Section D
RIPARIAN FUNCTION

INTRODUCTION

This module presents an assessment of the riparian function in the Navarro River Watershed Analysis Unit (WAU). This assessment was conducted during the summer of 1999. 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 response to LWD in order to determine the instream demands. The canopy closure and stream temperature assessment presents current canopy closure conditions and stream temperature monitoring which has been conducted. The goal of these evaluations is to provide baseline information on the current LWD loading in the channel and current status of riparian stand function in the Navarro River WAU.

LARGE WOODY DEBRIS RECRUITMENT AND INSTREAM DEMANDS

Methods

Short-term LWD recruitment potential (next 20-30 years) was evaluated in designated stream segments within the Navarro 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 1996 aerial photographs and field observations from the summer of 1999. 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-2).

Table D-2. Description of LWD Recruitment Potential Rating by Riparian Stand Classification for the Navarro 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 is that which is providing some habitat or morphologic function in the stream channel (i.e. pool formation, scour, debris dam, bank stabilization, or gravel storage). There was a 4 inch diameter (10 centimeter) and 10 foot length minimum size requirement for functional LWD. Rootwads were considered functional LWD even if they did not meet the length minimum. The 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 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: the LWD piece was part of a living tree, root associated (i.e. does it have a rootwad attached to it), part of the piece buried within stream gravel or the bank, or associated with a stream habitat enhancement structure. By assigning these attributes, the number of pieces in a segment which, for example, have a rootwad associated with the LWD can be calculated. This is important as these associations of the LWD provide context on the stability or ecological benefits that the LWD may possess.

Pieces that were partially buried were noted, as calculated volume for these pieces represent a minimum. 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 that 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 the following size requirement:

Table D-3. 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, defined as aggregates of LWD with >10 pieces, and debris accumulations, defined as aggregates of LWD with between 3-10 pieces, were noted. The total dimensions of a debris jam were recorded. The volume of the debris jam was calculated and added to total LWD volume with a correction factor of 50%. In other words, 50% of the total volume of a debris jam was considered to be "air space." Total number of pieces and number of key pieces in each debris jam was 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 that 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 is presented as a number of LWD pieces per 100 meters. This normalized quantity, by distance, was performed for functional and key LWD pieces within the active and bankfull channel. The key piece quantity in the bankfull channel (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 is derived from Bilby and Ward (1989) and Gregory and Davis (1992) and presented in Table D-4.

Table D-4. Target for Number of Key Large Woody Debris Pieces in Watercourses of the Navarro 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 was 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 aquatic habitat associations within the Navarro River WAU. The in-stream LWD demand was 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-5 shows how these three factors are used to determine the in-stream LWD demand.

Table D-5. In-stream LWD Demand

		Channel LWD Sensitivity Rating		
	LWD On Target **LWD Off Target**	**LOW**	**MODERATE**	**HIGH**
Recruitment Potential Rating	**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.

Results

The large woody debris recruitment potential and in-stream LWD demand for the Navarro 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 in-stream 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-6 a, b, and c. Only twelve of forty-seven channel segments surveyed in the Navarro River WAU met the key LWD targets. Generally, LWD loading in the Navarro WAU needs improvement.

Debris jams, where they occurred, were shown to be a significant portion of the total number of pieces and total volume. In the Navarro WAU, debris jams occurred in 16 segments and contained up to 90% of the total pieces and up to 100% of the total volume (See tables D-6 a and b). In the case of segment EN4, Spooner Creek, debris jams actually affected whether or not the segment met the LWD target. It was only through adding key pieces contained in debris jams that the segment exceeded the 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. A significant amount of the LWD volume in the Navarro River WAU was also contained in debris accumulations (4-10 LWD pieces). Up to 83 % of the volume of a segment could be found in these accumulations.

Buried LWD pieces were common in these streams. Up to 73% of the pieces in any given segment were at least partially buried (See Table D-6c). This indicates that we are unable to quantify a significant portion of the LWD volume that may be or is useful to the stream.

LWD species composition was largely redwood dominated (Table D-6b). This analysis was limited to pieces not contained within debris jams. The vast majority of LWD pieces in the Navarro WAU were redwood. The remainder of pieces consisted of an even mixture of fir, alder, hardwood, and unknown species. This may not be surprising as these streams flow through a redwood forest but it does show that the LWD currently found in these streams is more stable as redwood breaks down more slowly in streams than hardwood species.

As shown in Tables D-6 a, b and c and map D-1, there is a need for large woody debris in almost all of the channel segments of the Navarro WAU. Channel segments with LWD levels that are well below the target will need to be the priority for promoting future recruitment and restoration work. Even the stream segments that met the key piece target need good riparian stands to ensure that LWD levels are maintained to provide aquatic habitat and morphological function in the stream channels.

Table D-7 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 majority of the streams have a deficient LWD quality rating, with the remainder being marginal. None of the major streams in the Navarro WAU received an on target rating.

Table D-6a.-Large Woody Debris Piece Count in Selected Stream Segments of the Navarro River WAU.

Stream Segment Name	Stream Segment ID#	Total LWD Pieces w/o Debris Jams	Total LWD Pieces w/ Debris Jams	Total # of Debris Jams	Total # of Debris Accumulations	Total LWD (#/328ft) w/o Debris Jams	Total LWD (#/328ft) w/ Debris Jams	Key LWD Pieces w/o Debris Jams	Key LWD Pieces w/ Debris Jams	Key LWD Pieces/328ft w/o Debris Jams	Key LWD Pieces/328ft w/Debris Jams	% of Total Pieces in Debris Jams
N Branch Navarro	ED1	18	47	1	1	3.3	8.6	3	5	0.5	0.9	62%
Cook Creek	ED8	21	51	1	2	7.0	17.0	3	8	1.0	2.7	59%
North Fork Indian Creek	EI2	29	108	3	4	7.7	28.7	3	12	0.8	3.2	73%
John Smith Creek	EJ1	15	15	0	2	7.0	7.0	2	2	0.9	0.9	0%
John Smith Creek	EJI(2)	22	22	0	3	10.0	10.0	3	3	1.4	1.4	0%
SB Navarro	EL1	76	146	3	7	16.2	31.2	3	3	0.6	0.6	48%
South Branch Navarro	EM1	6	6	0	0	1.5	1.5	1	1	0.2	0.2	0%
Bear Creek	EM20	20	20	0	2	13.0	13.0	8	8	NA	NA	0%
Bridge Creek	EM29	14	25	1	2	5.4	9.6	3	6	1.2	2.3	44%
Bridge Creek	EM30	18	32	1	3	10.3	18.3	3	7	1.7	4.0	44%
Shingle Mill Creek	EM39	7	32	1	0	4.1	18.6	4	9	2.3	5.2	78%
Little NF Navarro	EN2	28	28	0	3	10.7	10.7	3	3	1.1	1.1	0%
Little NF Navarro	EN25	41	41	0	6	17.9	17.9	7	7	3.1	3.1	0%
Bottom Creek	EN3	12	12	0	0	6.5	6.5	5	5	2.7	2.7	0%
Sawyer Creek	EN38	29	29	0	2	21.4	21.4	4	4	3.0	3.0	0%
Spooner Creek	EN4	61	74	1	10	29.3	35.5	8	11	3.8	5.3	18%
Upper South Branch Navarro	EU1	19	56	2	3	2.8	8.3	7	14	1.0	2.1	66%
Low Gap Creek	EU20	5	21	1	0	2.4	10.3	2	3	1.0	1.5	76%
Rose Creek	EU24	9	53	1	2	5.2	30.8	3	7	1.7	4.1	83%
South Branch Navarro	EU4	17	17	0	3	5.5	5.5	4	4	1.3	1.3	0%
McGarvey Creek	EU7	29	68	3	5	9.4	22.0	11	15	3.6	4.8	57%
Flynn Creek	WF1	32	32	0	2	9.8	9.8	6	6	1.8	1.8	0%
Flynn Creek	WF1(u)	16	27	1	2	6.1	10.3	2	2	0.8	0.8	41%
Camp 16 Gulch	WF13	40	40	0	5	17.2	17.2	7	7	3.0	3.0	0%
Tank Gulch	WF26	34	34	0	6	37.5	37.5	5	5	NA	NA	0%
none	WH3	8	8	0	0	5.1	5.1	5	5	3.2	3.2	0%
Murray Gulch	WL19	25	25	0	0	14.6	14.6	10	10	5.8	5.8	0%
Flume Gulch	WL27	32	32	0	2	10.4	10.4	5	5	1.6	1.6	0%
Flume Gulch	WL28	52	52	0	3	30.0	30.0	19	19	11.0	11.0	0%
Navarro River	WL3	30	30	0	1	3.2	3.2	0	0	0.0	0.0	0%
Marsh Gulch	WL4	29	29	0	1	21.2	21.2	12	12	8.8	8.8	0%
Navarro River	WM2	28	28	0	0	3.3	3.3	0	0	0.0	0.0	0%
Skid Gulch	WM32	14	14	0	2	13.7	13.7	6	6	5.9	5.9	0%
Berry Creek	WM36	9	89	4	0	3.7	36.1	0	0	0.0	0.0	90%
Navarro River	WM5	4	4	0	0	0.6	0.6	1	1	0.1	0.1	0%
Dead Horse Gulch	WN10	38	38	0	2	32.2	32.2	7	7	5.9	5.9	0%
Dead Horse Gulch	WN11	12	12	0	0	19.9	19.9	4	4	NA	NA	0%
Coon Gulch	WN20	29	29	0	5	14.6	14.6	10	10	5.0	5.0	0%
Roller Gulch	WR11	24	24	0	2	8.9	8.9	8	8	3.0	3.0	0%
Ray Gulch	WR14	56	71	1	9	32.2	40.9	15	17	8.6	9.8	21%
Ray Gulch	WR15	41	41	0	3	25.6	25.6	13	13	8.1	8.1	0%
White Gulch	WR23	25	25	0	1	14.3	14.3	11	11	6.3	6.3	0%
Mustard Gulch	WR26	27	27	0	1	19.5	19.5	16	16	11.5	11.5	0%
Navarro River	WU1	20	20	0	1	2.8	2.8	0	0	0.0	0.0	0%
Kabiki Creek	WU15	0	NA	3	0	0.0	#VALUE!	0	NA	0.0	NA	#VALUE!
Sage Gulch	WU18	29	29	0	3	28.8	28.8	5	5	5.0	5.0	0%
Black Rock Creek	WU4	47	47	0	8	22.5	22.5	18	18	8.6	8.6	0%

Table D-6b. Large Woody Debris Volume Information in Selected Stream Segments of the Navarro River WAU.

Stream Segment Name	Stream Segment ID#	Total Volume (yd^3) w/o Debris Jams	Total Volume (yd^3) w/ DebrisJams	Total Vol/328ft (yd^3) w/o Debris Jams	Total Vol/328ft (yd^3) w/ Debris Jams	% of Total Volume in Debris Jams	% of Vol in Key Pieces w/o Jams	% of Total Volume By Species w/o Jams					% Current Recruitment (<10 yrs)
								Redwood	Fir	Alder	Hardwood	Unknown	
N Branch Navarro	ED1	51.8	125.9	9.5	23.0	59%	59%	44%	49%	0%	3%	4%	0-25
Cook Creek	ED8	30.9	130.9	10.3	43.6	76%	54%	36%	55%	0%	6%	3%	50-75
North Fork Indian Creek	EI2	111.4	251.4	29.6	66.8	56%	61%	80%	2%	0%	9%	10%	0-25
John Smith Creek	EJ1	45.1	45.1	21.0	21.0	0%	66%	48%	52%	0%	0%	1%	0-25
John Smith Creek	EJI(2)	19.7	19.7	9.0	9.0	0%	54%	62%	22%	0%	14%	1%	0-25
SB Navarro	EL1	167.6	410.2	35.8	87.5	59%	24%	76%	8%	0%	11%	4%	25-50
South Branch Navarro	EM1	9.8	9.8	2.4	2.4	0%	65%	83%	0%	0%	10%	7%	50-75
Bear Creek	EM20	72.8	72.8	47.4	47.4	0%	96%	23%	68%	0%	0%	8%	0-25
Bridge Creek	EM29	19.9	36.6	7.7	14.1	46%	73%	23%	67%	0%	6%	4%	25-50
Bridge Creek	EM30	55.1	75.9	31.4	43.3	27%	76%	94%	0%	0%	4%	1%	25-50
Shingle Mill Creek	EM39	9.2	30.0	5.3	17.5	69%	67%	54%	34%	0%	9%	2%	0-25
Little NF Navarro	EN2	57.5	57.5	21.9	21.9	0%	30%	91%	0%	0%	9%	0%	50-75
Little NF Navarro	EN25	36.7	36.7	16.0	16.0	0%	64%	85%	1%	0%	10%	4%	25-50
Bottom Creek	EN3	17.4	17.4	9.5	9.5	0%	79%	66%	0%	0%	0%	34%	25-50
Sawyer Creek	EN38	14.7	14.7	10.9	10.9	0%	71%	74%	0%	0%	1%	25%	NA
Spooner Creek	EN4	67.7	87.7	32.5	42.1	23%	49%	90%	4%	0%	0%	5%	0-25
Upper South Branch Navarro	EU1	89.0	153.0	13.3	22.8	42%	73%	67%	24%	0%	8%	1%	25-50
Low Gap Creek	EU20	13.0	21.9	6.4	10.7	41%	94%	99%	0%	0%	0%	1%	0-25
Rose Creek	EU24	40.6	107.3	23.6	62.3	62%	91%	66%	27%	0%	1%	6%	0-25
South Branch Navarro	EU4	42.6	42.6	13.7	13.7	0%	52%	98%	0%	0%	2%	1%	50-75
McGarvey Creek	EU7	81.5	174.8	26.3	56.5	53%	87%	34%	59%	0%	0%	7%	50-75
Flynn Creek	WF1	39.2	39.2	11.9	11.9	0%	44%	20%	63%	3%	7%	6%	25-50
Flynn Creek	WF1(u)	16.3	40.0	6.2	15.3	59%	41%	40%	49%	0%	9%	3%	25-50
Camp 16 Gulch	WF13	44.7	44.7	19.2	19.2	0%	76%	80%	1%	1%	4%	15%	NA
Tank Gulch	WF26	12.3	12.3	13.6	13.6	0%	51%	38%	4%	0%	44%	15%	50-75
none	WH3	36.8	36.8	23.3	23.3	0%	99%	100%	0%	0%	0%	0%	0-25
Murray Gulch	WL19	68.6	68.6	40.0	40.0	0%	77%	60%	3%	3%	33%	4%	0-25
Flume Gulch	WL27	46.7	46.7	15.2	15.2	0%	41%	57%	0%	19%	4%	19%	0-25
Flume Gulch	WL28	223.4	223.4	128.8	128.8	0%	89%	94%	0%	4%	0%	2%	0-25
Navarro River	WL3	20.5	20.5	2.2	2.2	0%	0%	20%	0%	0%	40%	39%	50-75
Marsh Gulch	WL4	148.1	148.1	108.4	108.4	0%	91%	97%	0%	0%	1%	2%	0-25
Navarro River	WM2	159.0	159.0	18.8	18.8	0%	0%	69%	24%	0%	4%	3%	50-75
Skid Gulch	WM32	34.5	34.5	33.9	33.9	0%	90%	100%	0%	0%	0%	0%	NA
Berry Creek	WM36	10.9	222.1	4.4	90.1	95%	0%	90%	0%	0%	2%	8%	0-25
Navarro River	WM5	47.2	47.2	6.5	6.5	0%	55%	44%	55%	0%	0%	1%	50-75
Dead Horse Gulch	WN10	46.0	46.0	39.0	39.0	0%	48%	71%	16%	0%	3%	10%	25-50
Dead Horse Gulch	WN11	15.3	15.3	25.3	25.3	0%	85%	91%	0%	0%	0%	8%	0-25
Coon Gulch	WN20	39.8	39.8	20.1	20.1	0%	58%	97%	2%	0%	0%	0%	0-25
Roller Gulch	WR11	65.3	65.3	24.2	24.2	0%	47%	71%	18%	0%	8%	2%	25-50
Ray Gulch	WR14	107.5	122.3	61.8	70.4	12%	69%	55%	41%	0%	0%	3%	25-50
Ray Gulch	WR15	107.5	107.5	67.1	67.1	0%	90%	35%	24%	24%	10%	15%	25-50
White Gulch	WR23	60.3	60.3	34.4	34.4	0%	83%	28%	68%	0%	0%	4%	50-75
Mustard Gulch	WR26	106.7	106.7	76.9	76.9	0%	91%	95%	0%	0%	0%	5%	0-25
Navarro River	WU1	50.7	50.7	7.0	7.0	0%	0%	26%	51%	0%	15%	8%	50-75
Kabiki Creek	WU15	0.0	33.0	0.0	21.7	100%	0%	0%	0%	0%	0%	0%	0-25
Sage Gulch	WU18	50.3	50.3	50.0	50.0	0%	73%	98%	0%	0%	0%	2%	0-25
Black Rock Creek	WU4	88.5	88.5	42.4	42.4	0%	85%	69%	25%	0%	0%	6%	25-50

Table D-6c. Large Woody Debris Attribute Information in Selected Stream Segments of the Navarro WAU

	Stream	Piece Count						Volume					
Stream	Segment	Root Associated		Buried		Alive		Root Associated		Buried		Alive	
Segment Name	ID#	#	%	#	%	#	%	Yd^3	%	Yd^3	%	Yd^3	%
N Branch Navarro	ED1	8	44%	2	11%	2	11%	35.3	68%	2.9	6%	1.0	2%
Cook Creek	ED8	1	5%	0	0%	0	0%	2.0	6%	0.0	0%	0.0	0%
North Fork Indian Creek	EI2	11	38%	2	7%	0	0%	62.7	56%	2.8	3%	0.0	0%
John Smith Creek	EJ1	1	7%	5	33%	0	0%	3.7	8%	5.2	12%	0.0	0%
John Smith Creek	EJI(2)	11	50%	9	41%	0	0%	8.3	42%	7.7	39%	0.0	0%
SB Navarro	EL1	20	26%	12	16%	0	0%	78.8	47%	30.7	18%	0.0	0%
South Branch Navarro	EM1	0	0%	0	0%	0	0%	0.0	0%	0.0	0%	0.0	0%
Bear Creek	EM20	2	10%	2	10%	0	0%	18.0	25%	0.1	0%	0.0	0%
Bridge Creek	EM29	4	29%	1	7%	0	0%	0.9	5%	0.9	5%	0.0	0%
Bridge Creek	EM30	2	11%	3	17%	0	0%	2.3	4%	1.5	3%	0.0	0%
Shingle Mill Creek	EM39	1	14%	0	0%	0	0%	2.6	28%	0.0	0%	0.0	0%
Little NF Navarro	EN2	3	11%	5	18%	0	0%	15.2	26%	8.1	14%	0.0	0%
Little NF Navarro	EN25	7	17%	5	12%	0	0%	6.1	17%	7.4	20%	0.0	0%
Bottom Creek	EN3	1	8%	3	25%	0	0%	0.2	1%	1.2	7%	0.0	0%
Sawyer Creek	EN38	10	34%	8	28%	0	0%	0.8	5%	2.9	20%	0.0	0%
Spooner Creek	EN4	12	20%	12	20%	0	0%	21.3	31%	14.1	21%	0.0	0%
Upper South Branch Navarro	EU1	7	37%	3	16%	0	0%	33.8	38%	16.2	18%	0.0	0%
Low Gap Creek	EU20	0	0%	1	20%	0	0%	0.0	0%	0.1	1%	0.0	0%
Rose Creek	EU24	1	11%	2	22%	1	11%	10.9	27%	1.4	3%	0.6	1%
South Branch Navarro	EU4	2	12%	0	0%	1	6%	0.7	2%	0.0	0%	0.4	1%
McGarvey Creek	EU7	6	21%	5	17%	0	0%	52.7	65%	2.9	4%	0.0	0%
Flynn Creek	WF1	3	9%	4	13%	2	6%	1.4	4%	1.8	5%	2.5	6%
Flynn Creek	WF1(u)	5	31%	0	0%	0	0%	7.1	44%	0.0	0%	0.0	0%
Camp 16 Gulch	WF13	5	13%	4	10%	1	3%	8.2	18%	1.4	3%	3.1	7%
Tank Gulch	WF26	0	0%	10	29%	0	0%	0.0	0%	2.5	20%	0.0	0%
none	WH3	1	13%	3	38%	0	0%	2.3	6%	22.9	62%	0.0	0%
Murray Gulch	WL19	2	8%	8	32%	1	4%	6.6	10%	5.1	7%	0.9	1%
Flume Gulch	WL27	12	38%	10	31%	4	13%	21.5	46%	4.1	9%	6.2	13%
Flume Gulch	WL28	7	13%	18	35%	4	8%	56.5	25%	81.1	37%	5.9	3%
Navarro River	WL3	3	10%	22	73%	0	0%	5.4	26%	14.0	68%	0.0	0%
Marsh Gulch	WL4	3	10%	13	45%	0	0%	51.9	35%	76.6	52%	0.0	0%
Navarro River	WM2	12	43%	4	14%	0	0%	71.9	45%	3.8	2%	0.0	0%
Skid Gulch	WM32	1	7%	3	21%	0	0%	18.6	54%	1.9	6%	0.0	0%
Berry Creek	WM36	4	44%	1	11%	0	0%	7.5	69%	0.8	7%	0.0	0%
Navarro River	WM5	1	25%	1	25%	0	0%	0.4	1%	0.4	1%	0.0	0%
Dead Horse Gulch	WN10	12	32%	3	8%	0	0%	14.8	32%	1.3	3%	0.0	0%
Dead Horse Gulch	WN11	1	8%	5	42%	0	0%	9.3	61%	2.3	15%	0.0	0%
Coon Gulch	WN20	2	7%	6	21%	0	0%	0.4	1%	4.4	11%	0.0	0%
Roller Gulch	WR11	3	13%	6	25%	0	0%	24.5	38%	10.8	17%	0.0	0%
Ray Gulch	WR14	8	14%	2	4%	1	2%	32.8	31%	0.7	1%	0.1	0%
Ray Gulch	WR15	7	17%	7	17%	3	7%	51.7	48%	12.6	12%	25.3	24%
White Gulch	WR23	6	24%	3	12%	0	0%	29.1	48%	1.0	2%	0.0	0%
Mustard Gulch	WR26	0	0%	5	19%	0	0%	0.0	0%	5.2	5%	0.0	0%
Navarro River	WU1	12	60%	6	30%	0	0%	0.0	0%	7.7	15%	0.0	0%
Kabiki Creek	WU15	0	0%	0	0%	0	0%	0.0	0%	0.0	0%	0.0	0%
Sage Gulch	WU18	1	3%	10	34%	0	0%	0.2	0%	3.7	7%	0.0	0%
Black Rock Creek	WU4	7	15%	5	11%	0	0%	14.3	16%	2.8	3%	0.0	0%

Table D-7. Instream LWD Quality Ratings for Major Streams and Sections of Streams or Rivers in Calwater Planning Watersheds for the Navarro WAU.

Stream	Calwater Planning Watershed	In-stream LWD Quality
Navarro R.	Lower Navarro River	Marginal
Navarro R.	Middle Navarro River	Marginal
Navarro R.	Upper Navarro River	Marginal
Navarro R.	Hendy Woods	Marginal
Marsh Gulch	Lower Navarro River	Marginal
Murray Gulch	Lower Navarro River	Marginal
Flume Crk.	Lower Navarro River	Marginal
Ray Gulch	Ray Gulch	Marginal
Flynn Crk.	Flynn Creek	Deficient
North Branch N.F. Navarro R.	Dutch Henry Creek	Deficient
North Branch N.F. Navarro R.	Little North Fork Navarro	Deficient
Cooks Crk.	Dutch Henry Creek	Deficient
John Smith Crk.	John Smith Creek	Deficient
Redwood Crk.	Little North Fork Navarro	Deficient
Little N.F. Navarro River	Little North Fork Navarro	Deficient
South Branch N.F. Navarro R.	Lower South Branch Navarro	Deficient
South Branch N.F. Navarro R.	Middle South Branch Navarro	Deficient
South Branch N.F. Navarro R.	Upper South Branch Navarro	Deficient
Bailey Crk.	Middle South Branch Navarro	Deficient
Bear Crk.	Middle South Branch Navarro	Marginal
Bridge Crk.	Middle South Branch Navarro	Deficient
Shingle Mill Crk.	Middle South Branch Navarro	Deficient
McGarvey Crk.	Upper South Branch Navarro	Marginal
Low Gap Crk.	Upper South Branch Navarro	Deficient
Hardscratch Crk.	Upper South Branch Navarro	Deficient
Tramway Gulch	North Fork Navarro River	Deficient
Perry Gulch	Floodgate Creek	ND
Berry Crk.	Middle Navarro River	Deficient
Floodgate Crk.	Floodgate Creek	Deficient
Black Rock Crk.	Upper Navarro River	Marginal
N.F. Indian Crk.	North Fork Indian Creek	Deficient
West Branch N.F. Indian Crk.	North Fork Indian Creek	Deficient
Cold Springs Crk.	Rancheria Creek	Deficient
Dago Crk.	Rancheria Creek	Deficient

CANOPY CLOSURE AND STREAM TEMPERATURE

Methods

Canopy closure, over watercourses, was estimated from 1996 aerial photographs. Four canopy closure classes were determined using aerial photographs. These classes are shown in table D-8. A map was produced for the Navarro WAU based on the aerial photograph interpretations (Map D-2).

Table D-8. Estimated levels of Canopy Closure from Aerial Photographs.

Stream surface not visible	>90% Canopy Closure
Stream surface visible or visible in patches	70-90% Canopy Closure
Stream visible but banks are not visible	40-70% Canopy Closure
Stream surface and banks visible	<40% Canopy Closure

During 1999 field measurements of canopy closure over select stream channels were performed. The field measurements were taken during the stream channel assessments in the Navarro 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 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.

Stream temperature has been monitored in Class I streams in the Navarro WAU, by Louisiana-Pacific Corp., 1989-97 and MRC in 1999-2002. In summer 2001 this was expanded to include Class II and one Class IV (Theron's Pond) watercourse 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 used electronic temperature recorders (Stowaway, Onset Instruments) which monitor the water temperature continuously 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-9 a and b describes the temperature monitoring locations.

Table D-9a. Class I Stream Temperature Monitoring Locations and Time Periods in the Navarro WAU (see map D-2).

Temperature Monitoring Station	Stream Channel Segment Number	Stream/River Name	Years Monitored
81-1	ED1	North Branch NF Navarro	92, '93, '94, '95, '99, '00, '01, '02
81-2	EJ1	John Smith Creek	1989-94, '97, '99, '00, '02
81-3	EN1	North Branch NF Navarro	1992-95, '99, '00, '01, '02
81-4	EJ1	John Smith Creek	89, '91, '02
81-5	EJ9	Sheep Gulch	01
81-6	ED8	Cooks Creek	02
81-7	EN14	Redwood Creek	02
81-8	EN2	Little North Fork Navarro	02
82-1	WL4	Marsh Gulch	89, 1991-94, '99, '00, '01,'02
82-2	WF1	Flynn Creek	93, '94, '97, '99, '00, '01, '02
82-3	WM2	Navarro River	1989-94, '99, '00, '01
82-4	WL6	Marsh Gulch	1989
82-5	WM5	Navarro River	89, '90, '91, '92, '01, '02
82-6	WL19	Murray Gulch	01
82-7	WN10	Deadhorse Gulch	01, '02
82-8	WF13	Camp 16 Gulch	01, '02
82-9	WL27	Flume Gulch	01, '02
85-1	EL1	South Branch NF Navarro	95, '96, '99 '00, '01, '02
85-2	EI3	South Branch NF Navarro	94, '95, '96, '99, '00, '01
86-1	EI1	NF Indian Creek	93, '94, '95, '96, '00, '01, '02
86-2	EI11	NF Indian Creek	94, '95, '96, '99, '00, '01, '02
88-1	WH1	Navarro River	1990-94, '99, '00, '02

Table D-9b. Class II Stream Temperature Monitoring Locations for Summer 2001.

Temperature Monitoring Station	Stream/River Name
82-21	Tributary to Flynn Creek
82-22	Mustard Gulch
82-23	Black Rock Creek
82-24	Berry Creek
82-25	Tramway Gulch
82-26	Tank 4 Gulch
82-27	Coon Creek
82-28	Ray Gulch
85-20	NF Rose Creek
85-21	SF Rose Creek
86-20	West Branch Indian Creek
86-21	Theron's Pond (CIV)

Maximum and mean daily temperatures were calculated for each temperature monitoring site and year and are presented 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 and maximum daily stream 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 segments 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. MRC uses 2 sequential sets of criteria to determine if a watershed has "on-target" effective shade, the first based on stream temperature, the second on effective shade:

- If the MWAT value for stream temperature at the outlet of a streams major basin (for North Branch Navarro the major basin is the Navarro River) lies below 15°C, then we consider that current shade conditions provide "on-target" effective shade for all watercourses in that basin.

However, if the MWAT value, for the major basin of a stream, lies above 15°C then the percentage of effective shade over each watercourse in the hydrologic watershed or planning watershed for streams and rivers that flow through a planning watershed determines the streams effective shade quality rating.

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.

Major streams were further classified by a stream temperature quality rating to provide insight to the habitat quality of a stream or stream segment based on water temperature. High water temperatures indicate unsuitable habitat for salmonids and cold water amphibians. However, it is not necessarily indicative of poor land use practices. Factors such as microclimate of the area and size of the stream or river and ability of riparian vegetation to shade it influence water temperature. To expect all streams and rivers to meet an “On Target” stream temperature quality rating is inappropriate. But as a determination of where appropriate summer rearing habitat for salmonids is located the stream temperature quality rating works well.

Table D-10. Summer Stream Temperature Quality Rating for Salmonids as a Function of Maximum Weekly Average Temperature (MWAT).

	Species Historically Present		
MWAT (°C)	**Coho Only**	**Steelhead Only**	**Coho and Steelhead**
<15	On Target	On Target	On Target
15-17	Marginal	On Target	Marginal
17-19	Deficient	Marginal	Deficient
>19	Deficient	Deficient	Deficient

To determine the stream-temperature quality rating for each watercourse, we selected the lowest species-specific stream-temperature rating among the salmonid species historically present in that particular watercourse. For each watercourse with multiple monitoring sites, we calculated a weighted-average of the stream-temperature quality ratings of segments for that watercourse. We assigned a value of 1 to “deficient” segments, 2 to “marginal” segments, and 3 to “on-target” segments, weighting this value by each segment’s proportion of the total watercourse length in the planning watershed. For example, take a watershed with a historic coho population and the following characteristics:

Monitoring site	**MWAT (°C)**	**Temperature quality rating**	**Proportion of total watercourse length**
A	14.2	On Target	0.50
B	18.0	Deficient	0.25
C	15.2	Marginal	0.25

Overall temperature quality value = 3(0.50) + 1(0.25) + 2(0.25)= 2.25

We use the following ranges to convert the weighted value into an overall rating:

1.00 - 1.66 = Deficient
1.67 - 2.33 = Marginal
2.34 - 3.00 = On Target

Results and Discussion

Canopy cover is less than ideal in streams in the Navarro River WAU (see Map D-2). The entire mainstem Navarro River falls into the 0-40% canopy cover range although this is to be expected of a mainstem channel in the lower reaches of a large watershed. Other problem areas are upper South Branch of the North Fork Navarro, lower North Branch of the North Fork, and Indian Creek. Canopy cover in these areas varies but rarely exceeds 70%. Flynn Creek as well as many of the smaller tributaries appear to have adequate stream shading. Table D-11 summarizes the results of canopy closure measurements at stream segments where stream channel and fish habitat information was collected.

Table D-11. Canopy Shading Streams of the Navarro WAU, 1999.

Stream Name	Segment ID	Mean Canopy over Stream
N Branch Navarro	ED1	29
Cook Creek	ED8	68
North Fork Indian Creek	EI2	48
John Smith Creek	EJ1	87
John Smith Creek	EJI(2)	81
SB Navarro	EL1	45
South Branch Navarro	EM1	74
Bear Creek	EM20	79
Bridge Creek	EM29	36
Bridge Creek	EM30	70
Shingle Mill Creek	EM39	76
Little NF Navarro	EN2	75
Little NF Navarro	EN25	80
Bottom Creek	EN3	80
Sawyer Creek	EN38	74
Spooner Creek	EN4	81
Upper South Branch Navarro	EU1	68
Low Gap Creek	EU20	83
Rose Creek	EU24	75
South Branch Navarro	EU4	66
McGarvey Creek	EU7	69
Flynn Creek	WF1	79
Flynn Creek	WF1(u)	80
Camp 16 Gulch	WF13	90
Tank Gulch	WF26	86
Tank Gulch	WF27	95
none	WH3	87
Murray Gulch	WL19	95
Flume Gulch	WL27	93
Flume Gulch	WL28	93
Navarro River	WL3	23
Marsh Gulch	WL4	89
Navarro River	WM2	43
Skid Gulch	WM32	97
Berry Creek	WM36	62
Navarro River	WM5	34
Dead Horse Gulch	WN10	95
Dead Horse Gulch	WN11	87
Coon Gulch	WN20	89
Roller Gulch	WR11	68
Ray Gulch	WR14	94
Ray Gulch	WR15	94
White Gulch	WR23	97
Mustard Gulch	WR26	87
Navarro River	WU1	18
Kabiki Creek	WU15	95
Sage Gulch	WU18	80

Class I summer stream temperatures in the larger channels of the Navarro WAU are always above the preferred temperature range of coho salmon. Temperatures recorded in the South Branch of the North Fork Navarro River, Indian Creek and especially mainstem Navarro River are much higher than the MWAT temperature thresholds for coho salmon (17-18 C^o). Maximum temperatures in these streams approach maximum lethal temperatures for coho salmon (23 C^o) and steelhead trout (26 C^o)(Brett, 1952 and Becker and Genoway, 1979). Conversely, MWAT values recorded in some of the smaller stream channels of the Navarro River WAU such as Marsh Gulch, Murray Gulch, Flume Gulch, Deadhorse Gulch, and Sheep Gulch are ideal for coho salmon. Temperatures in John Smith Creek, Flynn Creek, and Camp 16 Gulch are favorable for salmonids (see Tables D-12, D-13 and D-14). These smaller streams are the places in the Navarro WAU where coho salmon have been found in distribution studies.

Table D-12. Maximum Daily Temperatures for each station in the Navarro River WAU.
**- data not collected

Station No.	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
81-1	**	**	**	21.5	22.5	19.1	21.2	**	**	**	20.6	21.8	20.7	21.0
81-2	19.5	22.5	19.0	19.0	18.5	17.5	**	**	20.0	**	17.8	18.0	**	17.2
81-3	**	**	**	21.5	22.5	20.5	22.3	**	**	**	20.9	21.5	19.7	19.8
81-4	22.5	**	21.5	**	**	**	**	**	**	**	**	**	**	14.1
81-5	**	**	**	**	**	**	**	**	**	**	**	**	13.9	**
81-6	**	**	**	**	**	**	**	**	**	**	**	**	**	17.1
81-7	**	**	**	**	**	**	**	**	**	**	**	**	**	13.7
81-8	**	**	**	**	**	**	**	**	**	**	**	**	**	18.9
82-1	18.0	**	15.5	16.0	15.5	15.0	**	**	**	**	15.0	15.9	15.1	14.5
82-2	**	**	**	**	**	16.5	**	**	18.1	**	18.5	19.1	16.7	**
82-3	26.5	27.5	25.0	24.0	24.5	23.5	**	**	**	**	24.2	25.4	23.7	**
82-4	18.0	**	**	**	**	**	**	**	**	**	**	**	**	**
82-5	28.0	29.5	28.5	26.5	**	**	**	**	**	**	**	**	25.7	25.3
82-6	**	**	**	**	**	**	**	**	**	**	**	**	14.3	14.9
82-7	**	**	**	**	**	**	**	**	**	**	**	**	13.3	14.1
82-8	**	**	**	**	**	**	**	**	**	**	**	**	15.4	17.4
82-9	**	**	**	**	**	**	**	**	**	**	**	**	14.9	15.2
85-1	**	**	**	**	**	**	23.1	22.1	**	**	20.1	21.2	19.6	19.8
85-2	**	**	**	**	**	24.6	24.4	23.7	**	**	21.4	21.9	20.4	**
86-1	**	**	**	**	26.6	27.4	25.7	27.2	**	**	**	24.4	26.4	25.2
86-2	**	**	**	**	**	26.2	27.6	24.3	**	**	20.0	24.7	23.4	23.2
88-1	**	28.0	26.5	26.0	27.0	25.0	**	**	**	**	27.1	27.2	**	25.0

Table D-13. Maximum Weekly Average Temperature (MWAT) for each station in the Navarro River WAU. **- data not collected

Station No.	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
81-1	**	**	**	18.7	18.7	17.6	19.4	**	**	**	18.6	19.0	18.1	17.6
81-2	17.6	18.9	16.2	16.8	16.7	15.2	**	**	16.8	**	15.7	16.3	**	15.3
81-3	**	**	**	18.7	18.7	17.5	18.6	**	**	**	17.1	18.0	16.6	17.0
81-4	19.3	**	17.4	**	**	**	**	**	**	**	**	**	**	13.5
81-5	**	**	**	**	**	**	**	**	**	**	**	**	12.8	**
81-6	**	**	**	**	**	**	**	**	**	**	**	**	**	15.5
81-7	**	**	**	**	**	**	**	**	**	**	**	**	**	12.7
81-8	**	**	**	**	**	**	**	**	**	**	**	**	**	16.3
82-1	15.8	**	13.8	14.5	**	13.0	**	**	**	**	13.6	13.7	13.8	13.0
82-2	**	**	**	**	**	14.5	**	**	16.1	**	15.7	16.6	14.9	**
82-3	22.6	22.6	21.2	21.2	21.4	19.7	**	**	**	**	21.2	21.8	20.4	**
82-4	15.8	**	**	**	**	**	**	**	**	**	**	**	**	**
82-5	22.8	23.8	22.3	21.8	**	**	**	**	**	**	**	**	21.8	21.8
82-6	**	**	**	**	**	**	**	**	**	**	**	**	13.4	13.5
82-7	**	**	**	**	**	**	**	**	**	**	**	**	12.9	13.7
82-8	**	**	**	**	**	**	**	**	**	**	**	**	14.8	14.6
82-9	**	**	**	**	**	**	**	**	**	**	**	**	13.6	13.5
85-1	**	**	**	**	**	**	19.5	19.0	**	**	17.8	18.9	17.3	17.7
85-2	**	**	**	**	**	19.8	20.3	20.2	**	**	18.3	19.0	17.5	**
86-1	**	**	**	**	20.5	20.1	20.3	20.8	**	**	**	19.5	19.6	19.2
86-2	**	**	**	**	**	21.4	20.4	20.6	**	**	16.7	20.2	19.6	19.3
88-1	**	23.5	22.3	22.1	21.8	21.2	**	**	**	**	21.4	22.2	**	21.7

Table D-14. 7-Day Moving Average of the Daily Maximum for each station in the Navarro River WAU (MWMT). **- data not collected

Station No.	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	2000	2001	2002
81-1	**	**	**	20.8	21.1	18.8	20.9	**	**	**	20.2	21.4	20.1	20.4
81-2	18.9	21.2	18.4	18.3	17.9	17.1	**	**	19.4	**	17.0	17.8	**	16.8
81-3	**	**	**	20.8	21.1	20.2	21.5	**	**	**	19.9	20.6	19.2	19.2
81-4	21.9	**	20.4	**	**	**	**	**	**	**	**	**	**	13.8
81-5	**	**	**	**	**	**	**	**	**	**	**	**	13.2	**
81-6	**	**	**	**	**	**	**	**	**	**	**	**	**	16.7
81-7	**	**	**	**	**	**	**	**	**	**	**	**	**	13.7
81-8	**	**	**	**	**	**	**	**	**	**	**	**	**	18.2
82-1	17.5	**	14.7	15.7	14.9	14.5	**	**	**	**	14.6	14.6	14.8	13.9
82-2	**	**	**	**	**	15.9	**	**	17.7	**	17.5	18.4	16.0	**
82-3	25.8	25.9	24.1	23.4	23.0	22.7	**	**	**	**	23.1	24.1	23.1	**
82-4	17.5	**	**	**	**	**	**	**	**	**	**	**	**	**
82-5	27.4	28.4	27.3	25.6	**	**	**	**	**	**	**	**	23.8	24.6
82-6	**	**	**	**	**	**	**	**	**	**	**	**	14.0	14.1
82-7	**	**	**	**	**	**	**	**	**	**	**	**	13.1	14.1
82-8	**	**	**	**	**	**	**	**	**	**	**	**	15.0	16.6
82-9	**	**	**	**	**	**	**	**	**	**	**	**	14.6	14.4
85-1	**	**	**	**	**	**	21.7	21.1	**	**	19.0	20.3	19.0	18.8
85-2	**	**	**	**	**	23.9	22.8	22.6	**	**	20.5	21.0	19.5	**
86-1	**	**	**	**	25.8	27.1	25.5	26.4	**	**	**	23.8	25.9	24.6
86-2	**	**	**	**	**	25.8	24.1	23.6	**	**	19.1	24.0	22.8	22.5
88-1	**	27.5	25.5	25.1	25.9	22.8	**	**	**	**	25.8	26.5	**	24.1

Table D-15. Class II Stream Temperature Data for the Navarro River WAU.

Stream Name	Station Number	Maximum	MWAT
Tributary to Flynn Creek	82-21	14.1	13.4
Mustard Gulch	82-22	14.5	13.8
Black Rock Creek	82-23	16.0	14.9
Berry Creek	82-24	14.5	13.5
Tramway Gulch	82-25	14.5	13.6
Tank 4 Gulch	82-26	12.6	12.3
Coon Creek	82-27	14.1	13.7
Ray Gulch	82-28	13.7	13.3
NF Rose Creek	85-20	16.8	14.9
SF Rose Creek	85-21	14.9	13.8
West Branch Indian Creek	86-20	16.8	15.0
Theron's Pond (CIV)	86-21	20.2	18.2

Stream temperatures for the tributary watercourses in the lower portion of the Navarro River, in Navarro West, are all on target (Table D-16). Further, the small tributaries of the mainstem Navarro River in Navarro West are on target for stream temperatures. The mainstem of the Navarro River provides deficient water temperatures for salmonids. Sullivan et. al. (1990) developed a concept of threshold distance, that is the distance from the watershed divide where stream temperature was no longer a function of streamside canopy but a function of air temperature. Sullivan et. al. (1990) suggested this threshold distance from the watershed divide is between 40-50km in Washington. Stream temperature analysis from Coastal Northern California (Lewis et. al., 2000) suggests the threshold distance may be 70 km from the watershed divide. The proximity of the mainstem of the Navarro River's on the MRC ownership is greater than 70 km from the watershed divide demonstrating the limited ability streamside vegetation can affect stream temperatures for the Navarro River.

The North Fork of the Navarro River, both the South and North Branches exhibit stream temperatures that are either marginal or deficient to support salmonids (Table D-16). The North Fork of the Navarro River, a.k.a. Navarro East, is further inland and has higher air temperatures. Therefore, higher stream water temperatures should be expected. However, the stream shade quality is either marginal or deficient in the North Fork of the Navarro River (Navarro East). This suggests a need for improvement in stream shading to assist in maintaining more appropriate stream temperatures for aquatic organisms.

Table D-16. Stream Temperature and Stream Shade Quality Ratings for Major Streams and River/Stream Segments in Calwater Planning Watersheds for the Navarro WAU.

Stream	Planning Watershed(s)	Stream Temperature Quality	Stream Shade Quality
Navarro R.	Lower Navarro River	ND	N/a
Navarro R.	Middle Navarro River	Deficient	N/a
Navarro R.	Upper Navarro River	ND	N/a
Navarro R.	Hendy Woods	Deficient	N/a
Marsh Gulch	Lower Navarro River	On Target	On Target
Murray Gulch	Lower Navarro River	On Target	On Target
Flume Crk.	Lower Navarro River	On Target	On Target
Ray Gulch	Ray Gulch	On Target	On Target
Flynn Crk.	Flynn Creek	Marginal	On Target
North Branch N.F. Navarro R.	Dutch Henry Creek	Deficient	Deficient
North Branch N.F. Navarro R.	Little North Fork Navarro	Marginal	Marginal
Cooks Crk.	Dutch Henry Creek	ND	Marginal
John Smith Crk.	John Smith Creek	Marginal	On Target
Redwood Crk.	Little North Fork Navarro	ND	Marginal
Little N.F. Navarro River	Little North Fork Navarro	ND	Marginal
South Branch N.F. Navarro R.	Lower South Branch Navarro	Deficient	Marginal
South Branch N.F. Navarro R.	Middle South Branch Navarro	Deficient	Deficient
South Branch N.F. Navarro R.	Upper South Branch Navarro	ND	Deficient
Bailey Crk.	Middle South Branch Navarro	ND	Deficient
Bear Crk.	Middle South Branch Navarro	ND	Marginal
Bridge Crk.	Middle South Branch Navarro	ND	Deficient
Shingle Mill Crk.	Middle South Branch Navarro	ND	Marginal
McGarvey Crk.	Upper South Branch Navarro	ND	Marginal
Low Gap Crk.	Upper South Branch Navarro	ND	Marginal
Hardscratch Crk.	Upper South Branch Navarro	ND	Deficient
Tramway Gulch	North Fork Navarro River	On Target	Deficient
Perry Gulch	Floodgate Creek	ND	N/a
Berry Crk.	Middle Navarro River	On Target	Marginal
Floodgate Crk.	Floodgate Creek	ND	On Target
Black Rock Crk.	Upper Navarro River	On Target	On Target
N.F. Indian Crk.	North Fork Indian Creek	Deficient	Deficient
West Branch N.F. Indian Crk.	North Fork Indian Creek	On Target	Marginal
Cold Springs Crk.	Rancheria Creek	ND	Marginal
Dago Crk.	Rancheria Creek	ND	Marginal

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APPENDIX D

Riparian Function Module

Figure T81-01. Mean and Maximum Daily Stream Temperatures During Summer 2002 at North Branch North Fork Navarro River (Site T81-01), Mendocino County, California.

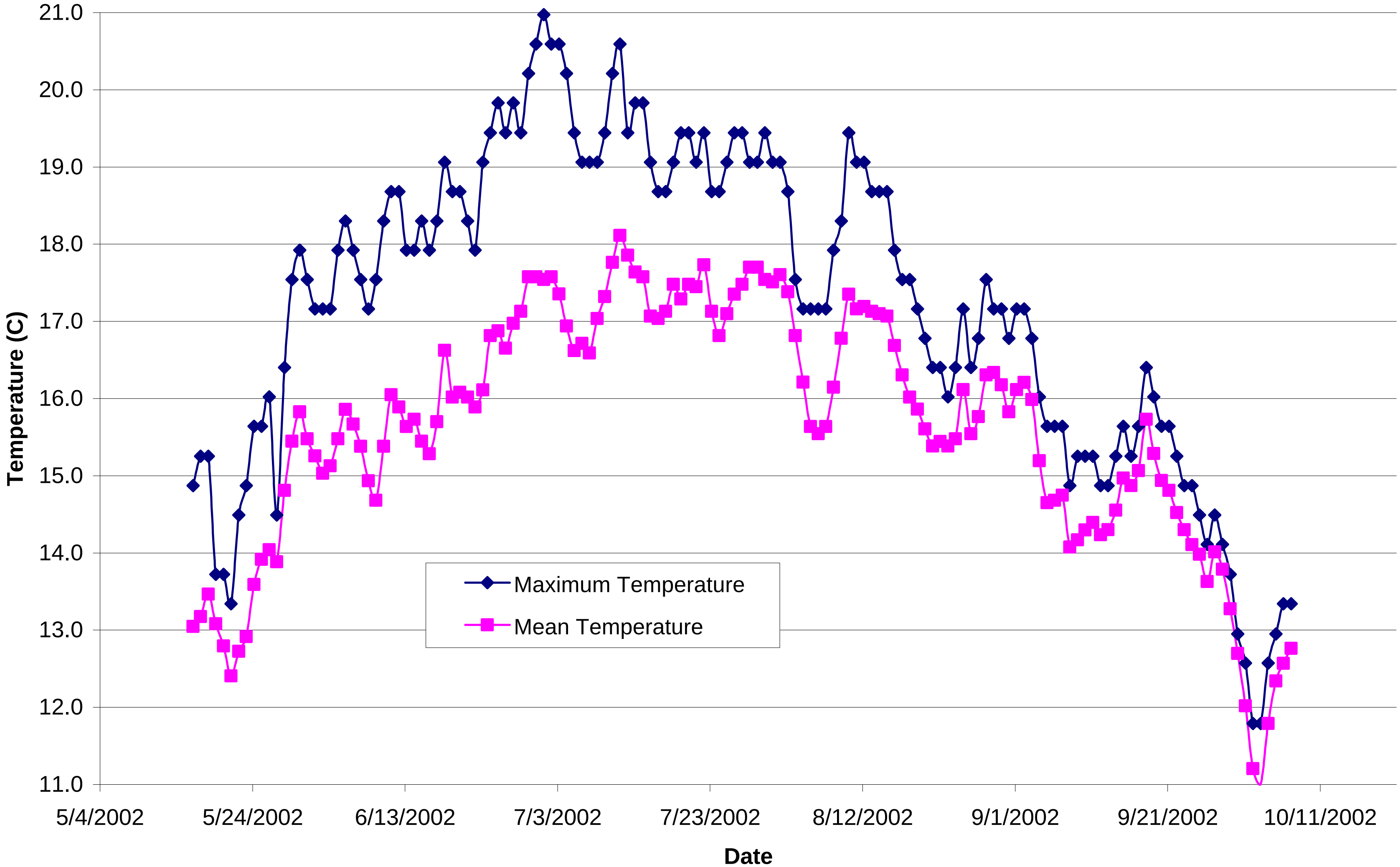


Figure T81-02. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2002 at John Smith Creek (Site T81-02), Mendocino County, California.

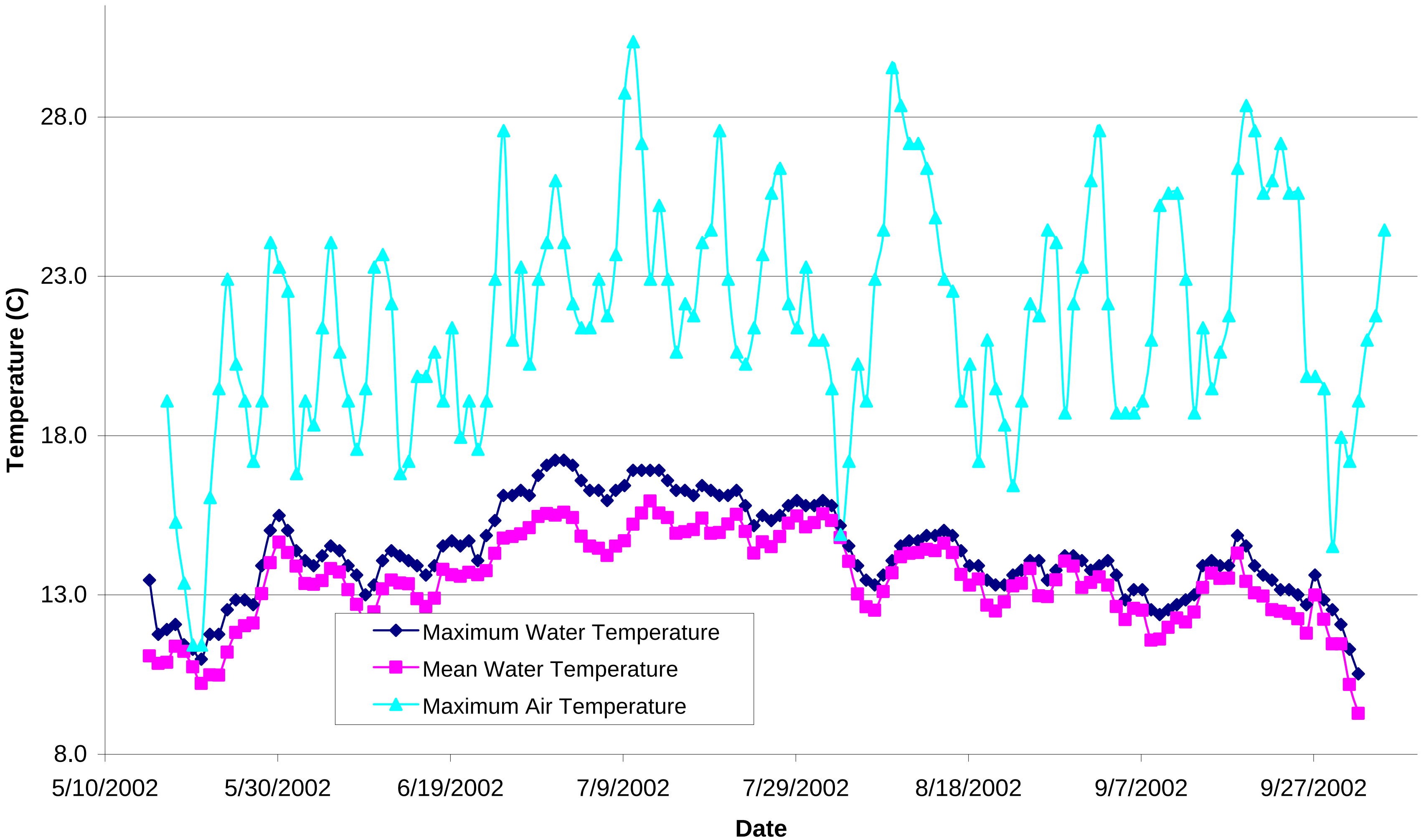


Figure T81-03. Mean and Maximum Daily Stream Temperatures During Summer 2002 at North Branch North Fork Navarro (Site T81-03), Mendocino County, California.

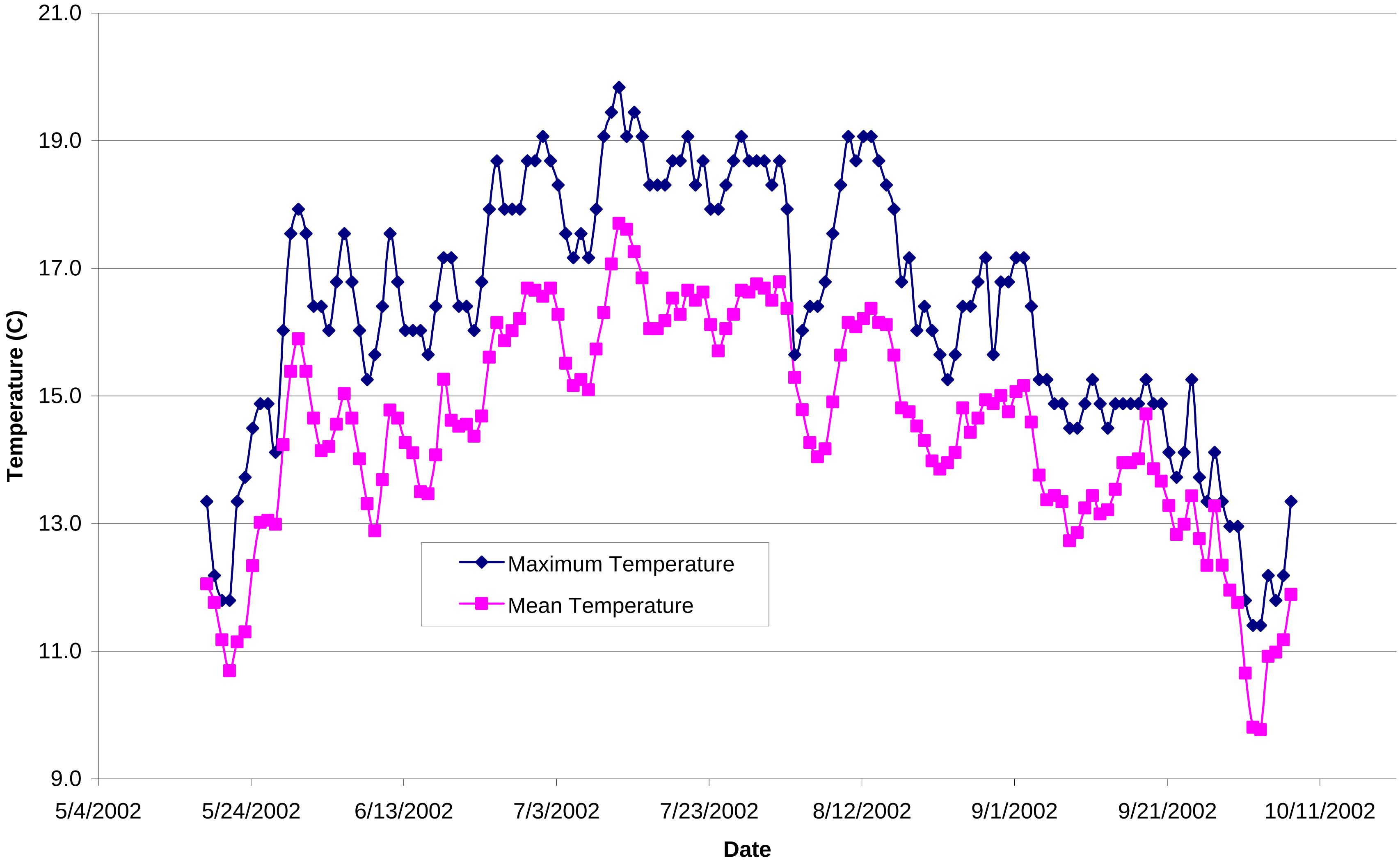


Figure T81-04. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Sheep Gulch (Site T81-04), Mendocino County, California.

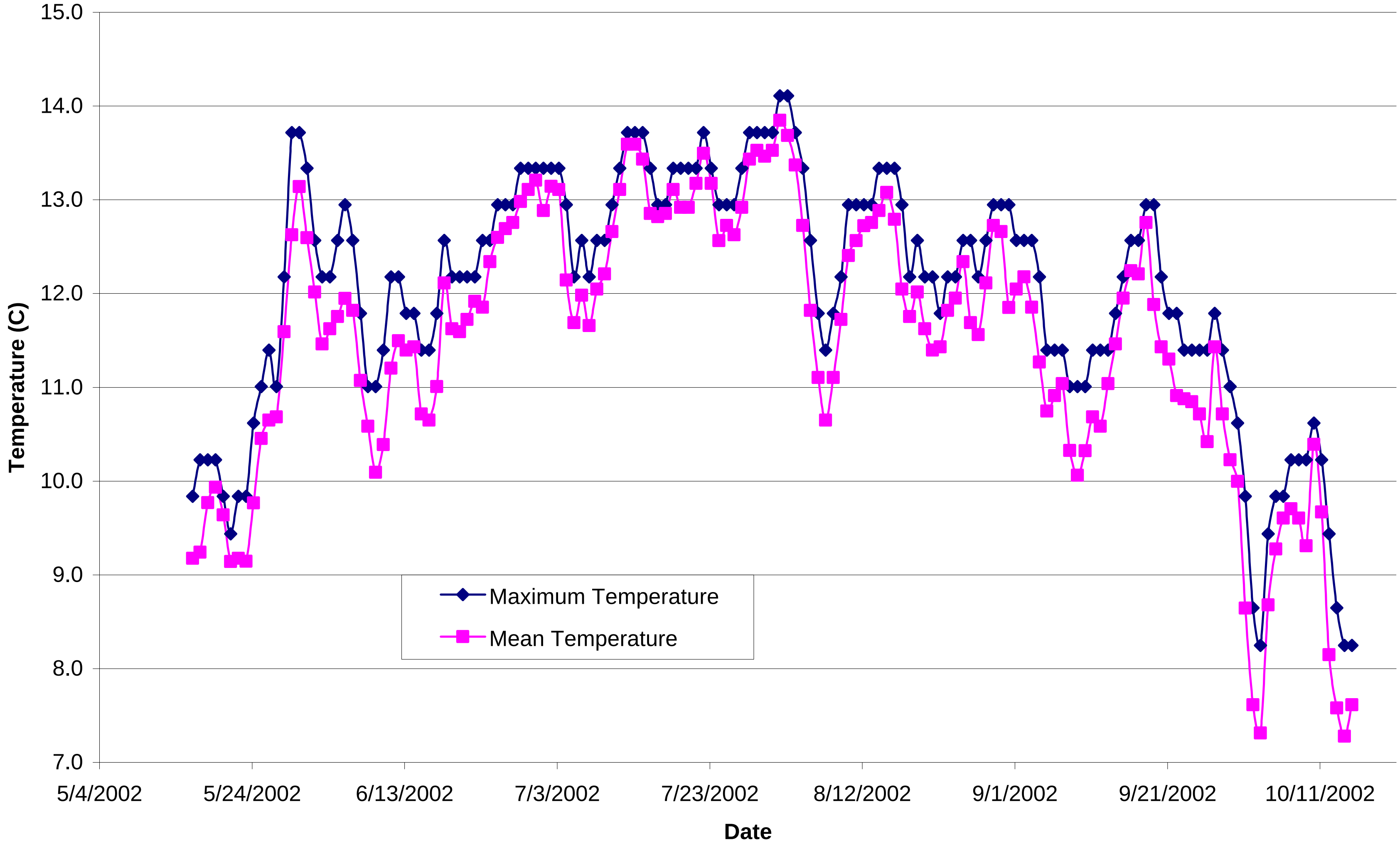


Figure T81-06. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Cooks Creek (Site T81-06), Mendocino County, California.

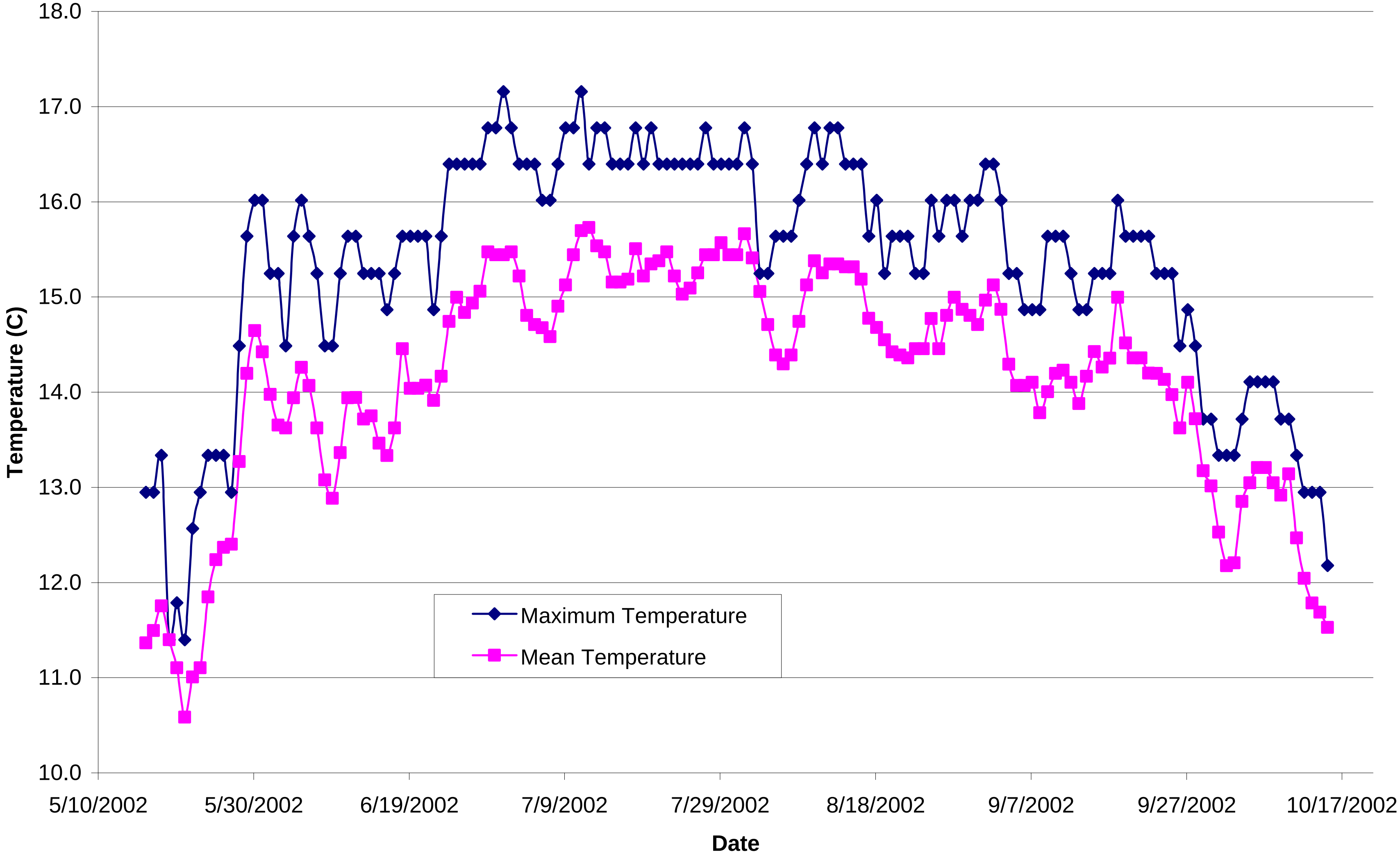


Figure T81-07. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Redwood Creek (Site T81-07), Mendocino County, California.

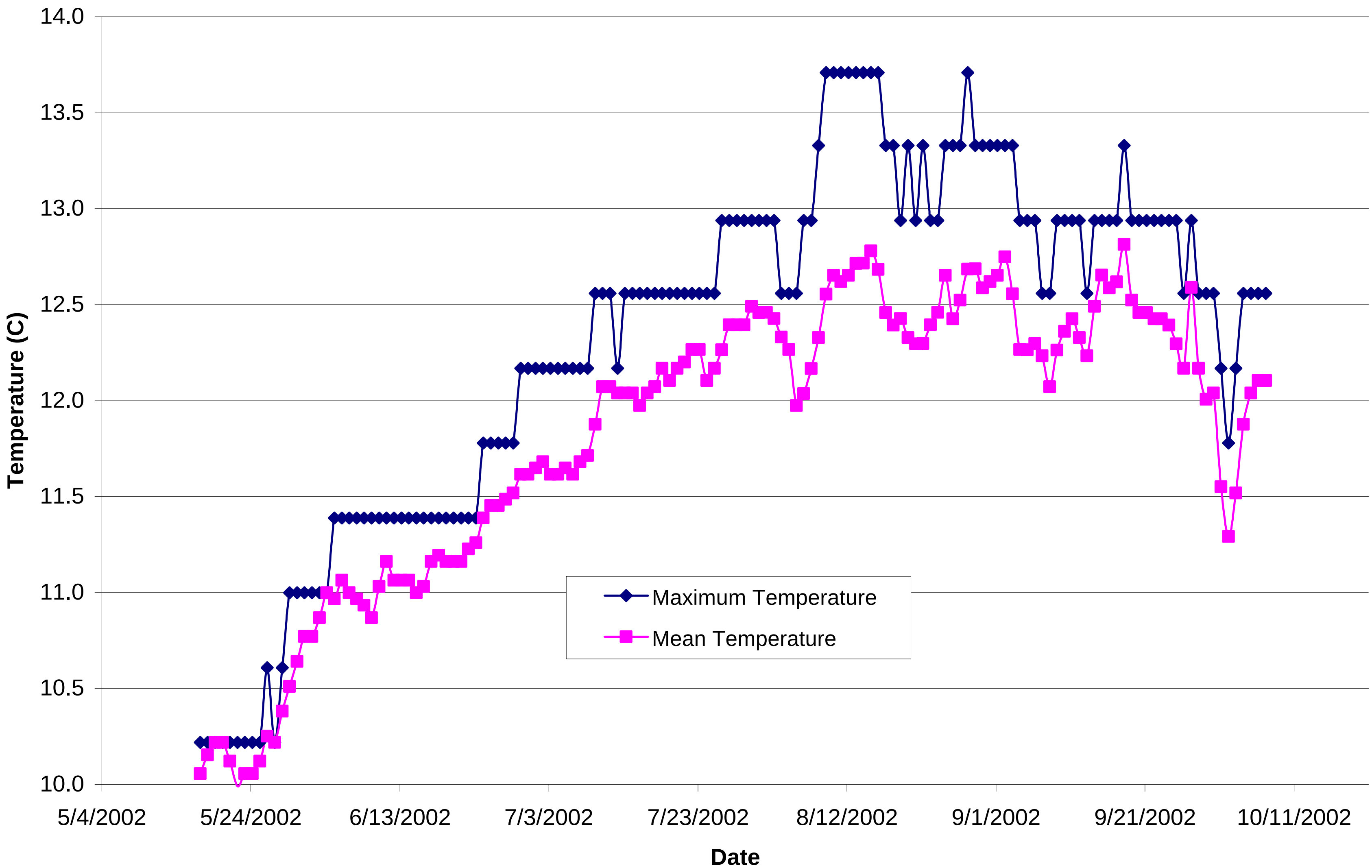


Figure T81-08. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2002 at Little North Fork Navarro River (Site T81-08), Mendocino County, California.

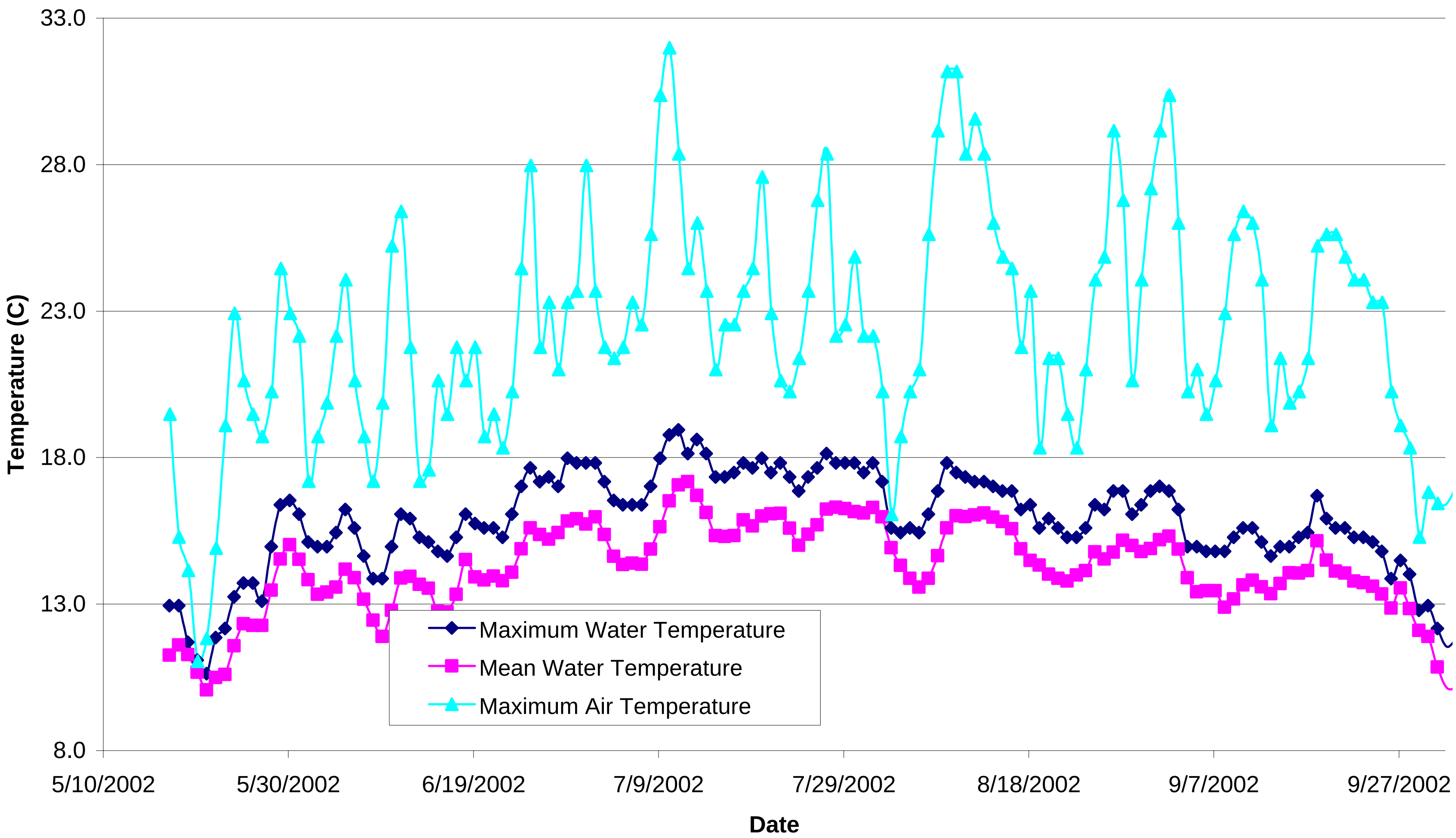


Figure T82-01. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2002 at Marsh Gulch (Site T82-01), Mendocino County, California.

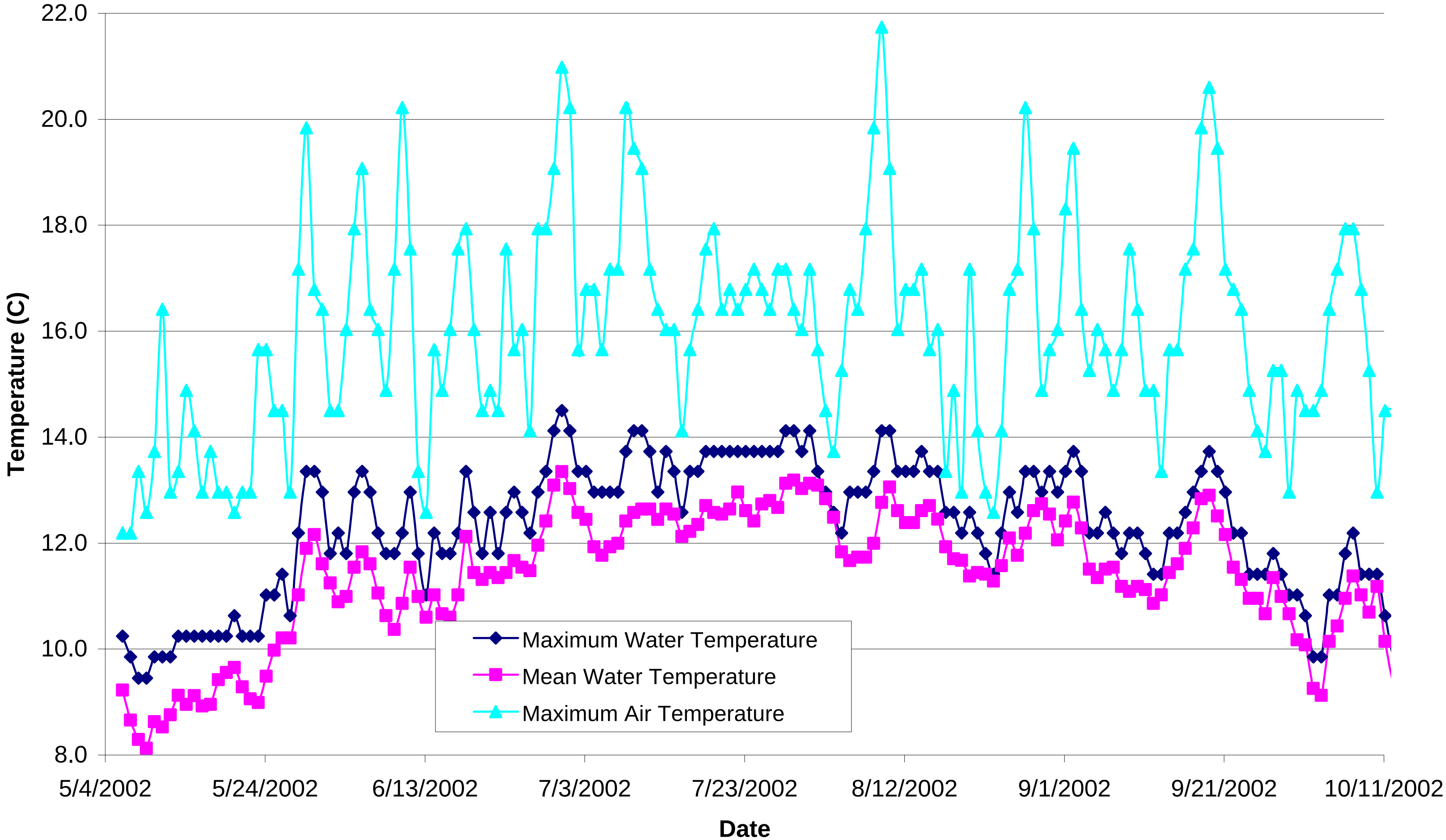


Figure T82-05. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Navarro River (Site T82-05), Mendocino County, California.

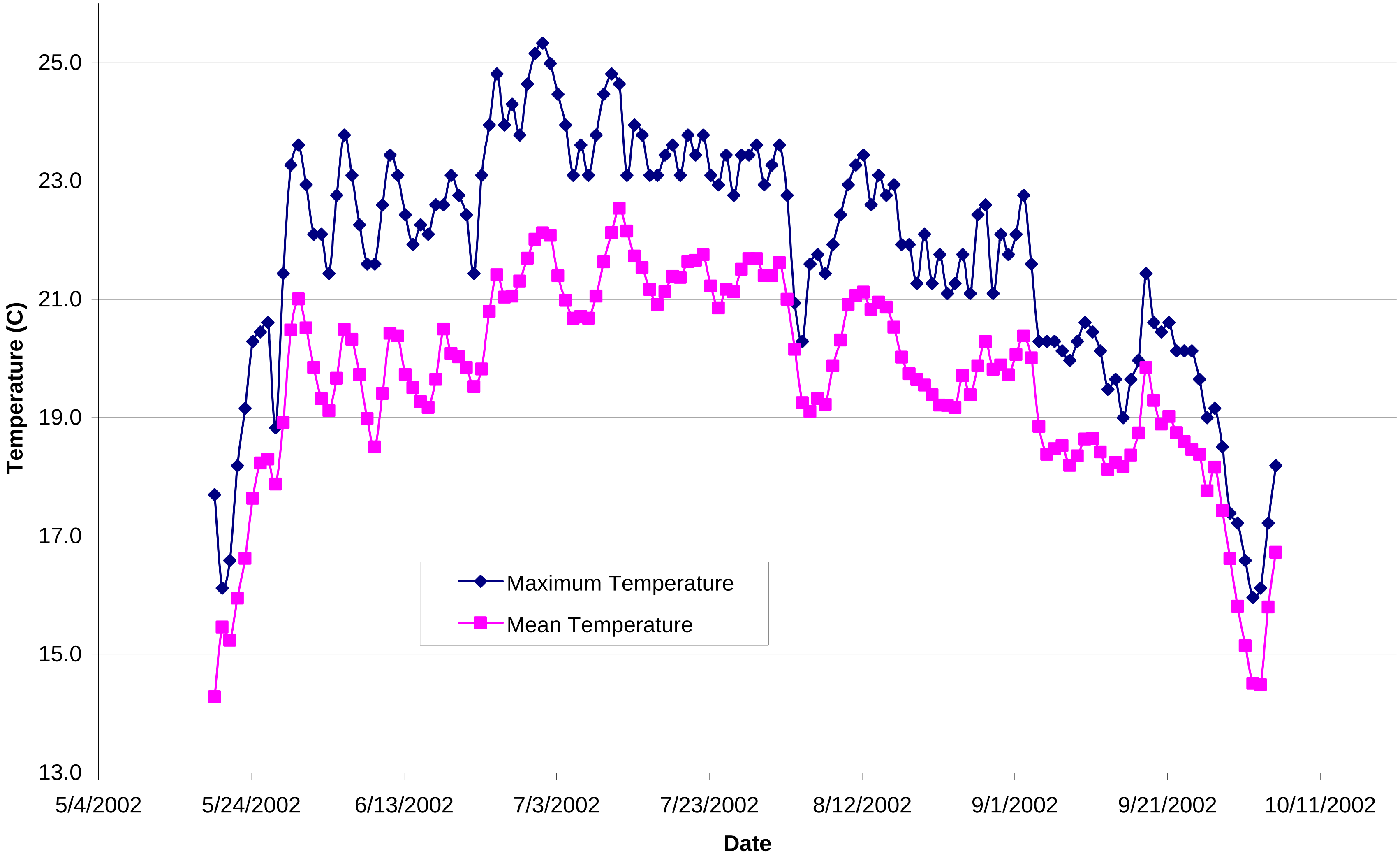


Figure T82-06. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Murray Gulch (Site T82-06), Mendocino County, California.

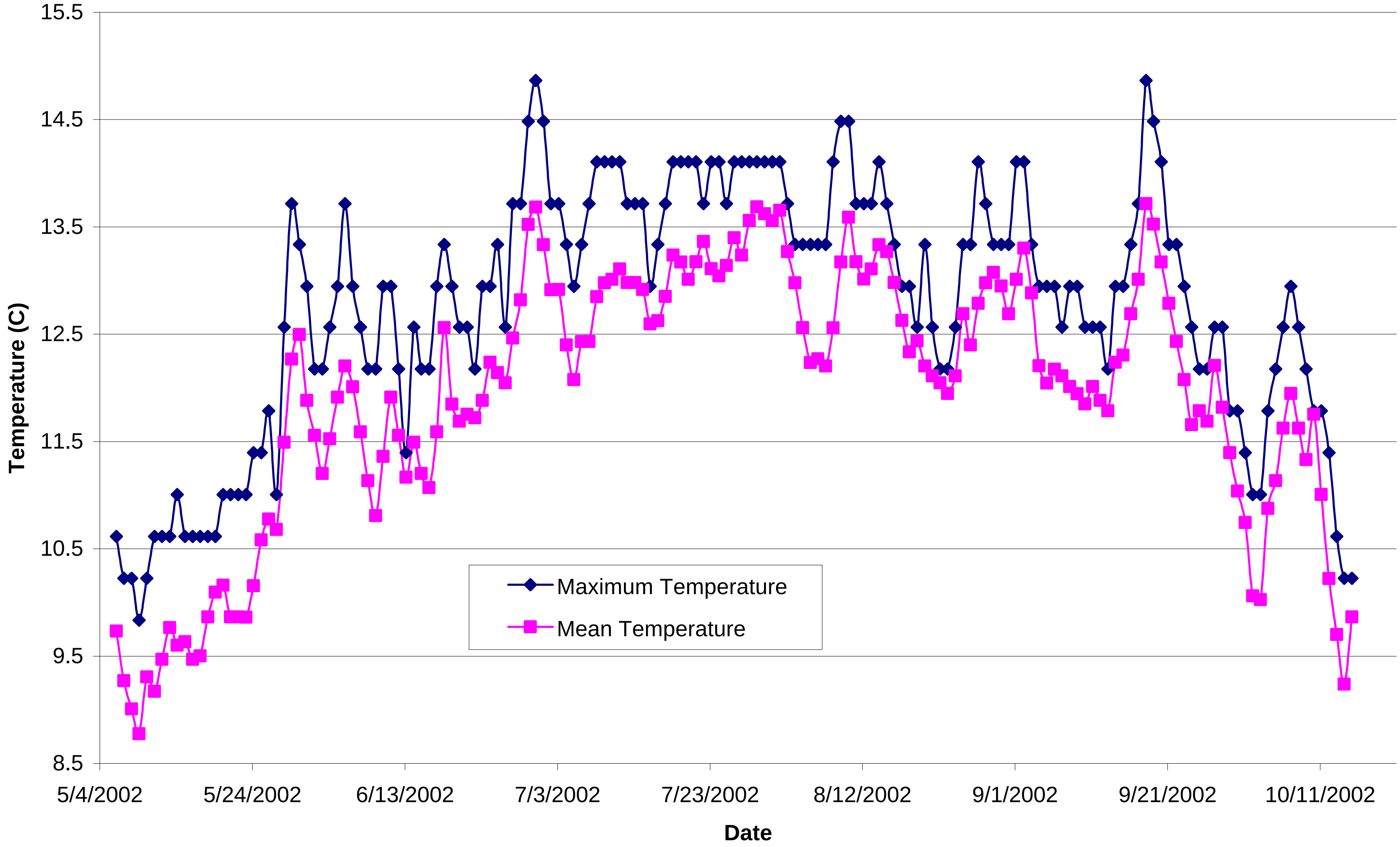


Figure T82-07. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Deadhorse Gulch (Site T82-07), Mendocino County, California.

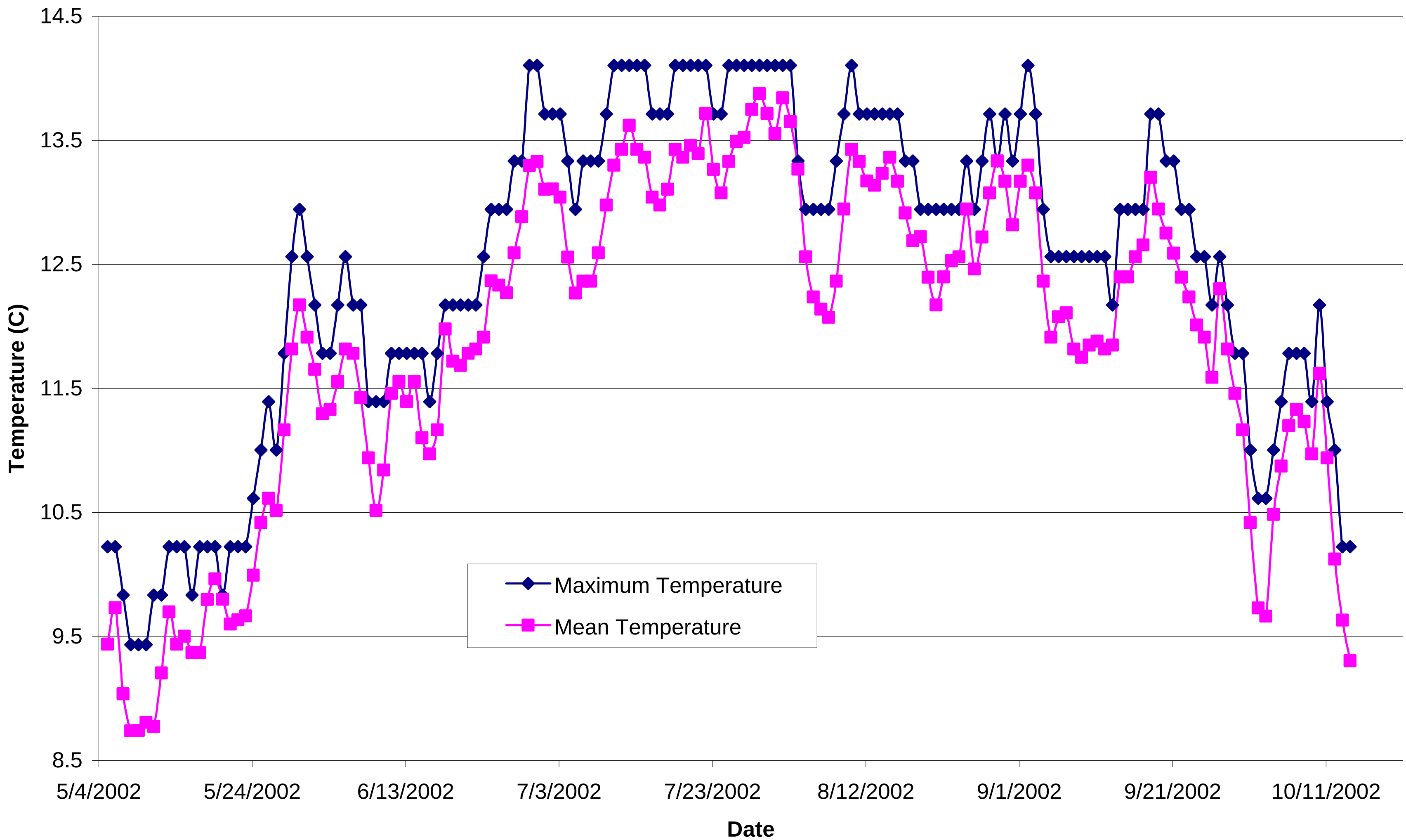


Figure T82-08. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Camp 16 Creek (Site T82-08), Mendocino County, California.

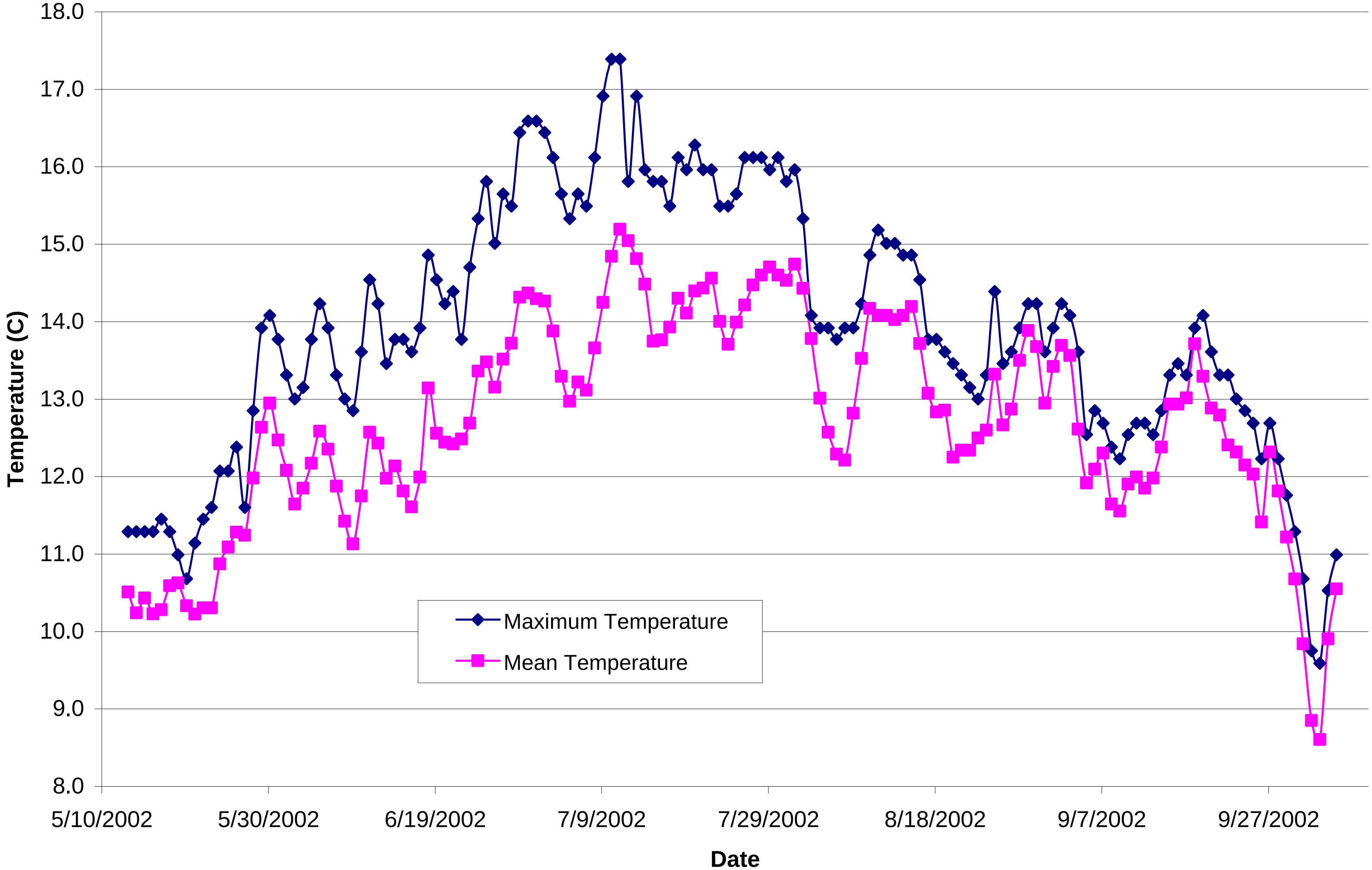


Figure T82-09. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Flume Gulch (Site T82-09), Mendocino County, California.

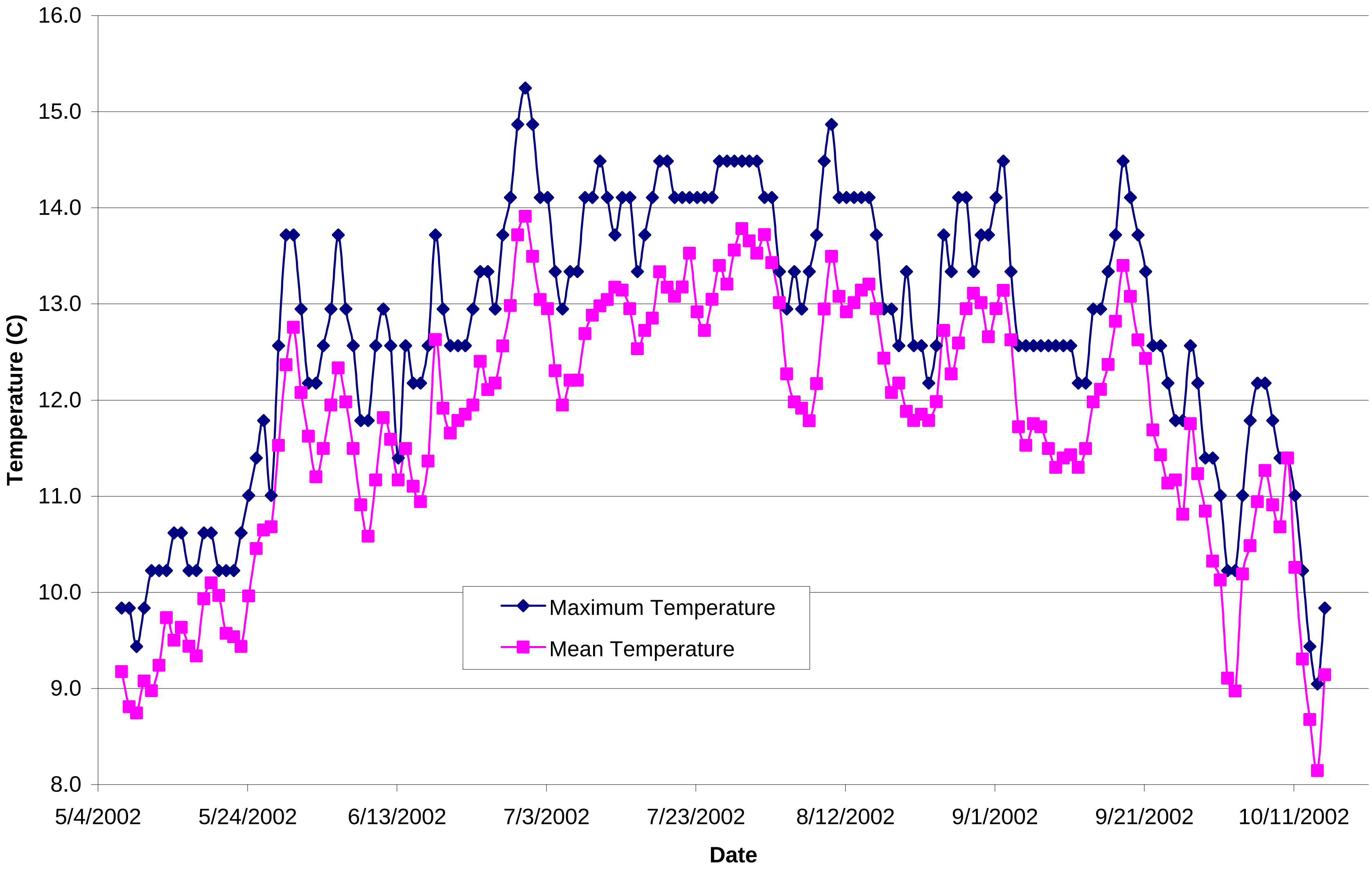


Figure T85-01. Mean and Maximum Daily Stream Temperatures During Summer 2002 at South Branch North Fork Navarro (Site T85-01), Mendocino County, California.

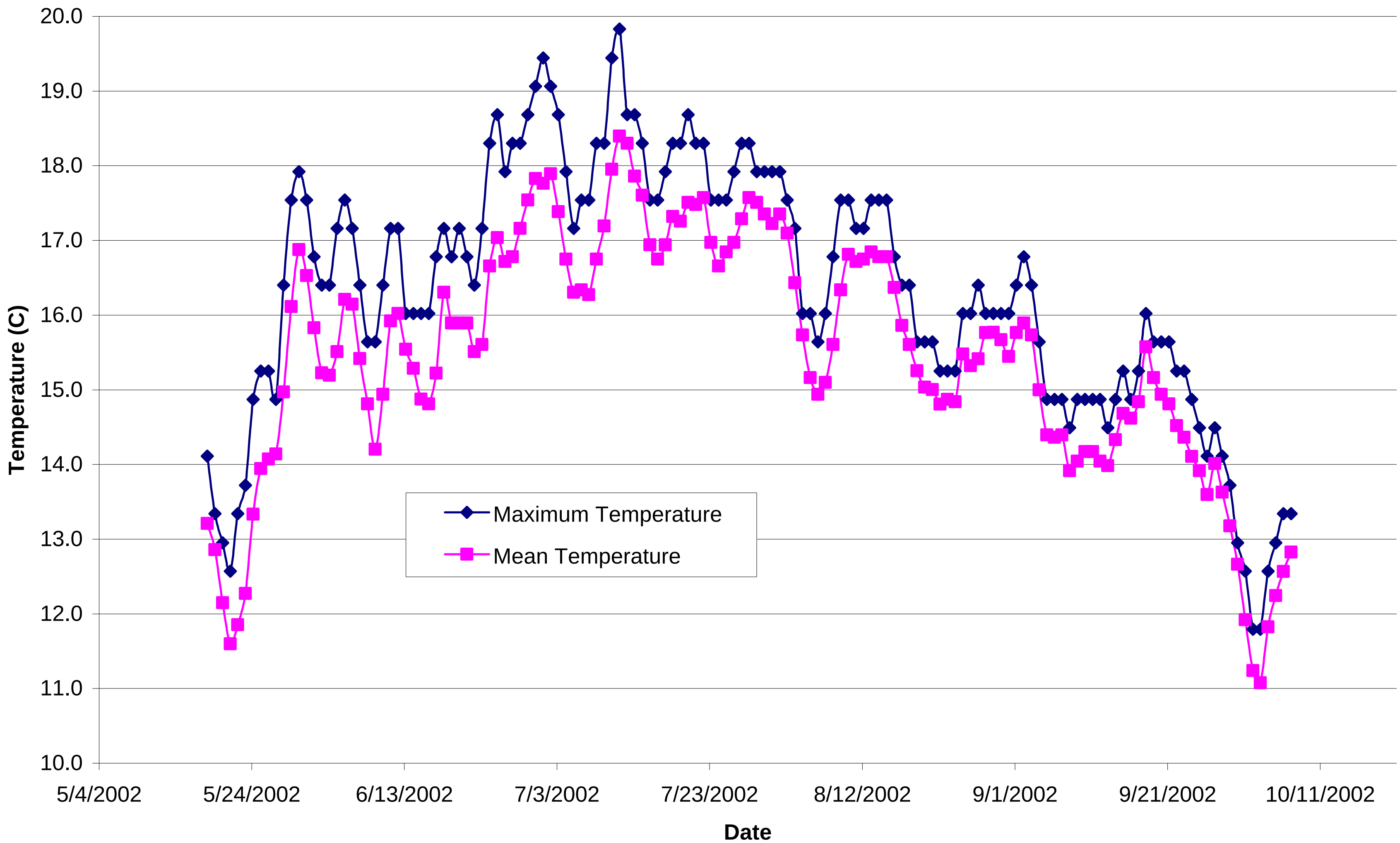


Figure T86-01. Mean and Maximum Daily Stream Temperatures During Summer 2002 at North Fork Indian Creek (Site T86-01), Mendocino County, California.

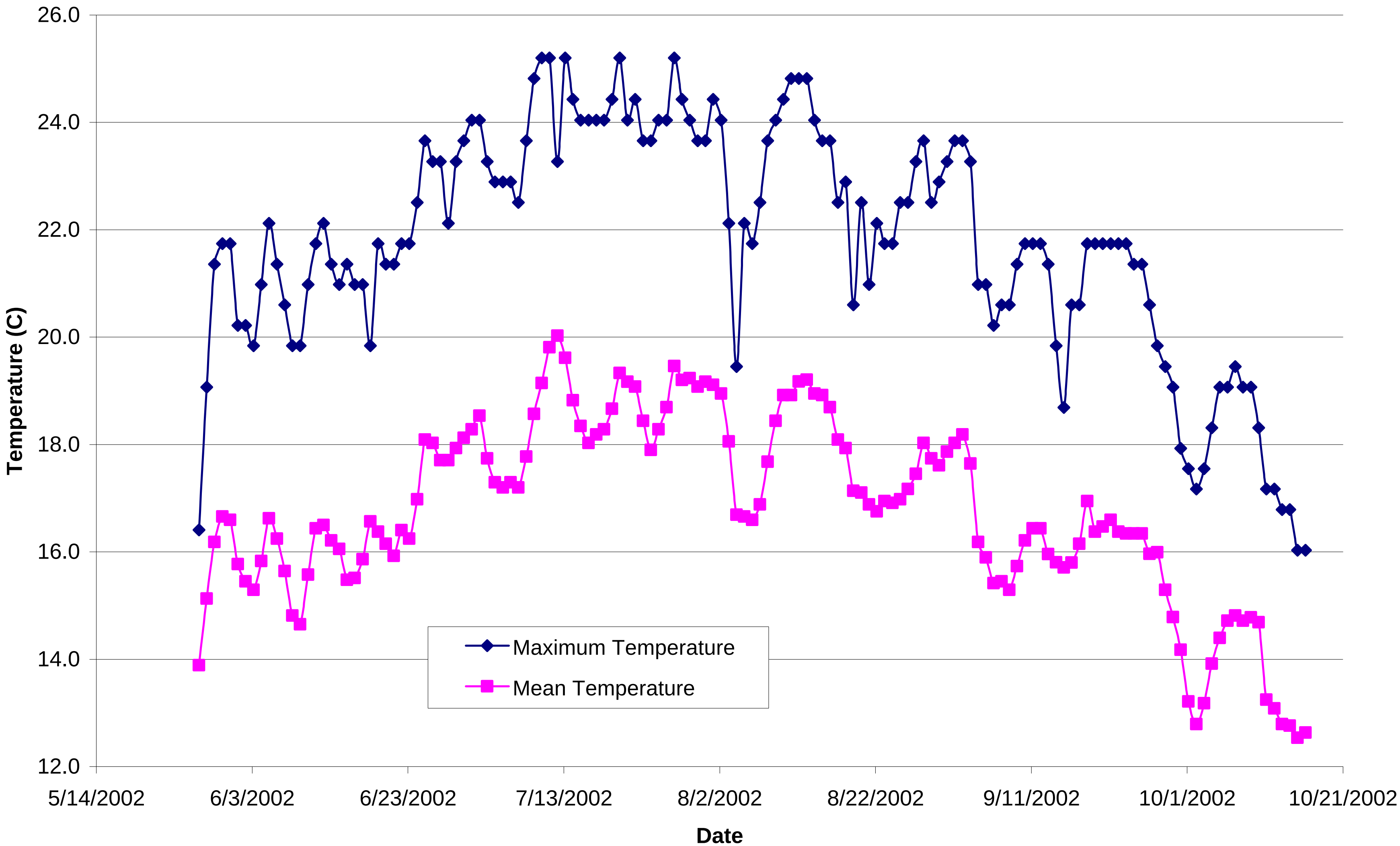


Figure T86-02. Mean and Maximum Daily Stream Temperatures During Summer 2002 at North Fork Indian Creek (Site T86-02), Mendocino County, California.

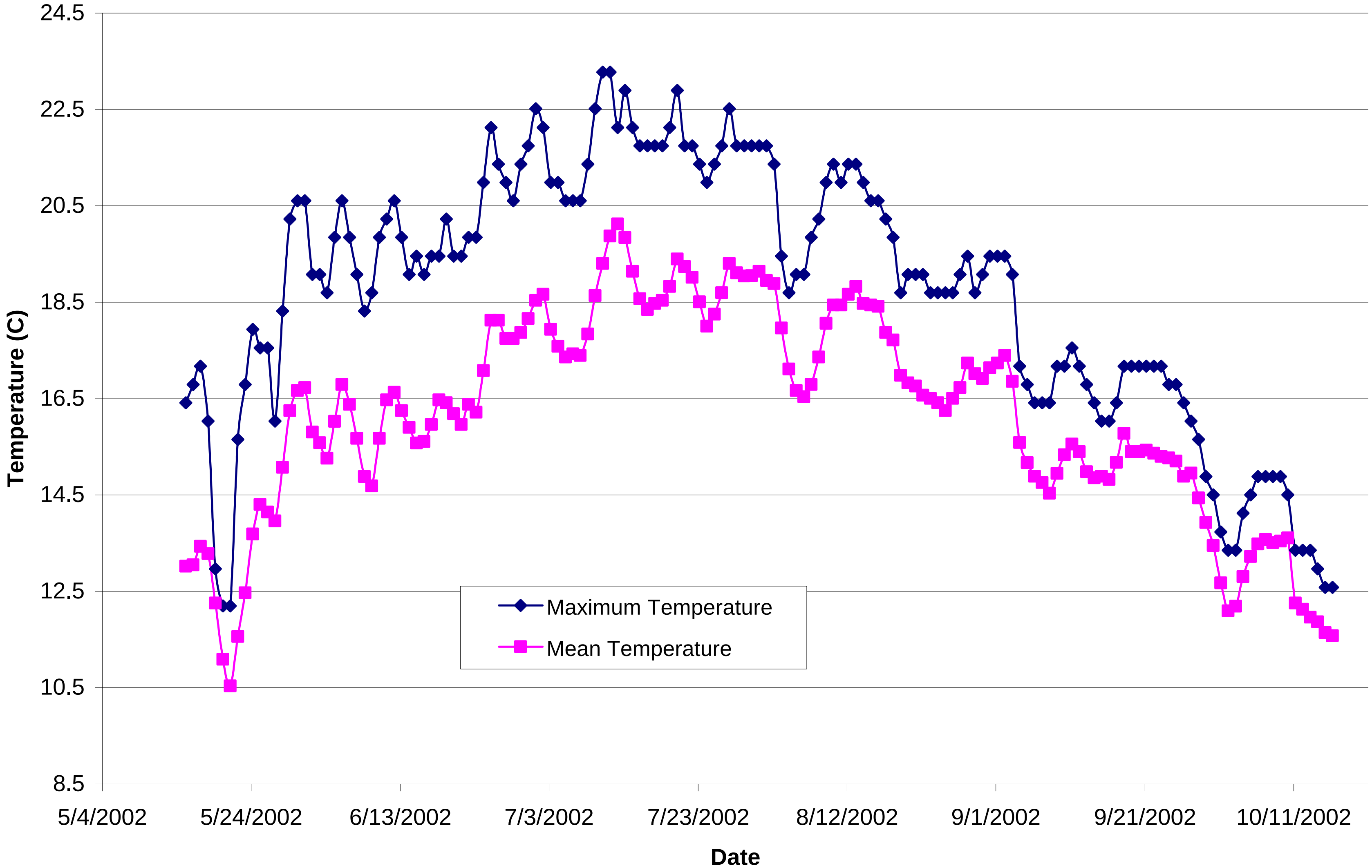


Figure T88-01. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Navarro River (Site T88-01), Mendocino County, California.

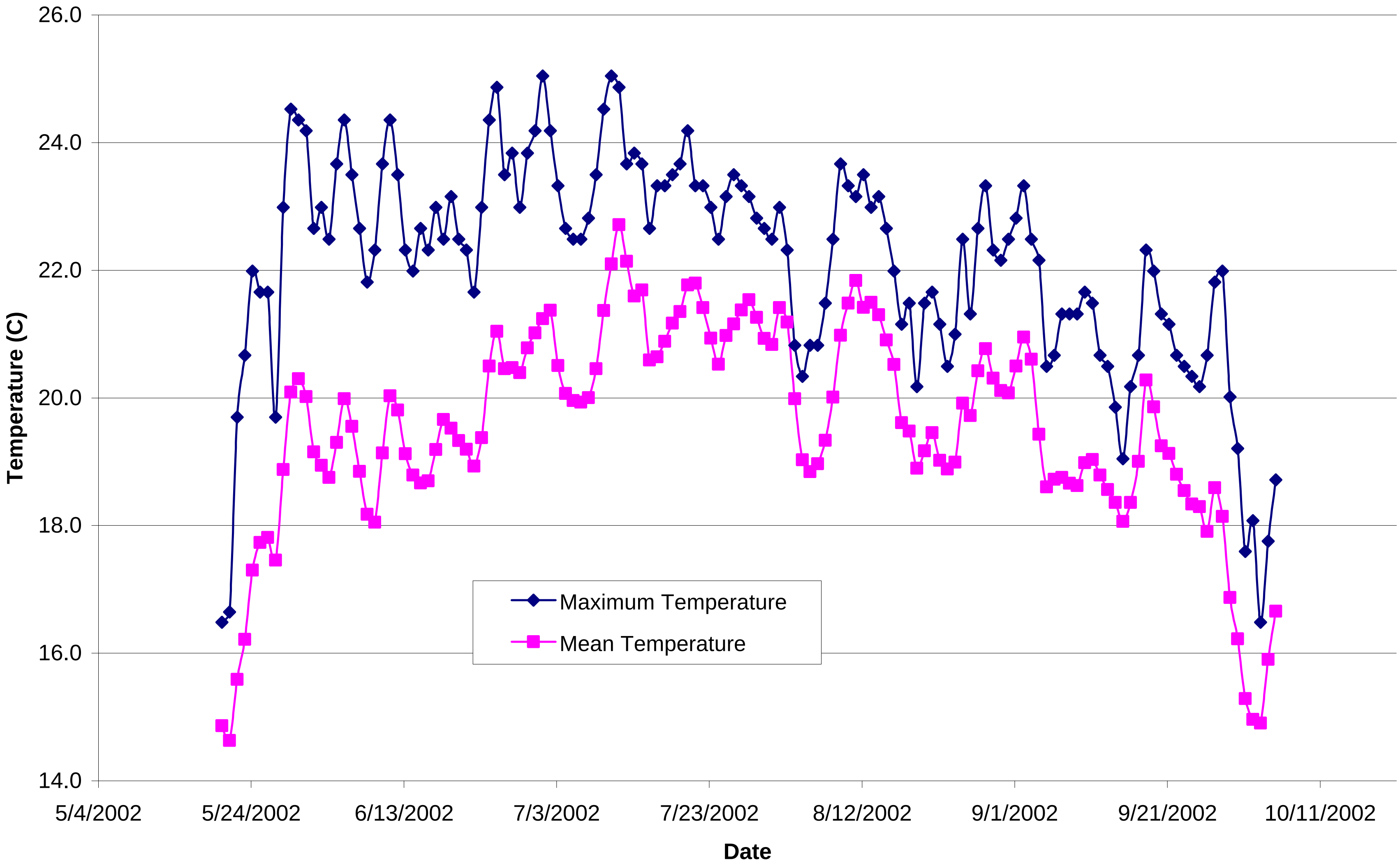


FIGURE 25. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1989) AT JOHN SMITH CREEK (MAP NO. 8; MONITOING SITE NO. 17), MENDOCINO CO., CALIFORNIA.

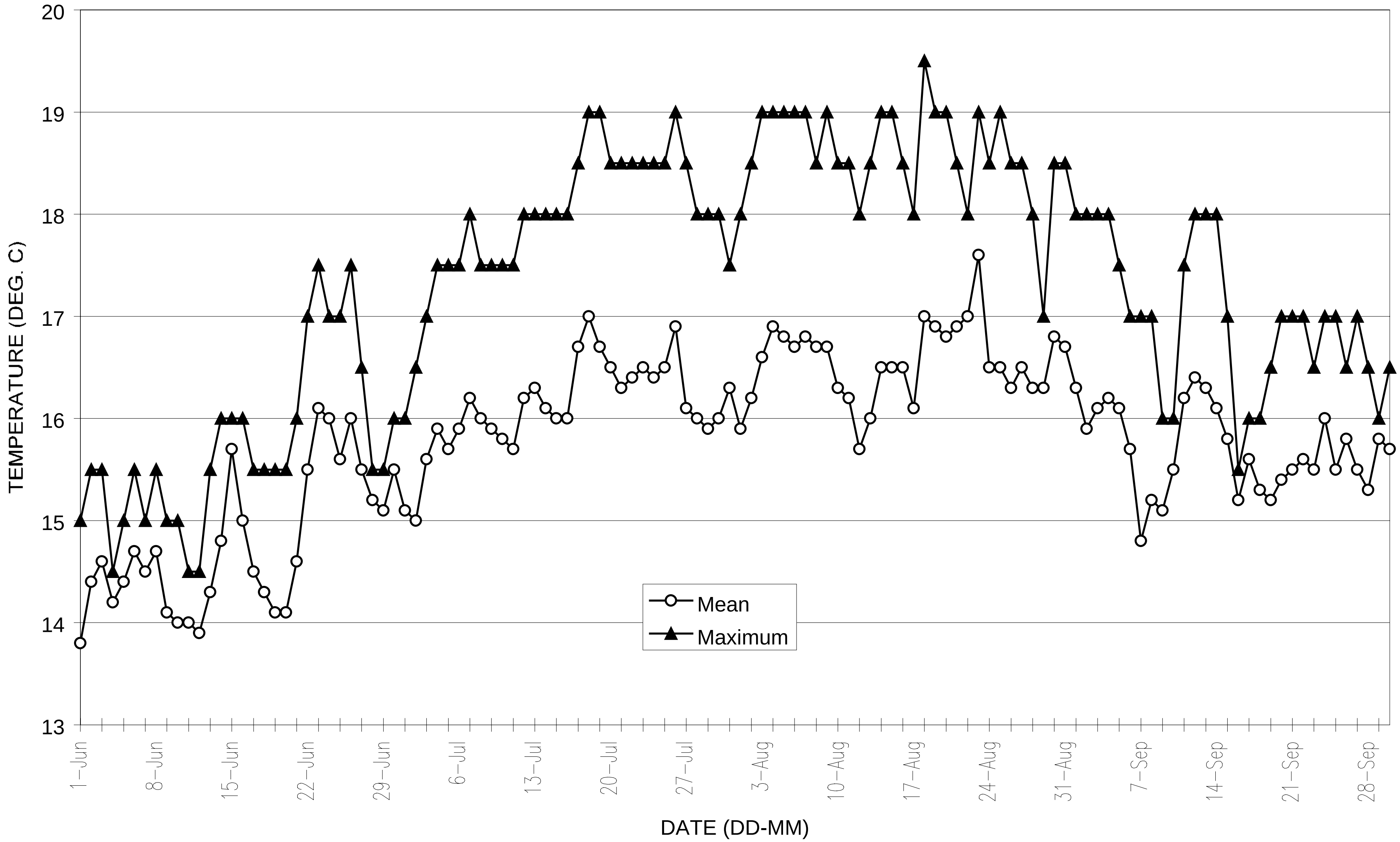


FIGURE 30. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1989) AT JOHN SMITH CREEK (MAP NO. 8; MONITORING SITE NO. 17A), MENDOCINO CO., CALIFORNIA.

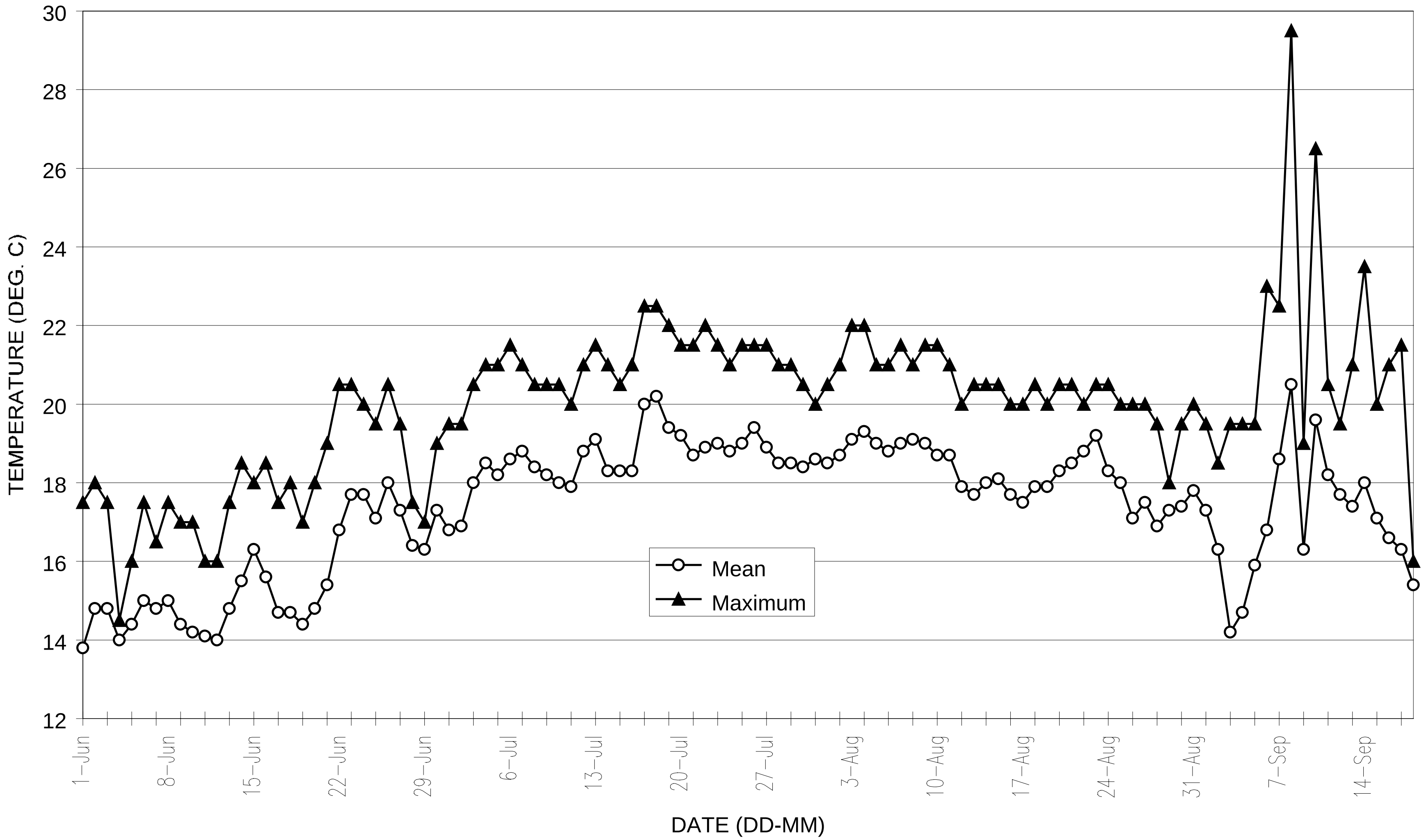


FIGURE 43. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1989) AT MARSH GULCH (MAP NO. 9; MONITOIRNG SITE NO. 16A), MENDOCINO CO., CALIFORNIA.

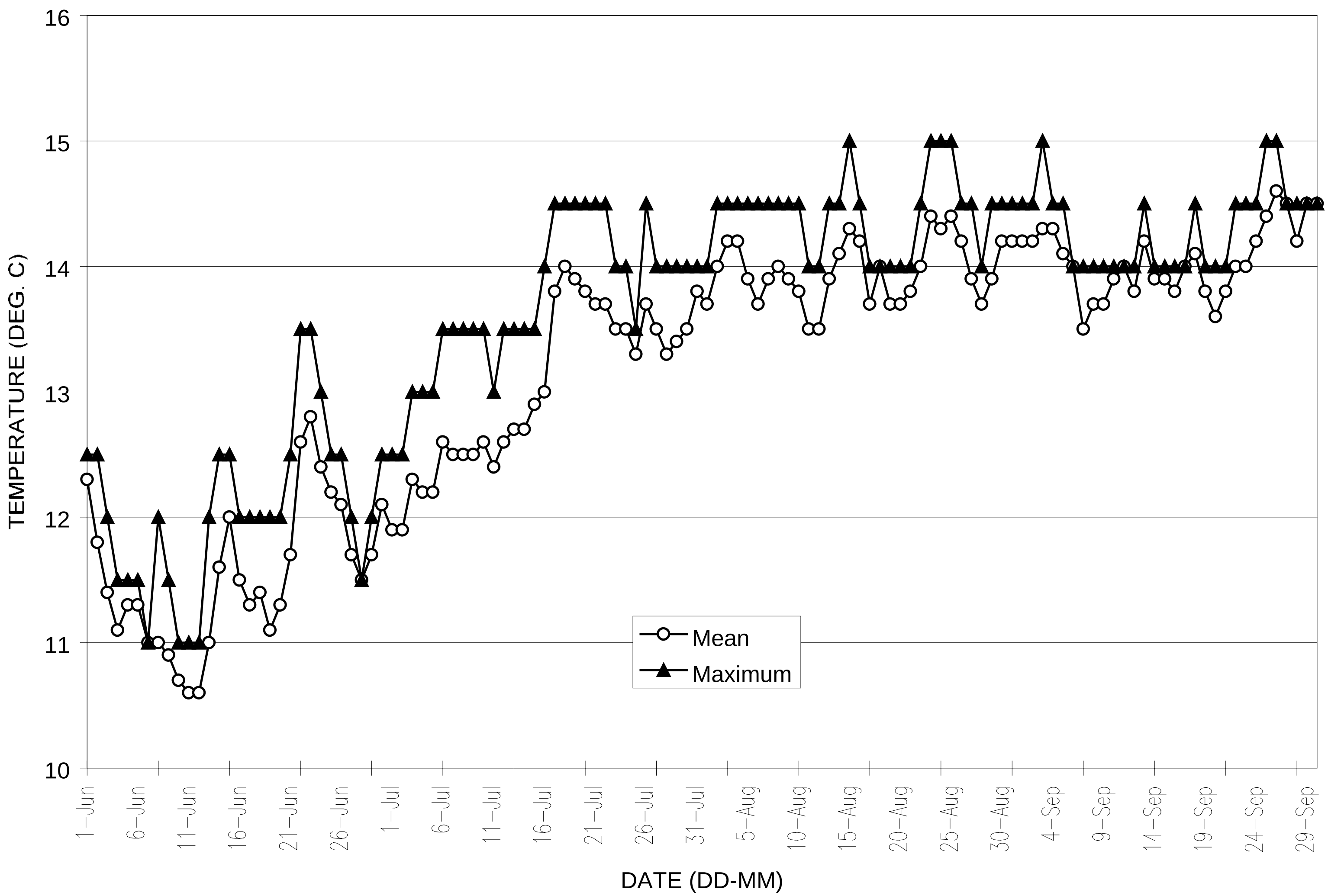


FIGURE 39. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1989) AT MARSH GULCH (MAP NO. 9; MONITORING SITE N0. 16), MENDOCINO CO., CALIFORNIA.

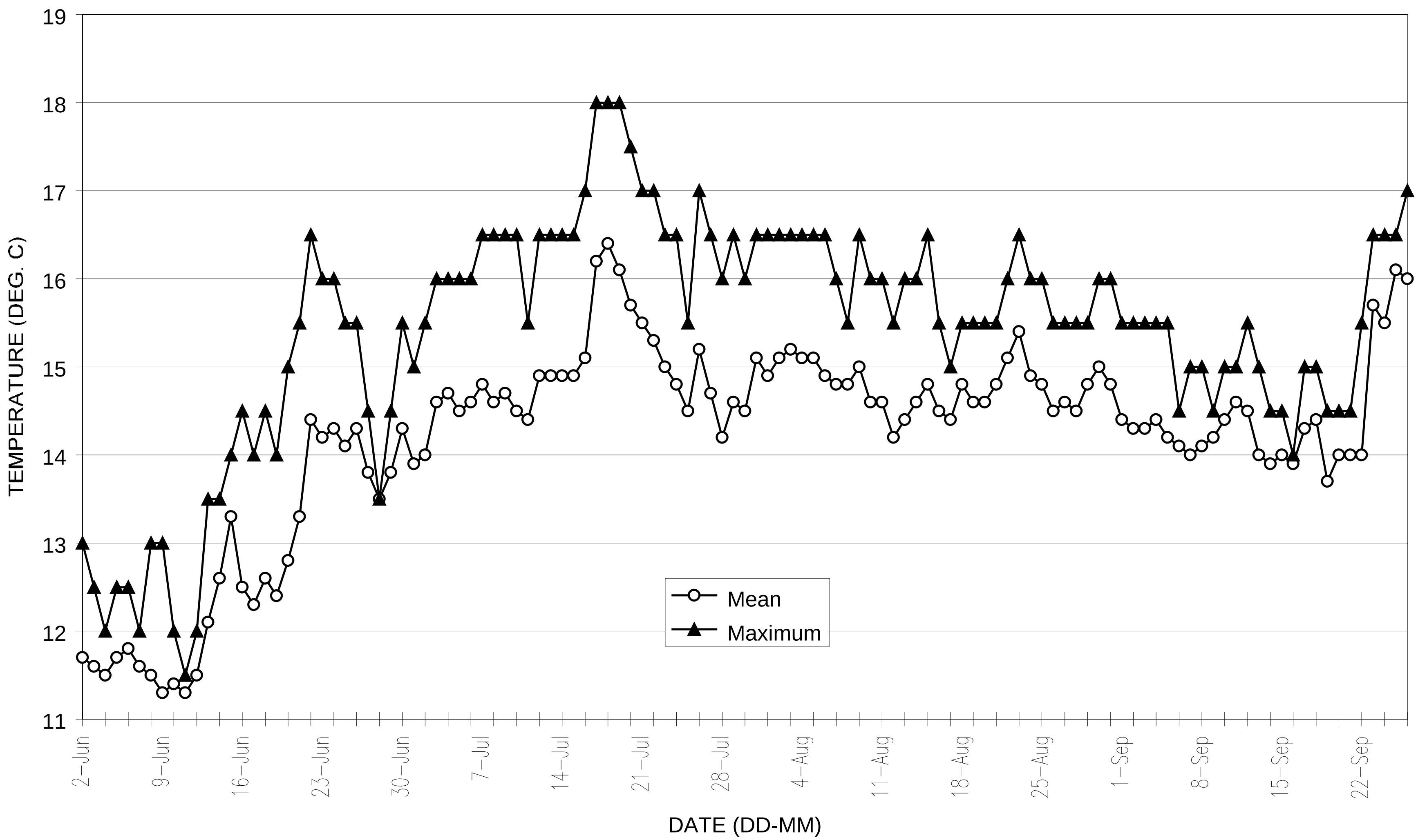


FIGURE 34. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1989) AT NAVARRO RIVER (MAP NO. 9; MONITORING SITE NO.14), MENDOCINO CO., CALIFORNIA.

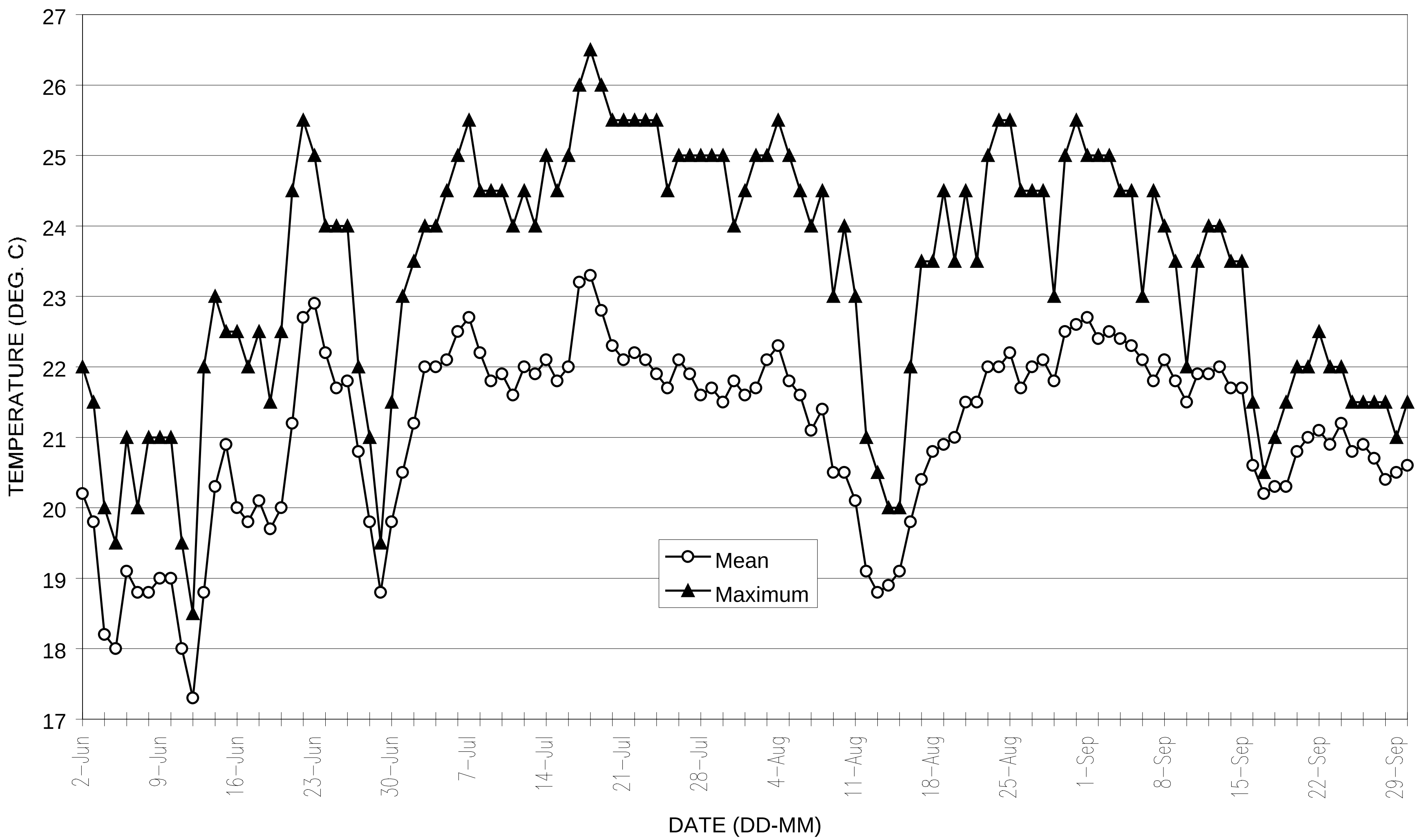


FIGURE 45. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1989) AT NAVARRO RIVER (MAP NO. 10; MONITORING SITE NO. 14A), MENDOCINO CO., CALIFORNIA.

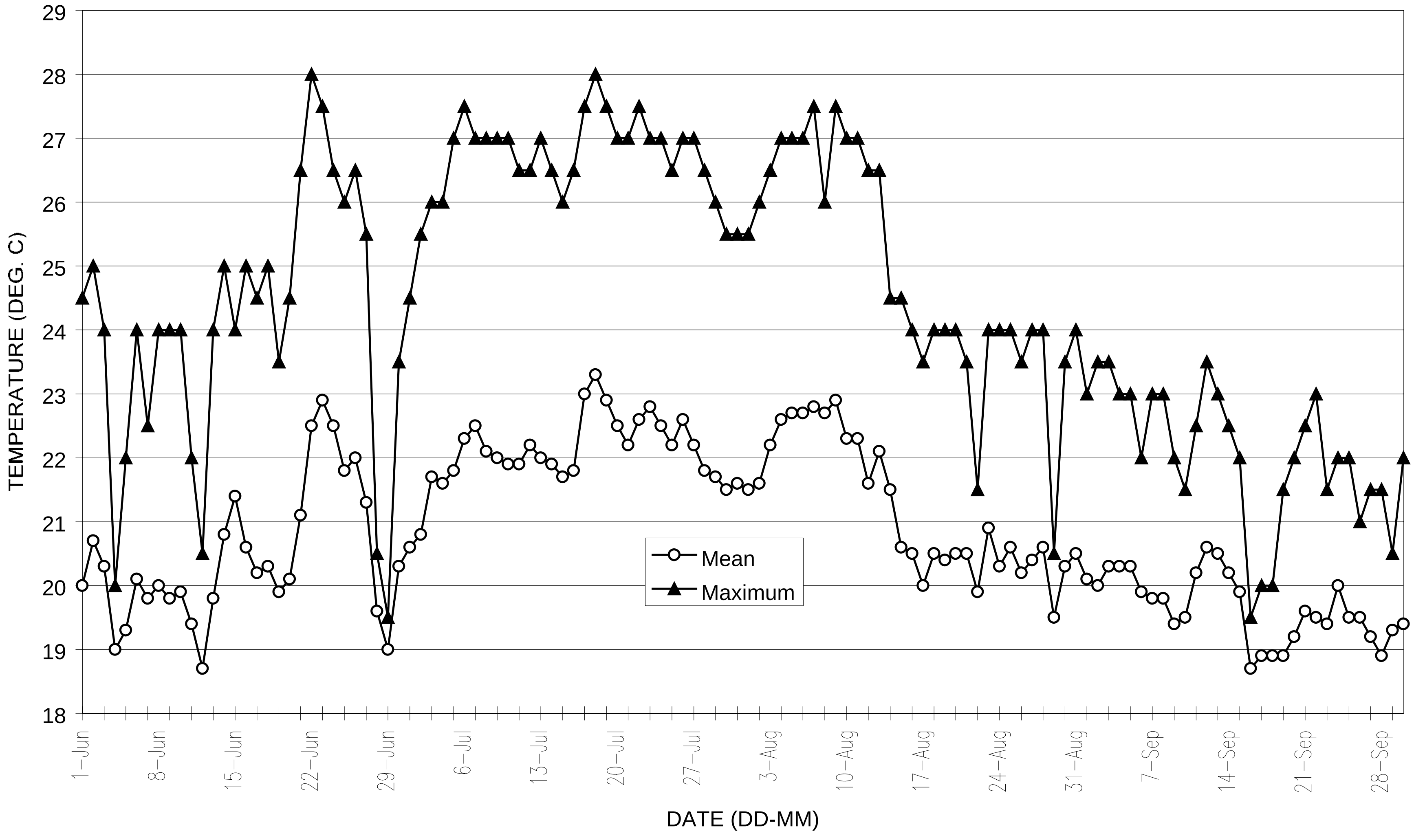


FIGURE 26.   MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1990) AT JOHN SMITH CREEK (MAP NO. 8; MONITORING SITE NO. 17), MENDOCINO CO., CALIFORNIA.

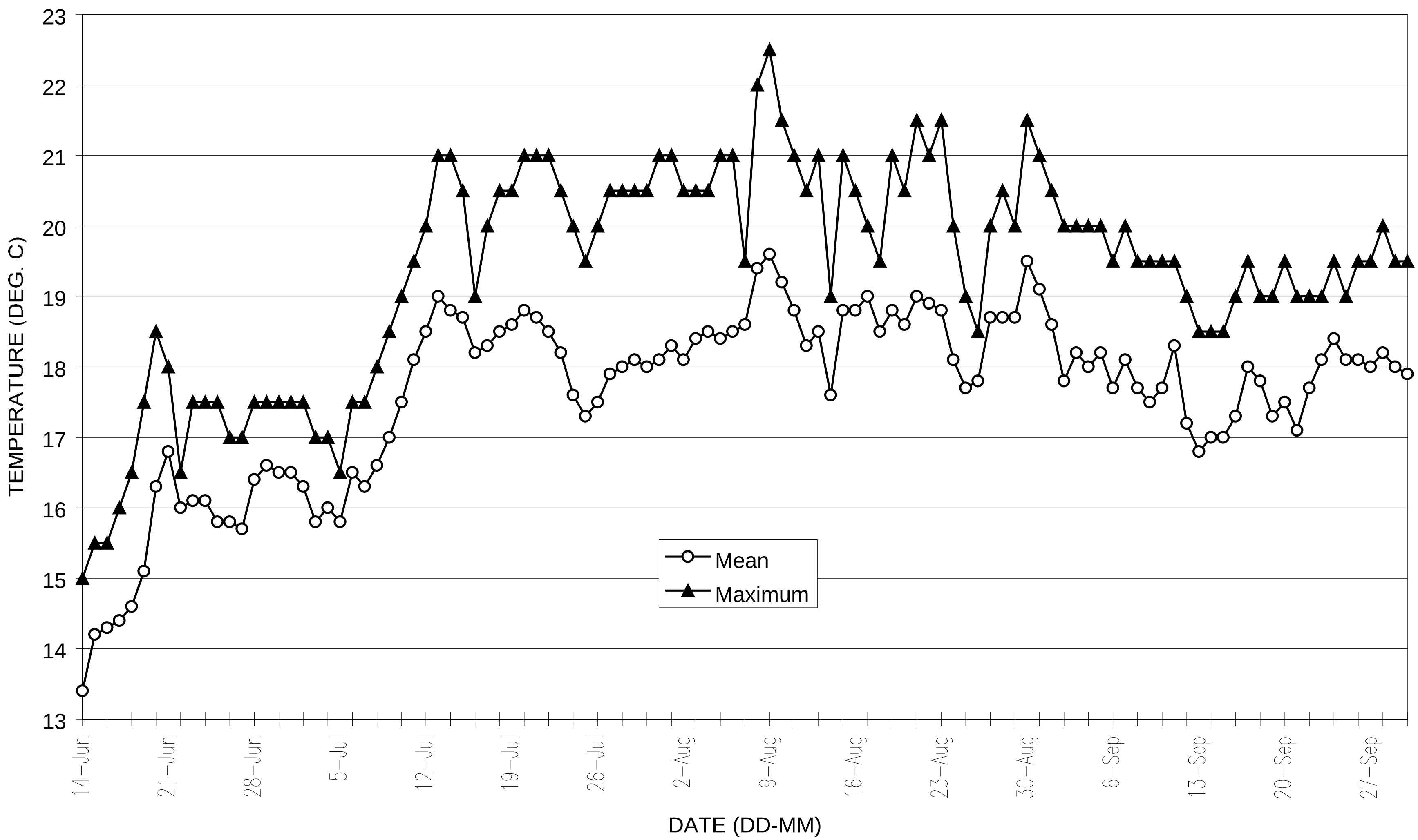


FIGURE 35. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-AUGUST 1990) AT NAVARRO RIVER (MAP NO. 9; MONITORING SITE NO. 14), MENDOCINO CO., CALIFORNIA.

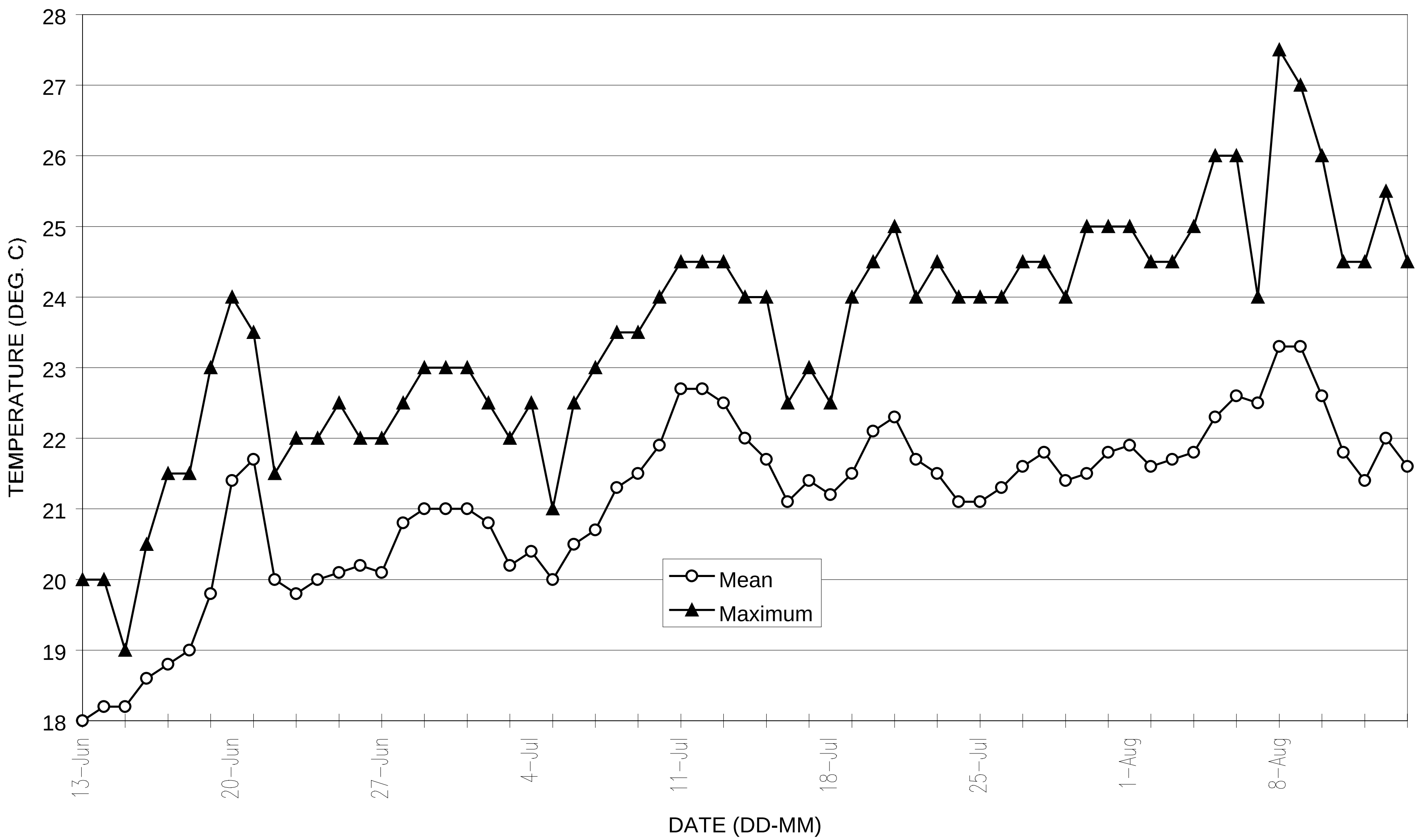


FIGURE 46. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (MAY-OCTOBER 1990) AT NAVARRO RIVER (MAP NO. 10; MONITORING SITE NO. 14A), MENDOCINO CO., CALIFORNIA.

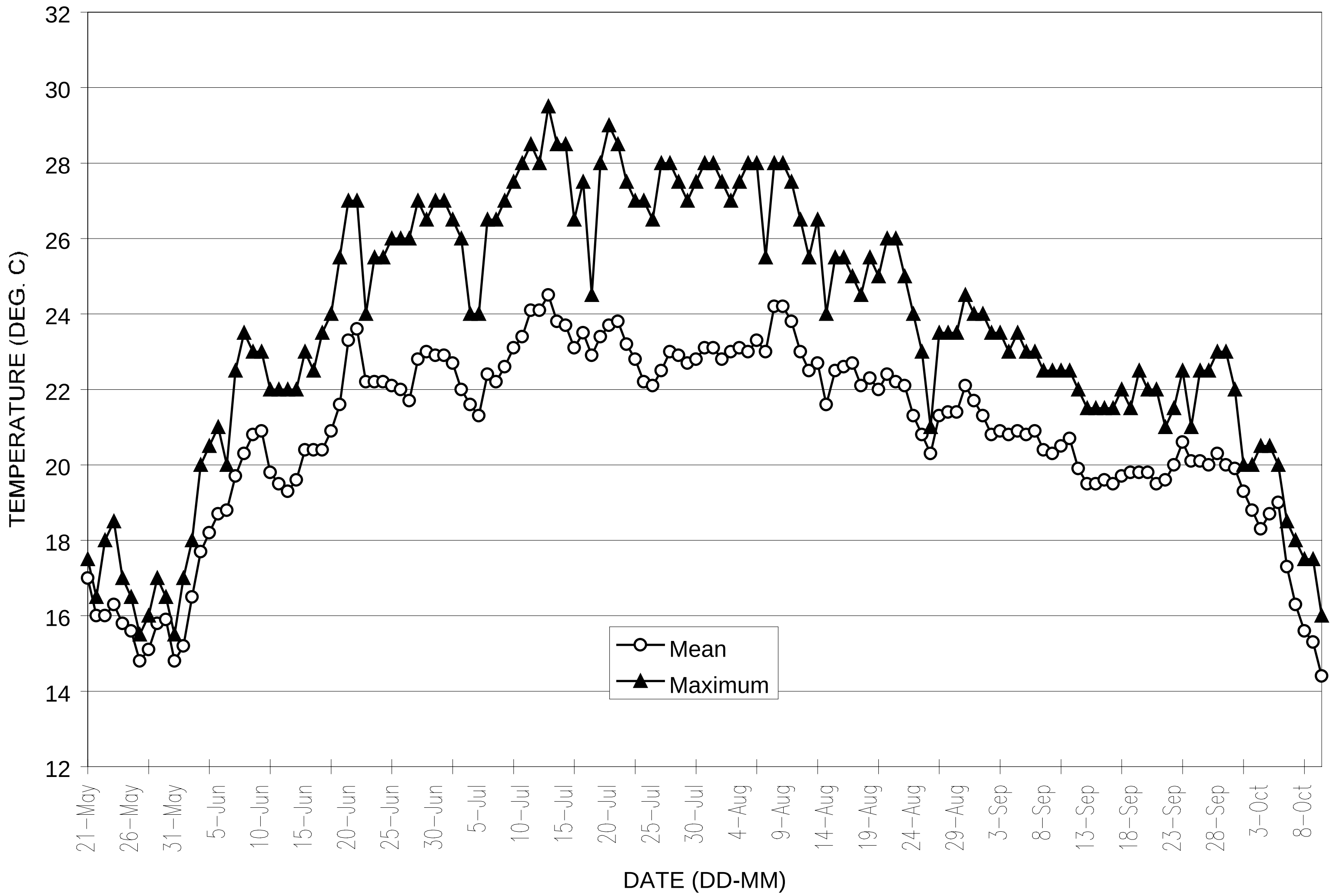


FIGURE 54. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1990) AT NAVARRO RIVER (MAP NO. 14; MONITORING SITE NO. 15), MENDOCINO CO., CALIFORNIA.

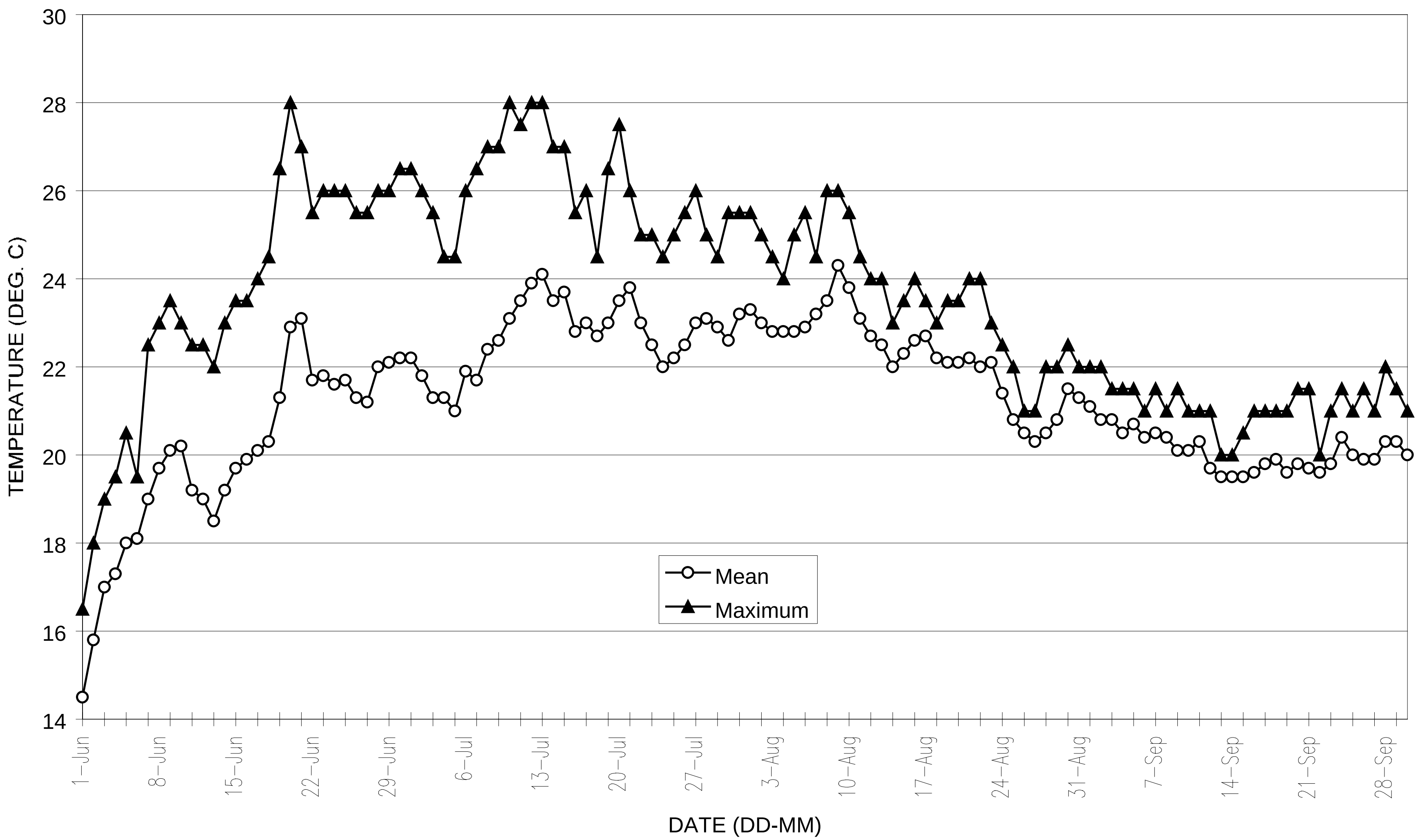


FIGURE 27. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1991) AT JOHN SMITH CREEK (MAP NO. 8; MONITORING SITE NO. 17), MENDOCINO CO., CALIFORNIA.

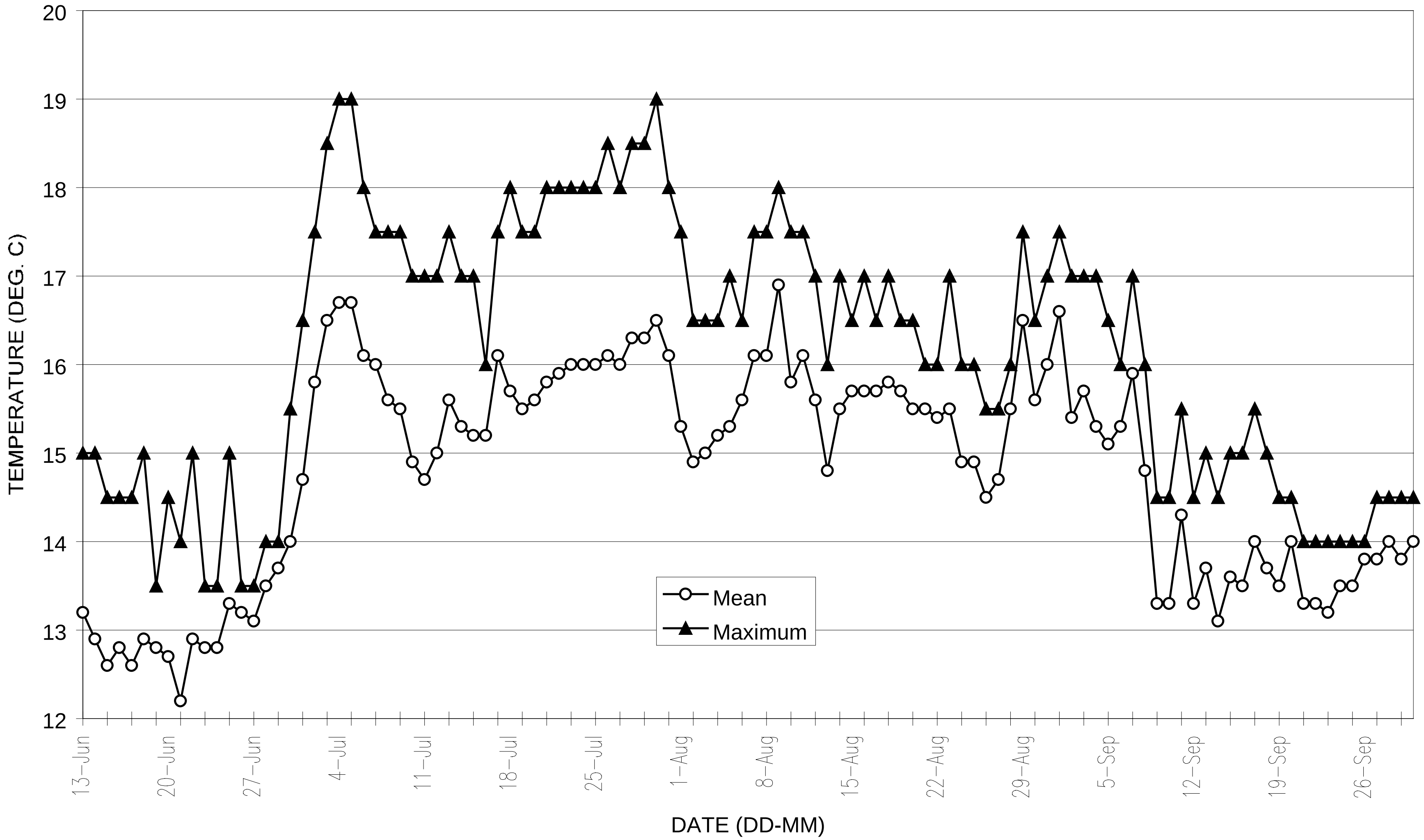


FIGURE 31. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1991) AT JOHN SMITH CREEK (MAP NO. 8; MONITORING SITE NO. 17A), MENDOCINO CO., CALIFORNIA.

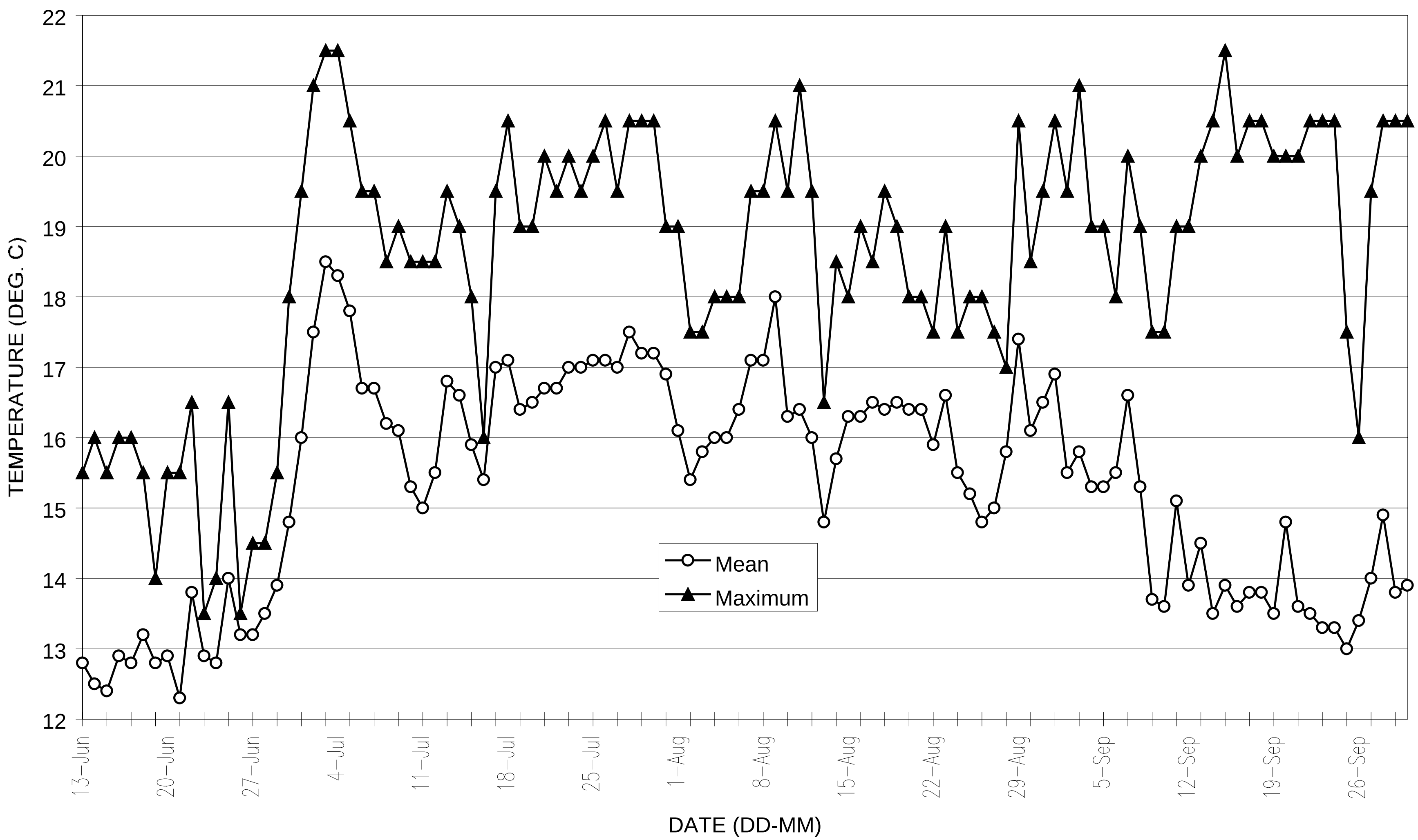


FIGURE 40. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1991) AT MARSH GULCH (MAP NO. 9; MONITORING SITE NO. 16), MENDOCINO CO., CALIFORNIA.

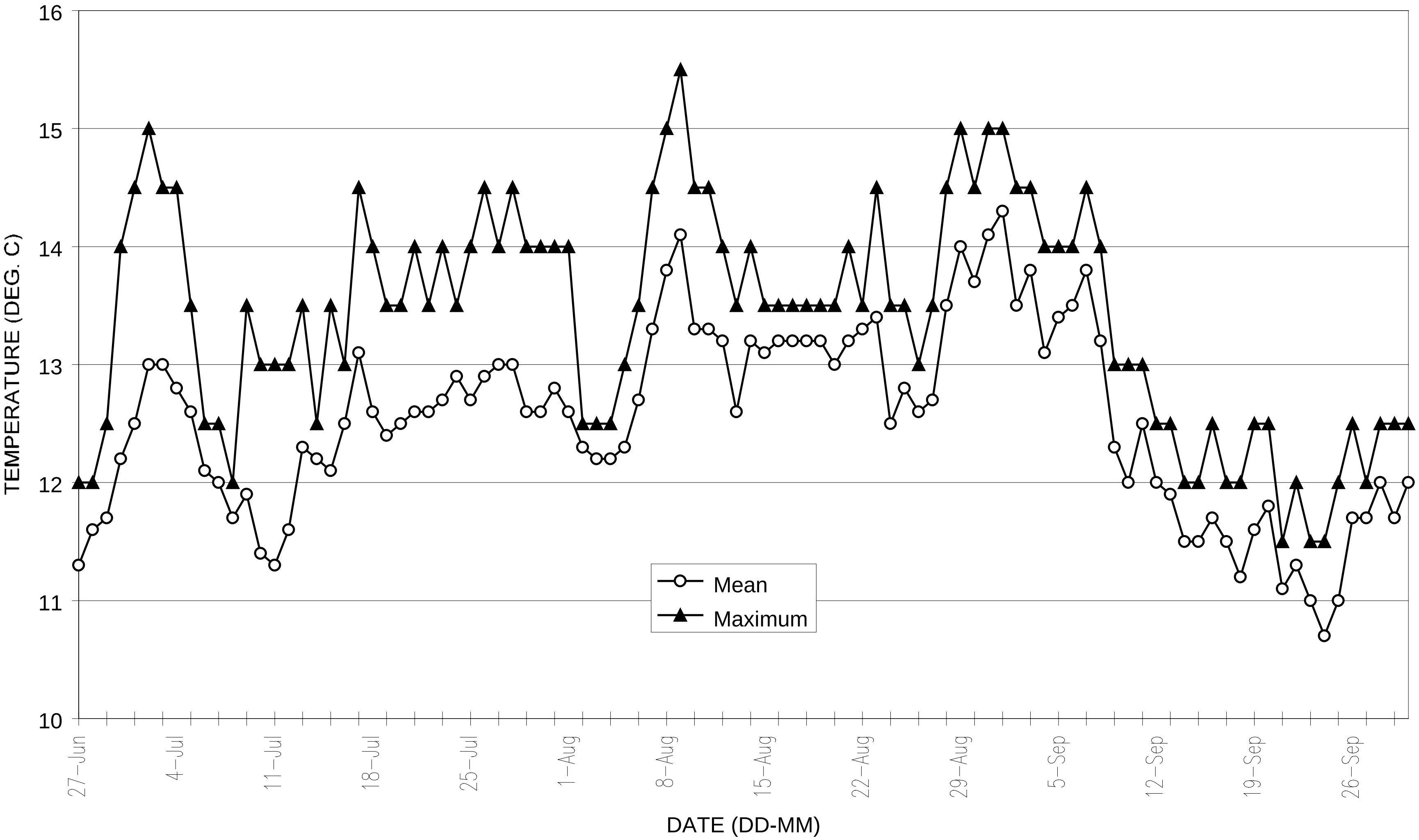


FIGURE 36. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1991) AT NAVARRO RIVER (MAP NO. 9; MONITORING SITE NO.14), MENDOCINO CO., CALIFORNIA.

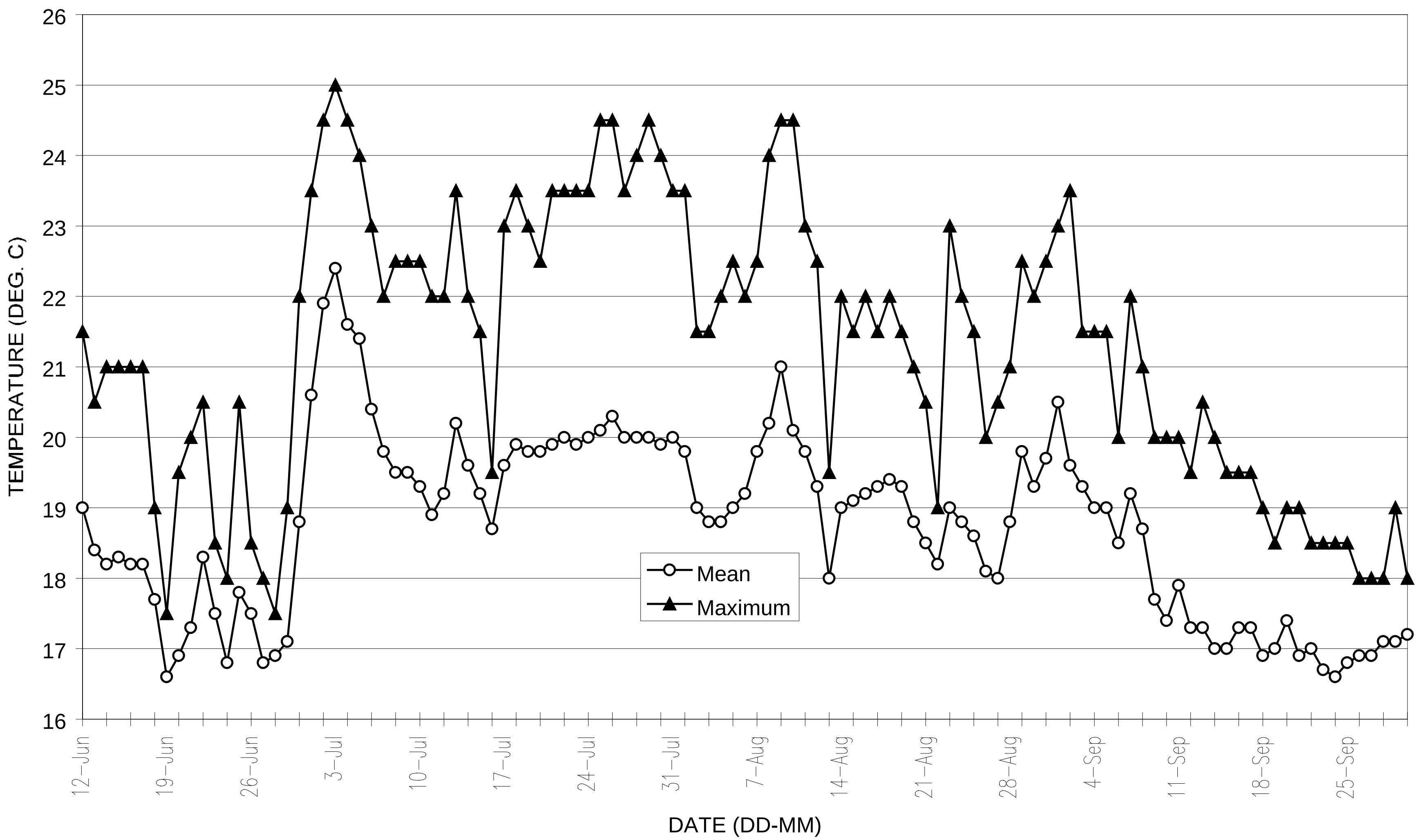


FIGURE 47. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-OCTOBER 1991) AT NAVARRO RIVER (MAP NO. 10; MONITORING SITE NO. 14A), MENDOCINO CO., CALIFORNIA.

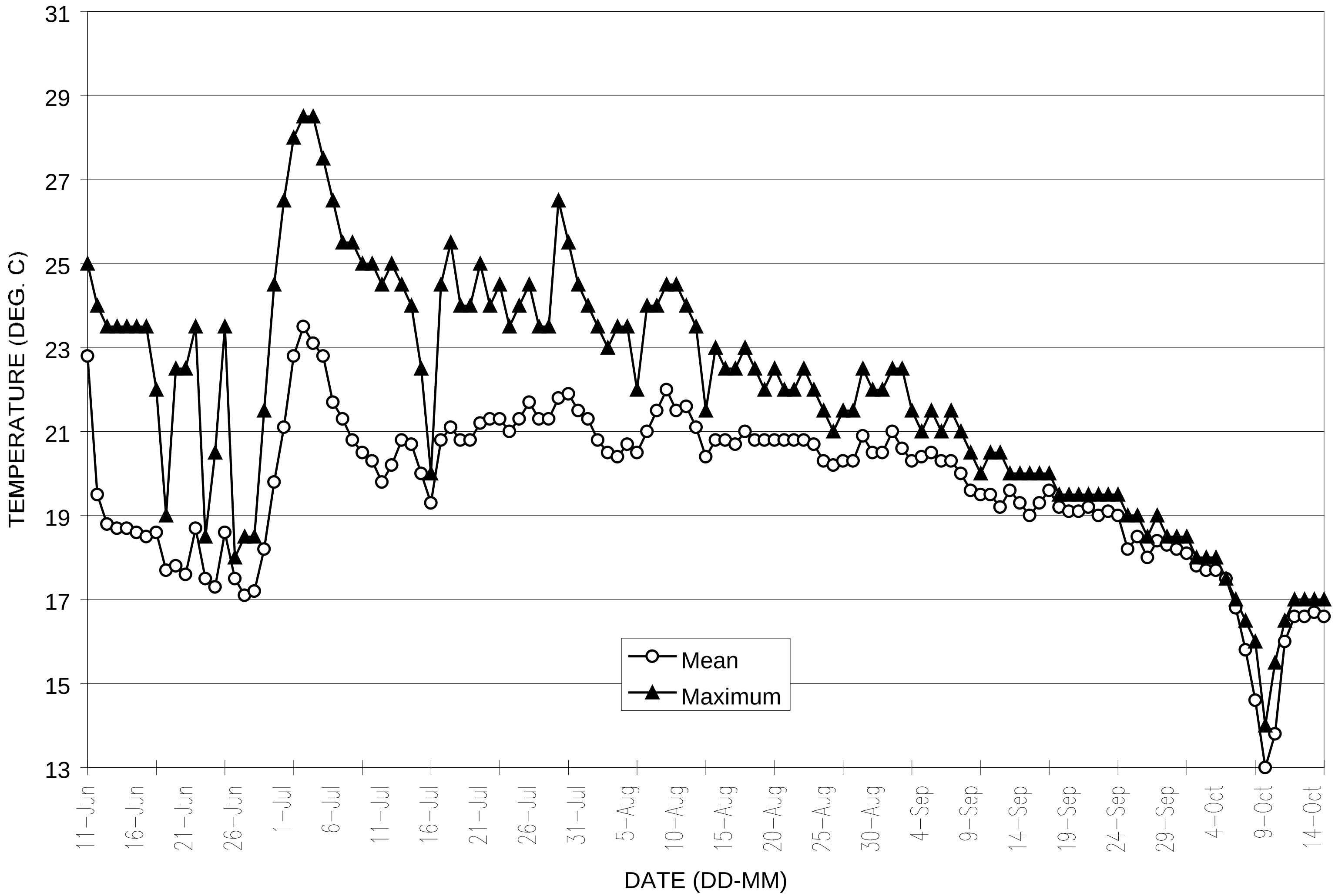


FIGURE 55. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1991) AT NAVARRO RIVER (MAP NO. 14; MONITORING SITE NO. 15), MENDOCINO CO., CALIFORNIA.

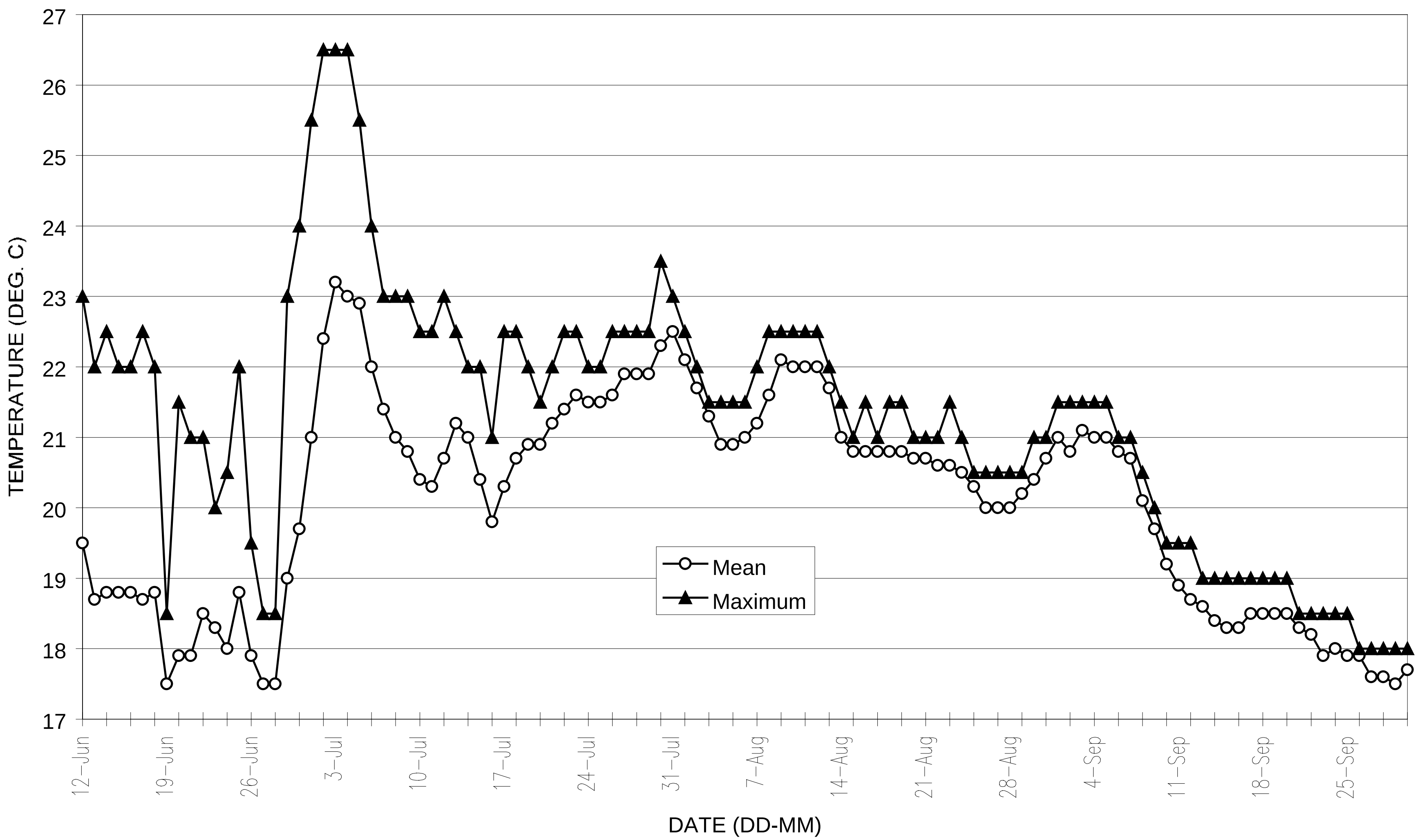


FIGURE 28. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT JOHN SMITH CREEK (MAP NO. 8; MONITORING SITE NO. 17), MENDOCINO CO., CALIFORNIA.

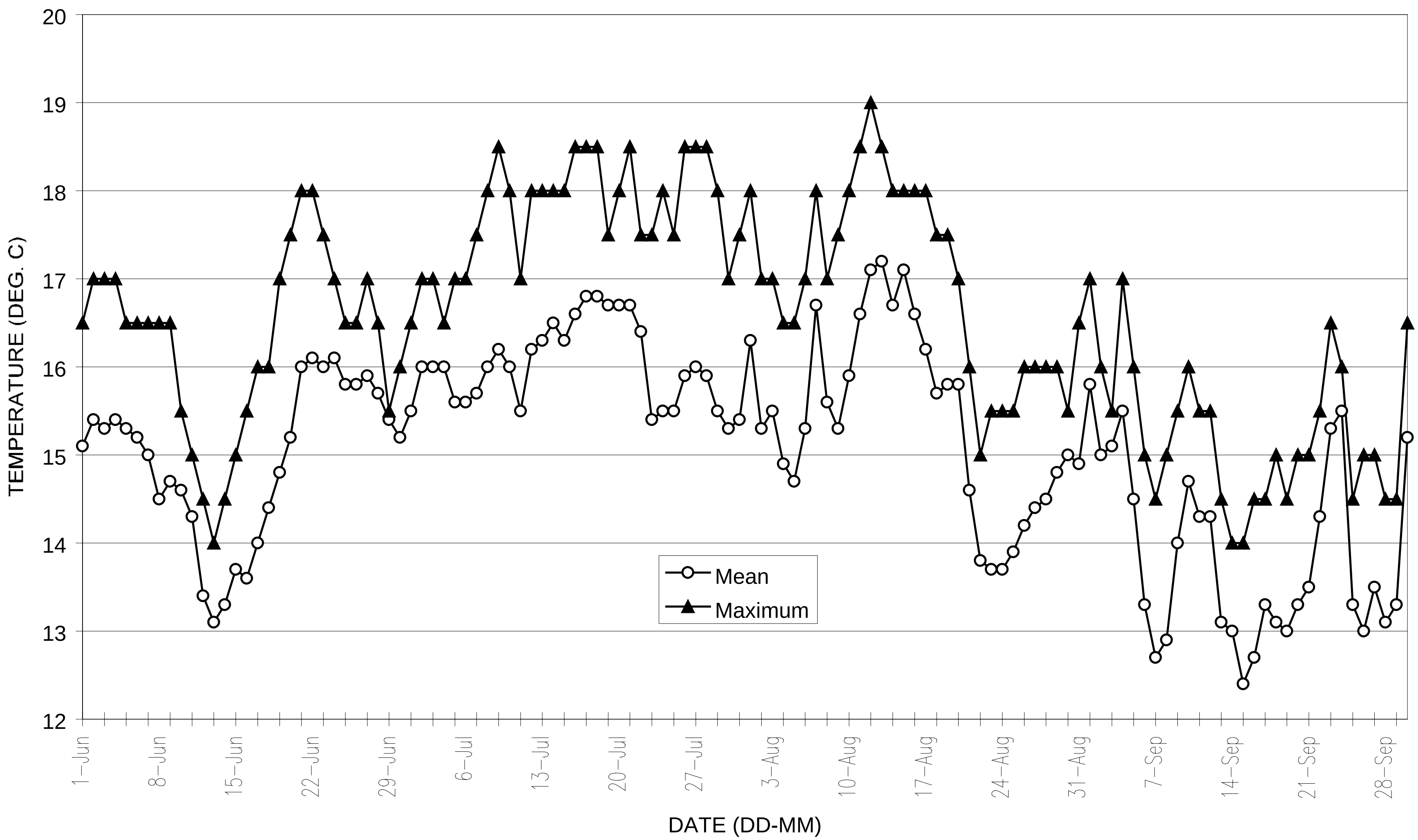


FIGURE 41. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT MARSH GULCH (MAP NO. 9; MONITORING SITE NO. 16), MENDOCINO CO., CALIFORNIA.

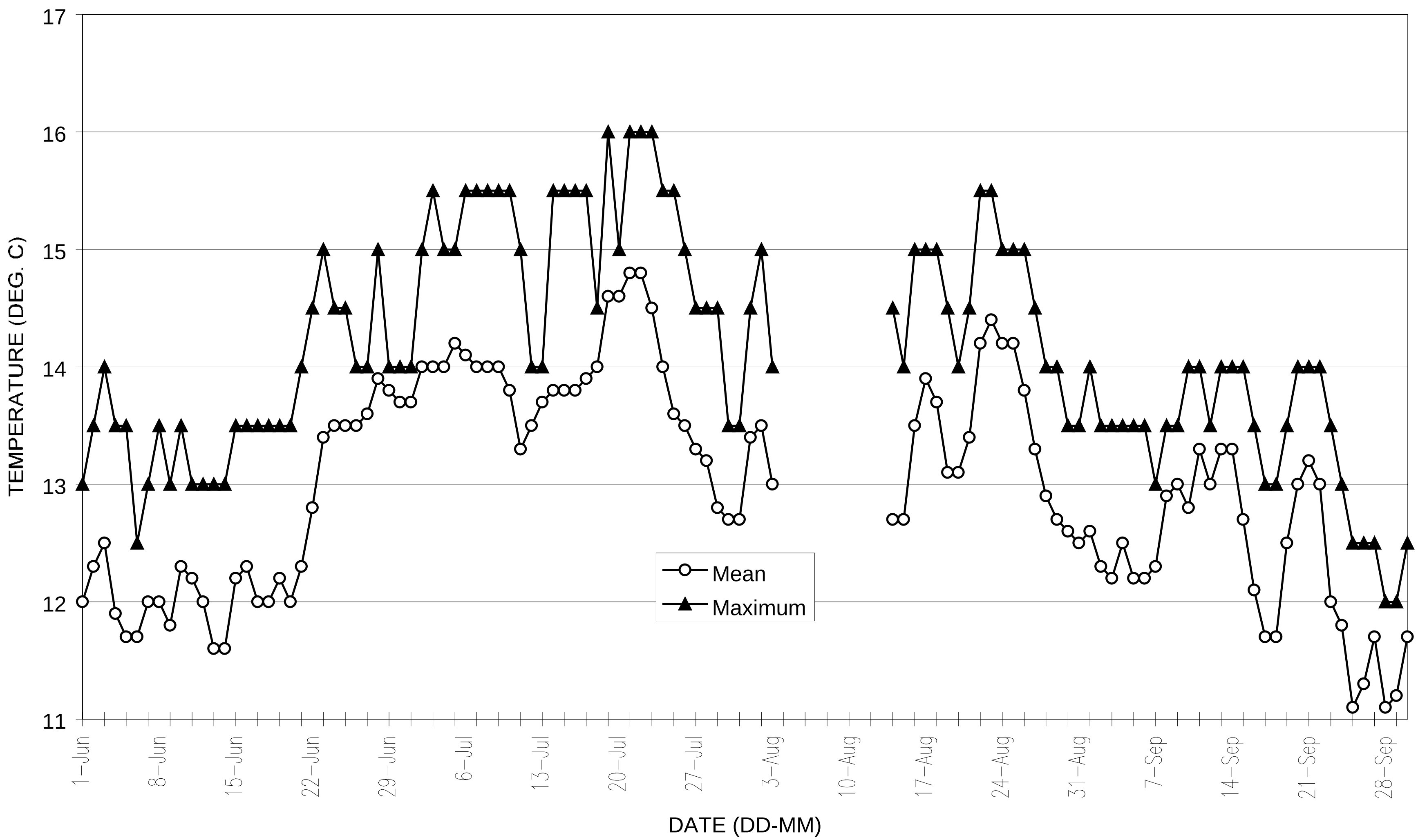


FIGURE 37. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT NAVARRO RIVER (MAP NO. 9; MONITORING SITE NO. 14), MENDOCINO CO., CALIFORNIA.

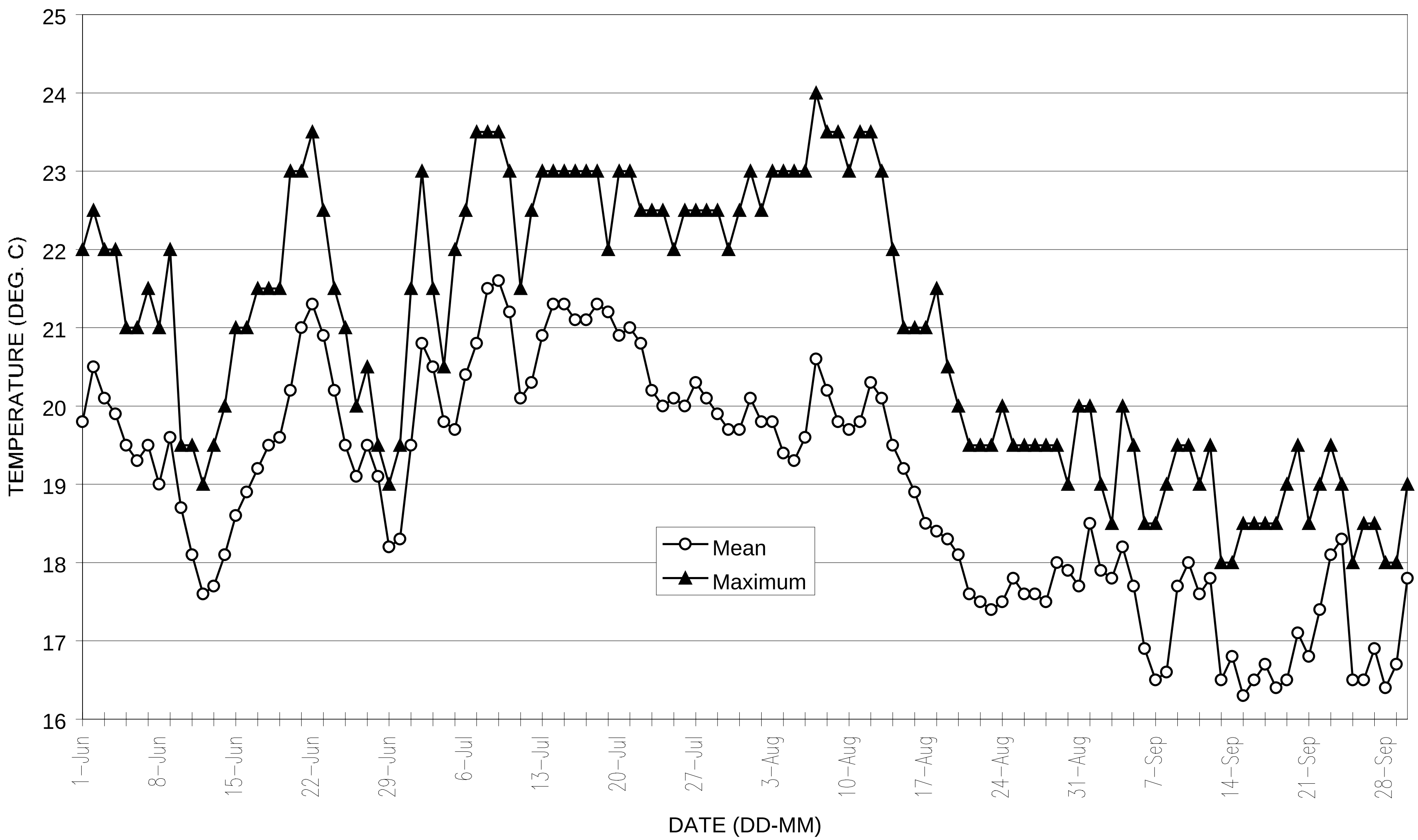


FIGURE 48. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT NAVARRO RIVER (MAP NO. 10; MONITORING SITE NO. 14A), MENDOCINO CO., CALIFORNIA.

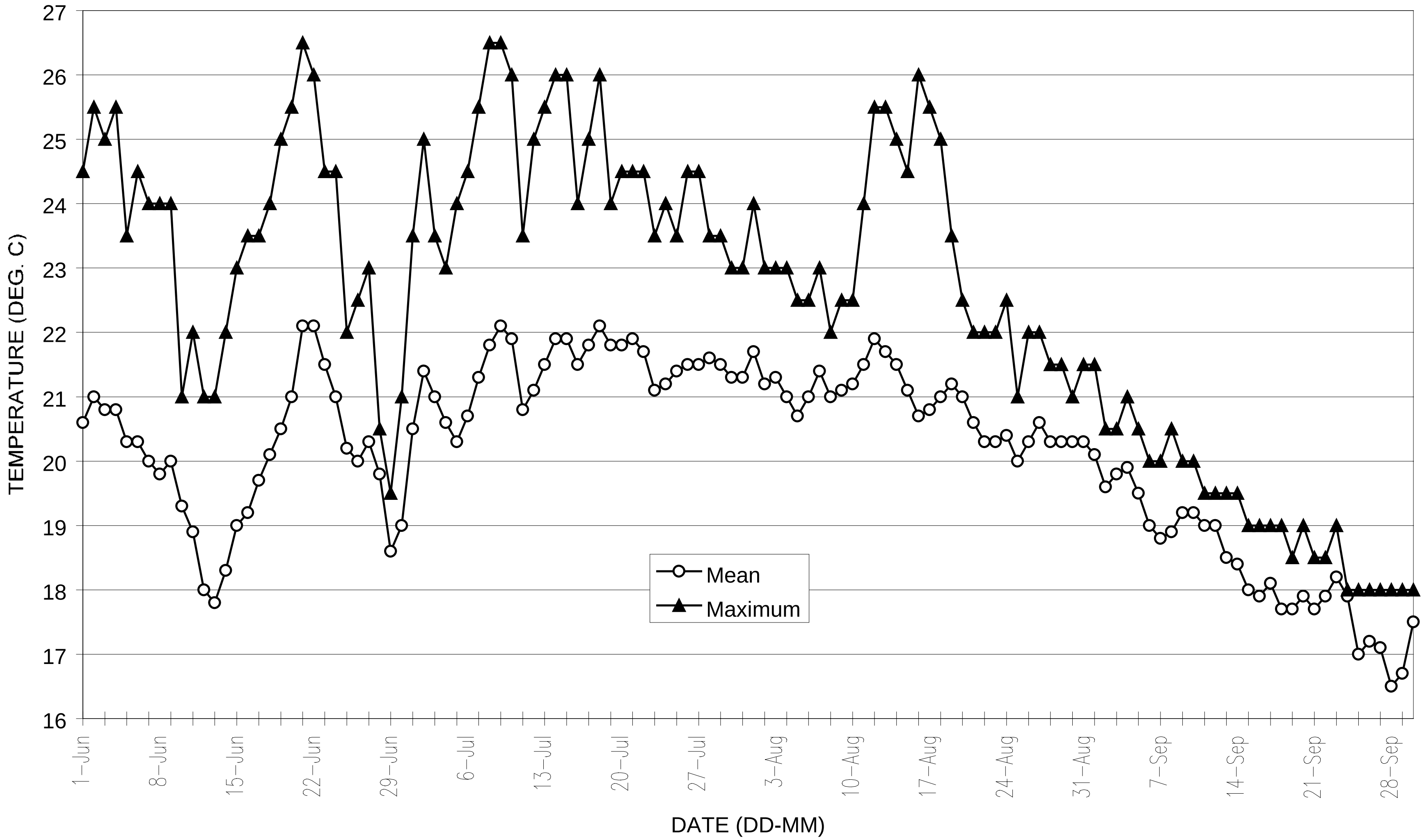


FIGURE 56. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT NAVARRO RIVER (MAP NO. 14; MONITORING SITE NO. 15), MENDOCINO CO., CALIFORNIA.

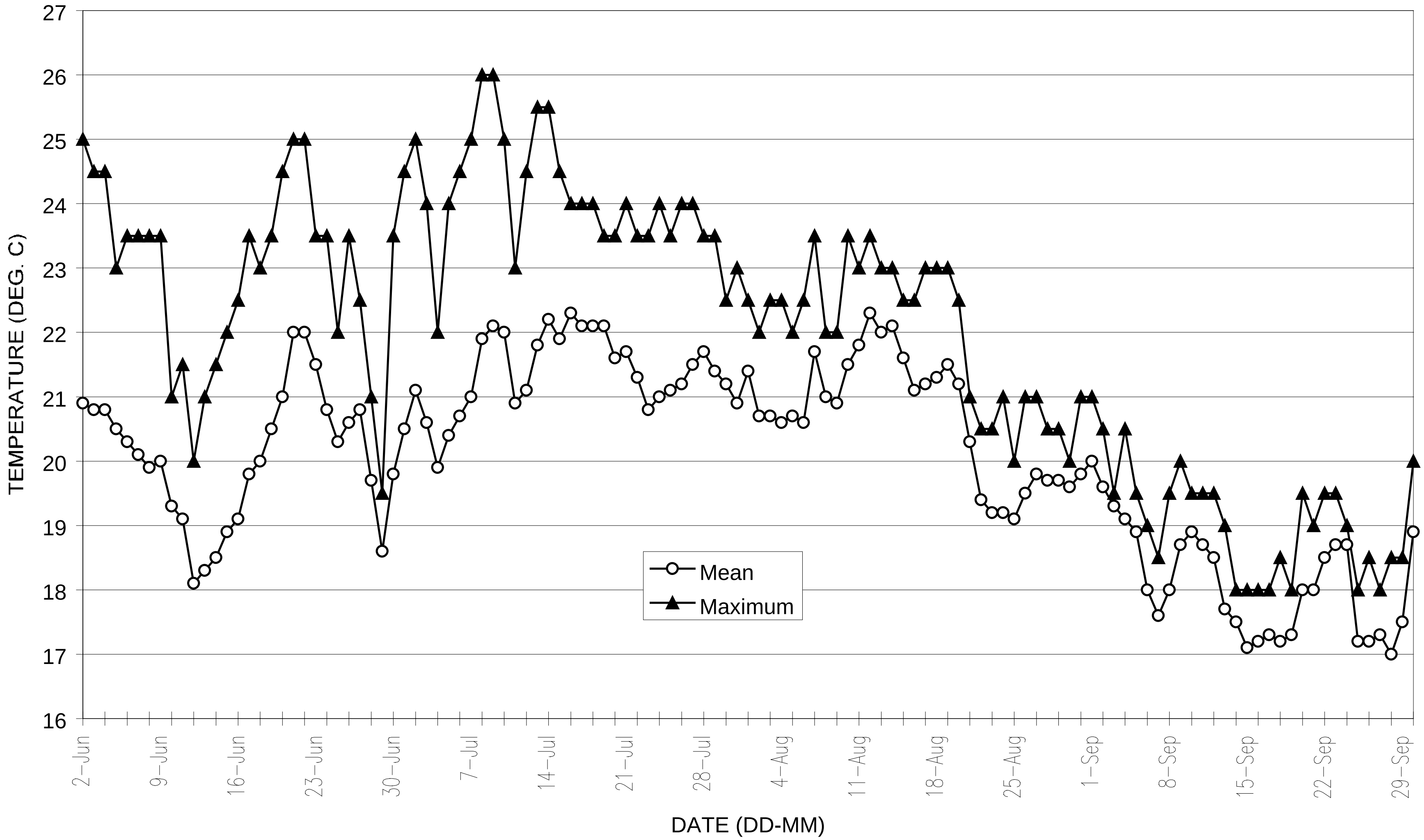


FIGURE 32. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT NORTH BRANCH OF NORTH FORK NAVARRO RIVER (MAP NO. 8; MONITORING SITE NO. 19), MENDOCINO CO., CALIFORNIA.

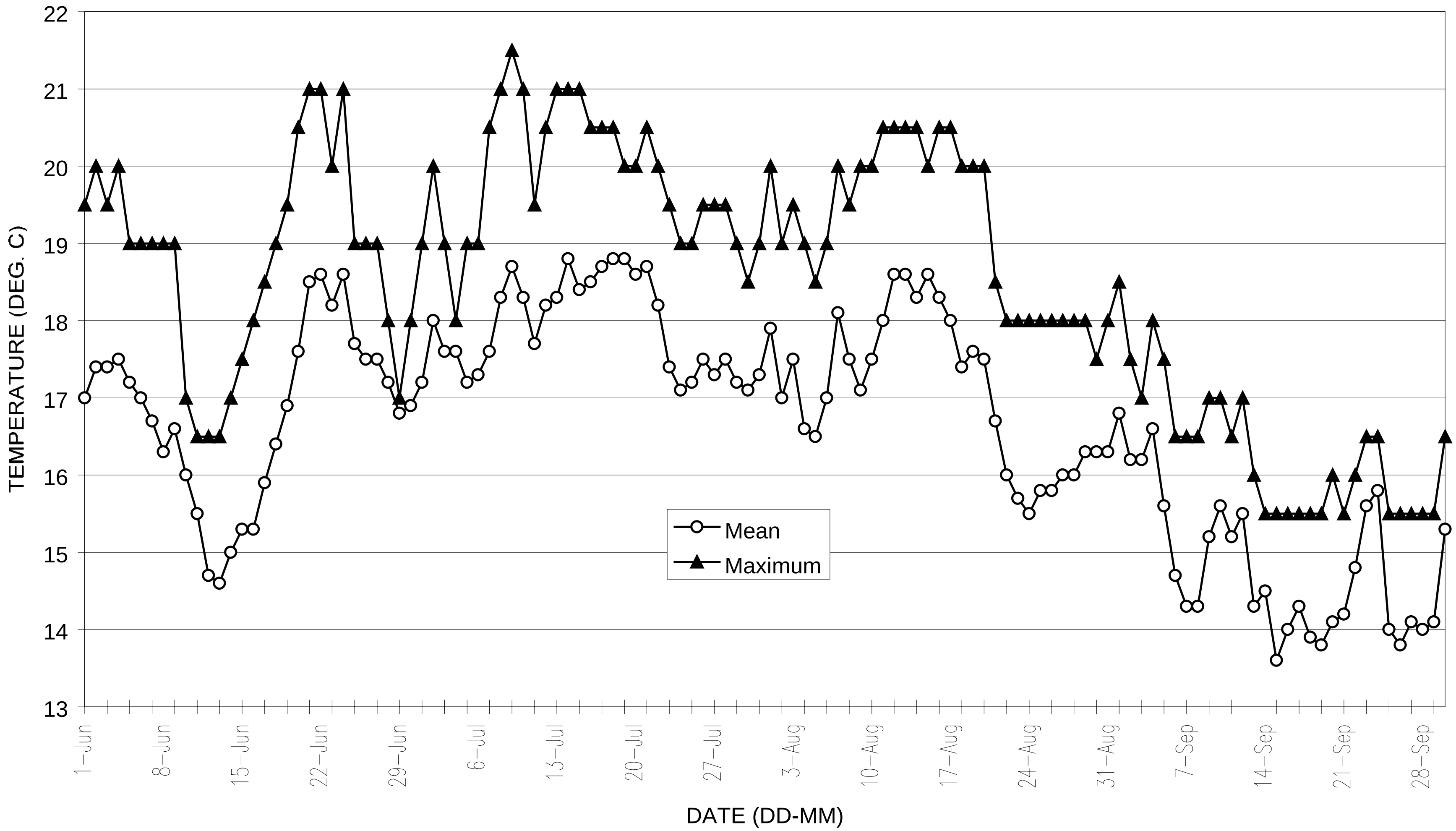


FIGURE 44. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT FLYNN CREEK (MAP NO. 9; MONITORING SITE NO. 21), MENDOCINO CO., CALIFORNIA.

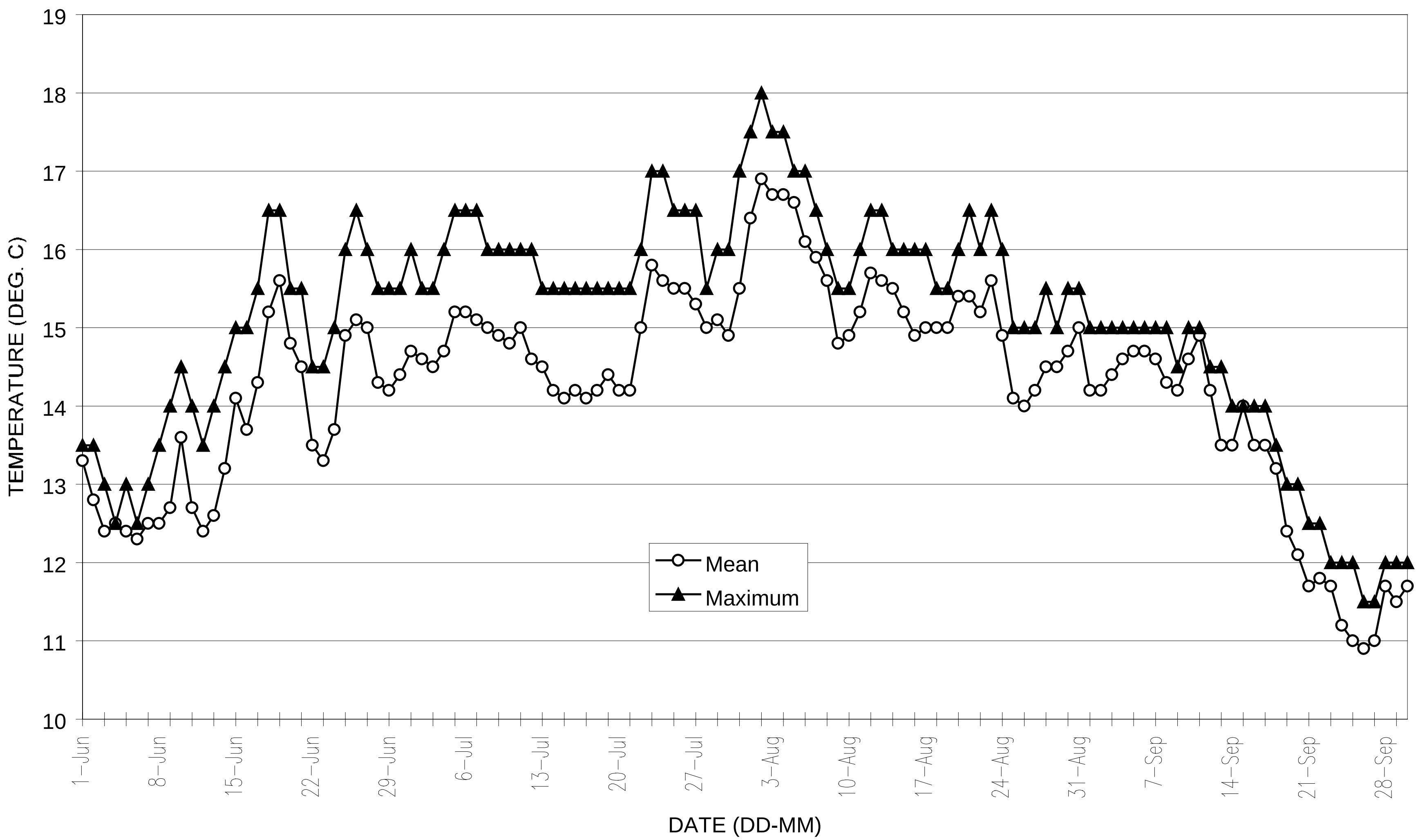


FIGURE 29. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT JOHN SMITH CREEK (MAP NO. 8; MONITORING SITE NO. 17), MENDOCINO CO., CALIFORNIA.

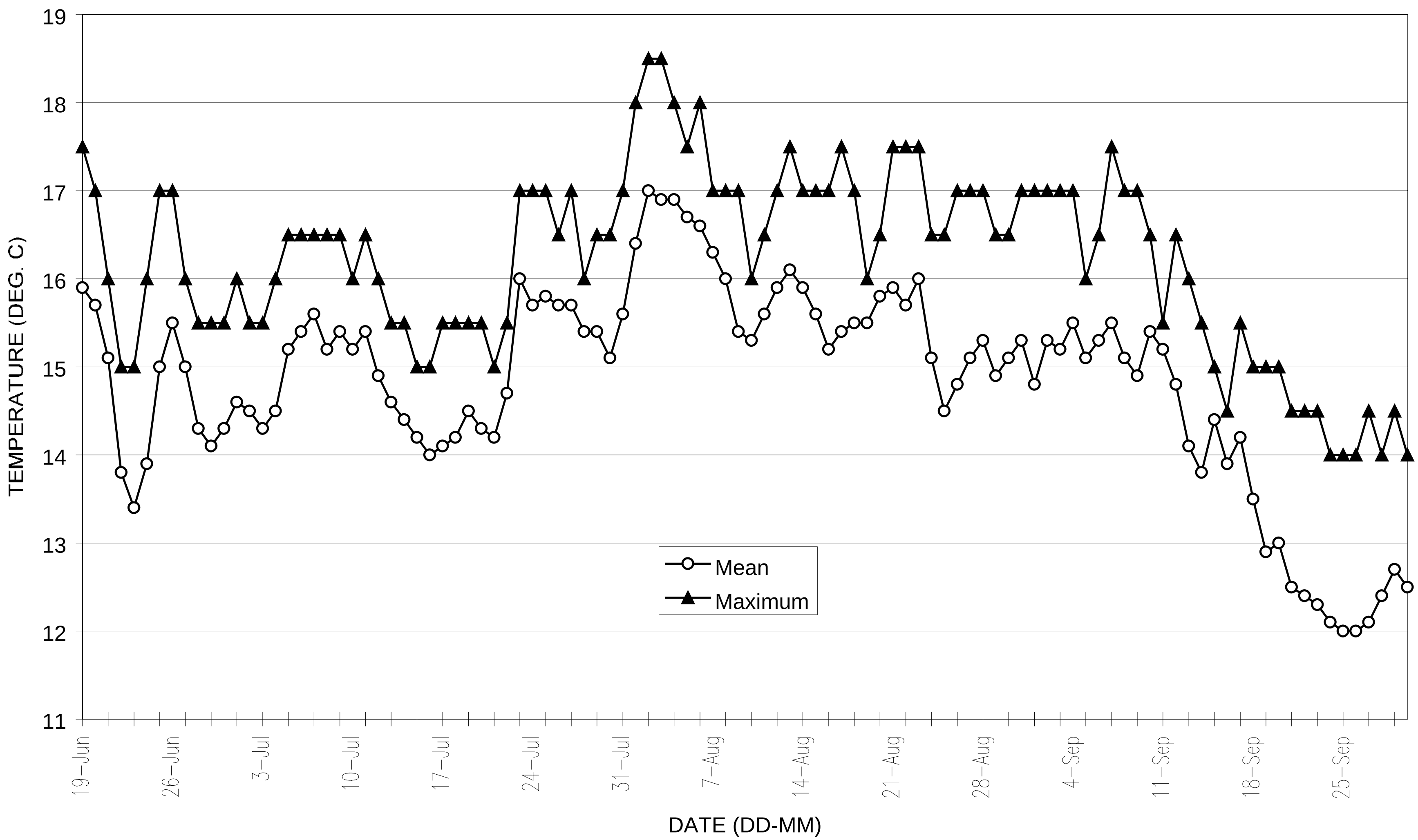


FIGURE 42. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT MARSH GULCH (MAP NO. 9; MONITORING SITE NO. 16), MENDOCINO CO., CALIFORNIA.

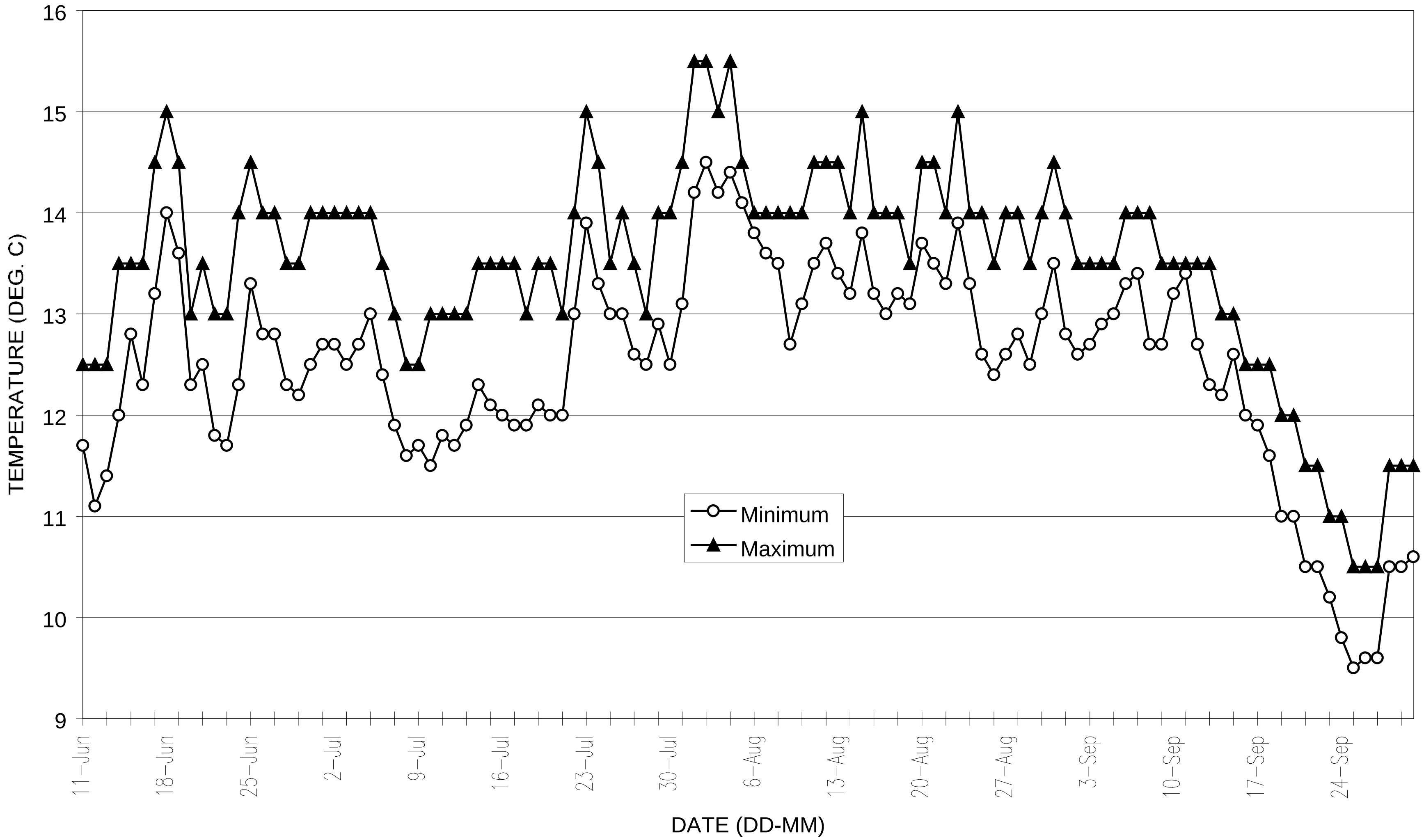


FIGURE 38. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING THE SUMMER (JULY-SEPTEMBER 1993) AT NAVARRO RIVER (MAP NO. 9; MONITORING SITE NO. 14), MENDOCINO CO., CALIFORNIA.

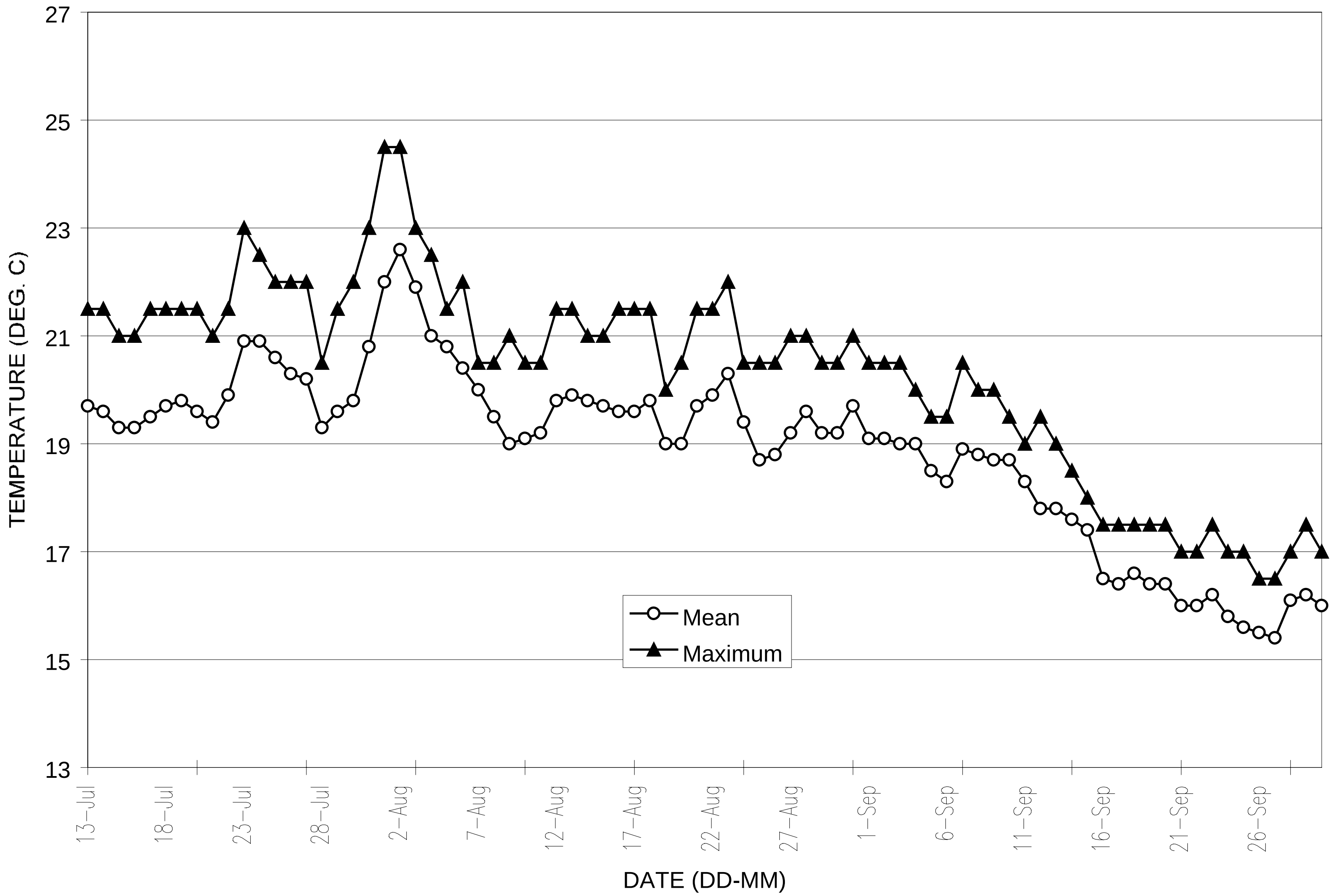


FIGURE 57. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT NAVARRO RIVER (MAP NO. 14; MONITORING SITE NO. I5), MENDOCINO CO., CALIFORNIA.

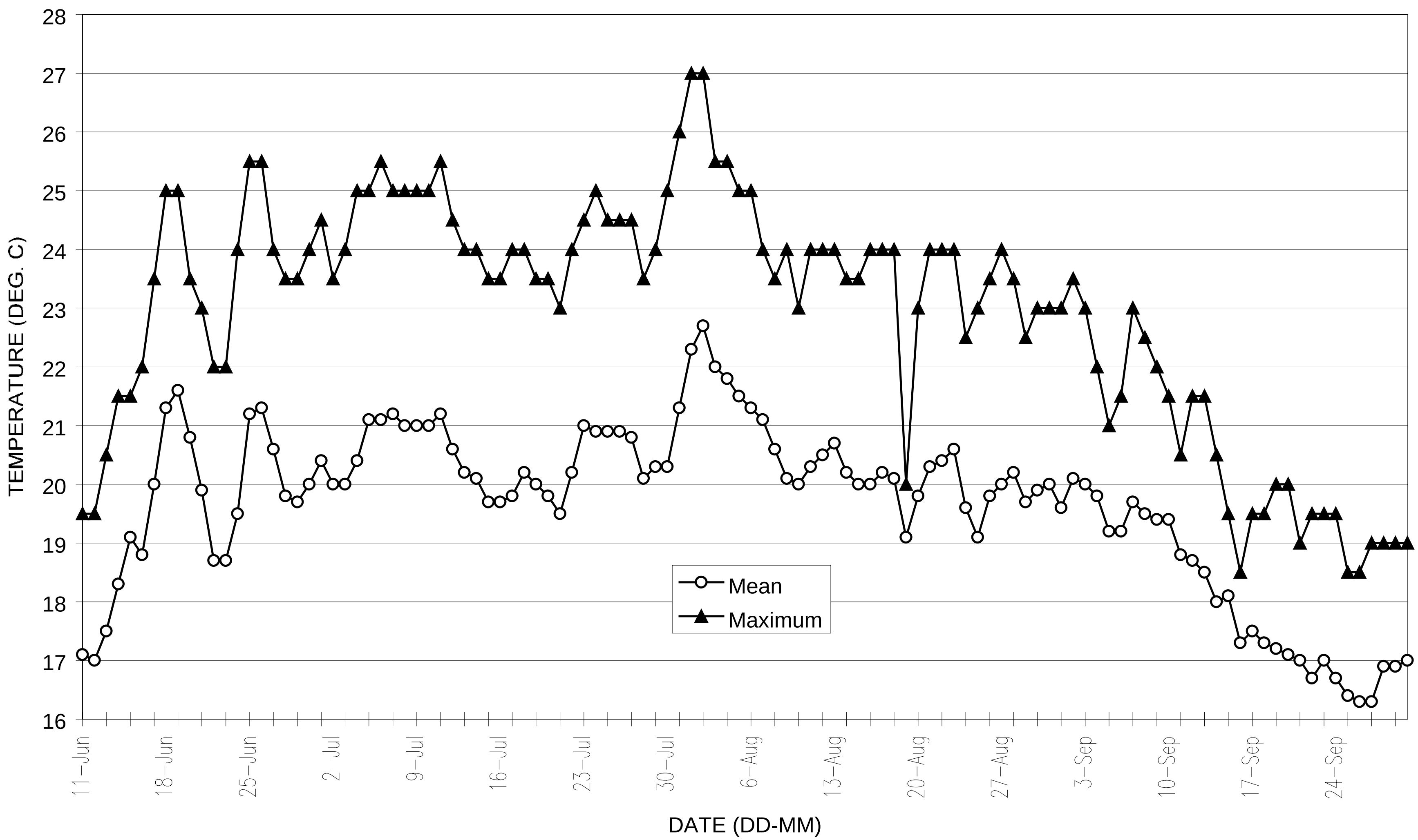


FIGURE 33. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT NORTH BRANCH OF NORTH FORK NAVARRO RIVER (MAP NO. 8; MONITORING SITE NO. 19), MENDOCINO CO., CALIFORNIA.

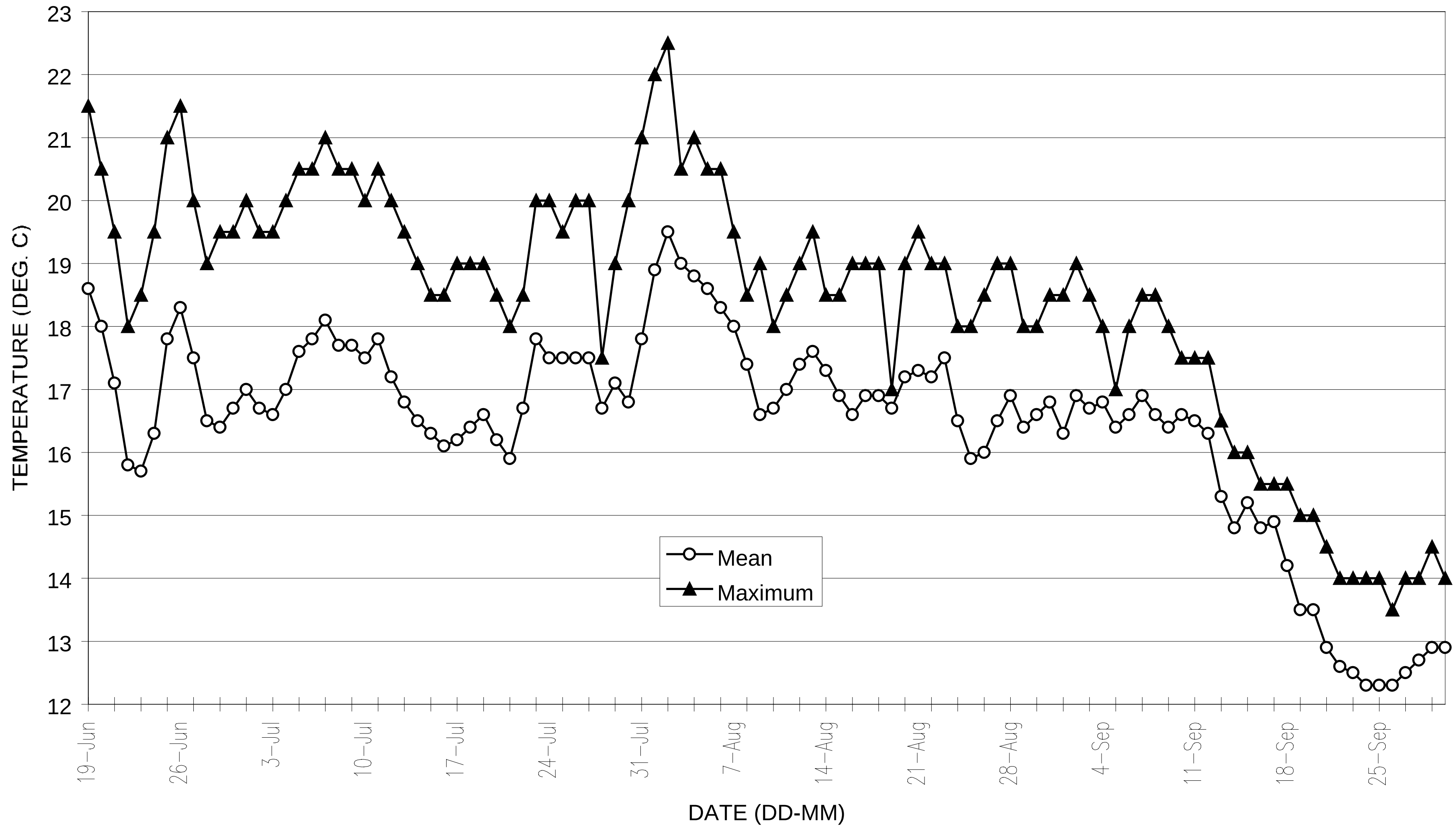


FIGURE 51. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT NORTH FORK INDIAN CREEK (MAP NO. 12; MONITORING SITE NO. 26), MENDOCINO CO., CALIFORNIA.

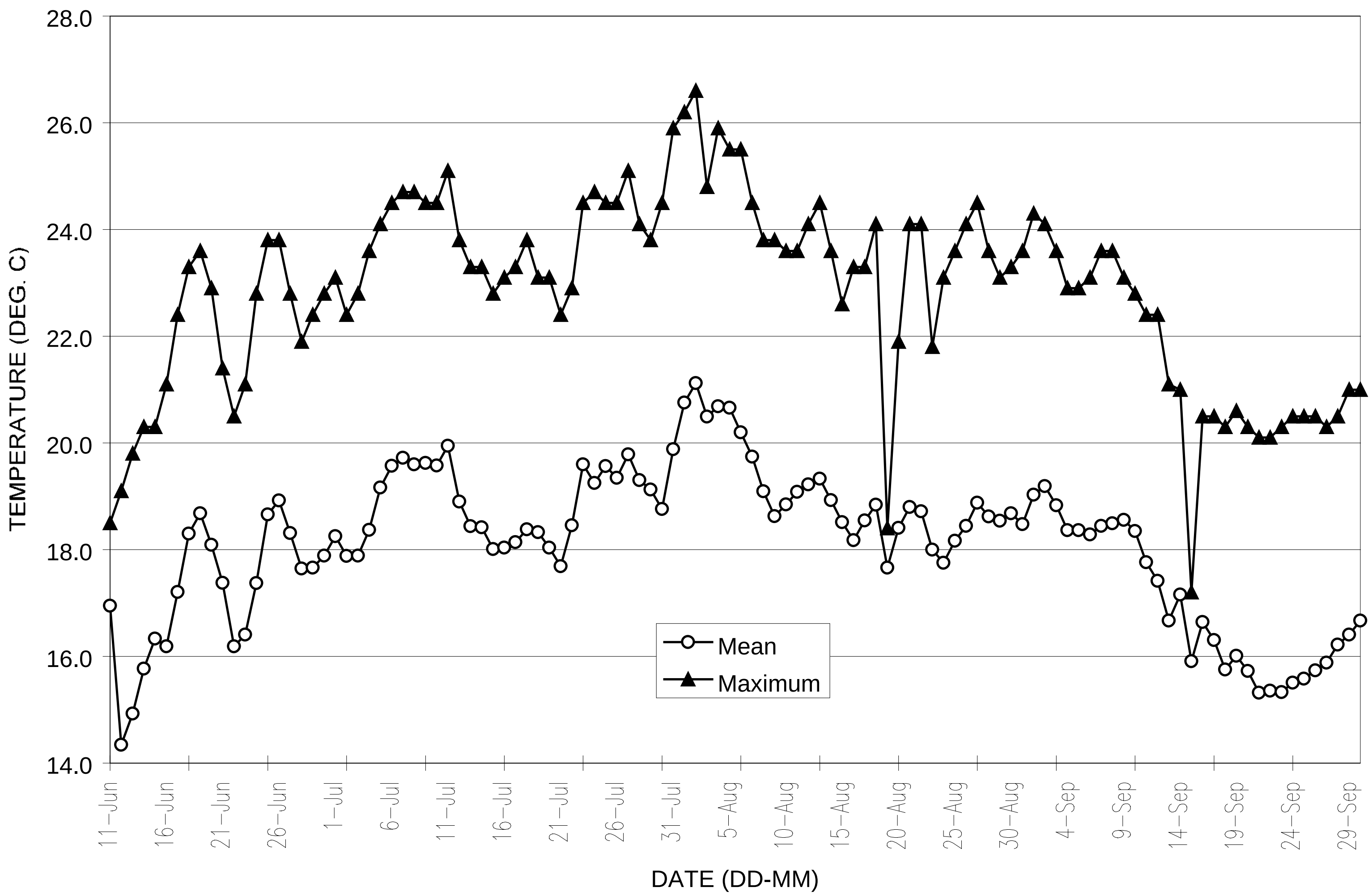


FIGURE 77. MEAN, AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT FLYNN CREEK (MAP NO. 14; MONITORING SITE NO. 82-2), MENDOCINO CO., CALIFORNIA.

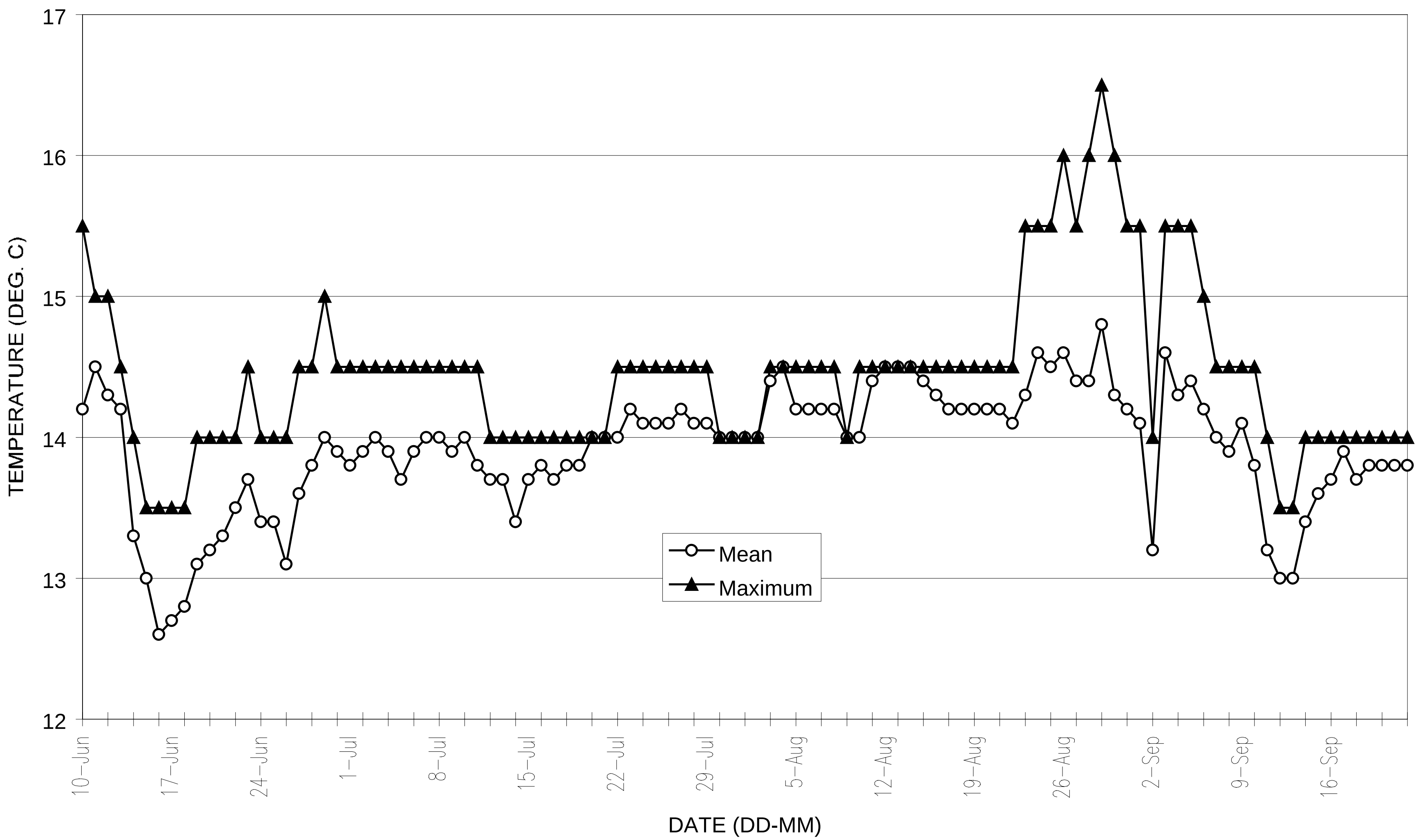


FIGURE 73. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT JOHN SMITH CREEK (MAP NO.13; MONITORING SITE NO. 81-2), MENDOCINO CO., CALIFORNIA.

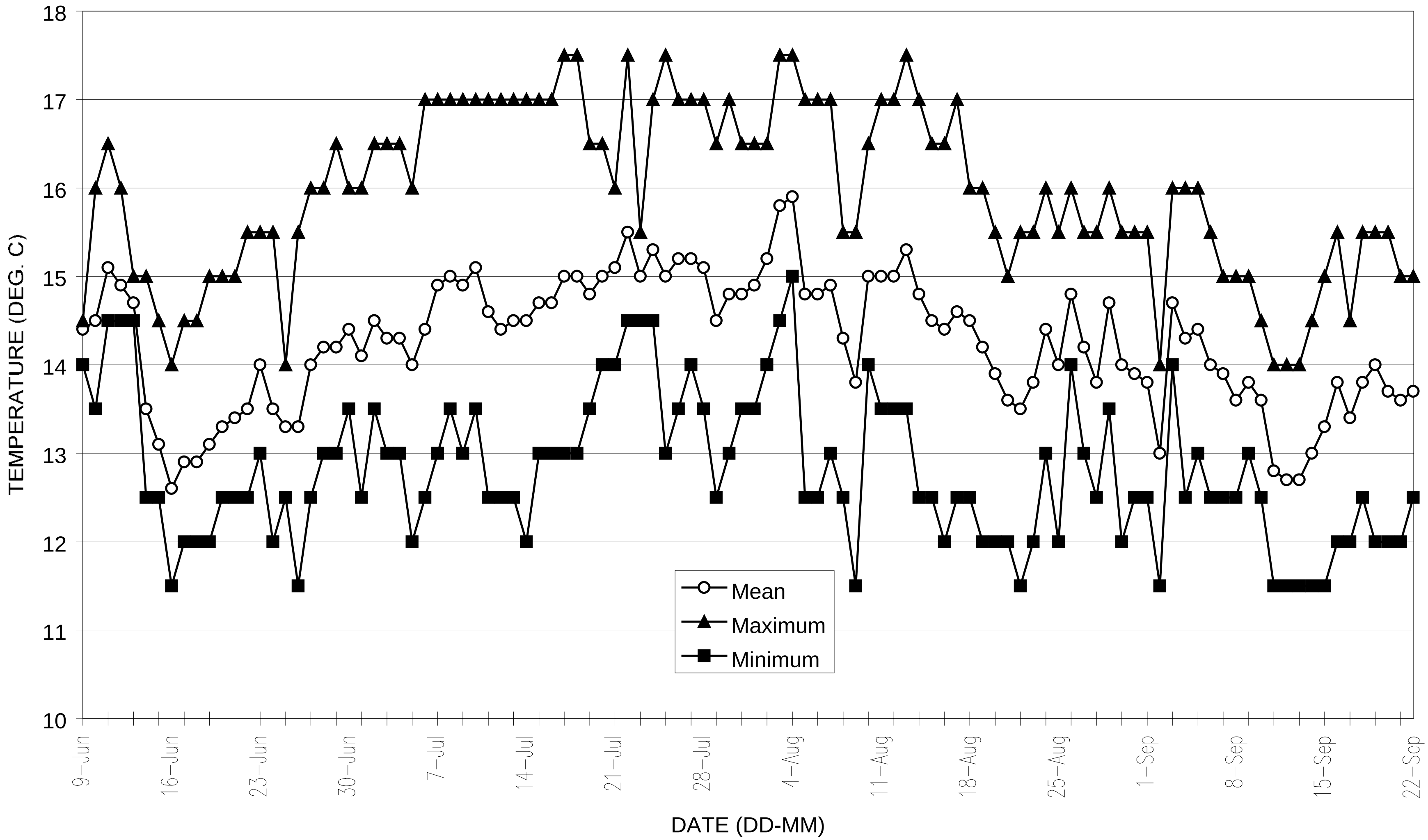


FIGURE 76. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT MARSH GULCH (MAP NO. 14; MONITORING SITE NO. 82-1), MENDOCINO CO., CALIFORNIA.

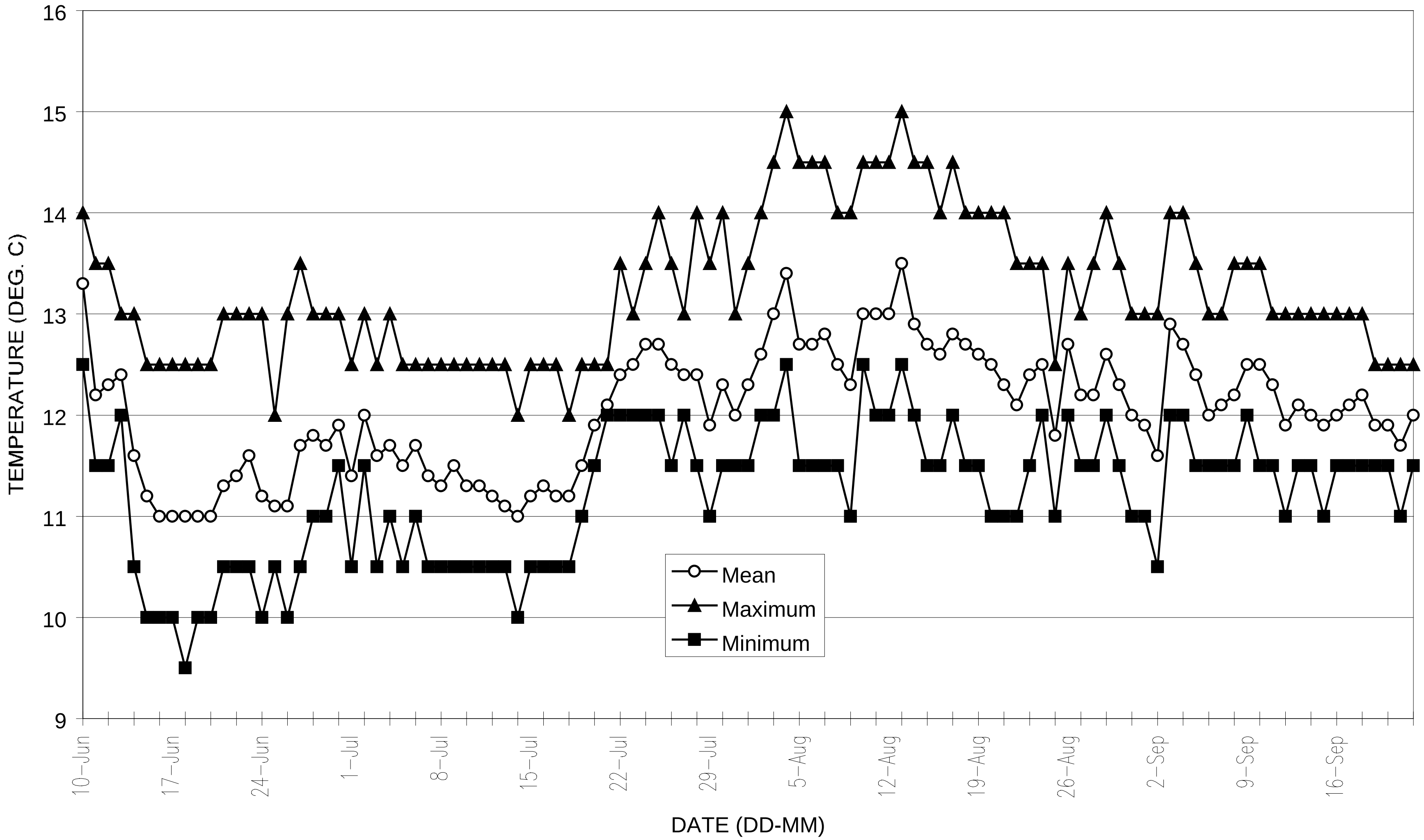


FIGURE 78. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT NAVARRO RIVER (MAP NO. 14; MONITORING SITE NO. 82-3), MENDOCINO CO., CALIFORNIA.

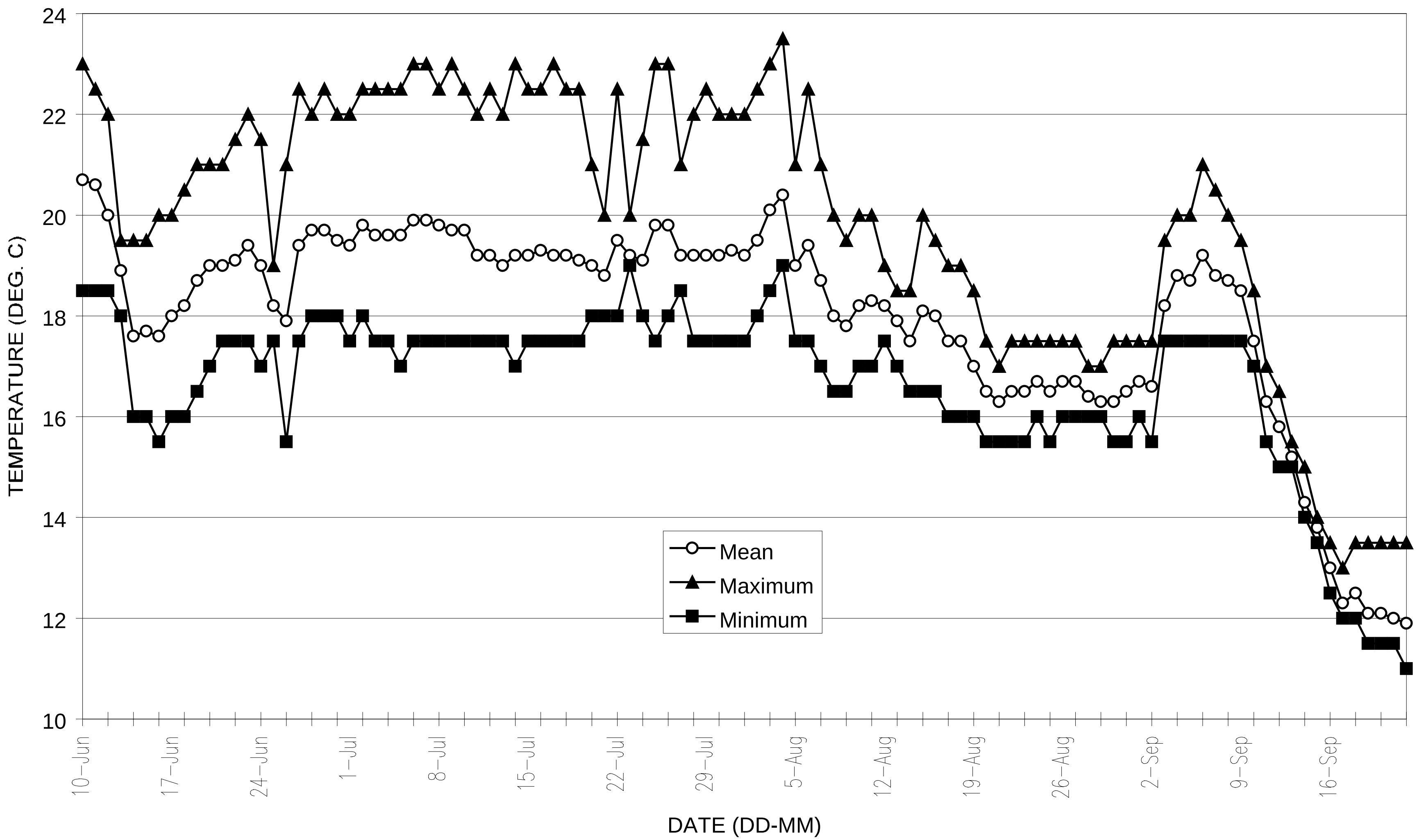


FIGURE 91. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT NAVARRO RIVER (MAP NO. 21; MONITORING SITE NO. 88-1), MENDOCINO CO., CALIFORNIA.

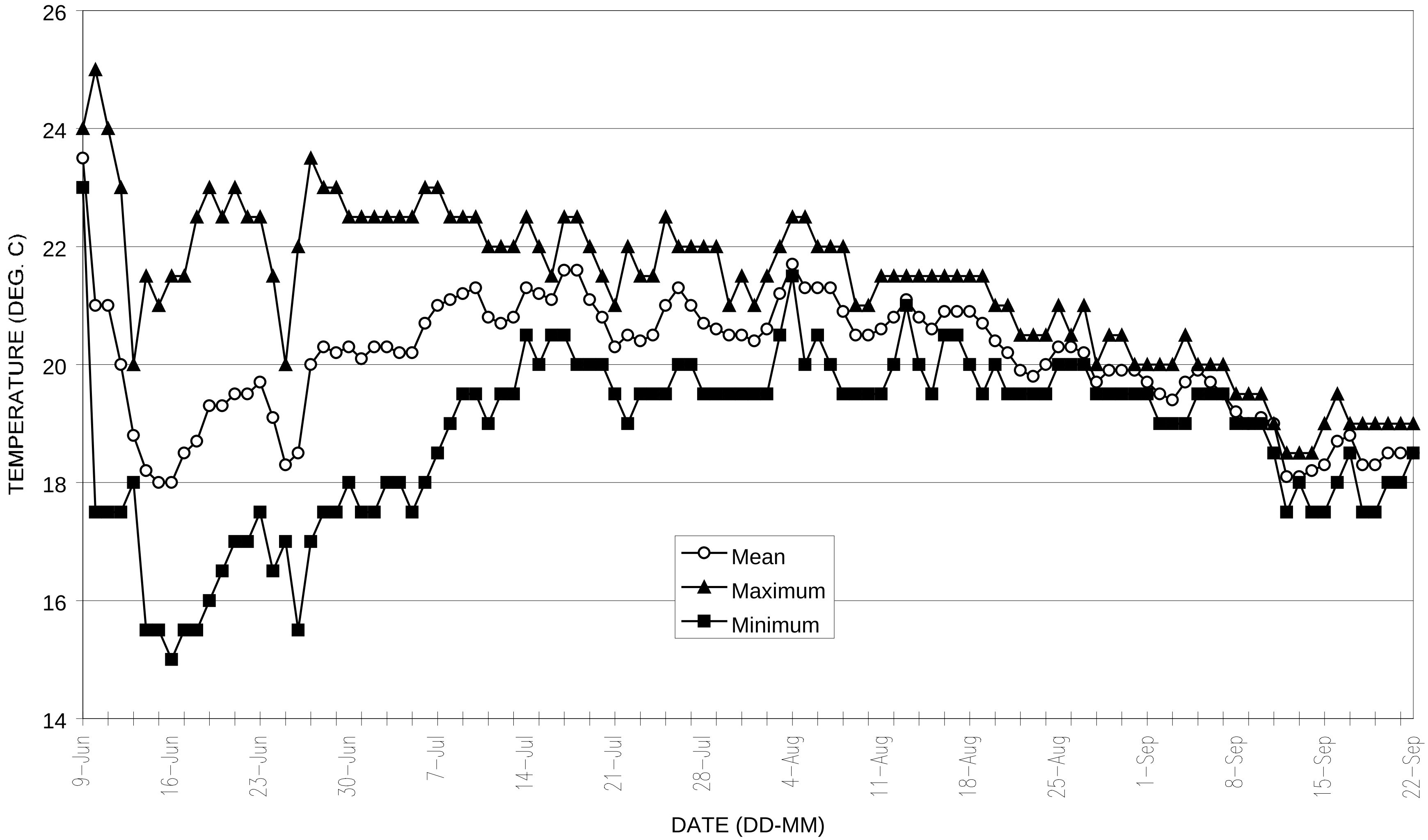


FIGURE 71. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT NORTH BRANCH OF THE NORTH FORK NAVARRO RIVER (MAP NO. 13; MONITORING SITE NO. 81-1), MENDOCINO CO., CALIFORNIA.

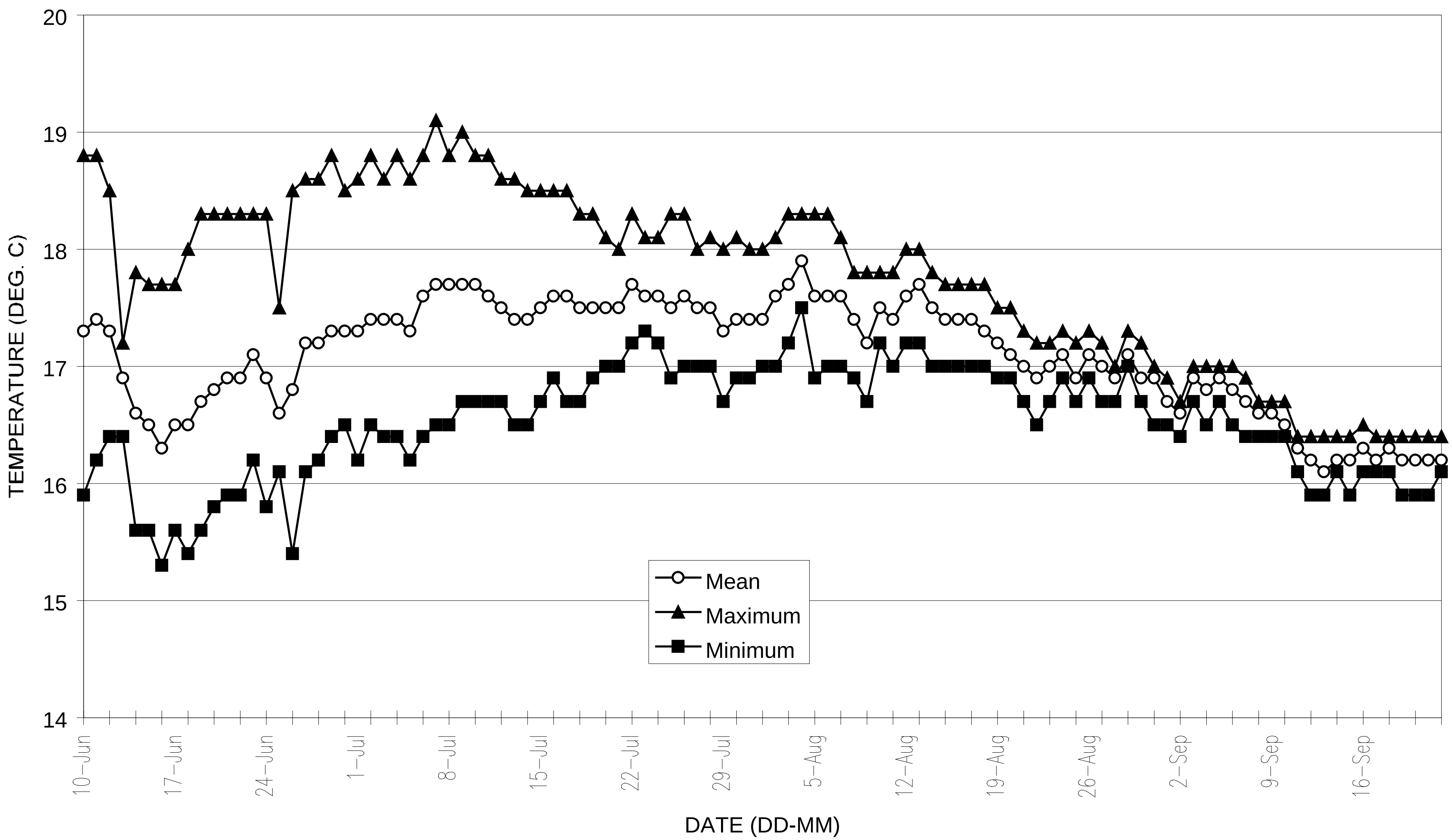


FIGURE 74. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT NORTH BRANCH OF NORTH FORK NAVARRO RIVER (MAP NO. 13; MONITORING SITE NO. 81-3), MENDOCINO CO., CALIFORNIA.

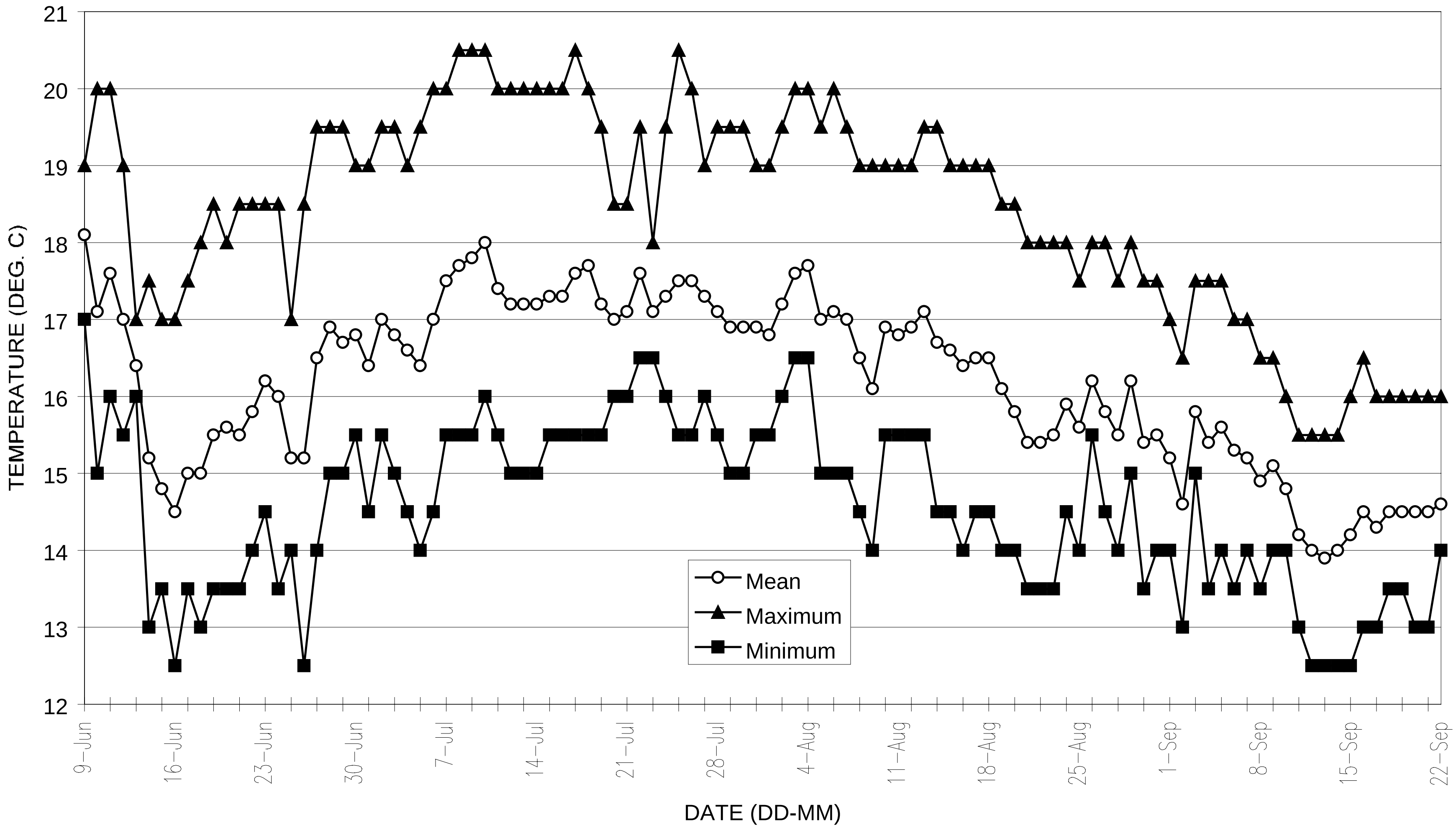


FIGURE 85. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT NORTH FORK INDIAN CREEK (MAP NO. 19; MONITORING SITE NO. 86-1), MENDOCINO CO., CALIFORNIA.

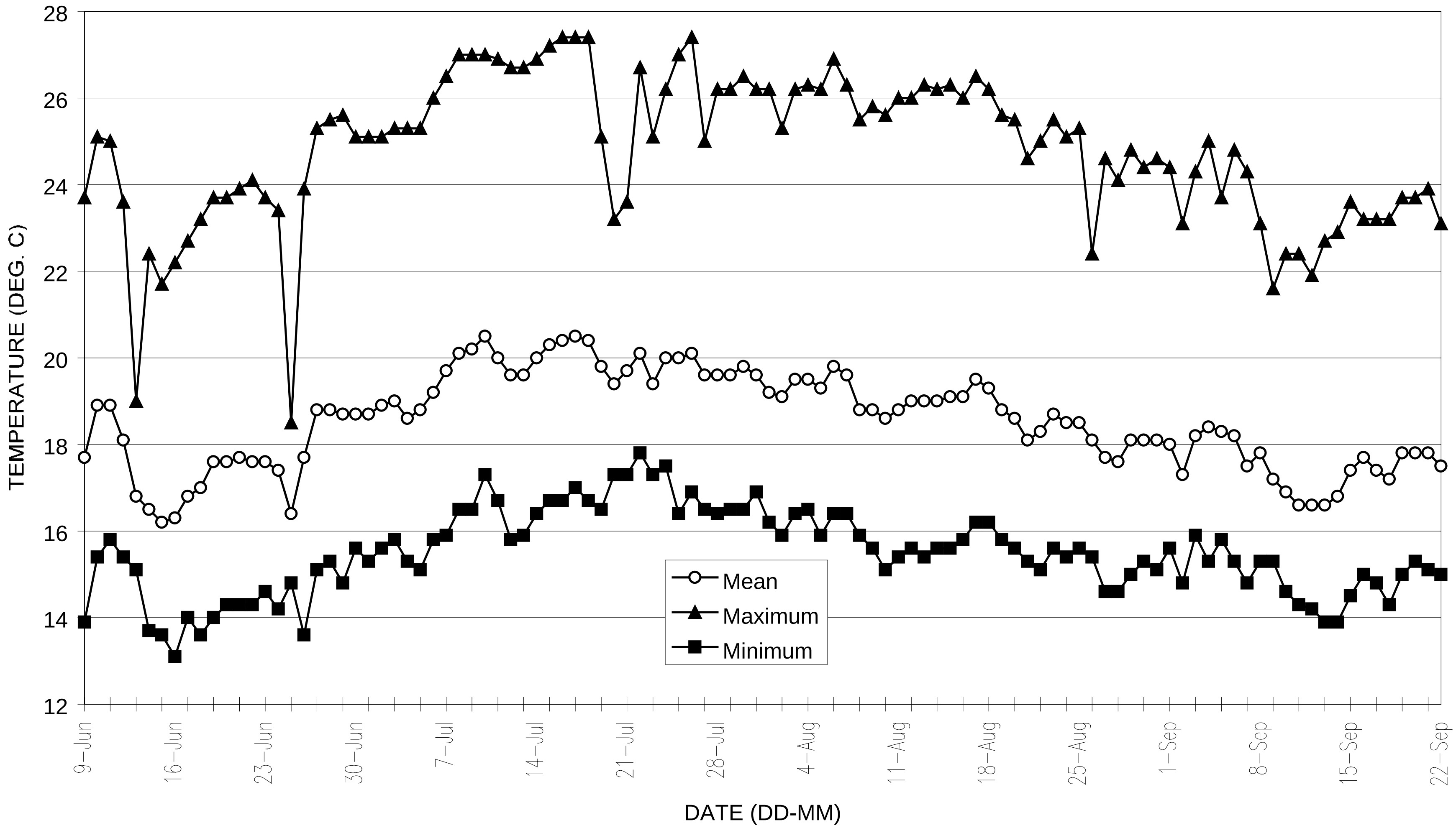


FIGURE 88. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT NORTH FORK INDIAN CREEK (MAP NO. 19; MONITORING SITE NO. 86-2), MENDOCIMO CO., CALIFORNIA.

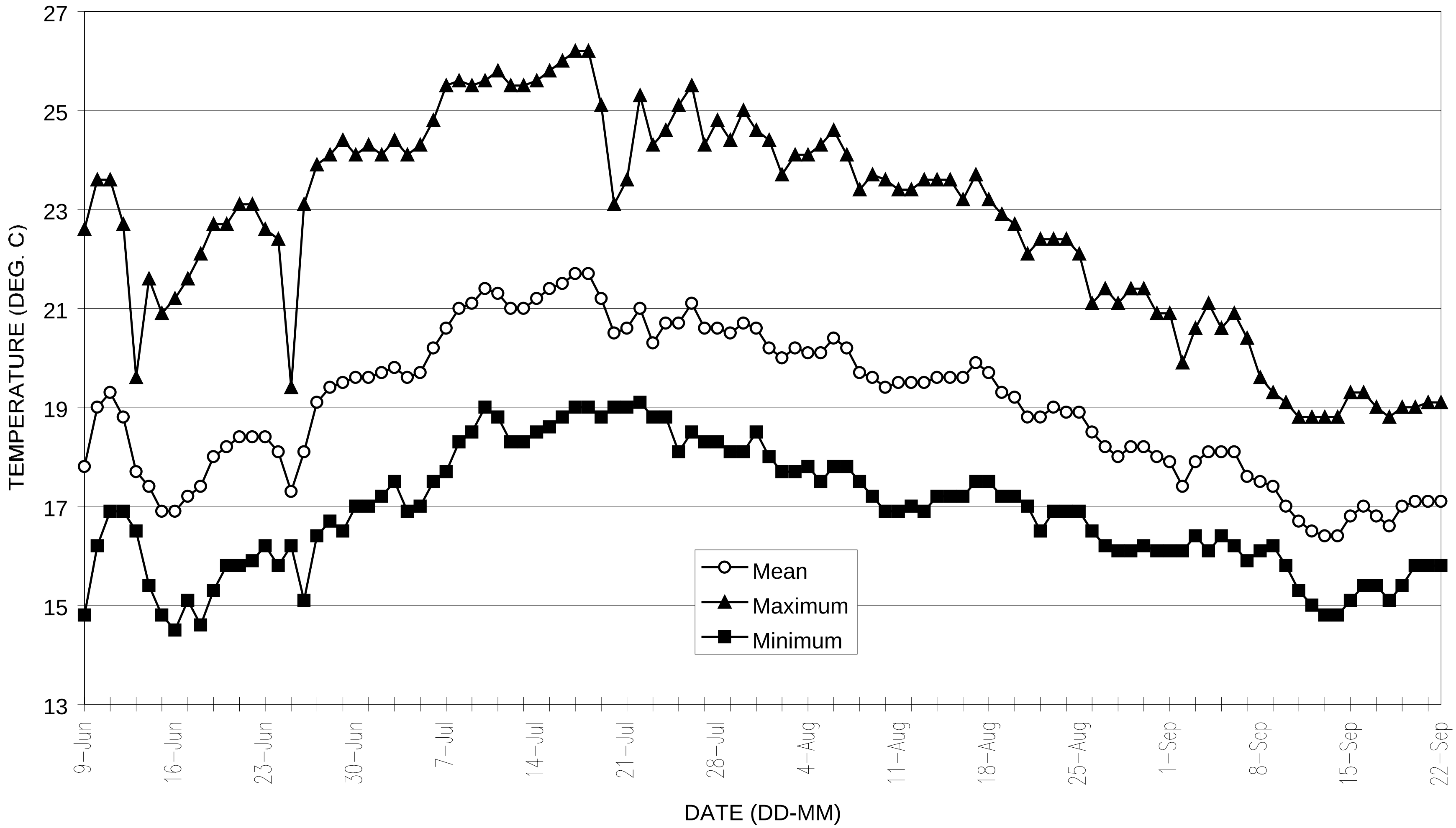


FIGURE 82. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT SOUTH BRANCH OF NORTH FORK NAVARRO RIVER (MAP NO. 15; MONITORING SITE NO. 85-2), MENDOCINO CO., CALIFORNIA.

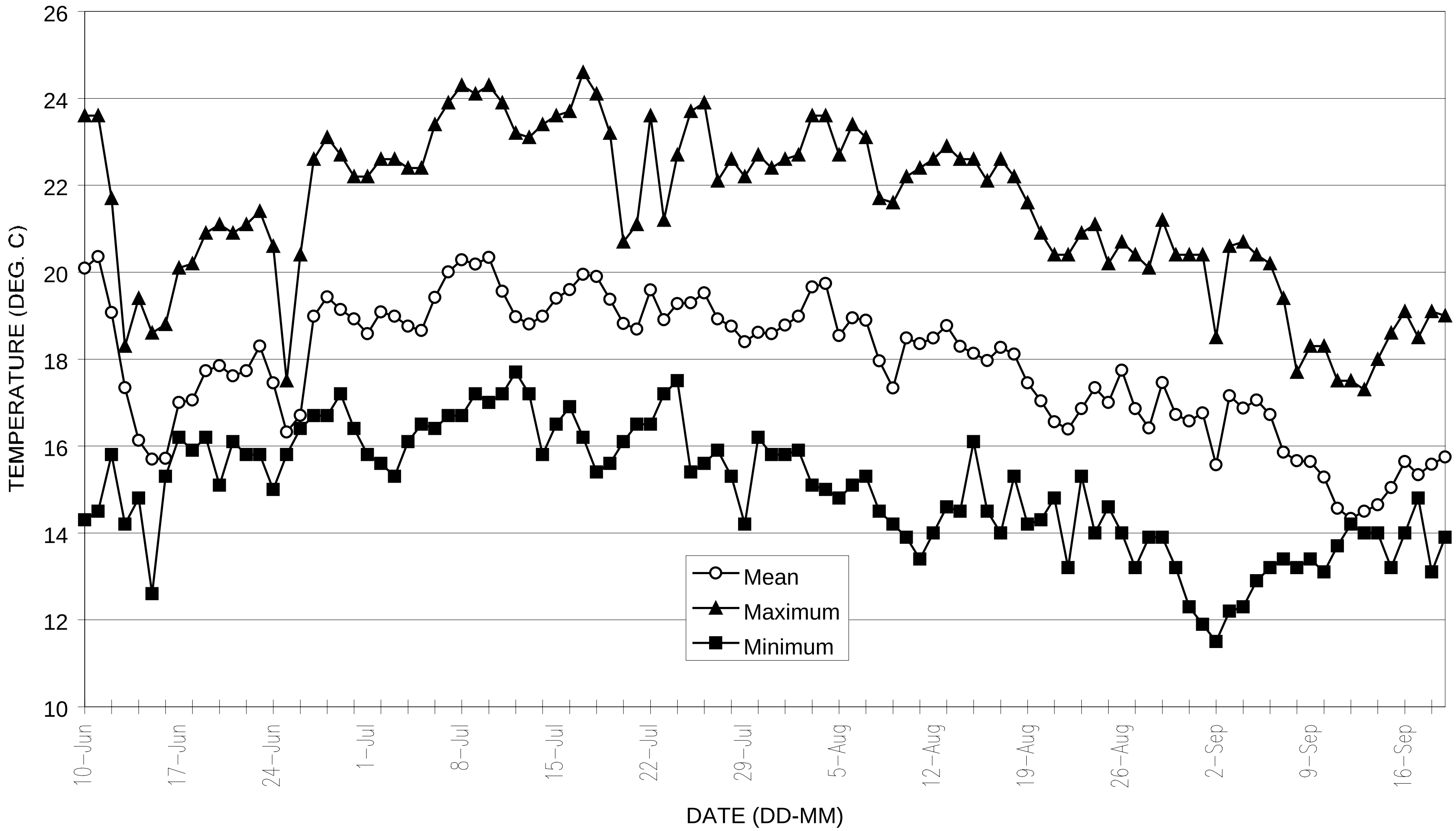


FIGURE 72. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT NORTH BRANCH OF THE NORTH FORK NAVARRO RIVER (MAP NO. 13; MONITORING SITE NO. 81-1) MENDOCINO CO., CALIFORNIA.

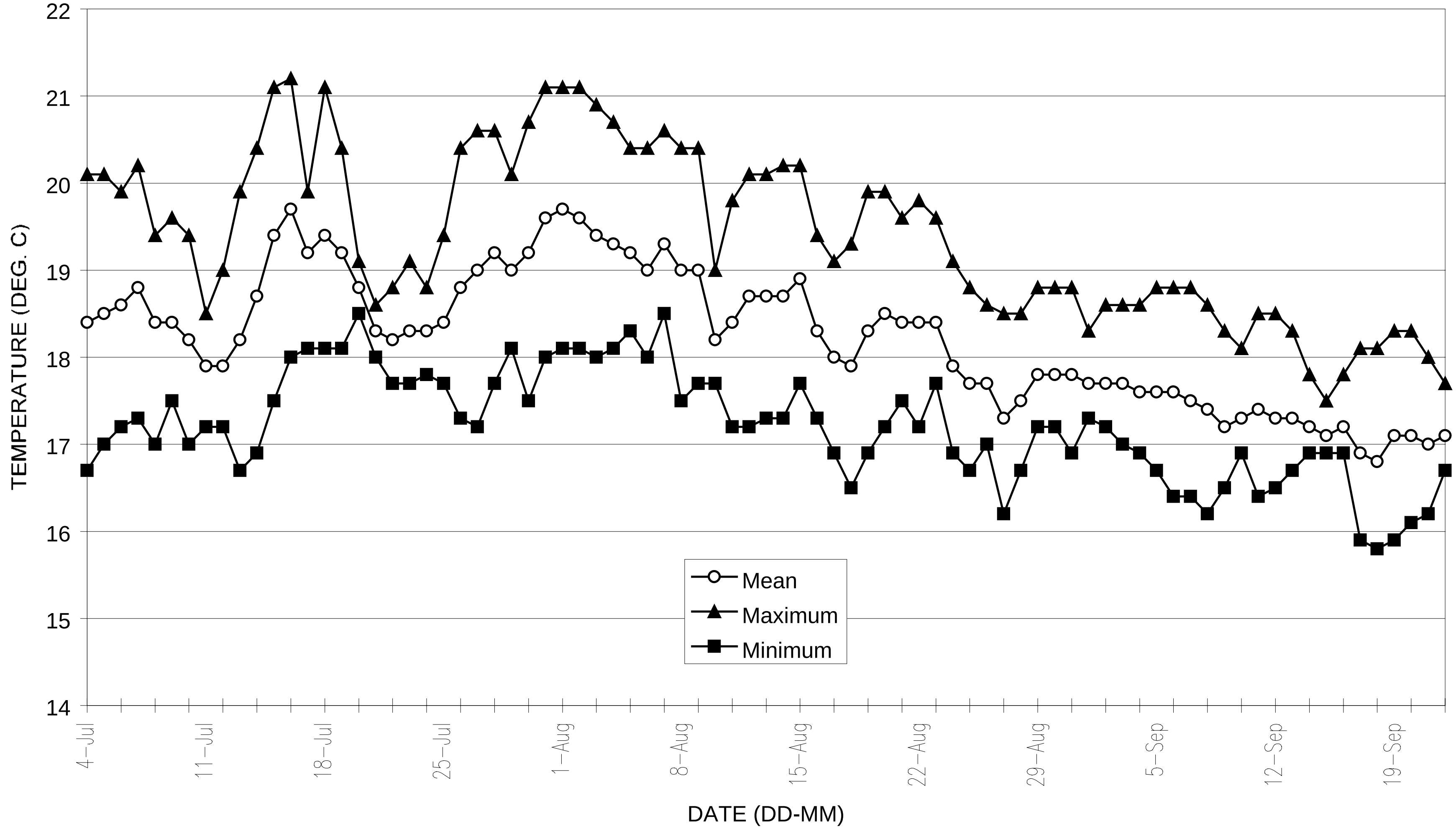


FIGURE 75. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT NORTH BRANCH OF THE NORTH FORK NAVARRO RIVER (MAP NO. 13; MONITORING SITE NO. 81-3), MENDOCINO CO., CALIFORNIA.

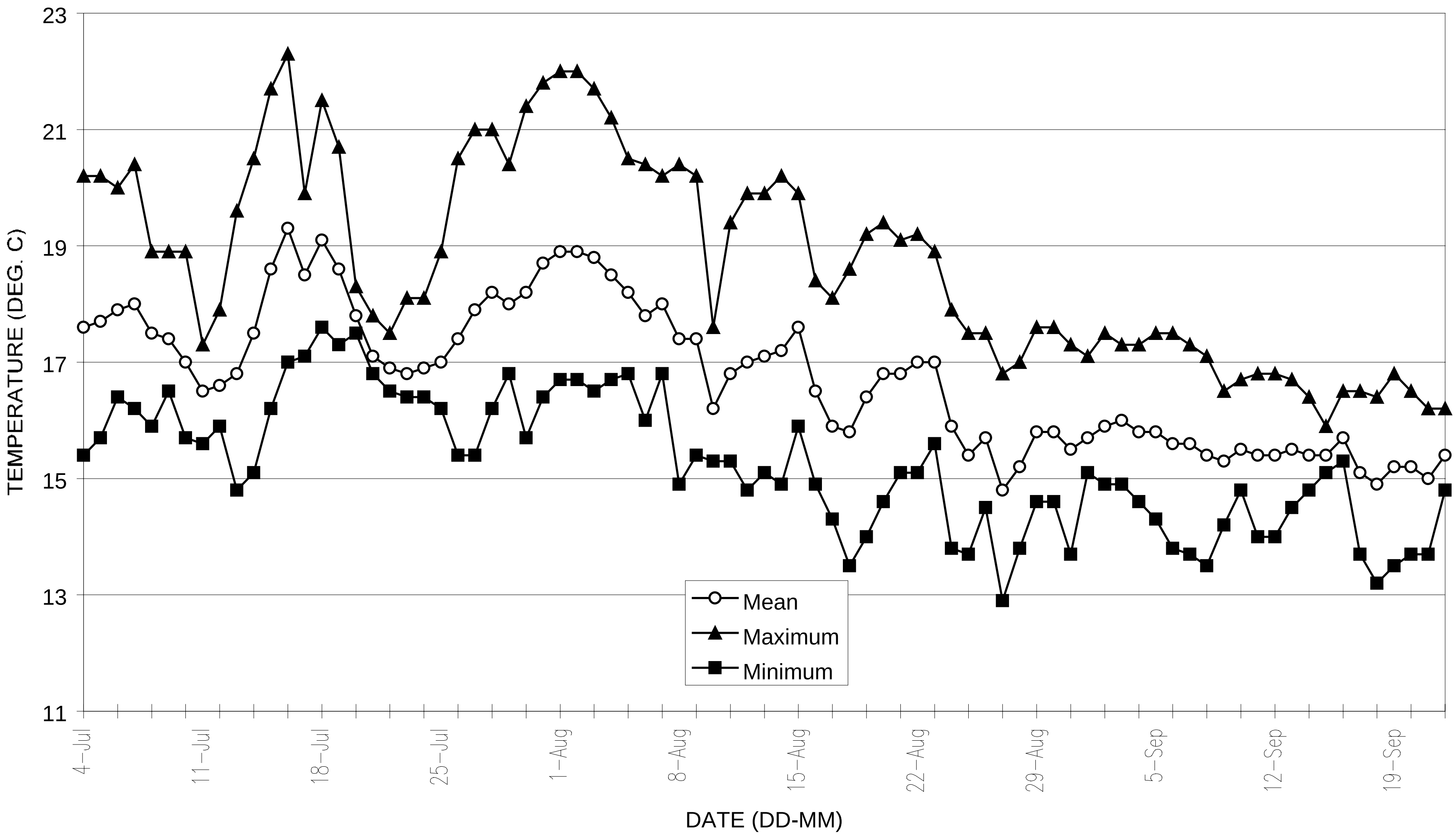


FIGURE 86. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY- SEPTEMBER 1995) AT NORTH FORK INDIAN CREEK (MAP NO. 19; MONITORING SITE NO. 86-1), MENDOCINO CO., CALIFORNIA.

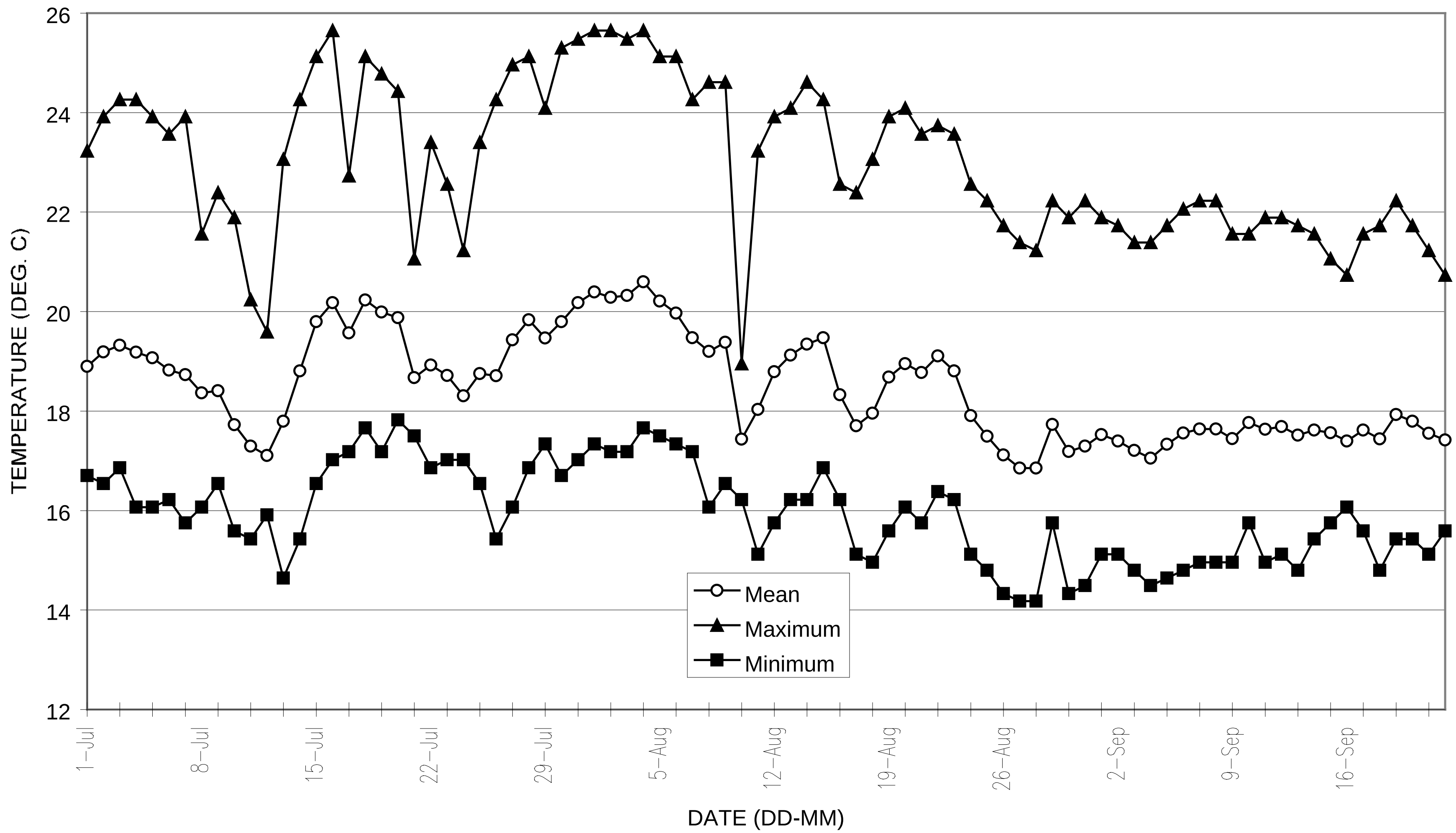


FIGURE 89. MEAN, MAXIMUM AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER(JULY-SEPTEMBER 1995) AT NORTH FORK INDIAN CREEK (MAP NO. 19; MONITORING SITE NO. 86-2), MENDOCINO CO., CALIFORNIA.

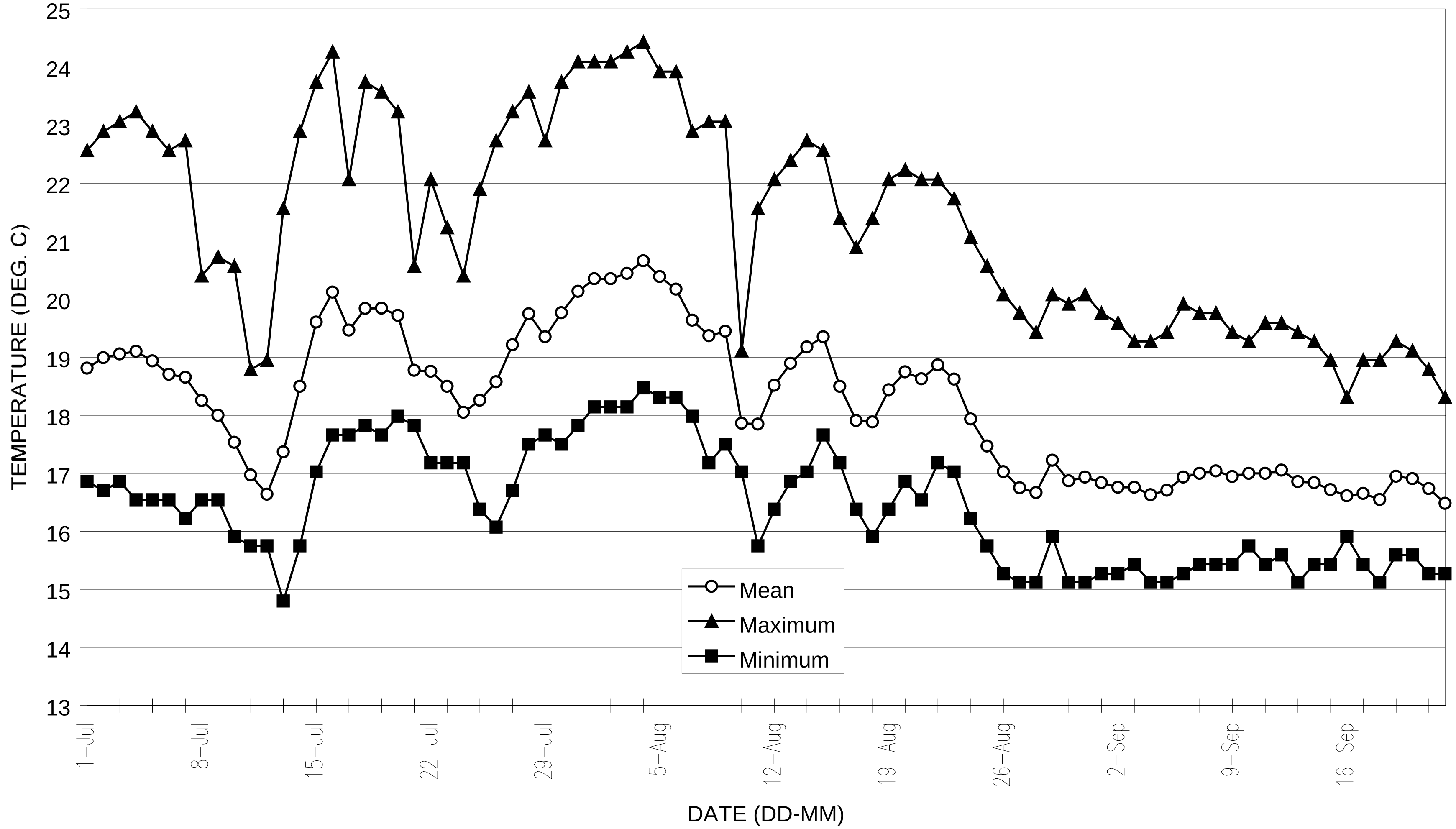


FIGURE 80. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY- SEPTEMBER 1995) AT SOUTH BRANCH OF THE NORTH FORK NAVARRO RIVER (MAP NO. 15; MONITORING SITE NO. 85-1), MENDOCINO CO., CALIFORNIA.

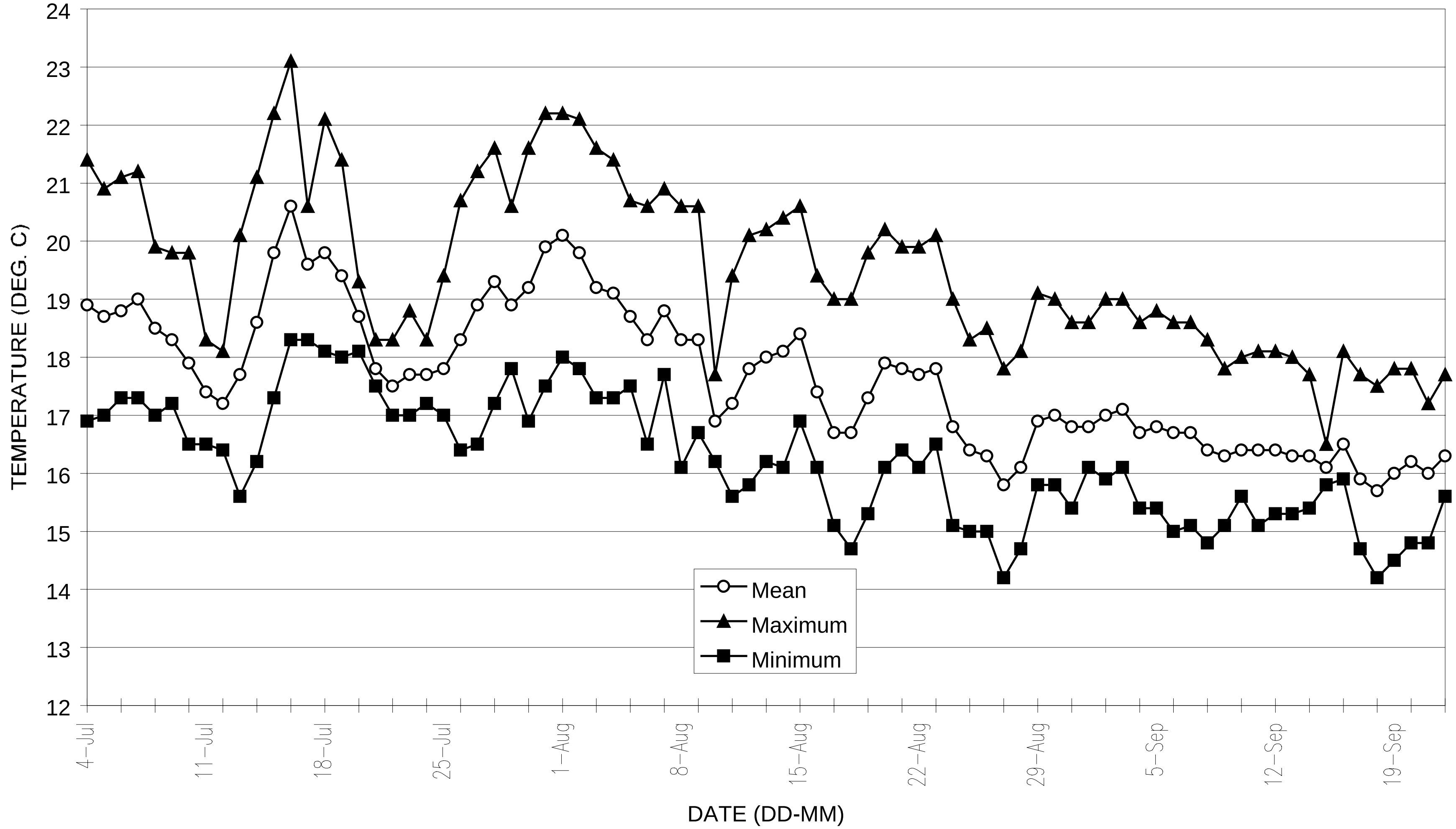


FIGURE 83. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT SOUTH BRANCH OF THE NORTH FORK NAVARRO RIVER (MAP NO. 15; MONITORING SITE NO. 85-2), MENDOCINO CO., CALIFORNIA.

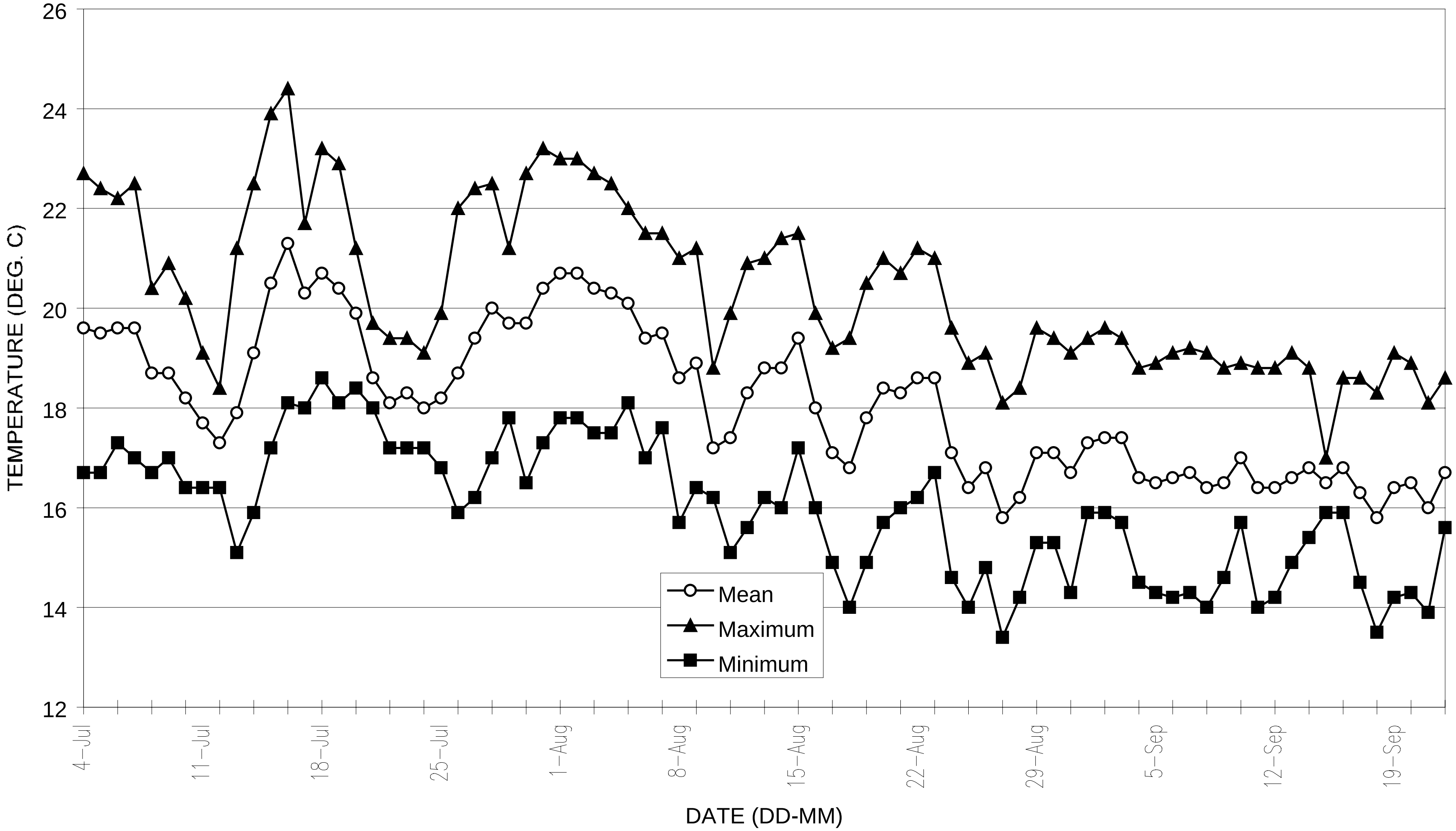


FIGURE 87. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT NORTH FORK INDIAN CREEK (MAP NO. 19; MONITORING SITE NO. 86-1), MENDOCINO CO., CALIFORNIA.

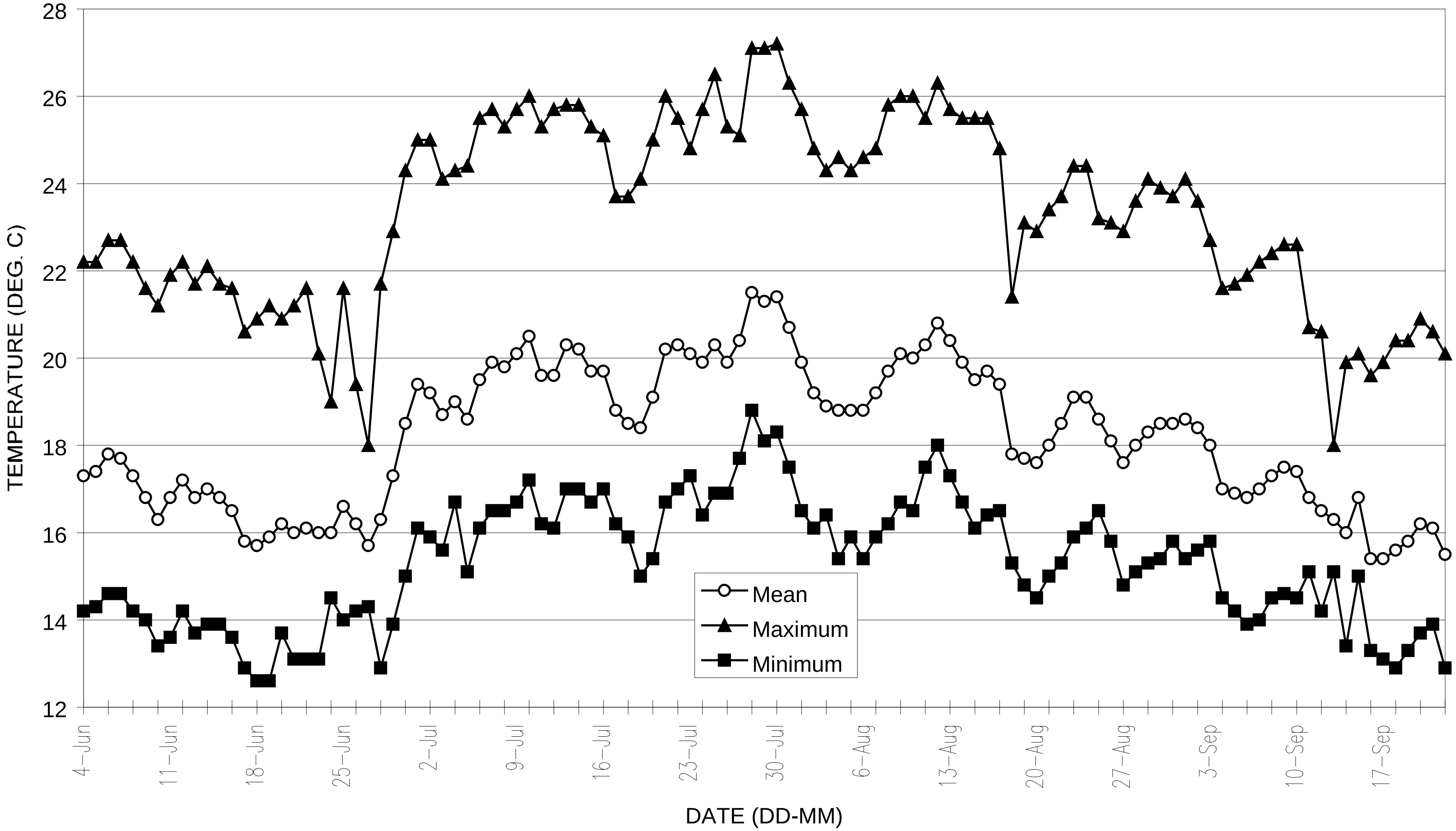


FIGURE 90. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT NORTH FORK INDIAN CREEK (MAP NO. 19; MONITORING SITE NO. 86-2), MENDOCINO CO., CALIFORNIA.

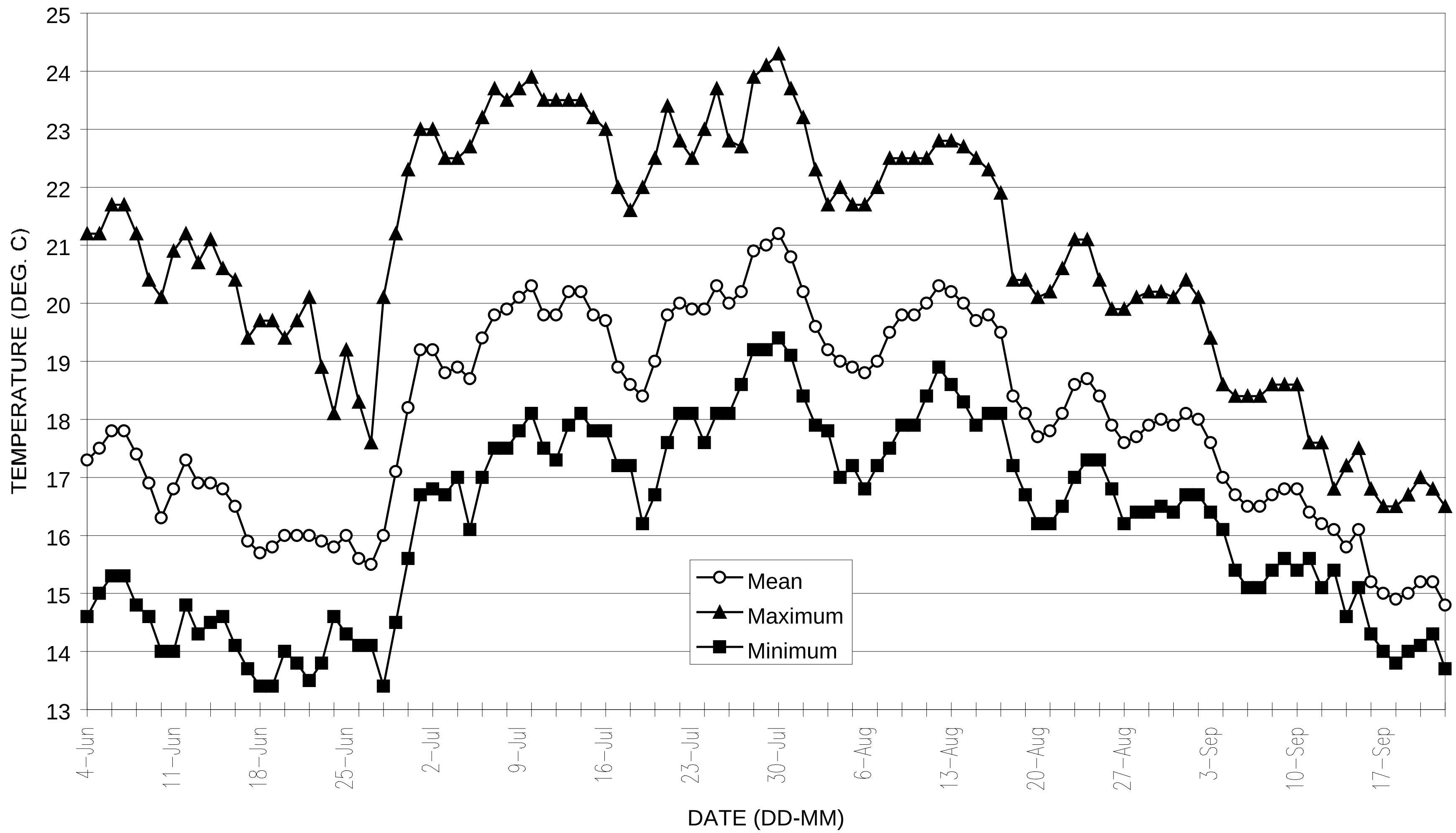


FIGURE 81. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (MAY-SEPTEMBER 1996) AT SOUTH BRANCH OF NORTH FORK NAVARRO RIVER (MAP NO. 15; MONITORING SITE NO. 85-1), MENDOCINO CO., CALIFORNIA.

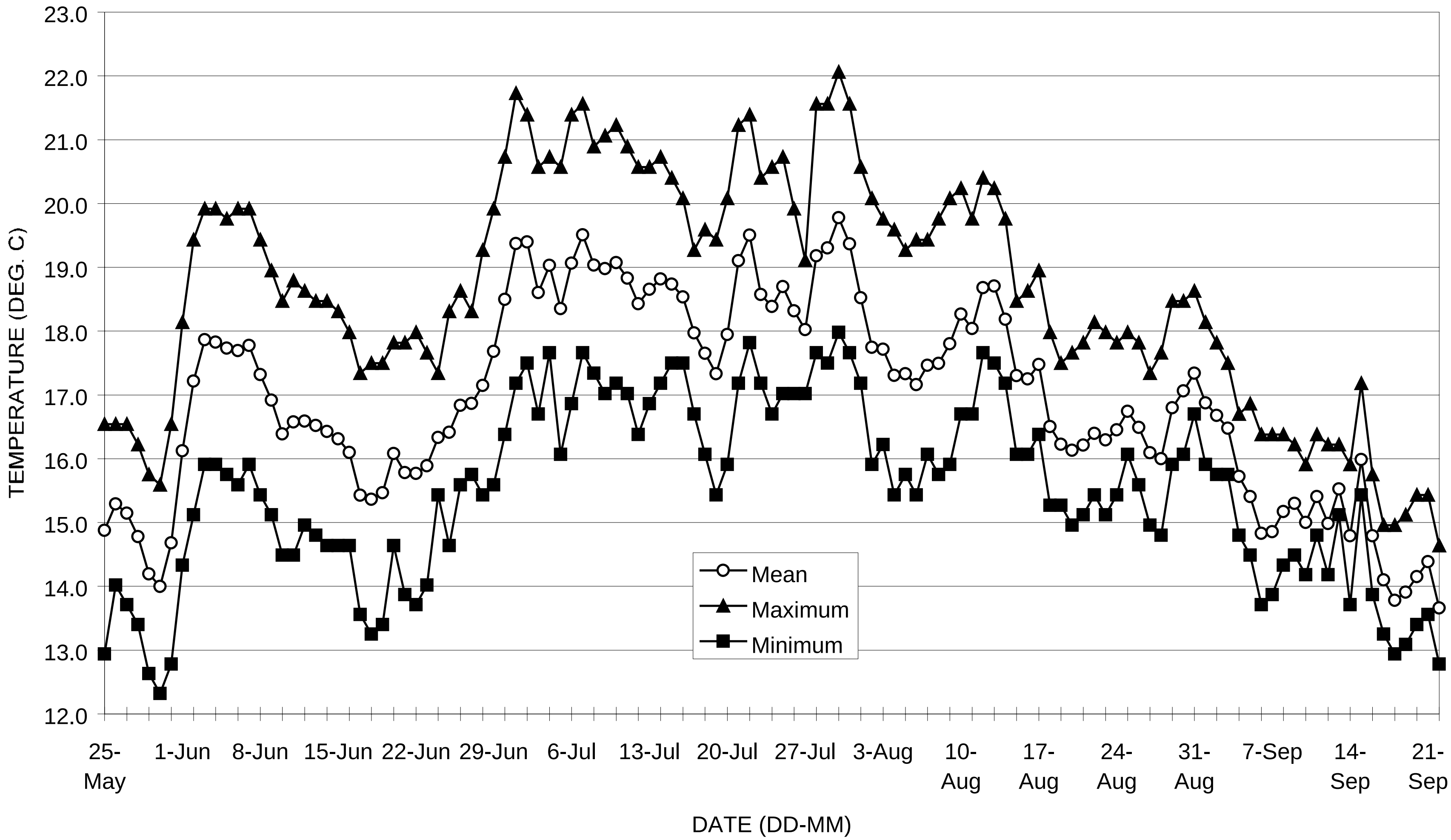


FIGURE 84. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (MAY-SEPTEMBER 1996) AT SOUTH BRANCH OF NORTH FORK NAVARRO RIVER (MAP NO. 15; MONITORING SITE NO. 85-2), MENDOCINO CO., CALIFORNIA.

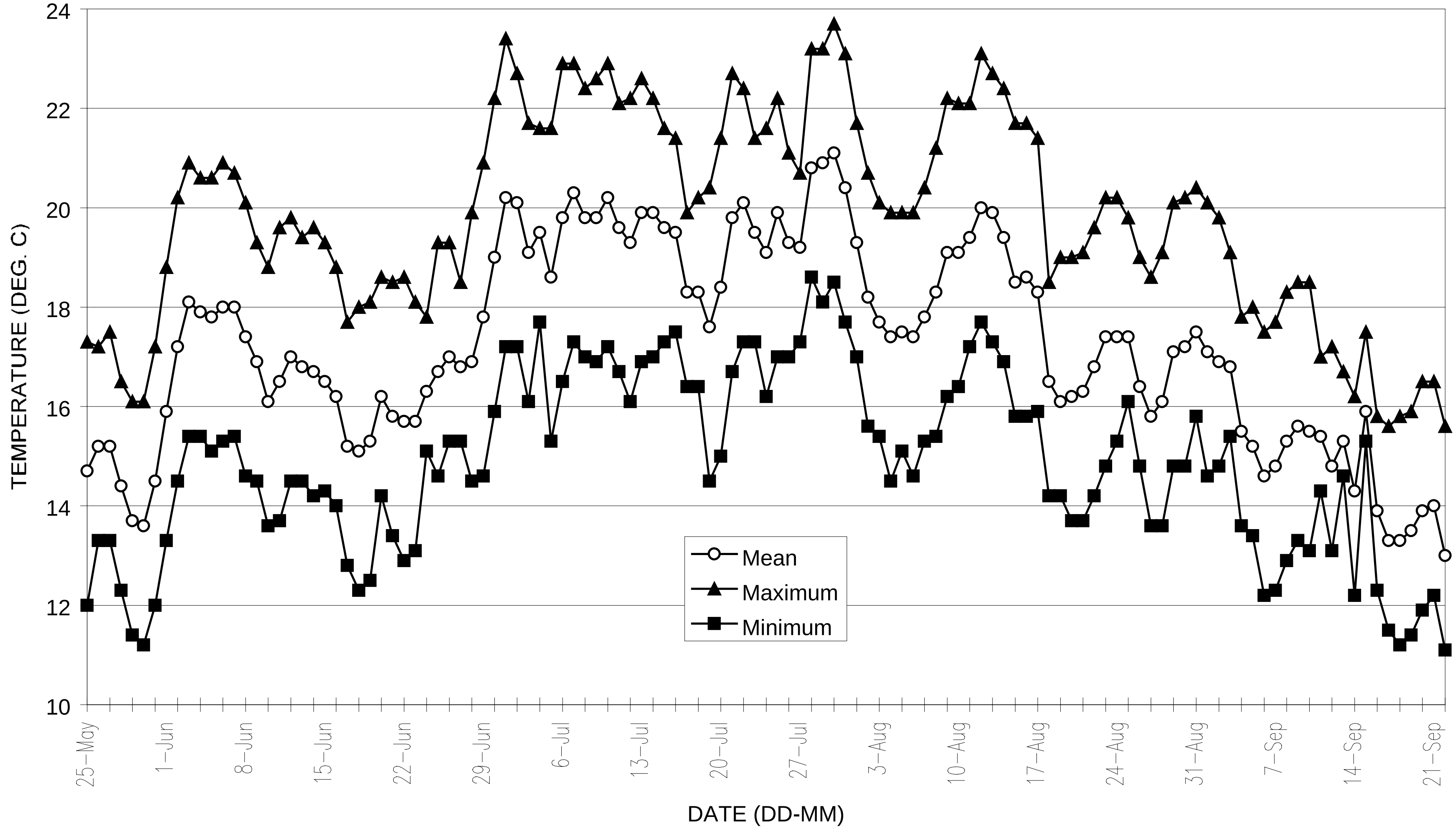


Figure 90. Mean and Maximum Daily Stream Temperatures During Summer 1997 at John Smith Creek (Site 81-2), Mendocino County, California.

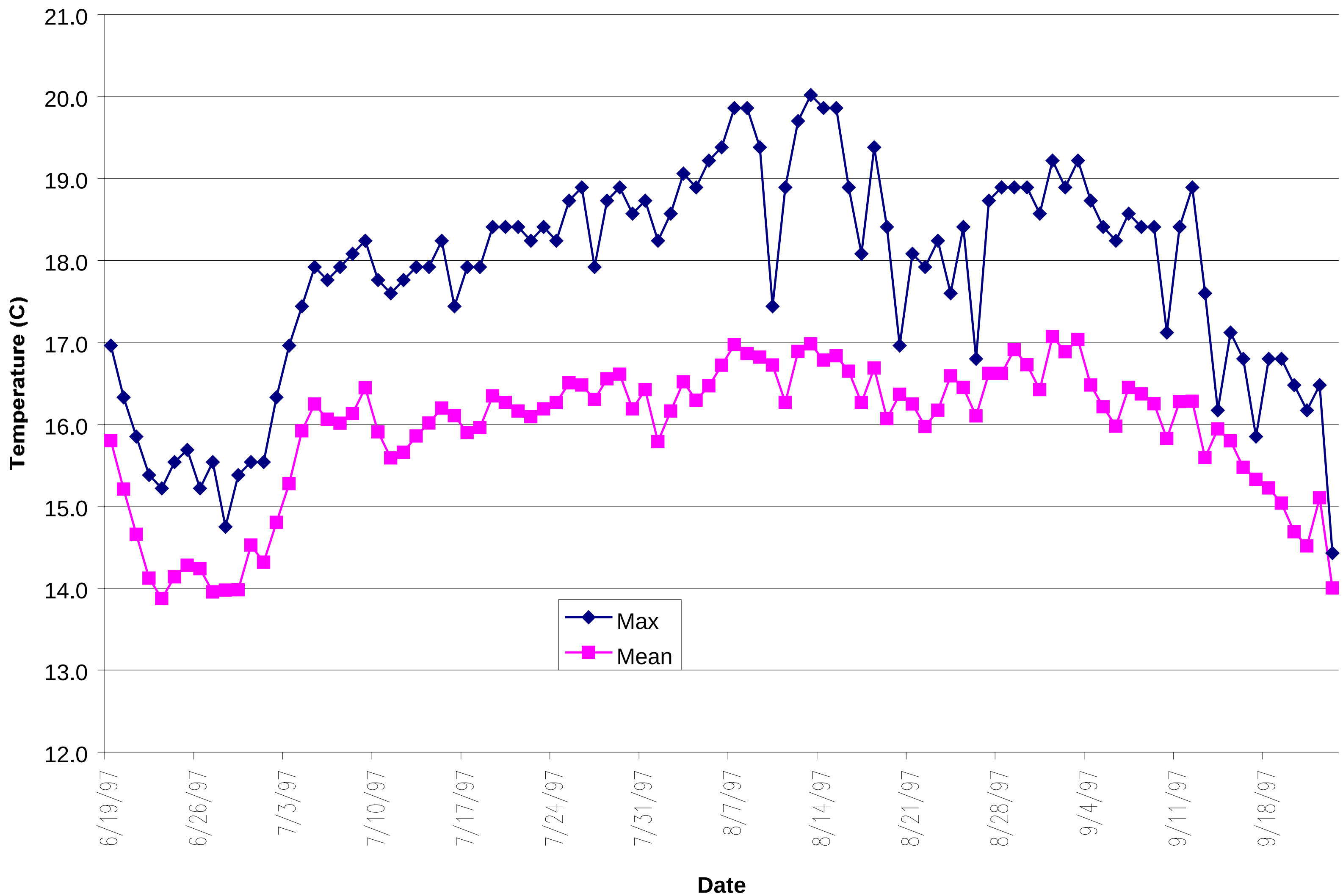


Figure 97. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Flynn Creek (Site 82-2), Mendocino County, California.

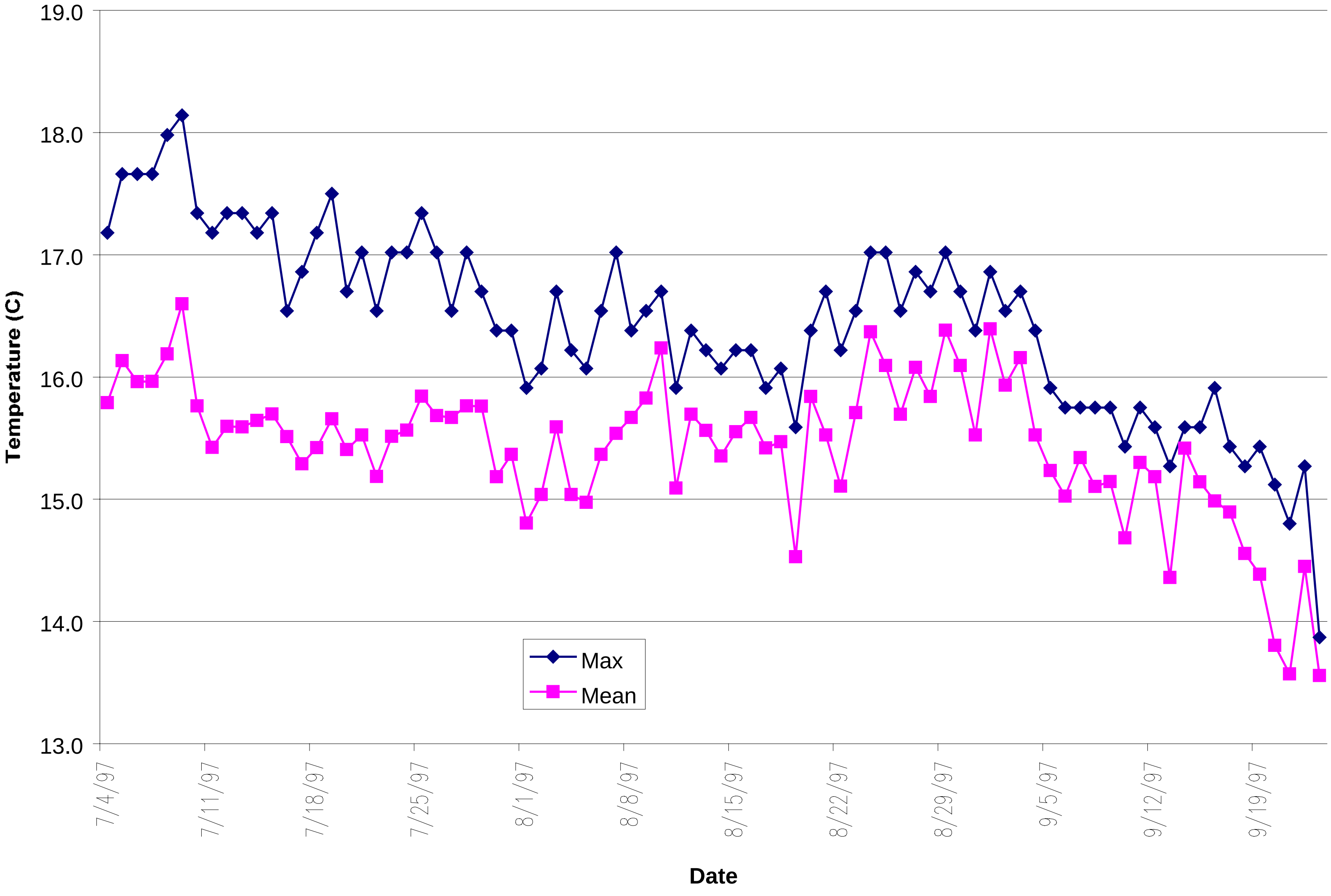


Figure 88. Mean and Maximum Daily Stream Temperatures During Summer 1999 at North Branch North Fork Navarro River (Site 81-1), Mendocino County, California.

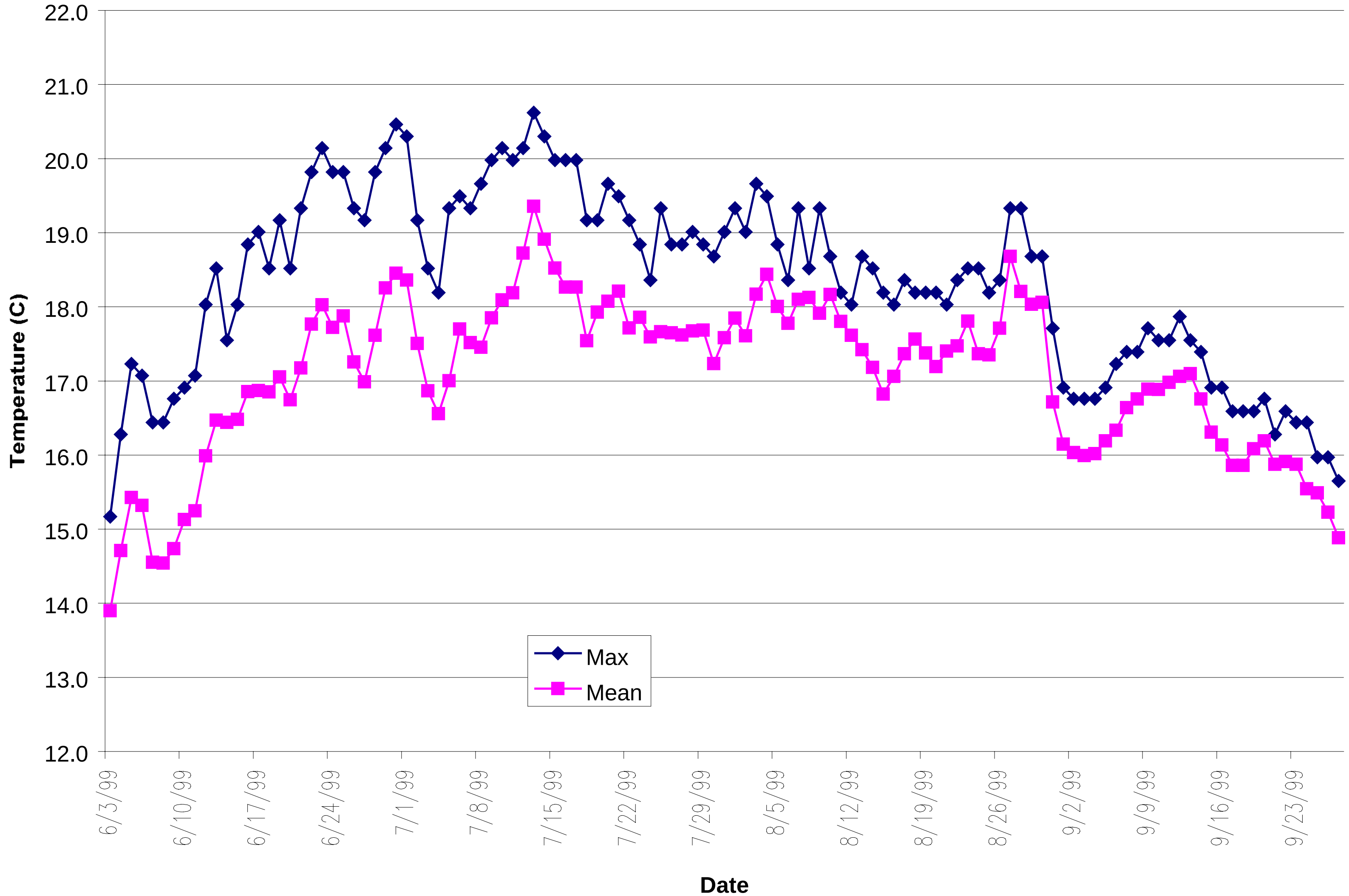


Figure 91. Mean and Maximum Daily Stream Temperatures During Summer 1999 at John Smith Creek (Site 81-2), Mendocino County, California.

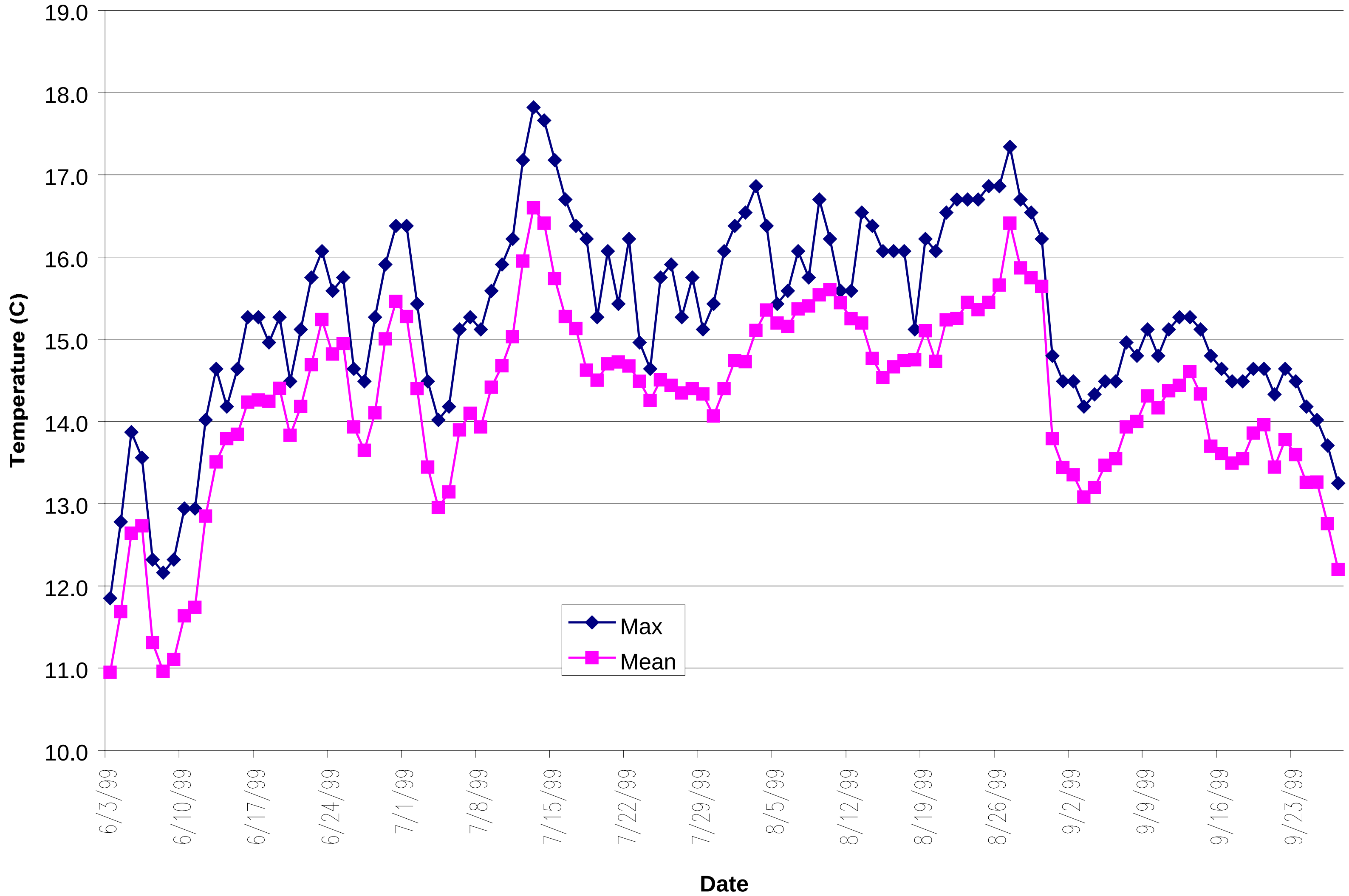


Figure 93. Mean and Maximum Daily Stream Temperatures During Summer 1999 at North Branch North Fork Navarro River (Site 81-3), Mendocino County, California.

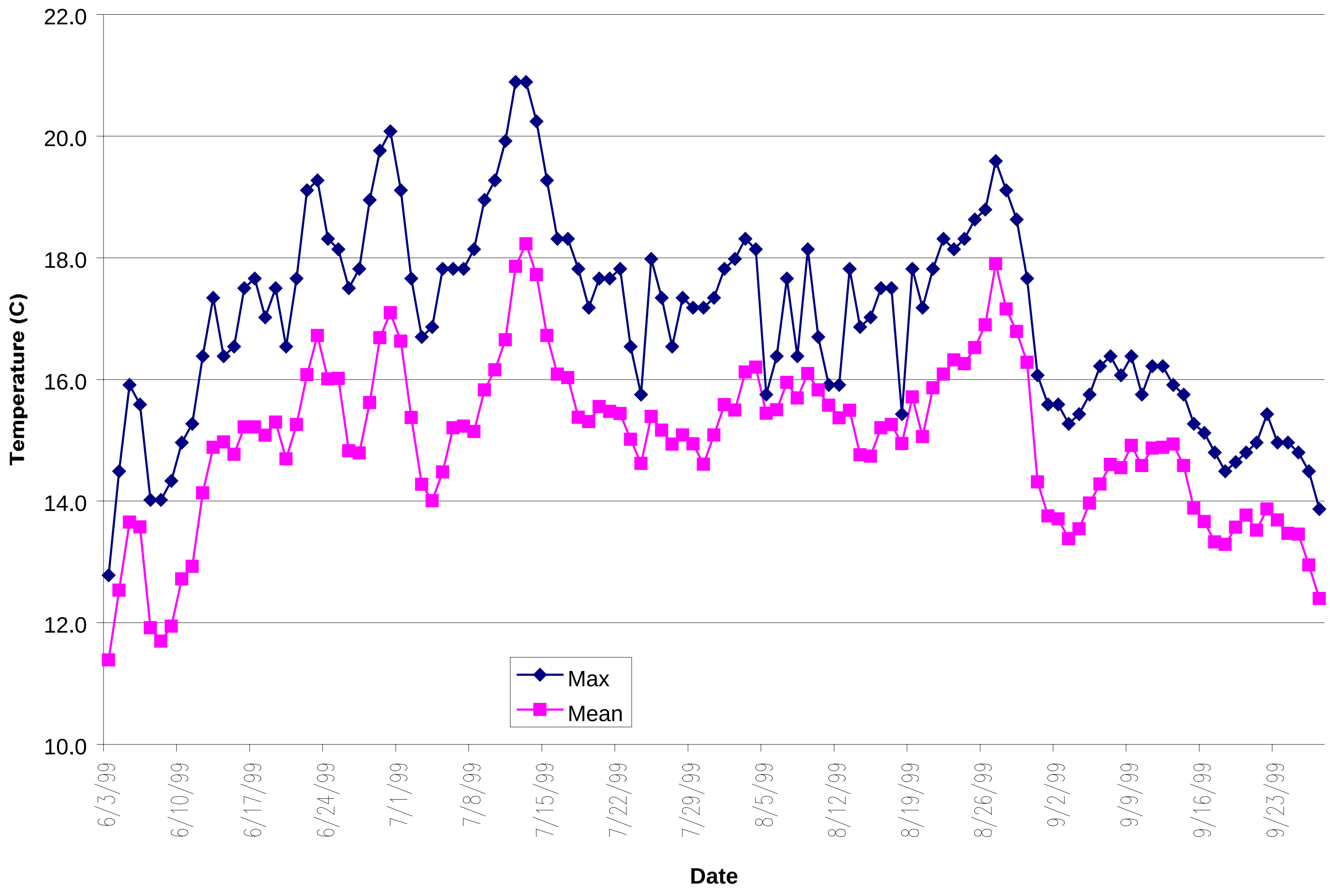


Figure 95. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Marsh Gulch (Site 82-1), Mendocino County, California.

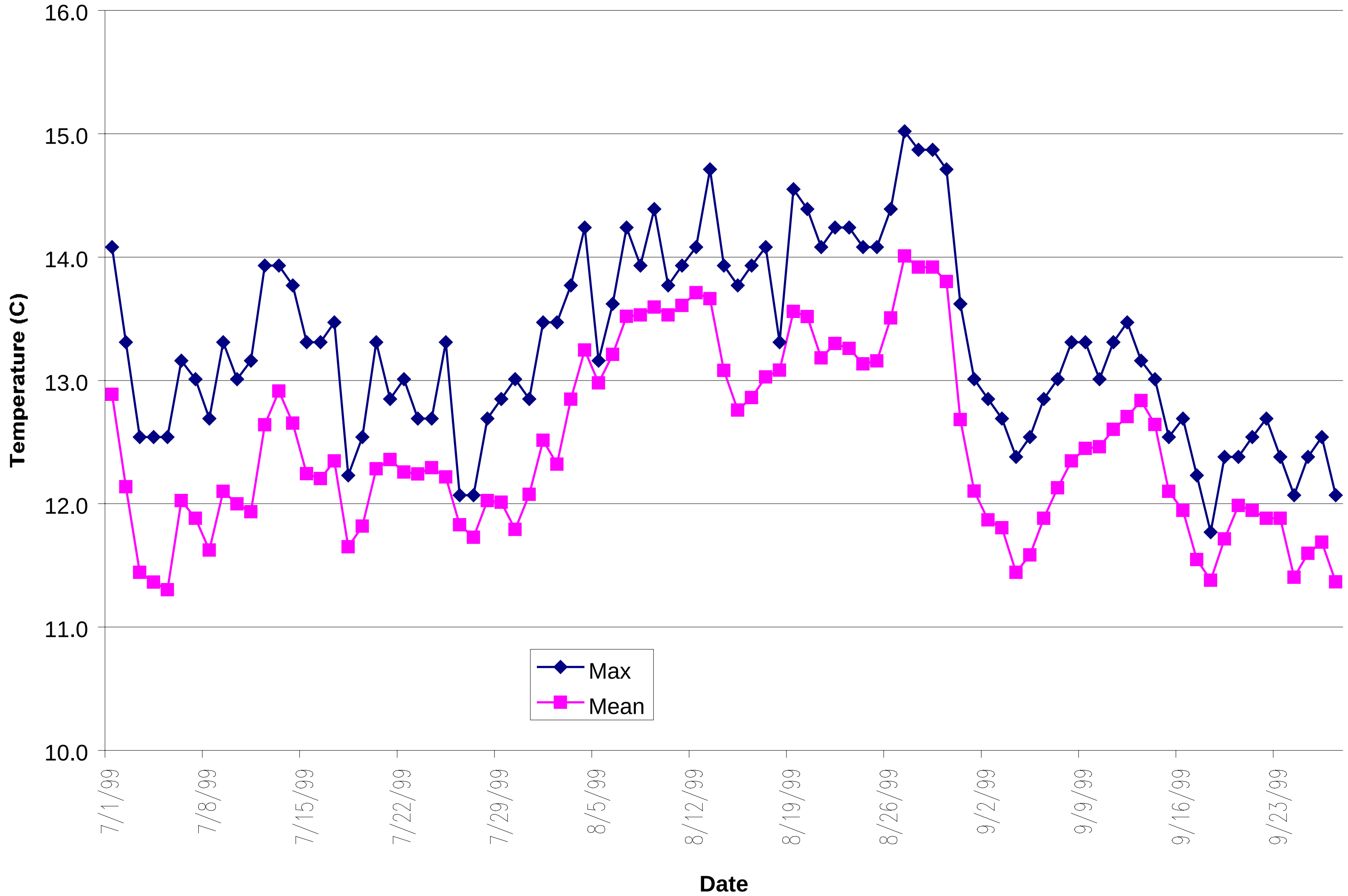


Figure 98. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Flynn Creek (Site 82-2), Mendocino County, California.

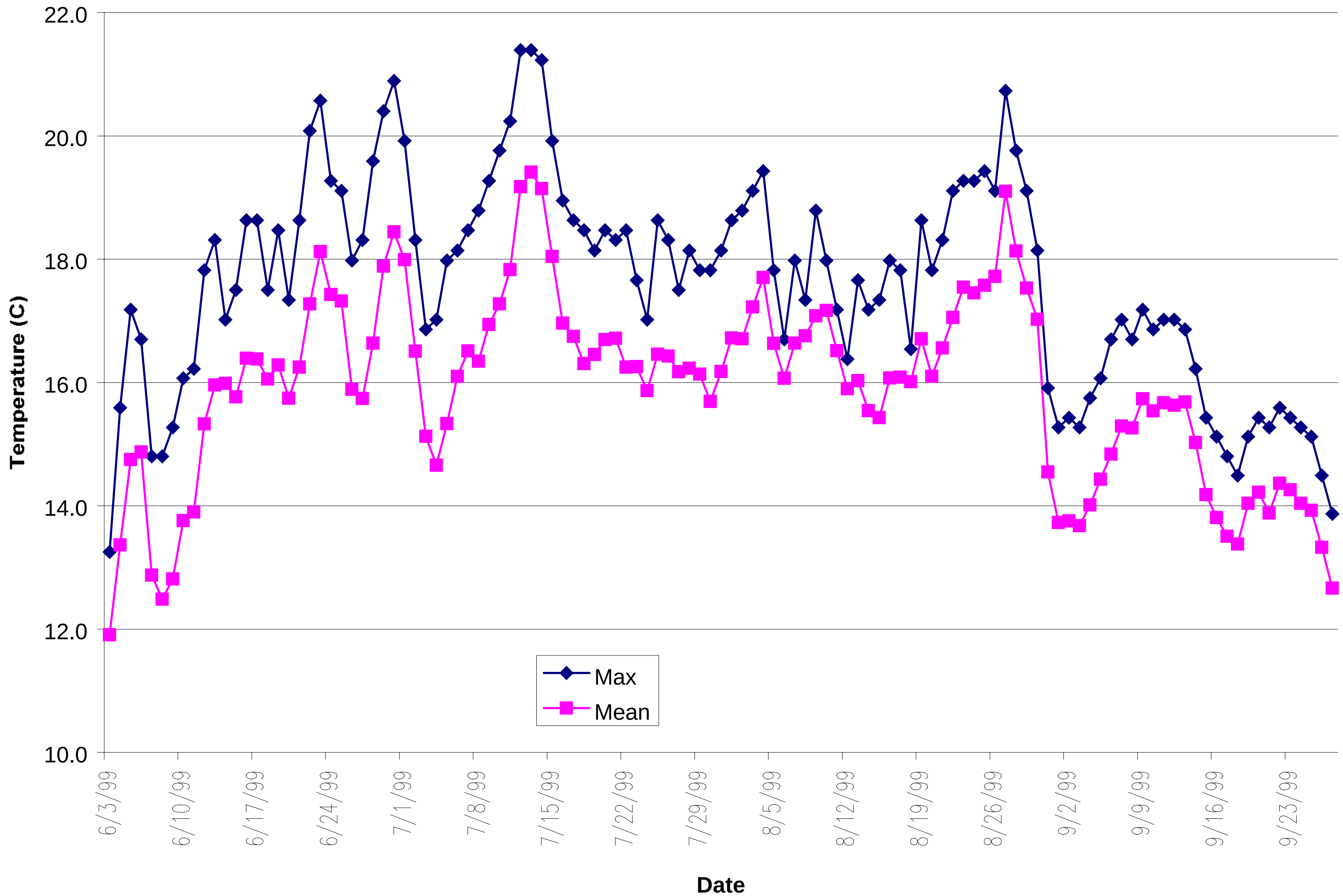


Figure 100. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Navarro River (Site 82-3), Mendocino County, California.

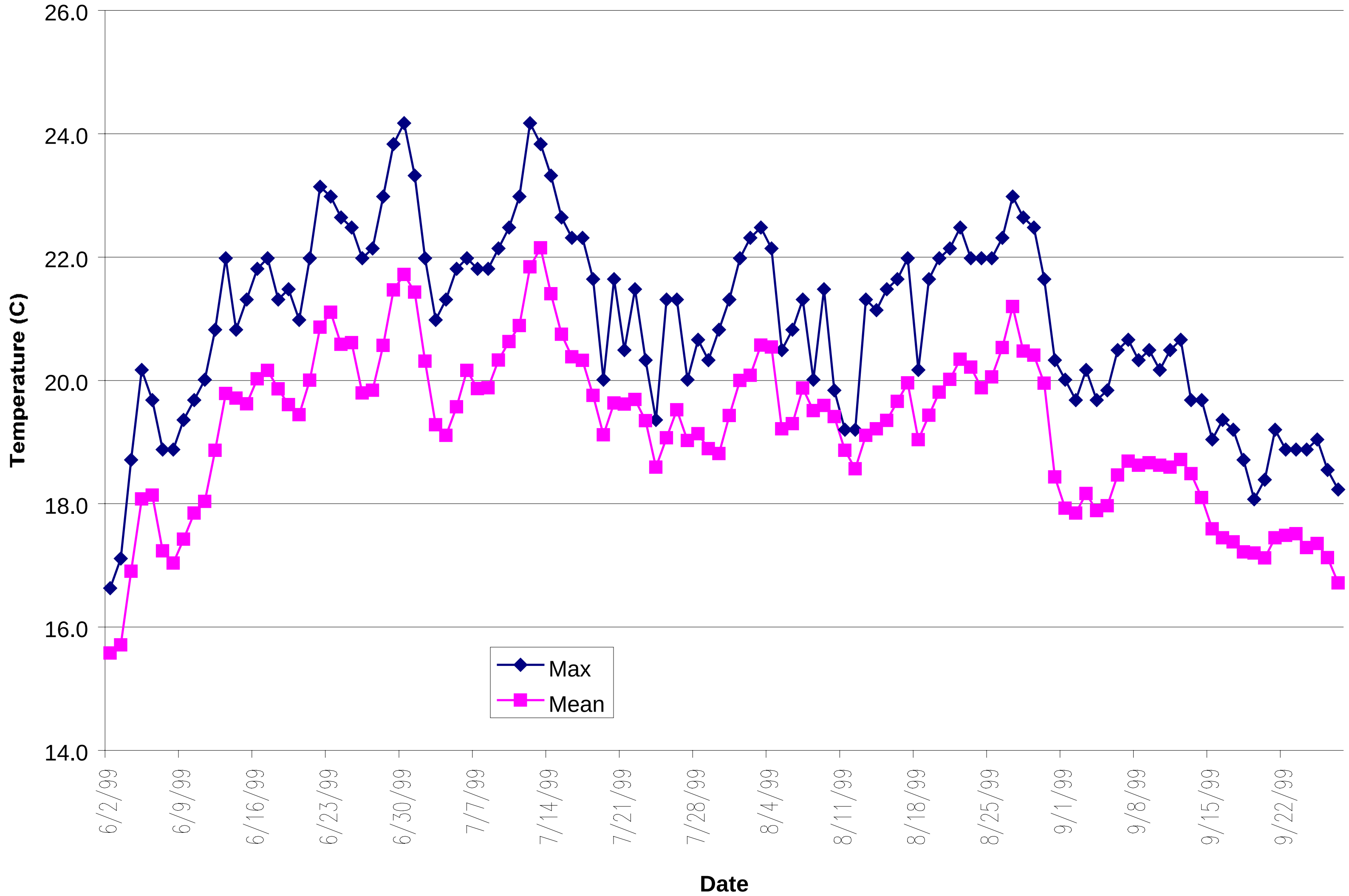


Figure 104. Mean and Maximum Daily Stream Temperatures During Summer 1999 at South Branch South Fork Navarro River (Site 85-2), Mendocino County, California.

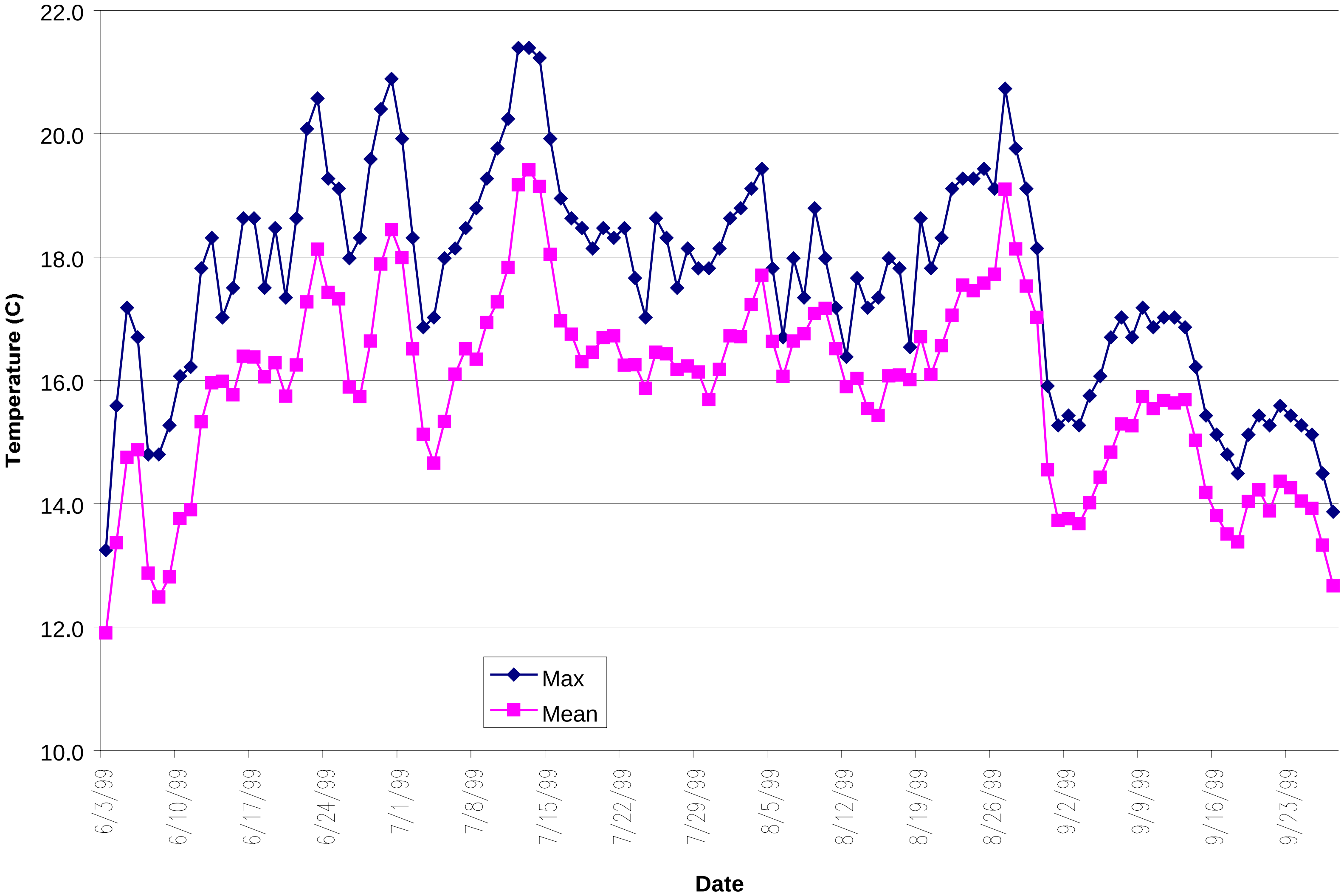


Figure 102. Mean and Maximum Daily Stream Temperatures During Summer 1999 at South Branch South Fork Navarro River (Site 85-1), Mendocino County, California.

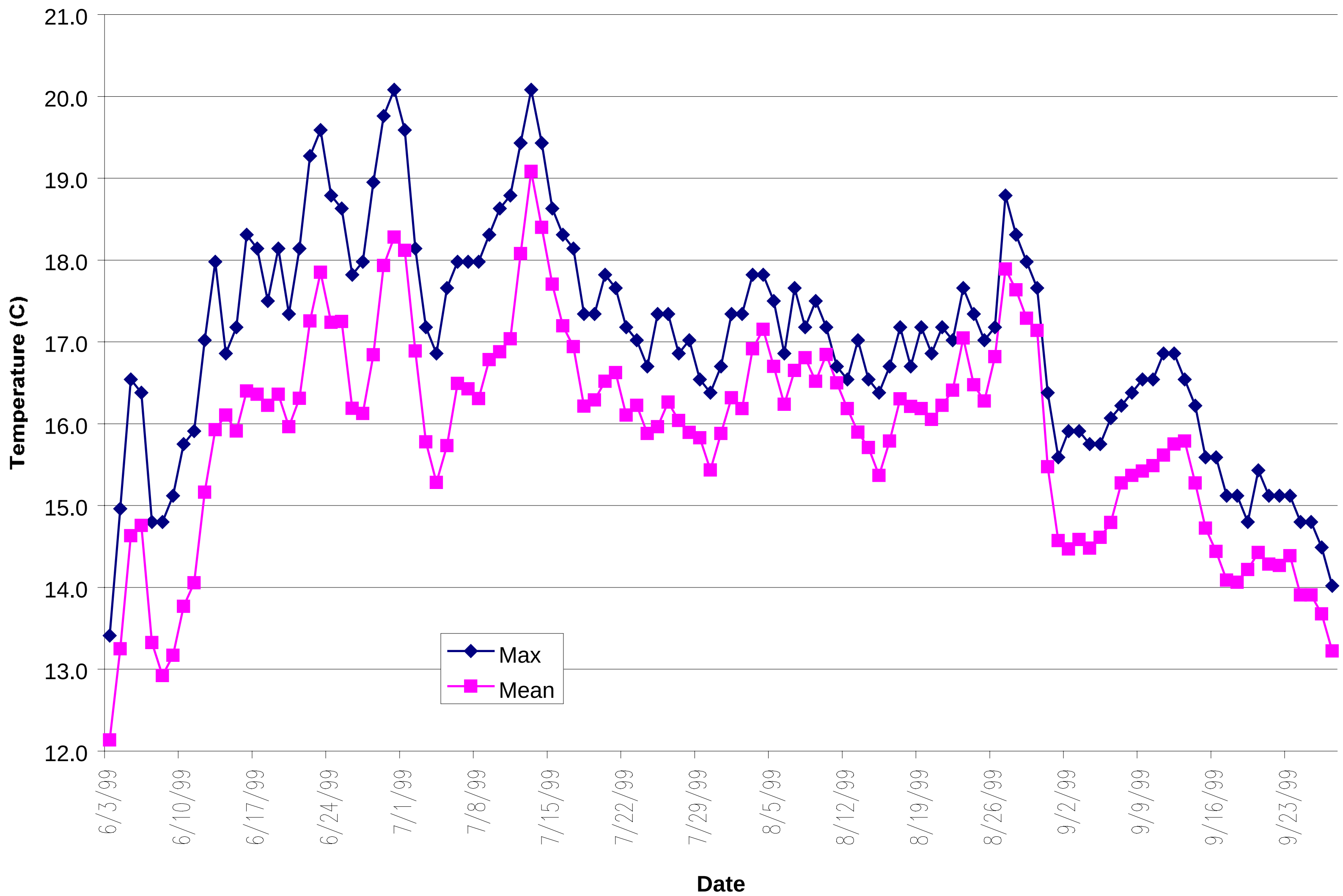


Figure 107. Mean and Maximum Daily Stream Temperatures During Summer 1999 at North Fork Indian Creek (Site 86-2), Mendocino County, California.

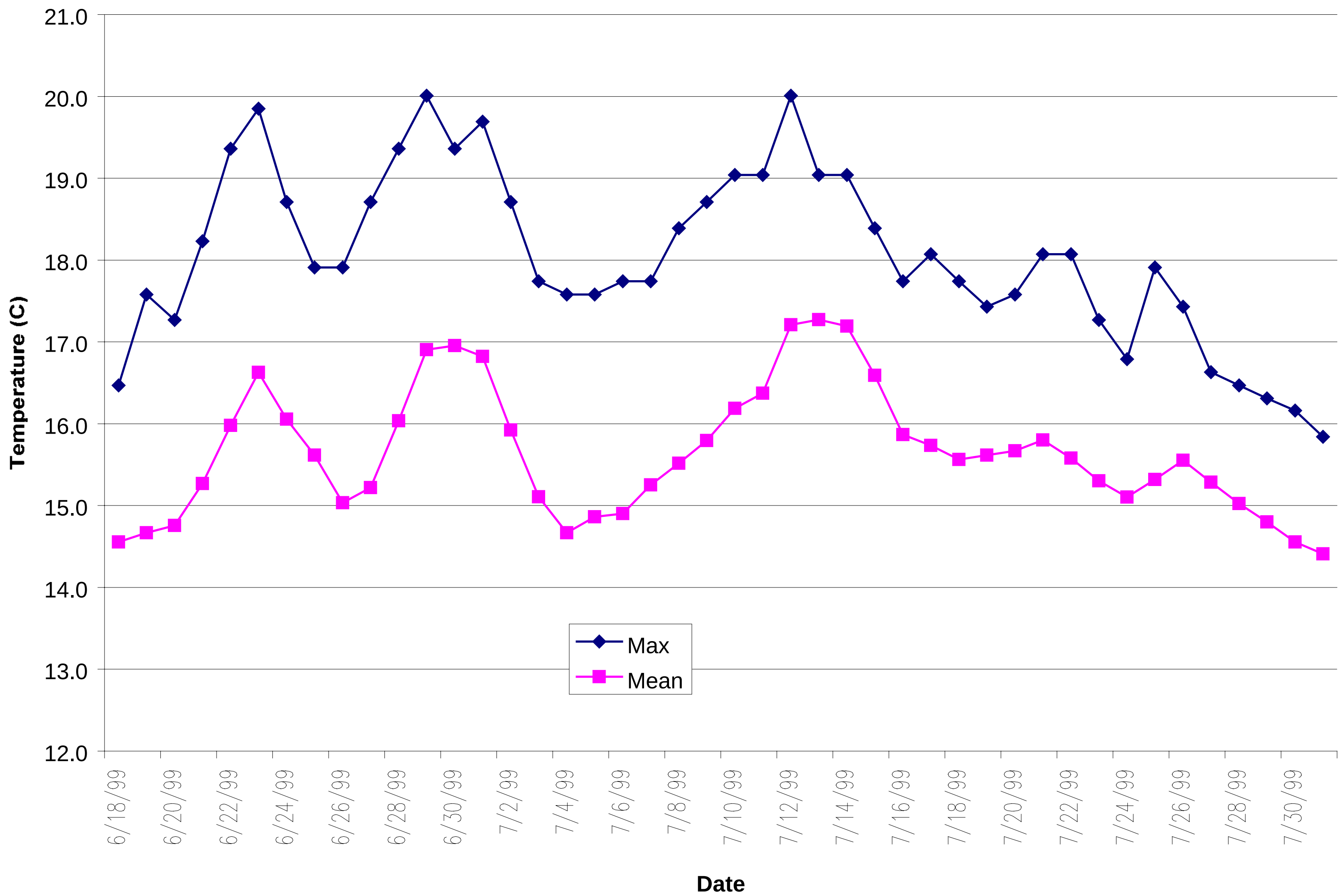


Figure 109. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Navarro River (Site 88-1), Mendocino County, California.

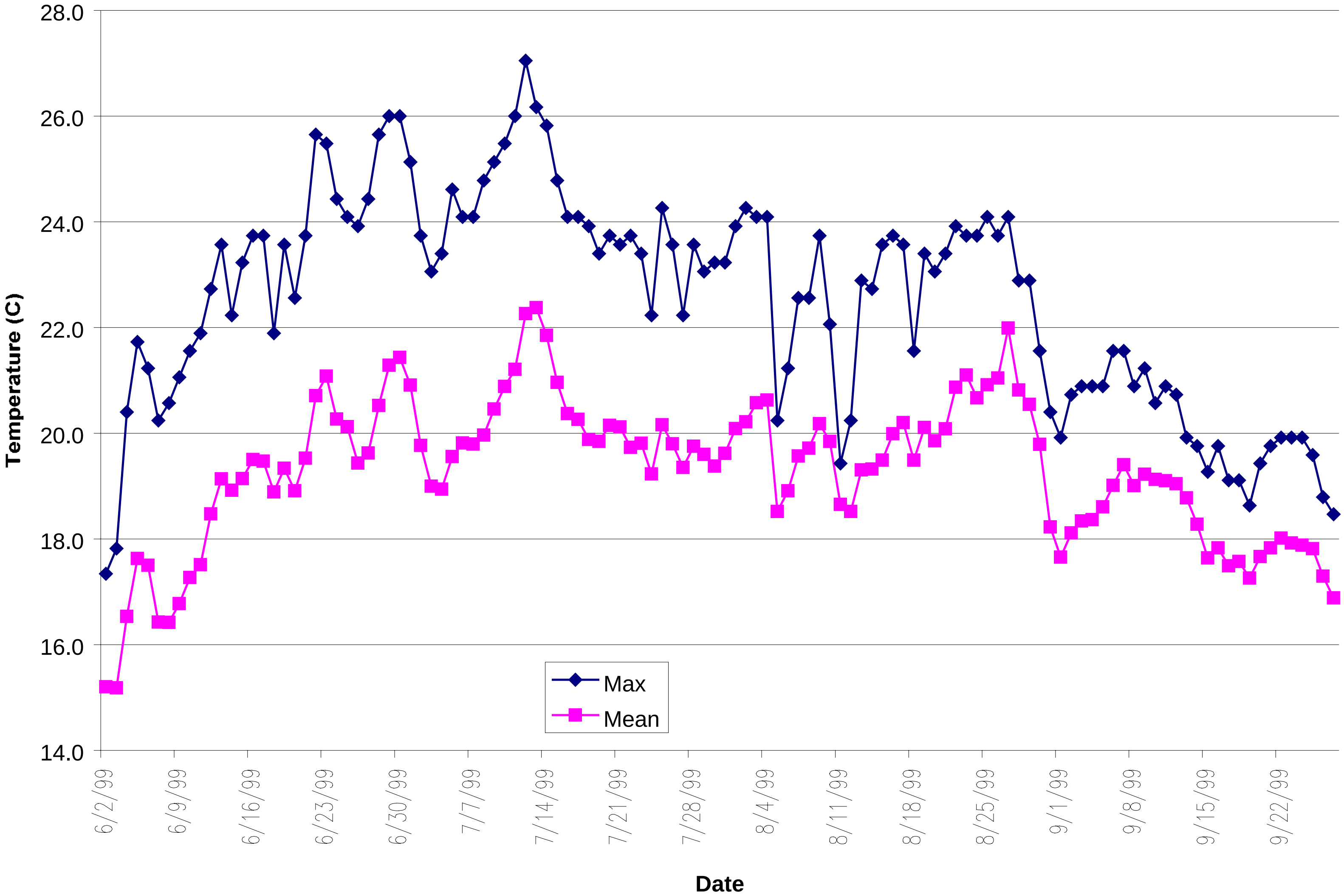


Figure 99. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Flynn Creek (Site 82-2), Mendocino County, California.

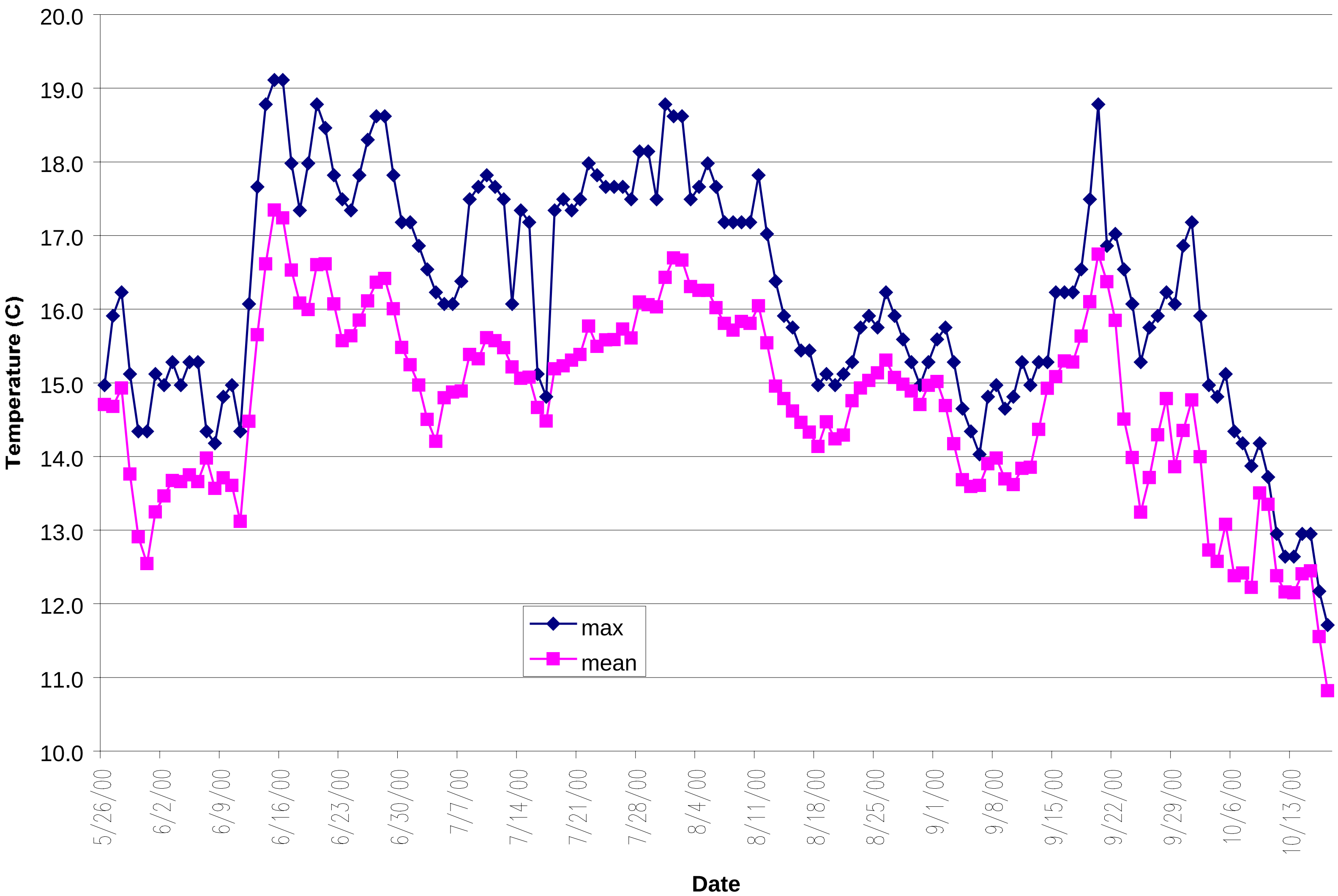


Figure 92. Mean and Maximum Daily Stream Temperatures During Summer 2000 at John Smith Creek (Site 81-2), Mendocino County, California.

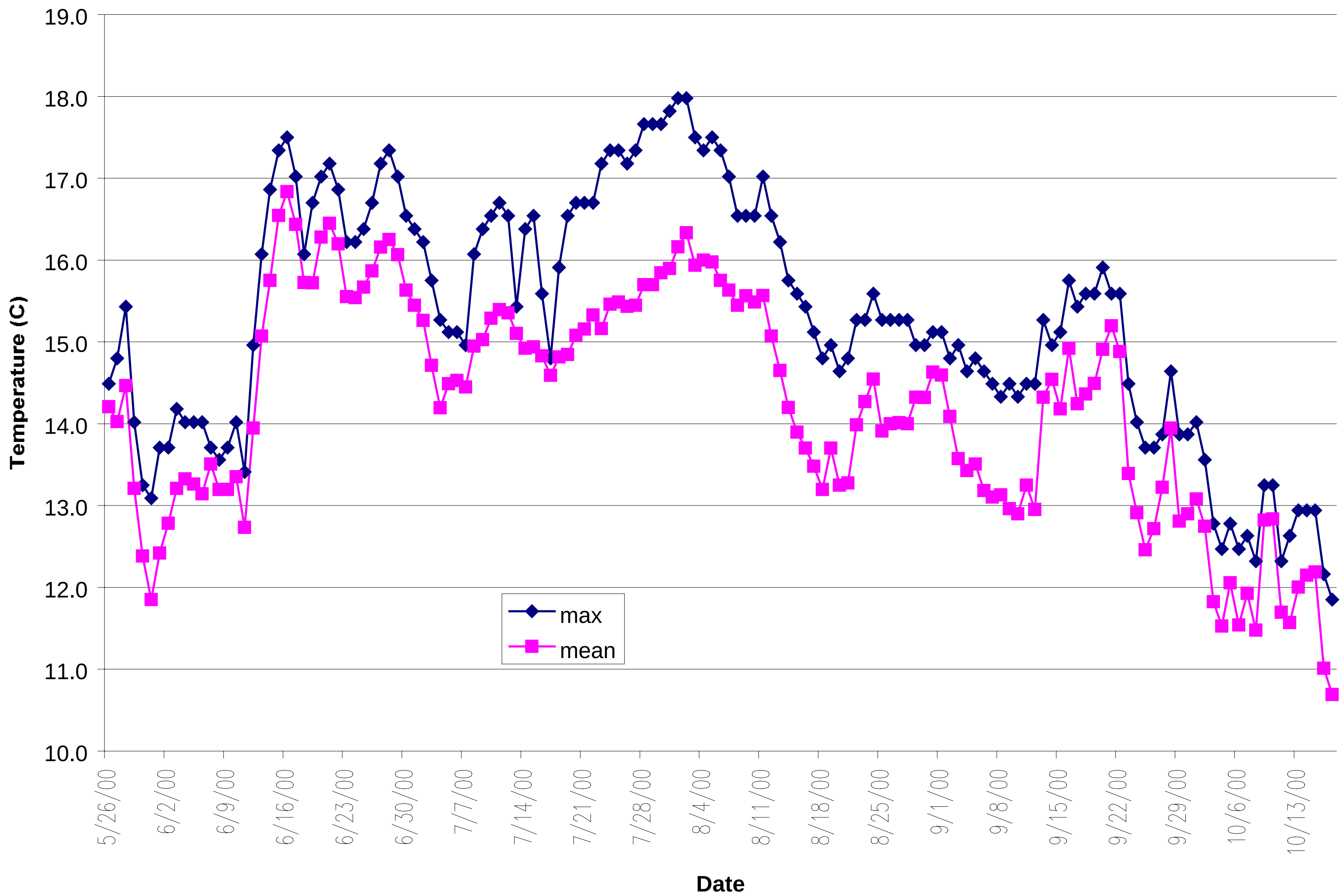


Figure 96. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Marsh Gulch (Site 82-1), Mendocino County, California.

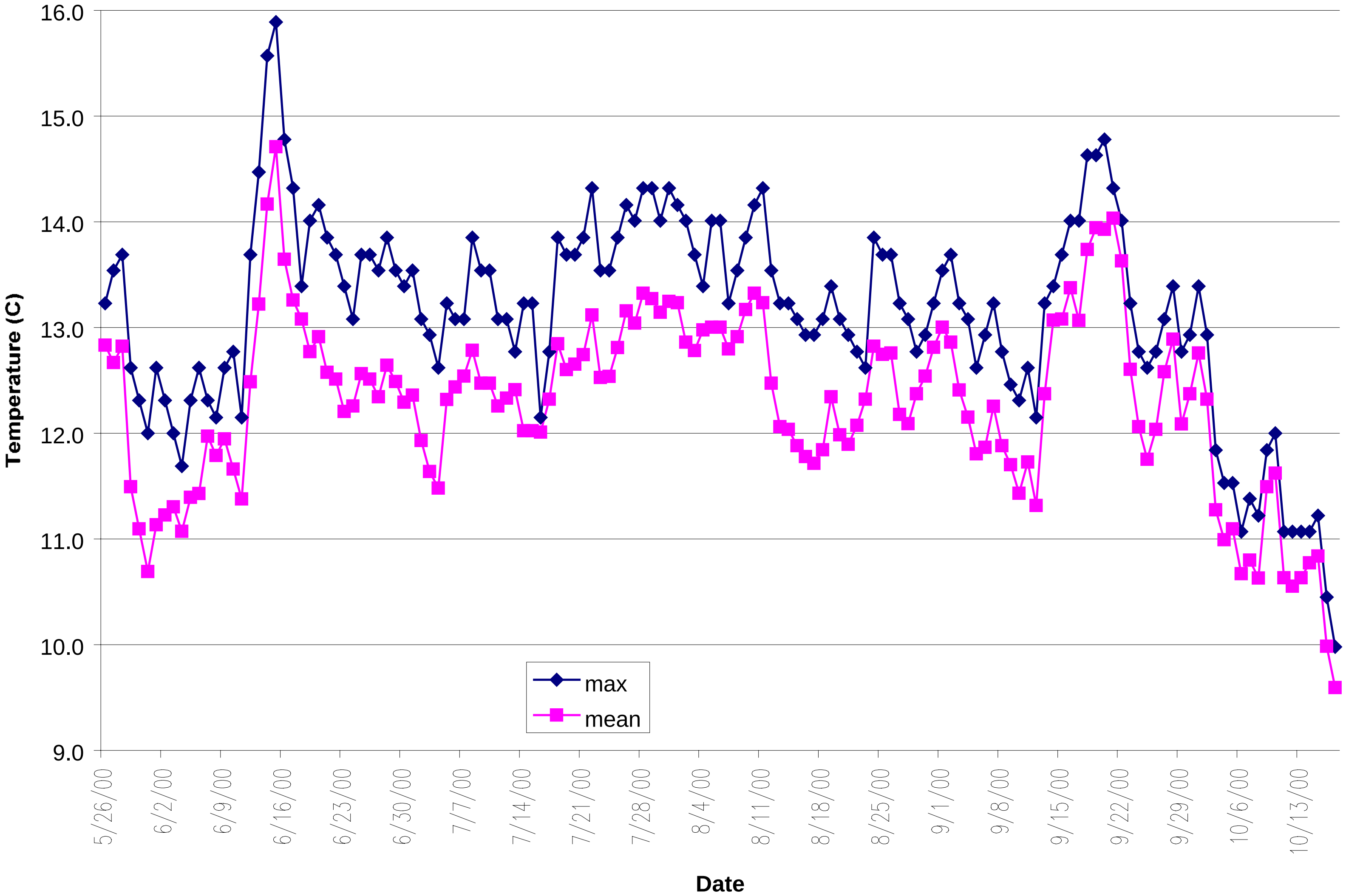


Figure 101. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Navarro River (Site 82-3), Mendocino County, California.

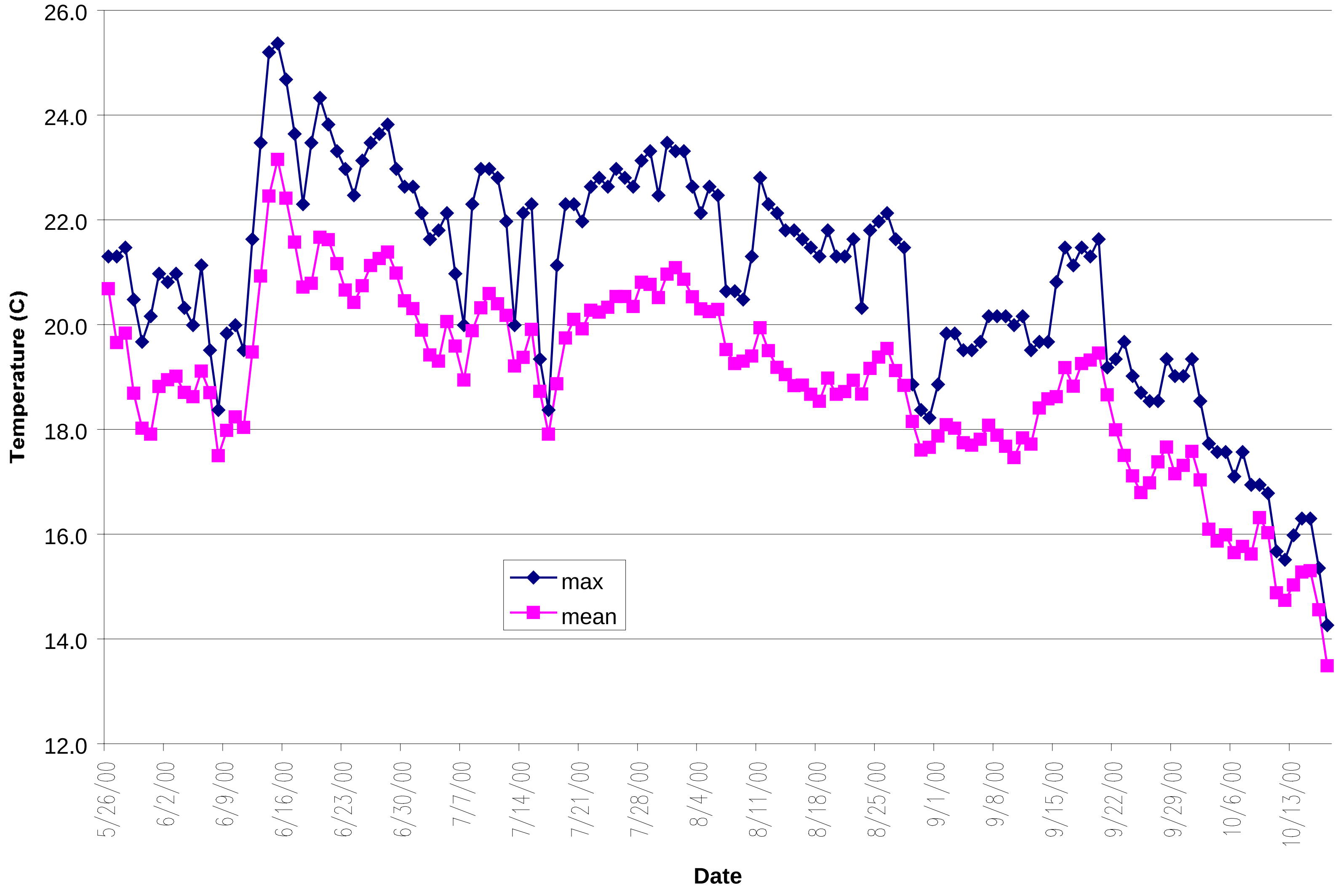


Figure 110. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Navarro River (Site 88-1), Mendocino County, California.

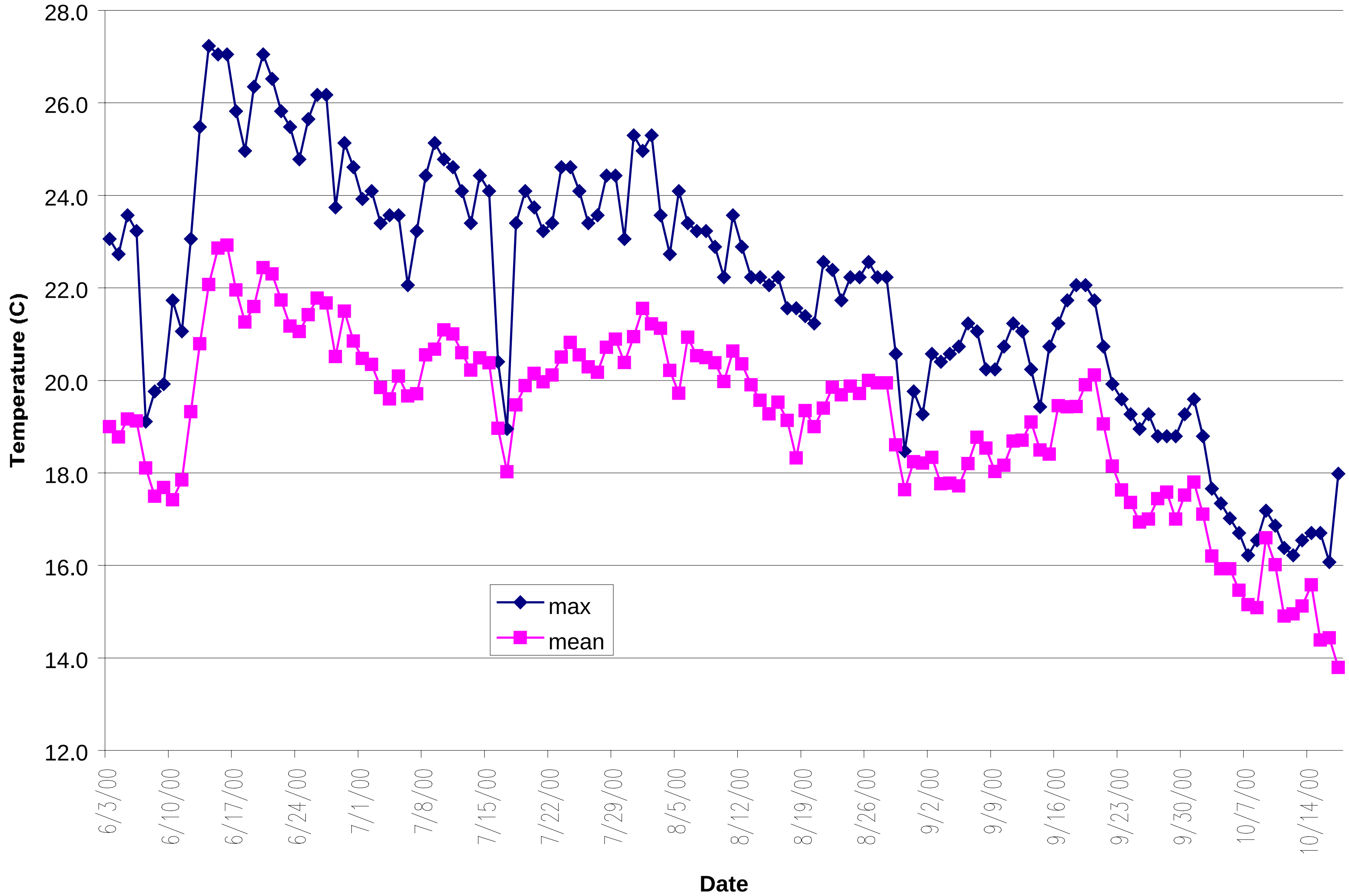


Figure 89. Mean and Maximum Daily Stream Temperatures During Summer 2000 at North Branch North Fork Navarro River (Site 81-1), Mendocino County, California.

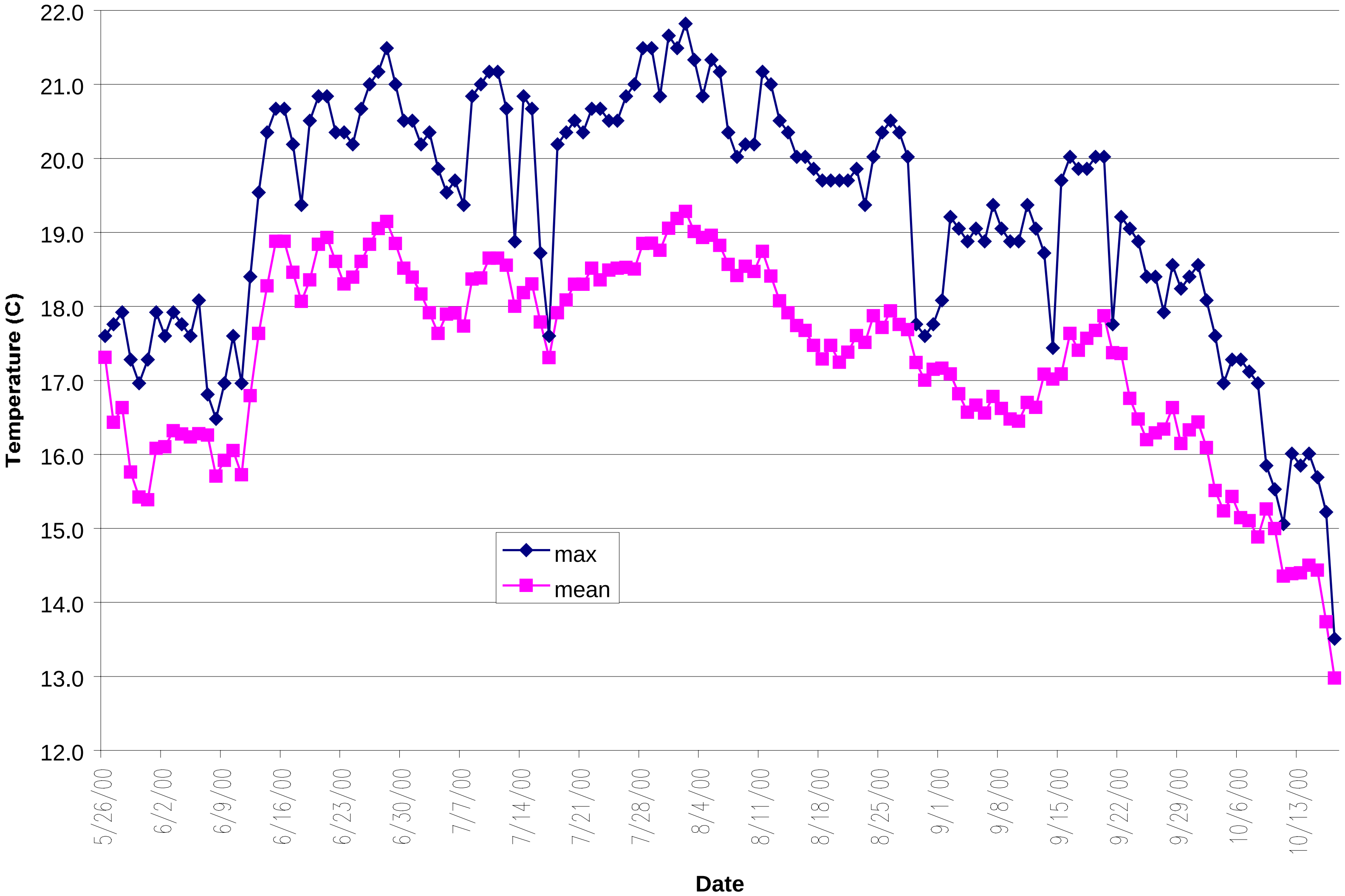


Figure 94. Mean and Maximum Daily Stream Temperatures During Summer 2000 at North Branch North Fork Navarro River (Site 81-3), Mendocino County, California.

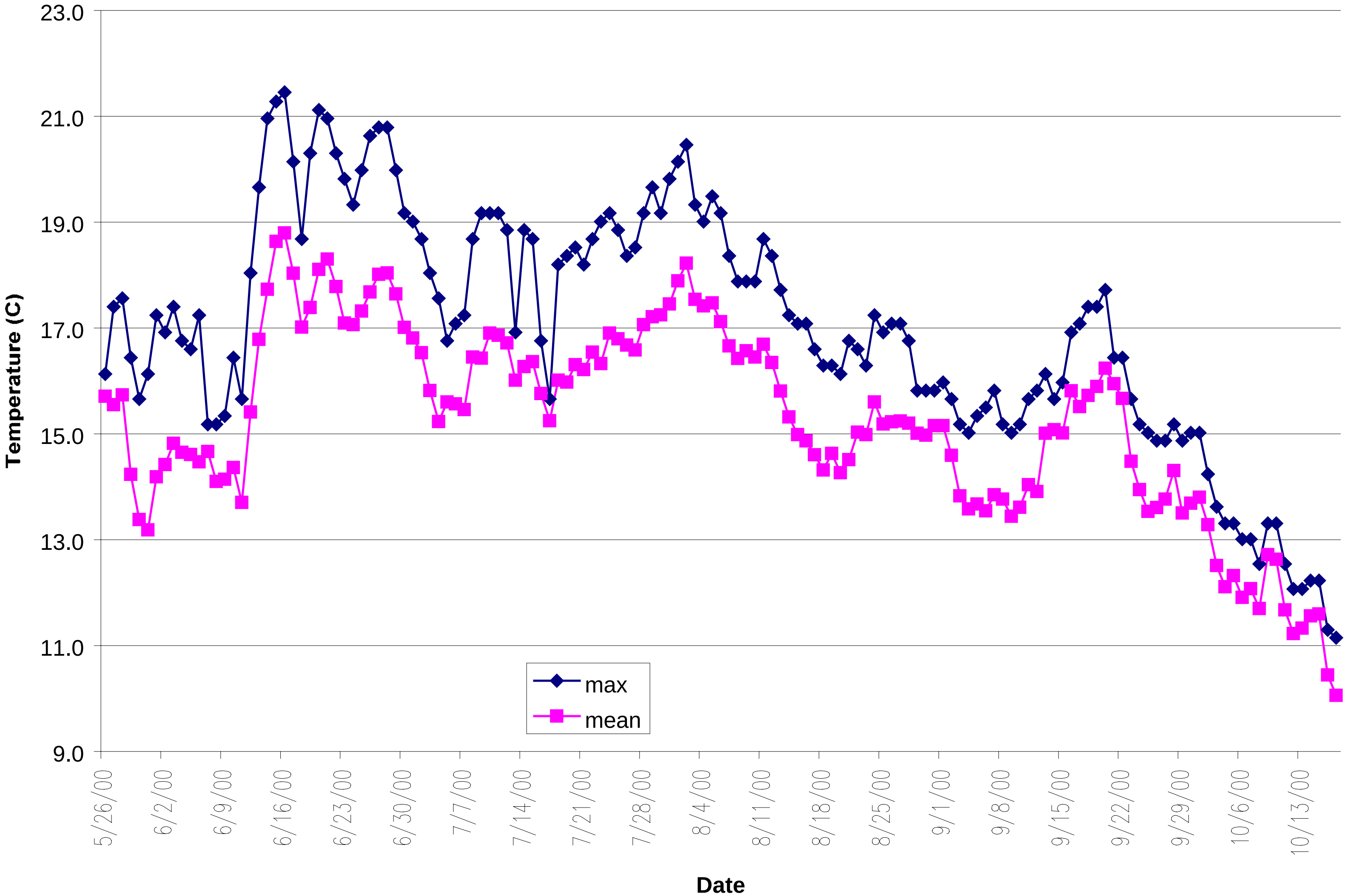


Figure 106. Mean and Maximum Daily Stream Temperatures During Summer 2000 at North Fork Indian Creek (Site 86-1), Mendocino County, California.

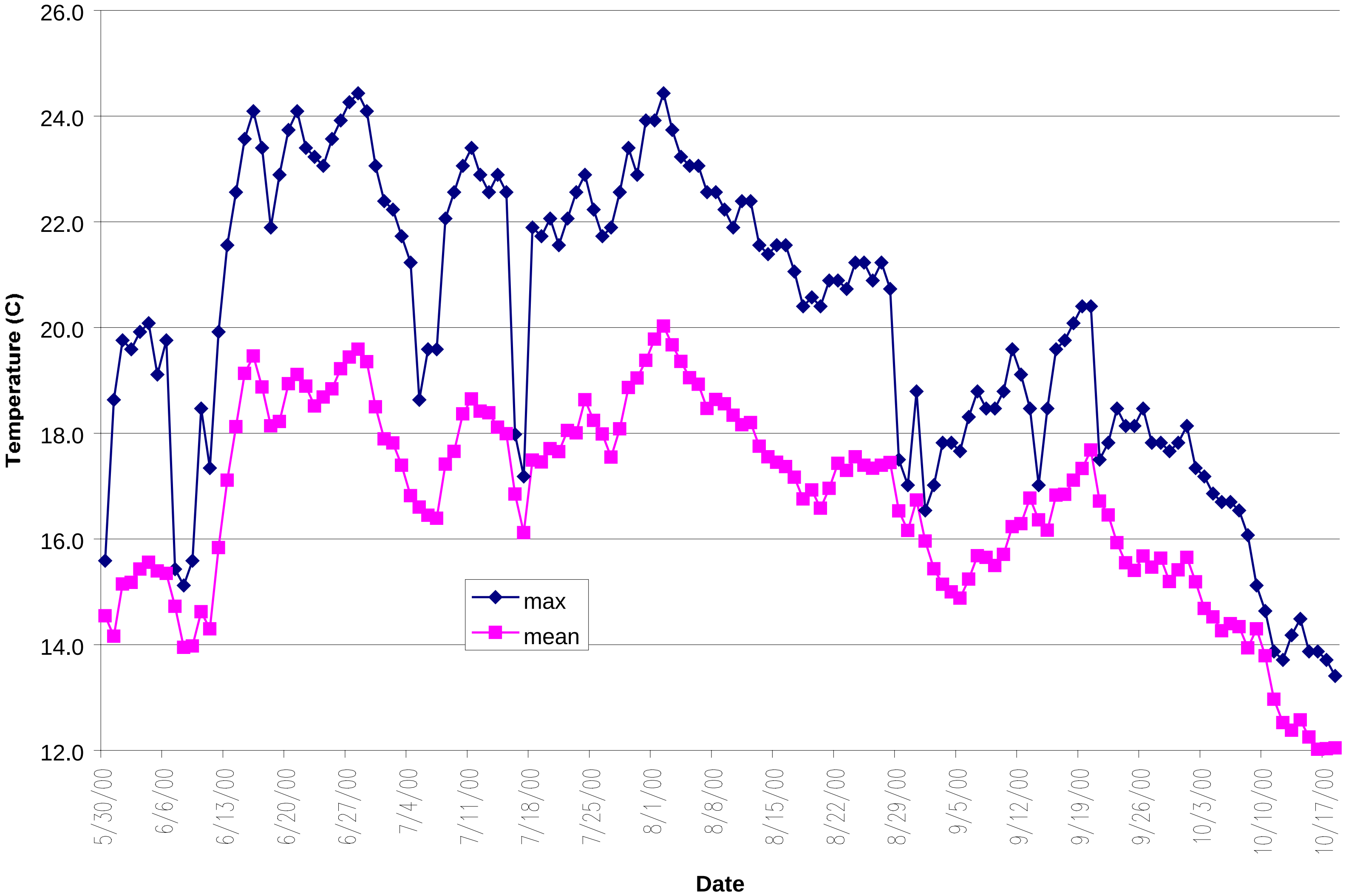


Figure 108. Mean and Maximum Daily Stream Temperatures During Summer 2000 at North Fork Indian Creek (Site 86-2), Mendocino County, California.

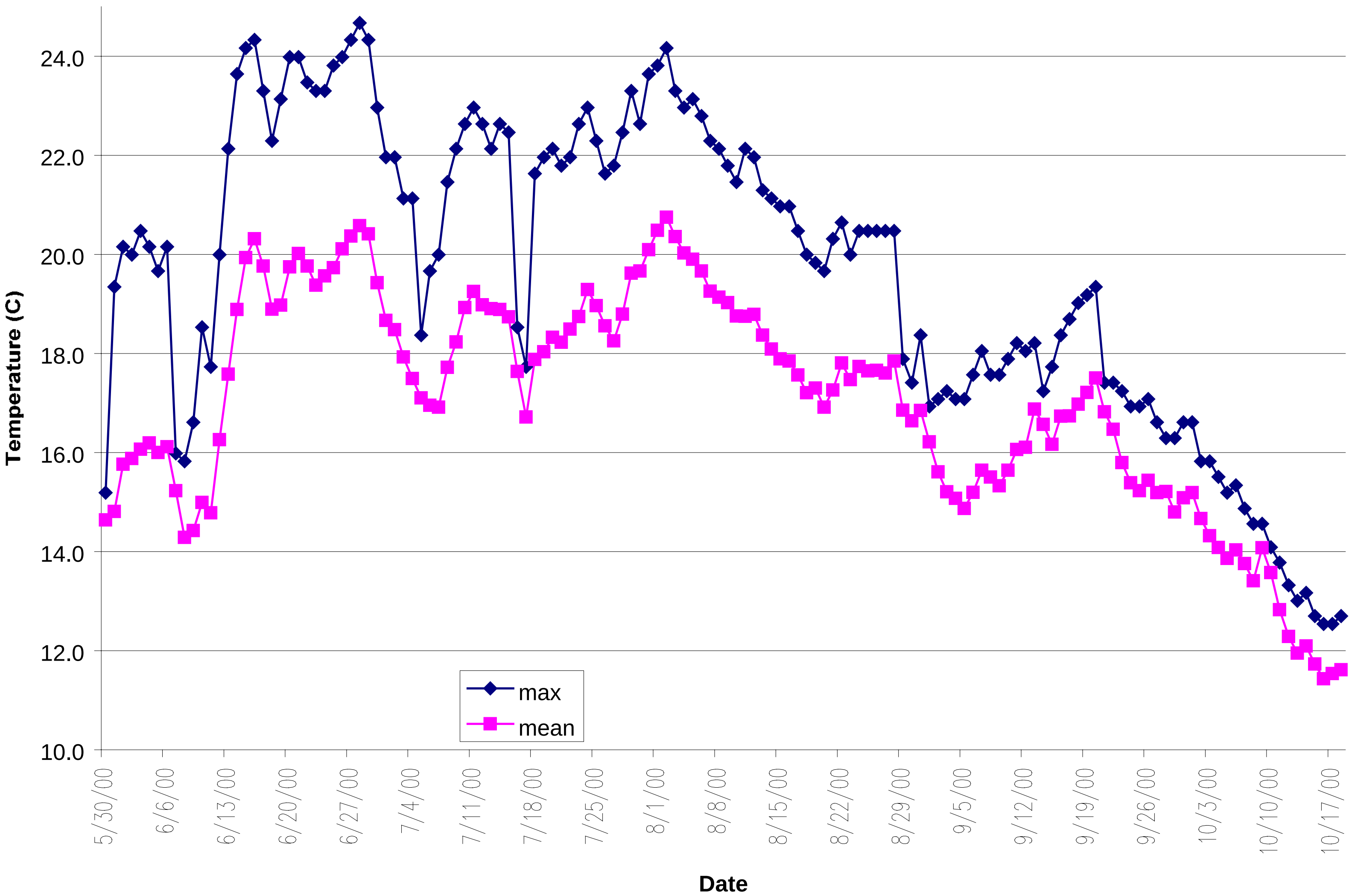


Figure 105. Mean and Maximum Daily Stream Temperatures During Summer 2000 at South Branch South Fork Navarro River (Site 85-2), Mendocino County, California.

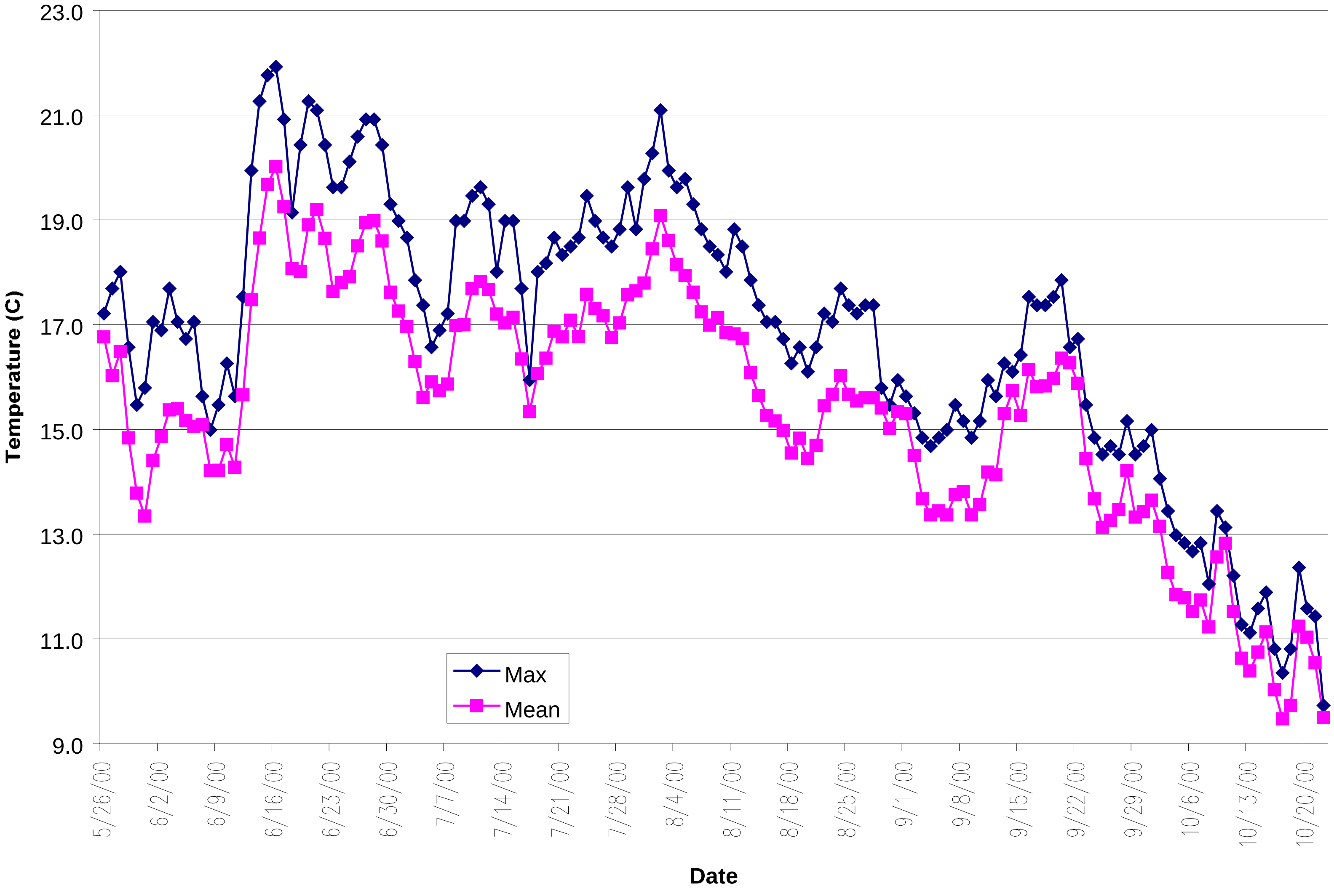
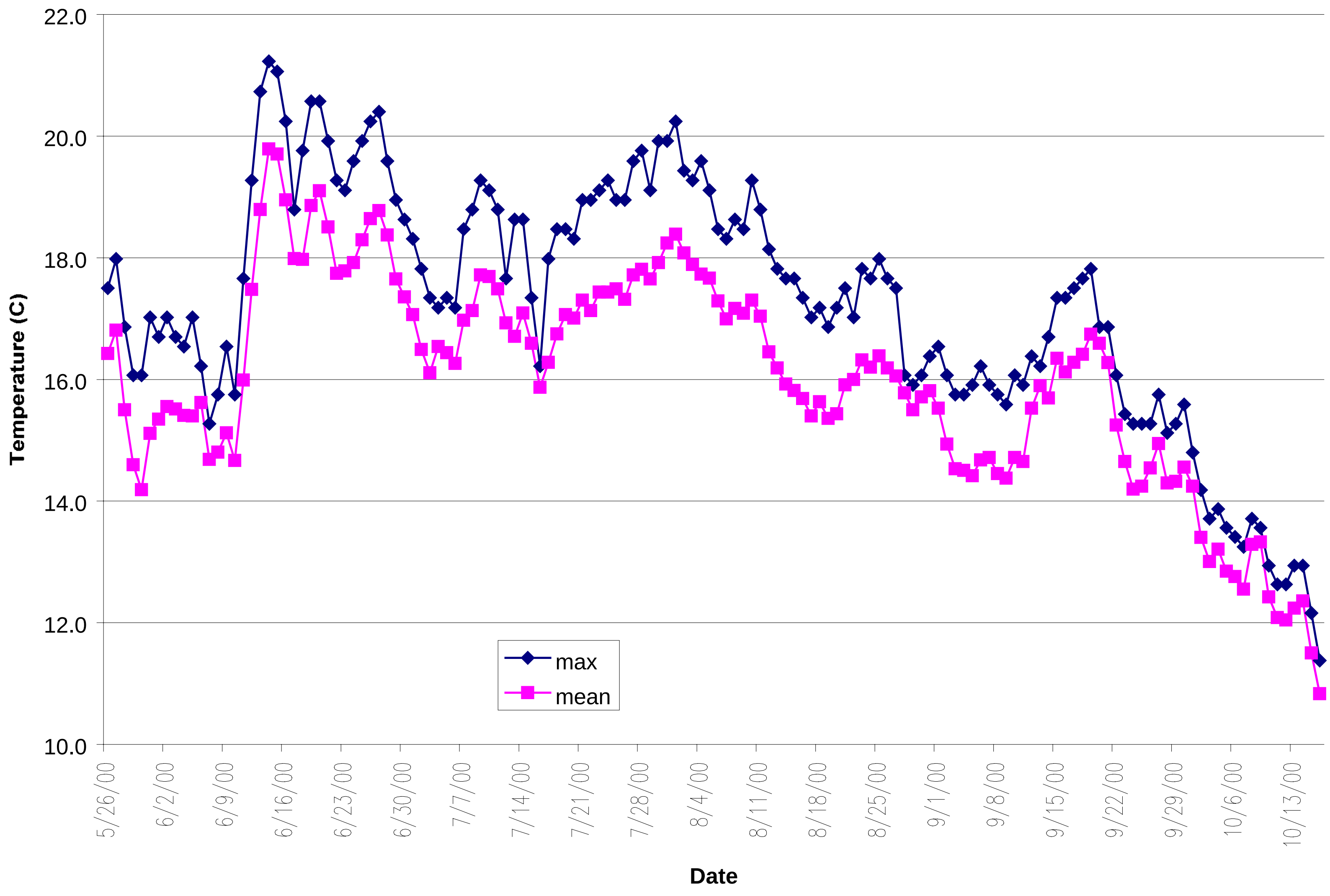
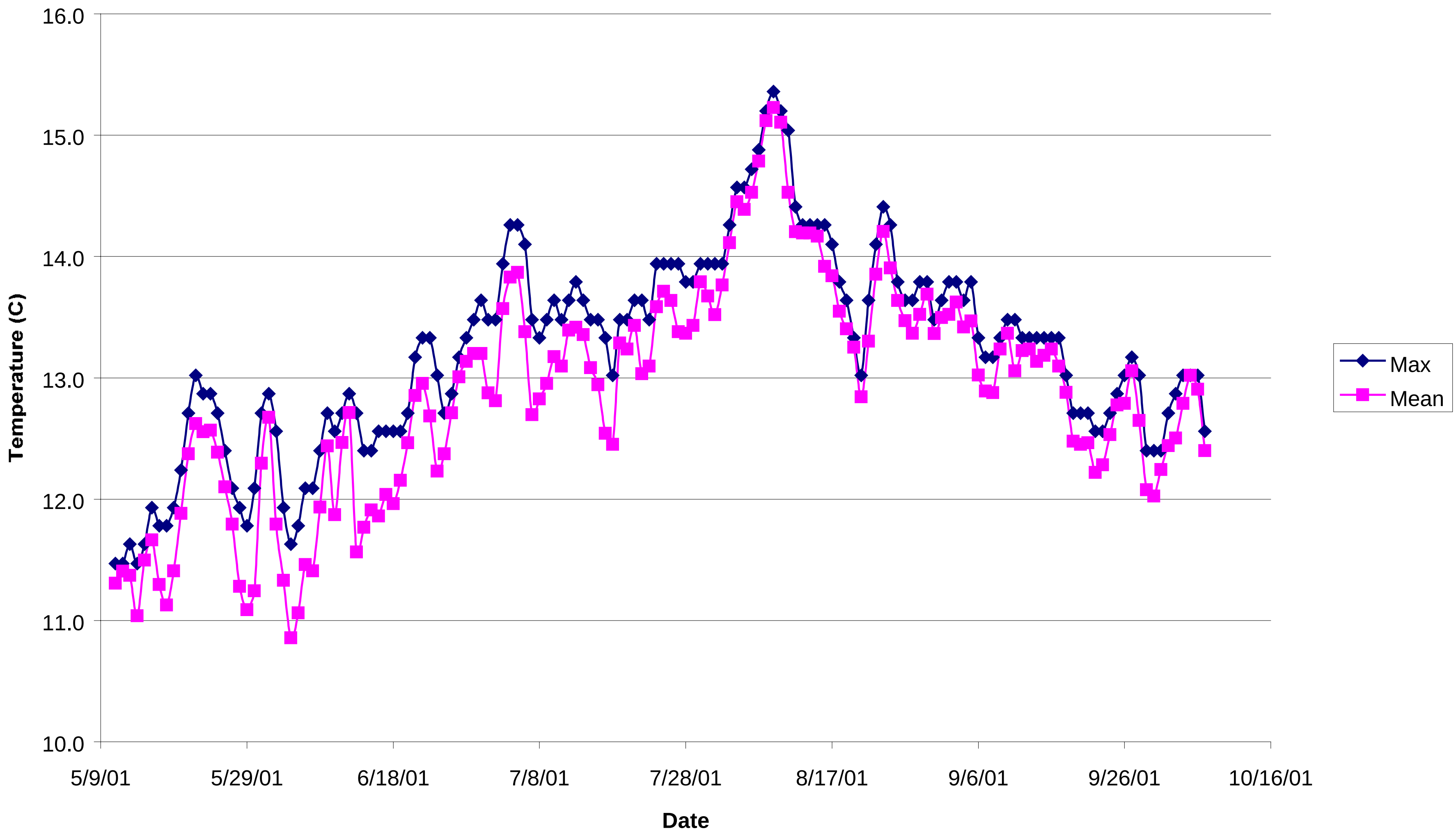
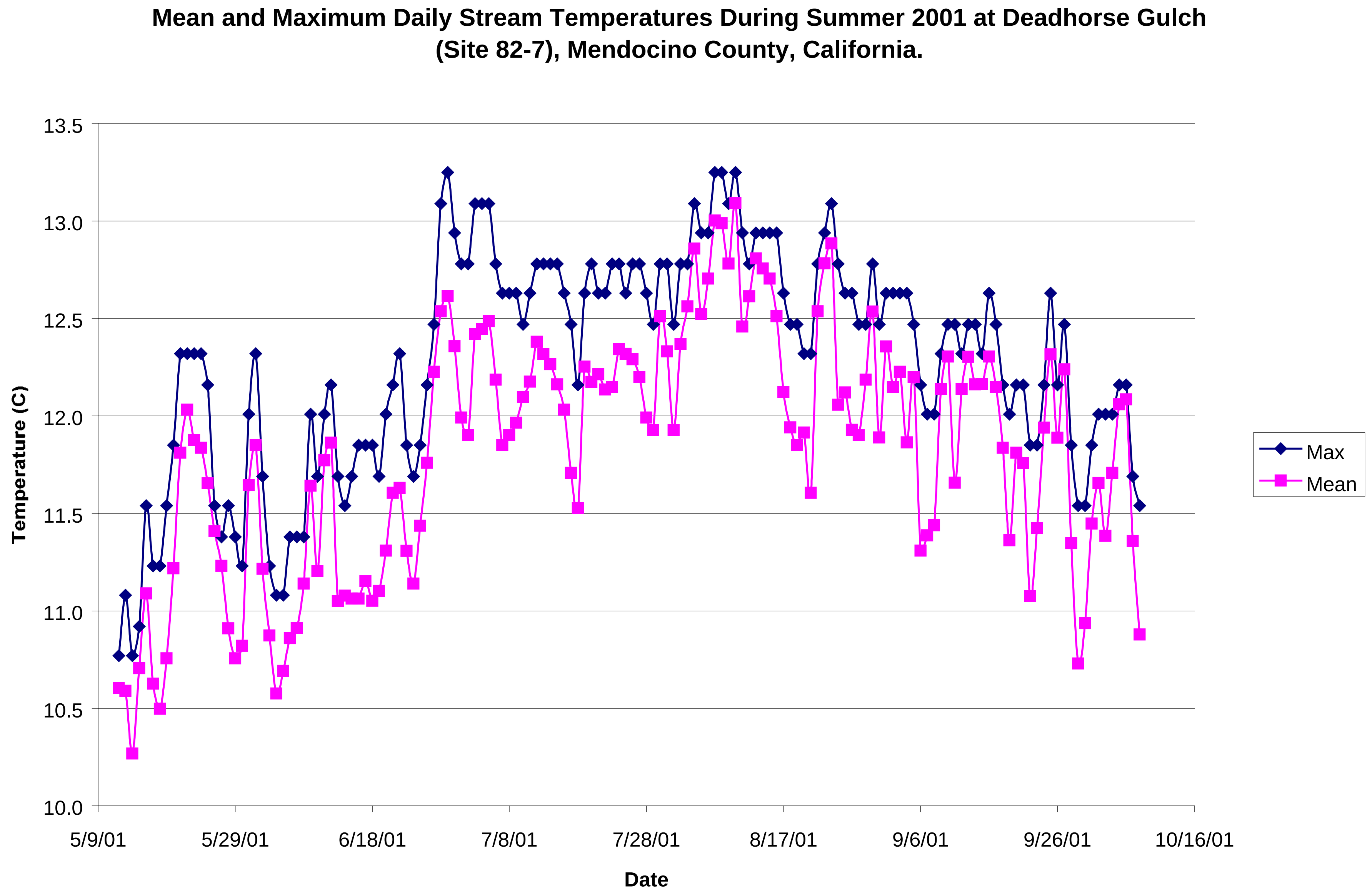


Figure 103. Mean and Maximum Daily Stream Temperatures During Summer 2000 at South Branch South Fork Navarro River (Site 85-1), Mendocino County, California.



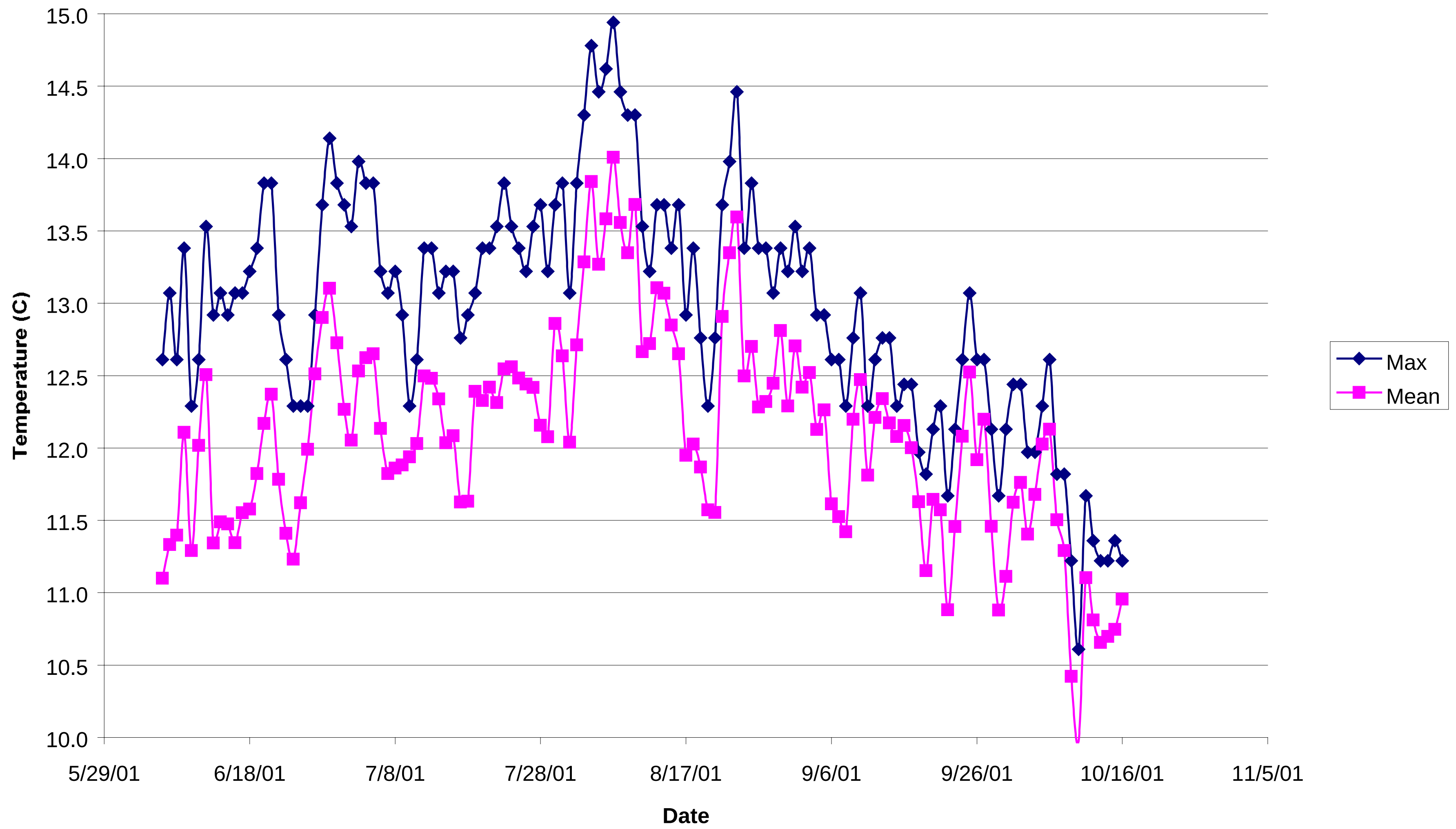
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Camp 16 Gulch (Site 82-8), Mendocino County, California.

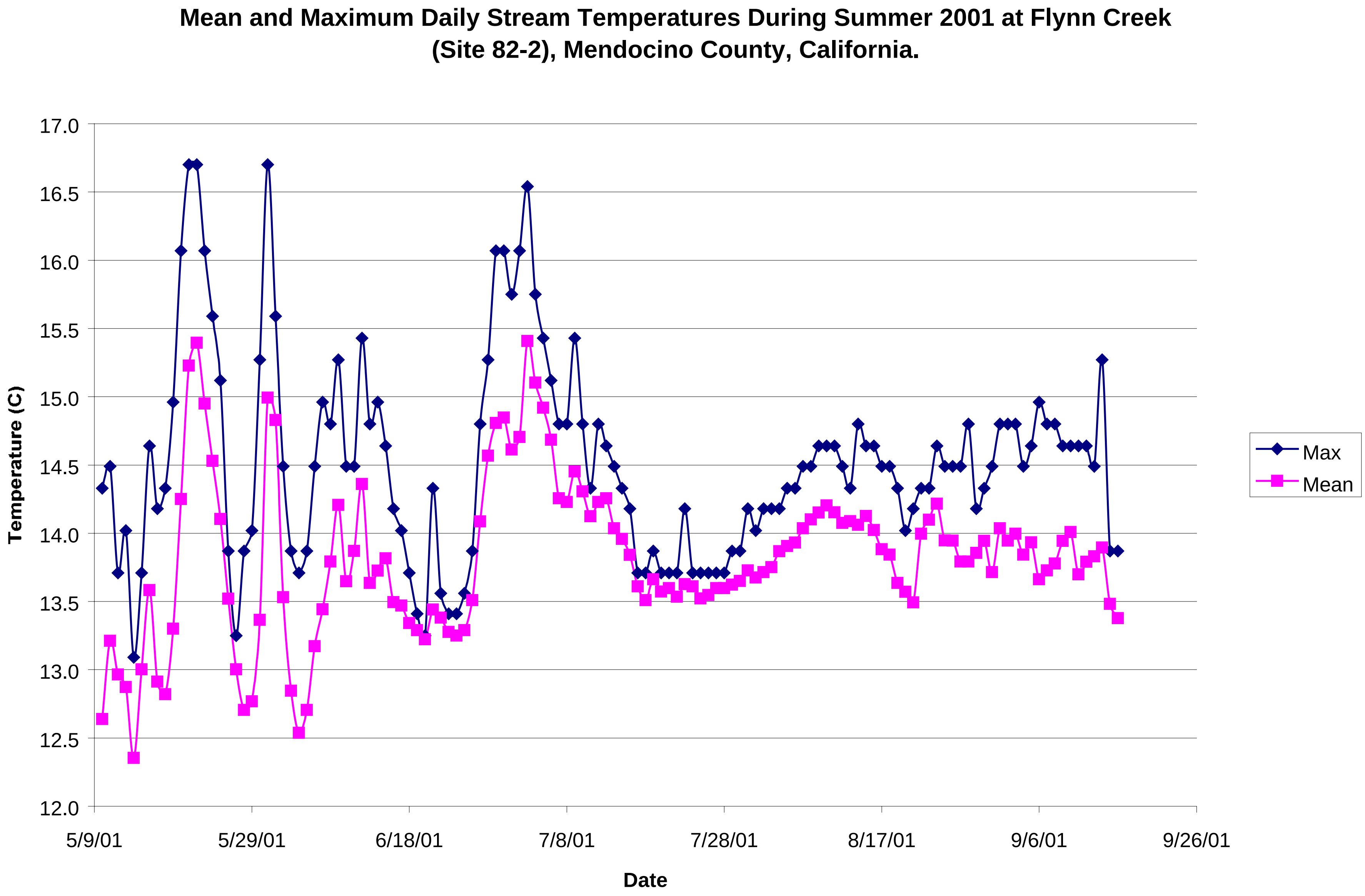




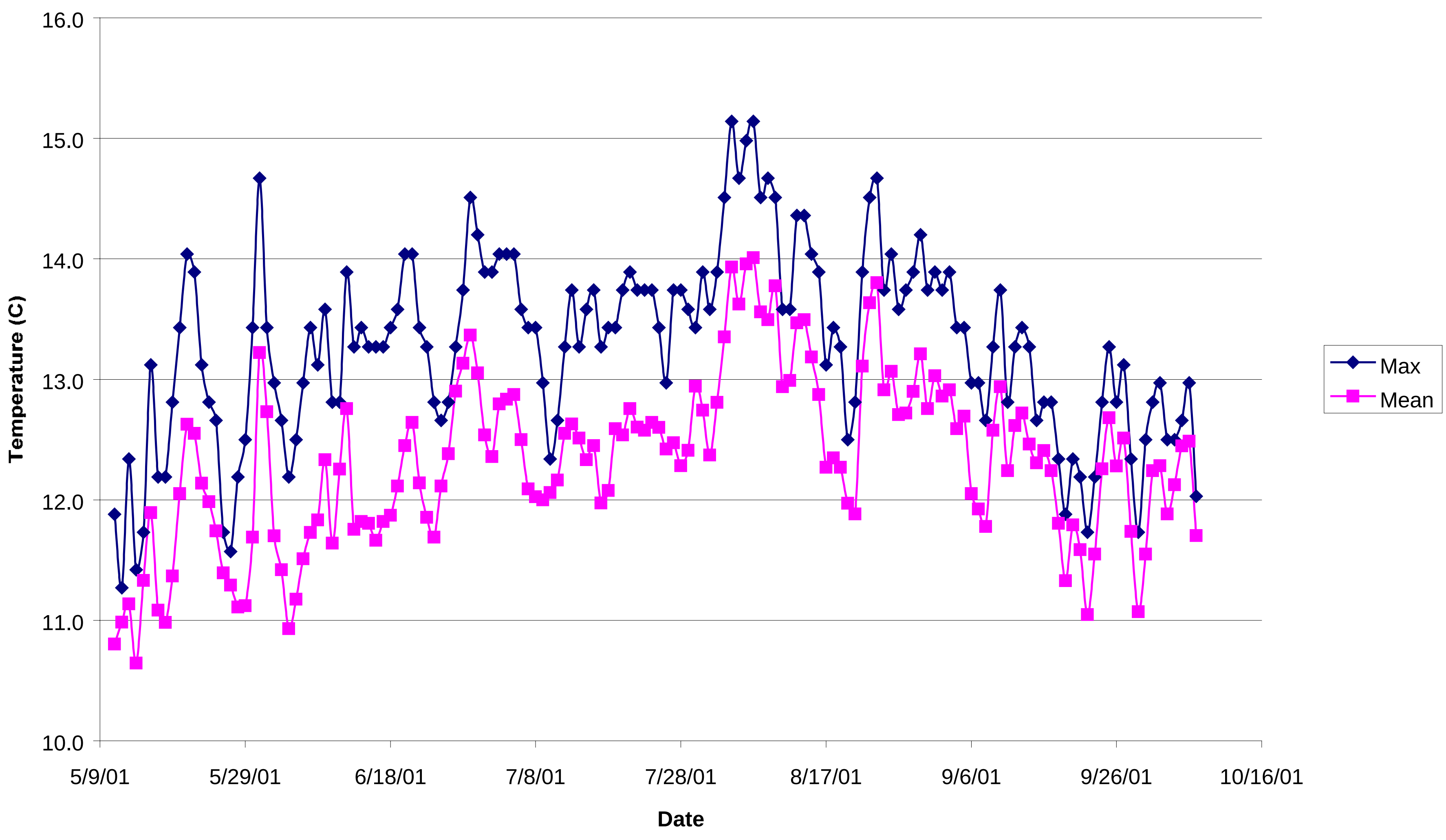
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Deadhorse Gulch
(Site 82-7), Mendocino County, California.
Temperature (C)
13.5
13.0
12.5
12.0
11.5
11.0
10.5
10.0
5/9/01
5/29/01
6/18/01
7/8/01
7/28/01
8/17/01
9/6/01
9/26/01
10/16/01
Date
Max
Mean

Mean and Maximum Daily Stream Temperatures During Summer 2001 at Flume Gulch (Site 82-9), Mendocino County, California.

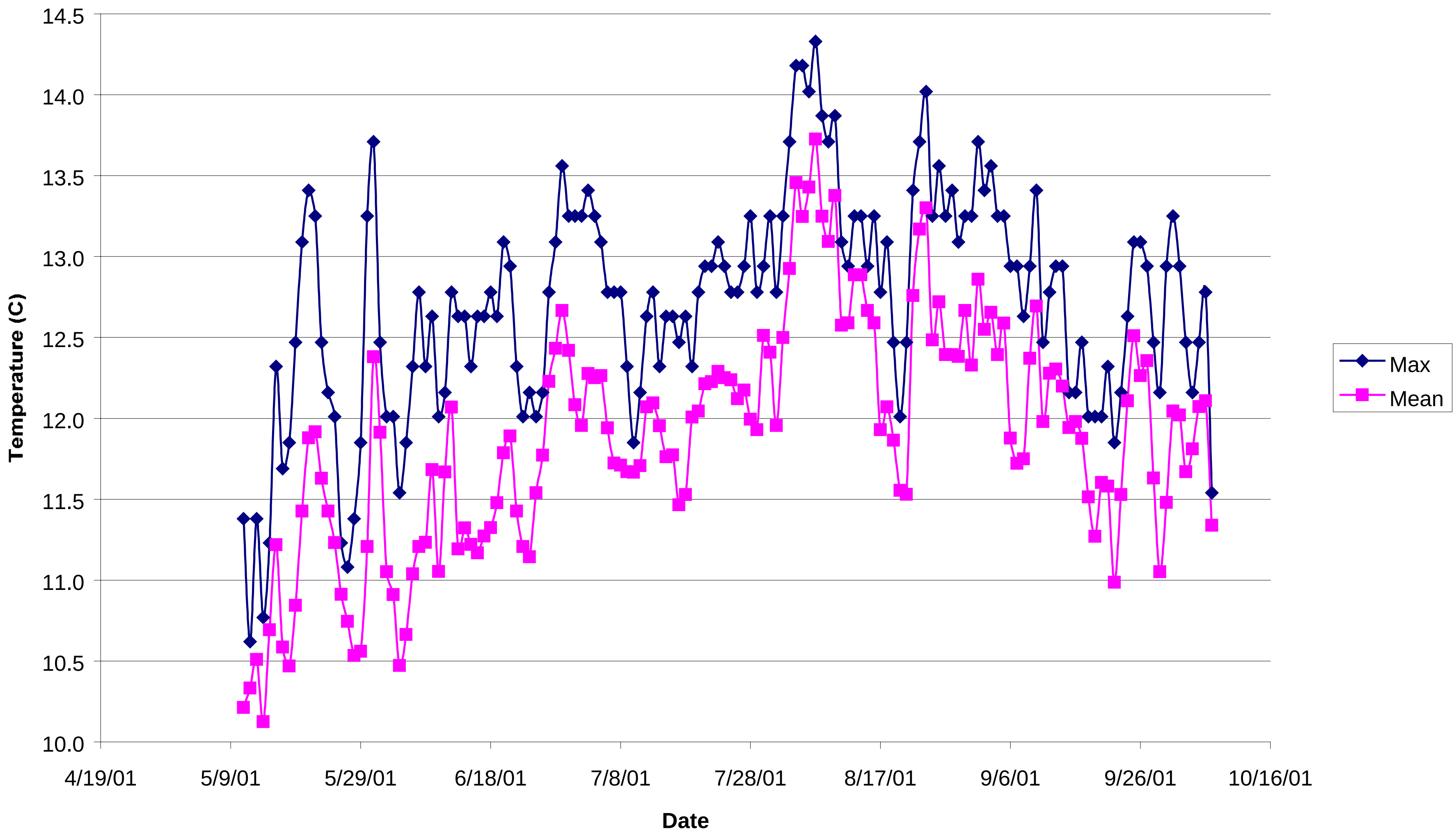



Mean and Maximum Daily Stream Temperatures During Summer 2001 at Flynn Creek
(Site 82-2), Mendocino County, California.
Temperature (C)
17.0
16.5
16.0
15.5
15.0
14.5
14.0
13.5
13.0
12.5
12.0
5/9/01
5/29/01
6/18/01
7/8/01
7/28/01
8/17/01
9/6/01
9/26/01
Date
Max
Mean

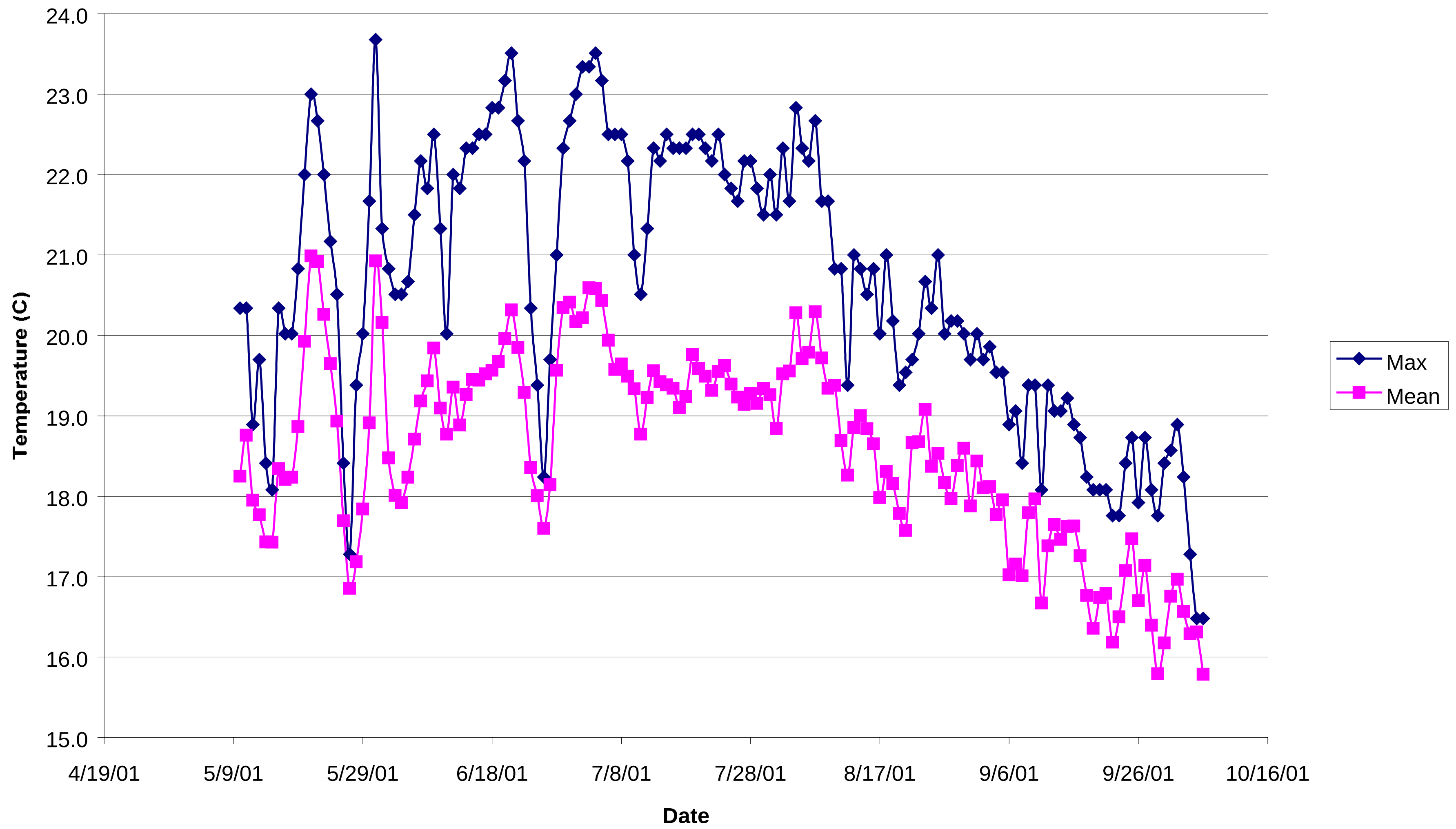
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Marsh Gulch (Site 82-1), Mendocino County, California.



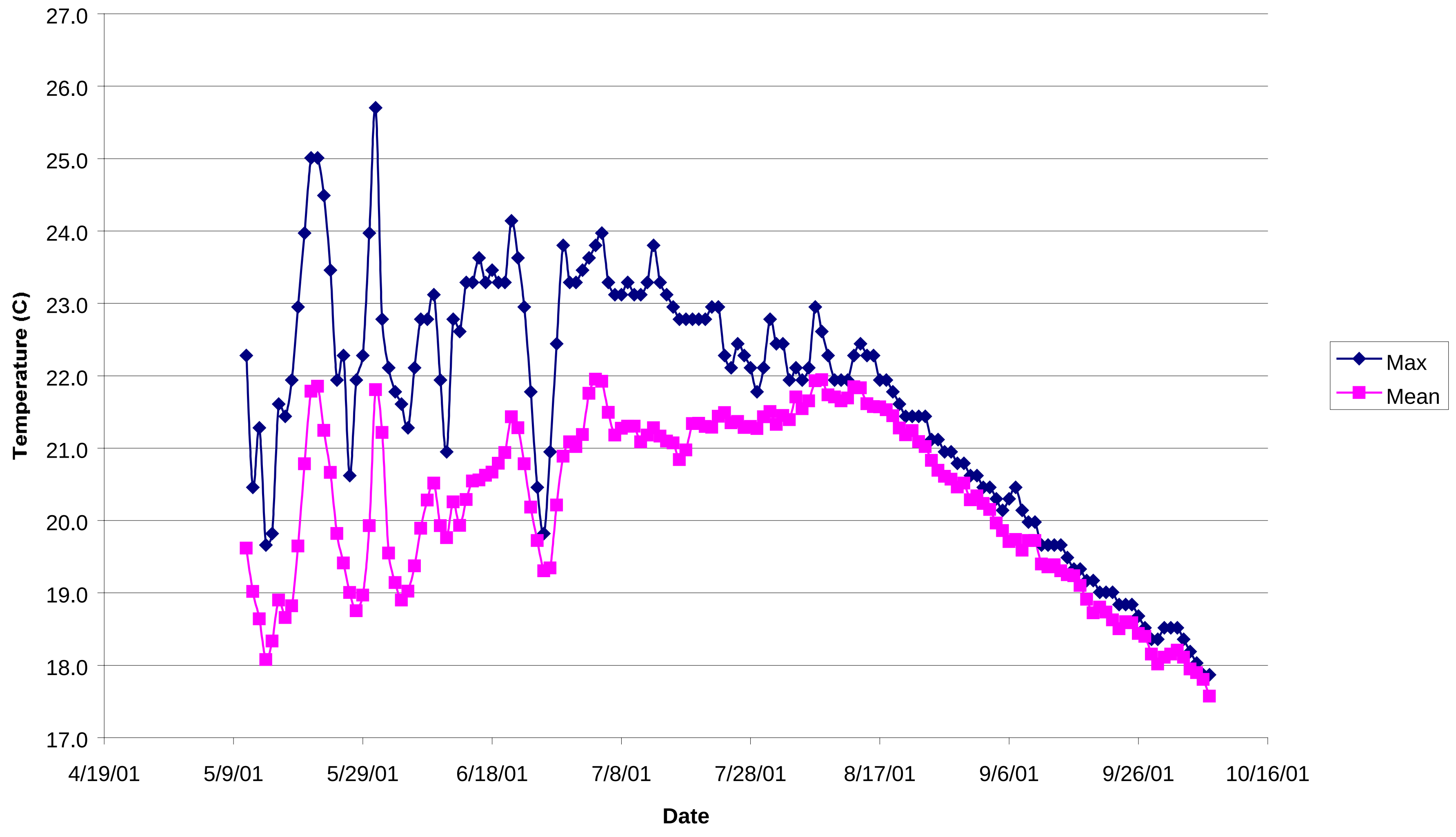
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Murray Gulch (Site 82-6), Mendocino County, California.



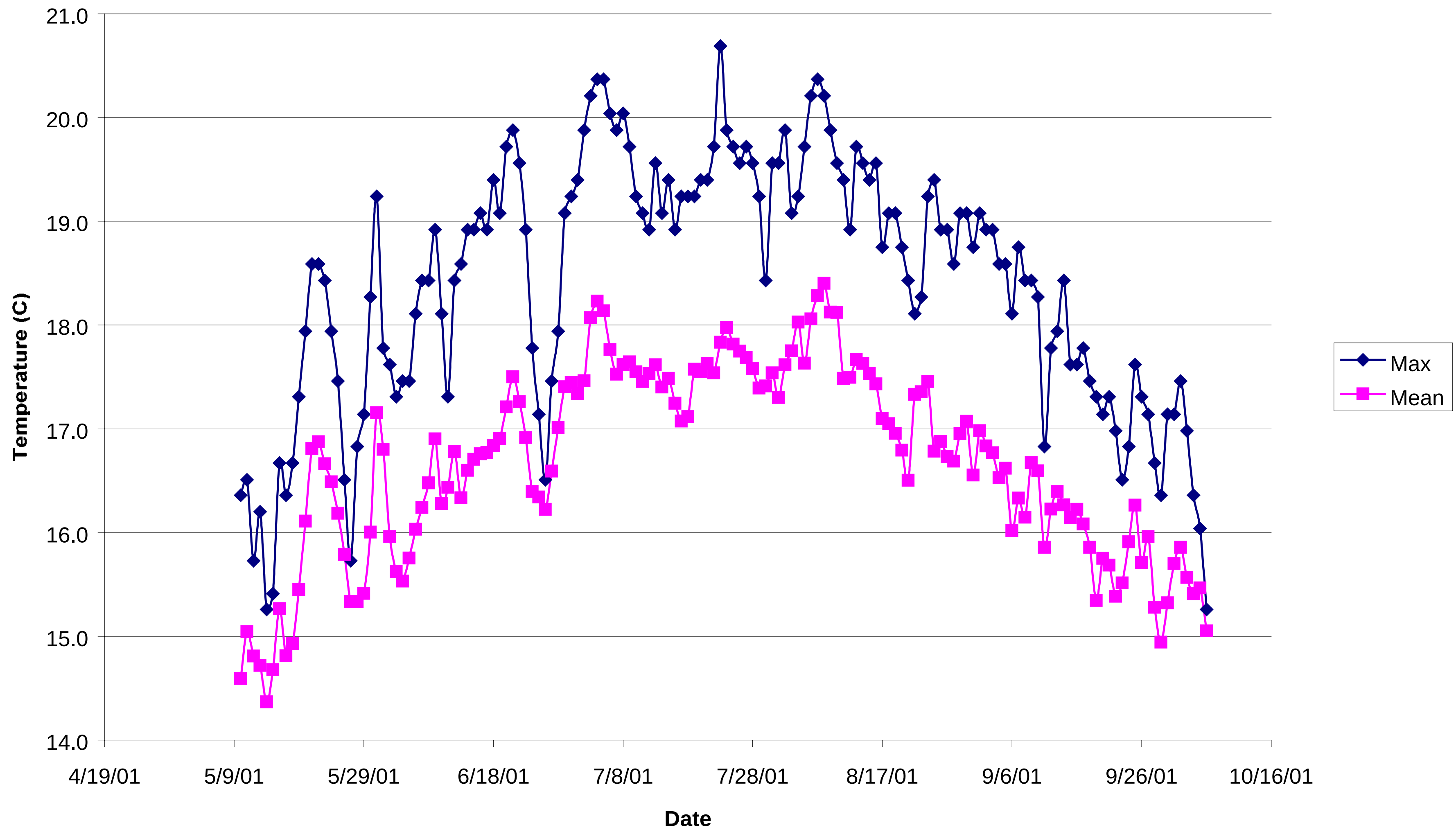
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Navarro River (Site 82-3), Mendocino County, California.

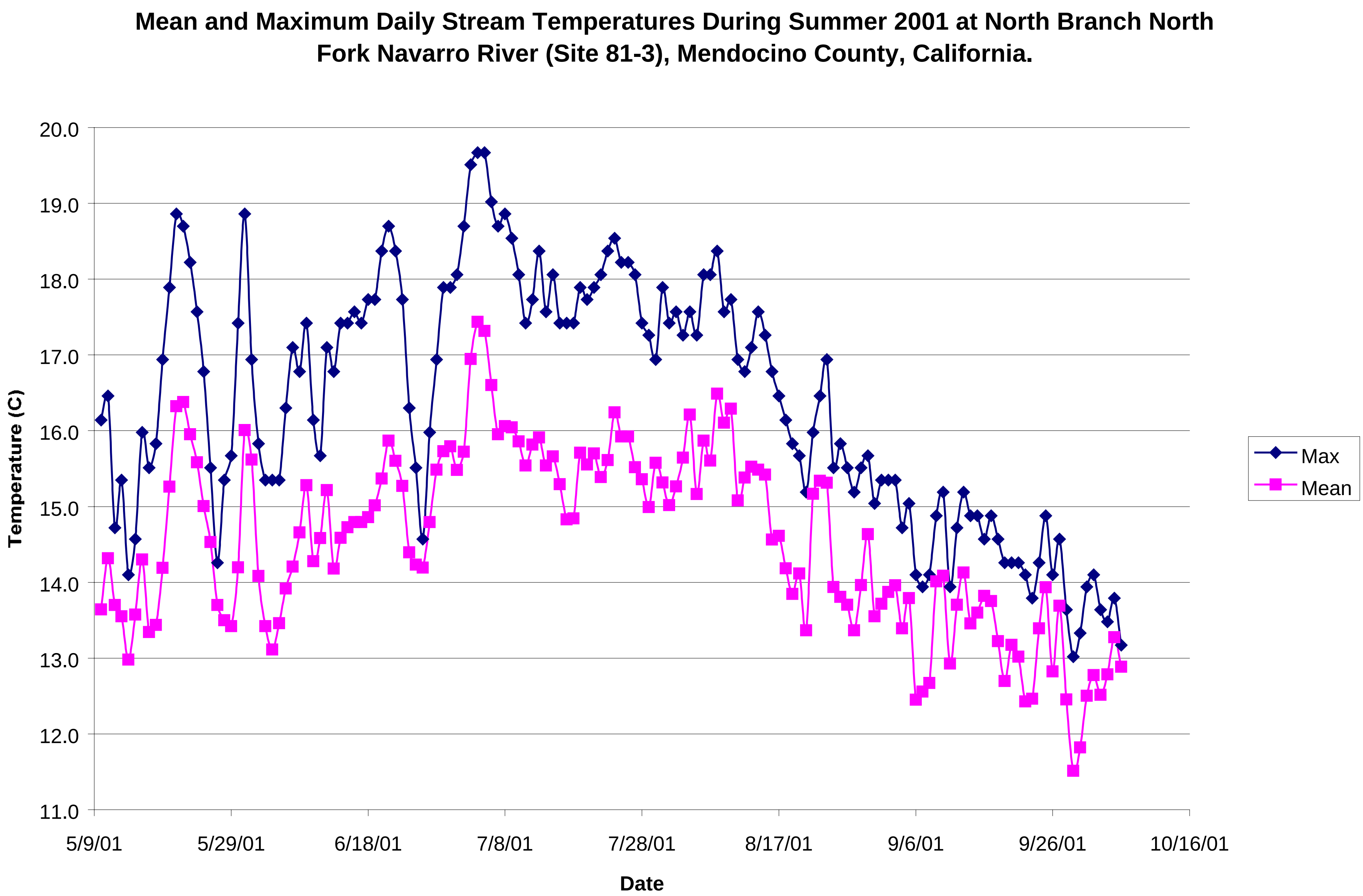


Mean and Maximum Daily Stream Temperatures During Summer 2001 at Navarro River (Site 82-5), Mendocino County, California.



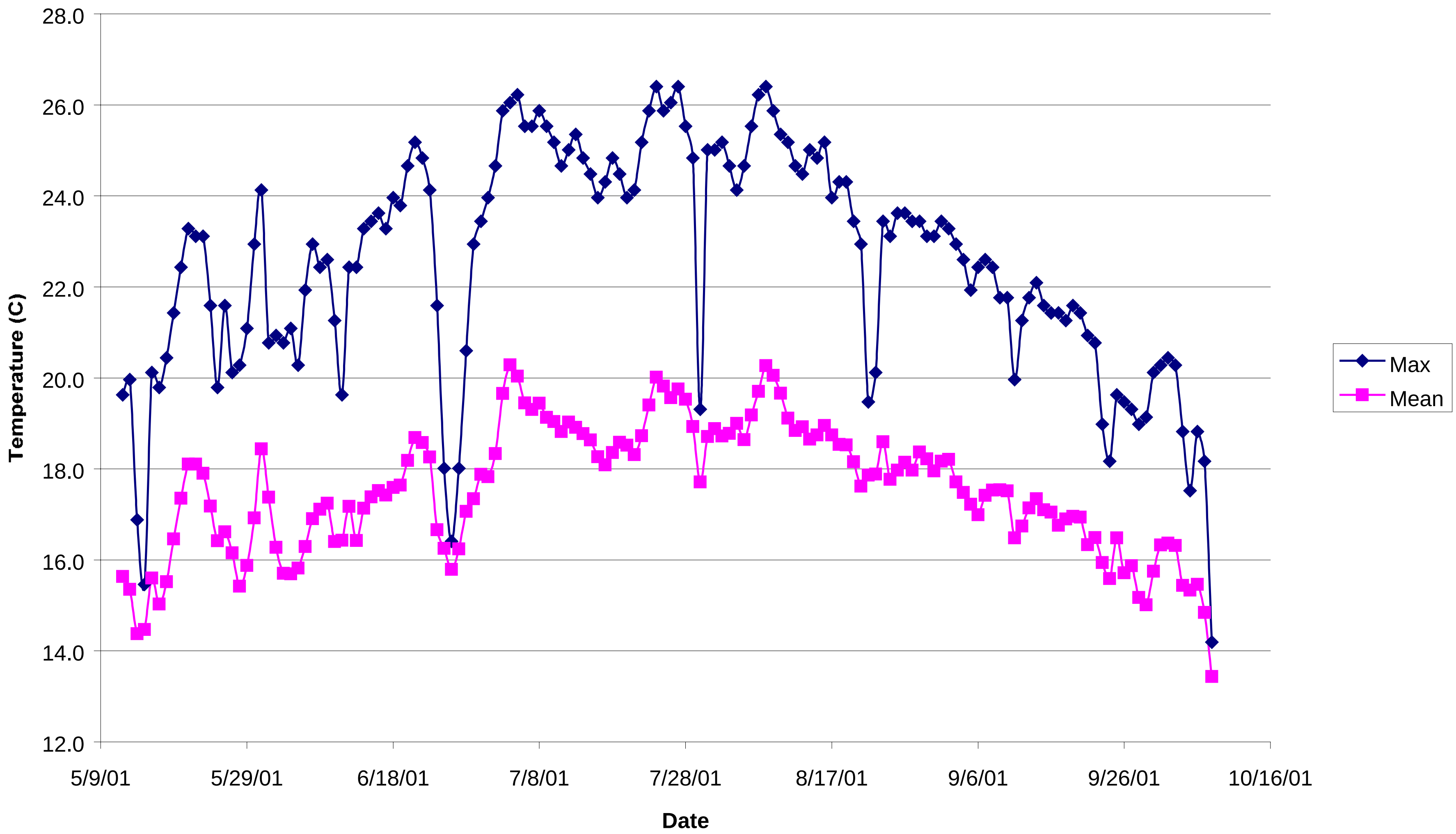
Mean and Maximum Daily Stream Temperatures During Summer 2001 at North Branch North Fork Navarro River (Site 81-1), Mendocino County, California.

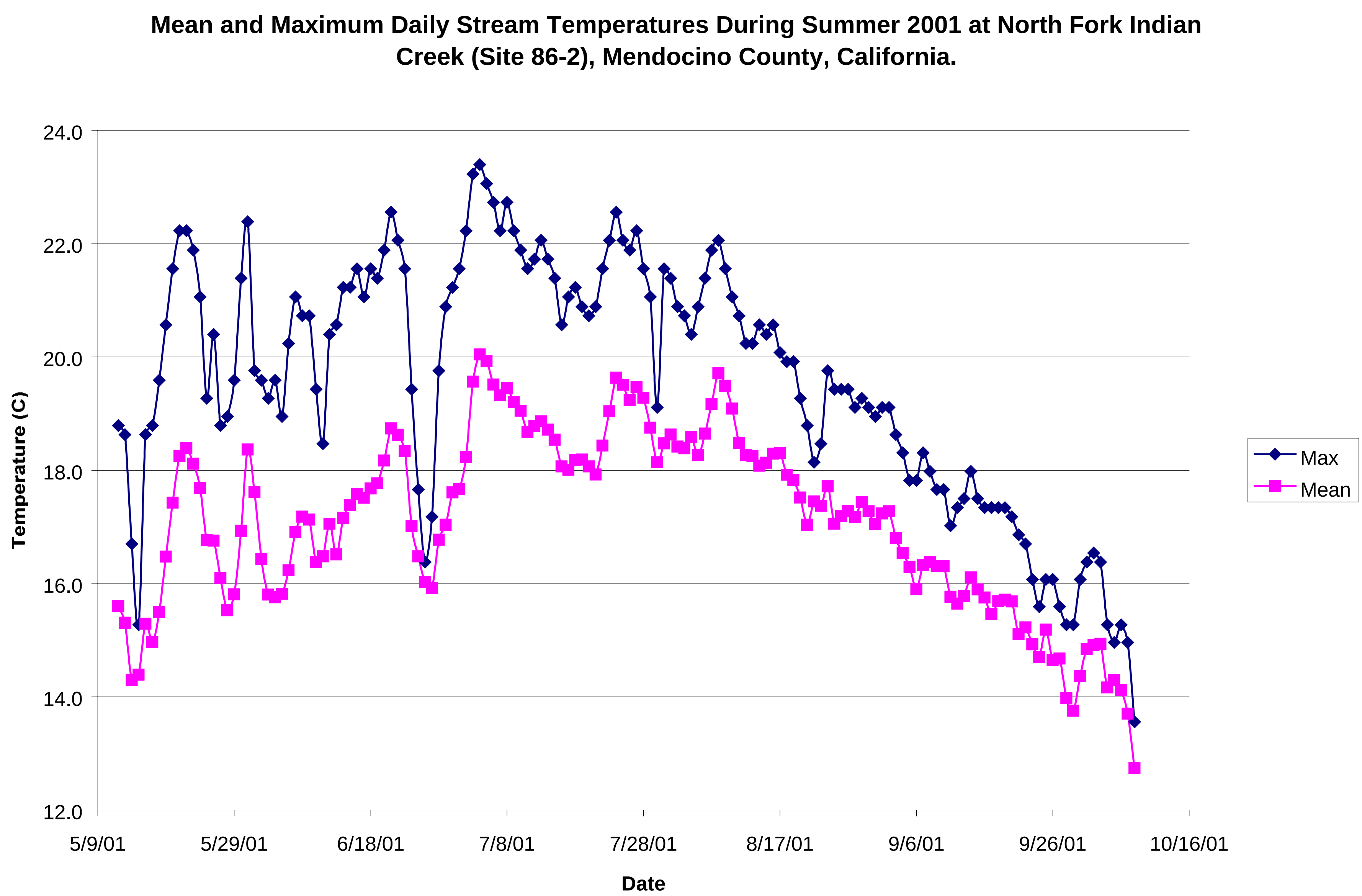




Mean and Maximum Daily Stream Temperatures During Summer 2001 at North Branch North Fork Navarro River (Site 81-3), Mendocino County, California.
20.0
19.0
18.0
17.0
16.0
15.0
14.0
13.0
12.0
11.0
Temperature (C)
5/9/01
5/29/01
6/18/01
7/8/01
7/28/01
8/17/01
9/6/01
9/26/01
10/16/01
Date
Max
Mean

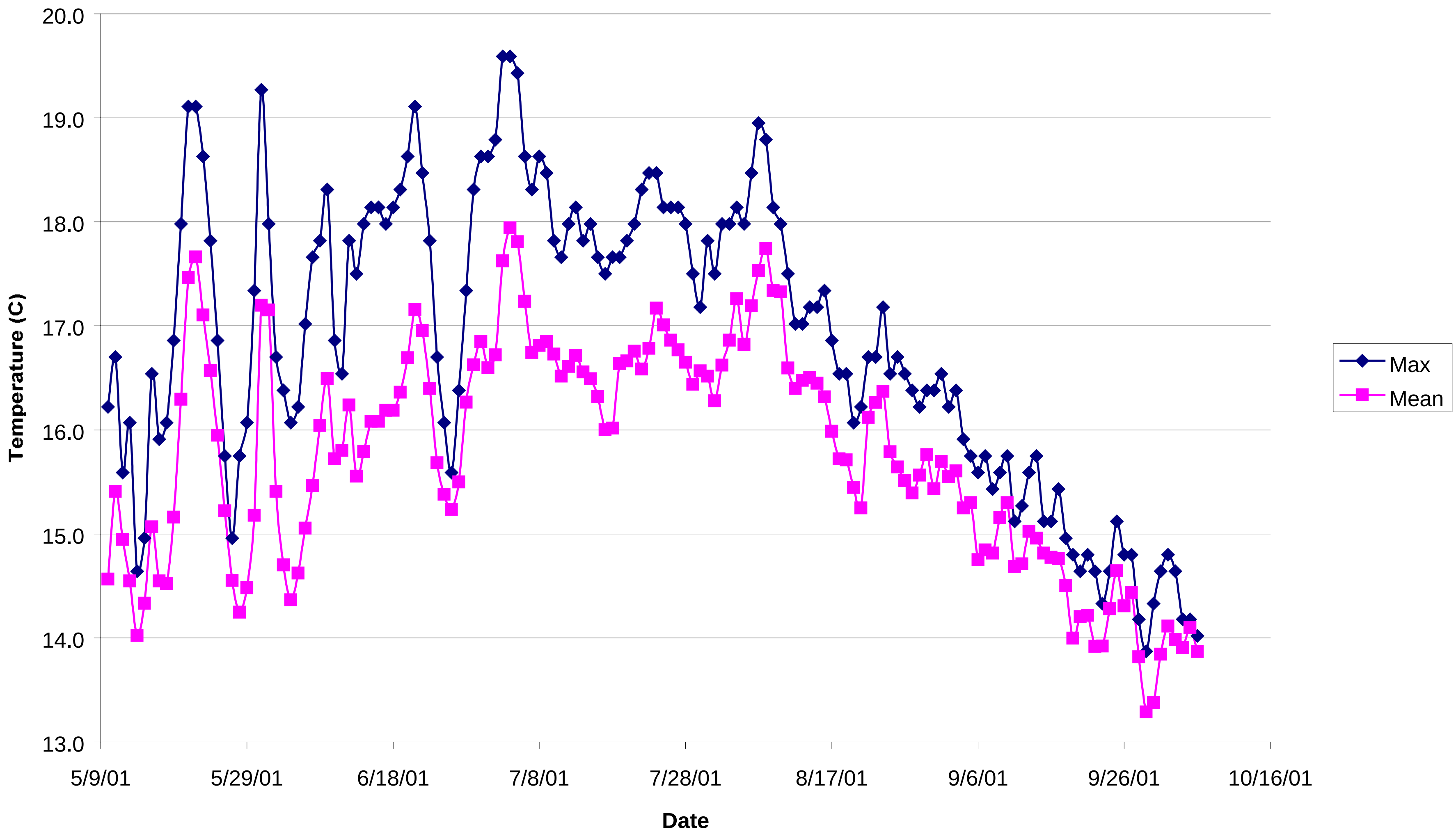
Mean and Maximum Daily Stream Temperatures During Summer 2001 at North Fork Indian Creek (Site 86-1), Mendocino County, California.



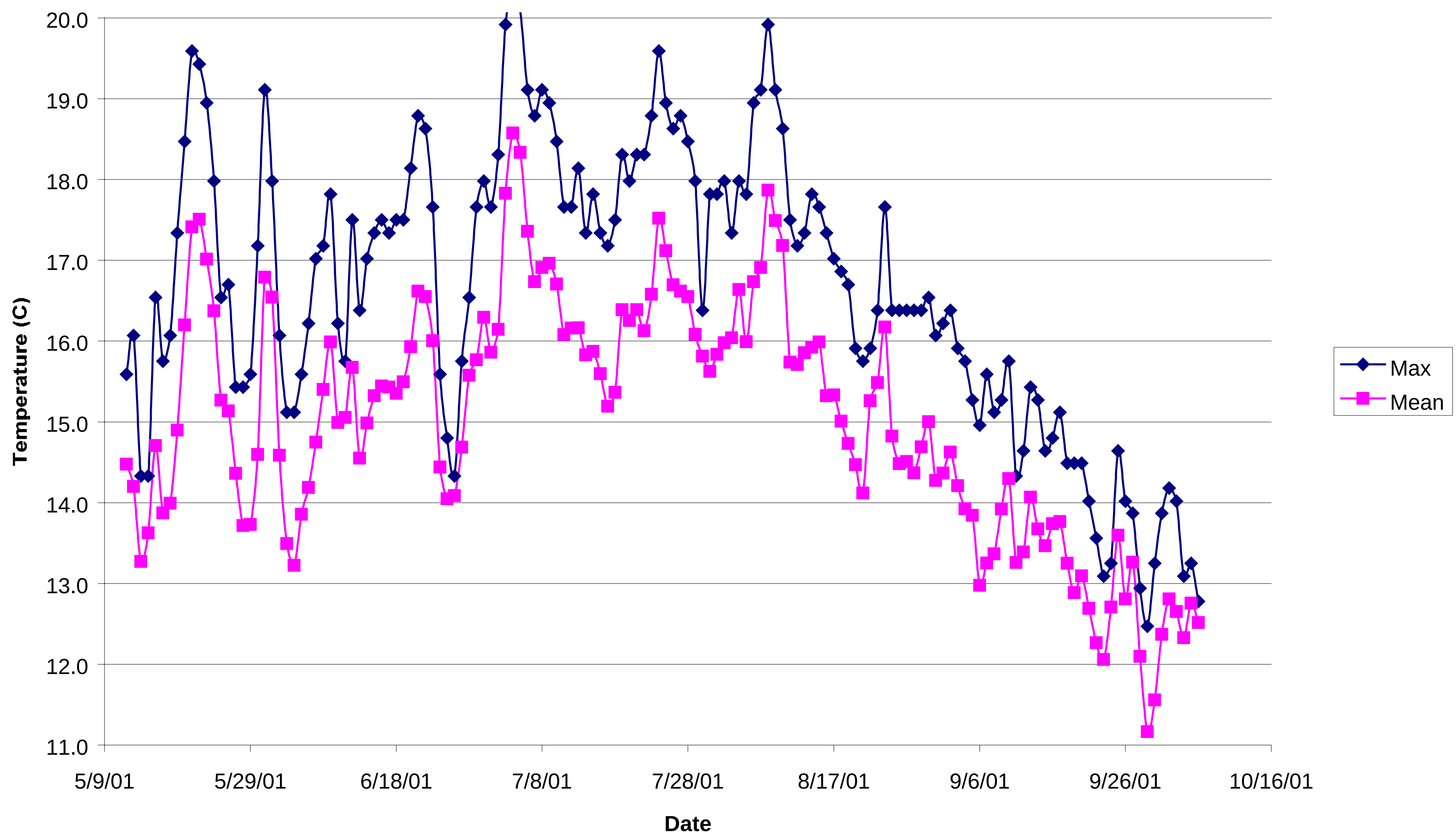


Mean and Maximum Daily Stream Temperatures During Summer 2001 at North Fork Indian Creek (Site 86-2), Mendocino County, California.
24.0
22.0
20.0
18.0
16.0
14.0
12.0
Temperature (C)
5/9/01
5/29/01
6/18/01
7/8/01
7/28/01
8/17/01
9/6/01
9/26/01
10/16/01
Date
Max
Mean

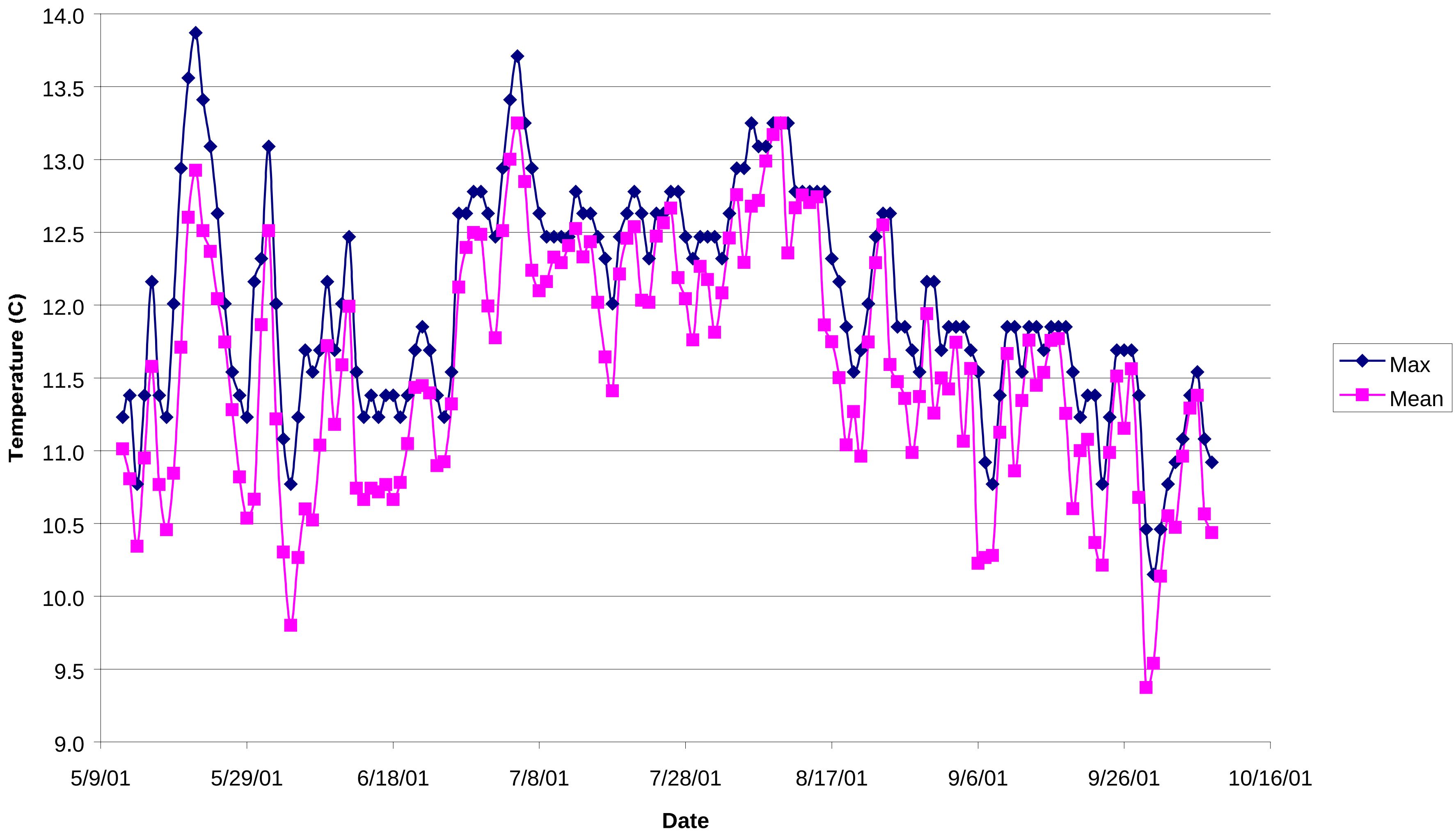
Mean and Maximum Daily Stream Temperatures During Summer 2001 at South Branch North Fork Navarro River (Site 85-1), Mendocino County, California.



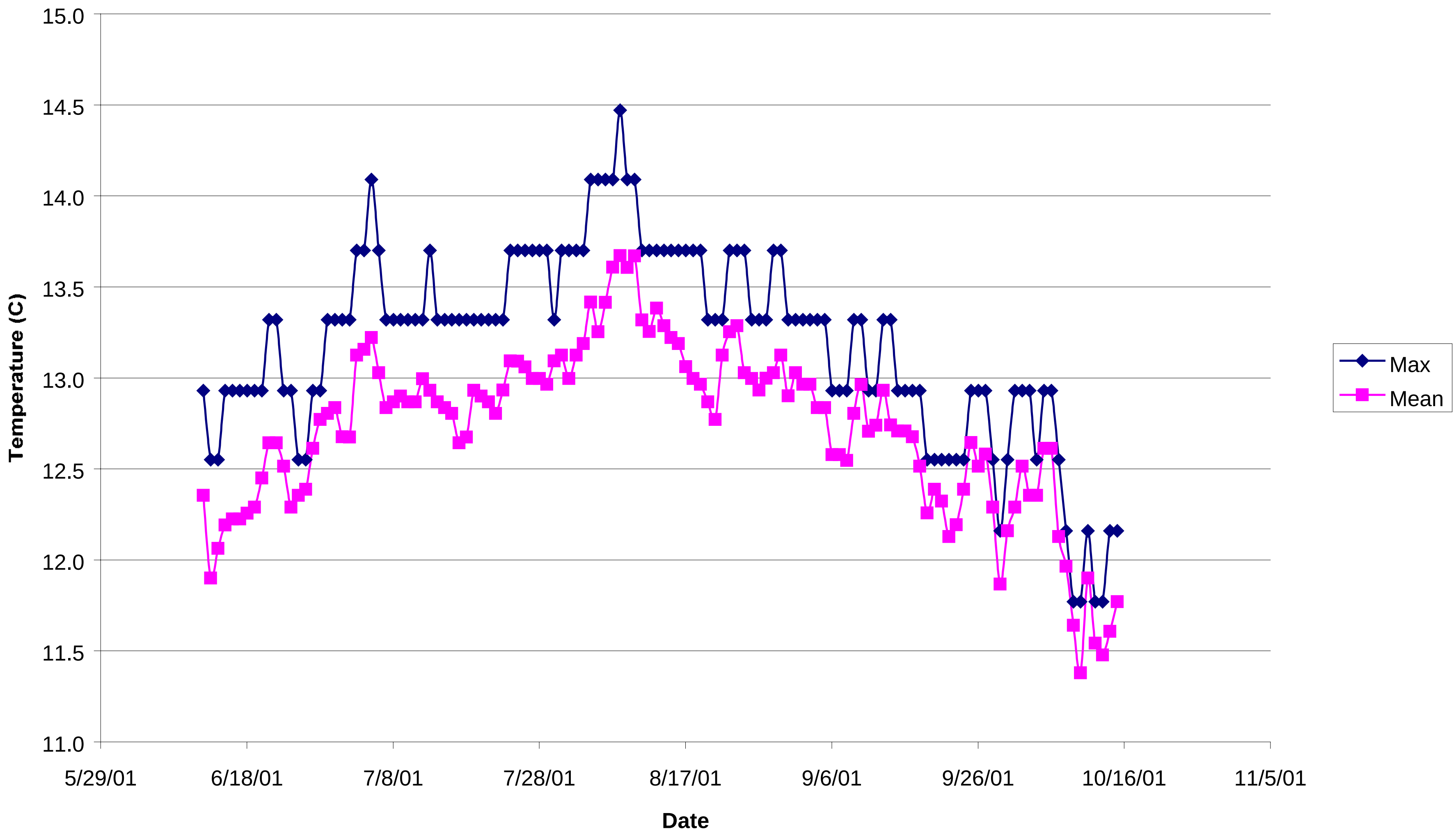
Mean and Maximum Daily Stream Temperatures During Summer 2001 at South Branch North Fork Navarro River Site (85-2), Mendocino County, California.



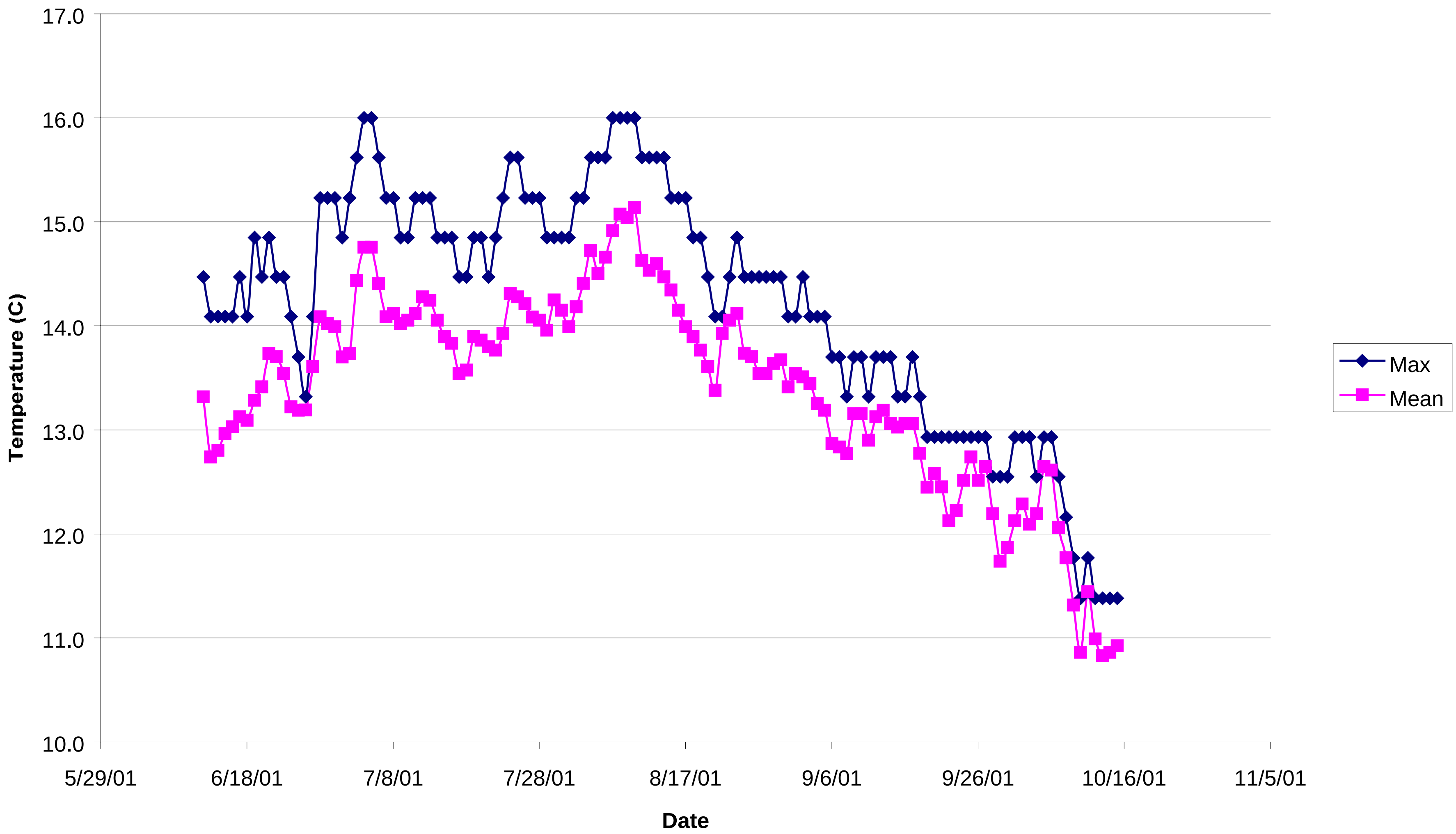
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Sheep Gulch (Site 81-5), Mendocino County, California.



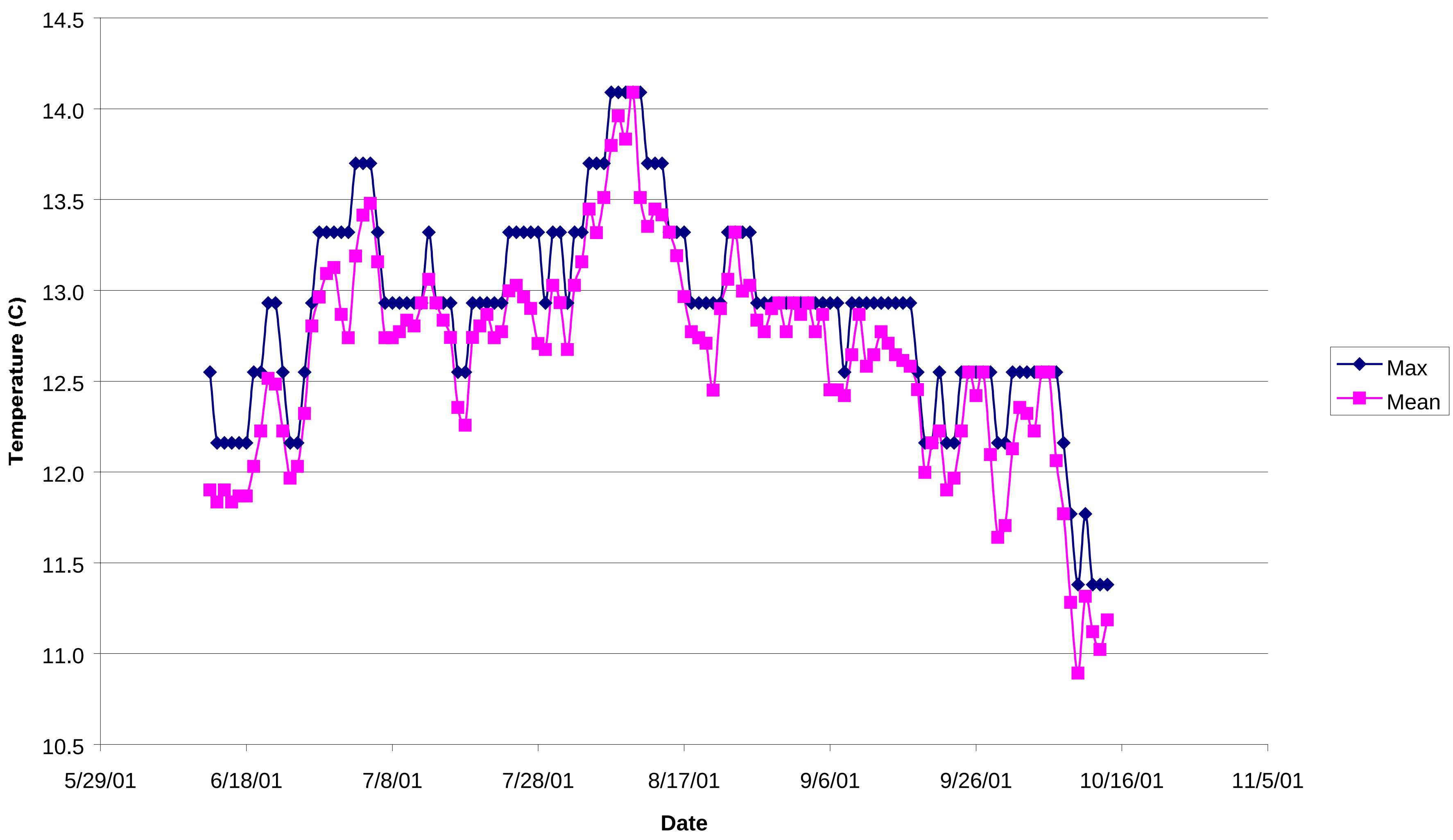
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Berry Creek (82-24), Mendocino County, California.



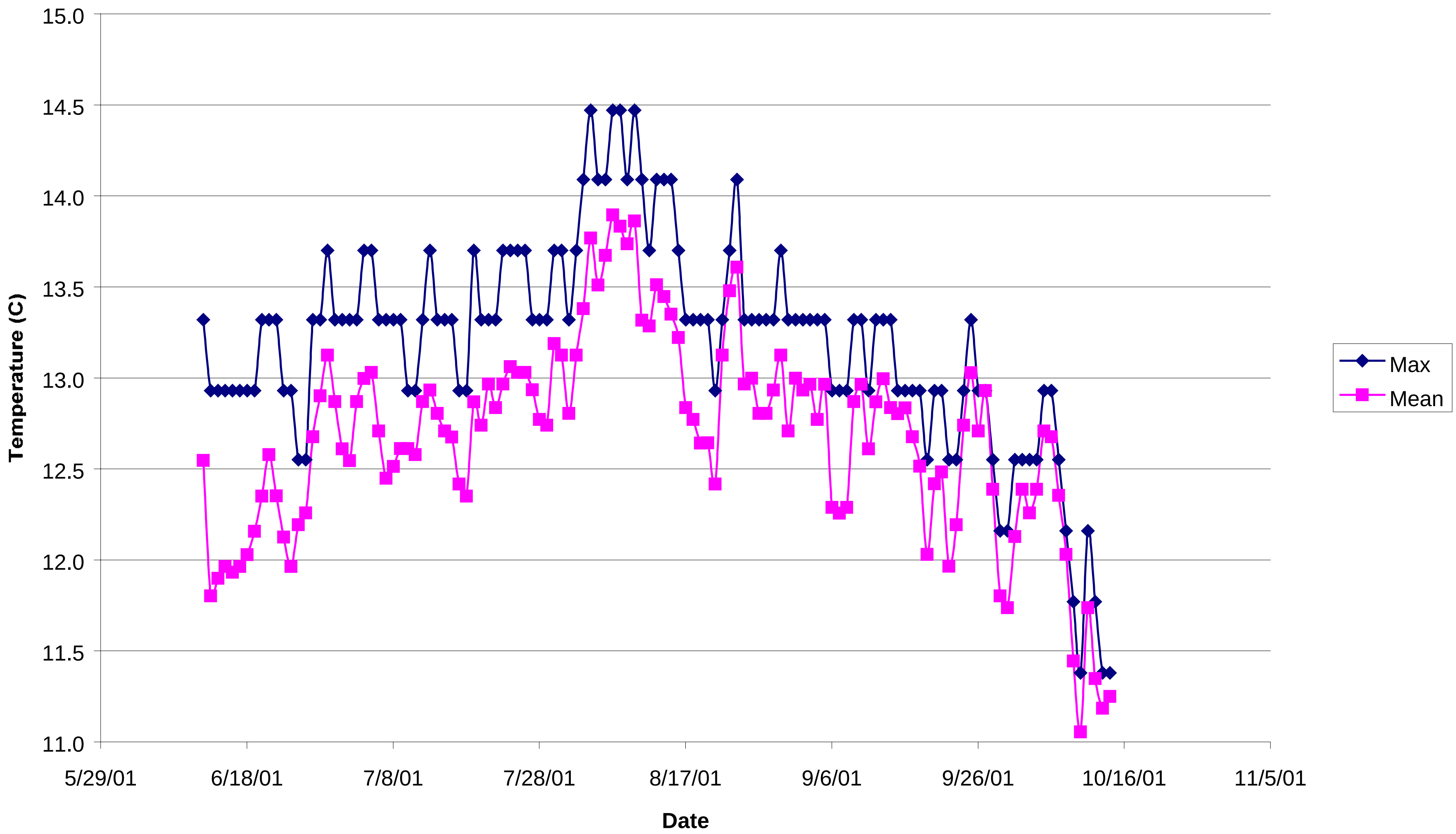
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Black Rock Creek (82-23), Mendocino County, California.



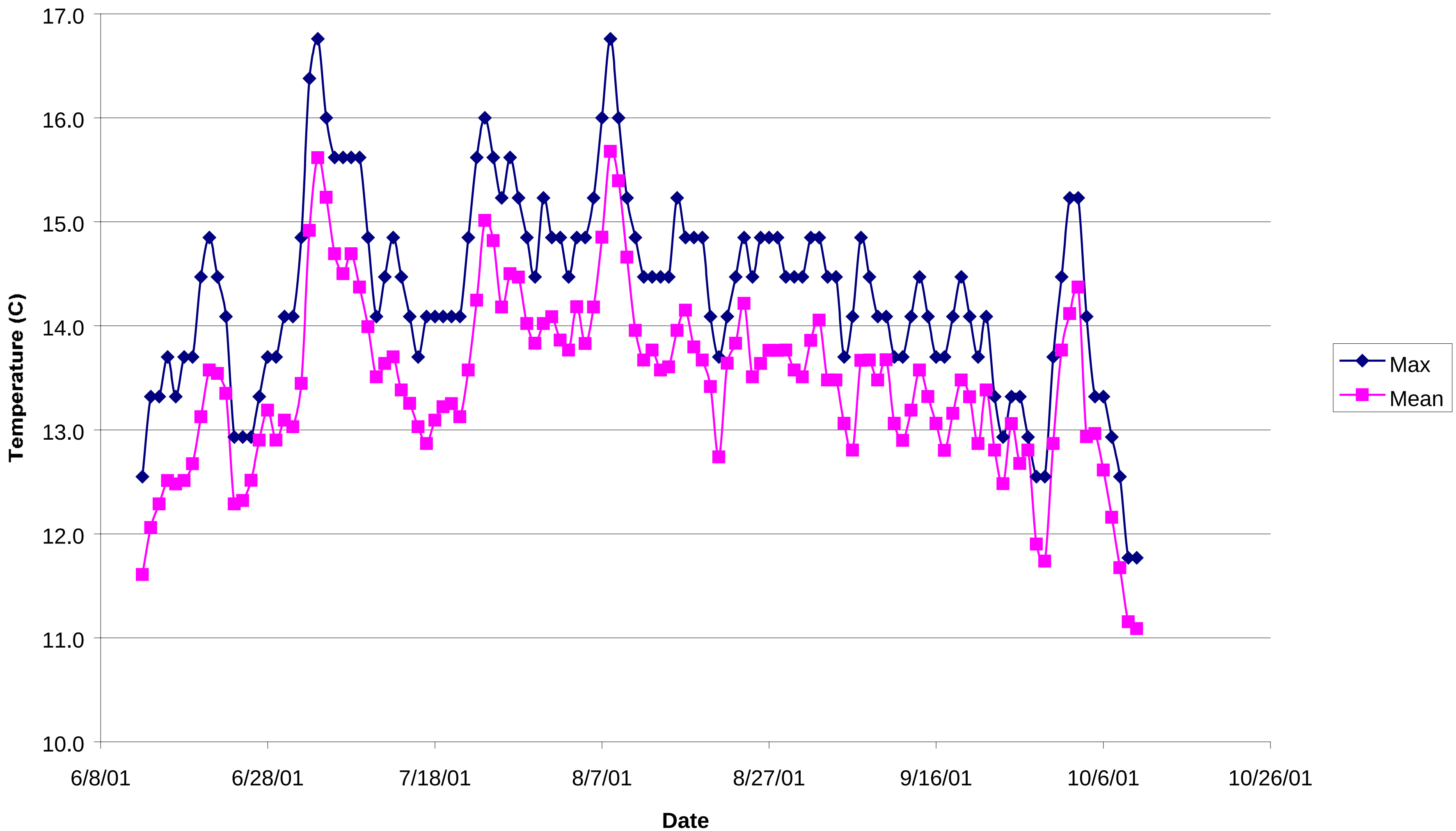
Mean and Maximum Stream Temperatures During Summer 2001 at Coon Creek(82-27), Mendocino County, California.



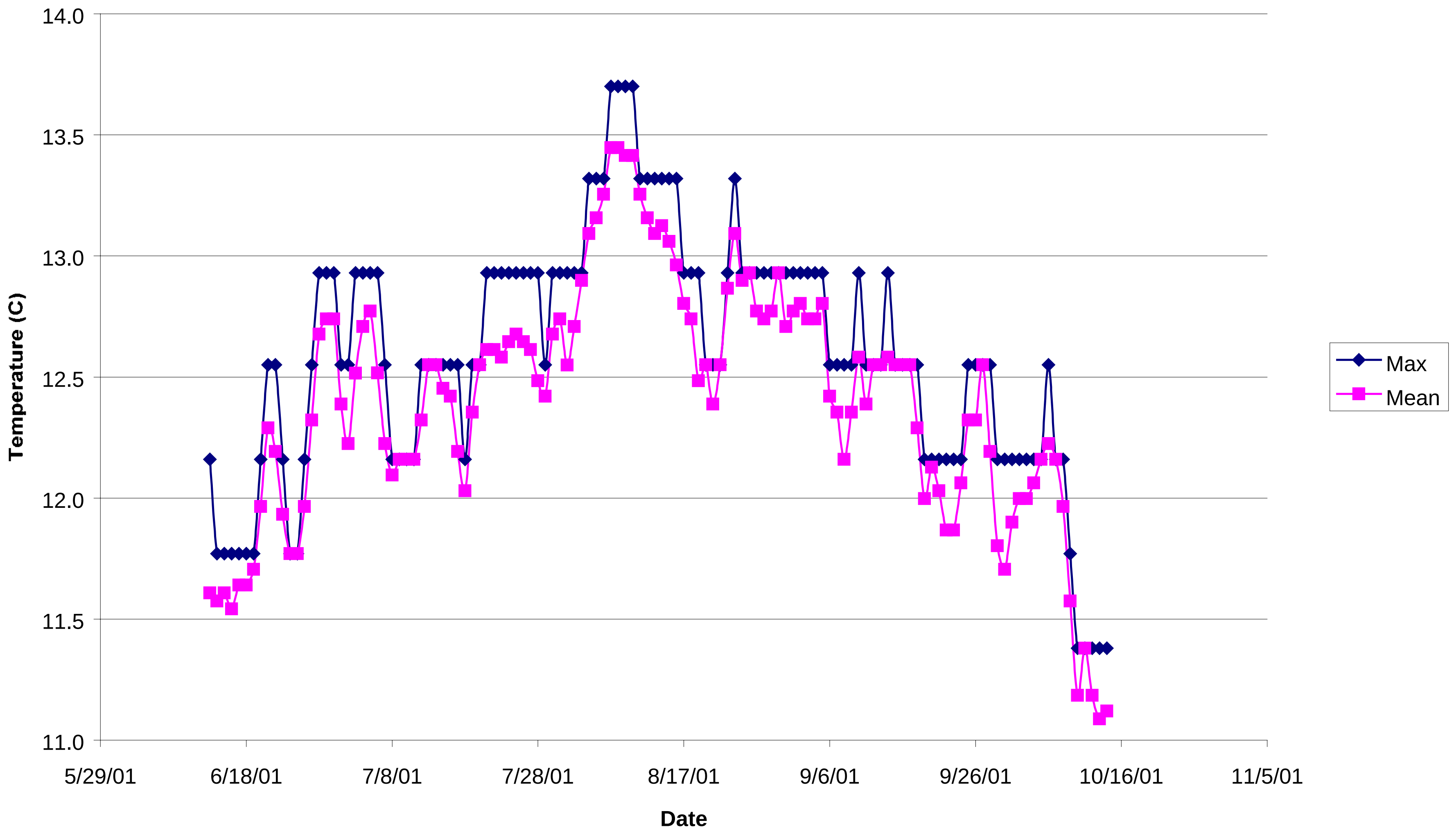
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Mustard Gulch (82-22), Mendocino County, California.



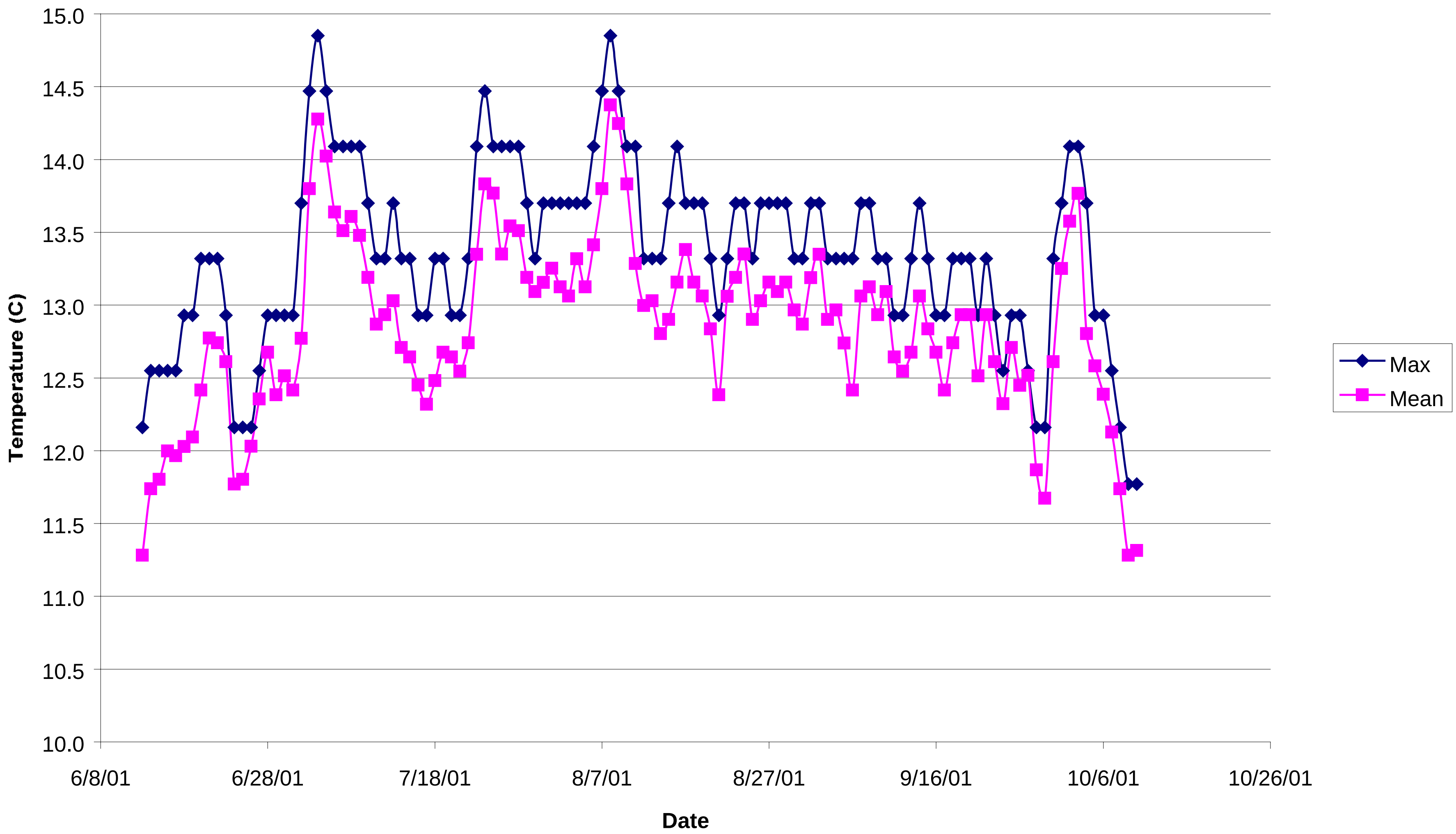
Mean and Maximum Daily Stream Temperatures During Summer 2001 at North Fork Rose Creek (85-20), Mendocino County, California.

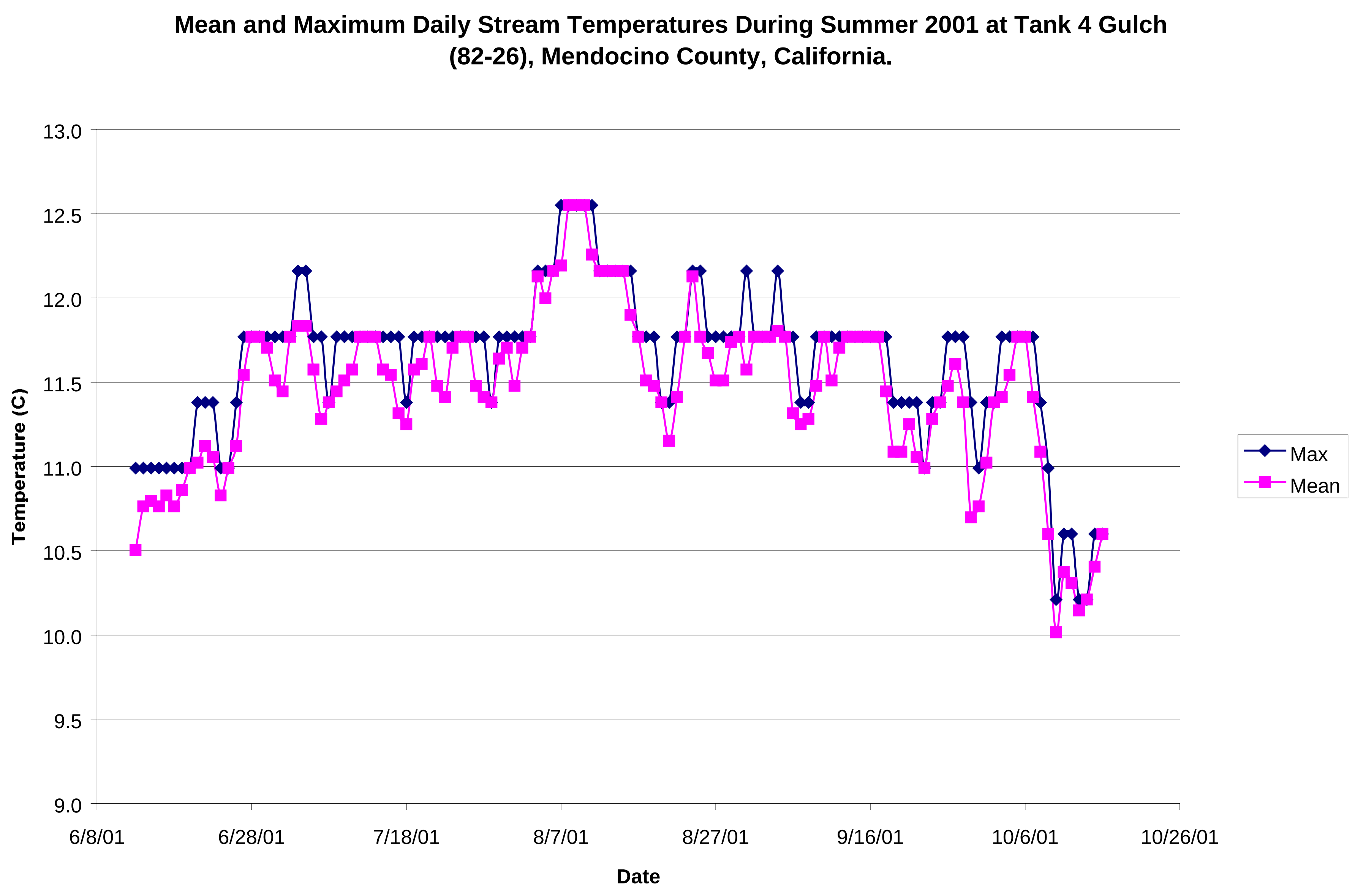


Mean and Maximum Daily Stream Temperatures During Summer 2001 at Ray Gulch (82-28), Mendocino County, California.

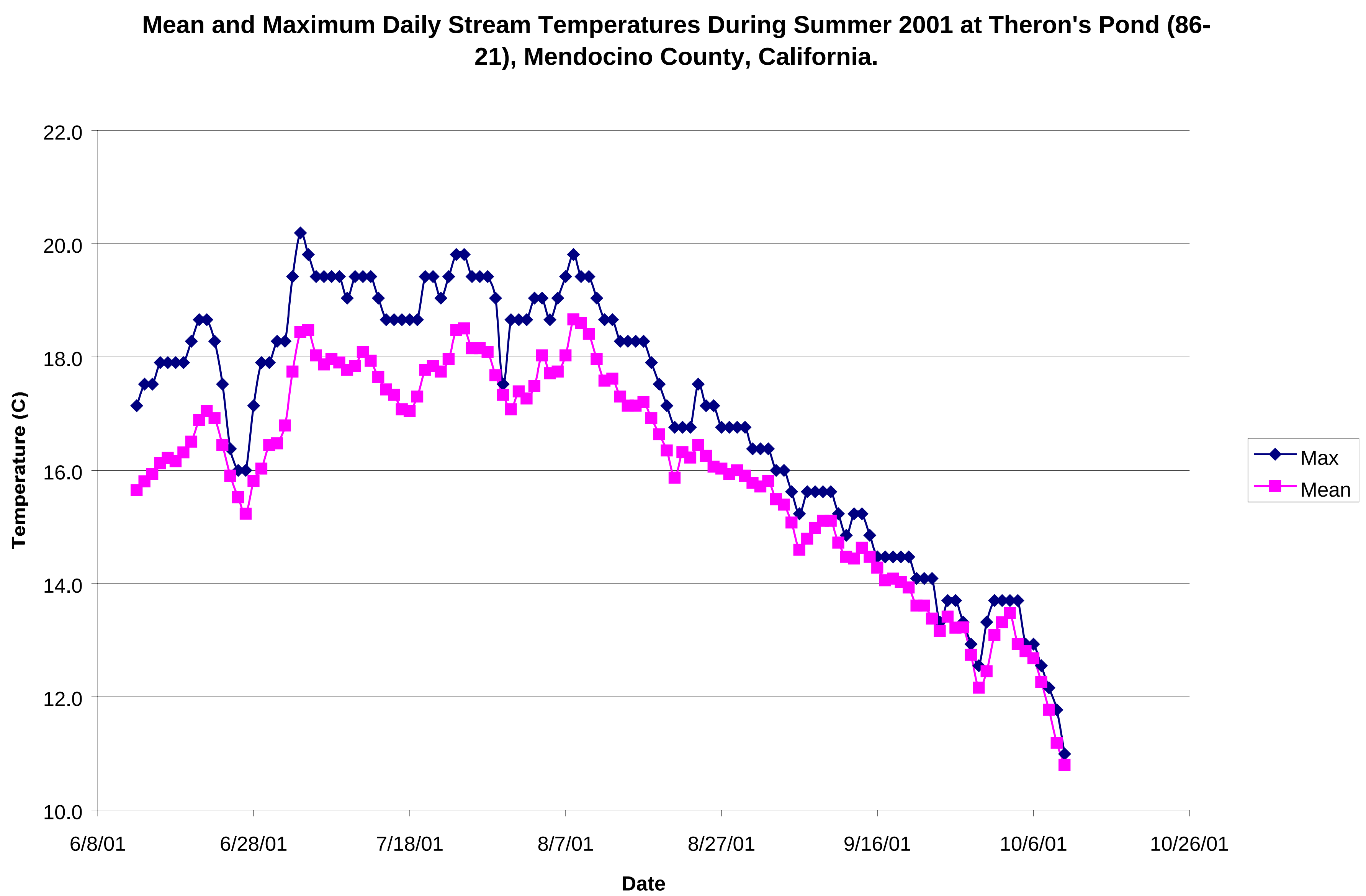


Mean and Maximum Daily Stream Temperatures During Summer 2001 at South Fork Rose Creek (85-21), Mendocino County, California.



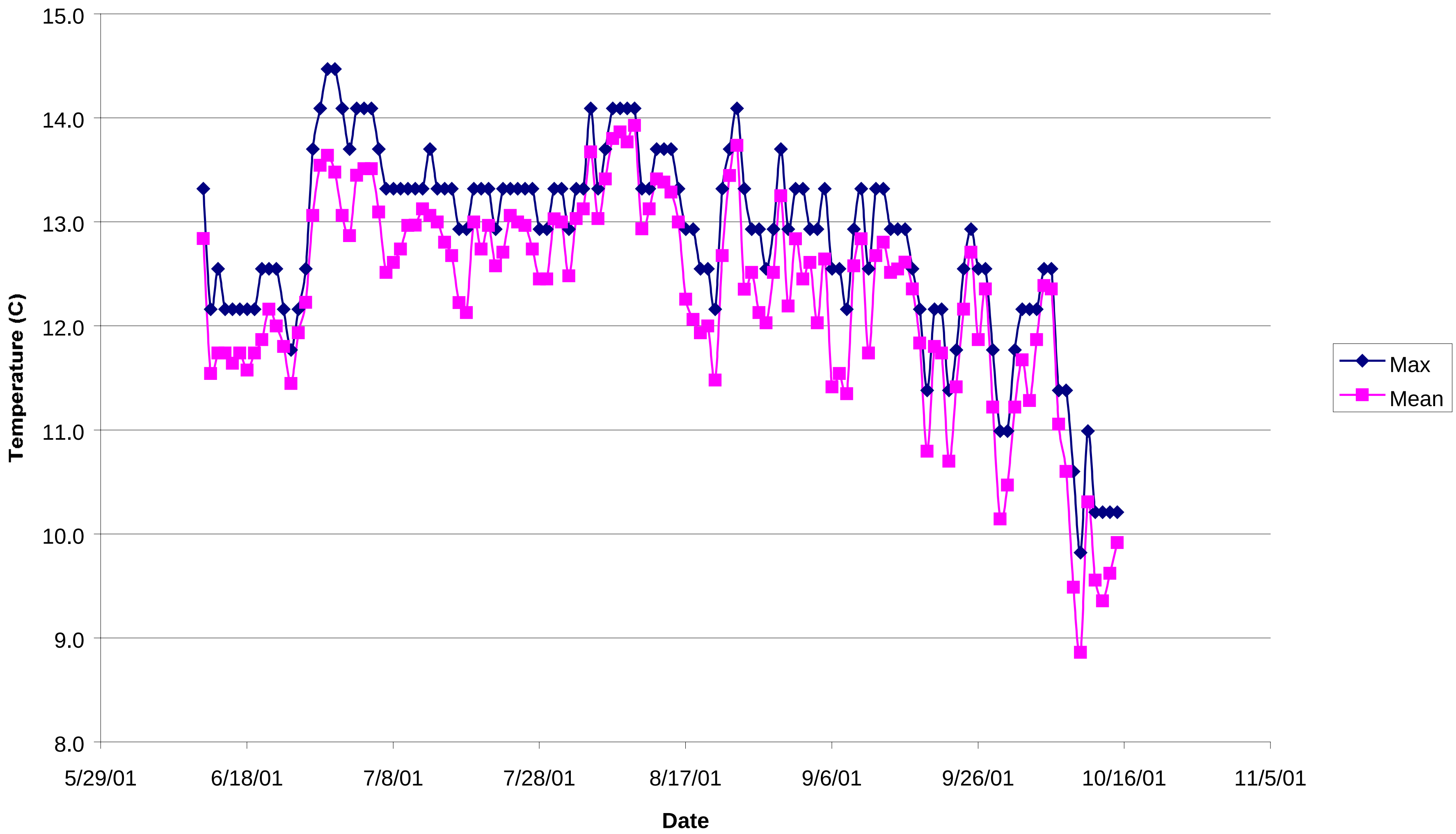


Mean and Maximum Daily Stream Temperatures During Summer 2001 at Tank 4 Gulch
(82-26), Mendocino County, California.
13.0
12.5
12.0
11.5
11.0
10.5
10.0
9.5
9.0
Temperature (C)
6/8/01
6/28/01
7/18/01
8/7/01
8/27/01
9/16/01
10/6/01
10/26/01
Date
Max
Mean

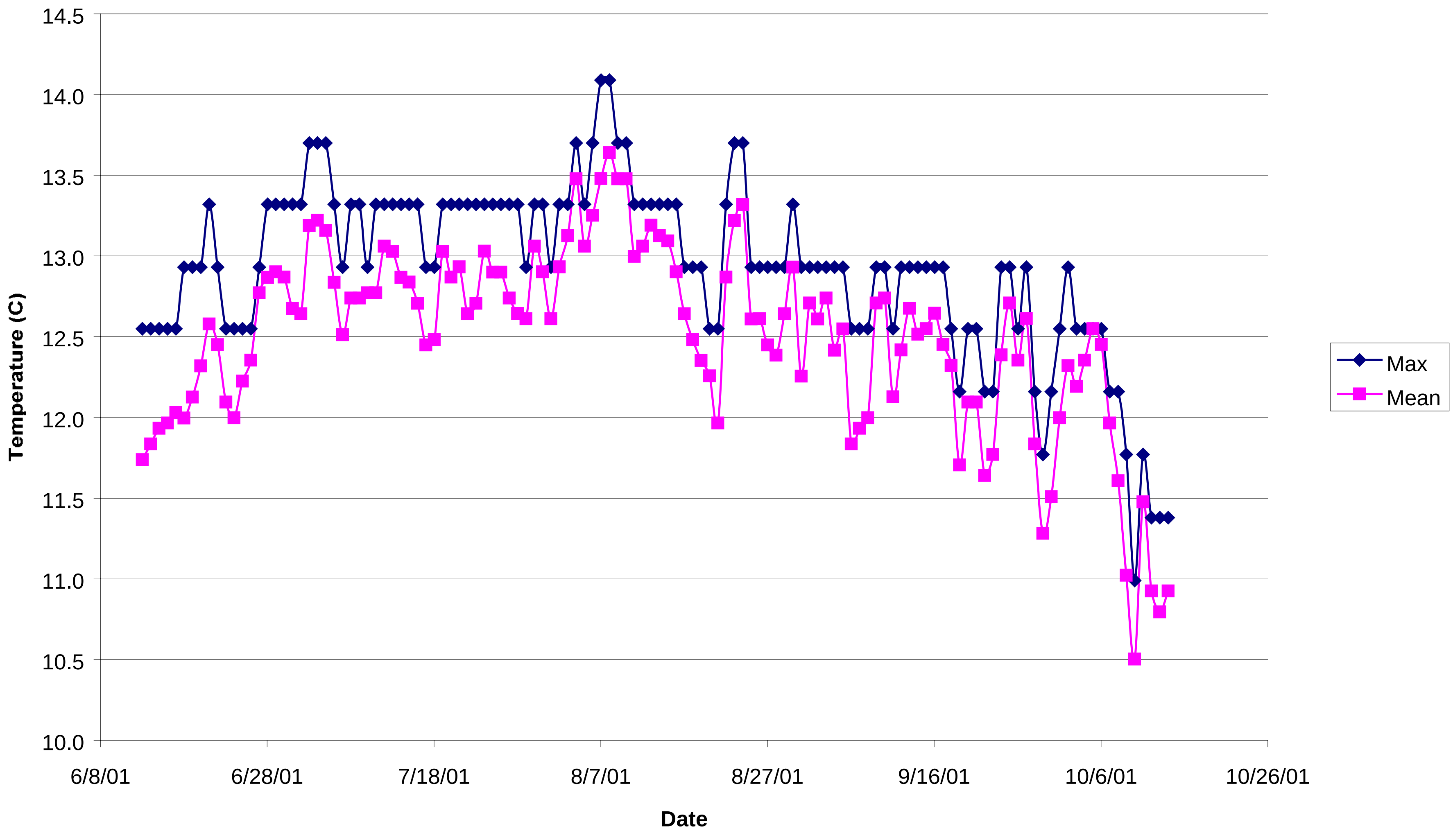


Mean and Maximum Daily Stream Temperatures During Summer 2001 at Theron's Pond (86-21), Mendocino County, California.
Temperature (C)
22.0
20.0
18.0
16.0
14.0
12.0
10.0
6/8/01
6/28/01
7/18/01
8/7/01
8/27/01
9/16/01
10/6/01
10/26/01
Date
Max
Mean

Mean and Maximum Daily Stream Temperatures During Summer 2001 at Tramway Gulch (82-25), Mendocino County, California.



Mean and Maximum Daily Stream Temperatures During Summer 2001 at Unnamed tributary to Flynn Creek (82-21), Mendocino County, California.



Mean and Maximum Daily Stream Temperatures During Summer 2001 at West Branch Indian Creek (86-20), Mendocino County, California.