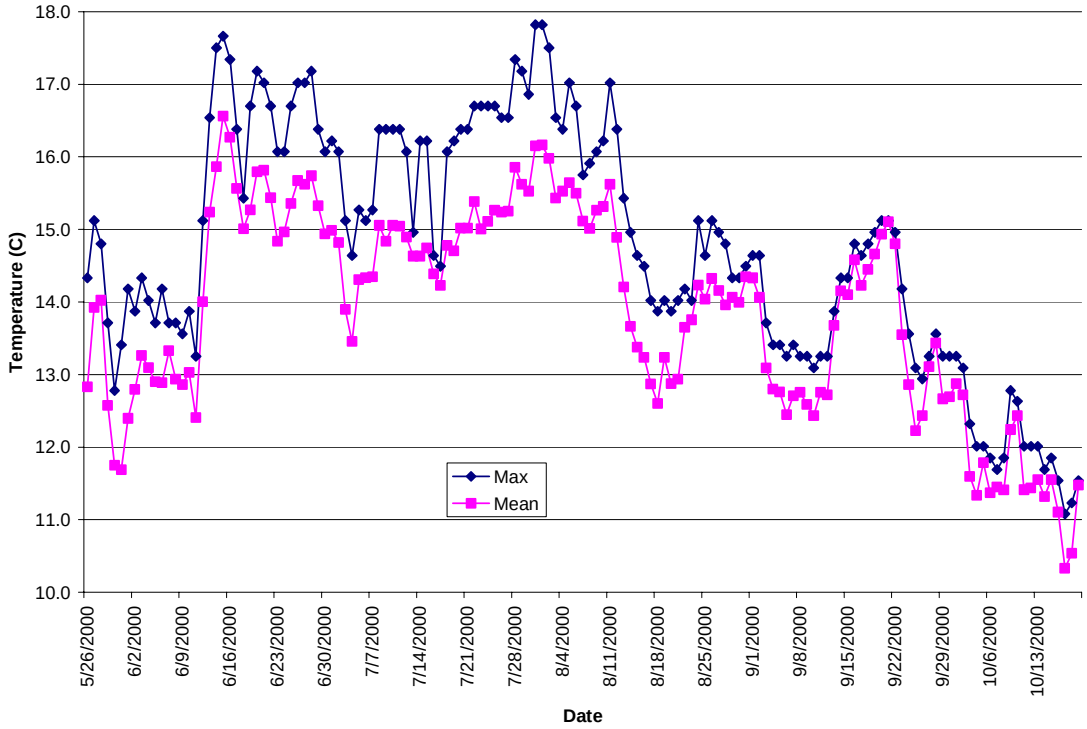


Figure 56. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Big River (Site 74-3), Mendocino County, California.

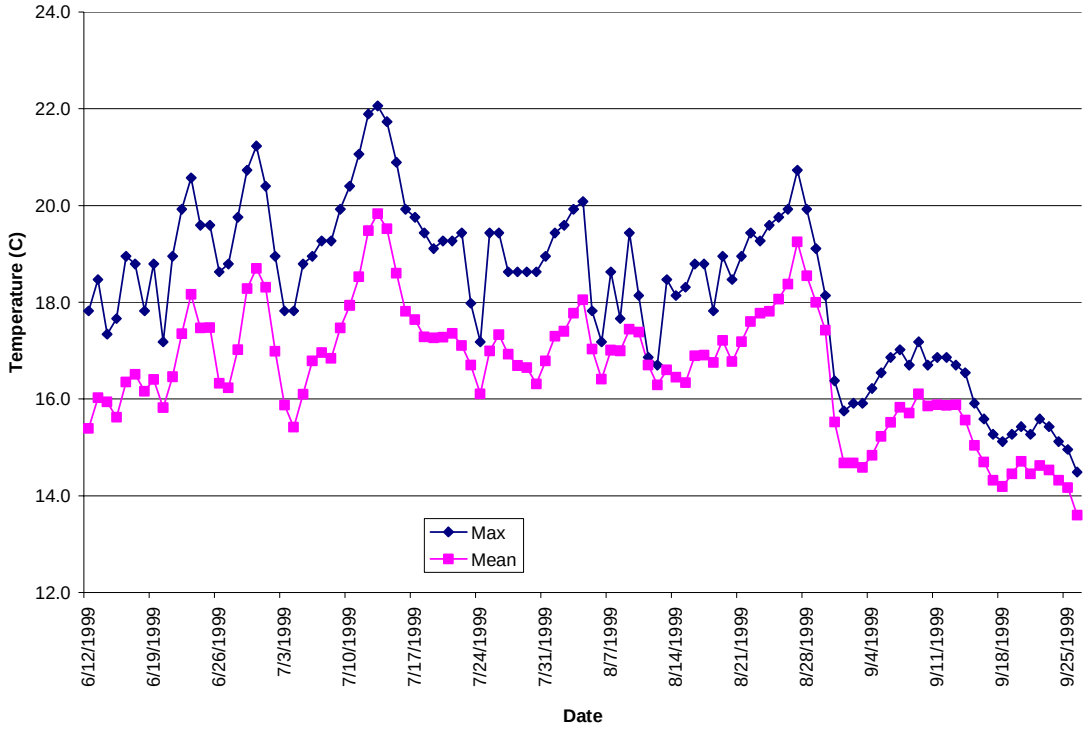


Figure 58. Mean and Maximum Daily Stream Temperatures During Summer 1999 at East Branch North Fork Big River (Site 75-1), Mendocino County, California.

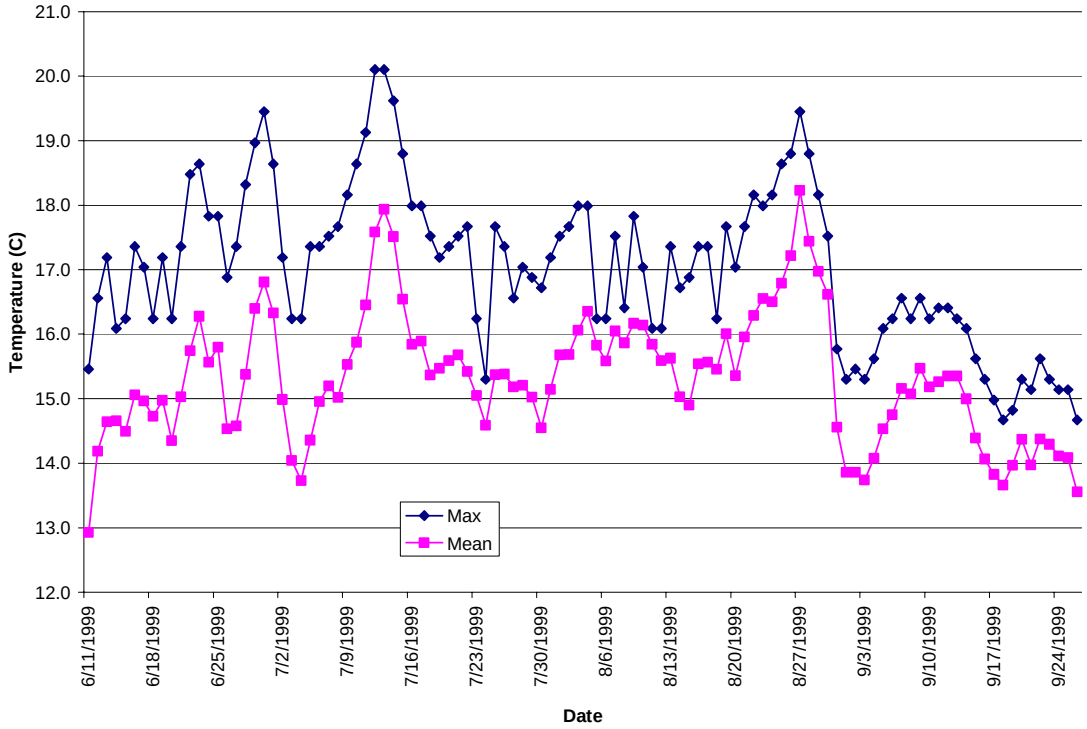


Figure 61. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Big River (Site 76-1), Mendocino County, California.

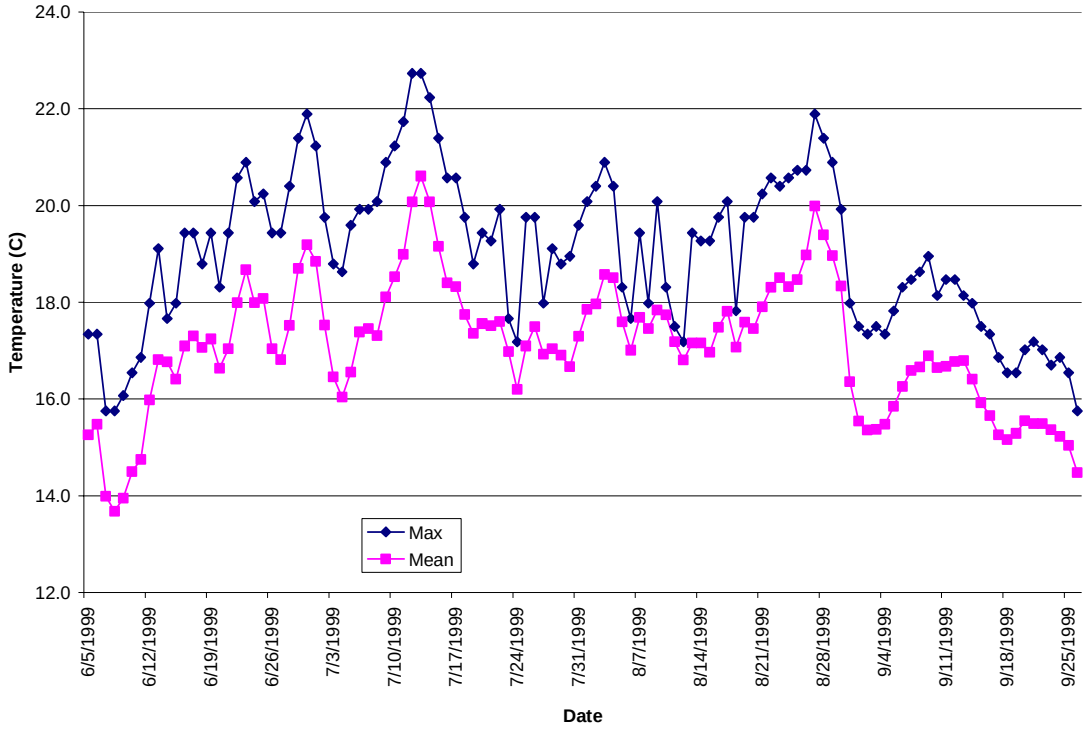


Figure 64. Mean and Maximum Daily Stream Temperatures During Summer 1999 at South Fork Big River (Site 79-1), Mendocino County, California.

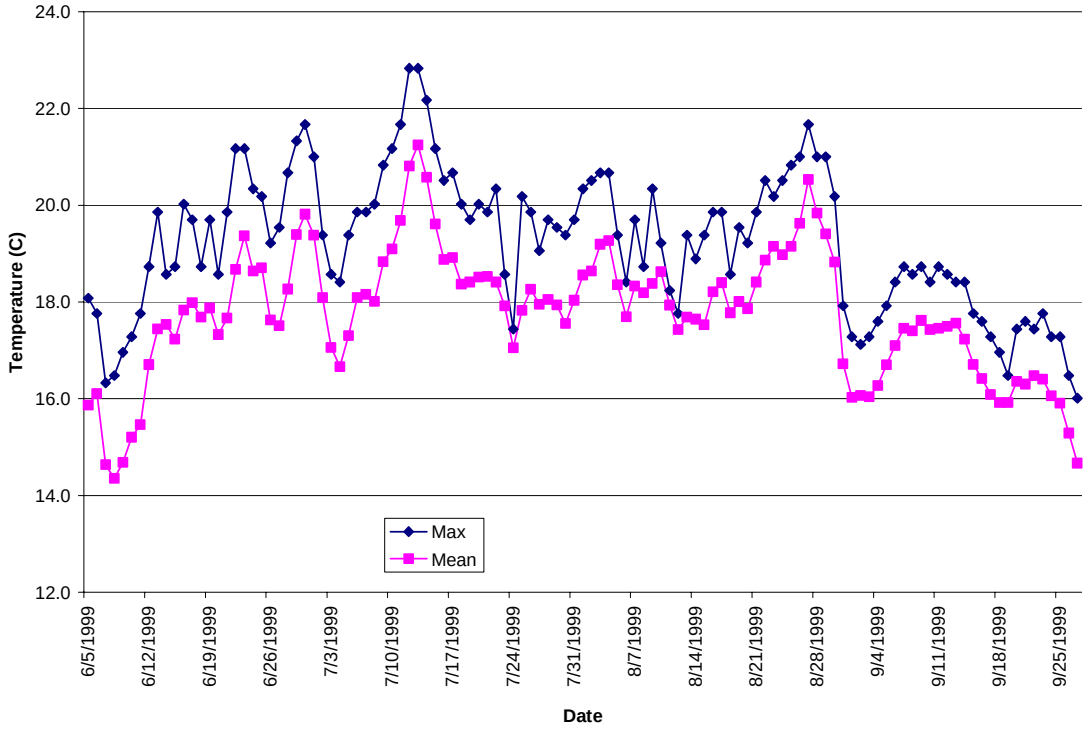


Figure 67. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Ramon Creek (Site 79-2), Mendocino County, California.

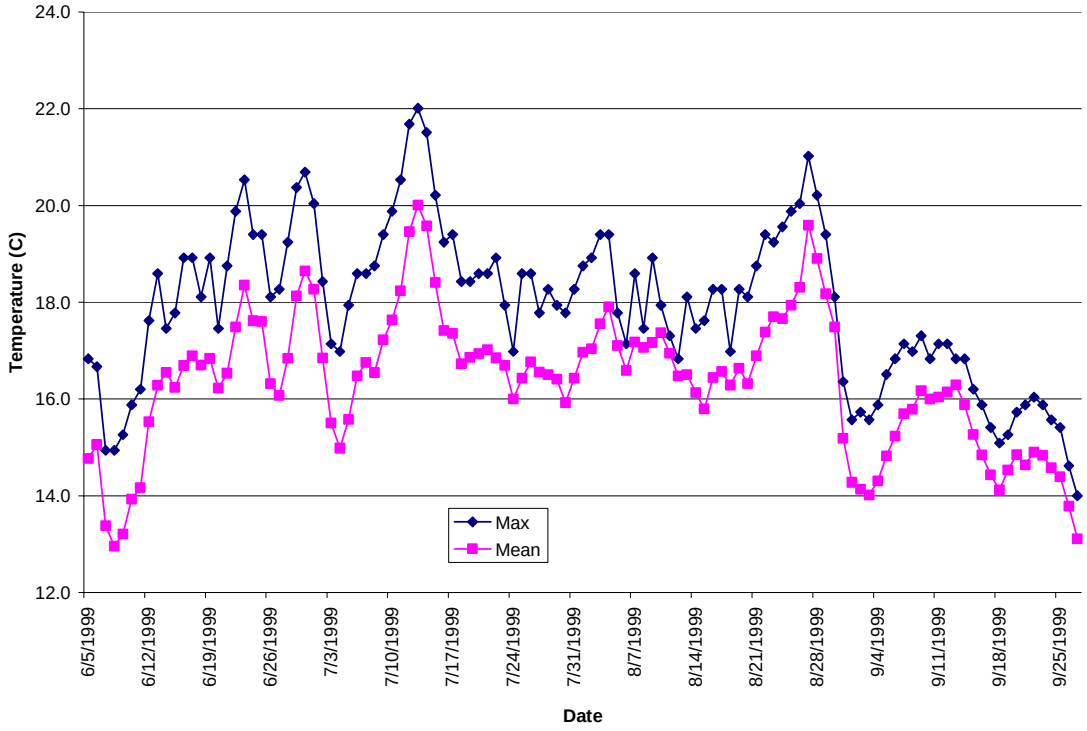


Figure 69. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Daugherty Creek (Site 79-4), Mendocino County, California.

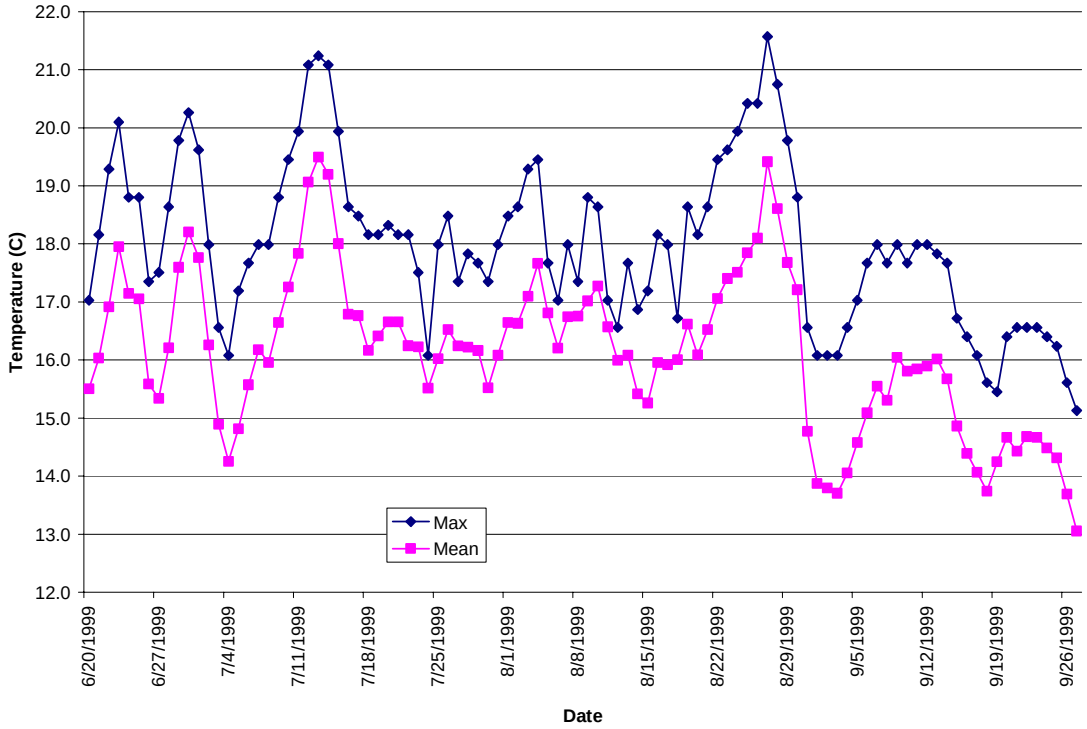


Figure 57. Mean and Maximum Daily Stream Temperatures During Summer 1997 at East Branch North Fork Big River (Site 75-1), Mendocino County, California.

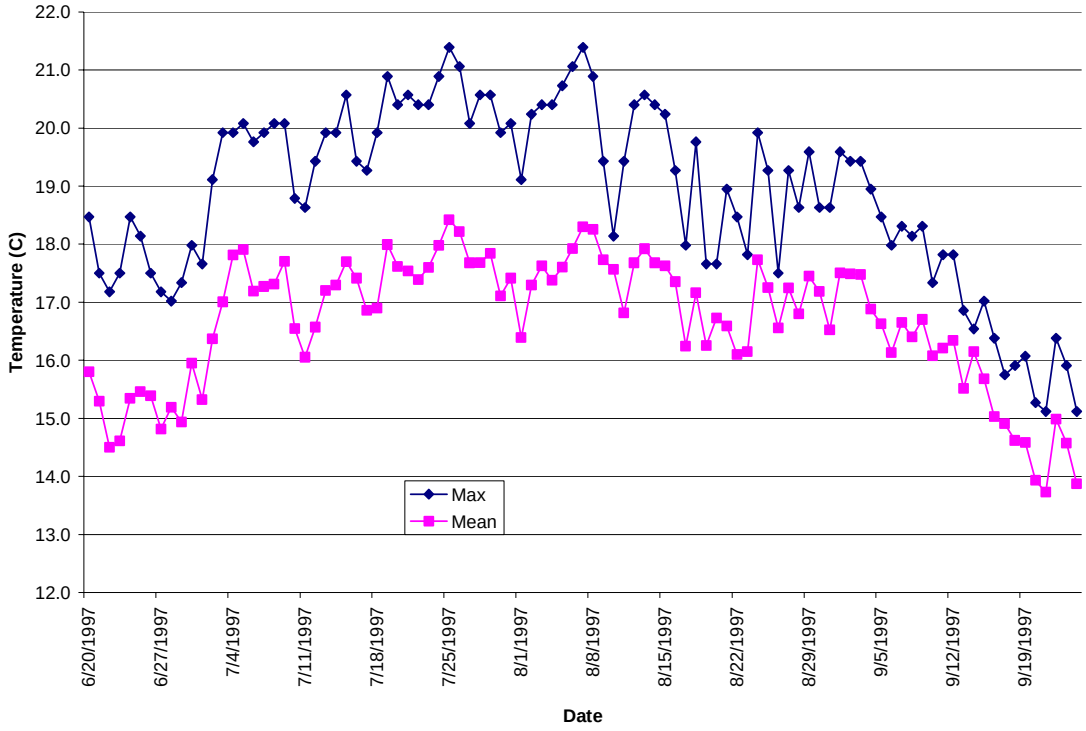


Figure 60. Mean and Maximum Daily Stream Temperatures During Summer 1997 at East Branch North Fork Big River (Site 75-2), Mendocino County, California.

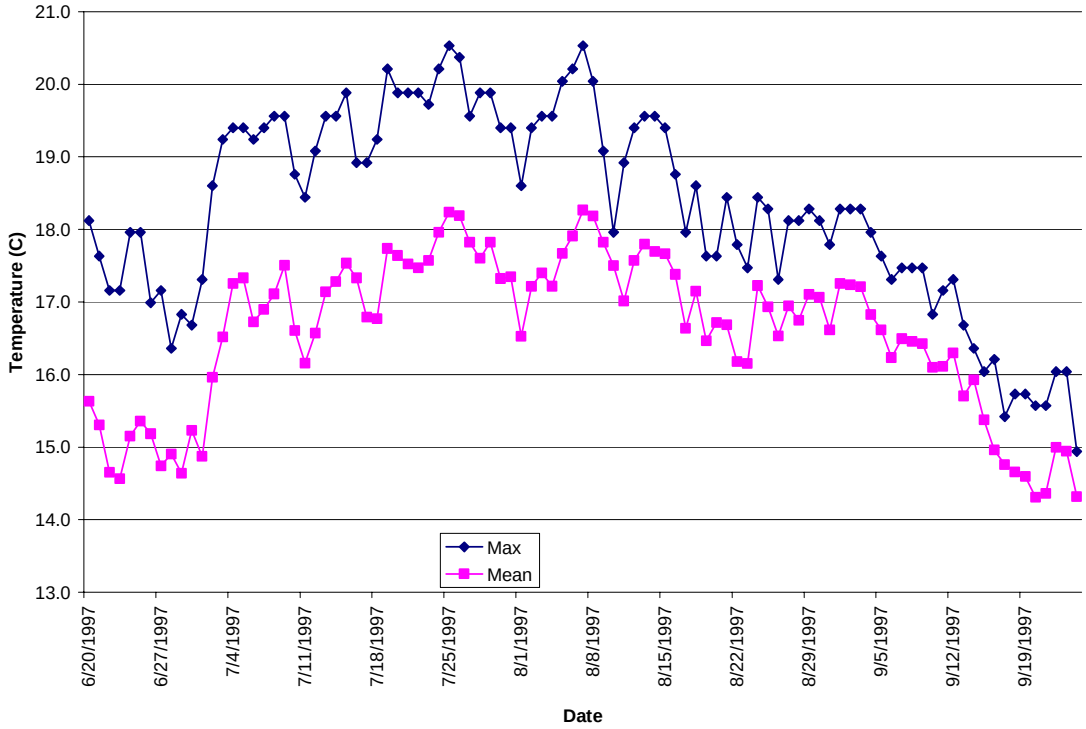


Figure 63. Mean and Maximum Daily Stream Temperatures During Summer 1997 at South Fork Big River (Site 79-1), Mendocino County, California.

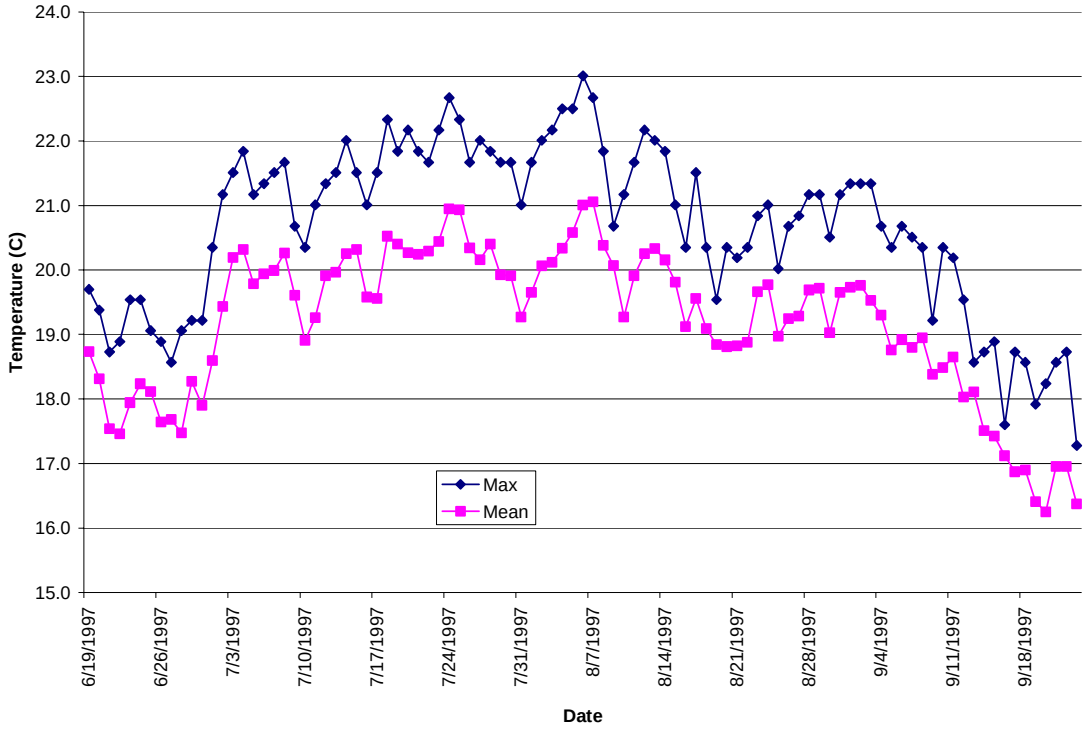


Figure 66. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Ramon Creek (Site 79-2), Mendocino County, California.

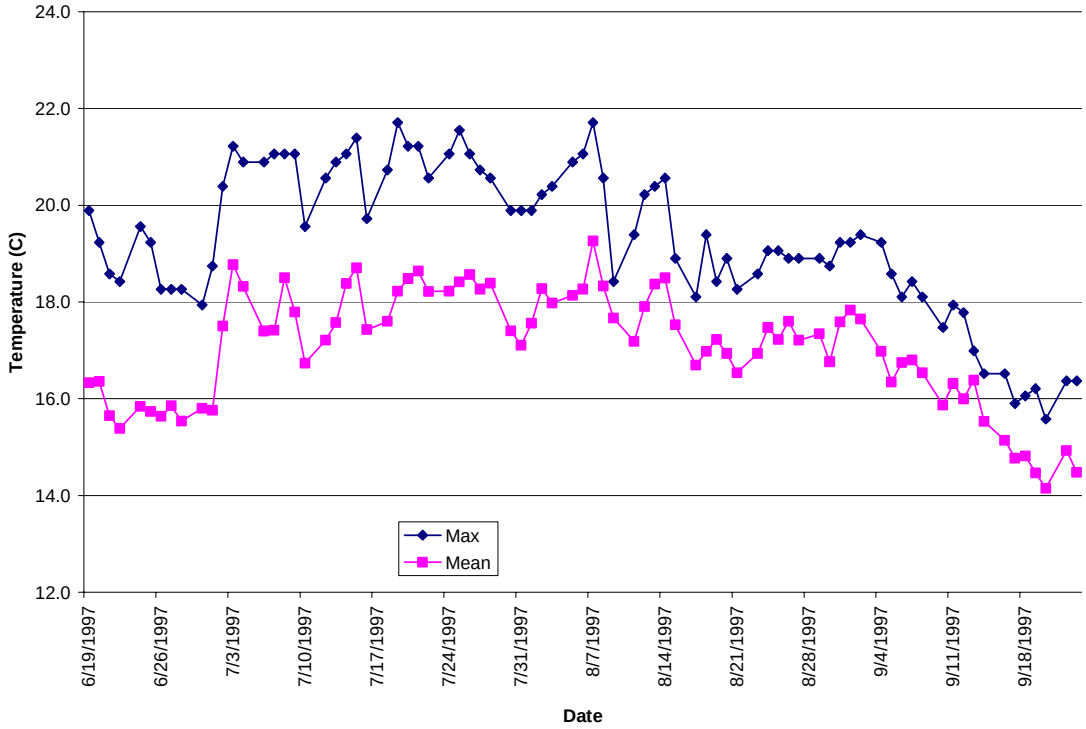


Figure 68. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Daugherty Creek (Site 79-4), Mendocino County, California.

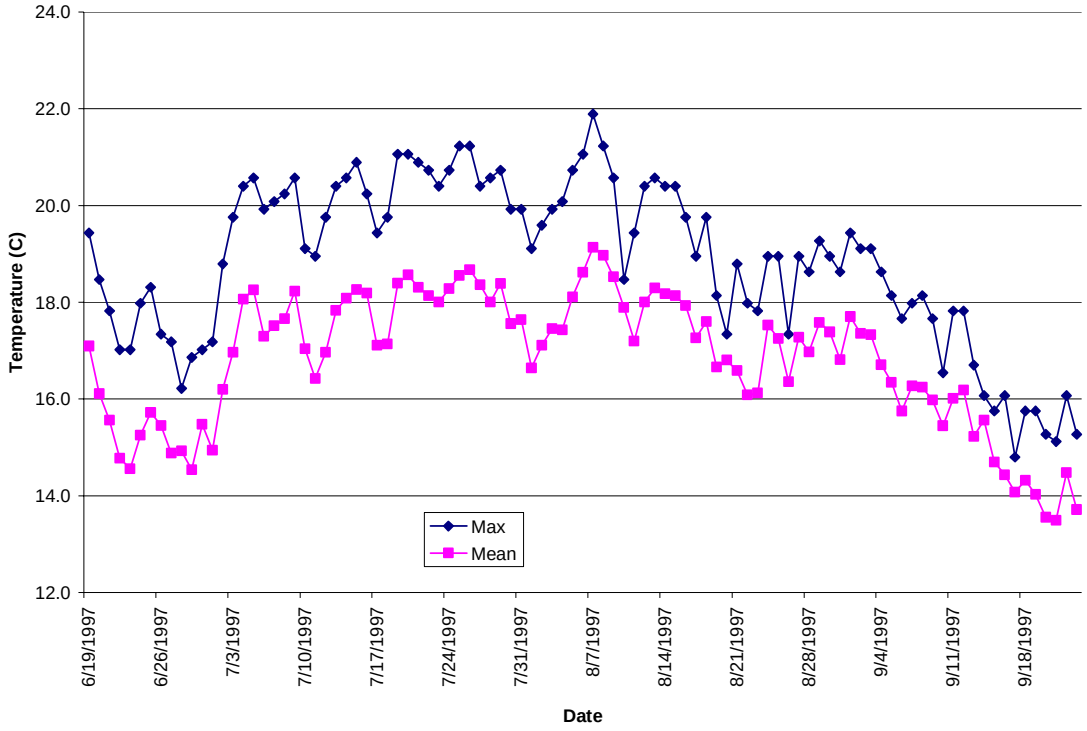


Figure 71. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Daugherty Creek (Site 79-5), Mendocino County, California.

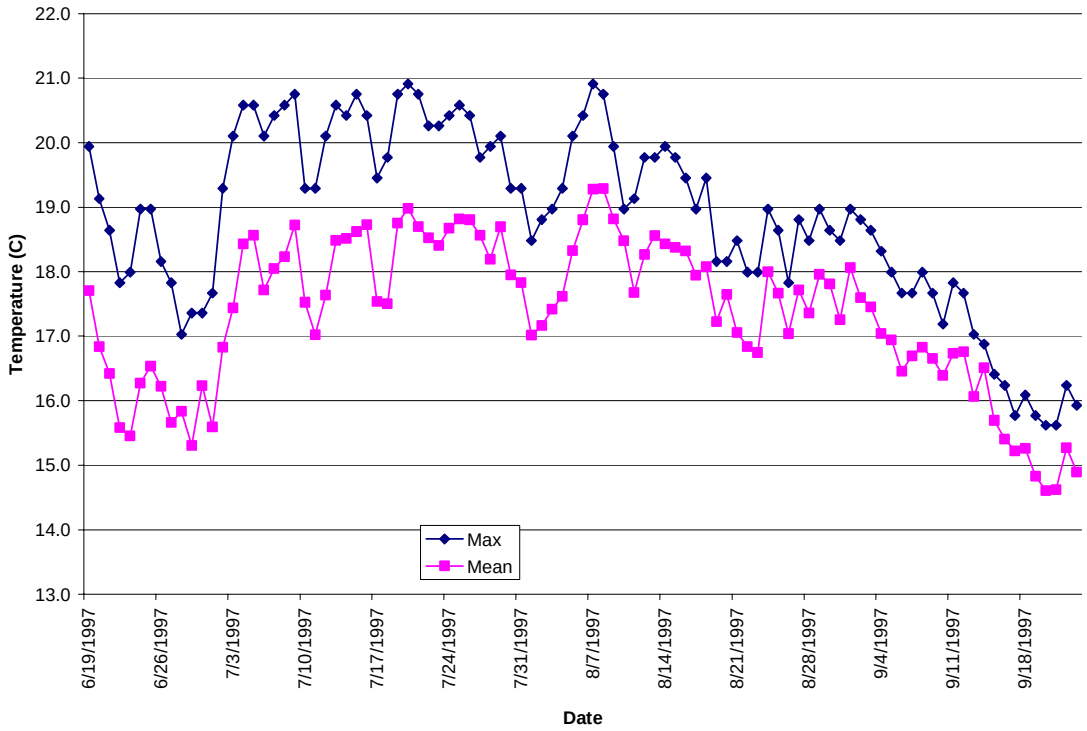


Figure 73. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Gates Creek (Site 79-9), Mendocino County, California.

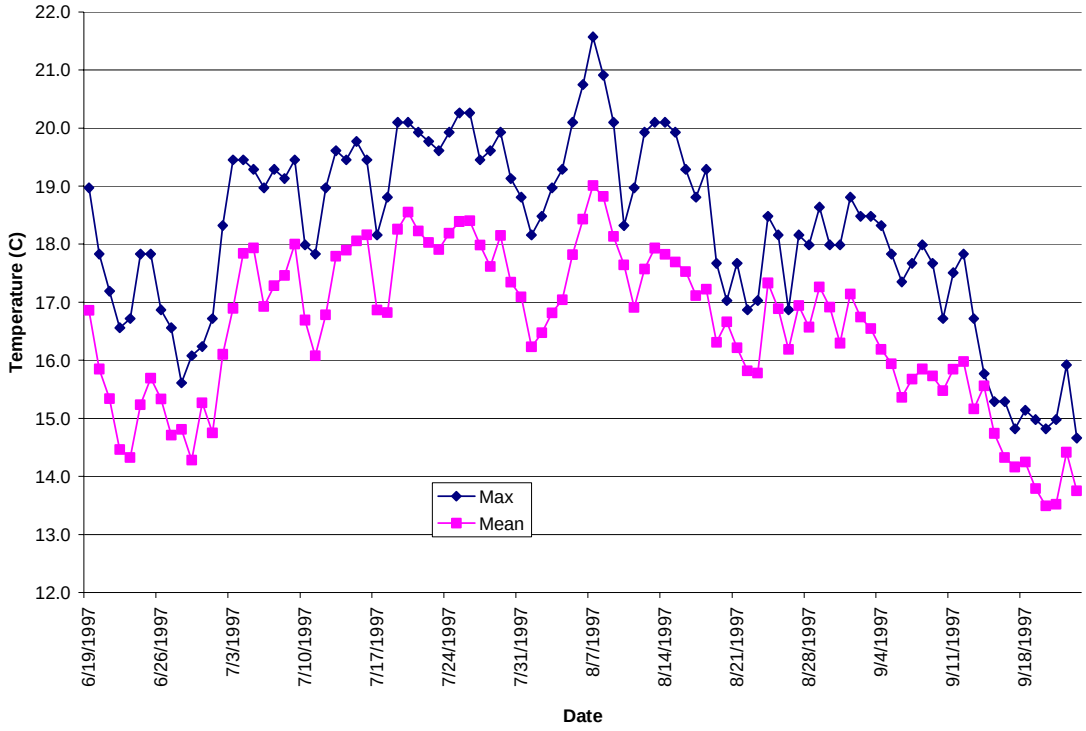


FIGURE 57. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT RAMOAN CREEK (MAP NO. 9; MONITORING SITE NO. 79-2), MENDOCINO CO., CALIFORNIA.

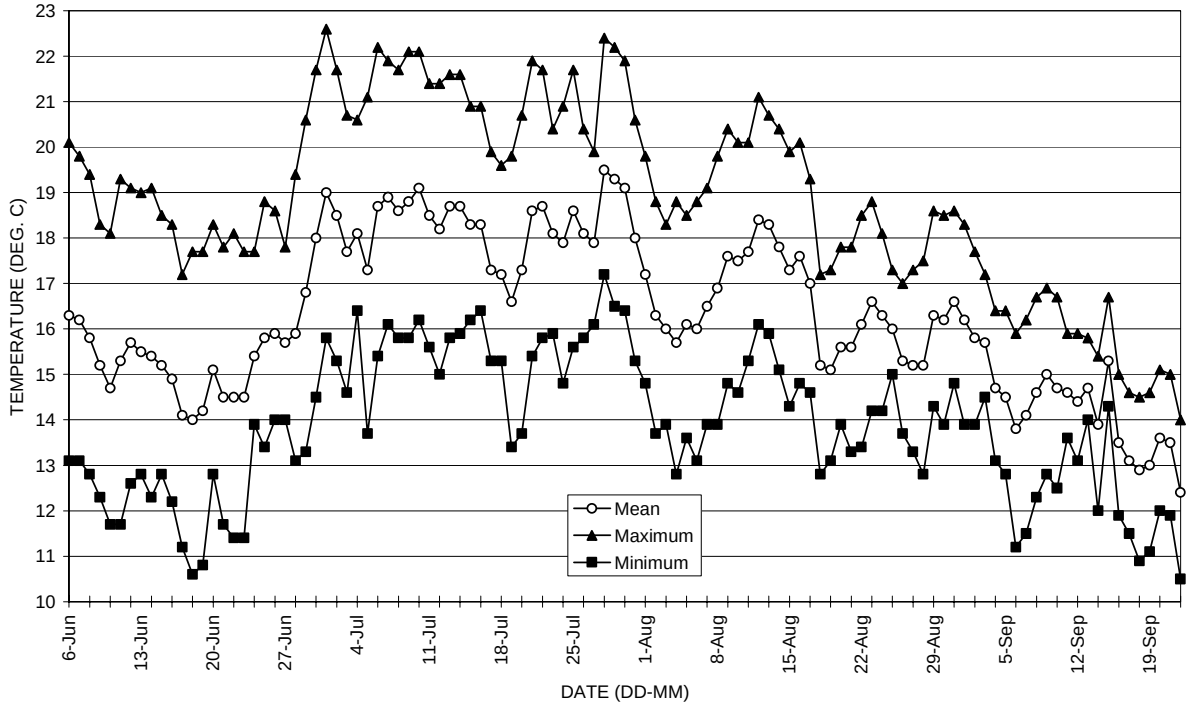


FIGURE 56. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT SOUTH FORK BIG RIVER (MAP NO. 9; MONITORING SITE NO. 79-1), MENDOCINO CO., CALIFORNIA.

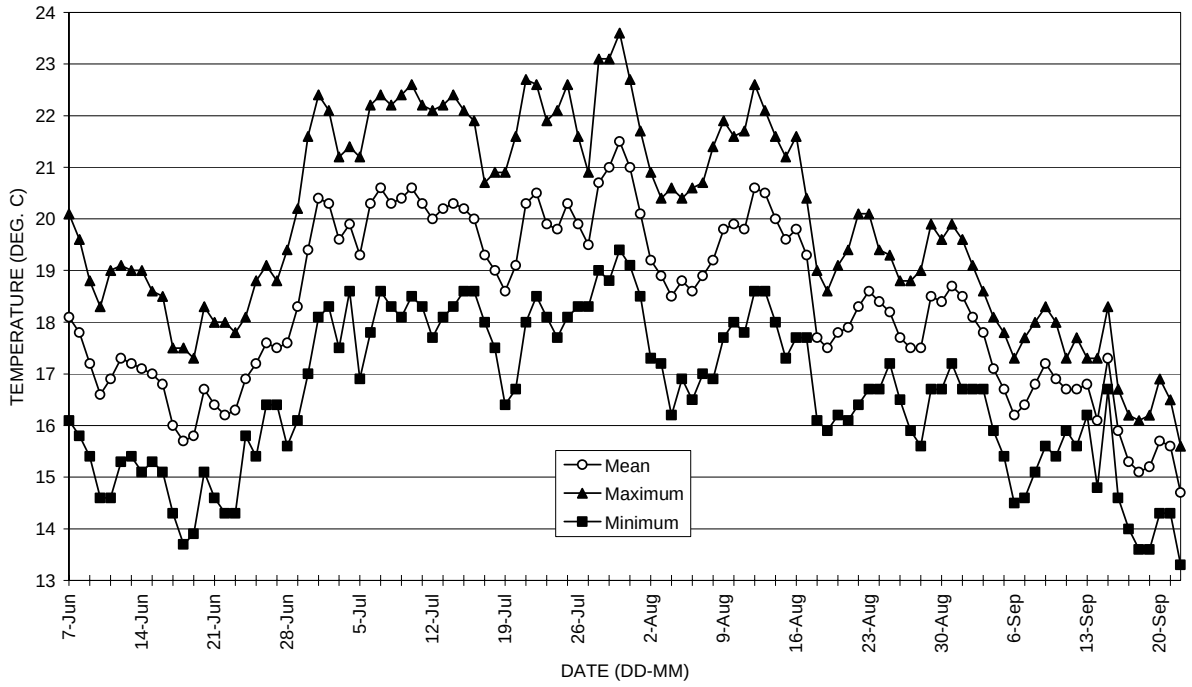


FIGURE 53. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY - SEPTEMBER 1995) AT BIG RIVER (MAP NO. 7; MONITORING SITE NO. 74-3), MENDOCINO CO., CALIFORNIA.

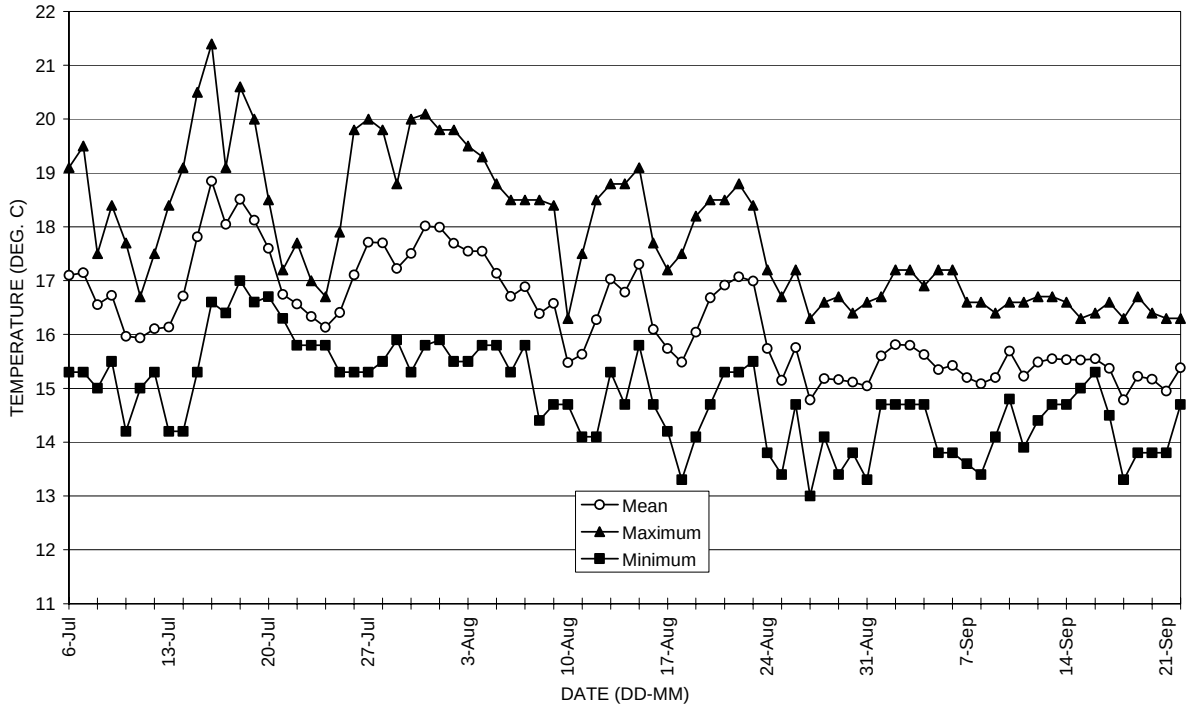


FIGURE 59. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT DAUGHERTY CREEK (MAP NO. 9; MONITORING SITE 79-4), MENDOCINO CO., CALIFORNIA.

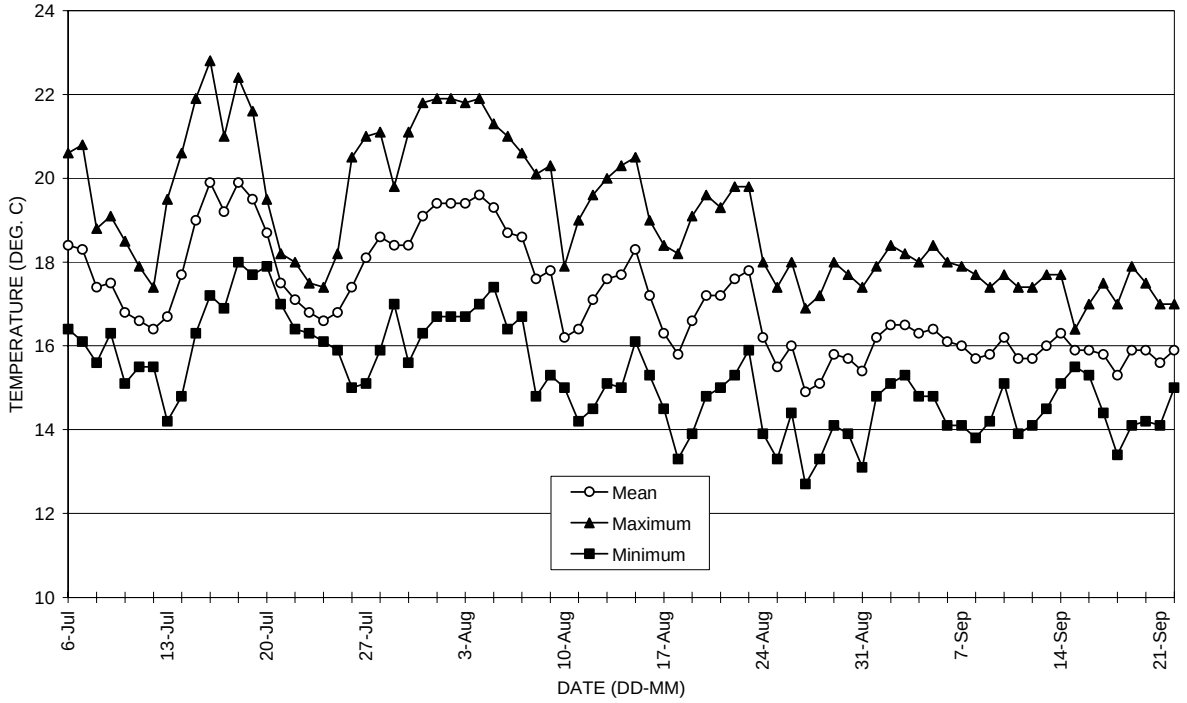


FIGURE 54. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT EAST BRANCH NORTH FORK BIG RIVER (MAP NO. 6; MONITORING SITE NO. 75-1), MENDOCINO CO., CALIFORNIA.

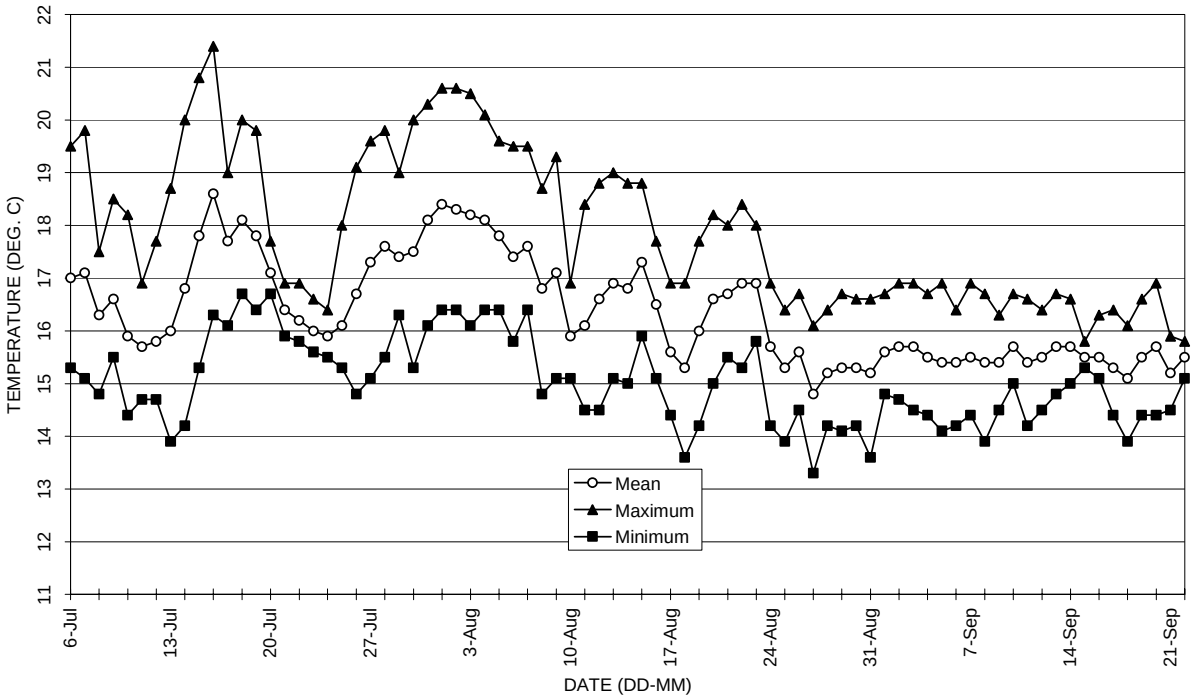


FIGURE 51. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY - SEPTEMBER 1995) AT RUSSELL BROOK (MAP NO. 7; MONITORING SITE NO. 74-2), MENDOCINO CO., CALIFORNIA.

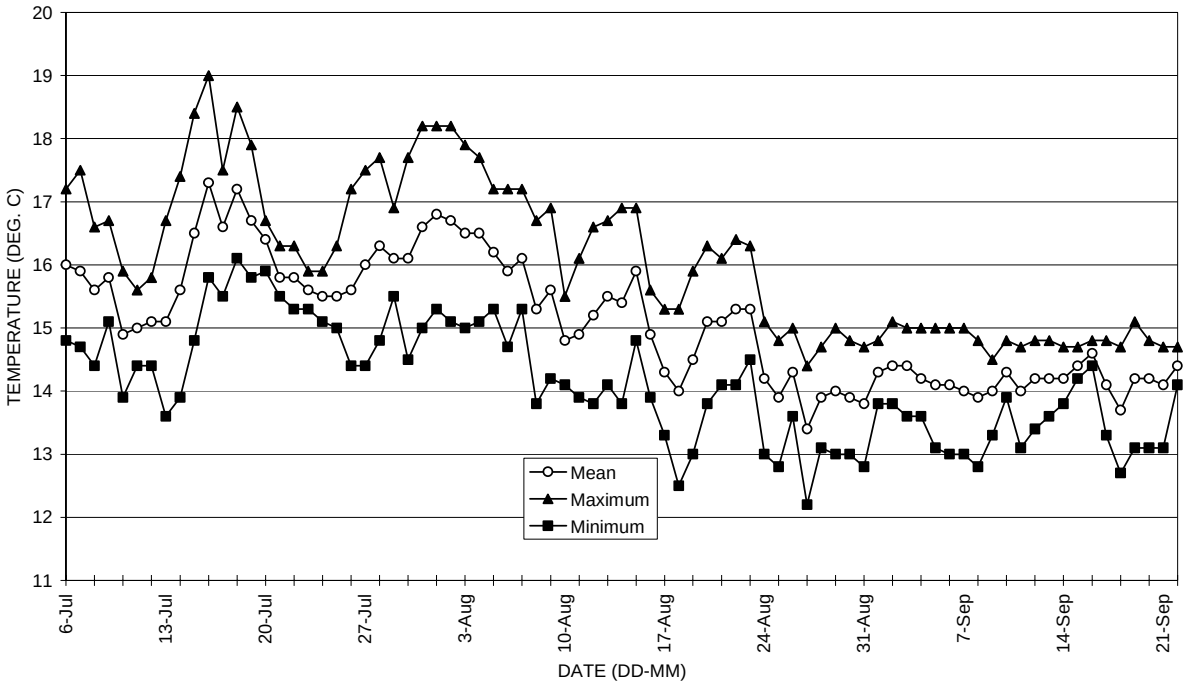


FIGURE 55. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT BIG RIVER (MAP NO. 8; MONITORING SITE NO. 76-1), MENDOCINO CO., CALIFORNIA.

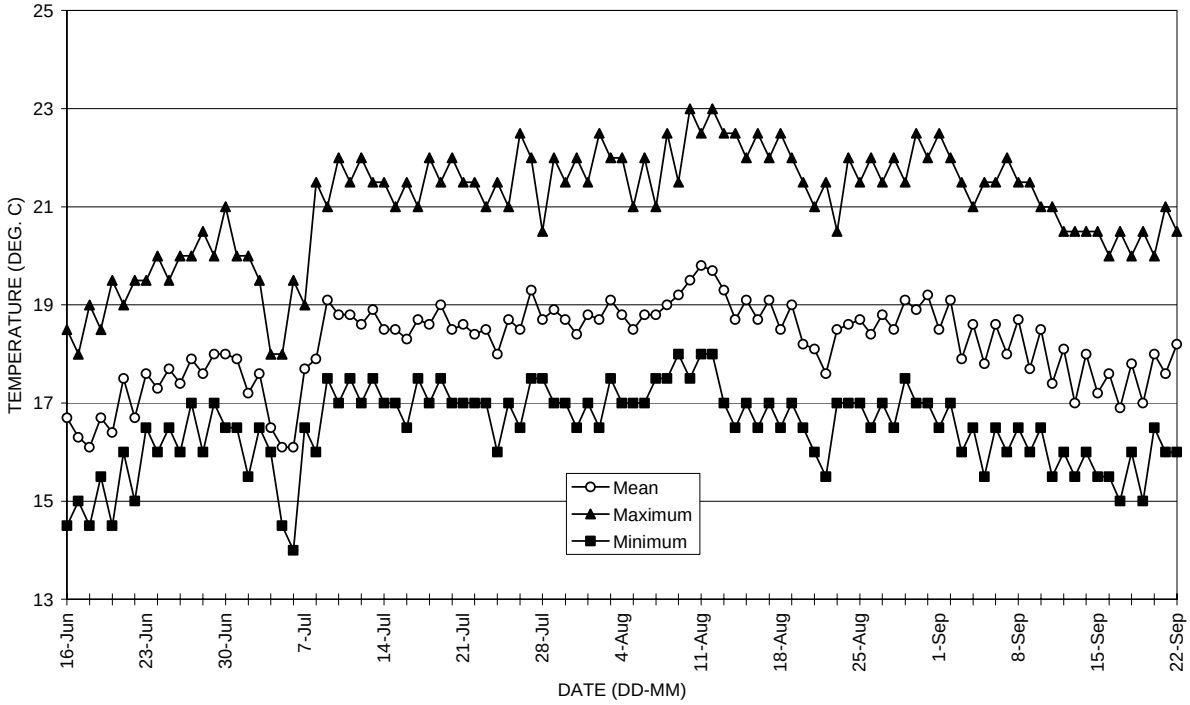


FIGURE 52. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT BIG RIVER (MAP NO. 7; MONITORING SITE NO. 74-3), MENDICINO CO., CALIFORNIA.

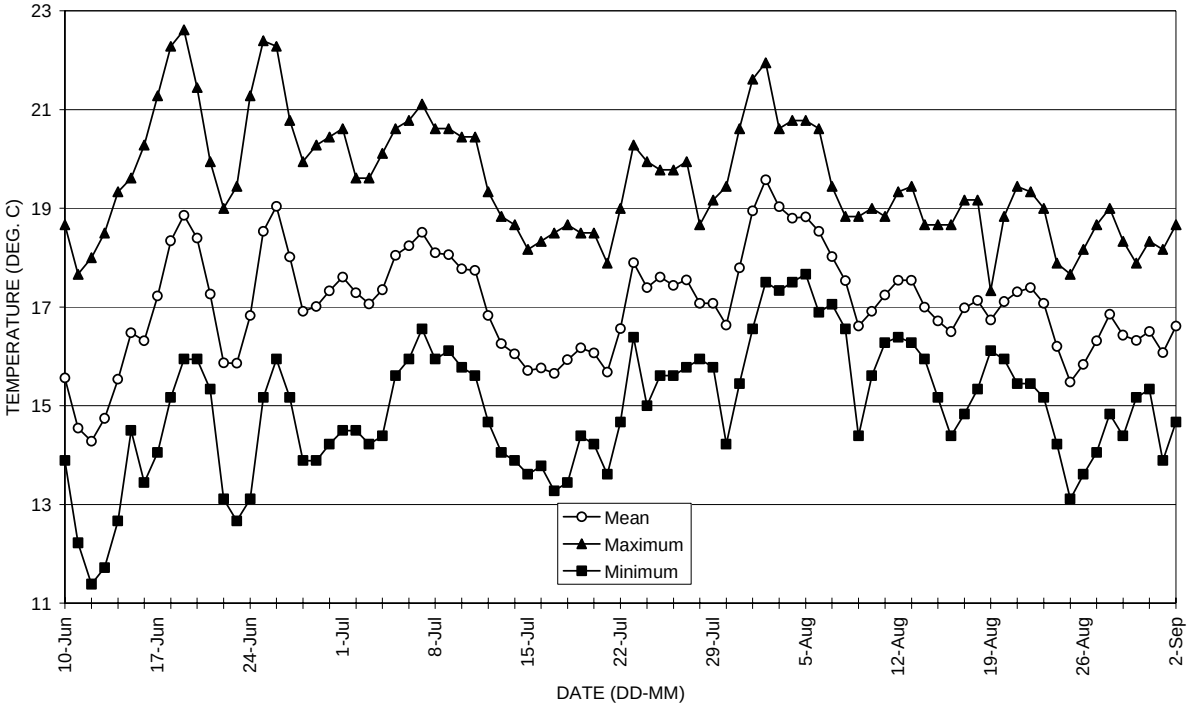


FIGURE 49. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURE DURING SUMMER (JULY-SEPTEMBER 1994) AT BIG RIVER (MAP NO. 7; MONITORING SITE NO. 74-1), MENDOCINO CO., CALIFORNIA.

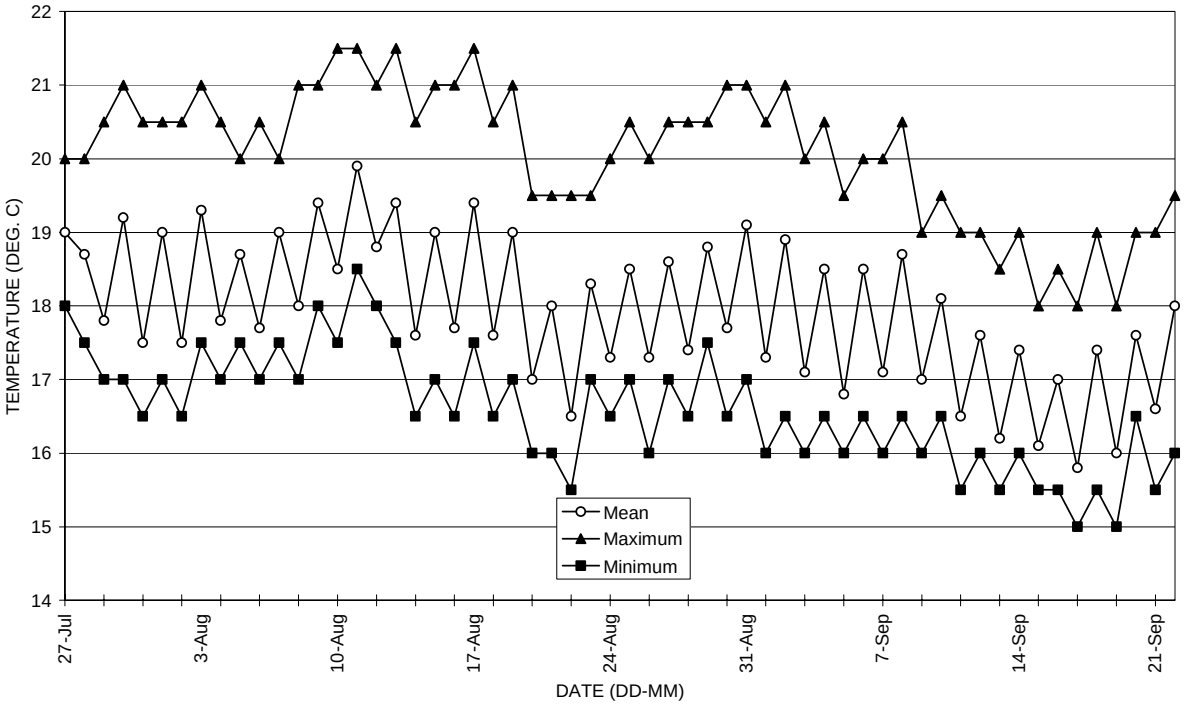


FIGURE 58. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT DAUGHERTY CREEK (MAP NO. 9; MONITORING SITE NO. 79-4), MENDOCINO CO., CALIFORNIA.

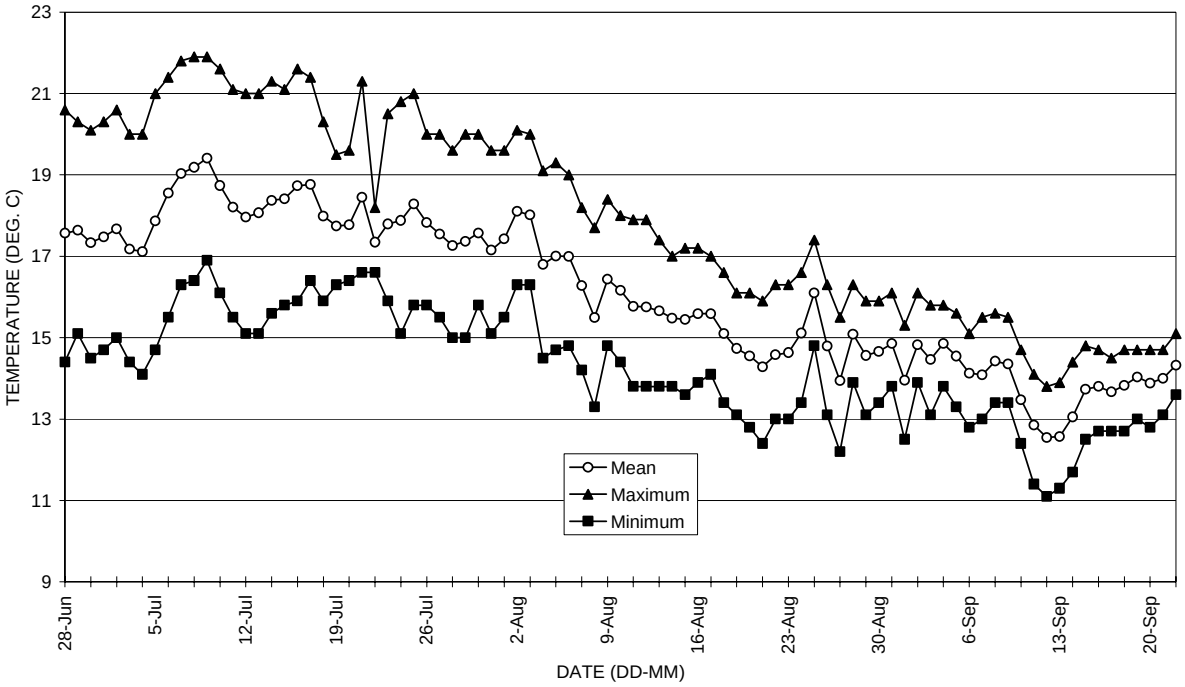


FIGURE 50. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT RUSSELL BROOK (MAP NO. 7; MONITORING SITE NO. 74-2), MENDOCINO CO., CALIFORNIA.

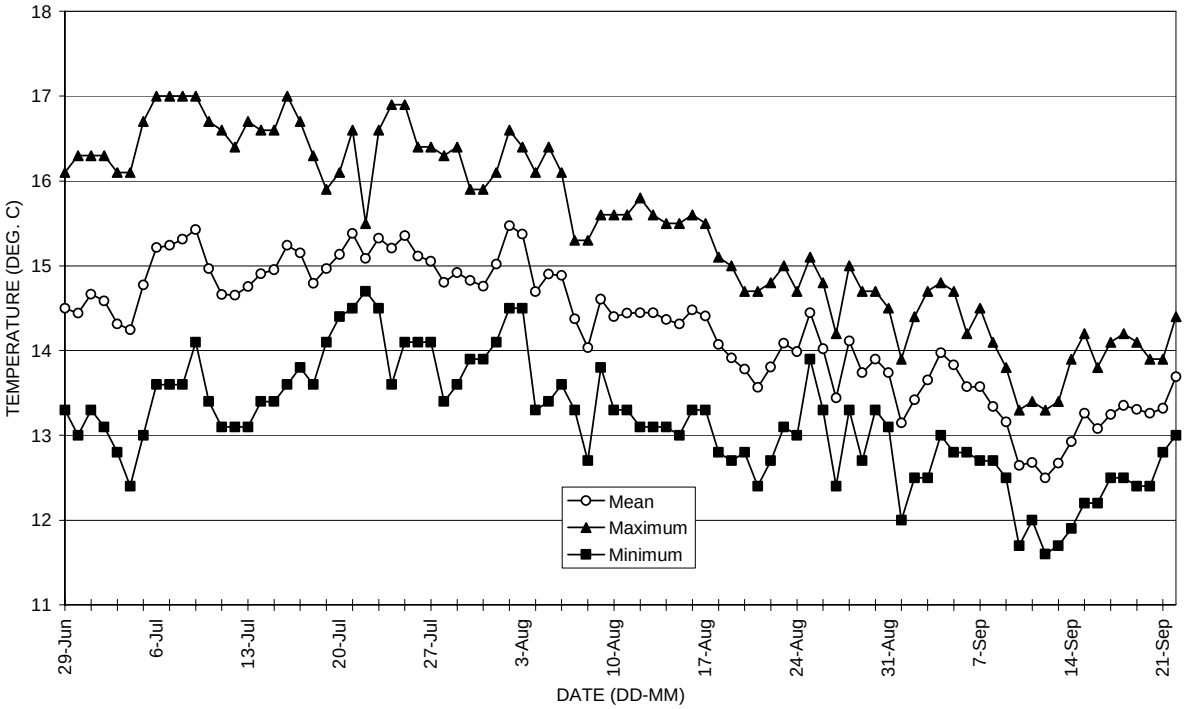


FIGURE 15. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1993) AT NORTH FORK BIG RIVER (MAP NO. 4; MONITORING SITE NO. 10A), MENDOCINO CO., CALIFORNIA.

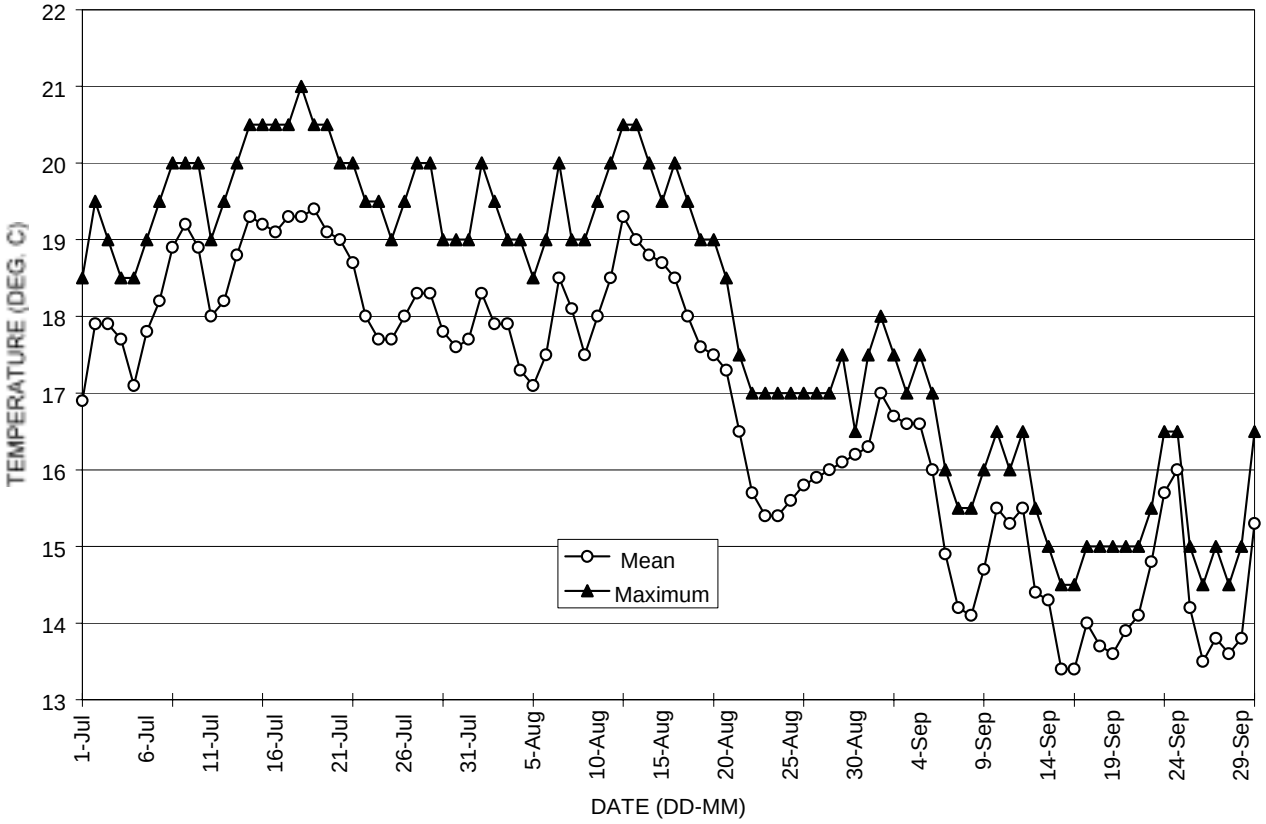


FIGURE 17. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT BIG RIVER (MAP NO. 5; MONITORING SITE NO. 9), MENDOCINO CO., CALIFORNIA.

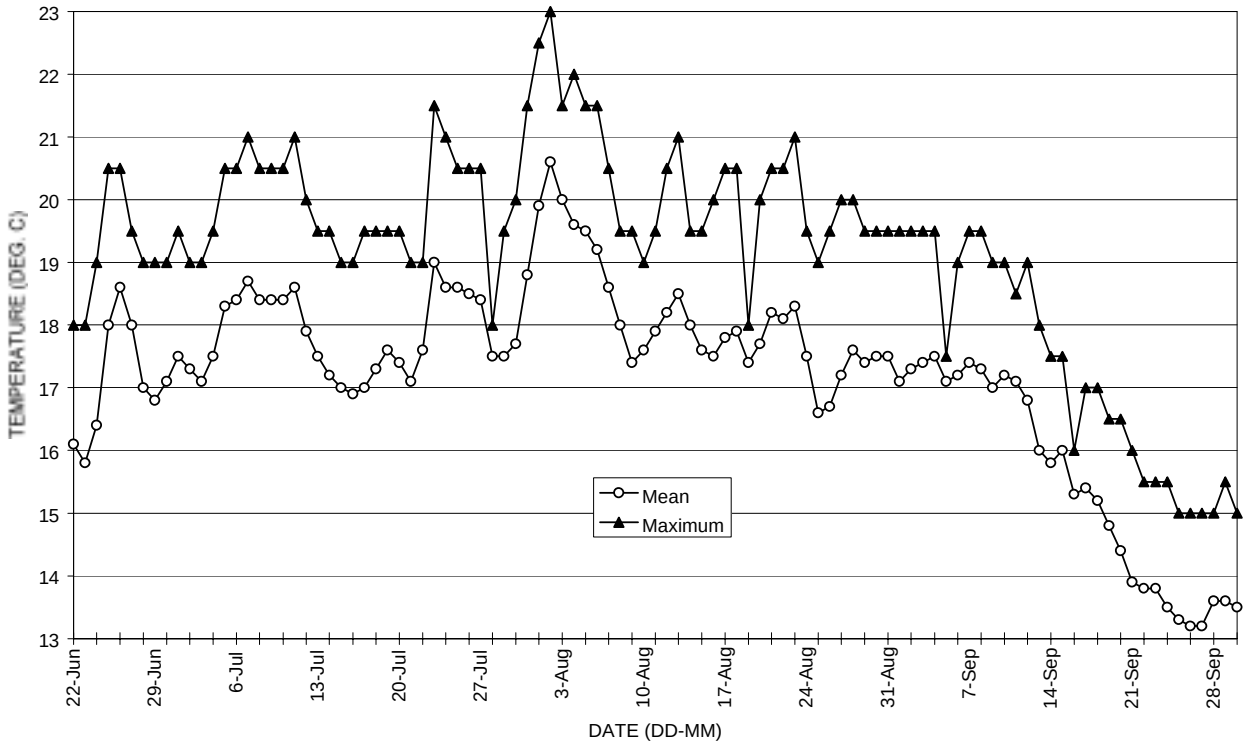


FIGURE 14. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-JULY 1993) AT BIG RIVER (MAP NO. 3; MONITORING SITE NO. 8), MENDOCINO CO., CALIFORNIA.

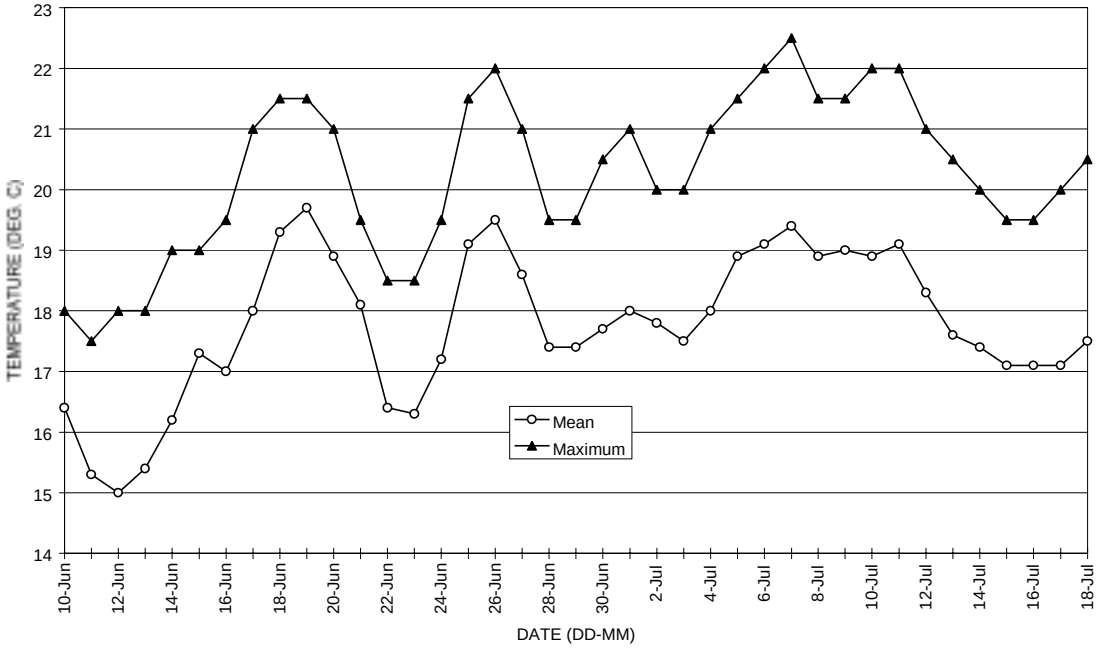


FIGURE 55. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT BIG RIVER (MAP NO. 8; MONITORING SITE NO. 76-1), MENDOCINO CO., CALIFORNIA.

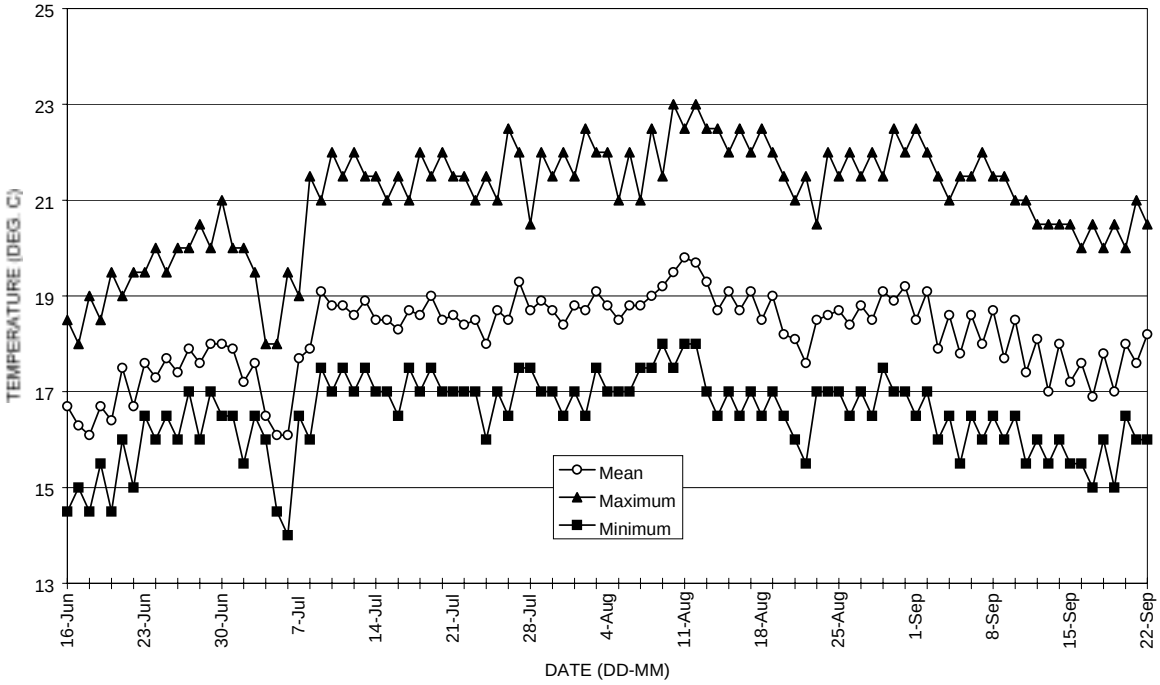


FIGURE 16. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993), AT EAST BRANCH OF THE NORTH FORK BIG RIVER (MAP NO. 4; MONITORING SITE NO. 11), MENDOCINO CO., CALIFORNIA.

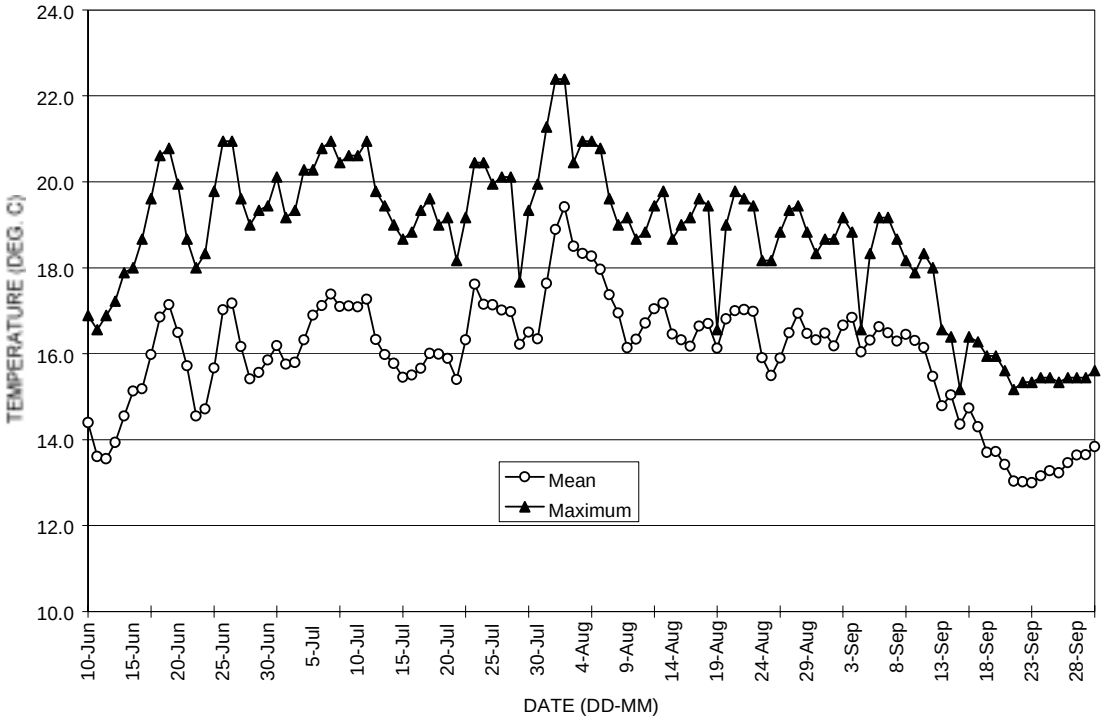


FIGURE 13. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1992) AT BIG RIVER (MAP NO. 3; MONITORING SITE NO. 8), MENDOCINO CO., CALIFORNIA.