Section D

Riparian Function

Introduction

An assessment was conducted of riparian function in the Noyo River Watershed Analysis Unit (WAU). This assessment is divided into two groups: 1) the potential of the riparian stand to recruit large woody debris (LWD) to the stream channel along with the level of concern about current LWD conditions in the stream, and 2) a canopy closure and stream temperature assessment. The LWD potential assessment evaluates short-term LWD recruitment, the next 2-3 decades. It shows what the current condition of the riparian stands are for generating LWD for stream habitat or stream channel stability. Field observations of current LWD levels in the stream channels are also presented along with the level of concern about the current condition of LWD in the stream compared to the riparian stand's ability to recruit LWD. The canopy closure and stream temperature assessment presents what the current canopy closure conditions are and what it means in context to the stream temperature monitoring which has been conducted. These evaluations are to provide baseline information on the current status of riparian stand function in the Noyo WAU.

Large Woody Debris Recruitment

Large woody debris (LWD) is widely recognized as an important part of the aquatic ecosystem (i.e. Swanson and Lienkaemper, 1978; Bilby and Likens, 1979; Bisson et. al., 1978). LWD has been recognized as a vital component of high quality habitat for anadromous fish (Bisson et. al., 1978). LWD provides an organic energy source for aquatic organisms, controls the routing of sediment through stream systems, and provides structure to the streambed and banks (Swanson and Lienkaemper, 1978; Bilby and Likens, 1979). Forest harvesting activities have affected large woody debris recruitment by removal of vegetation which could have been delivered to watercourses or salvage of downed LWD from the watercourse or adjacent banks. Furthermore, removal of LWD log jams throughout the Noyo WAU was done in the 1950's and 1960's (California Department of Fish and Game, 1966)(Table D-1). At that time large LWD accumulations were considered adverse to fish habitat and passage. Between 1959 and 1964 California Department of Fish and Game removed LWD accumulations by burning in channel and cutting material and placing it above the floodplain. The quantities of material (in board feet (bf)) removed from the tributaries is listed (Table D-1).

Table D-1. Large Woody Debris Removed in the Noyo WAU, 1959-1964.

Tributary	LWD Removed
Little North Fork Noyo	201,420 bf.
North Fork Noyo	18,000 bf.
Hayworth Creek	2,232,480 bf.
Burbeck Creek	67,800 bf.
Marble Gulch	604,440 bf.
Olds Creek	153,900 bf.
Redwood Creek	590,244 bf.
McMullen Creek	299,340 bf.

Large Woody Debris Recruitment Potential and In-stream Demand Methods

Short-term LWD recruitment potential (next 20-30 years) was evaluated in designated stream segments within the Noyo WAU. Stream segments were designated in the stream channel condition assessment and are shown on map E-1. Generally a stream segment was designated on any watercourse with less than a 20 percent gradient. In this assessment LWD recruitment is assumed to be influenced by the vegetation type, size and density with the best riparian vegetation for LWD recruitment to the watercourse 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 1998. 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:

<u>Vegetation Classes</u>

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

<u>Vegetation Size Classes</u>

1 - < 8 inches 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 starting with the proportion of basal area in size class 5 and summing the percentage of basal area in each lower size class. The size class that the sum exceeds 50% of the total basal area is the size class for 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 the condition of the riparian areas 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 LWD recruitment is assumed to be influenced by the vegetation type, size and density with the best riparian vegetation for LWD recruitment to the watercourse being large conifer trees. The LWD recruitment potential ratings reflect this. The following table presents the vegetation classifications 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 Noyo 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)	Dense (M, D, E)	Sparse (O,L)	Dense (M, D, E)
RW	Low	Low	Moderate	High	High	High
RD	Low	Low	Moderate	High	High	High
CH	Low	Low	Low	Moderate	High	High
MH	Low	Low	Low	Low	Moderate	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 the each sampled stream segment. Functional LWD is LWD 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 is no minimum size requirement for functional LWD. The dimensions of the functional LWD was recorded by diameter (within ± 2 inches) and length (within ± 5 feet). 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). LWD associated with an accumulation of 3 pieces or more, is recorded and the number of LWD accumulations in the stream survey reach is tallied. 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

The quantity of LWD observed is 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 is done by dividing the total number of LWD pieces in a survey segment by the length of the segment then by 100 meters. This normalized quantity, by distance, is performed for functional LWD within the active channel, within the bankfull channel and for key LWD pieces within the active channel 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 Noyo WAU.

	# Key Pieces		
Bankfull Width (ft)	**Per 328 feet**	**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 Noyo 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 Steam 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

Recruitment Potential Rating

LWD On Target **LWD Off Target**	**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.

Large Woody Debris Recruitment Potential and In-stream Demand Results

The large woody debris recruitment potential and in-stream LWD demand for the Noyo 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. LWD was determined to be sparse in the mainstem channel segments of the Noyo WAU; the Noyo River, North Fork Noyo River, and Hayworth Creek. Most sections of these mainstem rivers are large channels with high stream power. In the mainstem rivers of the Noyo River WAU very large LWD pieces or large debris jams are required to keep the LWD in the channel during high flow events. Recruiting and keeping large woody debris in the mainstem river channels of Noyo WAU will be a challenge.

LWD was determined to be mainly sparse with some areas of abundant LWD in the channel segments of Redwood Creek, Olds Creek, Middle Fork of the North Fork Noyo River, Burbeck Creek, and Marble Gulch. These areas are the medium sized creeks in the Noyo WAU so LWD should be not be as difficult to maintain as the larger mainstem rivers of the Noyo WAU. However, key LWD will still need to be fairly large.

The smaller tributaries of the Noyo WAU vary from having sparse to abundant LWD in their channel segments. These tributaries have smaller channels, than the mainstem rivers, and a higher probability of large woody debris remaining in the channel during high flows. Small LWD pieces recruited in the tributary channels will have a higher probability of success than along the mainstem rivers of the Noyo WAU.

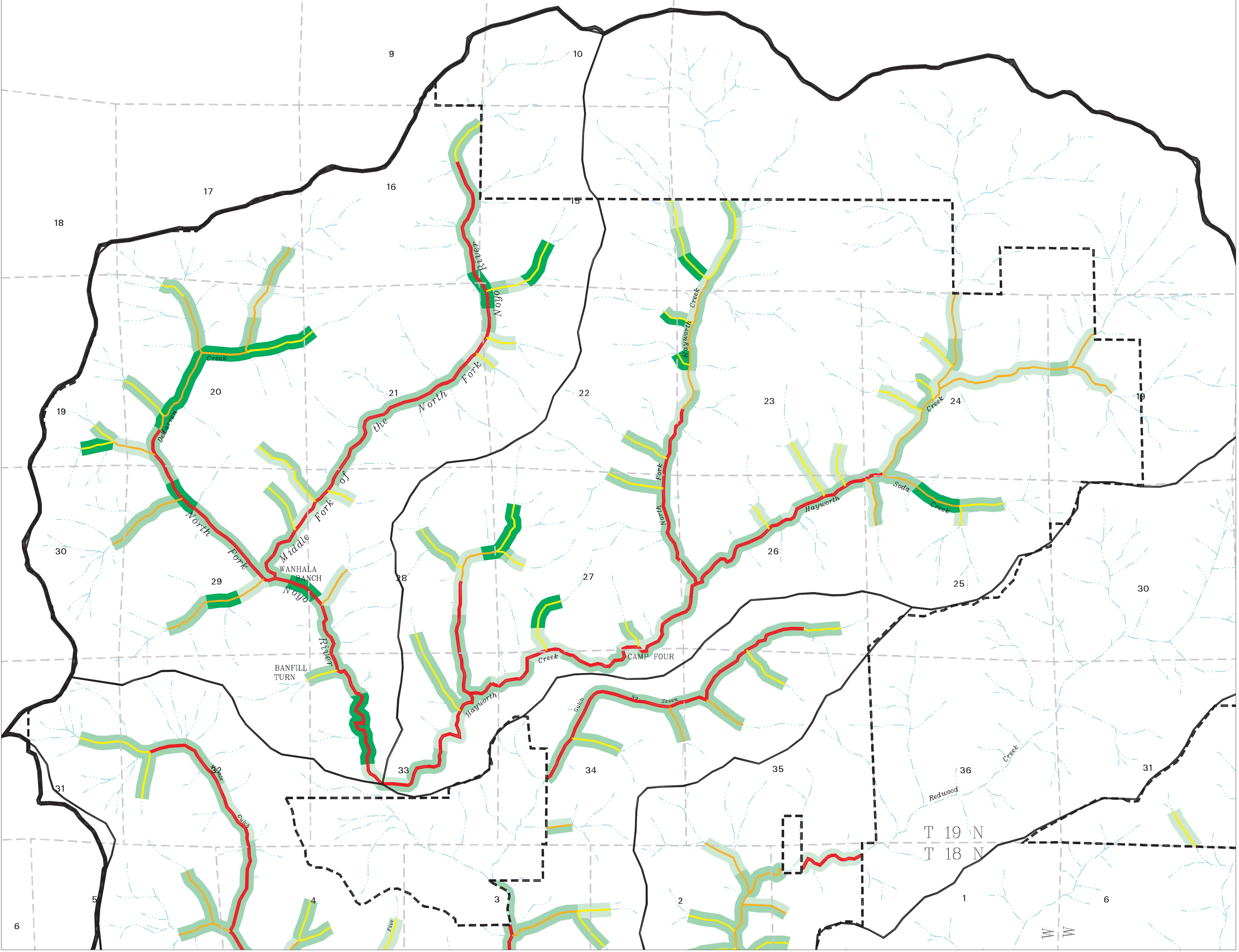
As shown in Table D-6, there is still a need for more large woody debris in many of the channel segments of the Noyo River tributaries. The channel segments with low LWD will need to be the priority for monitoring future recruitment or restoration work. Likewise, the channel segments with abundant large woody debris needs to have these levels maintained to ensure LWD is providing fish habitat and morphological function in the stream channels.

Currently in the Noyo WAU most of the streams are in the high and moderate in-stream LWD demand classification (Map D-1). The increased in-stream LWD demand in the Noyo WAU are primarily from low levels of LWD in the stream channels compounded by many riparian stands with moderate to low LWD recruitment potential.

Table D-6. Large Woody Debris in Selected Stream Segments of the Noyo WAU
(This information is also reported in the Stream Channel Condition module of this report.)

		Active Channel				**Bankfull Channel**				**Overall**
Stream Segment Name	Stream Segment* ID #	Functional LWD (# pieces)	Functional LWD (# /100 m)	Key LWD (# pieces)	Key LWD (# /100 m)	Functional LWD (# in bfull)	Functional LWD (bf #/100m)	Key LWD (# in bfull)	Key LWD (bf #/100m)	Percent Current/Relic Recruitment
Noyo River	56	3	0.8	1	0.3	5	1.3	2	0.5	n/a
Noyo River	1	10	2.1	2	0.4	11	2.3	2	0.4	90/10
North Fork Noyo	3	1	0.2	4	0.9	8	1.8	4	0.9	n/a
Hayworth	104	0	0.0	0	0.0	2	0.8	0	0.0	n/a
North Fork Noyo	152	4	2.0	0	0.0	4	2.0	1	0.5	n/a
Olds Creek	57	2	1.1	0	0.0	0	0.0	0	0.0	n/a
Marble Gulch	23	5	2.7	3	1.6	6	3.2	6	3.2	65/35
Hayworth Creek	106	3	0.9	0	0.0	5	1.5	1	0.3	60/40
Hayworth Creek	118	11	4.4	1	0.4	80	32.2	14	5.6	70/30
North Fork Noyo	152(2)	9	3.5	3	1.2	16	6.2	3	1.2	70/30
Redwood Creek	92	12	5.4	2	0.9	13	5.9	0	0.0	100/0
Redwood Creek	92(2)	35	10.8	5	1.5	38	11.7	6	1.8	n/a
Burbeck trib.	80	5	3.3	0	0.0	1	0.7	2	1.3	80/20
Upper trib. of Noyo	64	7	7.7	0	0.0	2	2.2	0	0.0	100/0
Unnamed trib. of Noyo	63	22	11.0	4	2.0	5	2.5	2	1.0	80/20
Gulch # 7	48	15	14.5	3	2.9	15	14.5	3	2.9	80/20
Middle Fork North Fork	153	19	8.7	0	0.0	22	10.1	1	0.5	90/10
Middle Fork North Fork	153(2)	13	9.3	1	0.7	15	10.7	3	2.1	90/10
North Fork Noyo	159(1)	10	3.6	4	1.4	27	9.8	4	1.4	90/10
North Fork Noyo	159(2)	24	14.7	0	0.0	26	15.9	0	0.0	95/5
Middle Fork North Fork	156	15	7.3	6	2.9	25	12.2	7	3.4	n/a
DeWarren Creek	161	51	33.5	11	7.2	51	33.5	15	9.8	80/20
North Fork Hayworth	112	1	0.5	2	1.1	31	16.9	26	14.2	10/90
Soda Creek	119	55	36.1	11	7.2	66	43.3	16	10.5	15/85

* - Stream segment identification numbers are shown on Map E-1, in the Stream Channel Condition module of this report.



Noyo River Watershed Analysis Unit

Map D-1 Large Woody Debris Recruitment Potential and Demand

LWD Recruitment Potential Classes

- High
- Moderate
- Low

Instream LWD Demand

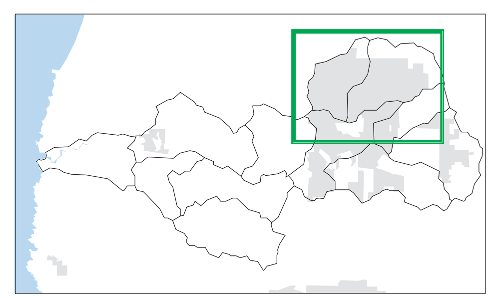
- High
- Moderate
- Low

Flow Class

- Class I
- Class II
- Class III

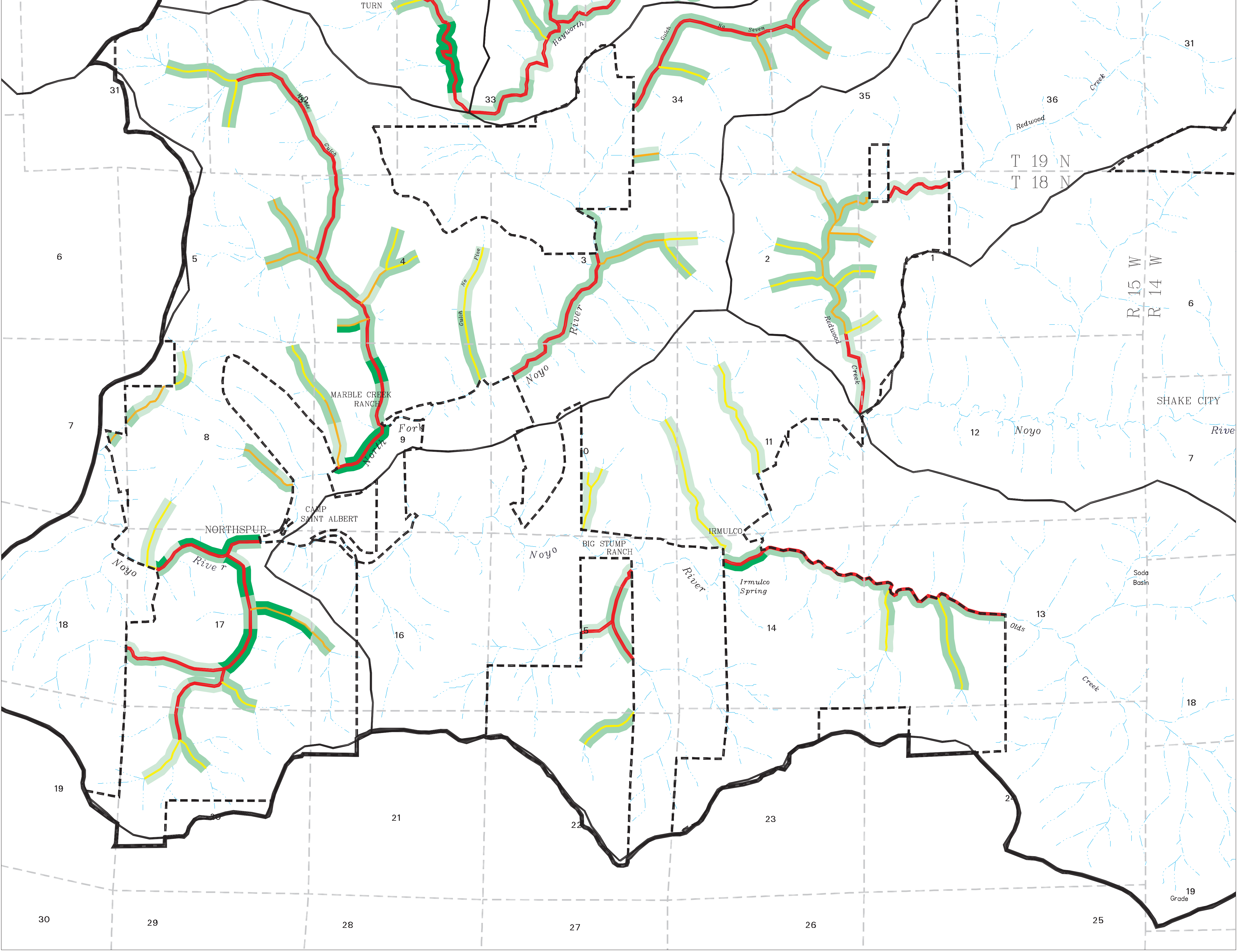
- MRC Ownership
- WWAA Boundary
- Planning Watershed Boundary

Sheet 1



0 1/2 1 Mile

July 18, 2000



Noyo River Watershed Analysis Unit

Map D-1 Large Woody Debris Recruitment Potential and Demand

LWD Recruitment Potential Classes

- High
- Moderate
- Low

Instream LWD Demand

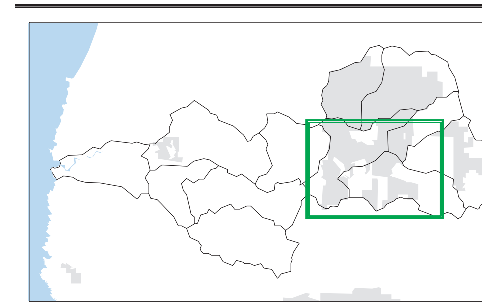
- High
- Moderate
- Low

Flow Class

- Class I
- Class II
- Class III

- MRC Ownership
- WWAA Boundary
- Planning Watershed Boundary

Sheet 2



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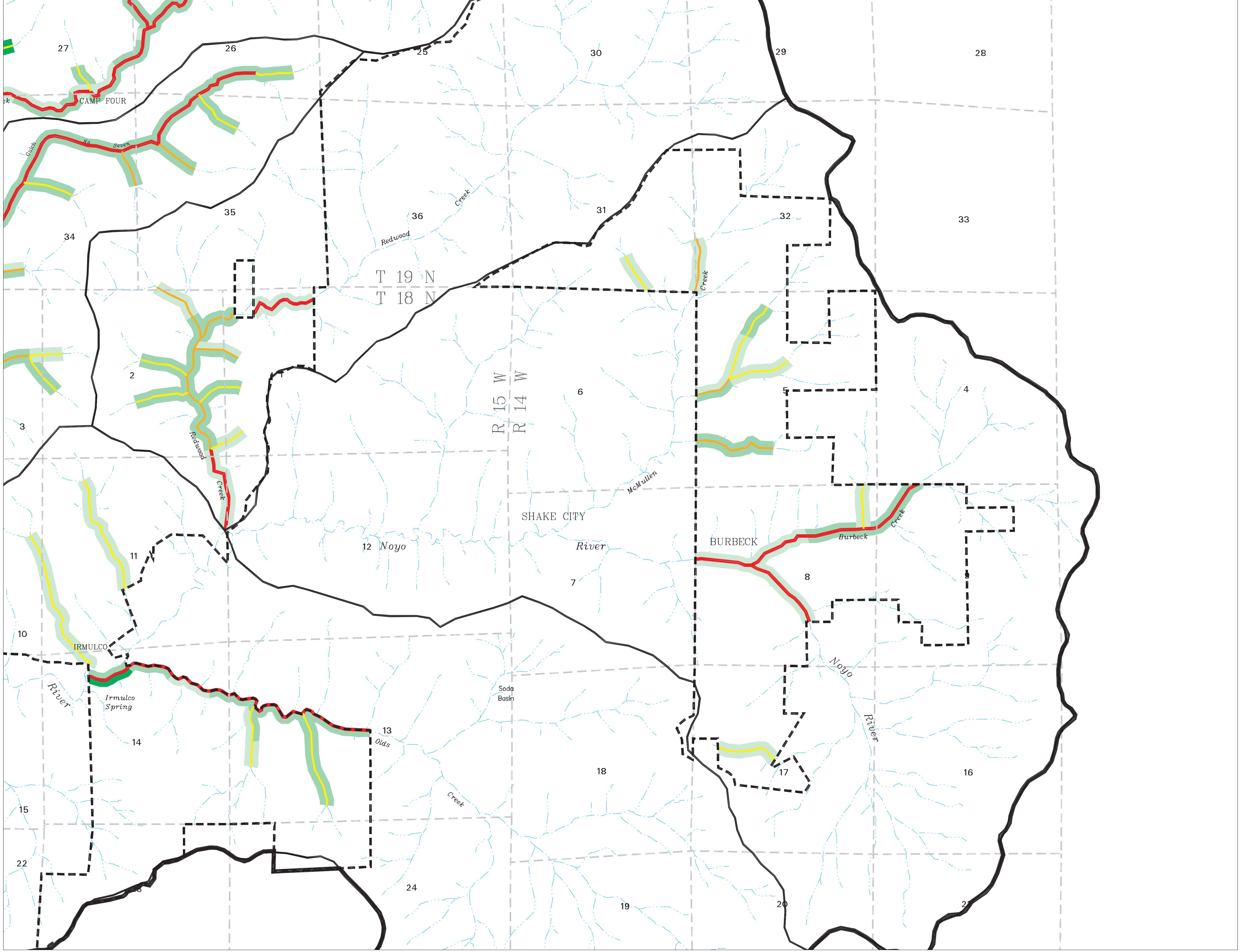


Noyo River Watershed Analysis Unit

Map D-1
Large Woody Debris Recruitment Potential and Demand

LWD Recruitment Potential Classes

- High
- Moderate
- Low

Instream LWD Demand

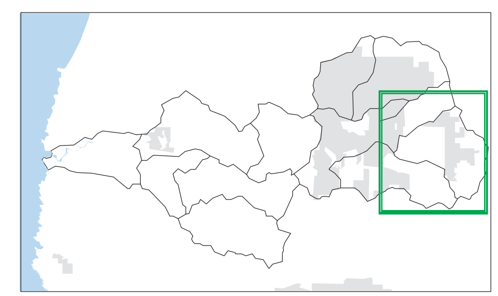
- High
- Moderate
- Low

Flow Class

- Class I
- Class II
- Class III

- MRC Ownership
- WWAA Boundary
- Planning Watershed Boundary

Sheet 3

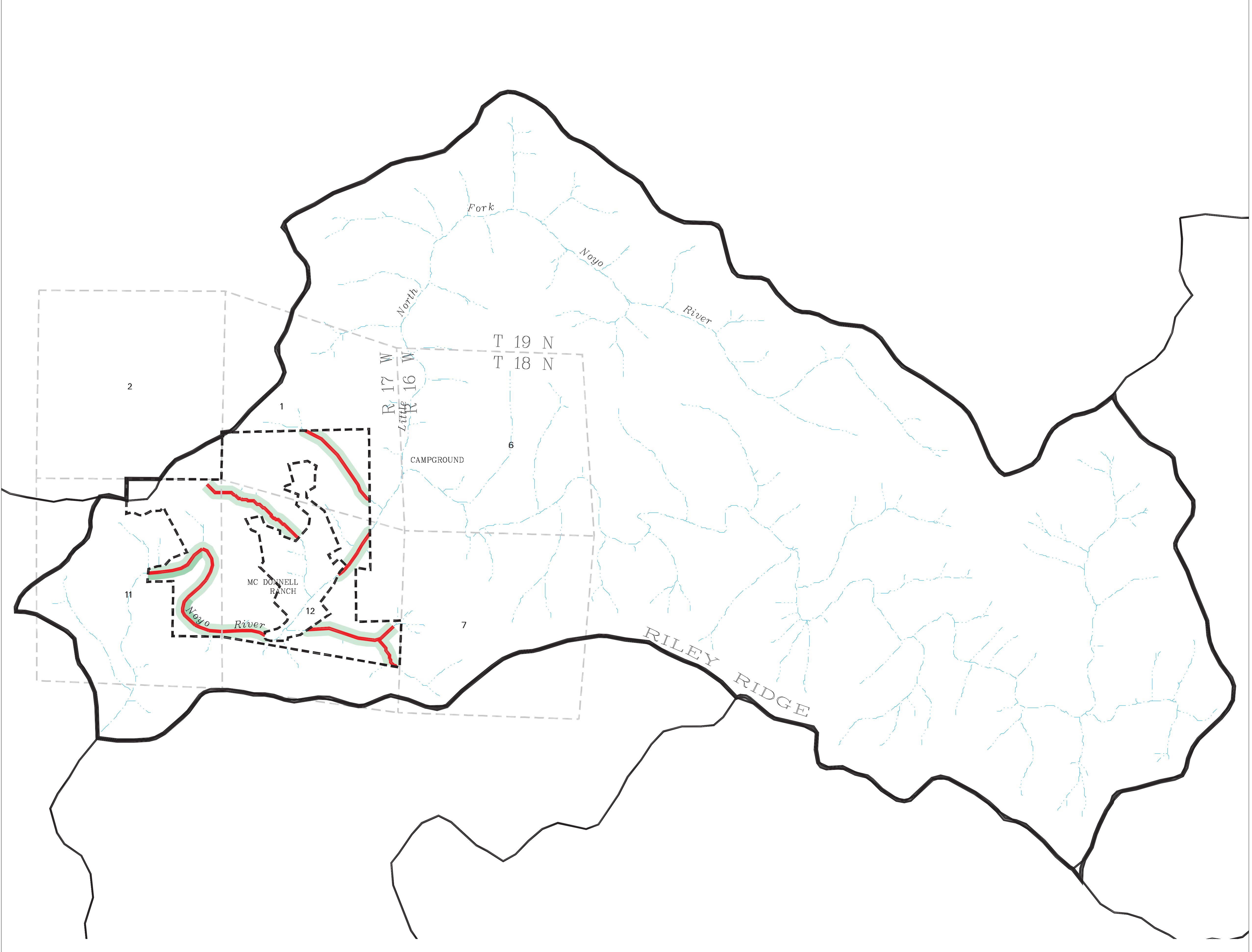


0 1/2 1 Mile

July 18, 2000

Noyo River Watershed Analysis Unit

Map D-1 Large Woody Debris Recruitment Potential and Demand



LWD Recruitment Potential Classes

- High
- Moderate
- Low

Instream LWD Demand

- High
- Moderate
- Low

Flow Class

- Class I
- Class II
- Class III

- MRC Ownership
- WWAA Boundary
- Planning Watershed Boundary

Sheet 4

July 18, 2000

Canopy Closure and Stream Temperature

Canopy cover is important in reducing the net gain of solar radiation. Stream water temperature responds to the input of solar radiation and is directly proportional to exposed stream surface area (Brown and Krygier, 1970) and inversely proportional to discharge (Sullivan et. al., 1990). Wide stream exposures receive greater solar radiation then streams with good canopy cover and narrow solar exposure. Several studies have shown that an intact streamside forest canopy will shade streams and minimize increases in summer water temperature. Brown and Krygier (1970) found diurnal variations in a well-shaded coastal Oregon stream to be less than 1^{o} C. However, complete removal of the forest canopy has been shown to increase summer maximum temperatures 3-8^{o} C (see review Beschta et. al., 1987). In a comparison of 20 years of temperature records from Steamboat Creek, Oregon, Hostetler (1991) found that streamside canopy cover was the most important variable to changes in stream temperature.

Many physical factors can influence stream temperature including: solar radiation, air temperature, relative humidity, water depth and ground water inflow. Forest management can most influence solar radiation input, riparian air temperature and relative humidity by alteration of streamside vegetation and cover. Water depth and ground water inflow are more difficult to influence from forest management practices. Therefore, our analysis focused on present canopy cover conditions for consideration for future forest management actions.

The optimal temperature for Pacific salmonids has been hypothesized to range from between 12 and 14^{o} C (Brett, 1952). Though there is considerable debate about what exactly is the optimal temperature and what it means. Temperatures lethal to salmonids have been determined in the laboratory and range from 23-29 ^{o}C (Beschta et. al., 1987). Though these temperatures are possible in some small forested streams, they would generally only occur for short periods of time in the summer.

Methods

Canopy closure, over watercourses, was estimated for Class I streams in the Noyo WAU during development of Louisiana-Pacific's Sustained Yield Plan for Coastal Mendocino (SYP). In the development of the SYP three canopy closure classes were determined using aerial photographs. These classes are: 1) 0-40% canopy closure, 2) 40-70% canopy closure, and 3) >70% canopy closure. A map was produced for the SYP based on the aerial photograph interpretations.

During 1998 field measurements of canopy closure over select stream channels were performed. The field measurements were taken during the stream channel assessments in the Noyo 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.

The streamside shade for the Noyo WAU is mapped in Map D-2. This map is the Louisiana-Pacific SYP map with corrections made from site specific field observations.

If field observations were not available for specific areas then the SYP information was not altered in those areas.

Stream temperature has been monitored in the Noyo WAU, by Louisiana-Pacific Corp., 1991-1997 and MRC in 1999. Stream temperature monitoring involved use of 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-7 describes the temperature monitoring locations.

Table D-7. Stream Temperature Monitoring Locations and Time Periods in the Noyo WAU (see Map D-2).

Temperature Monitoring Station	Stream Channel Segment Number	Stream/River Name	Years Monitored
70-1	2	North Fork Noyo River	’92,’93,’94,’95,’96,‘99
70-2	23	Marble Gulch	’94,’95,‘96,‘99
70-3	104	Hayworth Creek	’91,’92,’93,’94,’95,’96 ,‘99
70-5	109	North Fork Hayworth	’94,’95,’96 ,‘99
70-6	108	Hayworth Creek (upper)	’96,’97
70-7	152	North Fork Noyo River	’91,’92,’93,’94,’96 ,‘99
70-8	153	Middle Fork North Fork	’94,’95,’96 ,‘99
70-10	159	North Fork Noyo (upper)	‘95,‘99
70-11	1	Noyo River	’92,’93,’94,’95,’96 ,‘99
70-12	92	Redwood Creek	’94,’95,’96 ,‘99
70-13	79	McMullen Creek	‘96,‘99

Minimum, 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) were calculated for the 1996 and 1999 stream temperatures by taking a seven day average of the mean daily stream temperature.

Results

Canopy closure over watercourses varies throughout the Noyo WAU. The SYP mapping of canopy closure was updated from field observations collected in 1998 (Map D-2 and Table D-8). The canopy closure map shows a high proportion of Class I streams with a high streamside shade classification (58% of total Class I watercourses)(Map D-2). However, quite a bit of the Noyo WAU class I streams have moderate streamside shade classification (28% of Class I watercourses) and low streamside shade classification (14% of Class I watercourses).

Table D-8. 1998 Field Observations of Stream Canopy Closure for Select Stream Channel Segments in the Noyo WAU.

Stream Name	Segment Number	Mean Shade Canopy	Stream Name	Segment Number	Mean Shade Canopy
Noyo River	56	79%	Redwood Creek	92	84%
Noyo River	1	74%	Redwood Creek	92(upper)	81%
North Fork Noyo	3	82%	Burbeck	80	69%
North Fork Noyo	152	76%	Unnamed	63	87%
North Fork Noyo	152 (upper)	75%	Unnamed	64	84%
North Fork Noyo	159	87%	Gulch Seven	48	86%
North Fork Noyo	159(upper)	84%	Middle Fork North Fork	153	83%
Hayworth Creek	104	76%	Middle Fork North Fork	153(upper)	89%
Hayworth Creek	106	88%	Middle Fork North Fork	156	78%
Hayworth Creek	118	48%	DeWarren Creek	161	90%
Olds Creek	57	90%	North Fork Hayworth	112	59%
Marble Gulch	23	86%	Soda Creek	119	92%

The eastern proximity in the Coast Range of the Noyo WAU is evident in the stream temperatures of the Noyo WAU. The farther that you travel from the ocean the higher the air temperature gets, and the stream temperatures correlate. The instantaneous maximum daily stream temperature from 1991-1999 for the Noyo WAU varies from 17.8 to 24.7 ^{o}C (Table D-9). Typically these maximum stream temperature levels only occur for a few days during July and August (see Appendix D of this module), when high daytime air temperatures exists. The highest stream temperatures observed were at sites 70-3 and 70-7 in the early 1990's (Table D-8). In both cases these highest observed stream temperatures have lowered through time. The general trend for all the stream temperature observations in the Noyo WAU is a decreasing trend, with some areas showing no change. There is not an observed trend of increasing maximum stream temperature through time except for some high temperature "spikes" in individual years. These stream temperature spikes are likely created from a particularly hot summer or heat wave. MRC needs to work toward this decrease in the maximum stream temperature continuing or at least not increasing in the future.

Some areas of the Noyo WAU were observed to have only moderate or low shade canopy cover over the watercourse (42% of Class I streams; 28% moderate shade, 14% low shade). If greater canopy closure was available in some of the moderate and low streamside shade areas (see Map D-2) some of the highest stream temperatures might be reduced. Unfortunately, greater shade canopy is only possible where the streams are small enough or topographically aligned such that tree canopy can shade the stream surface. This is not the case in all areas of the Noyo WAU.

When put in context to the physiological effects of the stream temperature on salmonids in the Noyo WAU, the stream temperatures are at levels that MRC must be concerned about. For Coho salmon the maximum weekly average temperature (MWAT) has been reported to be between 17 and 18 ^{o}C (Brett, 1952 and Becker and Genoway, 1979). The maximum weekly average temperatures (MWAT) for 1996 and 1999 in the Noyo WAU (Table D-10) are right at this critical temperature threshold for all stations except 70-2 (Marble Gulch). Many of the maximum stream temperatures of the Noyo WAU exceed this range. However, the highest temperatures are high only for a few isolated days during the hottest summer months. Extra care must be taken to ensure that adequate shade along streams is provided and recruited in the Noyo WAU to protect from warming stream temperatures and to possibly provide for cooler temperatures.

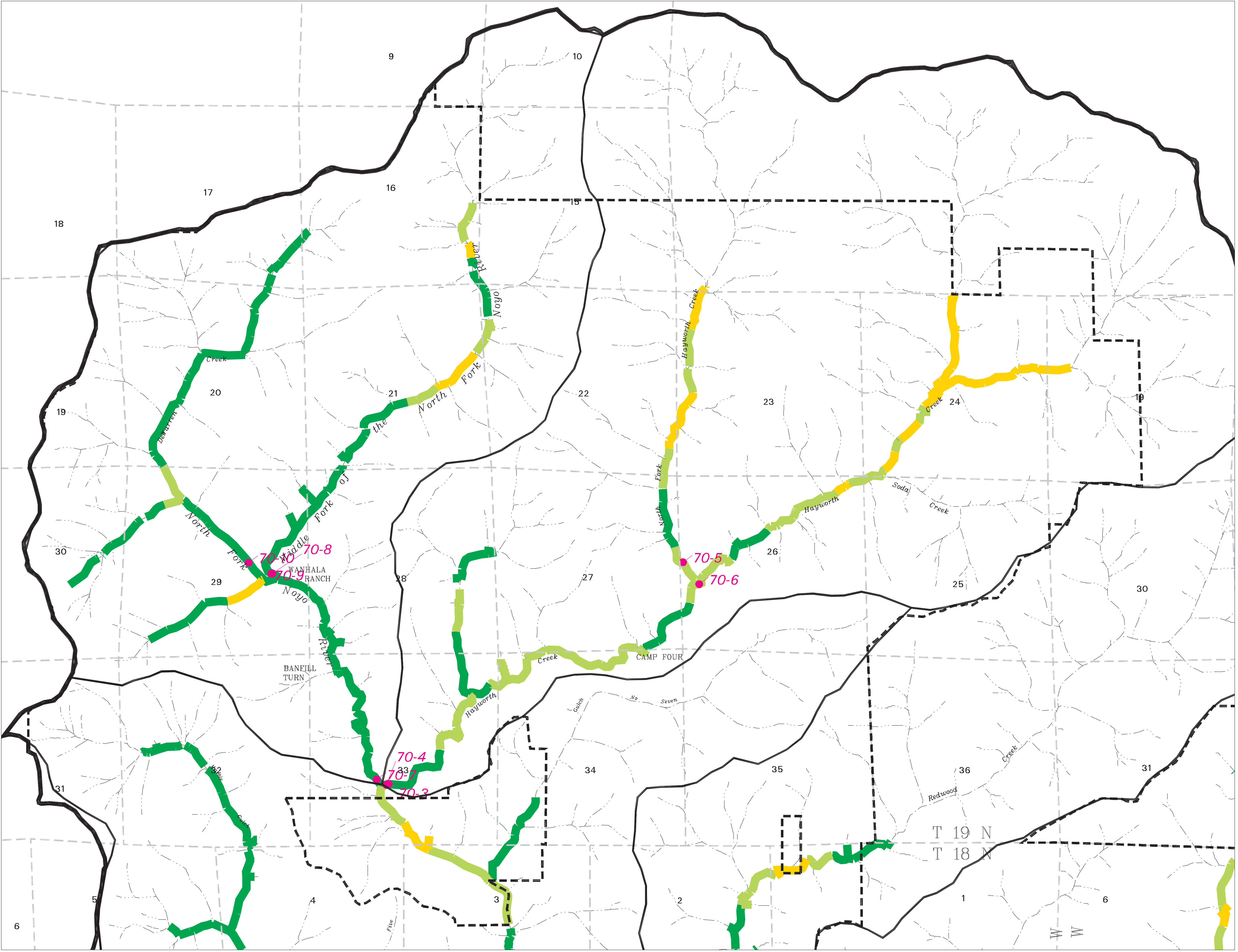
Table D-9. Maximum Daily Temperature for each Station in the Noyo WAU.
(see appendix of this module for complete records, for station locations see Map D-2)

Maximum Daily Mean Temperature (^{o}C)

Station No.	1991	1992	1993	1994	1995	1996	1997	1999
70-1	n/a	21.0	20.0	19.5	20.0	20.6	n/a	20.2
70-2	n/a	n/a	n/a	16.7	17.2	18.0	n/a	15.3
70-3	22.5	22.0	21.6	21.0	20.5	20.8	n/a	19.4
70-5	n/a	n/a	n/a	20.7	20.9	20.5	n/a	20.2
70-6	n/a	n/a	n/a	n/a	n/a	21.5	20.4	19.8
70-7	21.0	24.7	19.0	18.5	n/a	19.7	n/a	18.9
70-8	n/a	n/a	n/a	17.8	18.1	19.0	n/a	16.1
70-10	n/a	n/a	n/a	n/a	18.0	n/a	n/a	17.5
70-11	n/a	20.0	20.0	19.5	20.0	20.4	n/a	20.8
70-12	n/a	n/a	n/a	19.0	19.6	20.1	n/a	18.8
70-13	n/a	n/a	n/a	n/a	n/a	20.0	n/a	19.0

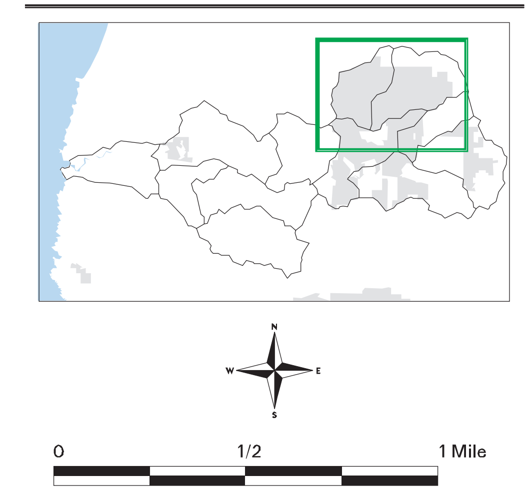
Table D-10. Maximum Weekly Average Temperature (MWAT) for 1996 for Select Temperature Monitoring Stations of the Noyo WAU (graphs of this data is located in the appendix of this module)(1997 MWAT is shown for Station 70-6).

Station No.	**MWAT (^oC) 1996**	**MWAT (^oC) 1999**
70-1	18.0	17.3
70-2	15.5	13.2
70-3	18.2	16.8
70-5	17.8	16.8
70-6	18.2	(1997)18.2
70-7	17.4	16.5
70-8	16.7	13.9
70-11	18.0	17.9
70-12	17.7	16.6
70-13	17.5	16.5



Noyo River Watershed Analysis Unit

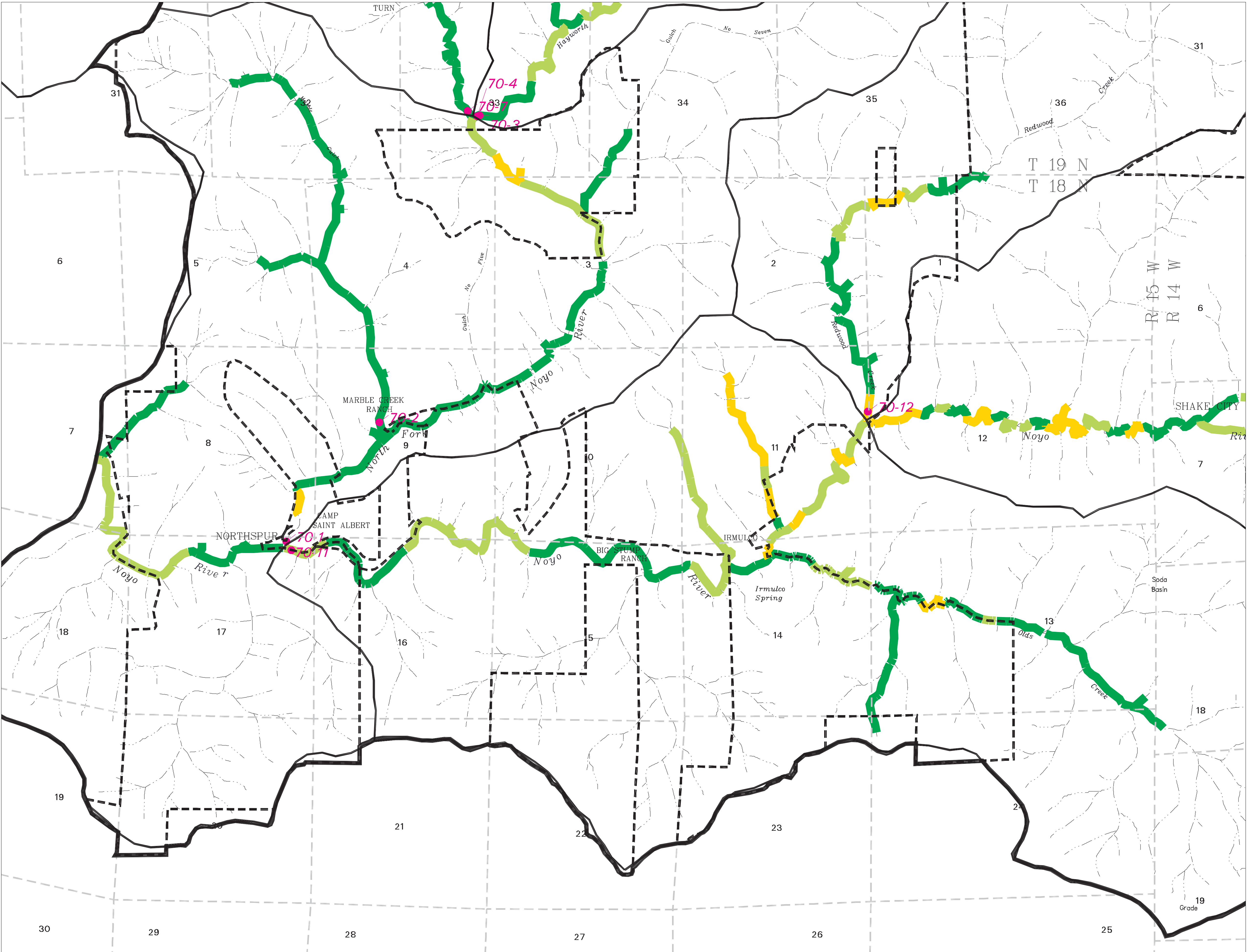
Map D-2
Stream Shade Classification and Temperature Monitoring Locations



July 18, 2000

Noyo River Watershed Analysis Unit

Map D-2
Stream Shade Classification and Temperature Monitoring Locations



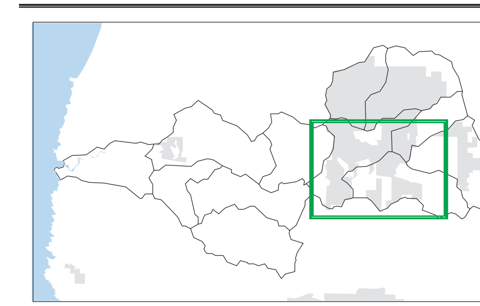
High (70-100 percent shade)
Moderate (40-69 percent shade)
Low (0-39 percent shade)
Temperature Monitoring Locations

Flow Class

Class I
Class II
Class III

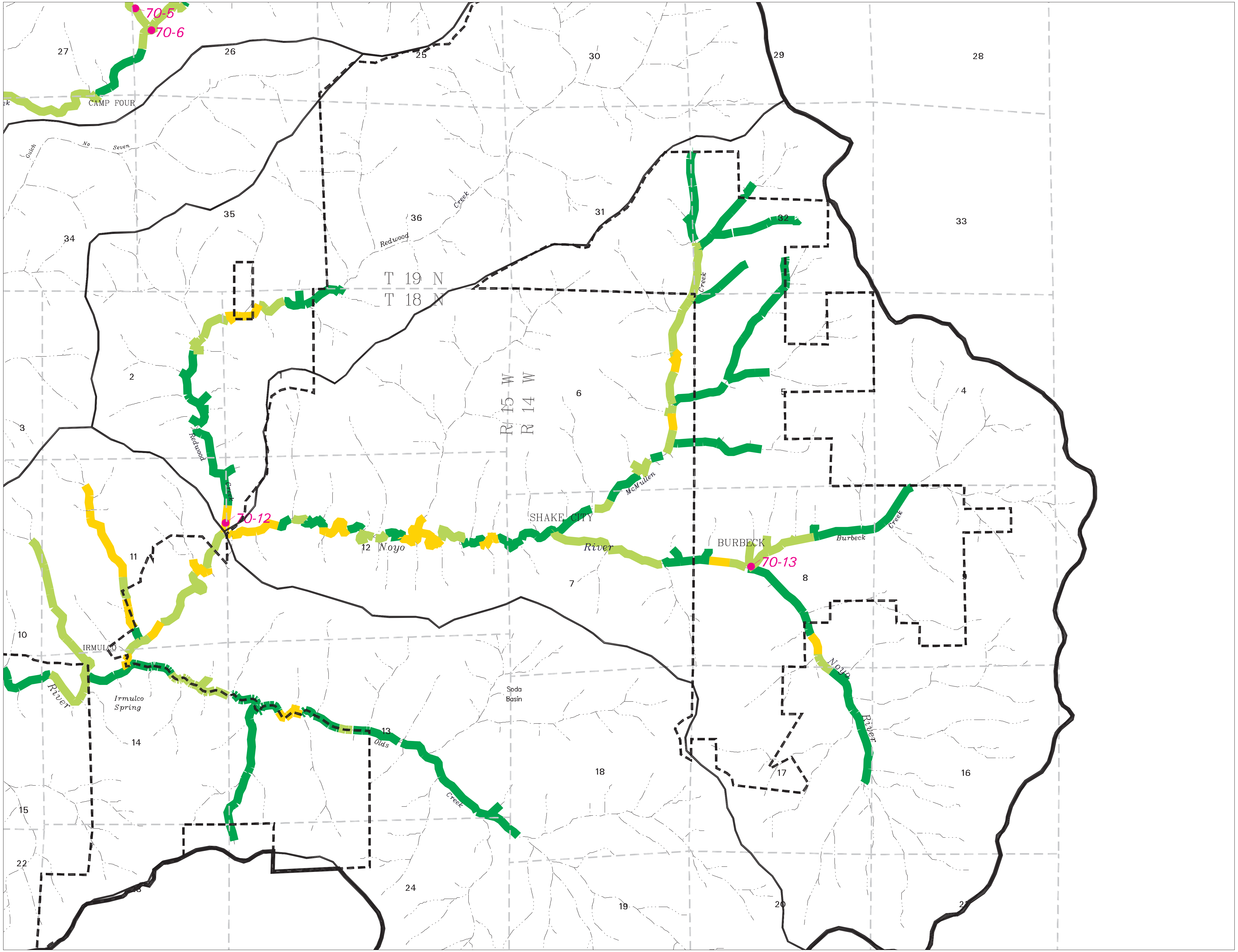
MRC Ownership
WWAA Boundary
Planning Watershed Boundary

Sheet 2



0 1/2 1 Mile

July 18, 2000



Noyo River Watershed Analysis Unit

Map D-2
Stream Shade Classification and Temperature Monitoring Locations

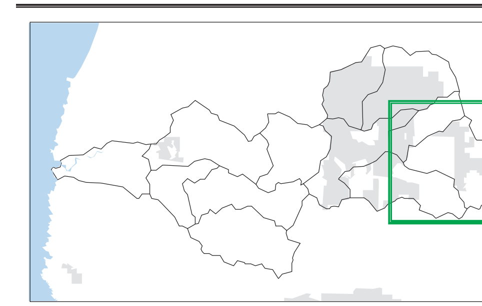
High (70-100 percent shade)
Moderate (40-69 percent shade)
Low (0-39 percent shade)
Temperature Monitoring Locations

Flow Class

Class I
Class II
Class III

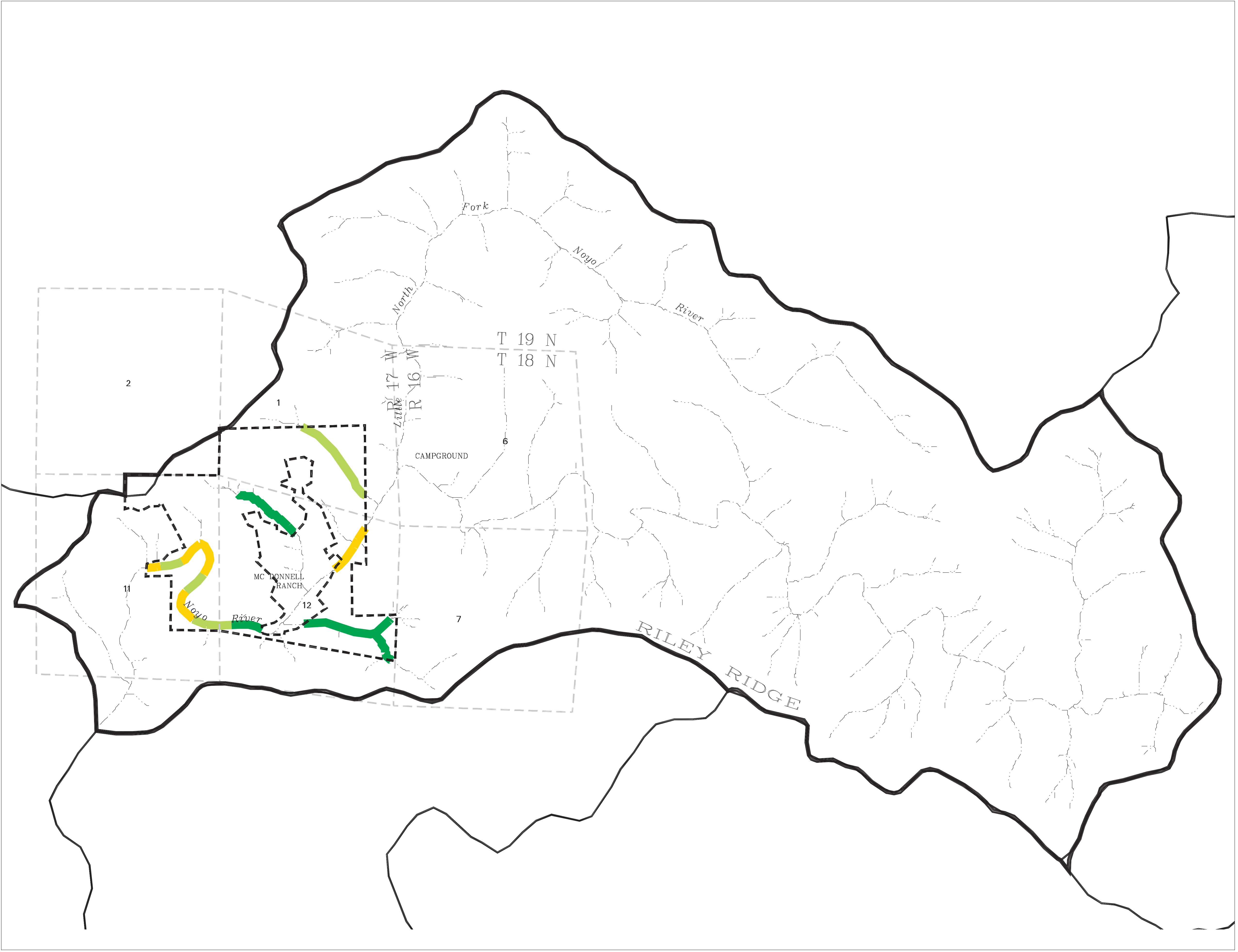
MRC Ownership
WWAA Boundary
Planning Watershed Boundary

Sheet 3



0 1/2 1 Mile

July 18, 2000



Noyo River Watershed Analysis Unit

Map D-2
Stream Shade Classification and Temperature Monitoring Locations

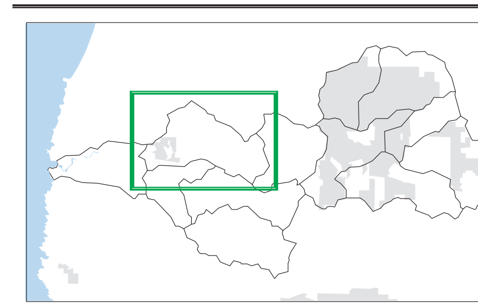
High (70-100 percent shade)
Moderate (40-69 percent shade)
Low (0-39 percent shade)
Temperature Monitoring Locations

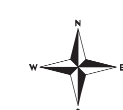
Flow Class

Class I
Class II
Class III

MRC Ownership
WWAA Boundary
Planning Watershed Boundary

Sheet 4





0 1/2 1 Mile

July 18, 2000

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Appendix D

Riparian Function

FIGURE 3. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT NORTH FORK NOYO RIVER (MAP NO. 2; MONITORING SITE NO. 70-1), MENDOCINO CO., CALIFORNIA.

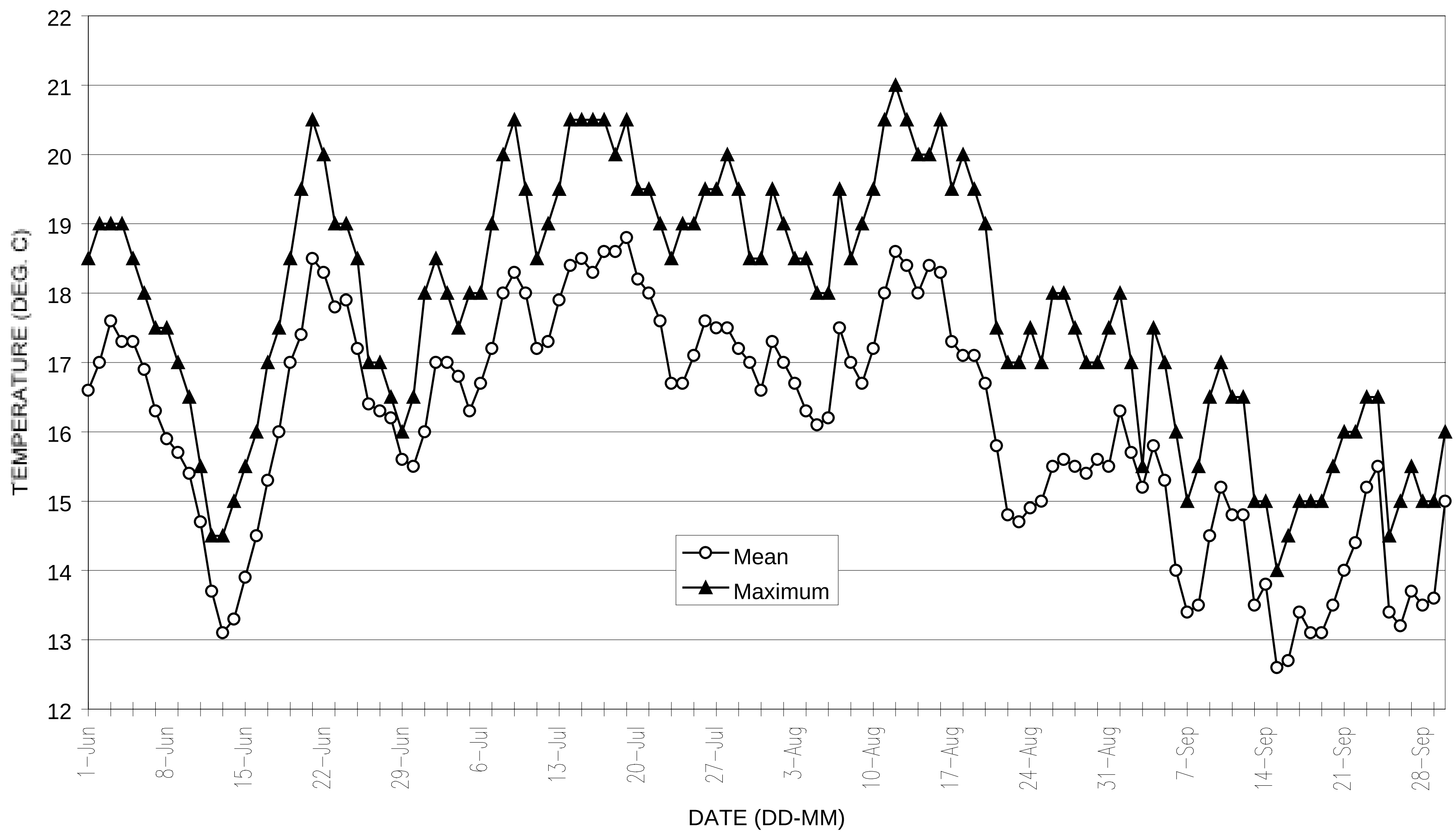


FIGURE 4. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT NORTH FORK NOYO RIVER (MAP NO. 2; MONITORING SITE NO. 70-1), MENDOCINO CO., CALIFORNIA.

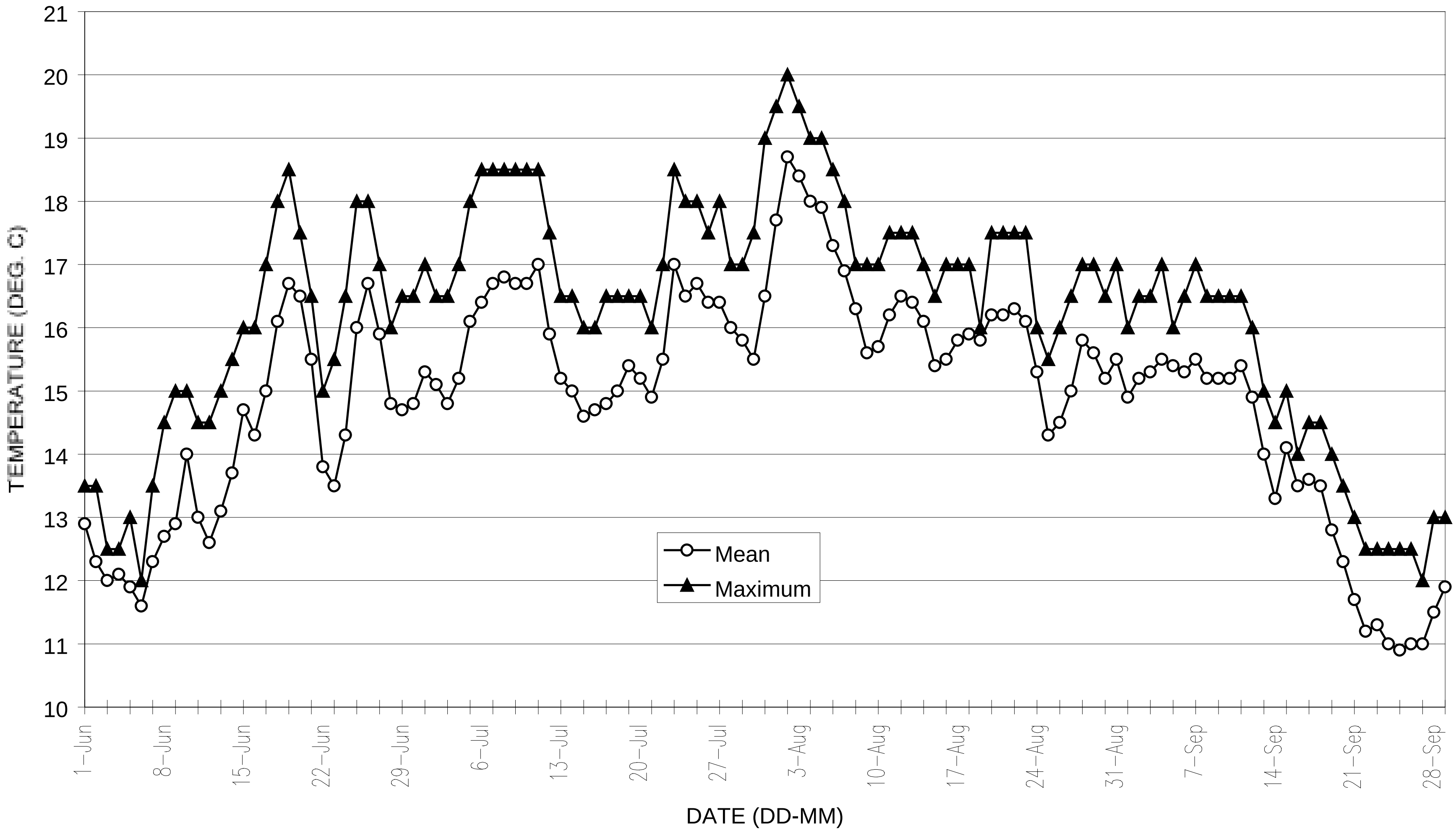


FIGURE 23. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (MAY-SEPTEMBER 1994) AT NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-1), MENDOCINO CO., CALIFORNIA.

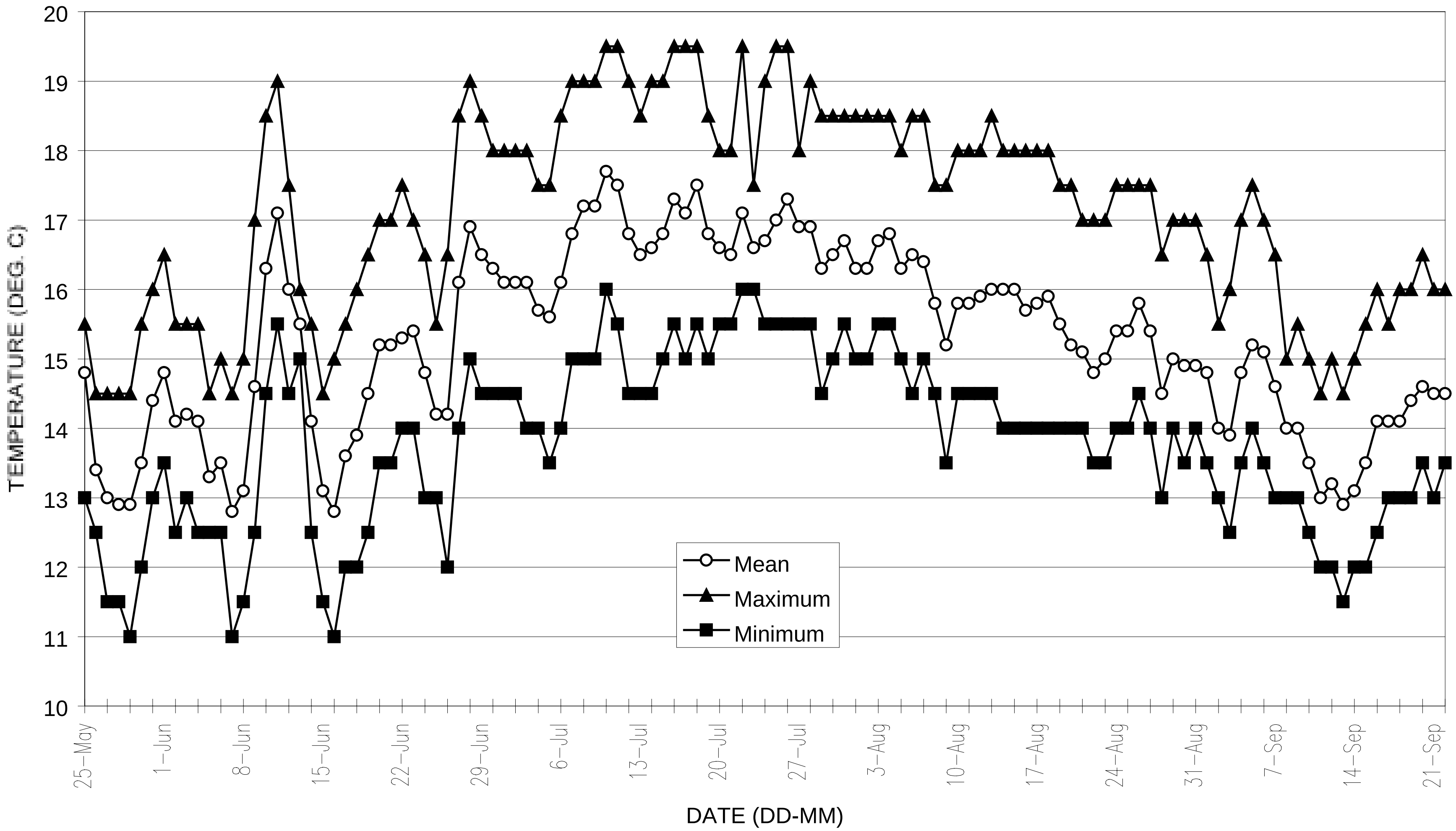


FIGURE 24. MEAN, MAXIMUM AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT THE NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-1), MENDOCINO CO., CALIFORNIA.

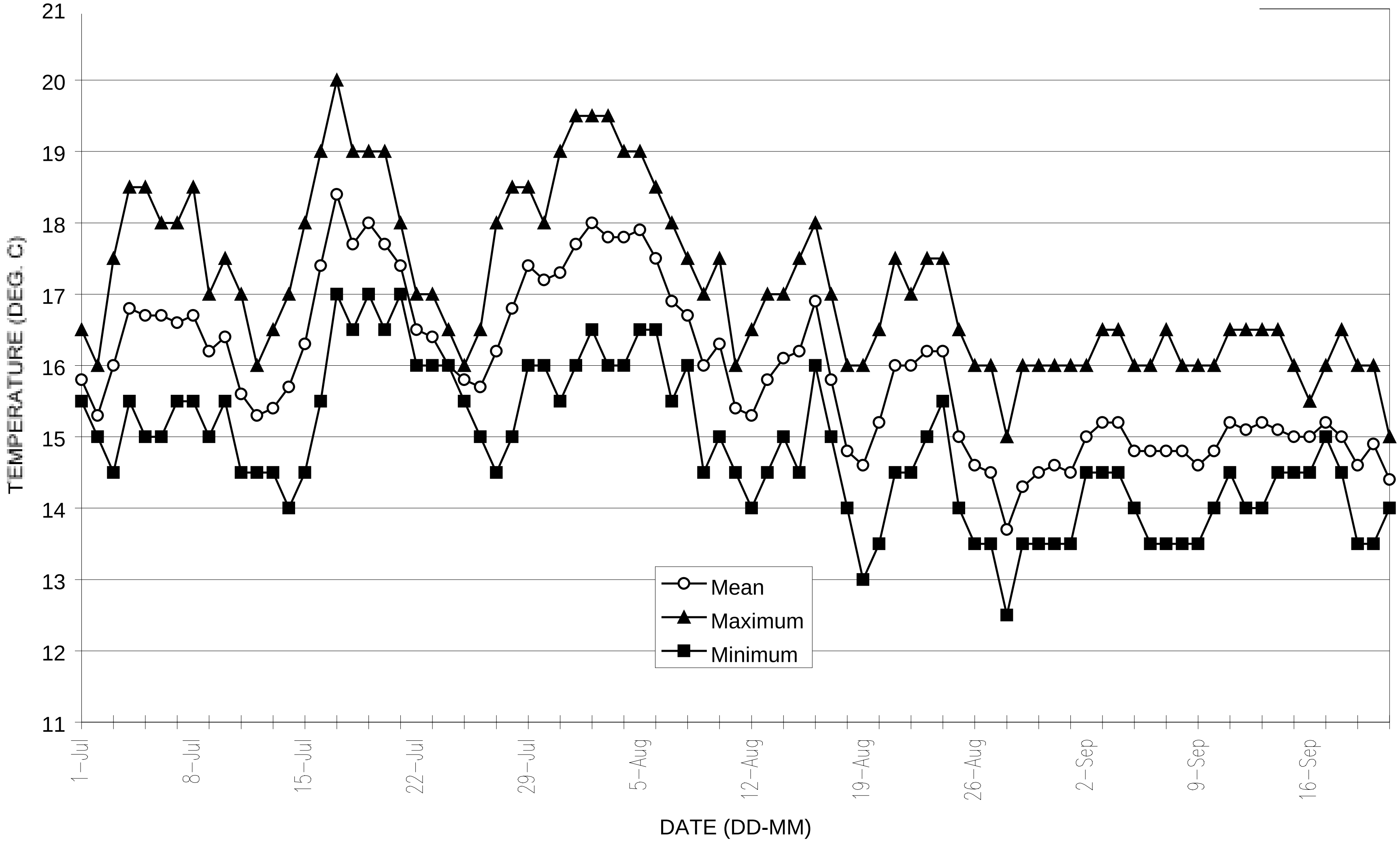


FIGURE 25. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-1), MENDOCINO CO., CALIFORNIA.

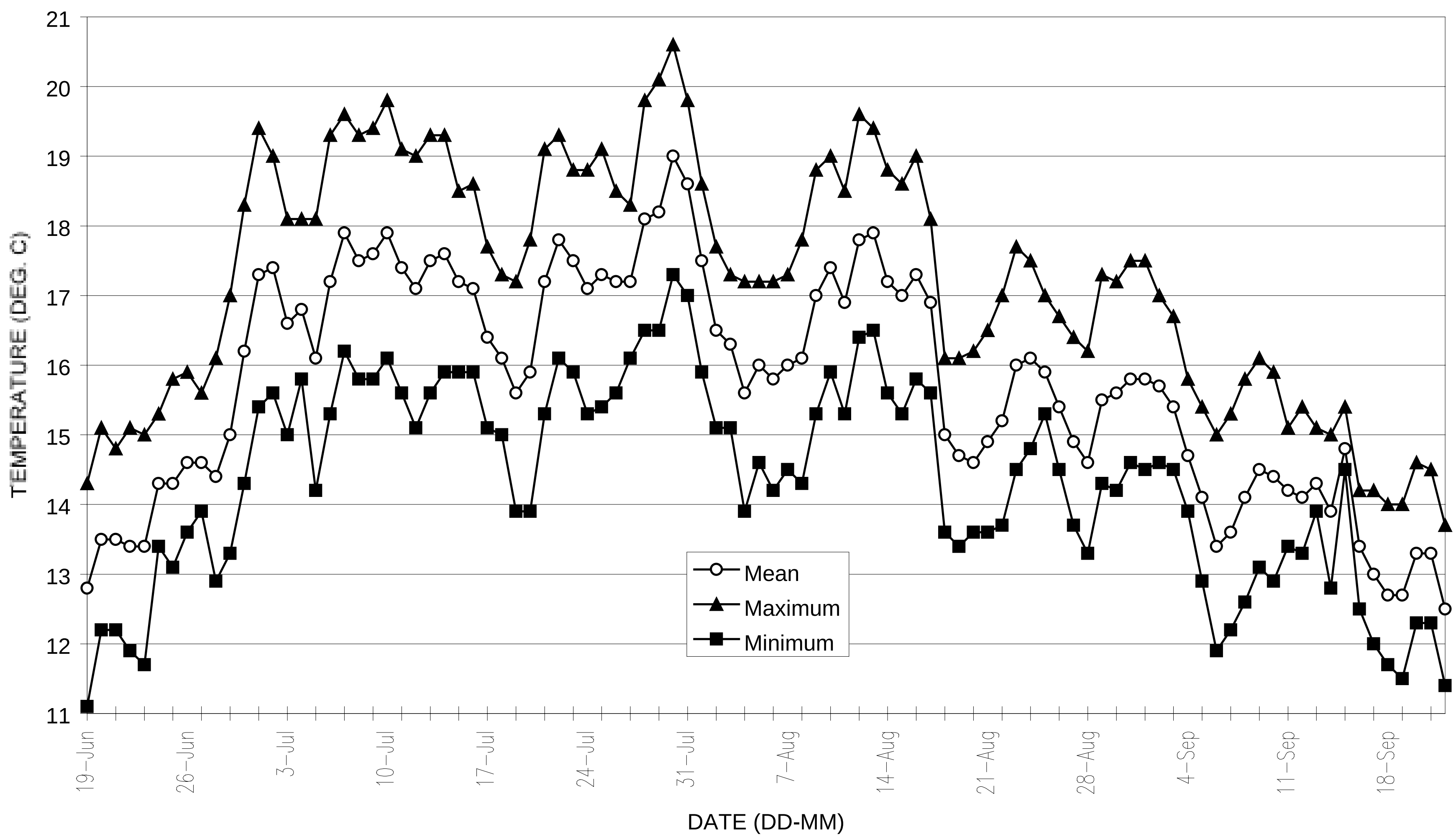


Figure 29. Mean and Maximum Daily Stream Temperatures During Summer 1999 at North Fork Noyo River (Site 70-1), Mendocino County, California.

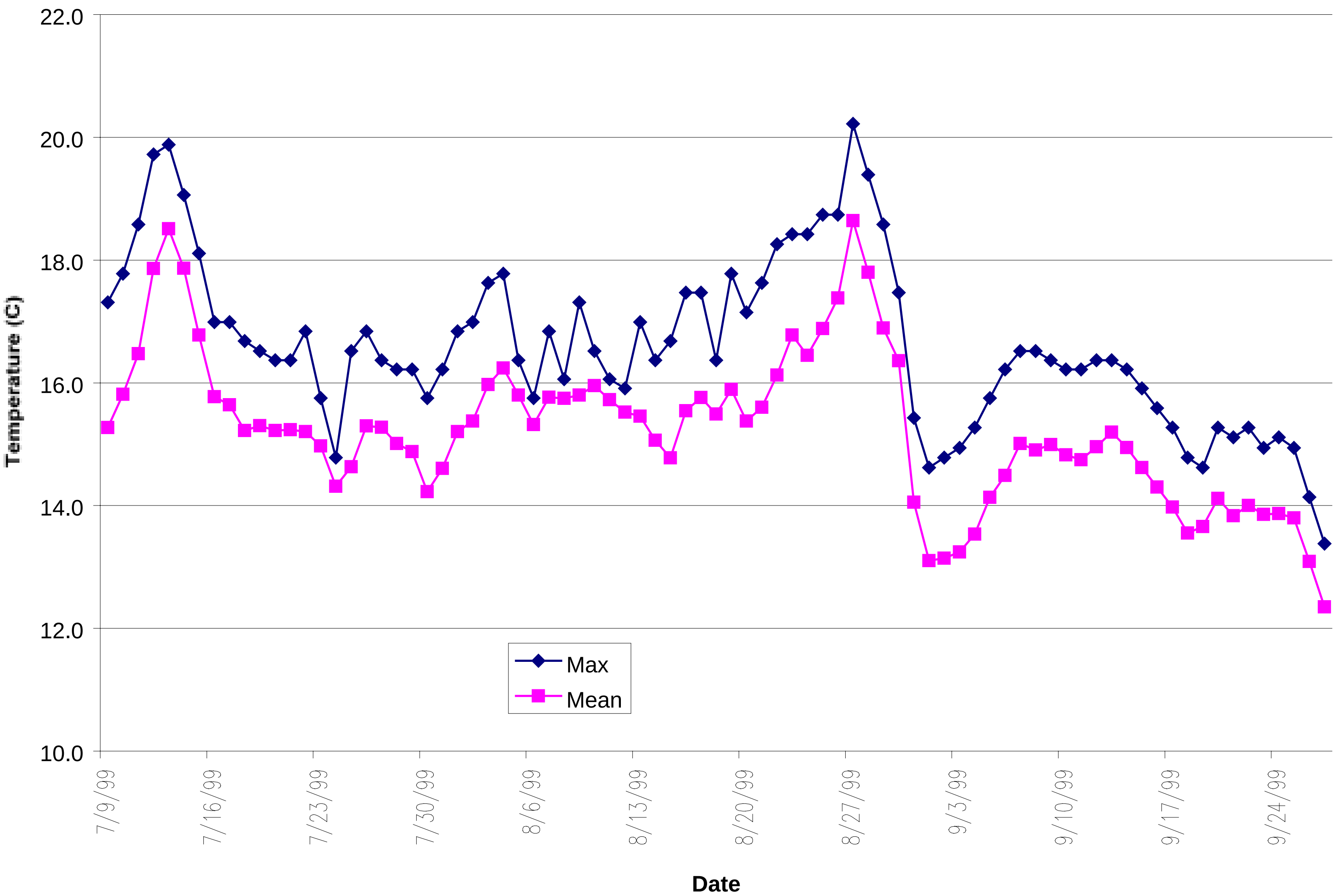


FIGURE 26. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT MARBLE GULCH (MAP NO. 5; MONITORING SITE NO. 70-2), MENDOCINO CO., CALIFORNIA.

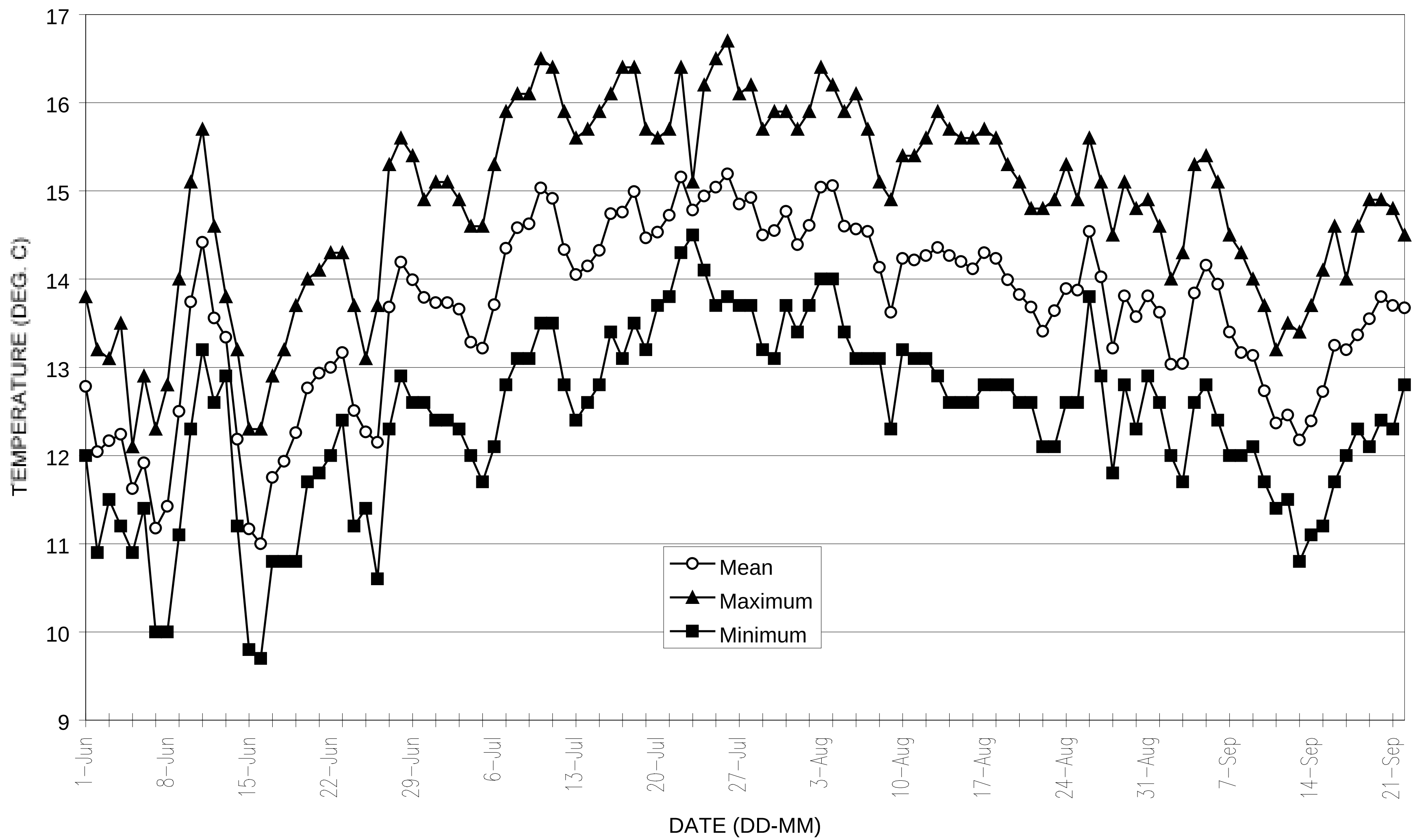


FIGURE 27. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE - SEPTEMBER 1995) AT MARBLE GULCH (MAP NO. 5; MONITORING SITE NO. 70-2), MENDOCINO CO., CALIFORNIA.

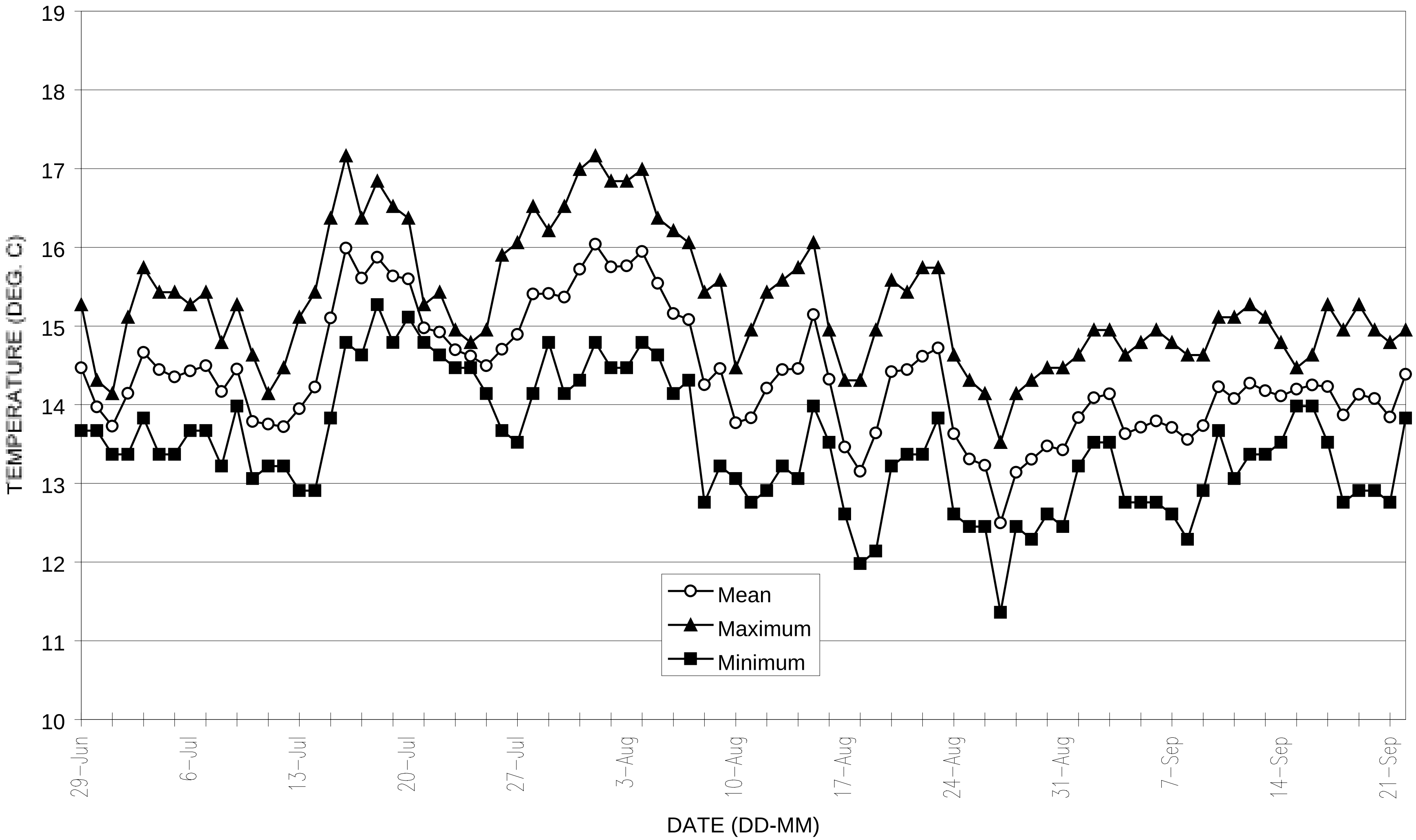


FIGURE 28. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT MARBLE GULCH (MAP NO. 5; MONITORING SITE NO. 70-2), MENDOCINO CO., CALIFORNIA.

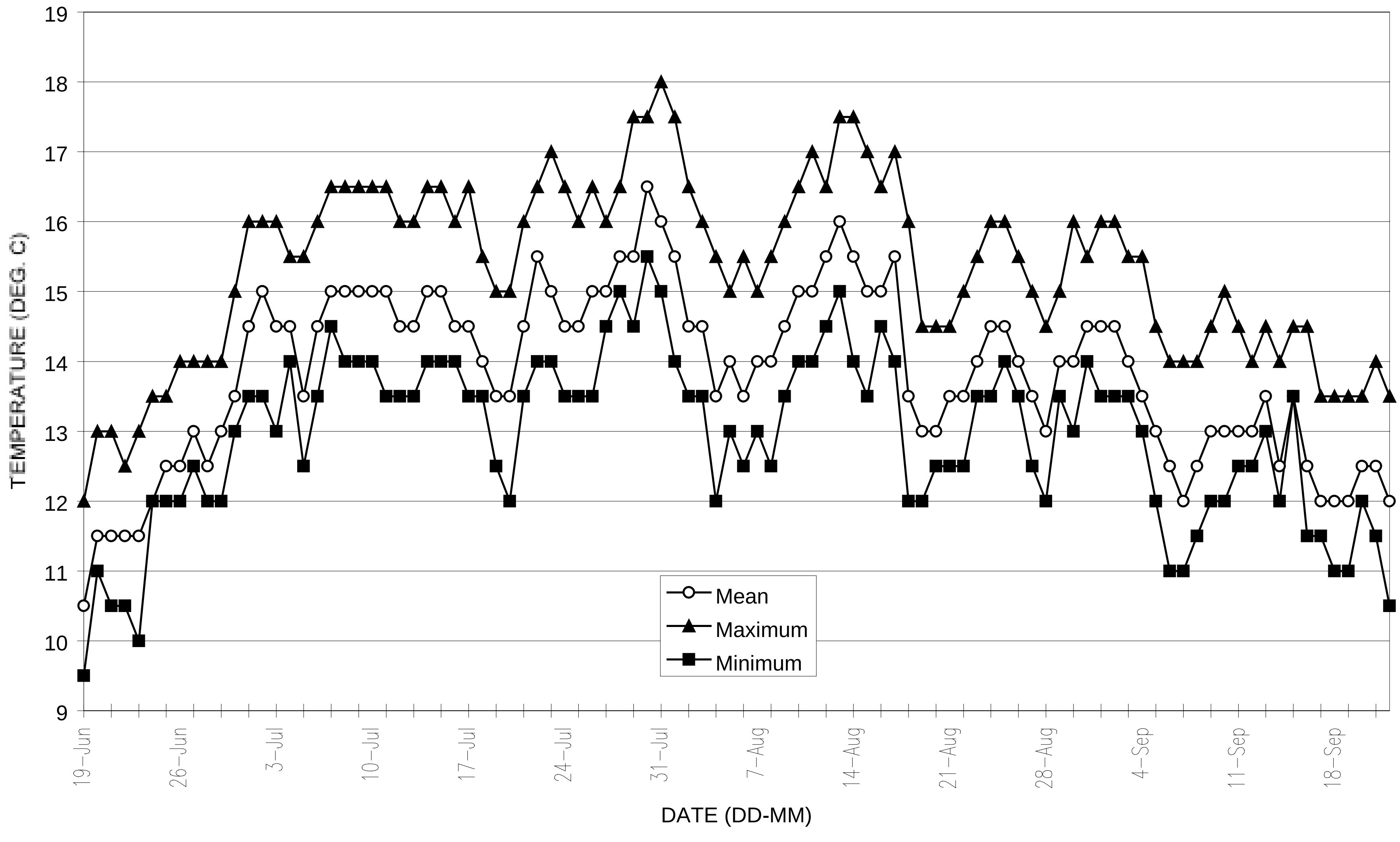


Figure 31. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Marble Gulch (Site 70-2), Mendocino County, California.

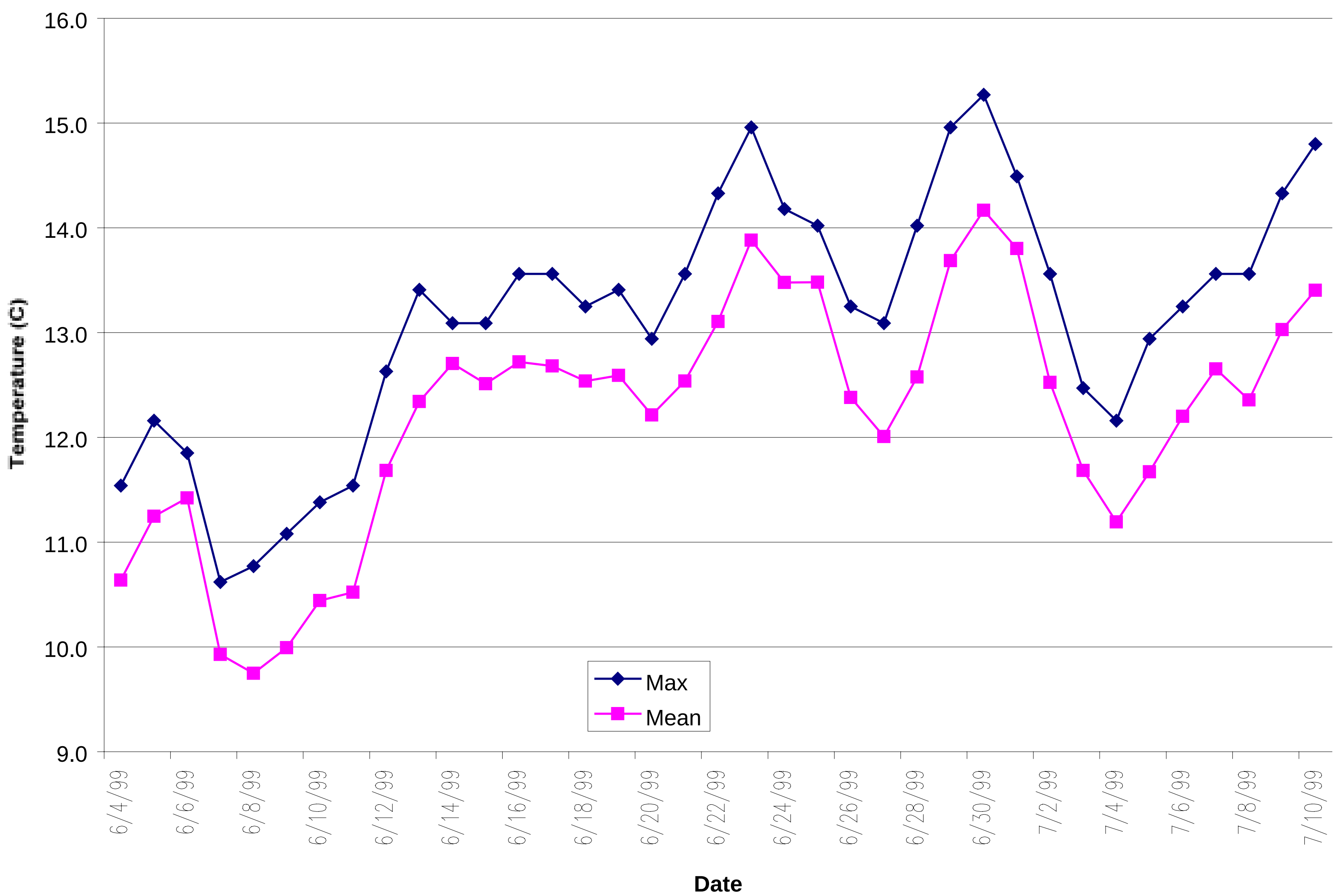
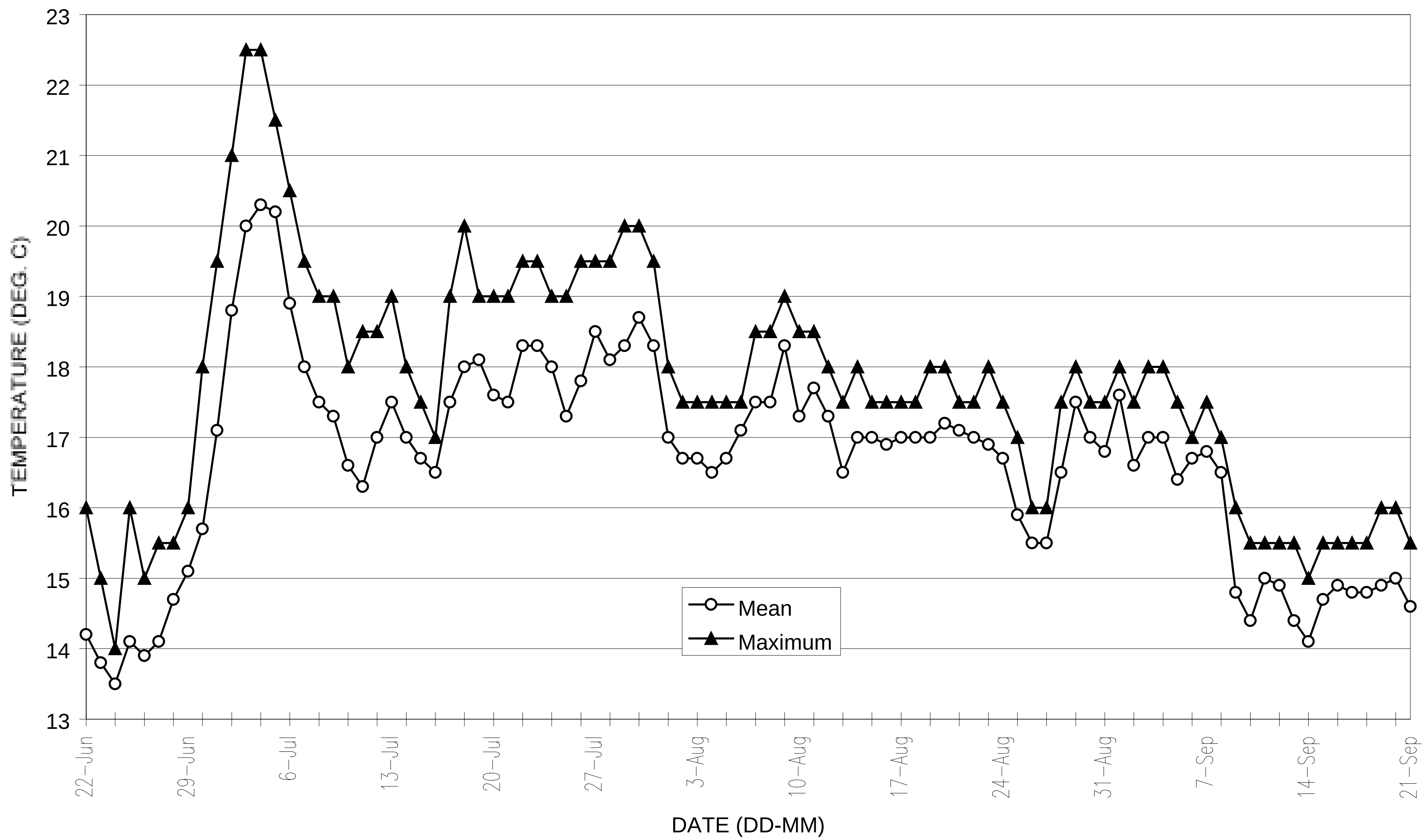


FIGURE 7. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURE DURING SUMMER (JUNE-SEPTEMBER 1991) AT HAYWORTH CREEK (MAP NO. 2; MONITORING SITE NO. 70-3), MENDOCINO CO., CALIFORNIA.



70-3

FIGURE 8. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT HAYWORTH CREEK (MAP NO. 2; MONITORING SITE ~~NO. 44~~), MENDOCINO CO., CALIFORNIA.

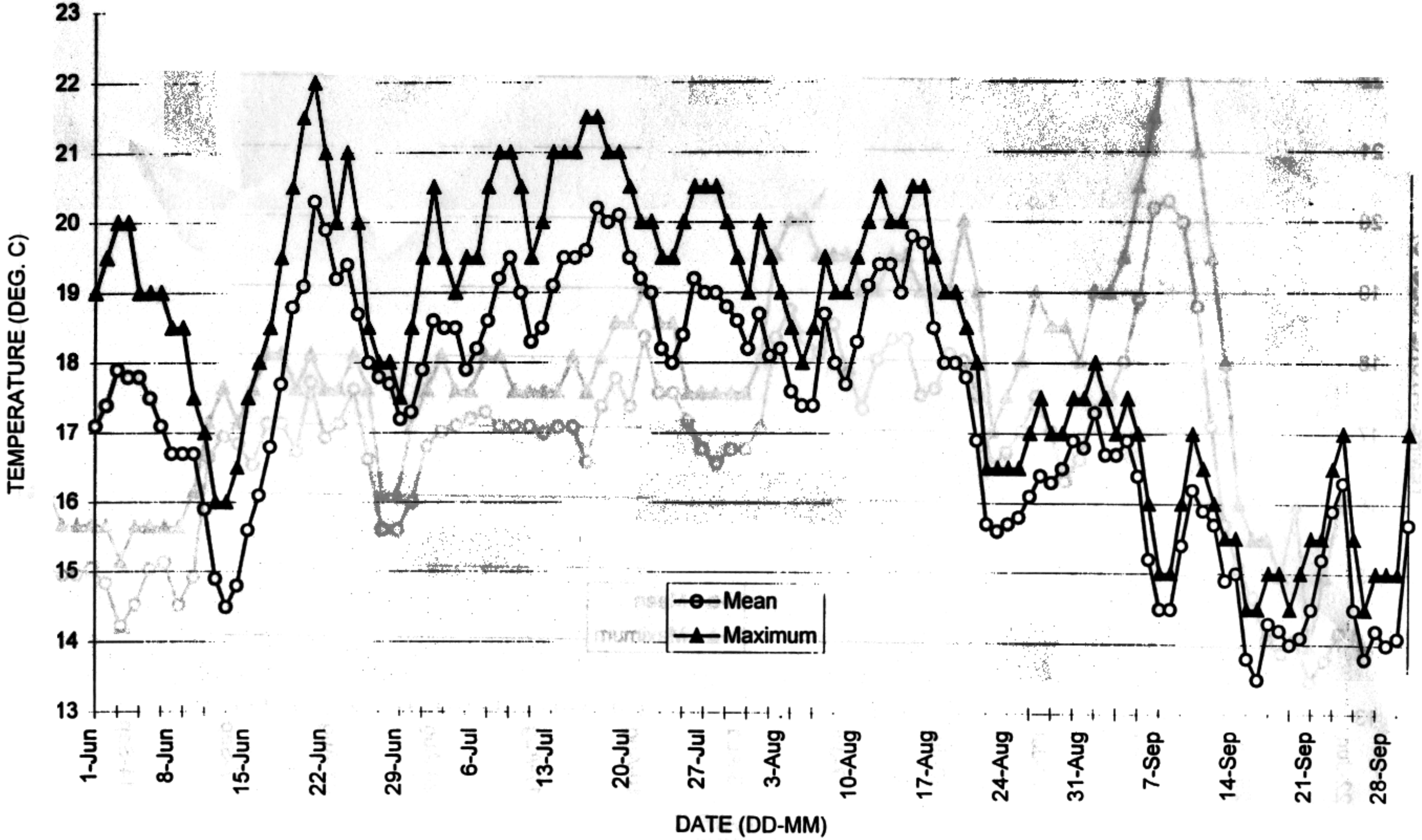


FIGURE 9. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-AUGUST 1993) AT HAYWORTH CREEK (MAP NO. 2; MONITORING SITE NO. 70-3), MENDOCINO CO., CALIFORNIA.

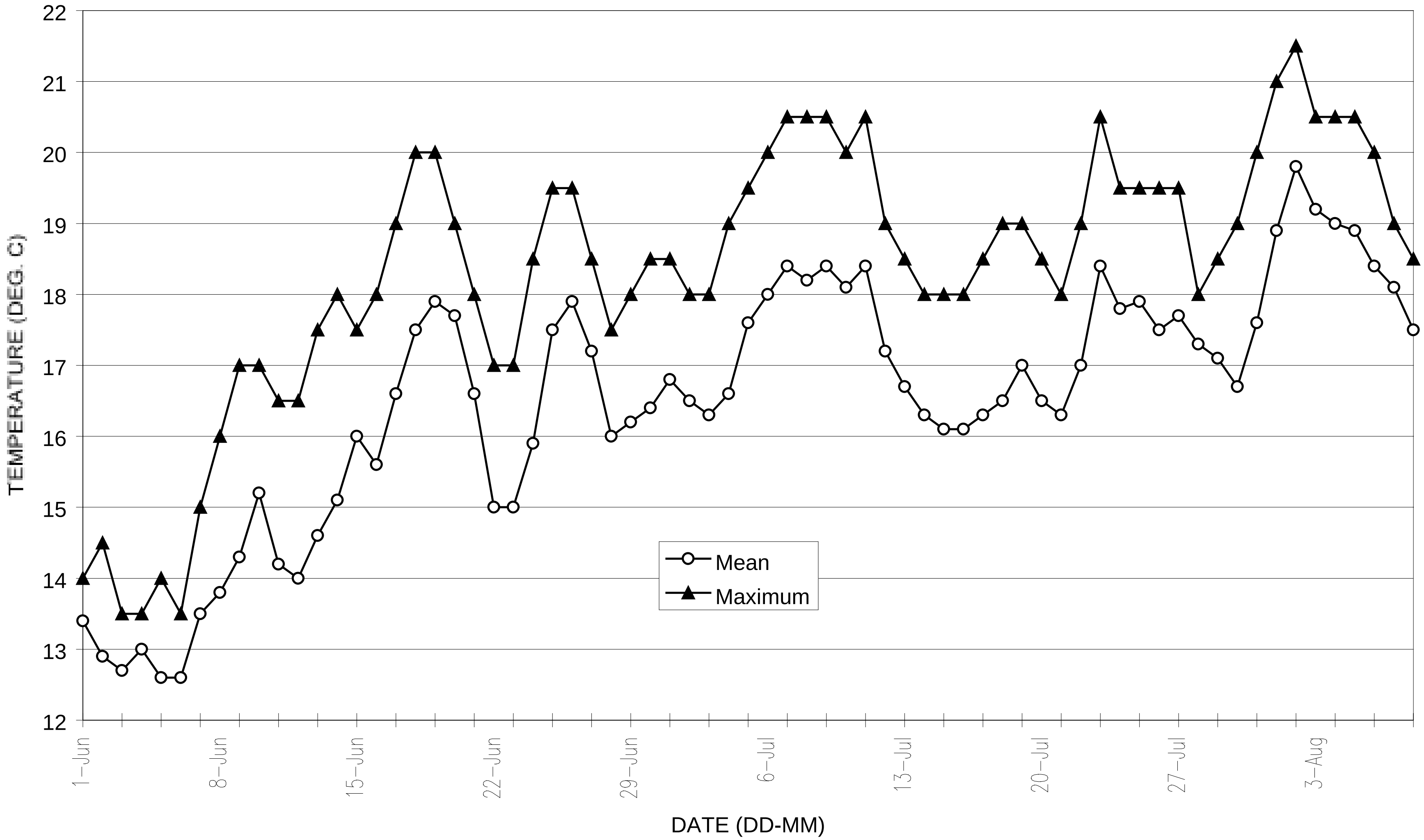


FIGURE 29. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (MAY-SEPTEMBER 1994) AT HAYWORTH CREEK (MAP NO. 5; MONITORING SITE NO. 70-3), MENDOCINO CO., CALIFORNIA.

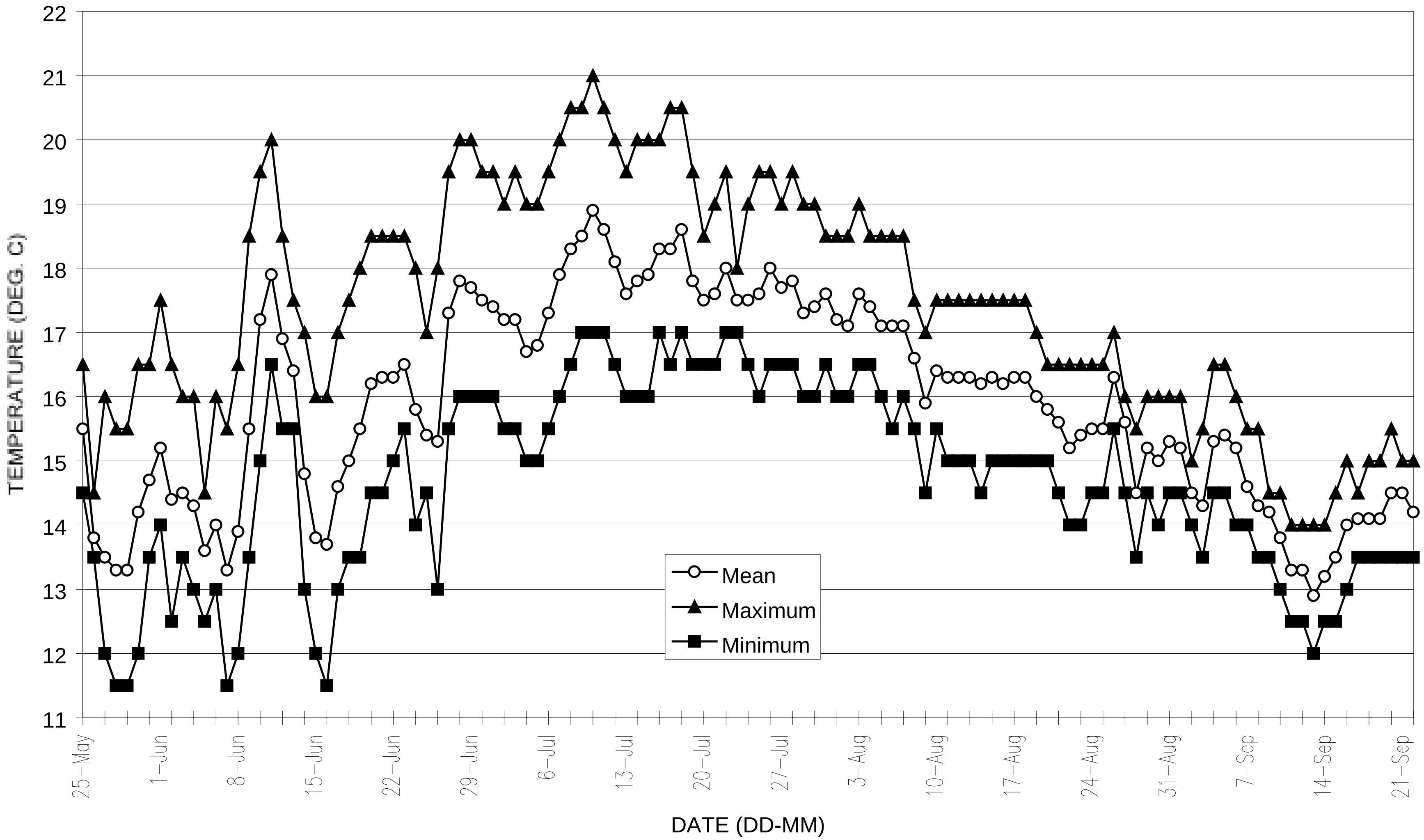


FIGURE 30. MEAN, MAXIMUM AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT HAYWORTH CREEK (MAP NO. 5; MONITORING SITE 70-3), MENDOCINO CO., CALIFORNIA.

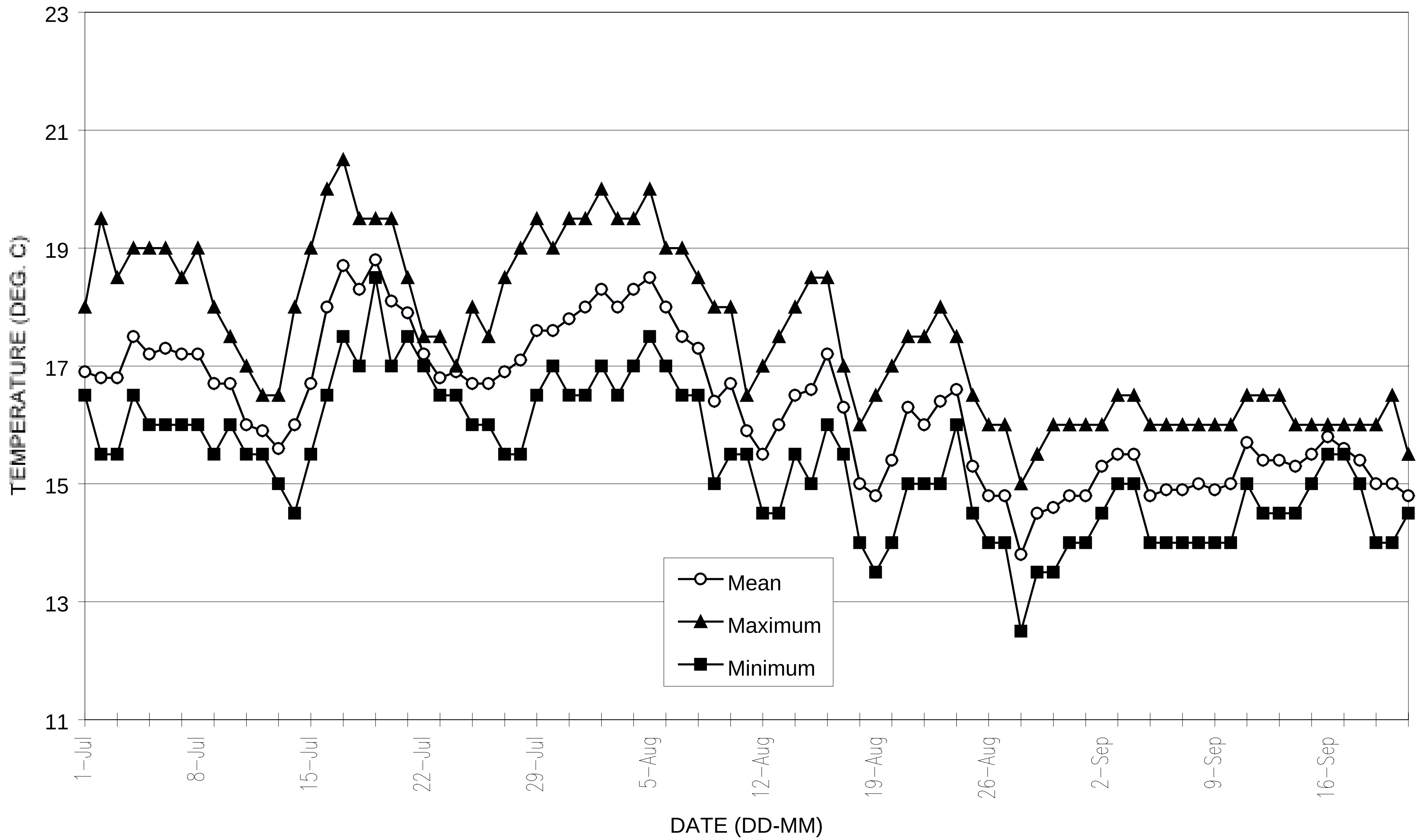


FIGURE 31. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT HAYWORTH CREEK (MAP NO. 5; MONITOING SITE NO. 70-3), MENDOCINO CO., CALIFORNIA.

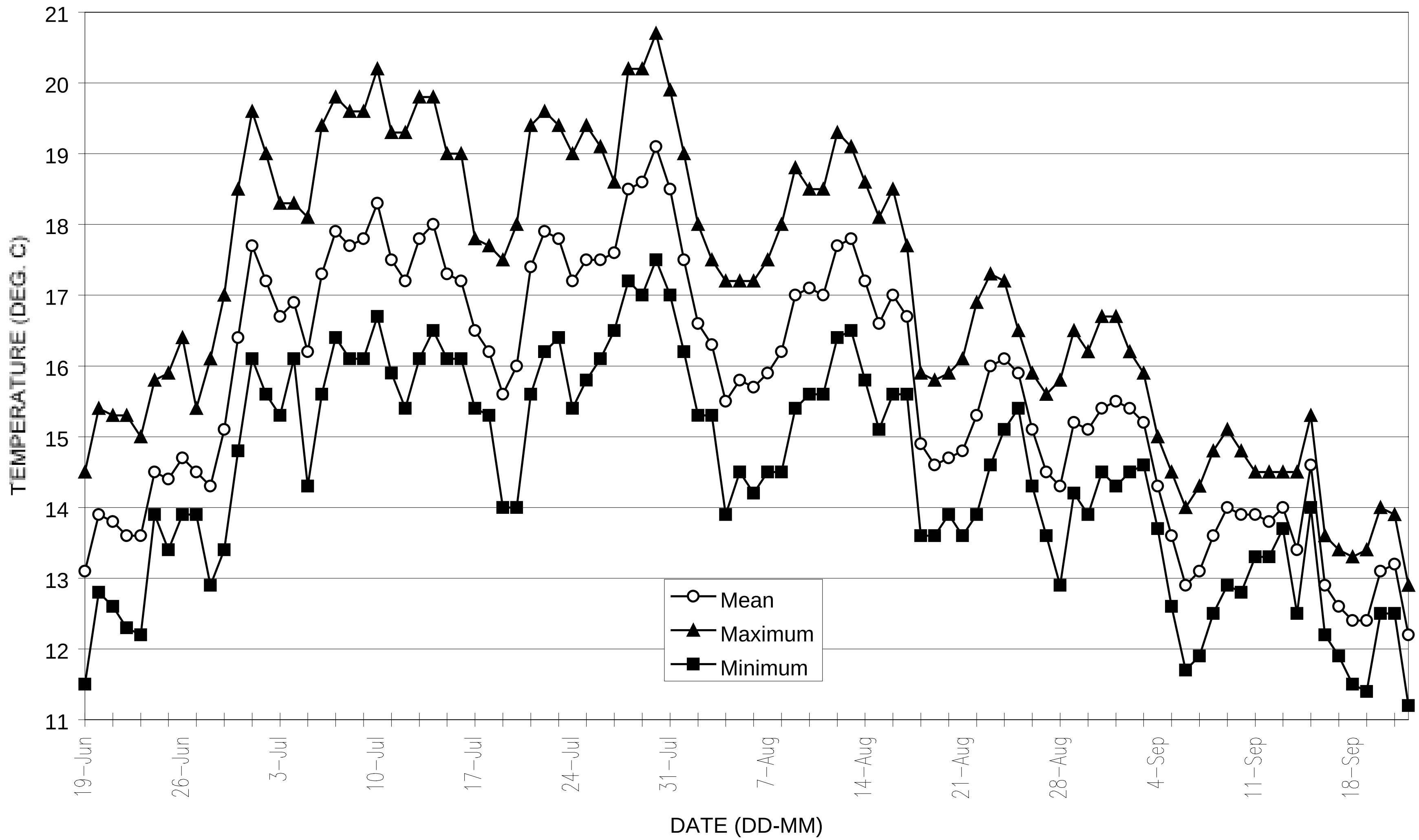


Figure 33. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Hayworth Creek (Site 70-3), Mendocino County, California.

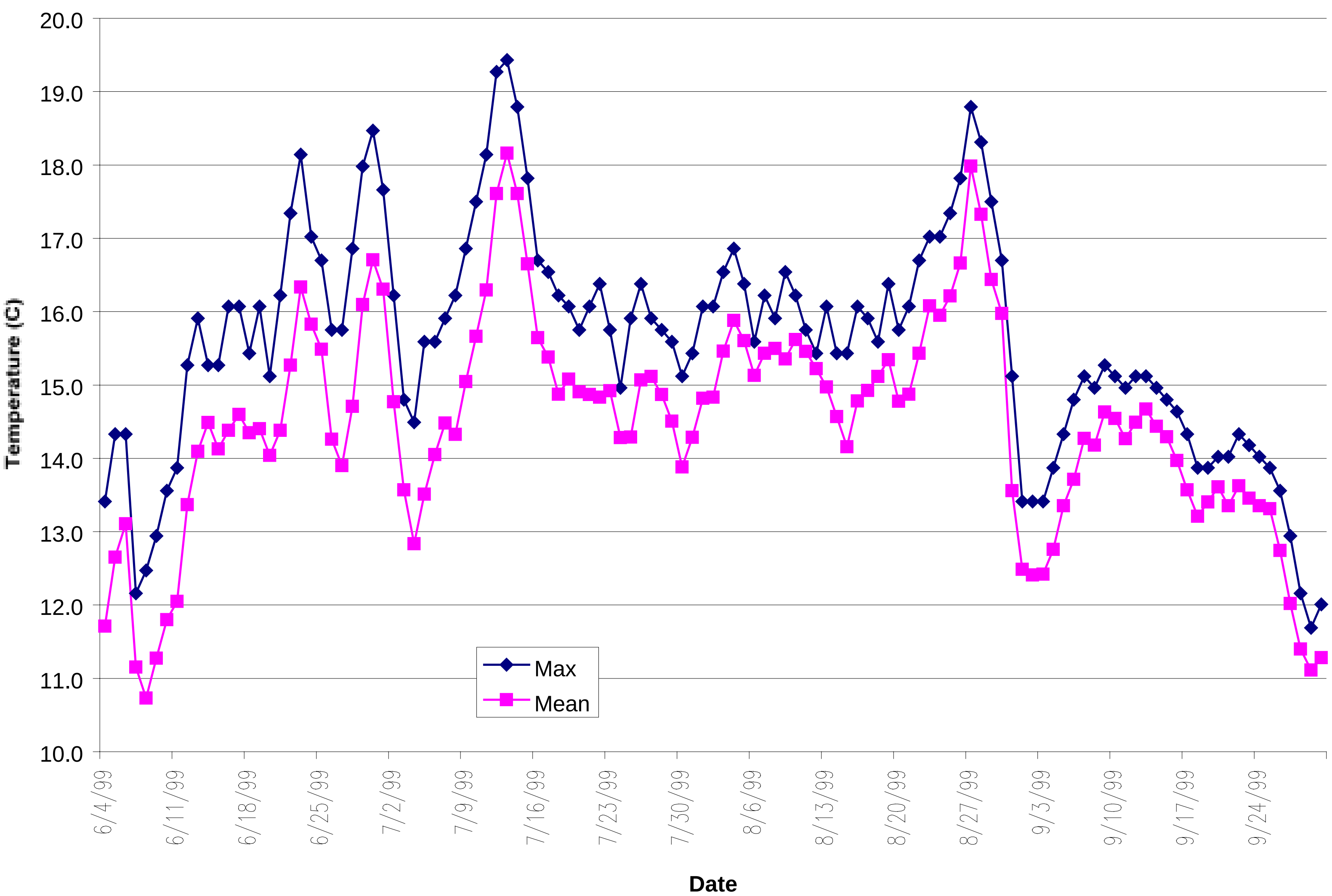


FIGURE 32. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT NORTH FORK HAYWORTH CREEK (MAP NO. 5; MONITORING SITE NO. 70-5), MENDOCINO CO., CALIFORNIA.

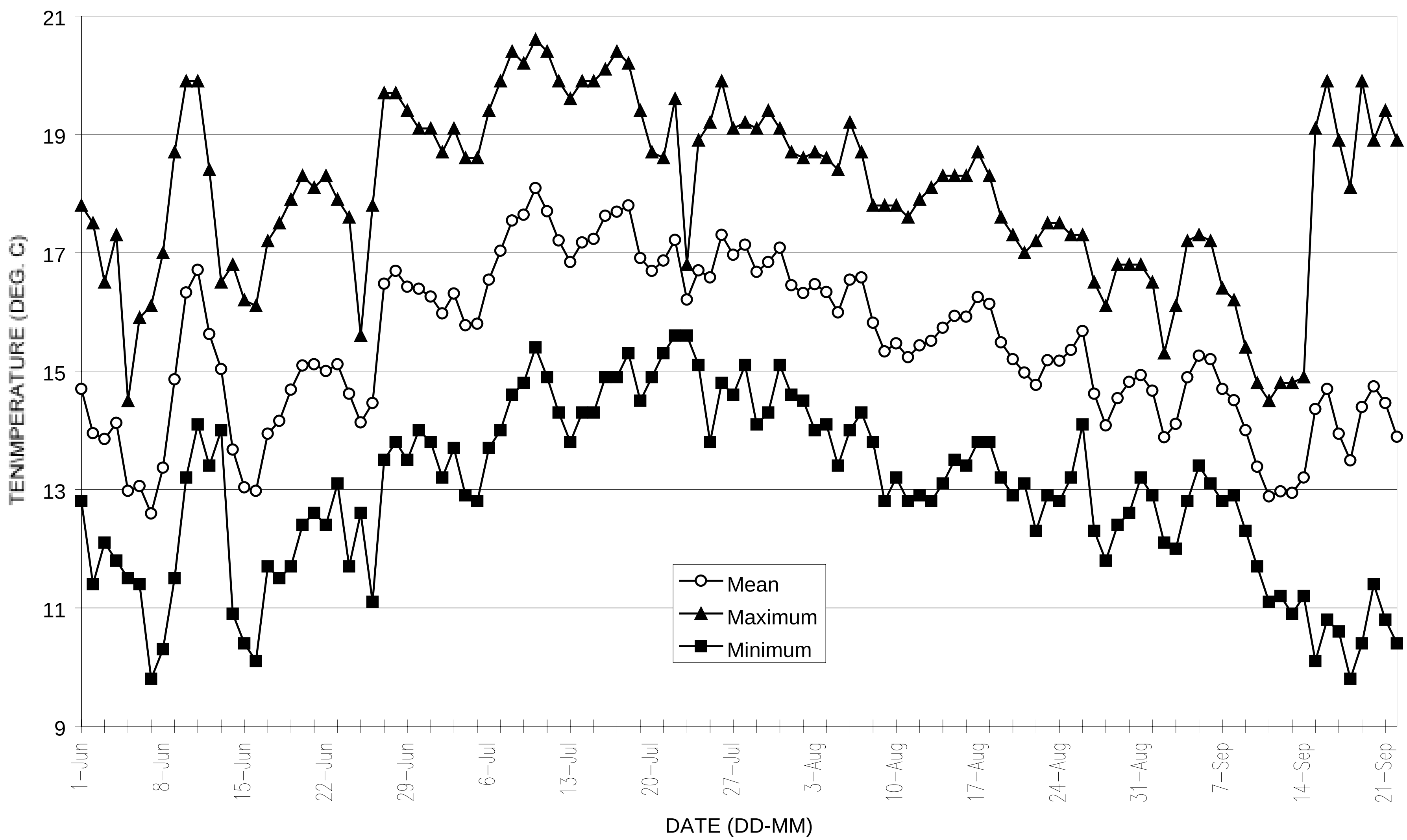


FIGURE 33. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE - SEPTEMBER 1995) AT NORTH FORK HAYWORTH CREEK (MAP NO. 5; MONITORING SITE NO. 70-5), MENDOCINO CO., CALIFORNIA.

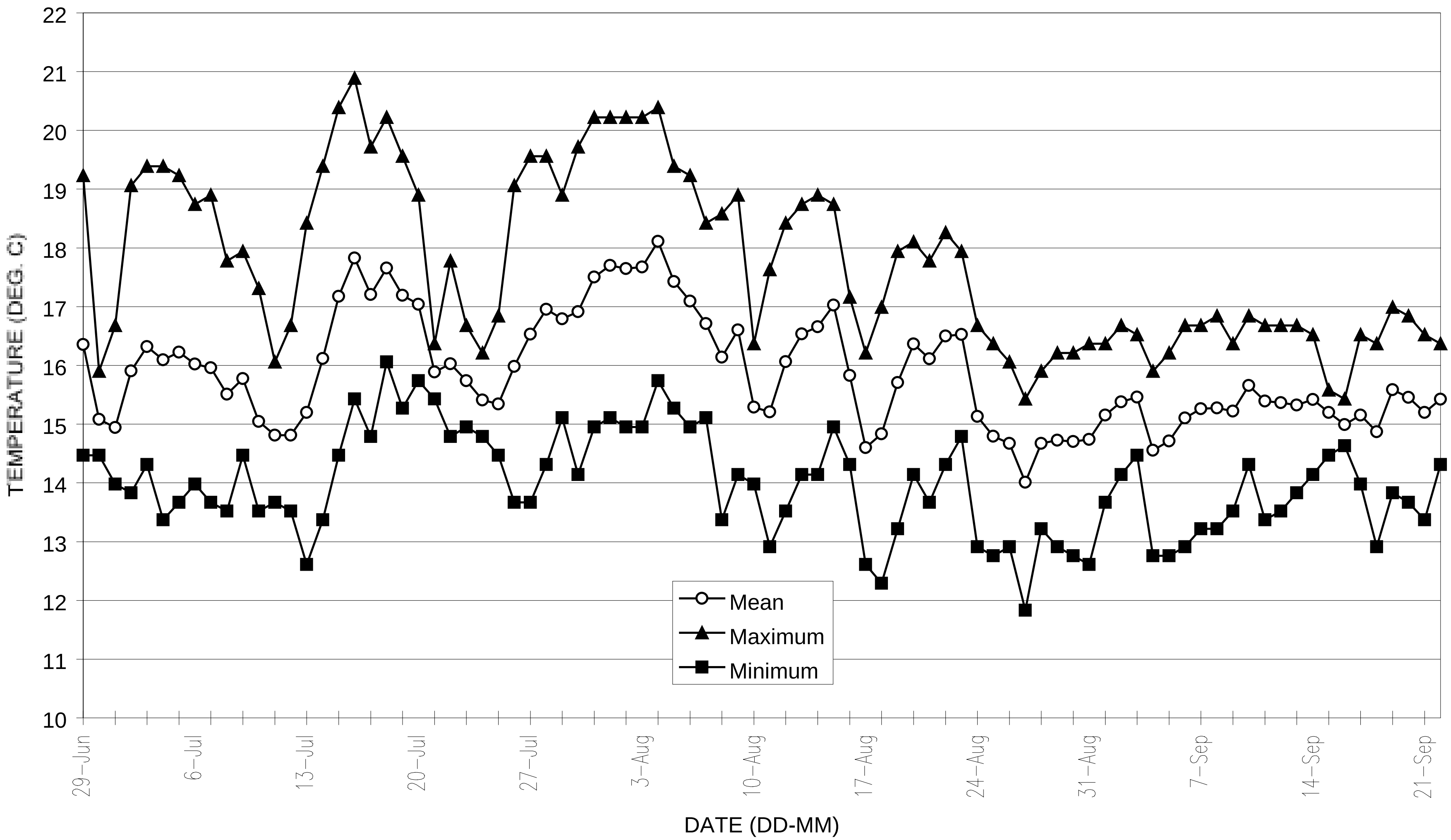


FIGURE 34. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT NORTH FORK HAYWORTH CREEK (MAP NO. 5; MONITORING NO. 70-5), MENDOCINO CO., CALIFORNIA.

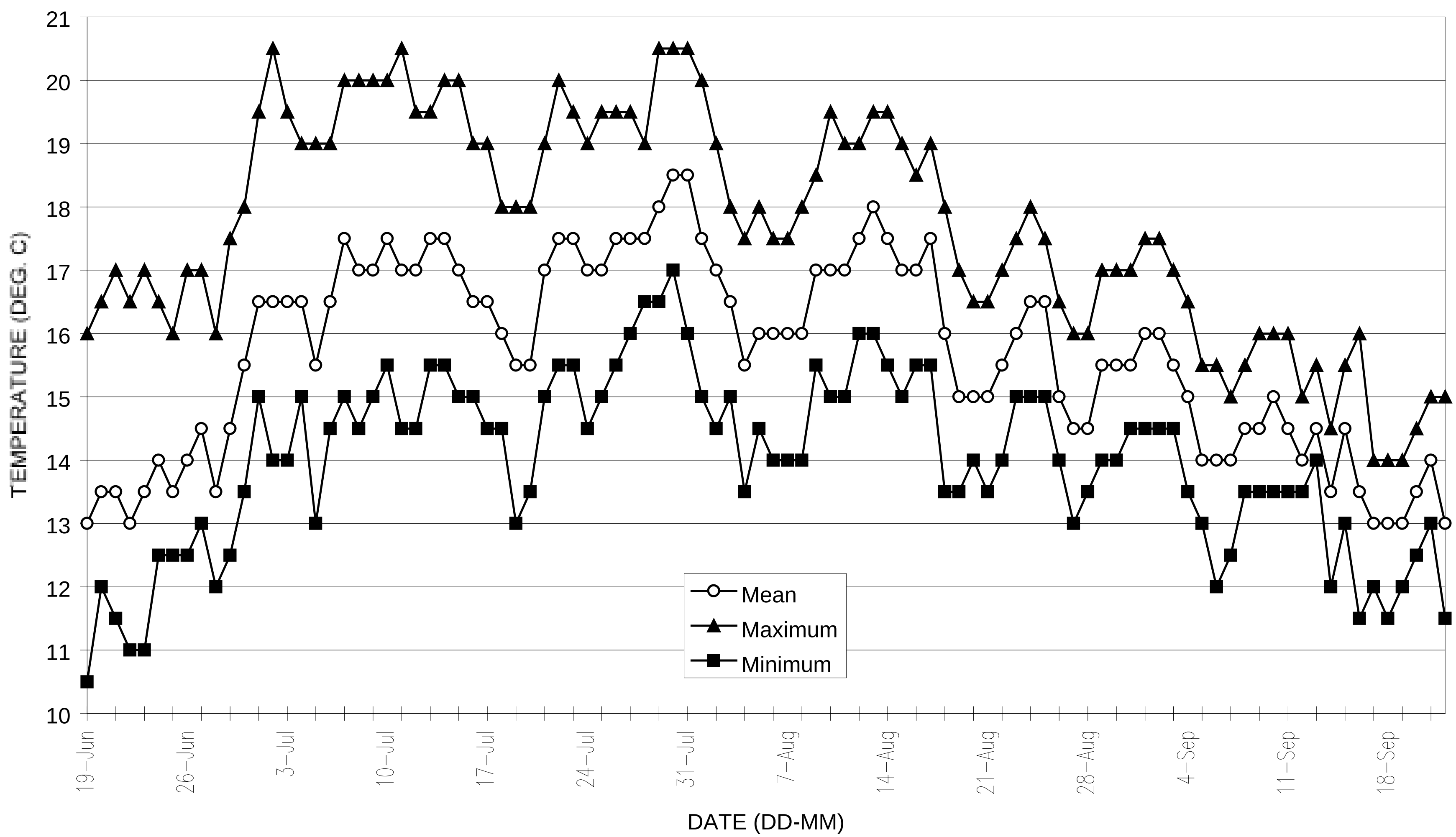


Figure 35. Mean and Maximum Daily Stream Temperatures During Summer 1999 at North Fork Hayworth Creek (Site 70-5), Mendocino County, California.

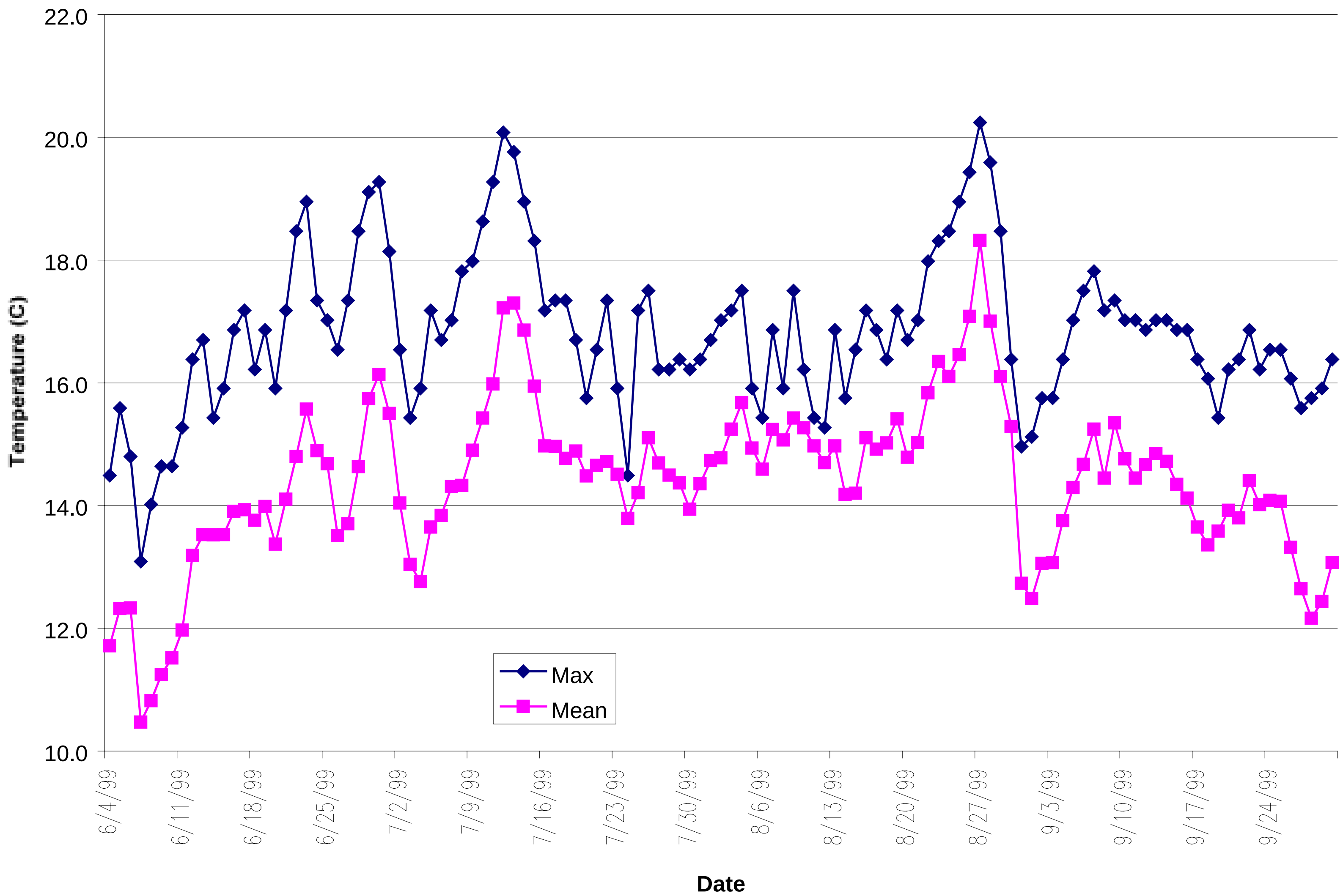


FIGURE 35. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT HAYWORTH CREEK (MAP NO. 5; MONITORING SITE NO. 70-6), MENDOCINO CO., CALIFORNIA.

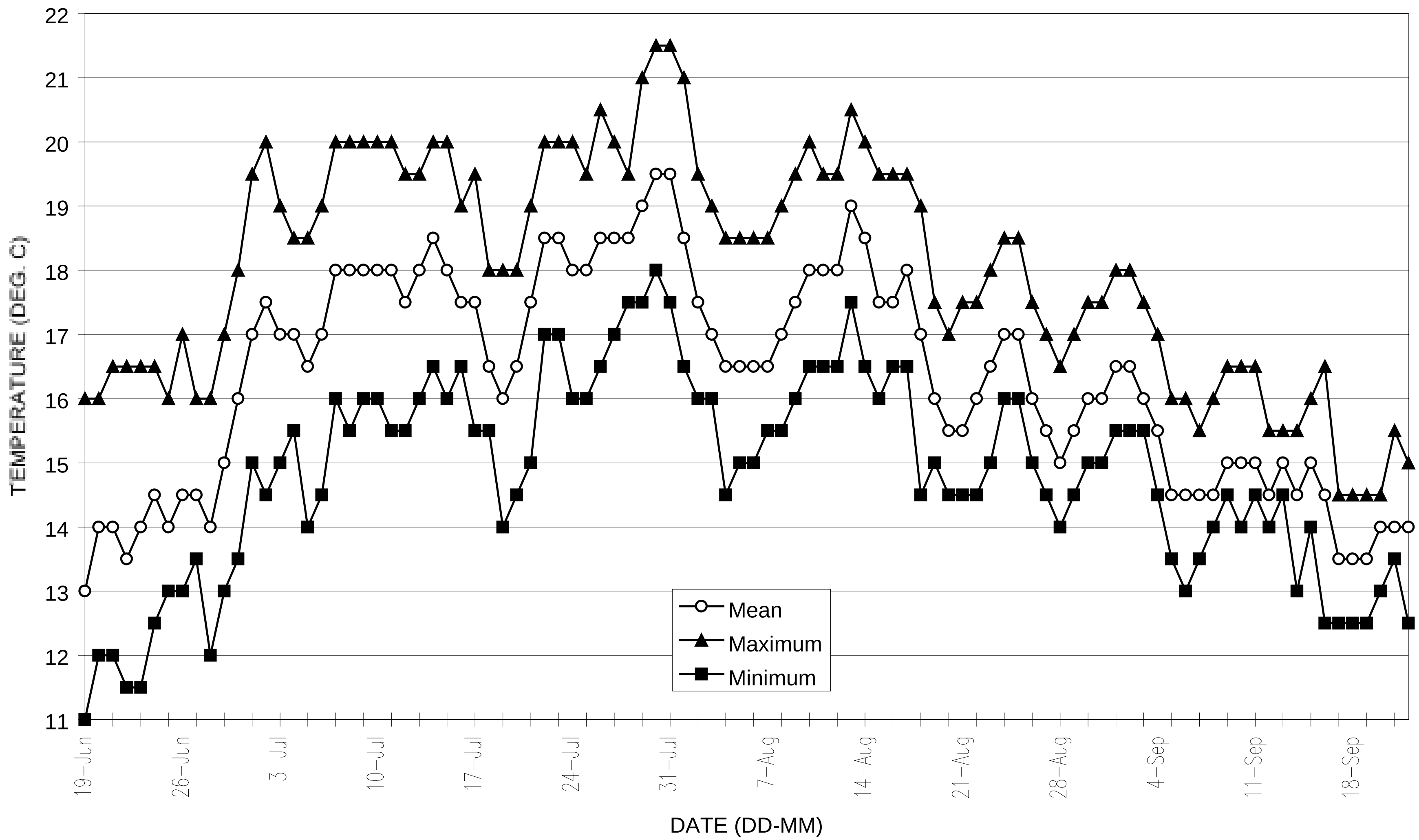


Figure 37. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Hayworth Creek (Site 70-6), Mendocino County, California.

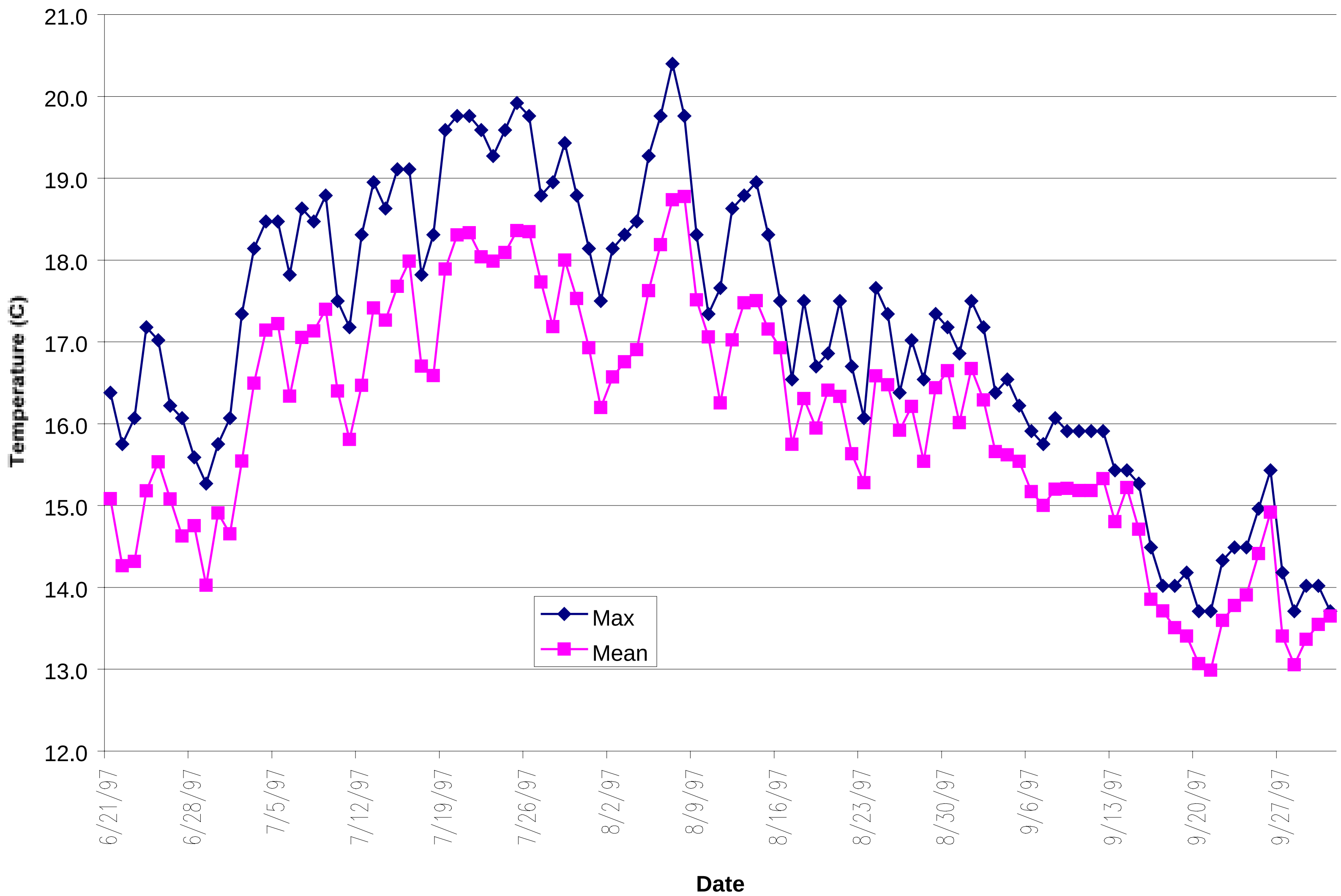


Figure 38. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Hayworth Creek (Site 70-6), Mendocino County, California.

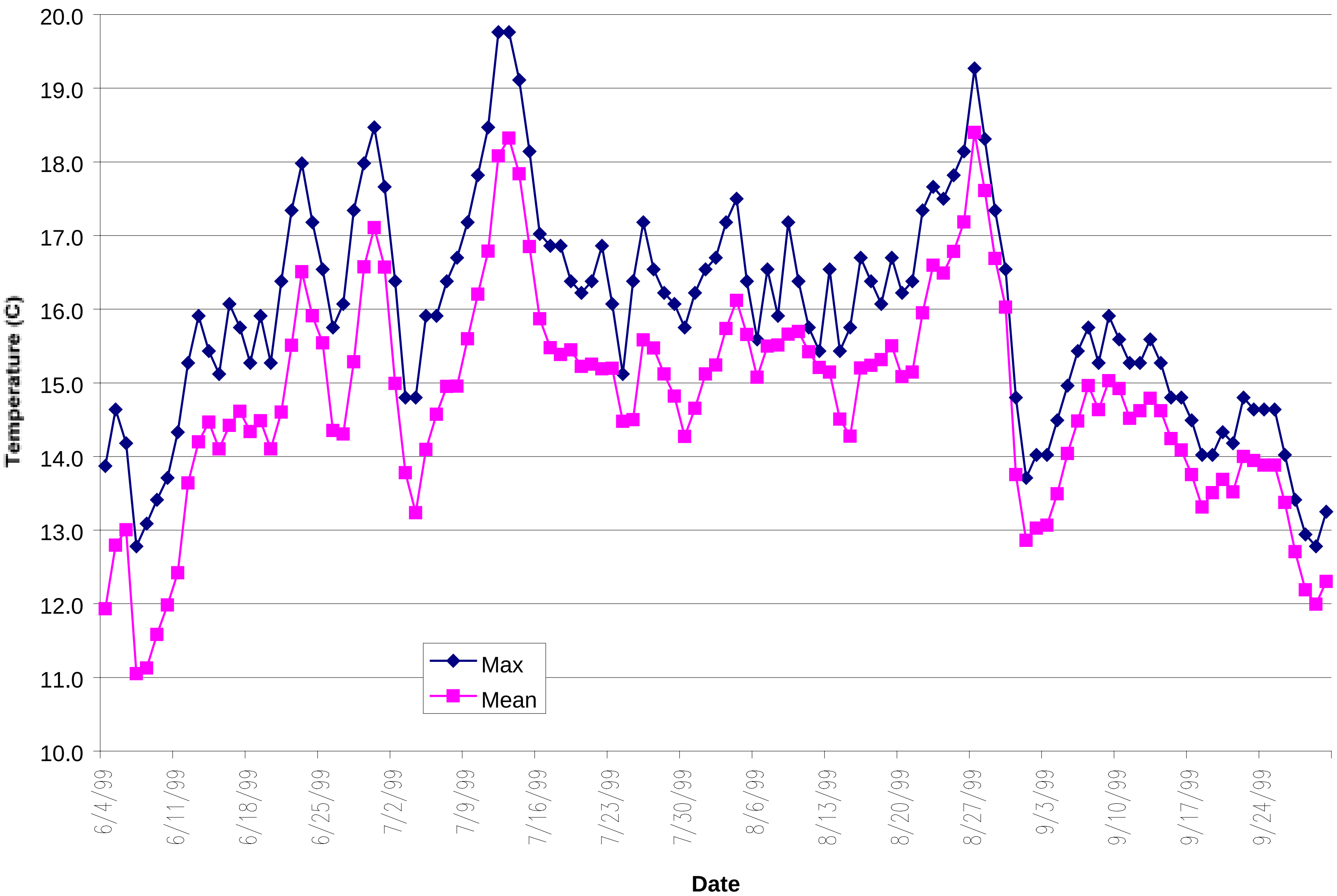


FIGURE 10. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1991) AT NORTH FORK NOYO RIVER (MAP NO. 2; MONITORING SITE NO. 70-7), MENDOCINO CO., CALIFORNIA.

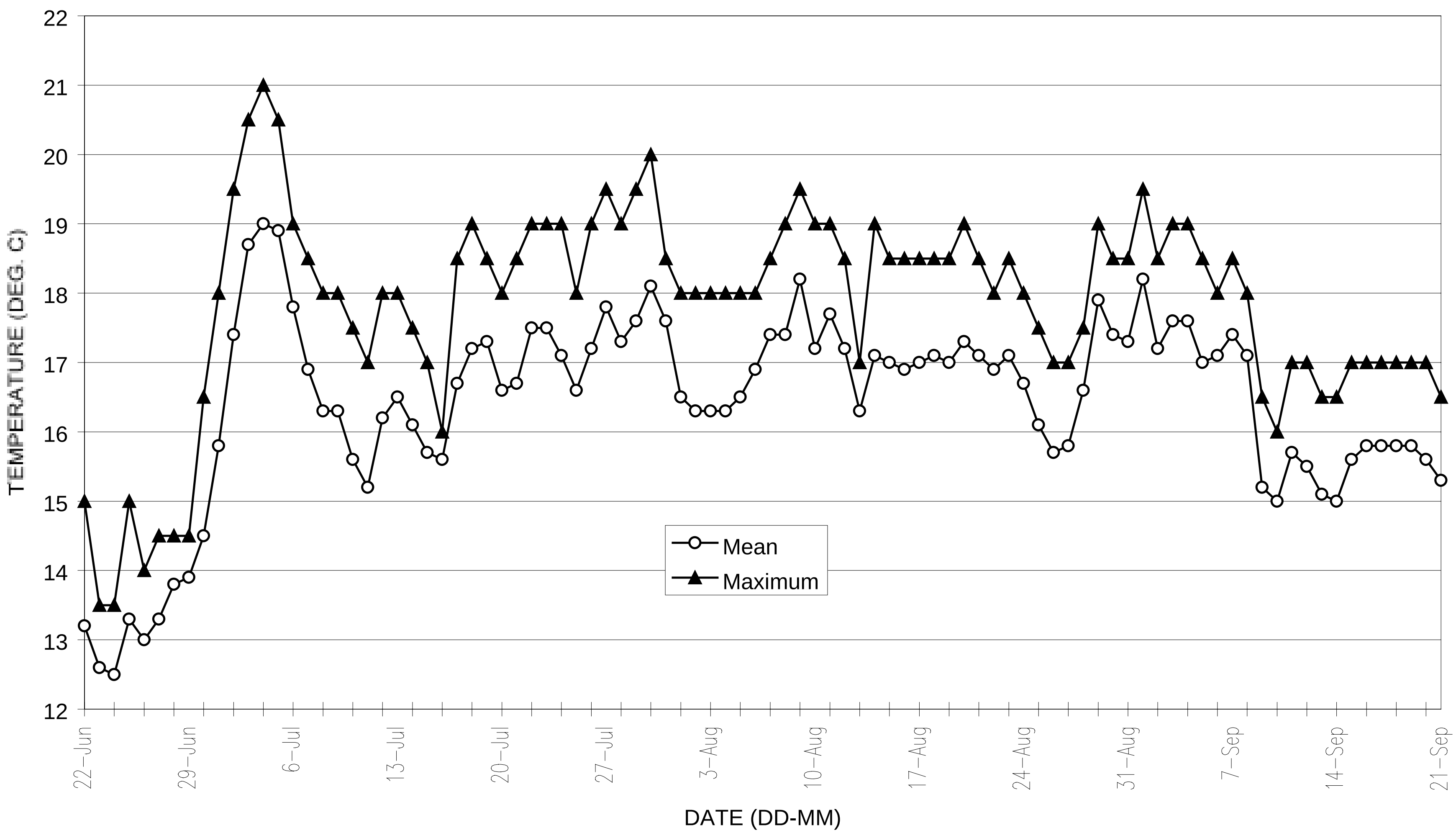


FIGURE 11. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT NORTH FORK NOYO RIVER (MAP NO. 2; MONITORING SITE NO. 70-7), MENDOCINO CO., CALIFORNIA.

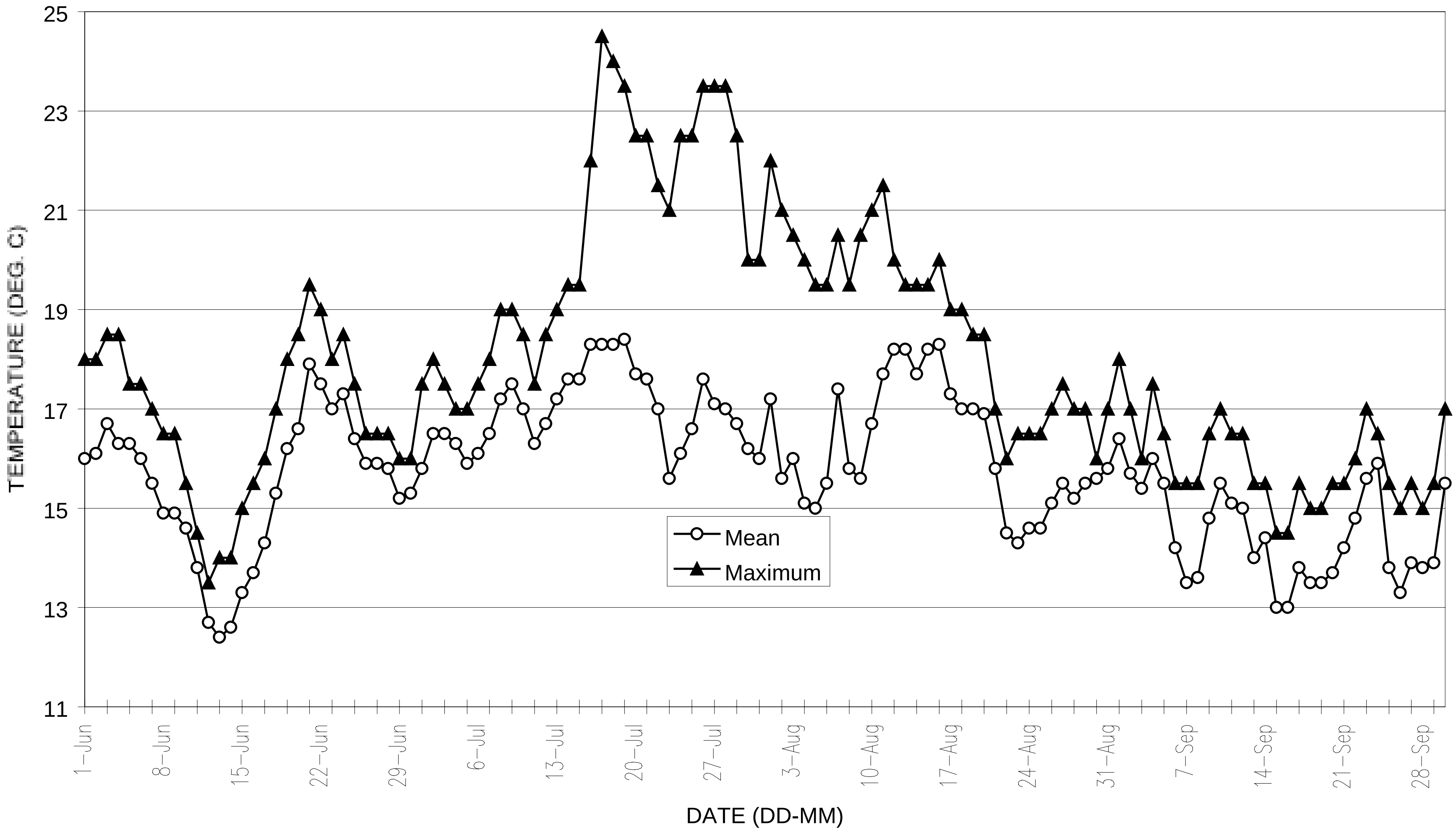


FIGURE 12. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-AUGUST 1993) AT NORTH FORK NOYO RIVER (MAP NO. 2; MONITORING SITE NO. 70-7), MENDOCINO CO., CALIFORNIA.

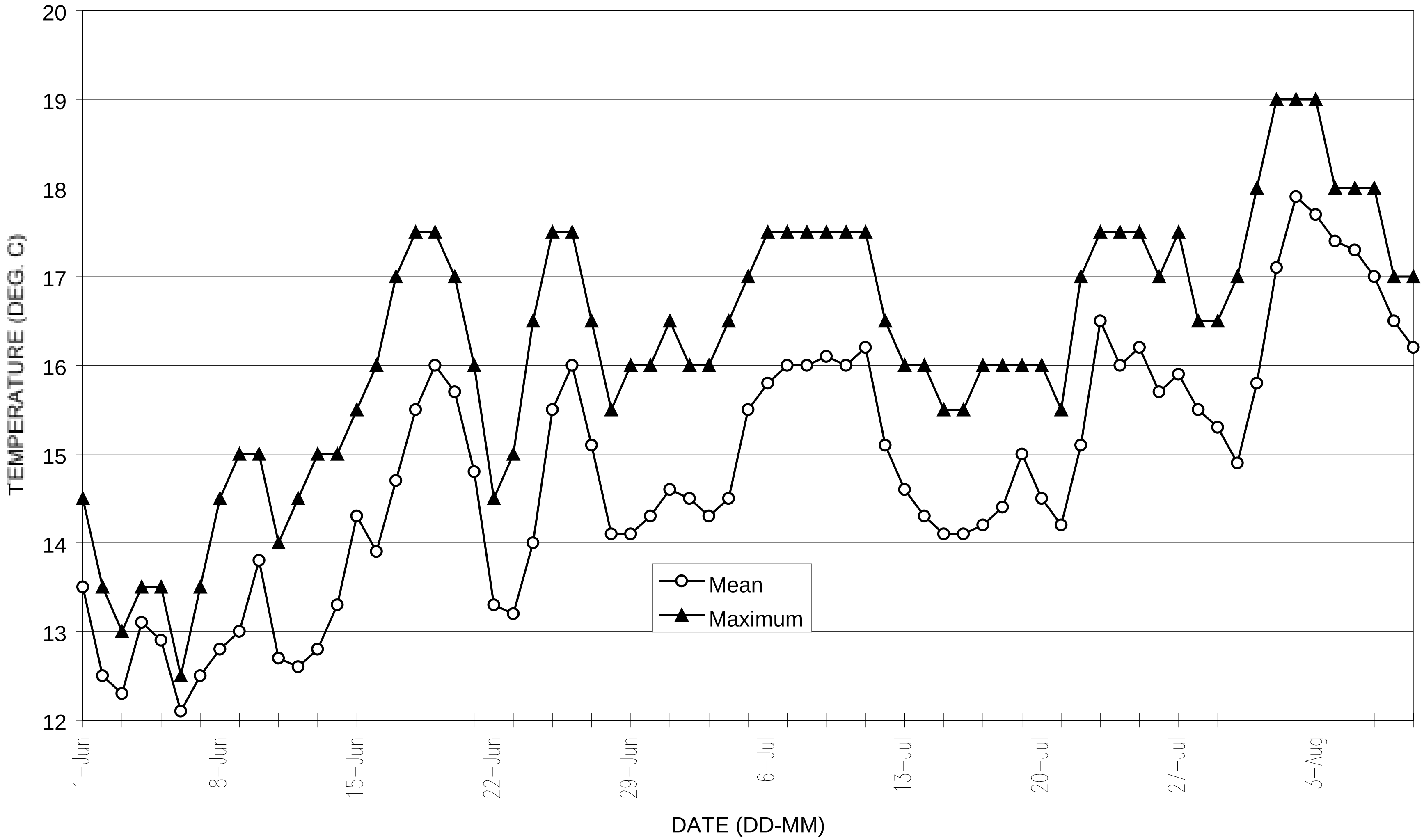


FIGURE 36. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (MAY-SEPTEMBER1994) AT NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-7), MENDOCINO CO., CALIFORNIA.

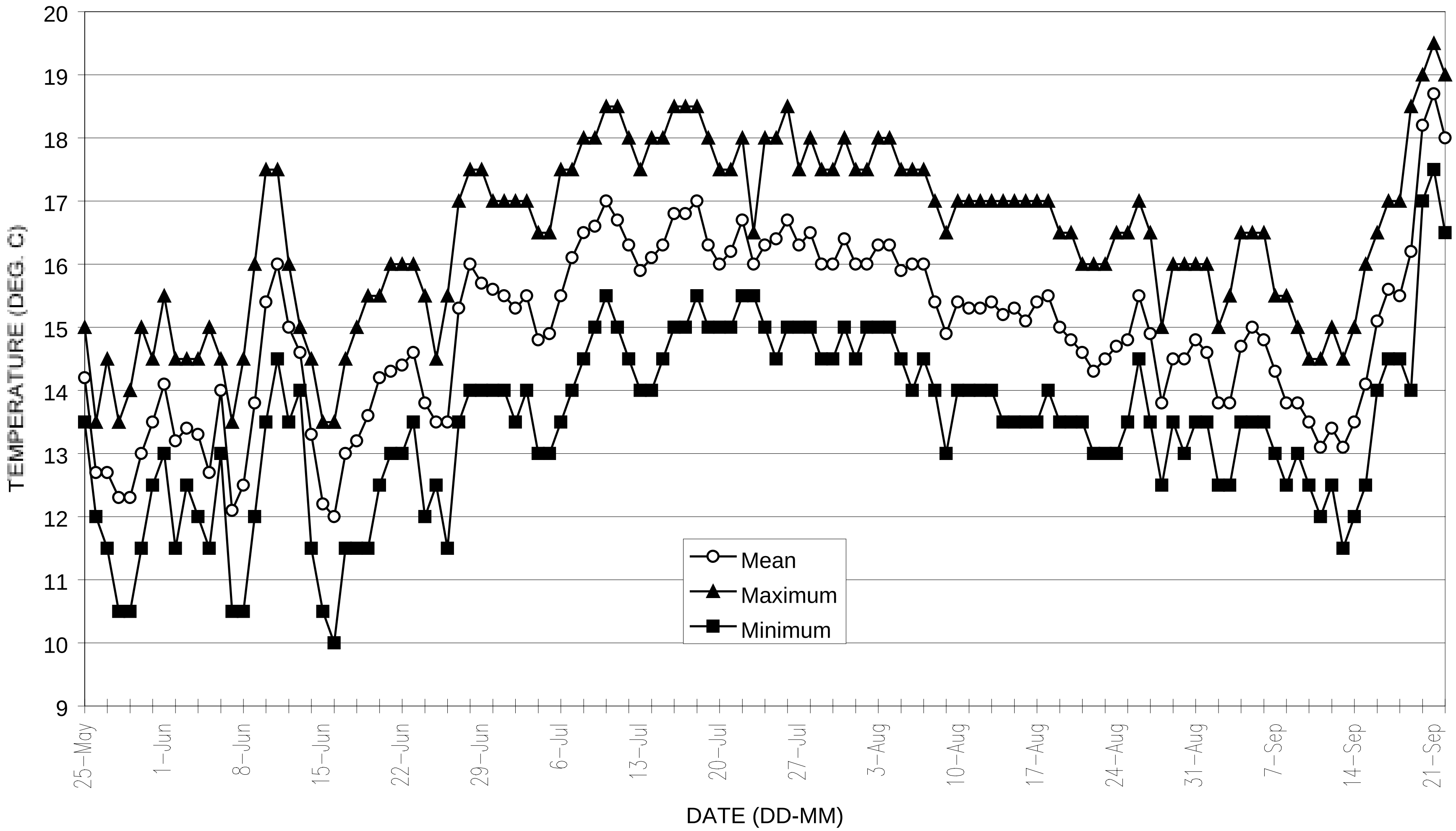


FIGURE 37. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-7), MENDOCINO CO., CALIFORNIA.

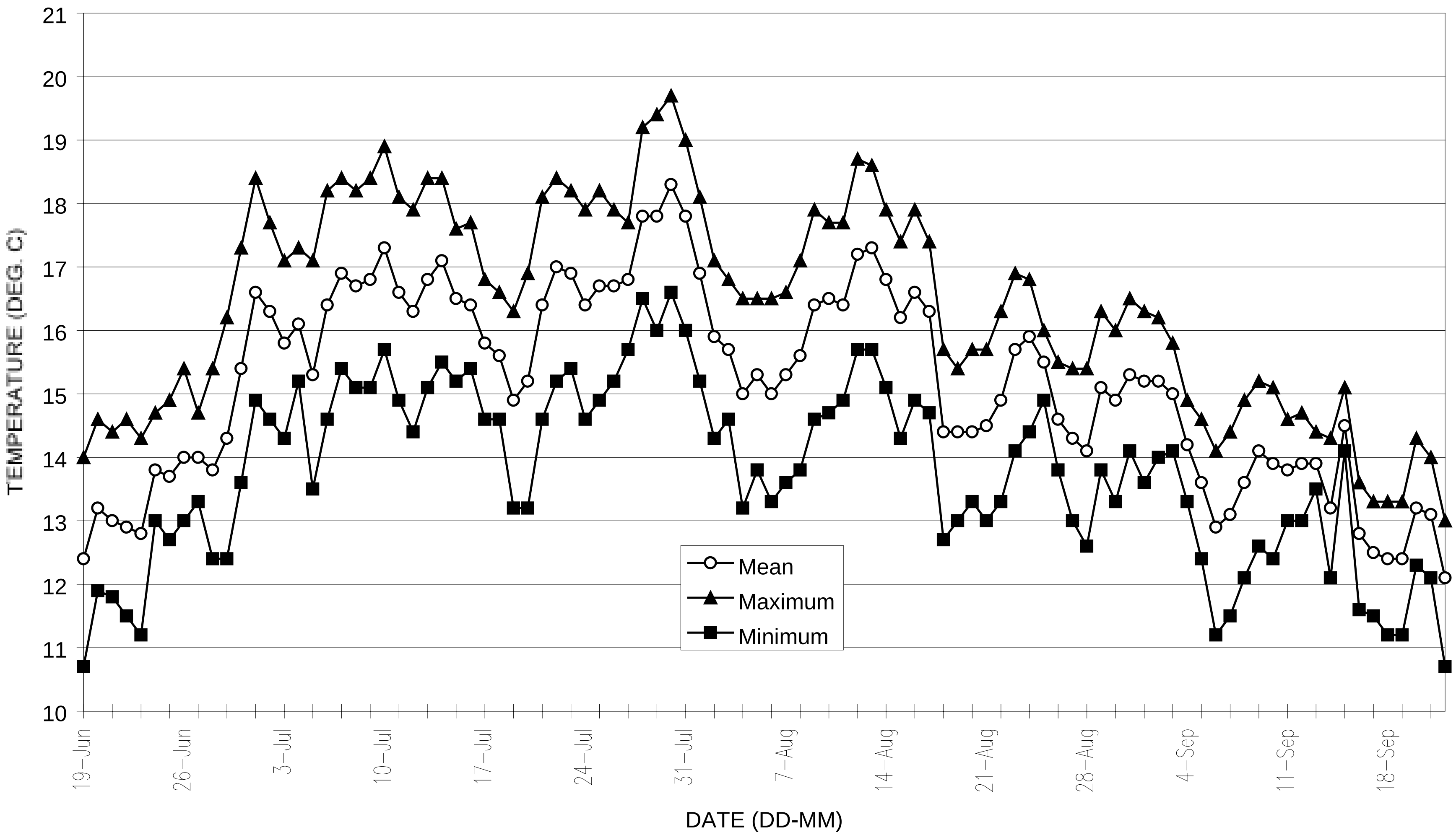


Figure 40. Mean and Maximum Daily Stream Temperatures During Summer 1999 at North Fork Noyo River (Site 70-7), Mendocino County, California.

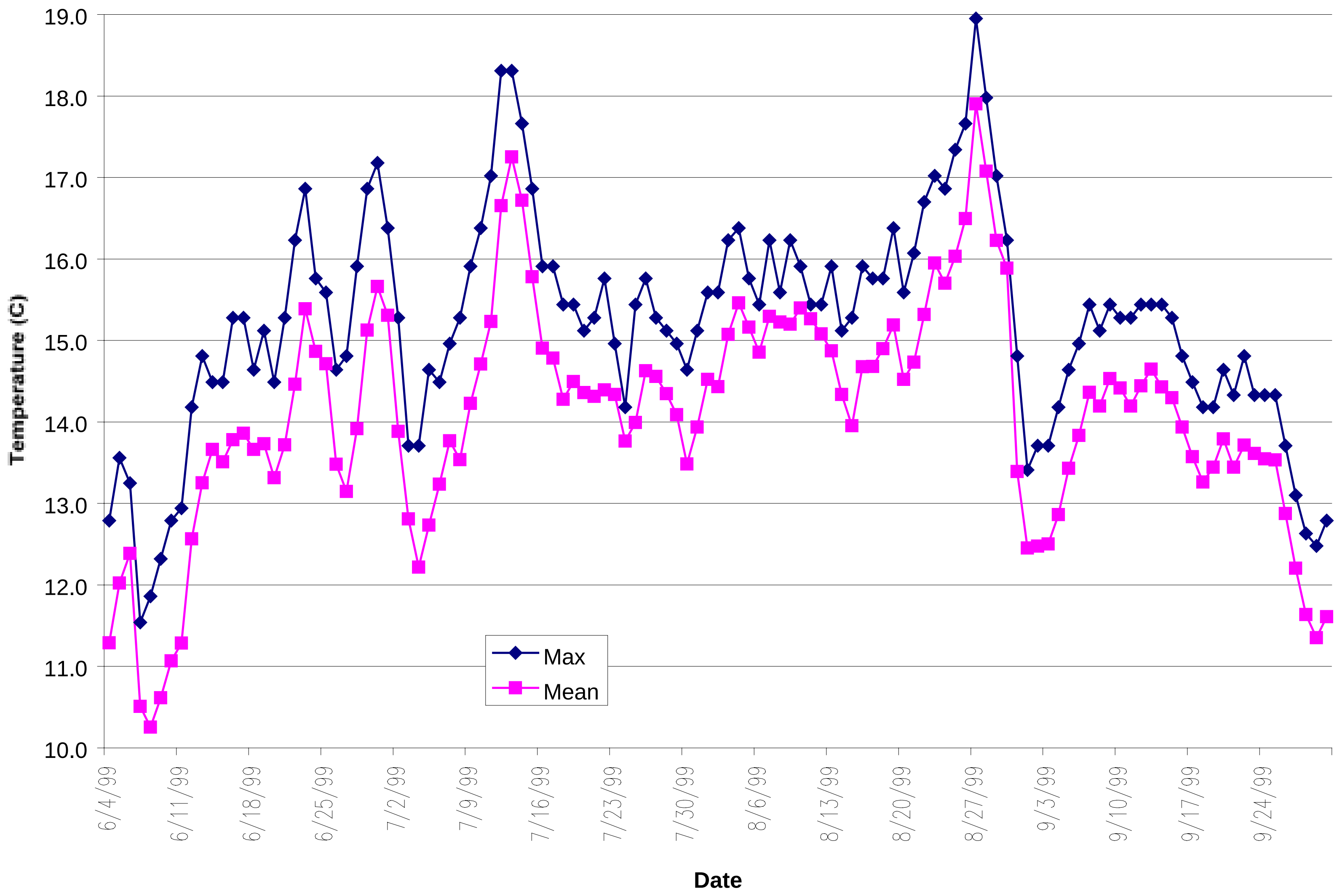


FIGURE 38. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT MIDDLE FORK OF NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-8), MENDOCINO CO., CALIFORNIA.

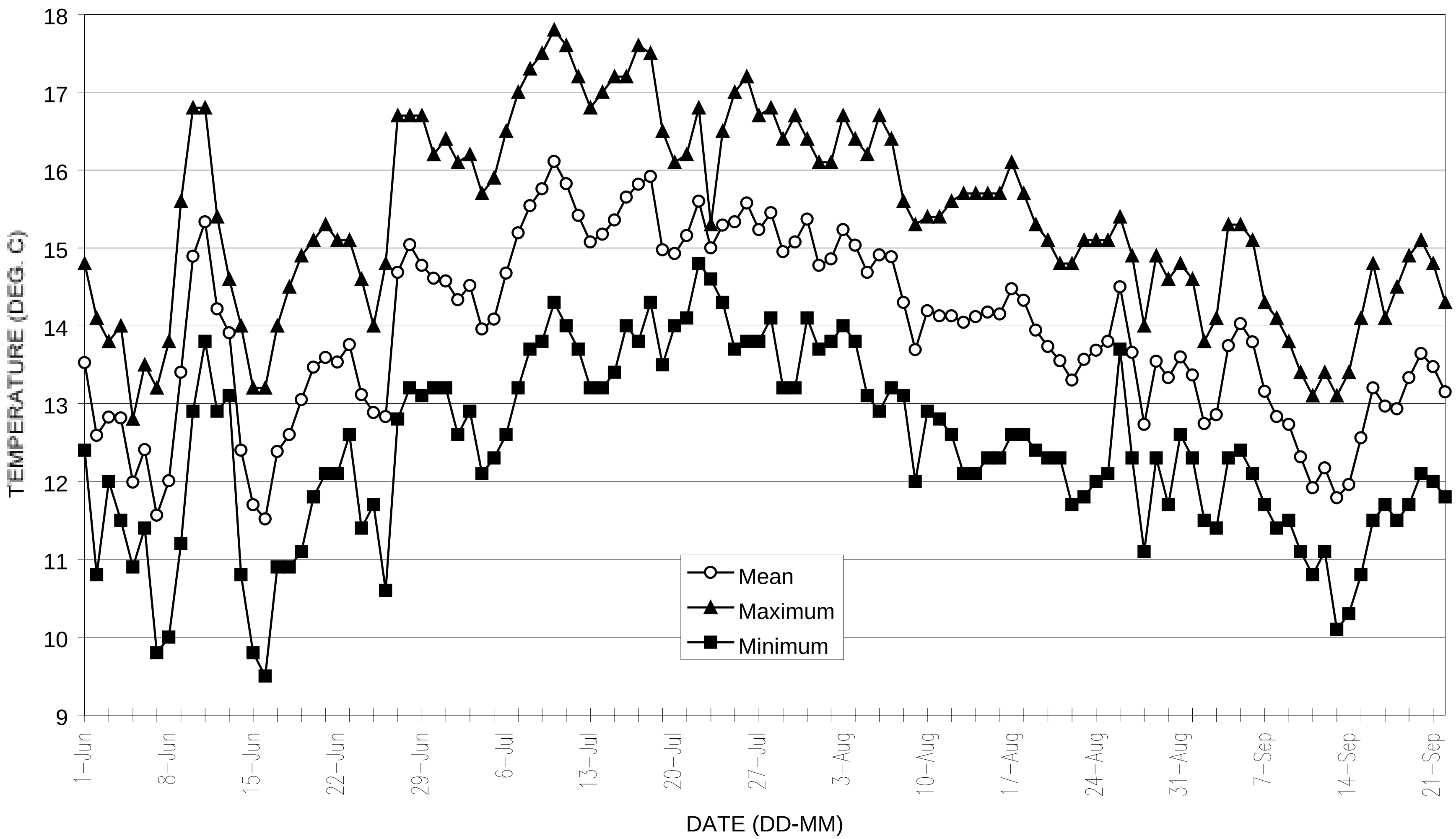


FIGURE 39. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE - SEPTEMBER 1995) AT MIDDLE FORK OF NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-8), MENDOCINO CO., CALIFORNIA.

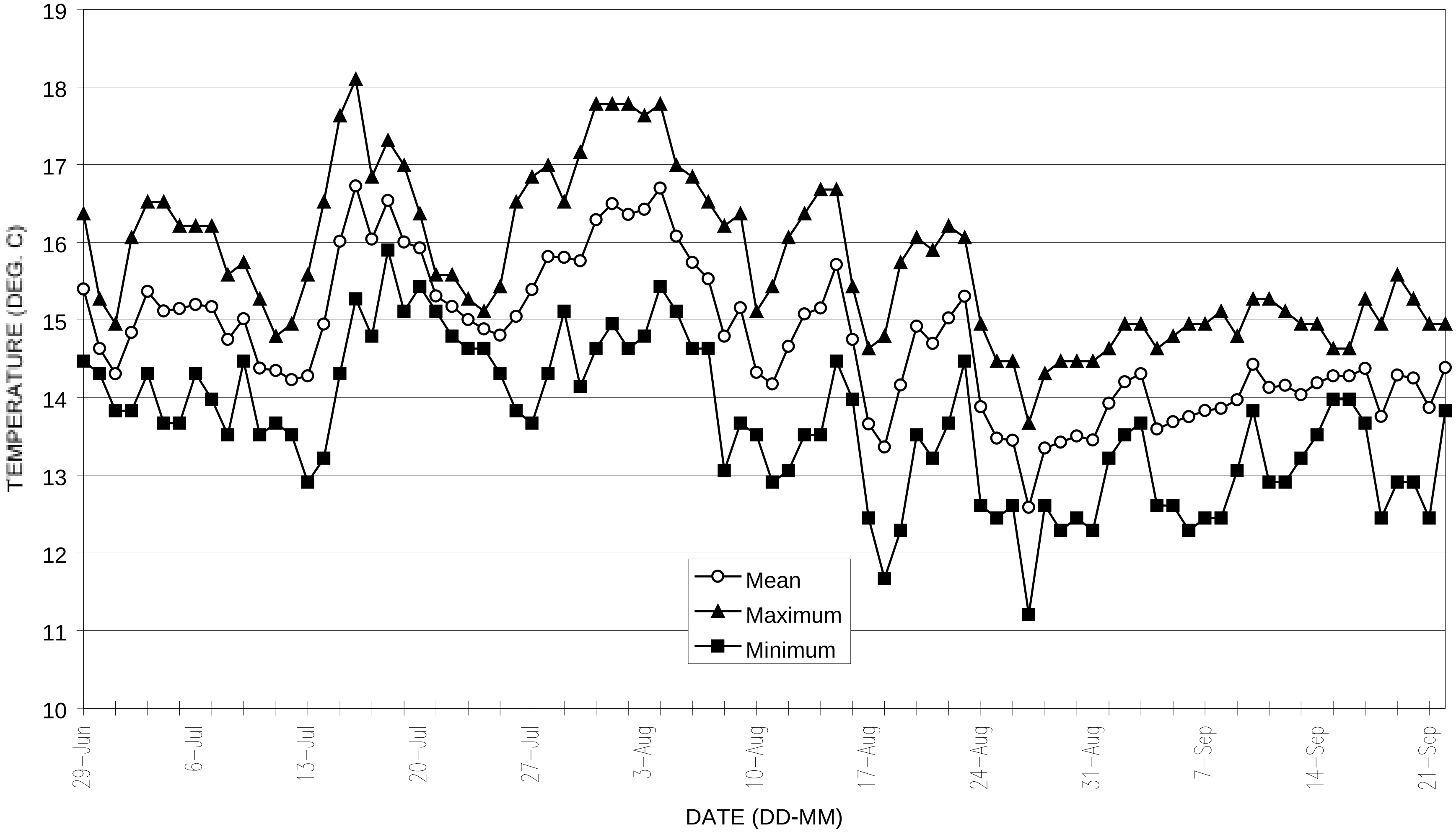


FIGURE 40. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT MIDDLE FORK OF NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-8), MENDOCINO CO., CALIFORNIA.

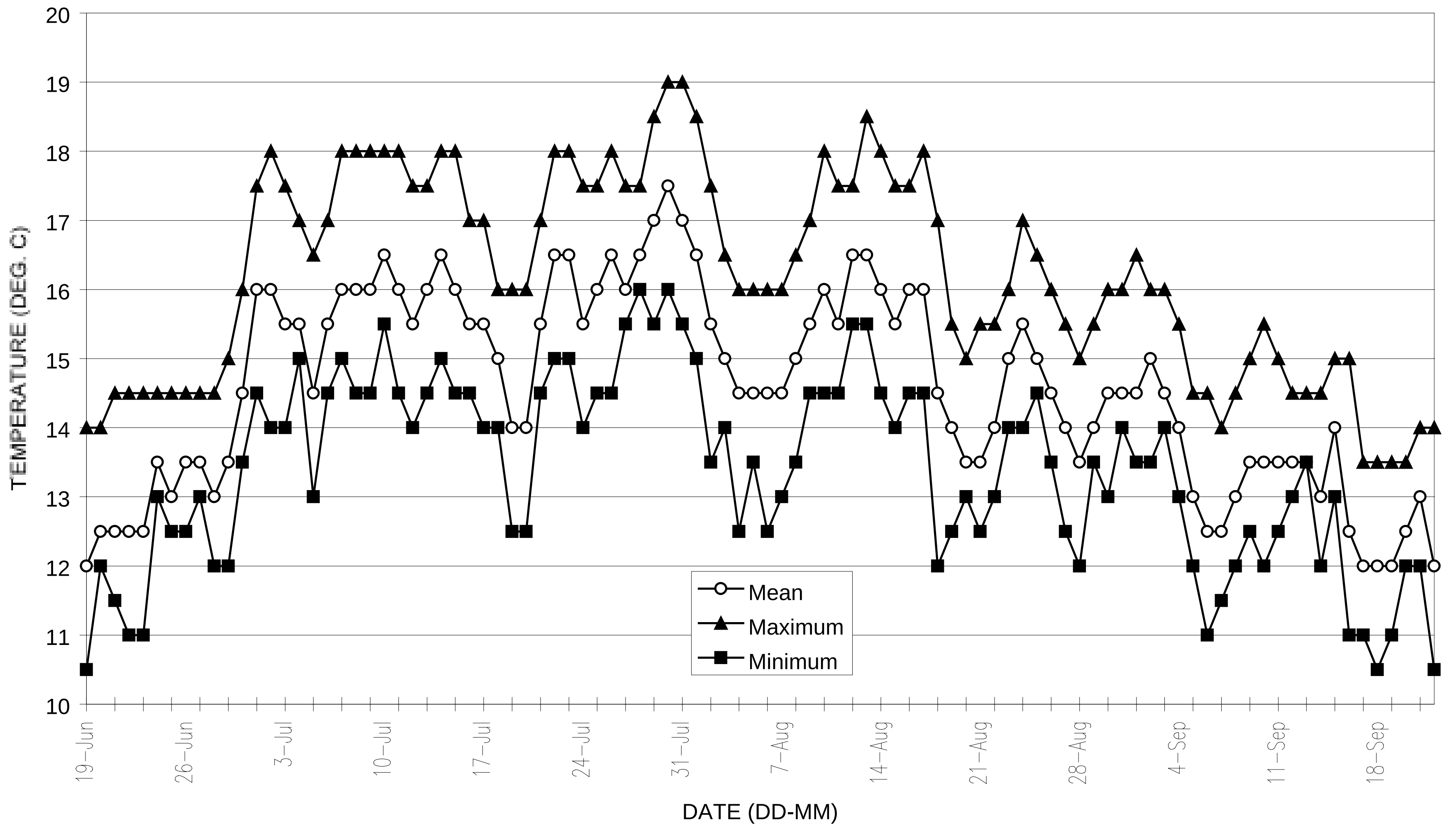


Figure 42. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Middle Fork North Fork Noyo River (Site 70-8), Mendocino County, California.

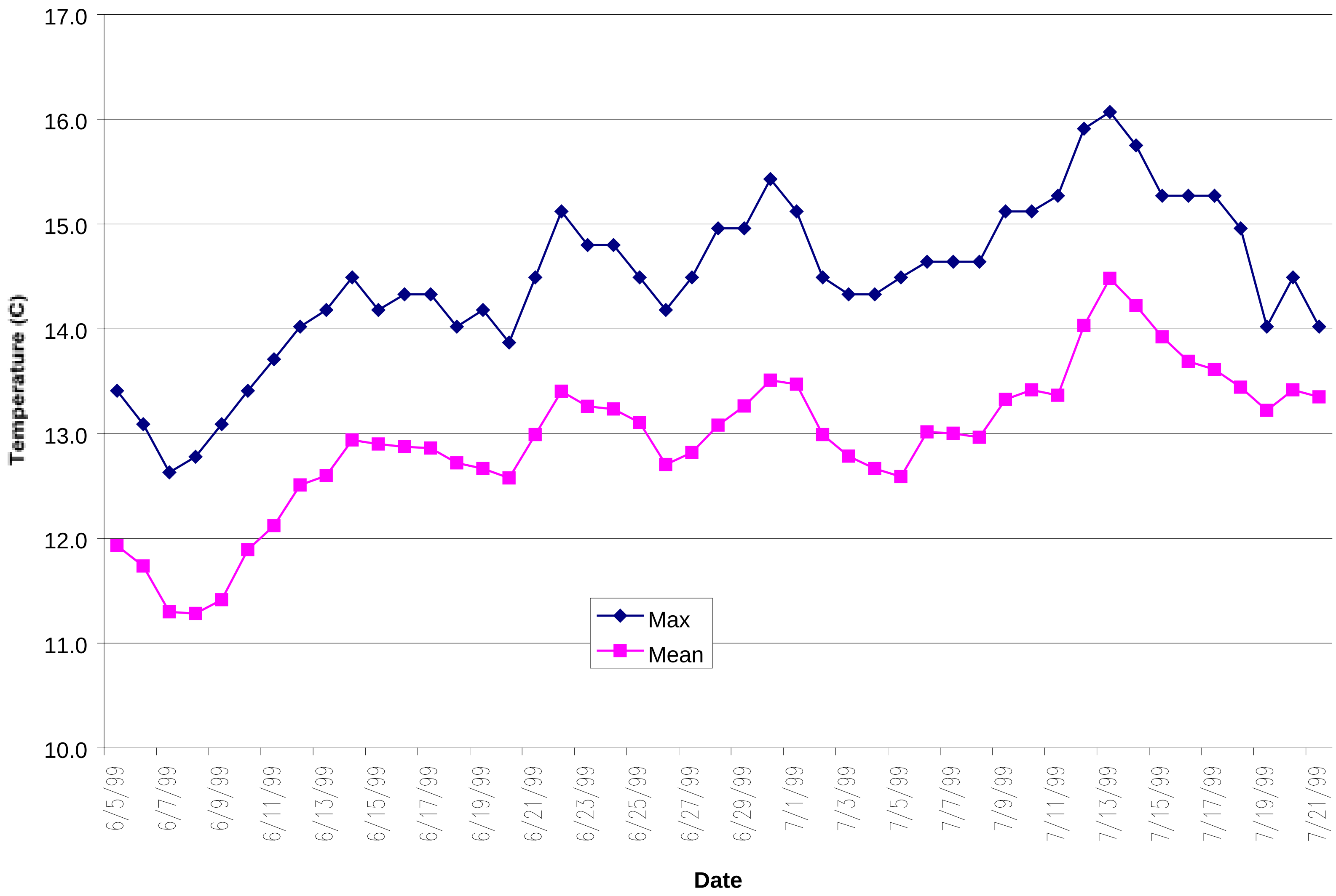


FIGURE 41. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE - SEPTEMBER 1995) AT NORTH FORK NOYO RIVER (MAP NO. 5; MONITORING SITE NO.70-10), MENDOCINO CO., CALIFORNIA.

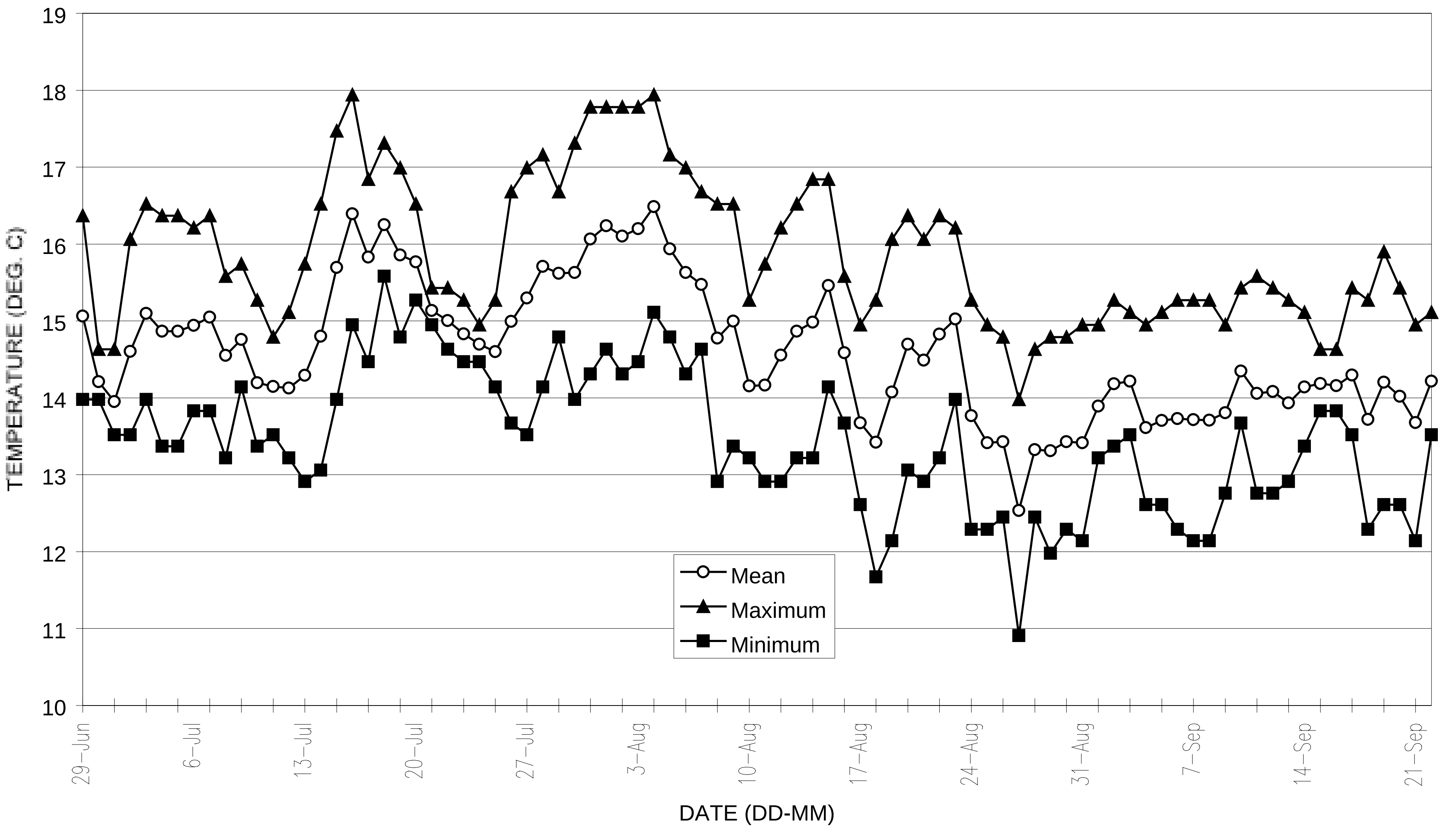


Figure 44. Mean and Maximum Daily Stream Temperatures During Summer 1999 at North Fork Noyo River (Site 70-10), Mendocino County, California.

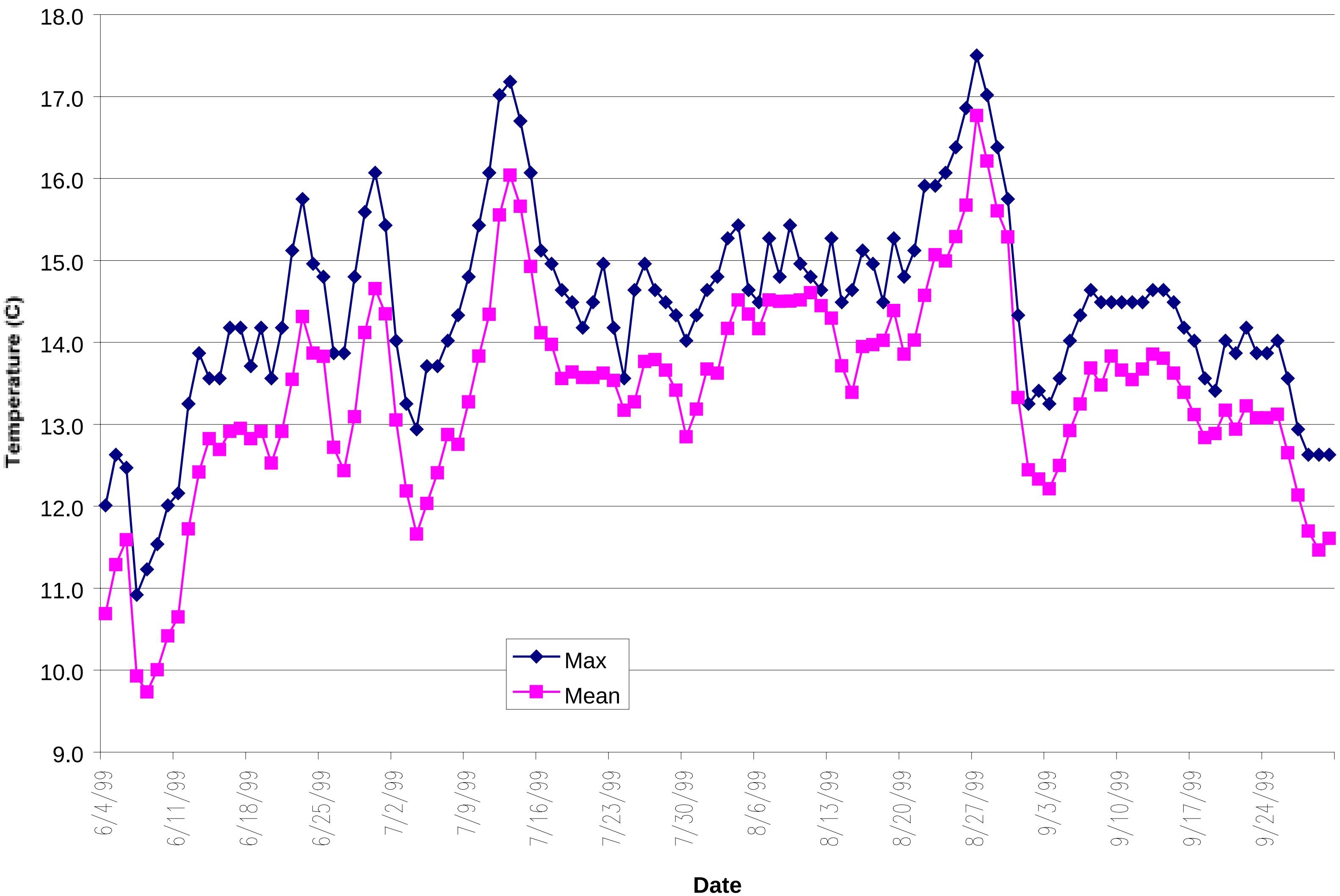


FIGURE 5. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1992) AT NOYO RIVER (MAP NO. 2; MONITORING NO. 70-11), MENDOCINO CO., CALIFORNIA.

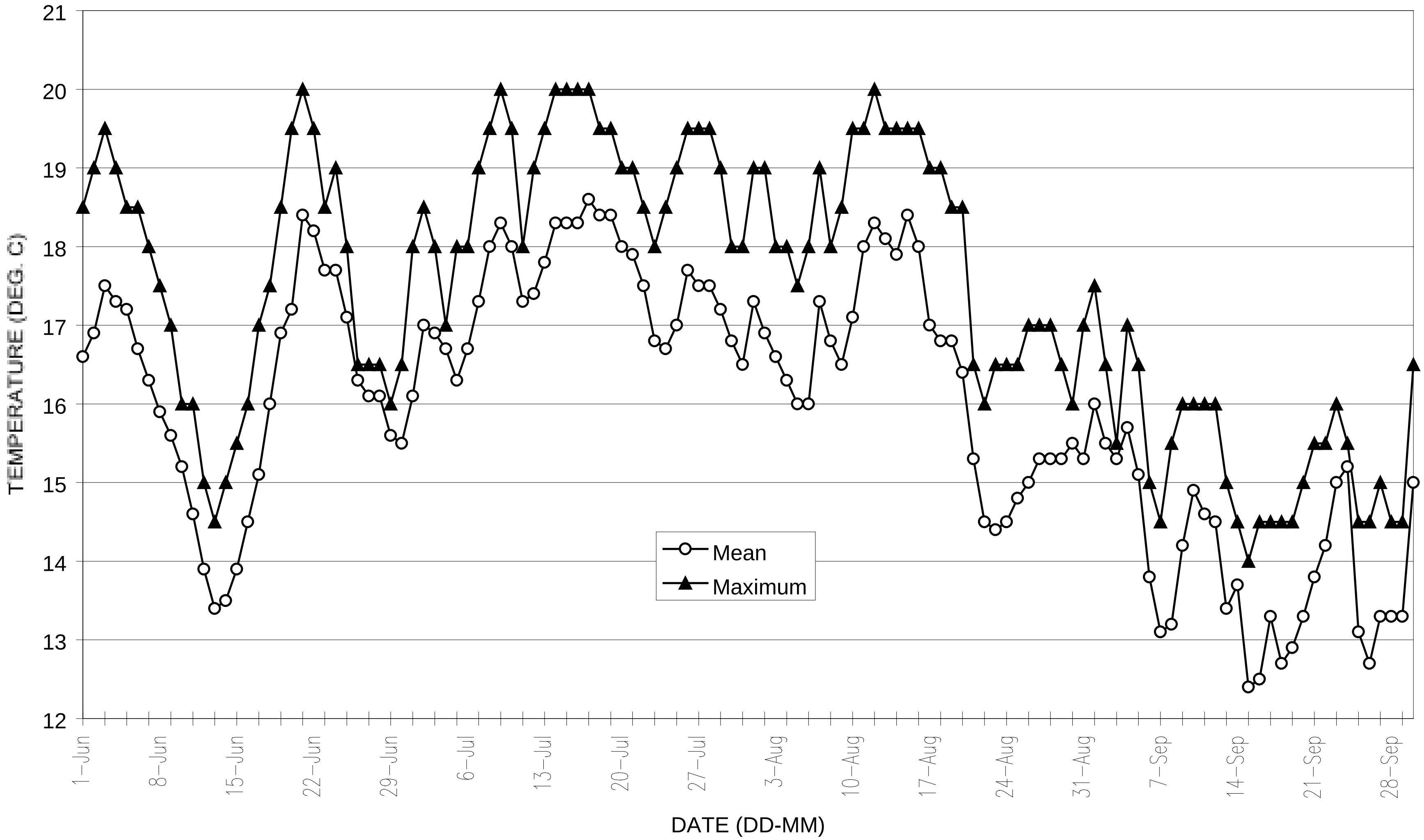


FIGURE 6. MEAN AND MAXIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1993) AT NOYO RIVER (MAP NO. 2; MONITORING SITE NO. 70-11), MENDOCINO CO., CALIFORNIA.

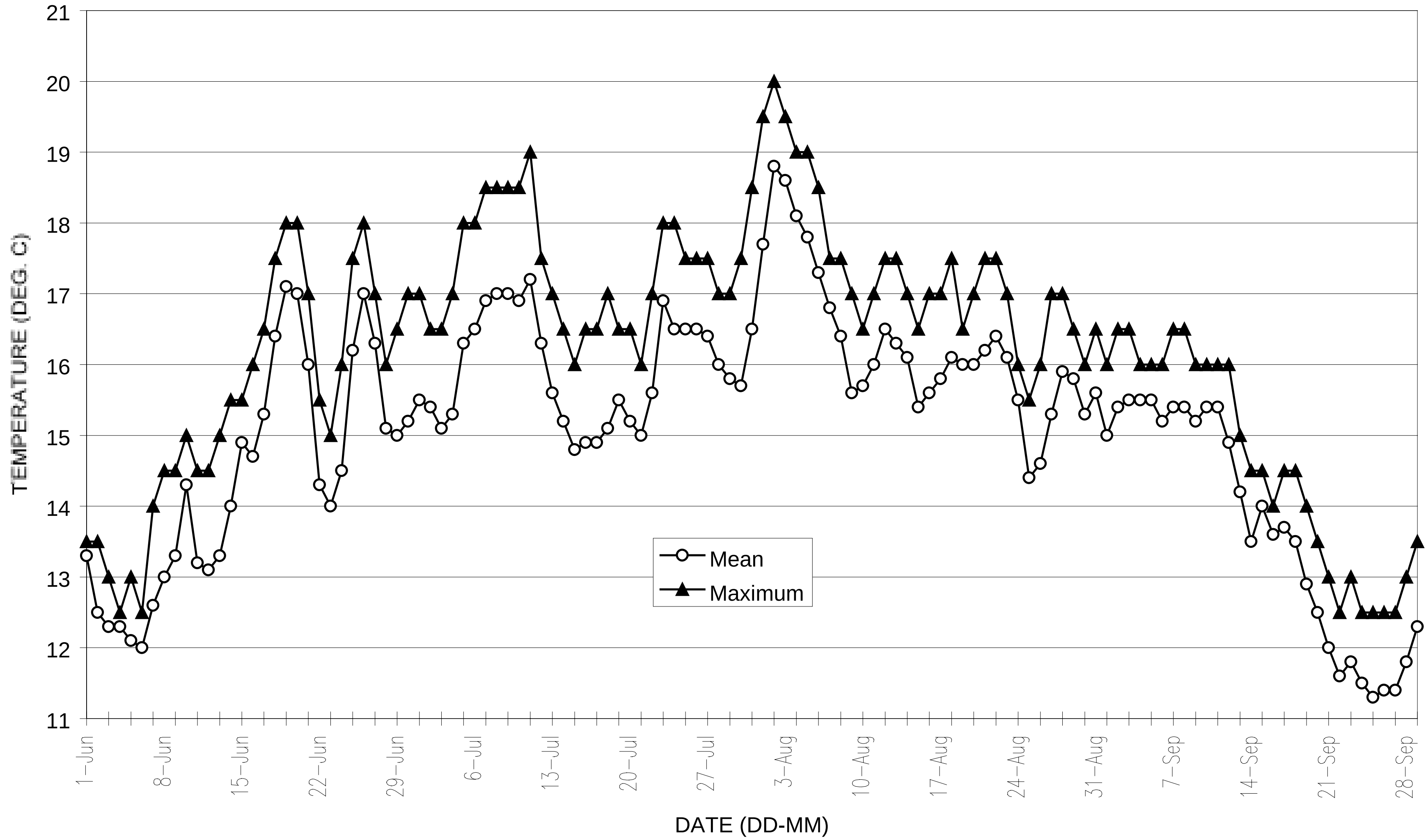


FIGURE 42. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (MAY-SEPTEMBER 1994) AT THE NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-11), MENDOCINO CO., CALIFORNIA.

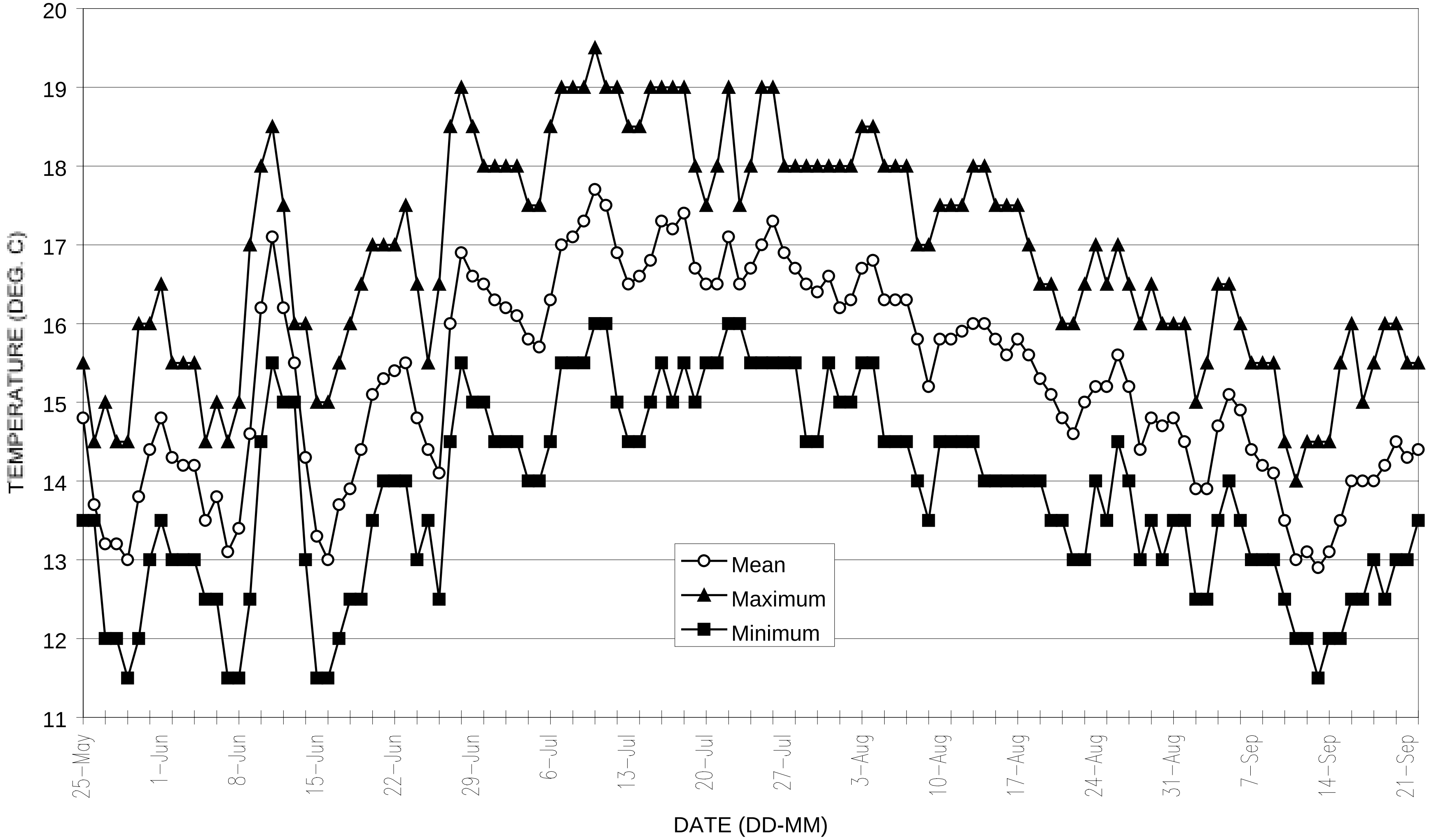


FIGURE 43. MEAN, MAXIMUM AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-AUGUST 1995) AT THE NOYO RIVER (MAP NO. 5; MONITORING SITE 70-11), MENDOCINO CO., CALIFORNIA.

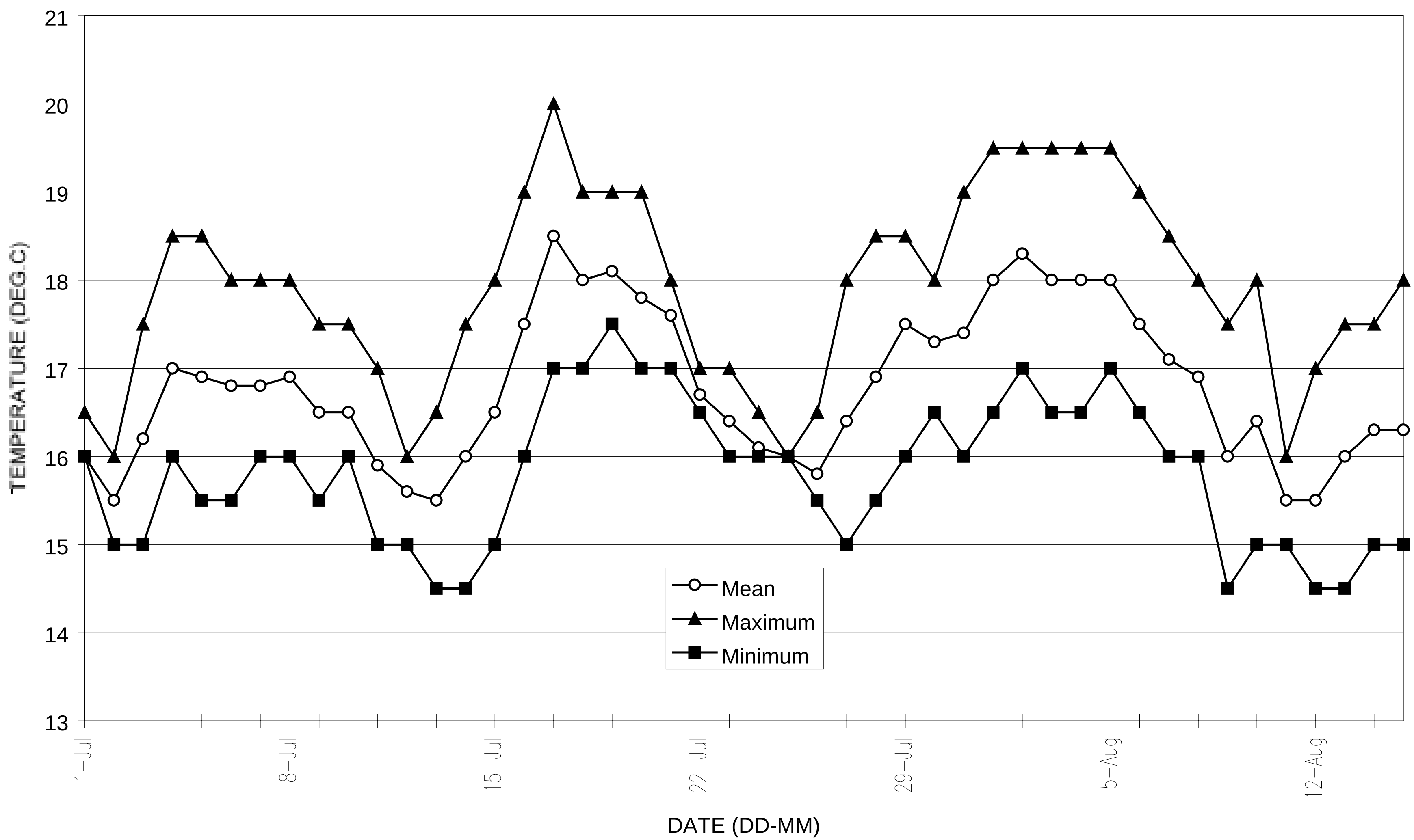


FIGURE 44. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING THE SUMMER (JUNE-SEPTEMBER 1996) AT NOYO RIVER (MAP NO. 5; MONITORING SITE NO. 70-11), MENDOCINO CO., CALIFORNIA.

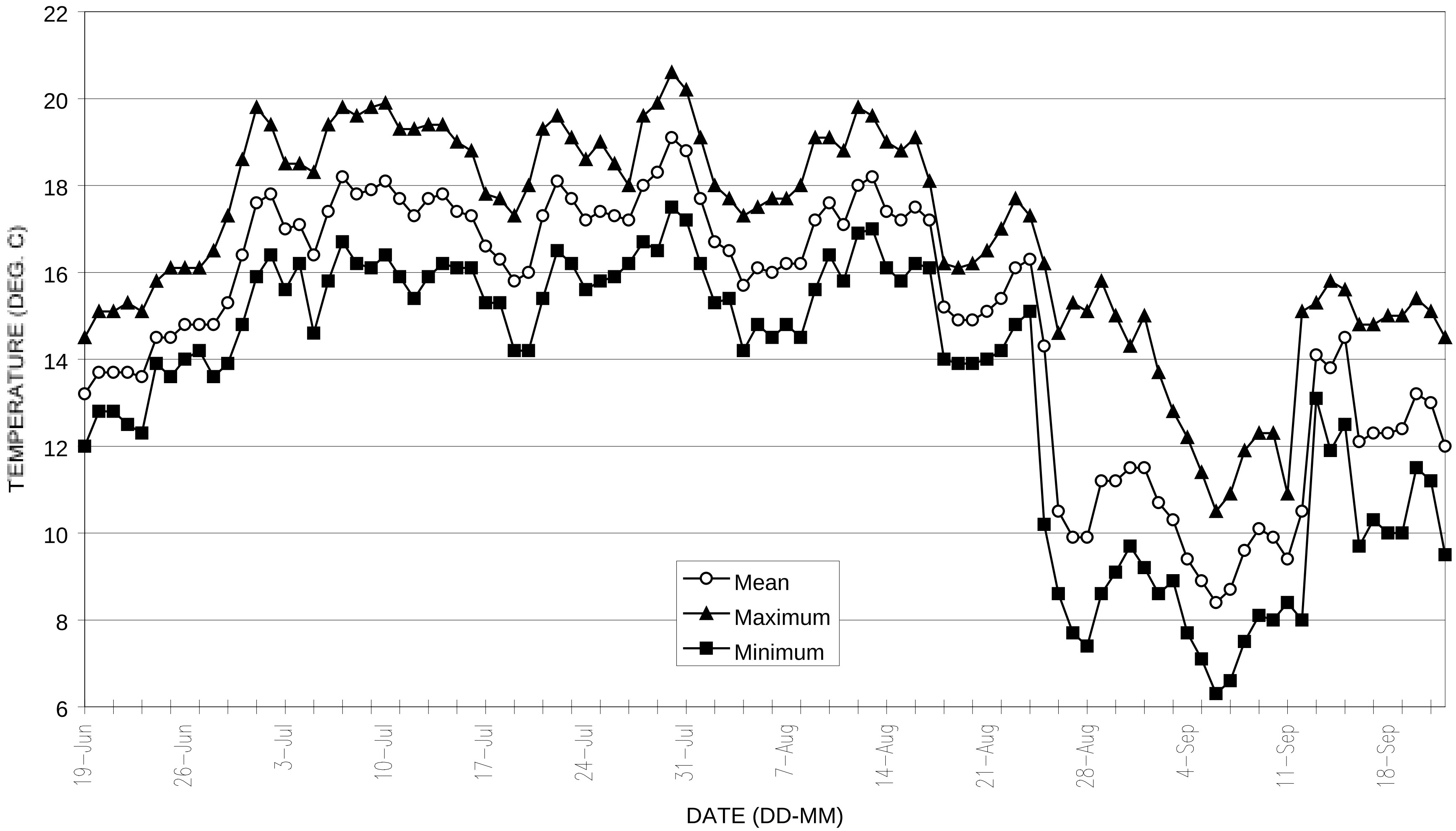


Figure 46. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Noyo River (Site 70-11), Mendocino County, California.

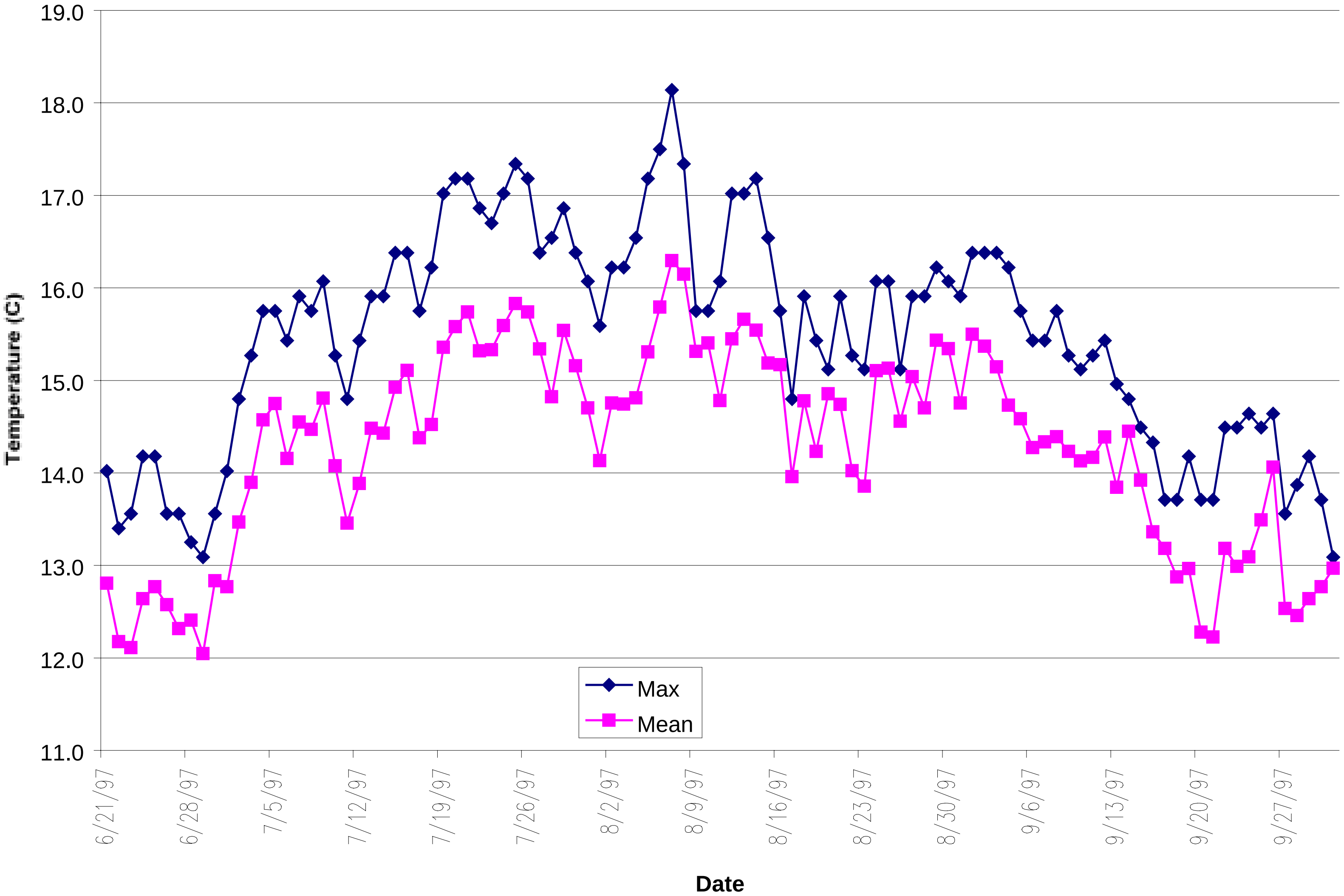


Figure 47. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Noyo River (Site 70-11), Mendocino County, California.

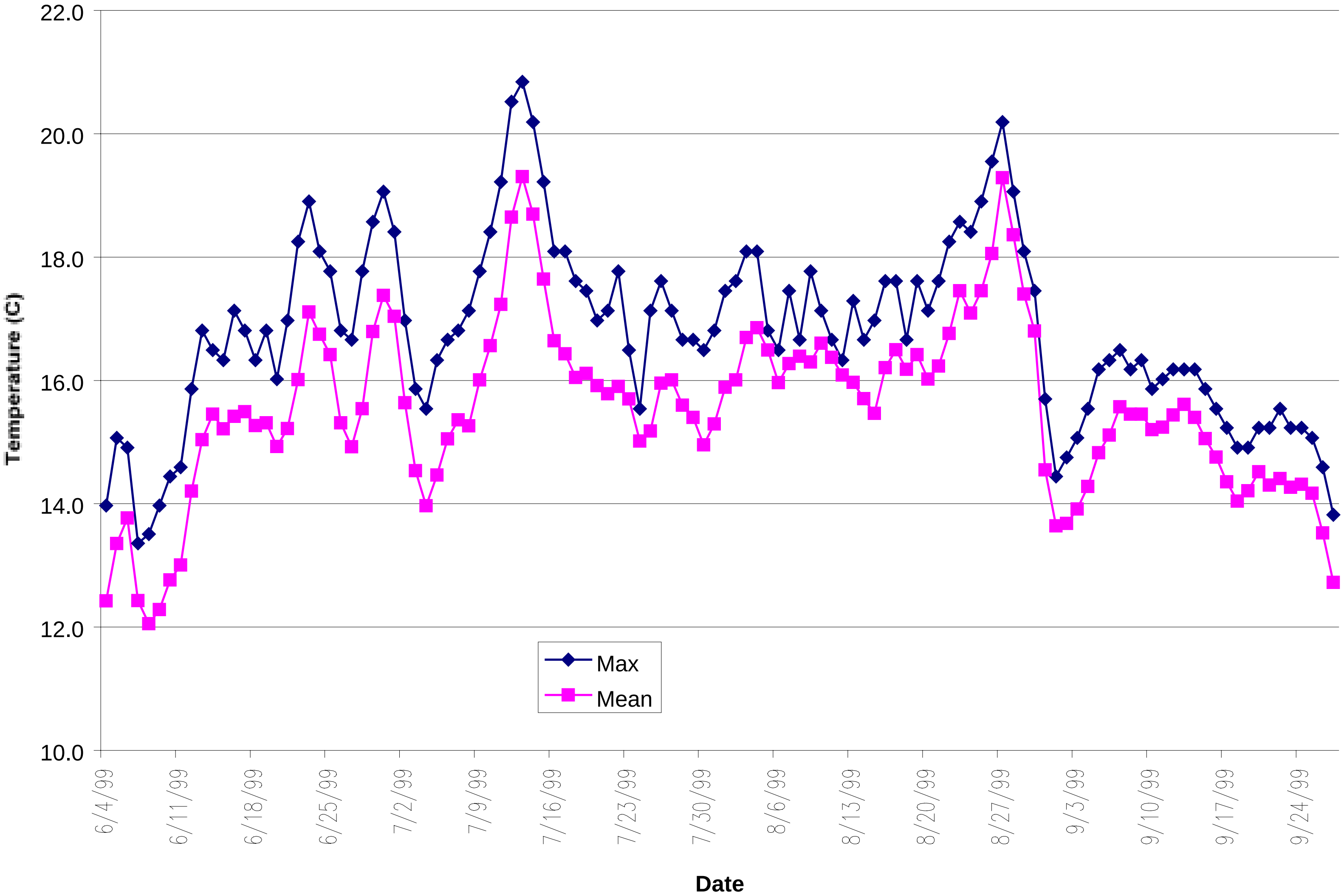


FIGURE 45. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-AUGUST 1994) AT REDWOOD CREEK (MAP NO. 5; MONITORING SITE NO. 70-12), MENDOCINO CO., CALIFORNIA.

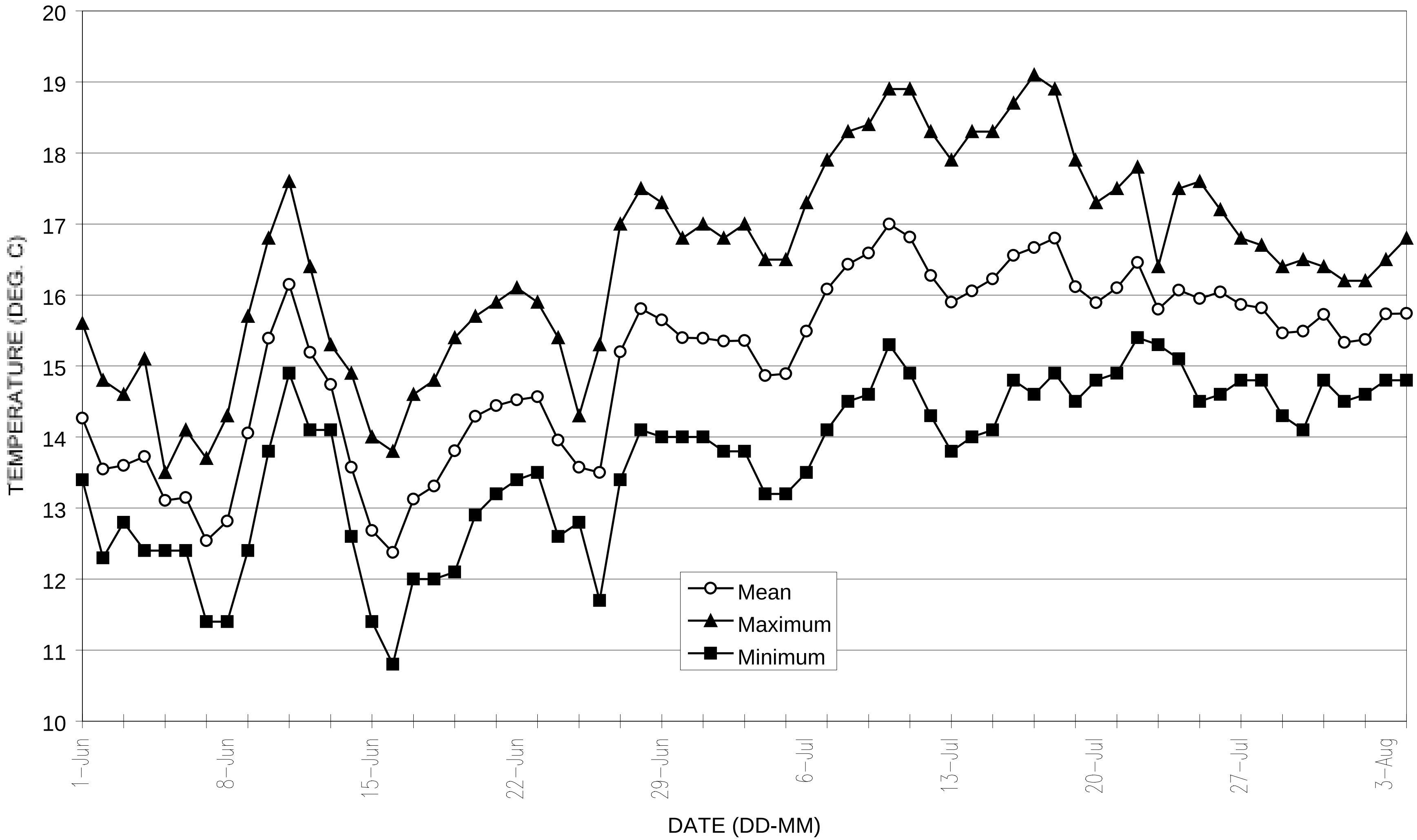


FIGURE 46. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE - SEPTEMBER 1995) AT REDWOOD CREEK (MAP NO. 5; MONITORING SITE NO. 70-12), MENDOCINO CO., CALIFORNIA.

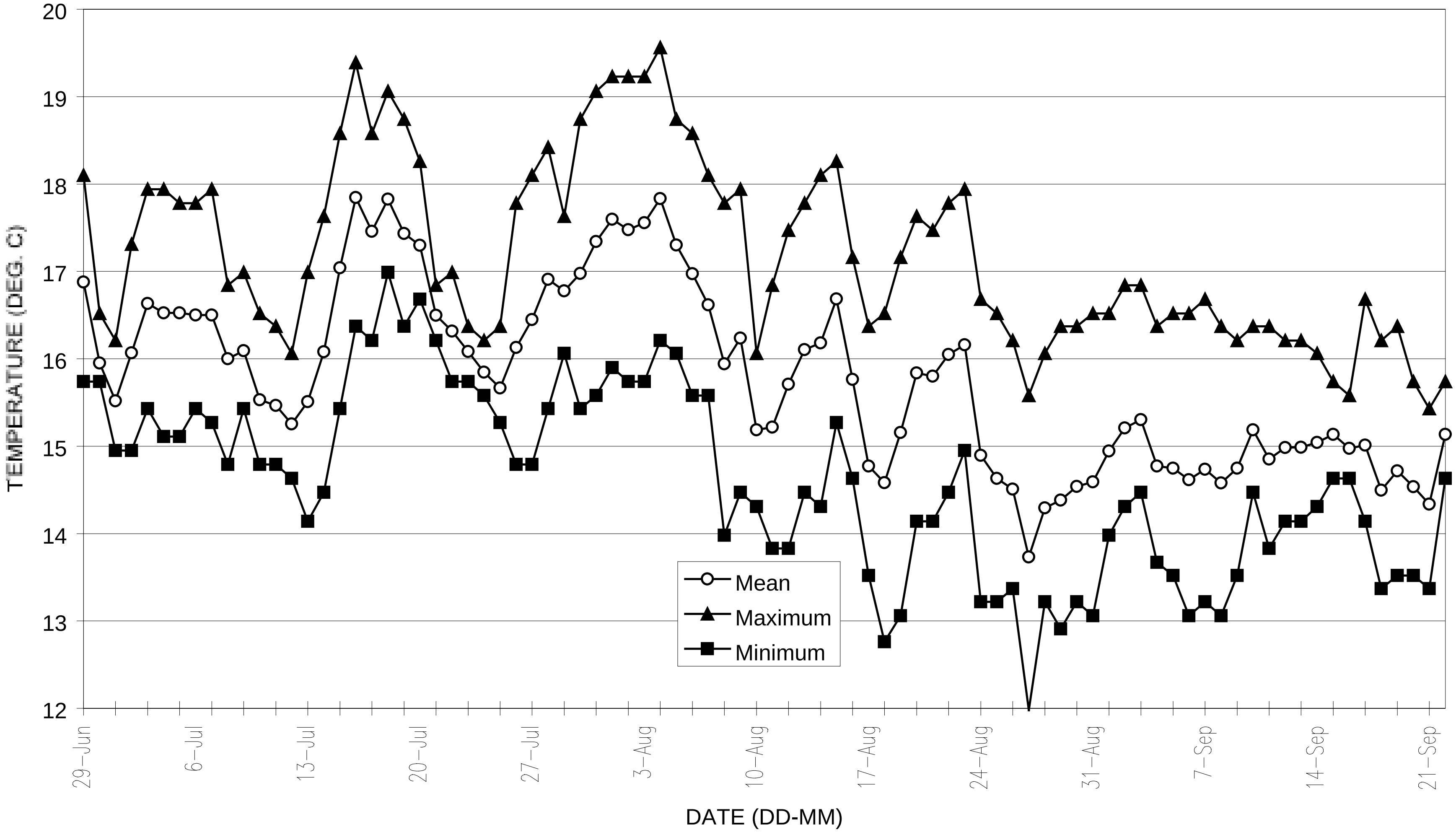


FIGURE 47. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT REDWOOD CREEK (MAP NO. 5; MONITORING SITE NO. 70-12), MENDOCINO CO., CALIFORNIA.

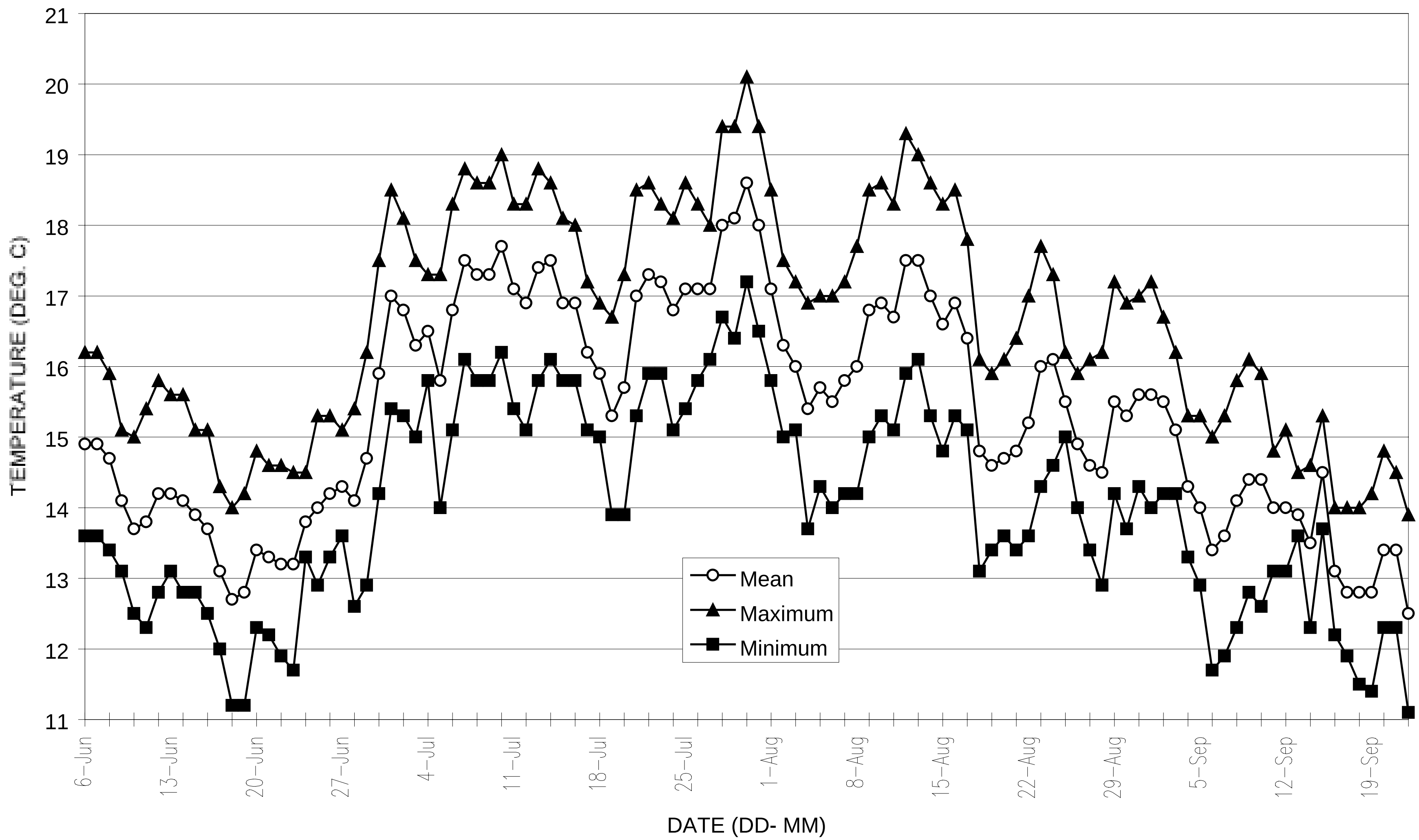
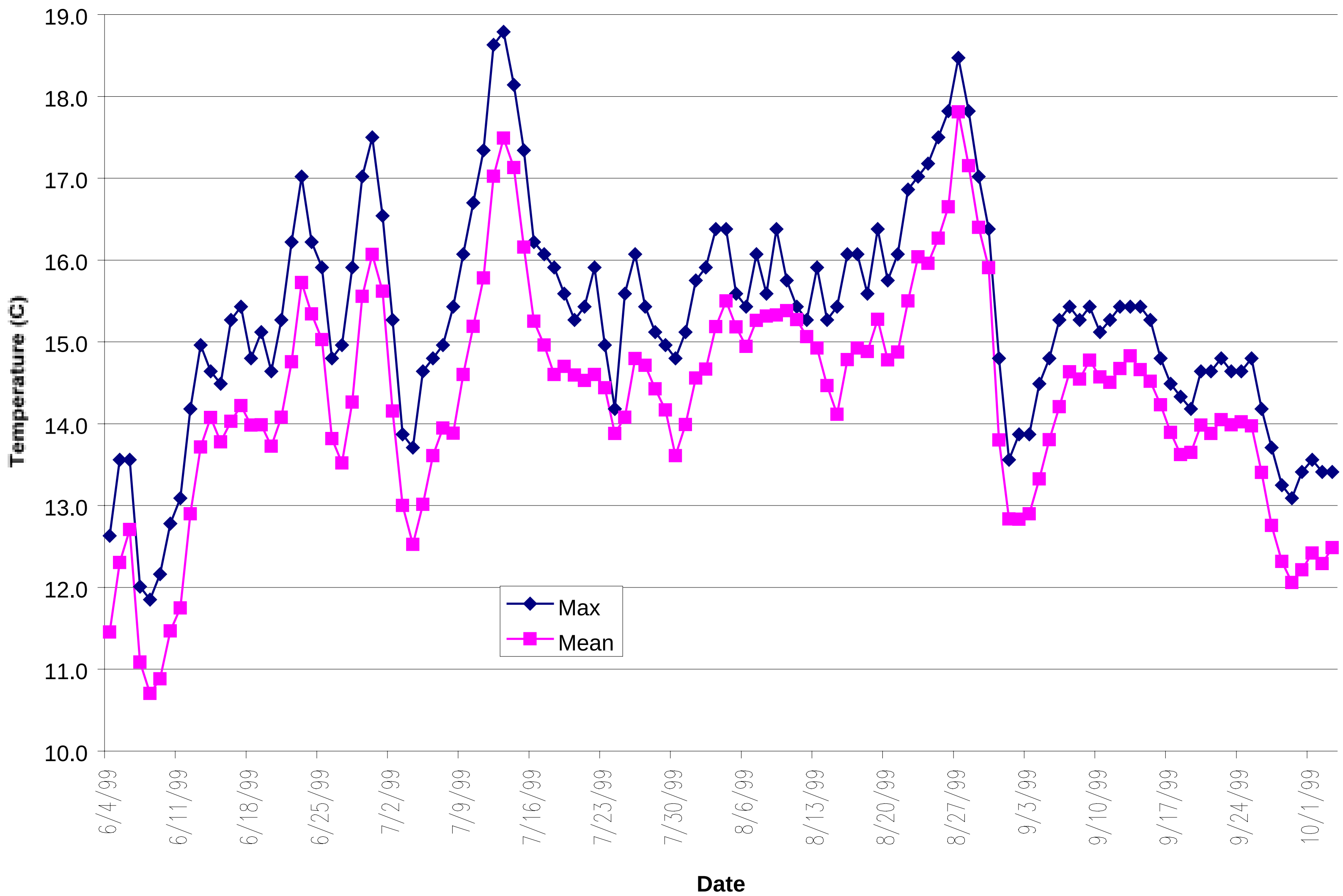


Figure 49. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Redwood Creek (Site 70-12), Mendocino County, California.



Mean, Maximum, and Minimum Daily Stream Temperatures and MWAT, Station 70-13, Summer 1996

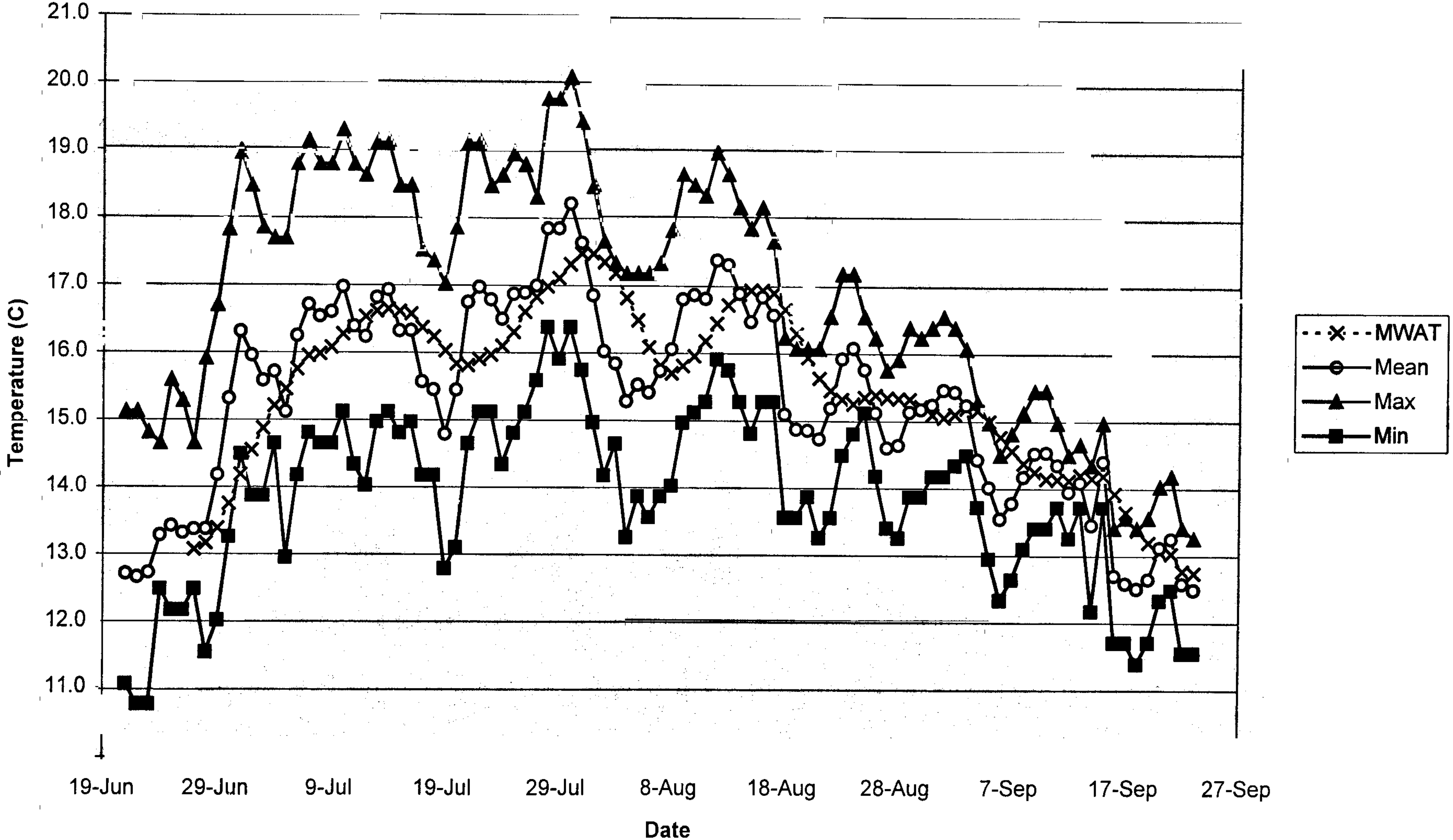


Figure 51. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Burbeck Creek (Site 70-13), Mendocino County, California.

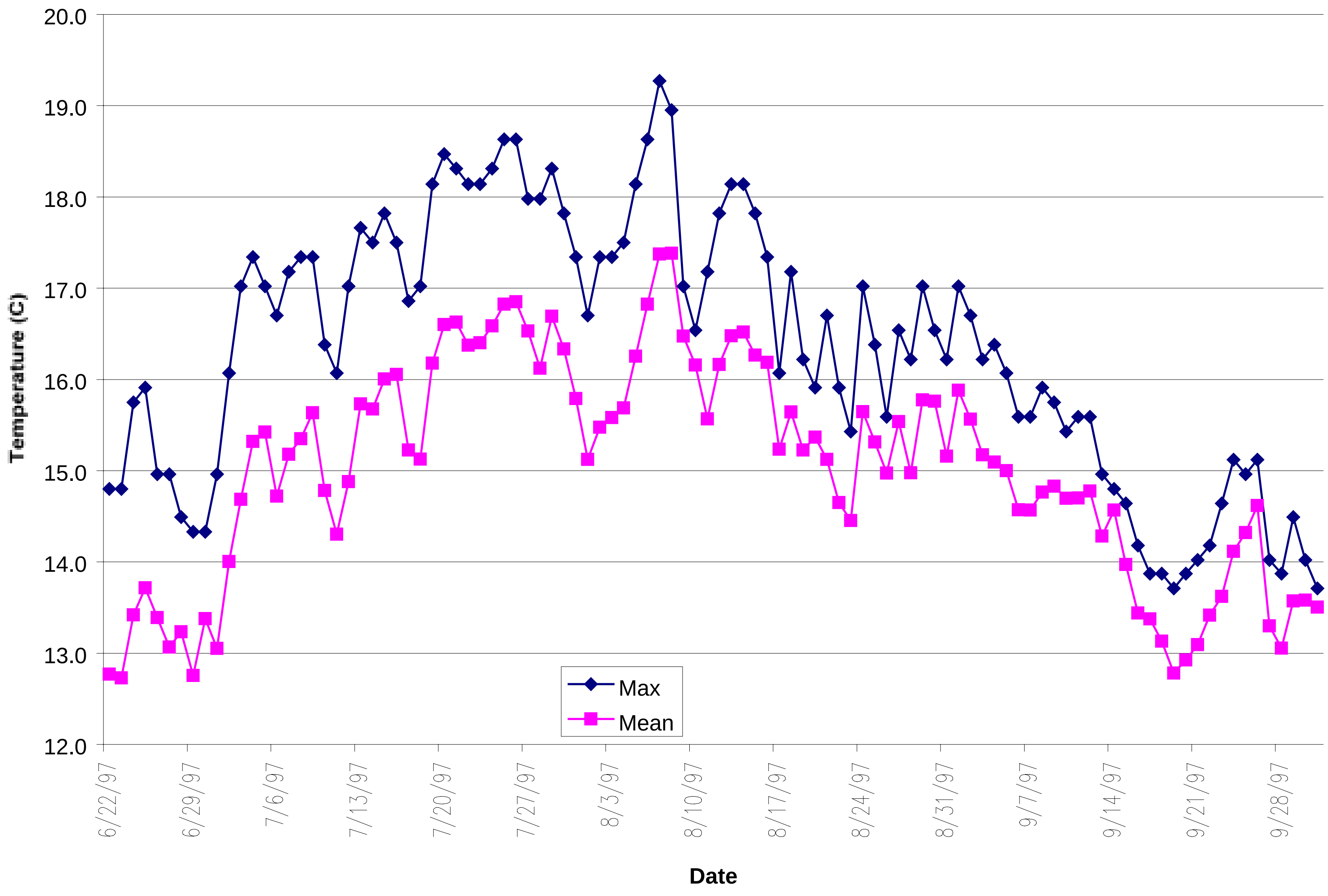


Figure 52. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Burbeck Creek (Site 70-13), Mendocino County, California.