SECTION D
RIPARIAN FUNCTION

INTRODUCTION

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

LARGE WOODY DEBRIS RECRUITMENT AND INSTREAM DEMAND METHODS

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

To determine the LWD recruitment potential, riparian stands were classified using year 2000 aerial photographs and field observations from the summer of 2000. The riparian stands were evaluated for a distance of approximately one tree height on either side of the watercourse. Riparian stands were evaluated separately for each side of the watercourse. The following vegetation classification scheme for the Mendocino Redwood Company (MRC) timber inventory was used to classify the riparian stands:

<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

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

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

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

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

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

Table D-1. Description of LWD Recruitment Potential Rating by Riparian Stand Classification for the Gualala 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)	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 each sampled stream segment. Functional LWD was that LWD which was providing some habitat or morphologic function in the stream channel (i.e. pool formation, scour, debris dam, bank stabilization, or gravel storage). The minimum size requirement for functional LWD is 4 inch diameter and 10 foot length. LWD can be functional if the minimum size is not meet if a rootwad is attached.

The LWD was classified by tree species class, either redwood, fir (Douglas-fir, hemlock, grand fir), hardwood (alder, tan oak, etc.), or unknown (if tree species is indeterminable). Length and diameter were recorded for each piece so that volume could be calculated. LWD associated with an accumulation of 3 pieces or more was recorded and the number of LWD accumulations in the stream survey reach was tallied. LWD pieces were also assigned attributes if they fall into certain categories. These categories are: if the LWD piece was part of a living tree, root associated (i.e. does it have a rootwad attached to it), is part of the piece buried within stream gravel or the bank, or associated with a restoration structure. By assigning these attributes, the number of pieces in a segment which, for example, have a rootwad associated with the piece can be noted. This is important as these types of pieces can be more stable or have ecological benefits above that which a LWD piece alone may have.

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

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

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

Debris jams (>10 pieces) were noted and total dimensions of the jam recorded. A volume for the debris jam was calculated assuming 50% porosity. 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 were noted. Species and dimensions were not recorded for individual pieces contained in debris jams. All volume estimates and piece counts were separated in two groups, one not considering jams and one considering all LWD pieces in the segment, debris jams included. The percentage of total volume and total pieces per segment contained in debris jams was also calculated.

The quantity of LWD observed was normalized by distance, for comparison through time or to other similar areas, and was presented as a number of LWD pieces per 100 meters. 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-3.

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

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

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

Table D-4. In-stream LWD Demand

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

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

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

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

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

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

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

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

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

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

LARGE WOODY DEBRIS RECRUITMENT AND INSTREAM DEMAND RESULTS

The large woody debris recruitment potential and in-stream LWD demand for the Gualala River WAU is illustrated in Map D-1. The large woody debris recruitment potential and in-stream LWD demand provides baseline information on the structure and composition of the riparian stand and the level of concern about current LWD conditions in the stream. This map provides a tool for prioritizing riparian and stream management for improving LWD recruitment and 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 appropriate functions to the watercourses.

Current LWD loading is shown in Table D-5 a and b. Three out of ten segments surveyed in the Gualala River WAU met the LWD target for key pieces. Segments SA19, ST19 and ST10 had exceptionally high LWD loading values (14.4, 16.7 and 18.7 key pieces/100m, respectively). However, a large log jam (50'x25x4’) at the bottom of the latter segment undoubtedly influenced this value.

Debris jams, where they occurred, were shown to be a significant portion of the total piece count and volume. In the Gualala River WAU, debris jams occurred in five segments and contained up 44-72% % of the total pieces and 20-80% of the total volume (see Table D-5 a and b). In the case of segments SH1 to ST10, debris jams actually affected whether or not the segment met the LWD target. It was only with adding in the key pieces that were contained in debris jams that the segment exceeded the LWD target. Although there obviously can be a significant amount of LWD in debris jams, the ecological function may not be accurately represented by numbers alone. All of the pieces in a debris jam may actually have more habitat value if they were spread out in the stream as opposed to being piled up in one spot.

The percent of volume contained in debris accumulations (>3 pieces) varied widely in segments in the Gualala River WAU. From 0% to 80% of the total volume in a given segment could be found in these accumulations. Buried LWD pieces were common in these streams. Up to 80% of the pieces in any given segment were at least partially buried. This indicates that we are unable to quantify a significant portion of the LWD volume which may eventually be useful to the stream.

LWD species composition was largely redwood dominated (Table D-6b). This analysis was limited to pieces not contained within debris jams. Over 90% of the volume of LWD was redwood in the Gualala River WAU. The remainder of the 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 streams within the Gualala River WAU is more stable as redwood breaks down more slowly in streams than hardwood species.

All segments in the Gualala River WAU contained LWD that was not recently contributed to the stream. All segments inventoried fell into a 0-25% category for LWD recently contributed (<10 years). It did not appear that many of the LWD pieces had been contributed within the last 10 years.

As shown in tables D-5 a and b, there is a considerable functional LWD in channel segments of the Gualala River WAU. However, only a few of the channels have high numbers of the key LWD pieces. This suggests that smaller pieces of LWD are performing the habitat functions in the stream channels. Smaller pieces can be less stable and have lower residence times. The few segments that met the key piece target need LWD levels to be maintained to ensure LWD is providing fish habitat and morphological function in the stream channels over the long term.

Riparian recruitment potential is very poor in the Gualala River WAU (See Map D-1). The entire MRC ownership in the watershed is in the low riparian recruitment potential rating. Past harvesting activities in riparian areas have resulted in small-sized, open stands which are composed of hardwood or mixed conifer hardwood species. Though reasonable functional LWD loading levels are present, these are often accompanied by low recruitment potential riparian stands. Because of this, all of the stream segments in the Gualala River WAU are currently in the high and moderate in-stream LWD demand classification (Map D-1). The Wheatfield Fork of the Gualala River has a moderate LWD demand largely due to the low channel sensitivity rating. Tobacco Creek has a moderate demand due to adequate LWD loading.

Table D-5 a. Summary of LWD Pieces by Stream for the Gualala River WAU 2000.

Stream Name	ID#	Functional LWD w/o Debris Jams	Functional LWD w/ Debris Jams	Total # of Debris Jams	Total # of Debris Accumulations	Functional LWD (#/100m) w/o Debris Jams	Functional LWD (#/100m) w/ Debris Jams	Key LWD Pieces w/o Debris Jams	Key LWD Pieces w/ Debris Jams	Key LWD #/100m w/o Debris Jams	Key LWD #/100m w/Debris Jams	% Pieces in Debris Jams
Wheatfield Fork	SA1	39	39	0	4	6.7	6.7	3	3	0.5	0.5	0%
Annapolis Falls	SA13	20	20	0	0	11.5	11.5	3	3	1.7	1.7	0%
Unnamed trib.	SA19	51	91	2	2	33.5	59.7	15	22	9.8	14.4	44%
Haupt Creek	SH1	40	145	2	1	12.5	45.4	2	13	0.6	4.1	72%
Fuller Creek	SR1	21	21	0	1	6.4	6.4	2	2	0.6	0.6	0%
Fuller Creek	SR3	30	100	1	3	9.3	30.1	1	11	0.3	3.4	70%
Sullivan Crk	SR11	21	21	0	5	15.8	15.8	2	2	1.5	1.5	0%
Crocker Crk	ST10	36	118	3	1	26.0	85.1	6	26	4.3	18.7	69%
Crocker Crk	ST11	30	30	0	3	37.3	37.3	2	2	2.5	2.5	0%
Tobacco Crk	ST19	59	144	3	4	37.9	92.6	12	26	7.7	16.7	59%

Table D-5 b. Summary of LWD Volume by Stream for the Gualala River WAU 2000.

Stream Name	ID#	Total Volume (yd^3) w/o Debris Jams	Total Volume (yd^3) w/ Debris Jams	Total Vol/100m (yd^3) w/o Debris Jams	Total Vol/100m (yd^3) w/ Debris Jams	% of Total Volume in Debris Accumulations	% of Total Volume in Debris Jams	% of Vol in Key Pieces w/o Jams	% Current Recruitment (<10 yrs)
Wheatfield Fork	SA1	47.2	47.2	8.2	8.2	83%	0%	53%	0-25
Annapolis Falls	SA13	21.2	21.2	12.3	12.3	0%	0%	79%	0-25
Unnamed Trib.	SA19	50.0	66.7	32.8	43.8	17%	25%	78%	0-25
Haupt Creek	SH1	75.2	241.9	23.6	75.9	1%	69%	30%	0-25
Fuller Creek	SR1	24.2	24.2	7.4	7.4	9%	0%	42%	0-25
Fuller Creek	SR3	21.1	65.6	6.5	20.3	9%	68%	20%	0-25
Sullivan Creek	SR11	21.0	21.0	15.8	15.8	68%	0%	47%	0-25
Crocker Creek	ST10	51.1	232.6	36.8	167.7	0%	78%	81%	0-25
Crocker Creek	ST11	22.9	22.9	28.5	28.5	33%	0%	63%	0-25
Tobacco Creek	ST19	53.9	97.0	34.7	62.4	15%	44%	58%	0-25

Table D-5 c. Breakdown of LWD by Species, Root Associated, Buried and Alive for the Gualala WAU 2000.

Stream Name	ID#	Percent of Total Volume By Species w/o Jams					LWD Volume by Attribute					
							Root Associated		Buried		Alive	
		Redwood	Fir	Alder	Hardwood	Unknown	Yd^3	Percent	Yd^3	Percent	Yd^3	Percent
Wheatfield Fork	SA1	91%	0%	5%	3%	1%	13.0	27%	0.3	<1%	1.2	3%
Annapolis Falls	SA13	94%	0%	3%	0%	3%	0.8	4%	2.4	11%	0.5	2%
Trib to Annapolis Falls	SA19	95%	3%	0%	<1%	2%	1.9	4%	5.4	11%	0.2	<1%
Haupt Creek	SH1	94%	2%	<1%	3%	<1%	50.3	67%	7.6	10%	1.6	2%
Fuller Creek	SR1	93%	0%	2%	5%	0%	20.9	87%	11.2	47%	7.4	31%
Fuller Creek	SR3	91%	0%	0%	1%	8%	4.1	20%	6.4	30%	0.0	0%
Sullivan Creek	SR11	97%	0%	0%	0%	3%	9.9	49%	9.2	46%	0.0	0%
Crocker Creek	ST10	98%	0%	0%	1%	1%	13.6	27%	16.4	32%	0.0	0%
Crocker Creek	ST11	99%	0%	0%	<1%	<1%	0.3	32%	15.9	70%	0.1	1%
Tobacco Creek	ST19	98%	0%	0%	0%	2%	9.8	18%	22.0	41%	0.0	0%

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

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

Stream	Calwater Planning Watershed	Instream LWD Quality Rating
Wheatfield Fork	Annapolis	Deficient
Wheatfield Fork	Tobacco Creek	Deficient
Annapolis Falls Creek	Annapolis	Marginal
Fuller Creek	Flat Ridge Creek	Deficient
Haupt Creek	Haupt Creek	Deficient
Crocker Creek	Tobacco Creek	Marginal
Tobacco Creek	Tobacco Creek	Marginal

CANOPY CLOSURE AND STREAM TEMPERATURE

Methods

Canopy closure, over watercourses, was estimated from aerial photographs (2000) and field observations during the summer of 2000. Field measurements of canopy closure over select stream channels were taken during the stream channel assessments in the Gualala 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. Based on the field observations and aerial photograph observations four canopy closure classes were determined using aerial photographs (Map D-2). These classes as well as the criteria for an aerial photograph interpretation are shown in Table D-7.

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

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

Stream temperature has been monitored in Class I watercourses (fish-bearing) in the Gualala River WAU since 1994. In summer 2001 this was expanded to include Class II watercourses (aquatic life present but no fish) temperatures as part of a herpetological study. Stream temperature monitoring was conducted with 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-8 describes the temperature monitoring locations.

Table D-8. Stream Temperature Monitoring Locations and Year for the Gualala River WAU, 1994-2002 (see map D-2 for locations).

Temperature Monitoring Station	**Stream ID#**	**Stream/River Name**	**Years Monitored**
97-1	SA13	Annapolis Falls Creek	‘95, '96, '99
97-2	SR1	Fuller Creek	‘94, '95, '99, '00, ’01, ‘02
97-4	ST10	Crocker Creek	‘97, ’01, ‘02
97-5	SH1	Haupt Creek	2001
97-6	ST19	Tobacco Creek	’01, ‘02
97-7	ST1	Wheatfield Fork Gualala River	‘02
97-8	SA1	Wheatfield Fork Gualala River	‘02
97-20	n/a	Tributary to Wheatfield Fork	‘01

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

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

CANOPY CLOSURE AND STREAM TEMPERATURE
Results

Canopy closure over watercourses varies from very good to quite poor throughout the Gualala River WAU (Map D-2 and Table D-10). All of the Wheatfield Fork Gualala River has canopy closure which falls into the 0-20% range. However, this is to be expected in a wide river channel. The majority of the main tributaries and Class II channels have canopy cover which falls into to moderate to high streamside shade classification (70-90% or >90%). Exceptions are the main channel of Haupt Creek (20-40% cover) and one fork of Tobacco Creek (20-40% cover). Besides these two tributaries, canopy cover is generally favorable in the Gualala River WAU.

Table D-10. Field Observations of Stream Canopy Closure for Select Stream Channel Segments in the Gualala River WAU, 2000.

Stream Name	Segment ID#	Mean Shade Canopy
Wheatfield Fork Gualala River	SA1	21%
Annapolis Falls	SA13	91%
Tributary to Annapolis Falls	SA19	85%
Haupt Creek	SH1	44%
Fuller Creek	SR1	81%
Fuller Creek	SR3	68%
Sullivan Creek	SR11	94%
Crocker Creek	ST10	95%
Crocker Creek	ST11	83%
Tobacco Creek	ST19	81%

Stream temperatures in the Gualala River WAU are on the high end of tolerance for salmonids. Instantaneous maximum temperatures recorded in Fuller Creek and the Wheatfield Fork are higher than the preferred temperature ranges for salmonids. Temperature values for Annapolis

Falls Creek and Crocker Creek are at the high end for coho salmon, but within a reasonable range tolerated by steelhead (see Tables D-11, D-12 and D-13).

Table D-11. Maximum Daily Temperatures for each station in the Gualala River WAU.

Station No.	1994	1995	1996	1997	1998	1999	2000	2001	2002
97-1	**	19.3	18.2	**	**	15.7	**	**	**
97-2	24.3	25	**	**	**	24.0	23.2	22.1	20.2
97-4	**	**	**	18.1	**	**	**	16.4	16.0
97-5	**	**	**	**	**	**	**	22.5	**
97-6	**	**	**	**	**	**	**	17.5	16.8
97-7	**	**	**	**	**	**	**	**	24.5
97-8	**	**	**	**	**	**	**	**	25.2
97-20	**	**	**	**	**	**	**	15.6	**

**data not collected

Table D-12. Maximum Weekly Average Temperature (MWAT) for each station in the Gualala River WAU.

Station No.	1994	1995	1996	1997	1998	1999	2000	2001	2002
97-1	**	16.8	15.7	**	**	14.5	**	**	**
97-2	19.1	19.5	**	**	**	18.9	19.1	18.7	18.0
97-4	**	**	**	16.2	**	**	**	15.0	15.0
97-5	**	**	**	**	**	**	**	17.8	**
97-6	**	**	**	**	**	**	**	15.7	15.9
97-7	**	**	**	**	**	**	**	**	22.0
97-8	**	**	**	**	**	**	**	**	22.1
97-20	**	**	**	**	**	**	**	14.5	**

**data not collected

Table D-13. 7-Day Moving Average of the Daily Maximum for each station in the Gualala River WAU.

Station No.	1994	1995	1996	1997	1998	1999	2000	2001	2002
97-1	**	18.7	17.6	**	**	15.1	**	**	**
97-2	23.4	23.7	**	**	**	22.6	21.3	21.2	19.5
97-4	**	**	**	17.2	**	**	**	16.1	15.9
97-5	**	**	**	**	**	**	**	21.4	**
97-6	**	**	**	**	**	**	**	16.8	16.6
97-7	**	**	**	**	**	**	**	**	23.8
97-8	**	**	**	**	**	**	**	**	24.6
97-20	**	**	**	**	**	**	**	15.1	**

**data not collected

Canopy cover over the stream is low in a few tributaries in the Gualala WAU. Currently several stream segments have deficient stream shade quality ratings, with the several being marginal with only one segment being on target (Table D-14). Because of this, care should be taken to ensure that adequate shade along streams is promoted.

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

Stream	**Calwater Planning Watershed**	**Stream Shade Quality Rating**
Wheatfield Fork	Annapolis	Deficient
Wheatfield Fork	Tobacco Creek	Deficient
Annapolis Falls Creek	Annapolis	On Target
Fuller Creek	Flat Ridge Creek	Marginal
Haupt Creek	Haupt Creek	Deficient
Crocker Creek	Tobacco Creek	Marginal
Tobacco Creek	Tobacco Creek	Marginal

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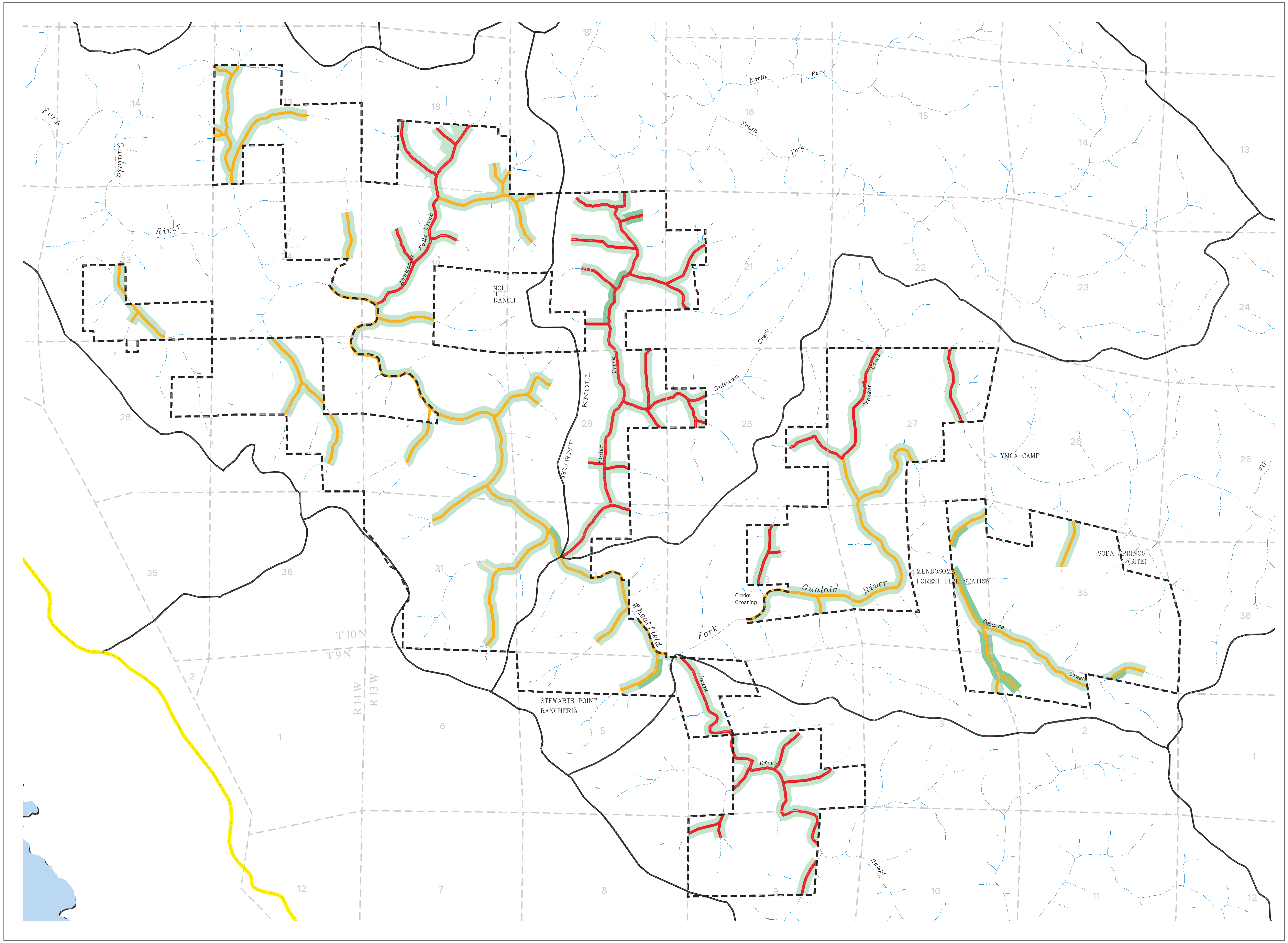
Bilby, R.E. and J.W. Ward. 1989. Changes in characteristics and function of woody debris with increasing size of streams in Western Washington. Transactions of the American Fisheries Society 118: pp. 368-378.

Gregory, K.J, and R.J. Davis. 1992. Coarse woody debris in stream channels in relation to river channel management in woodland areas. Regulated Rivers: Research and Management 7: pp. 117-136.



Gualala River Watershed Analysis Unit

Map D-1
Large Woody Debris Recruitment Potential and Demand

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

LWD Recruitment Potential Classes
- High
- Moderate
- Low

Instream LWD Demand
- High
- Moderate
- Low

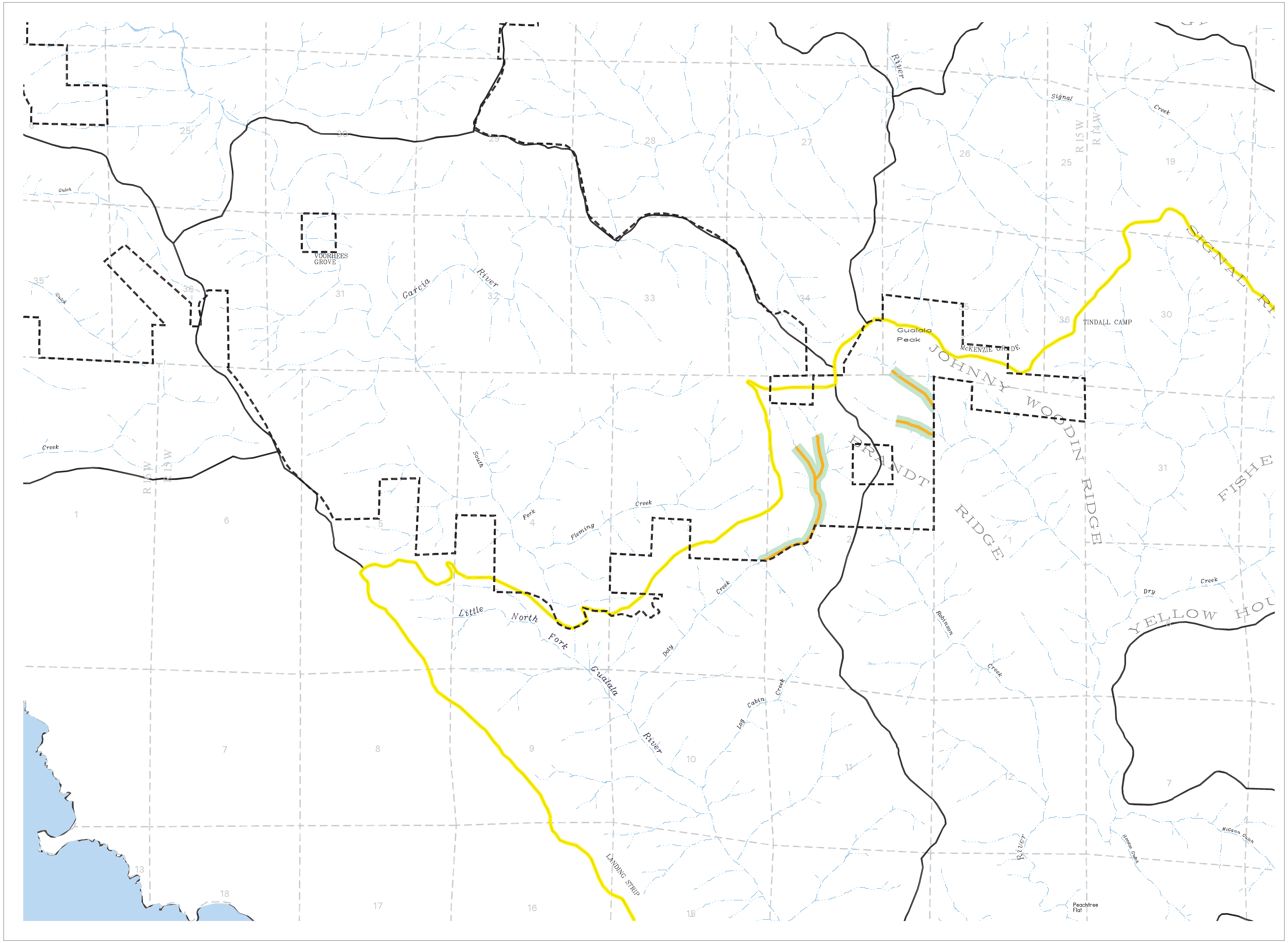
- MRC Ownership
- Planning Watershed Boundary
- Gualala River Watershed Boundary

Flow Class
- Class I
- Class II
- Class III

Sheet 1

0 1/2 1 Mile

June 2003



Gualala River Watershed Analysis Unit

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- Moderate
- Low

Instream LWD Demand
- High
- Moderate
- Low

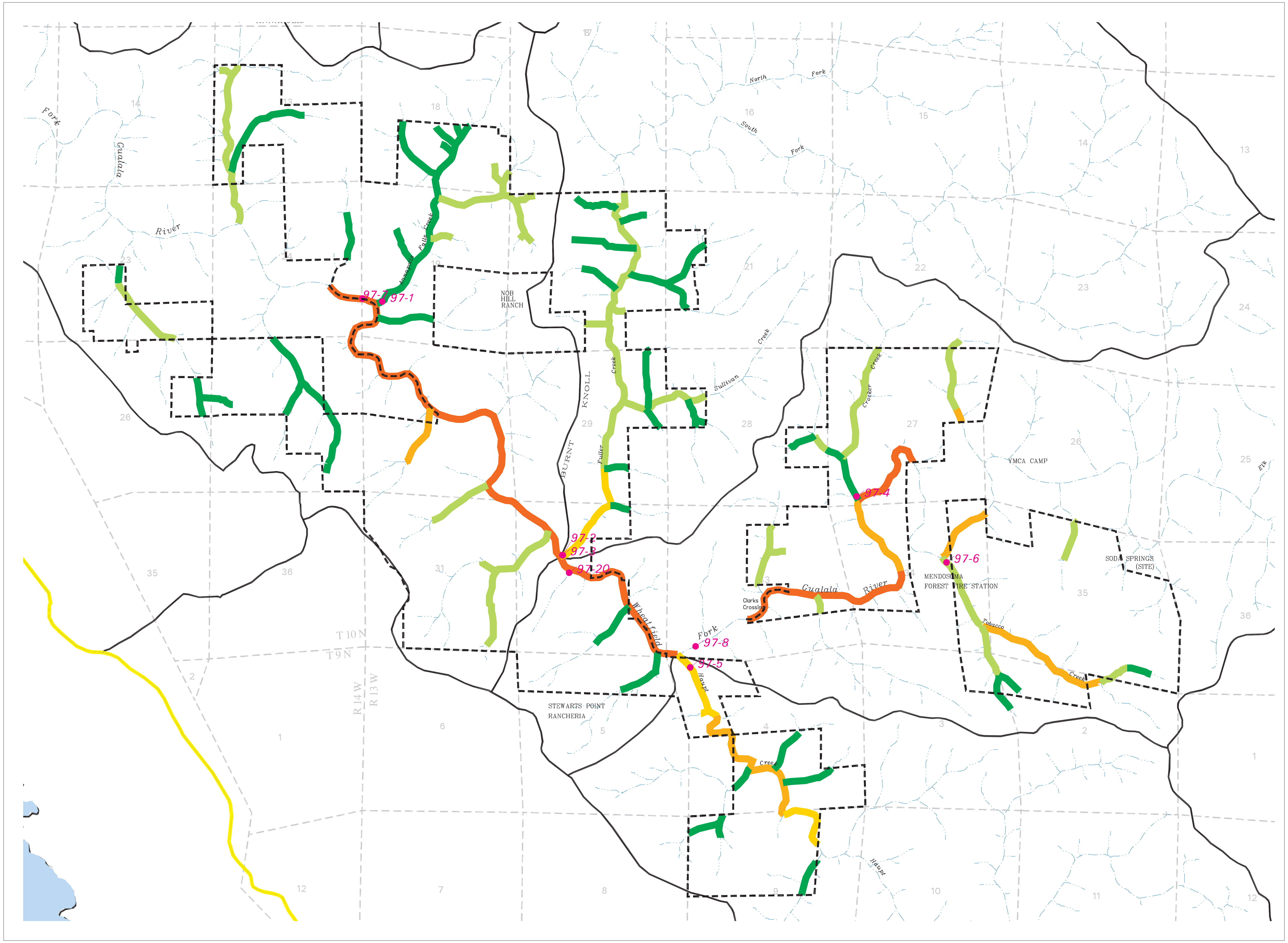
- MRC Ownership
- Planning Watershed Boundary
- Gualala River Watershed Boundary

Flow Class
- Class I
- Class II
- Class III

Sheet 2

0 1/2 1 Mile

June 2003



Gualala River Watershed Analysis Unit

Map D-2 Stream Canopy Classification and Temperature Monitoring Locations

This map presents the canopy closure, over watercourses, for streams and rivers within the MRC ownership in the Gualala WAU. The canopy was estimated for four canopy closure classes from 2000 aerial photographs. The location of stream temperature monitoring locations is also presented. These locations are monitoring during the summer each year.

Stream Canopy Classes
- > 90%
- 70-90%
- 40-70%
- 20-40%
- 0-20%

Temperature Monitoring Locations

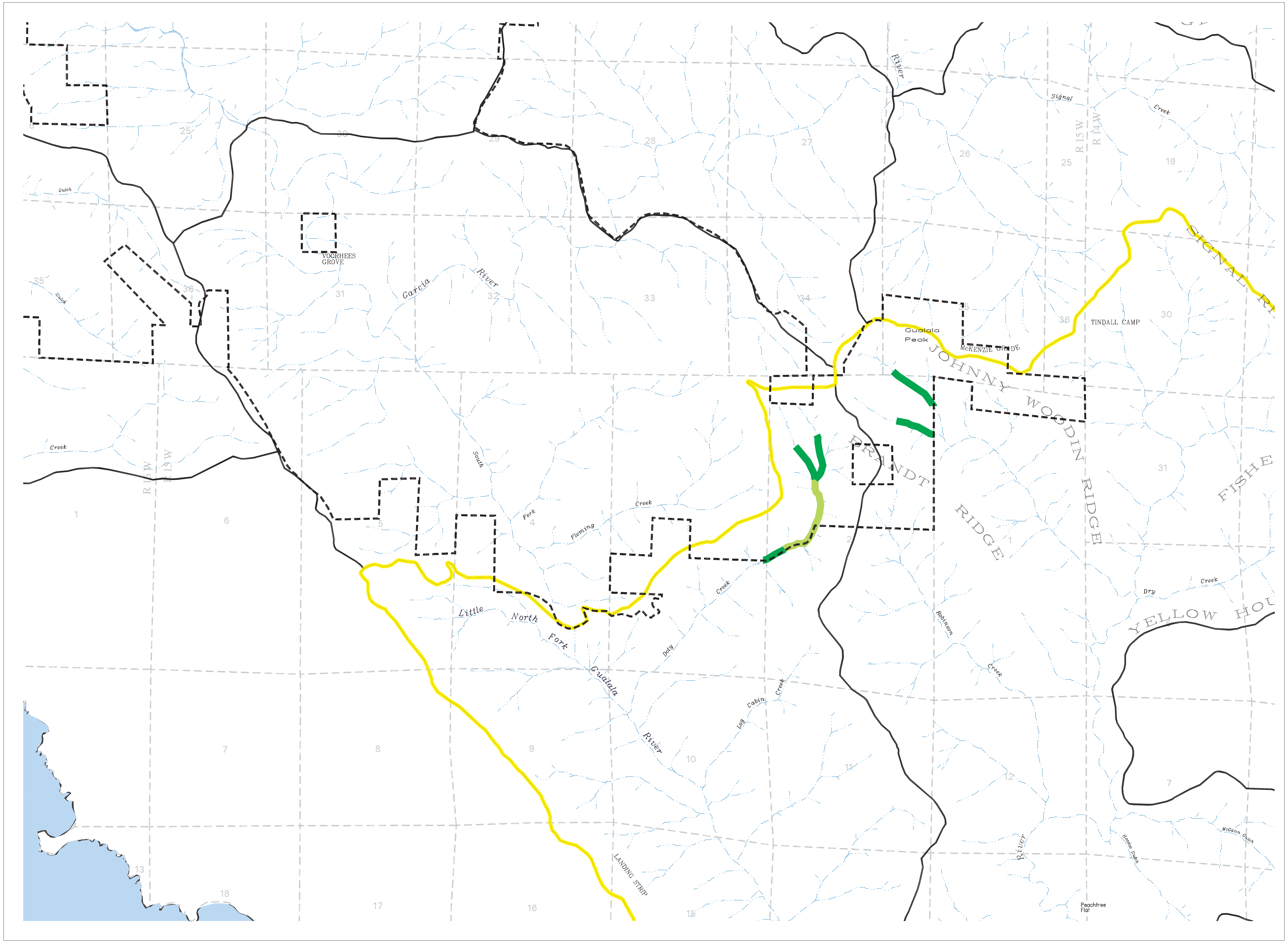
MRC Ownership
Planning Watershed Boundary
Gualala River Watershed Boundary

Flow Class
- Class I
- Class II
- Class III

Sheet 1

0 1/2 1 Mile

June 2003



Gualala River Watershed Analysis Unit

Map D-2
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- 70-90%
- 40-70%
- 20-40%
- 0-20%

Temperature Monitoring Locations

MRC Ownership
Planning Watershed Boundary
Gualala River Watershed Boundary

Flow Class
- Class I
- Class II
- Class III

Sheet 2

0 1/2 1 Mile

June 2003

Appendix D

FIGURE 108. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT ANNAPOLIS FALLS CREEK (MAP NO. 25; MONITORING SITE NO. 97-1), SONOMA CO., CALIFORNIA.

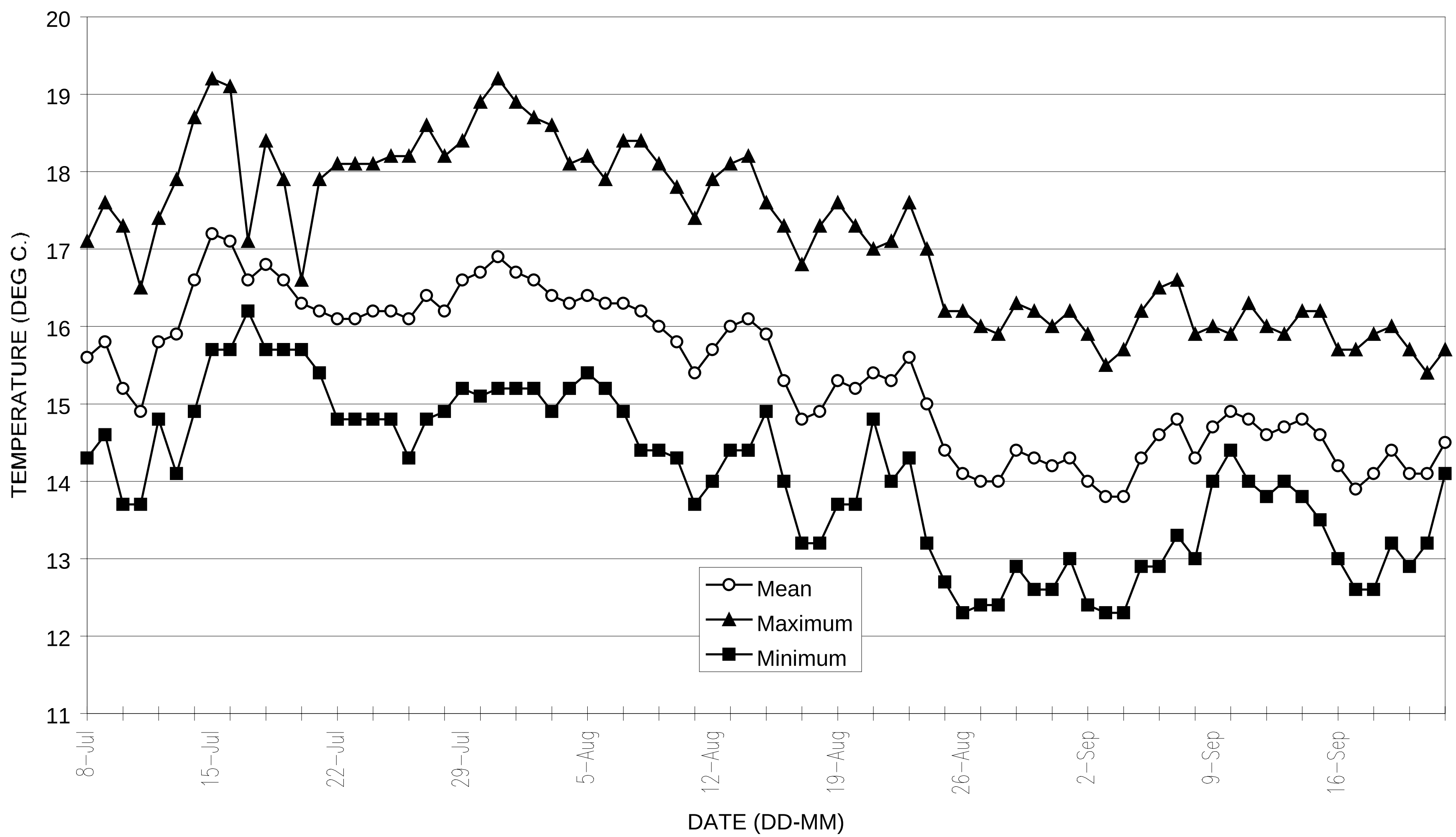


FIGURE 109. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT ANNAPOLIS FALLS CREEK (MAP NO. 25; MONITORING SITE NO. 97-1), SONOMA CO., CALIFORNIA.

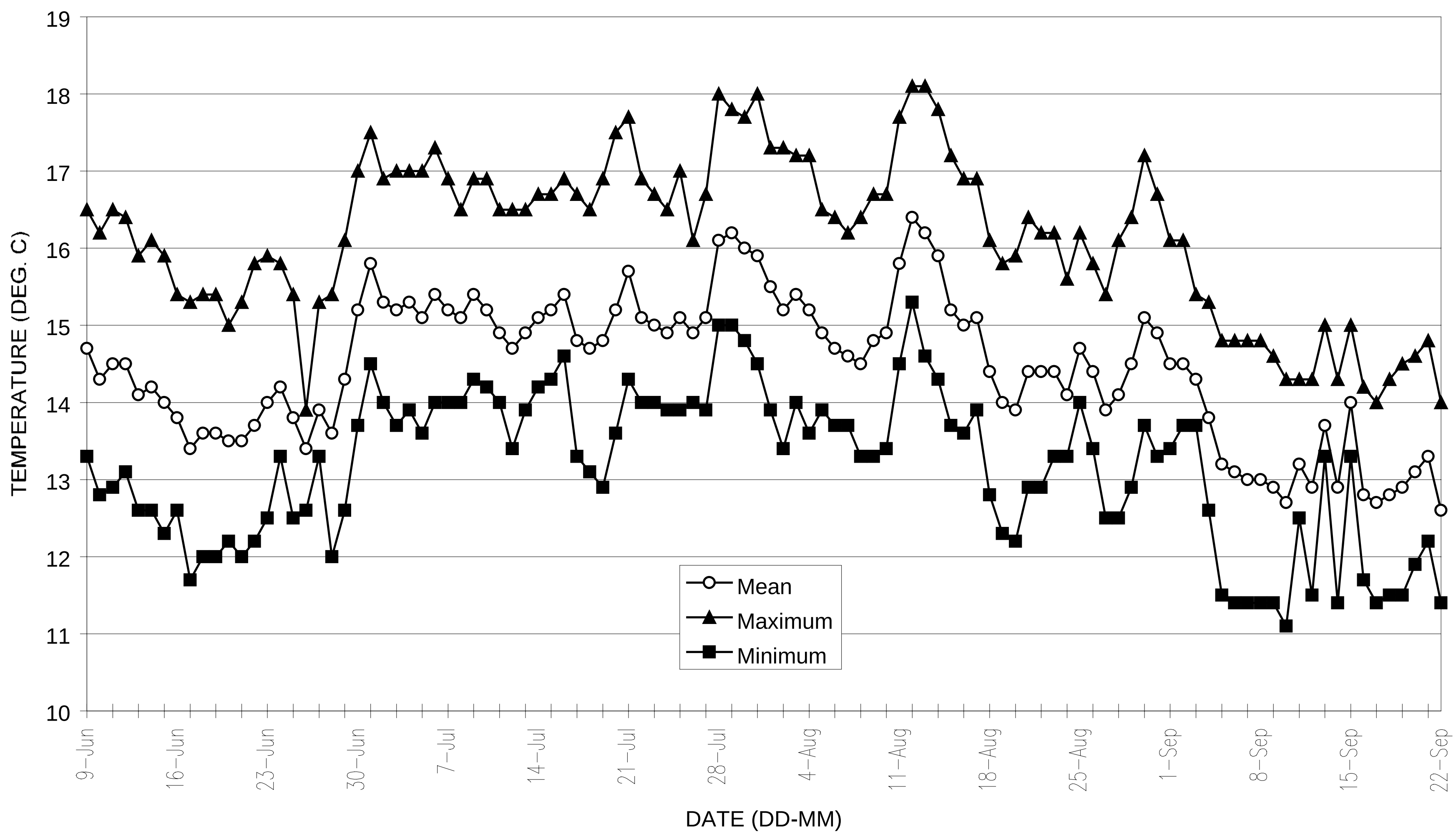


FIGURE 110. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1994) AT FULLER CREEK (MAP NO. 25; MONITORING SITE NO. 97-2), SONOMA CO., CALIFORNIA.

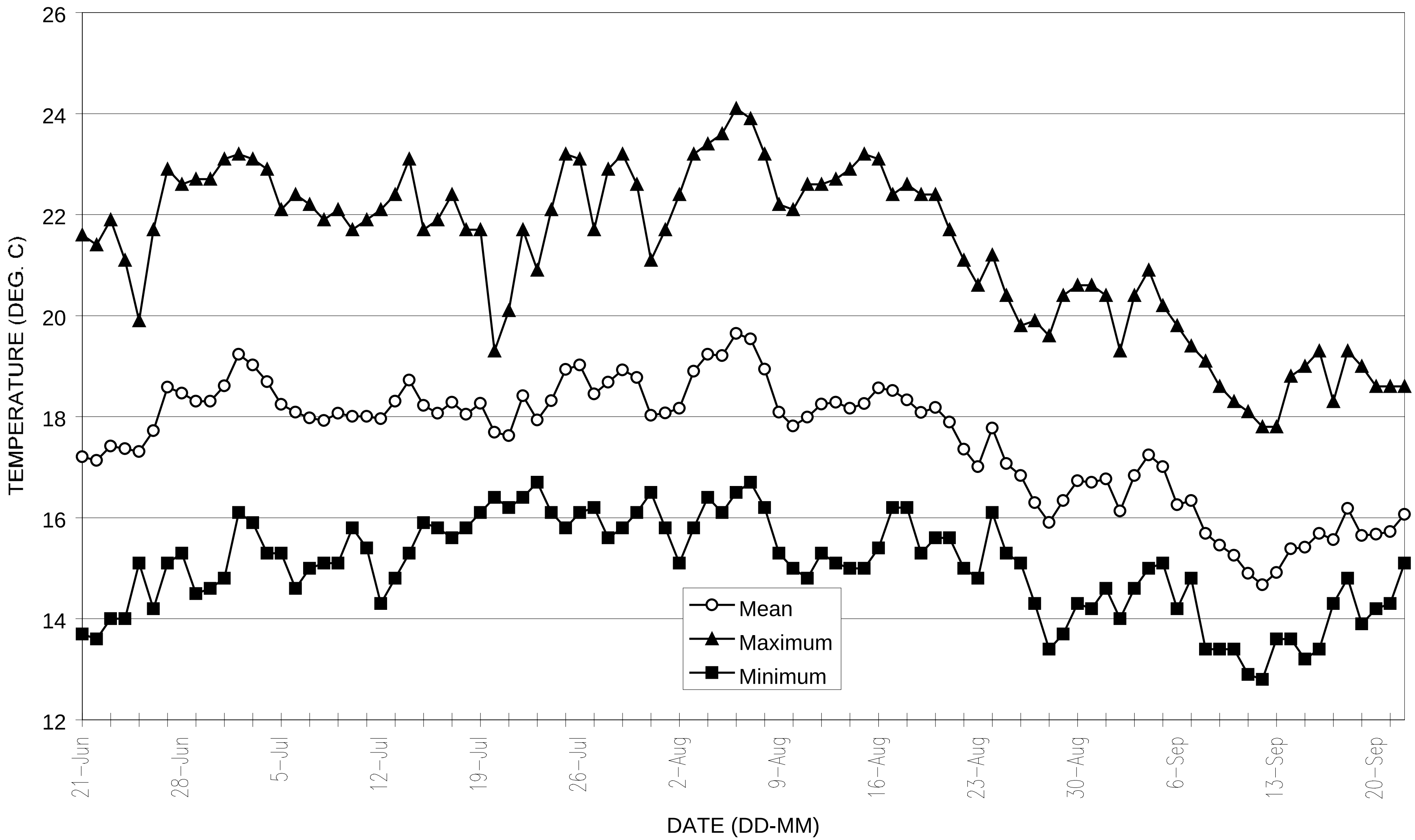


FIGURE 111. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JULY-SEPTEMBER 1995) AT FULLER CREEK (MAP NO. 25; MONITORING SITE NO. 97-2), SONOMA CO., CALIFORNIA.

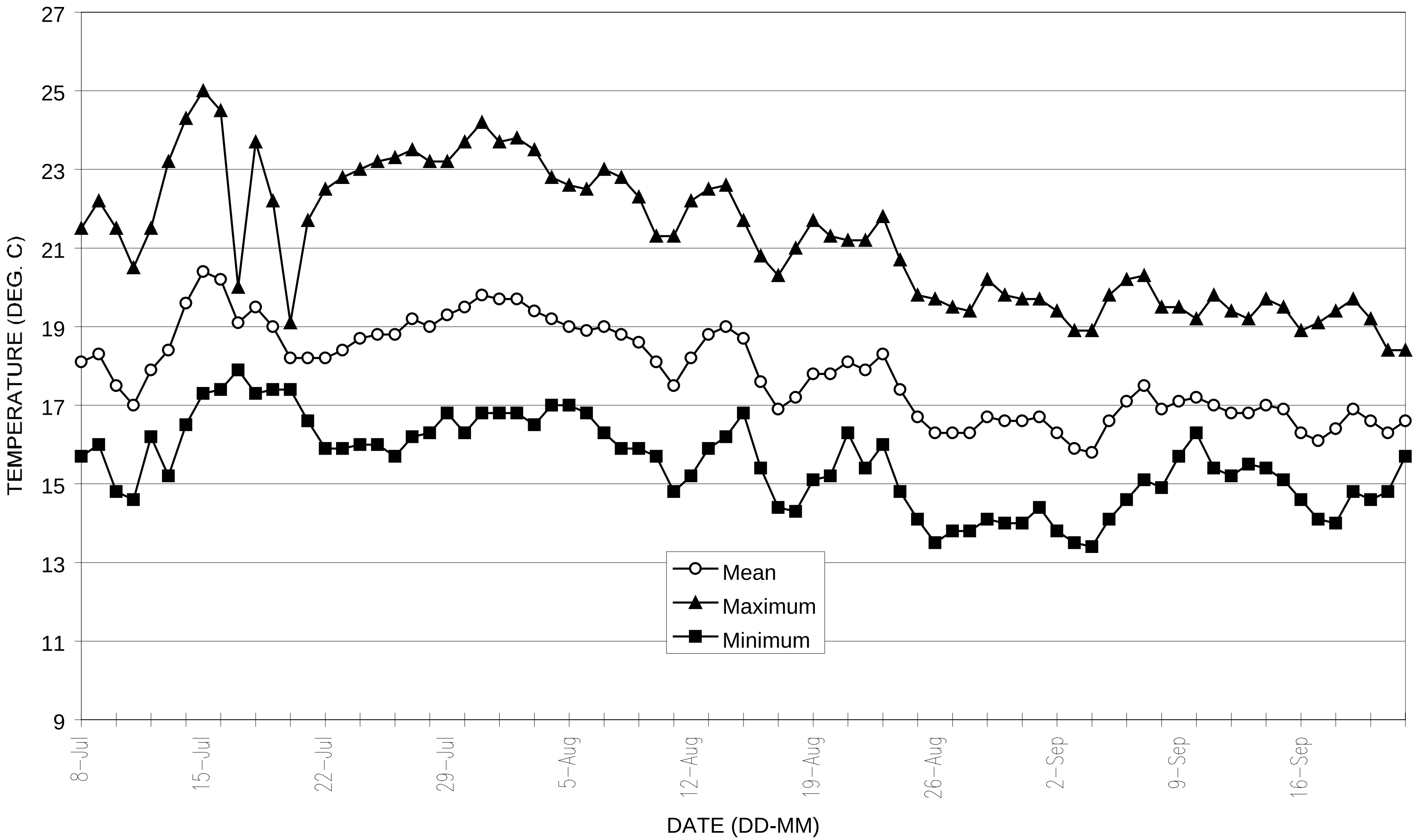


Figure 158. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Crocker Creek (Site 97-4), Sonoma County, California.

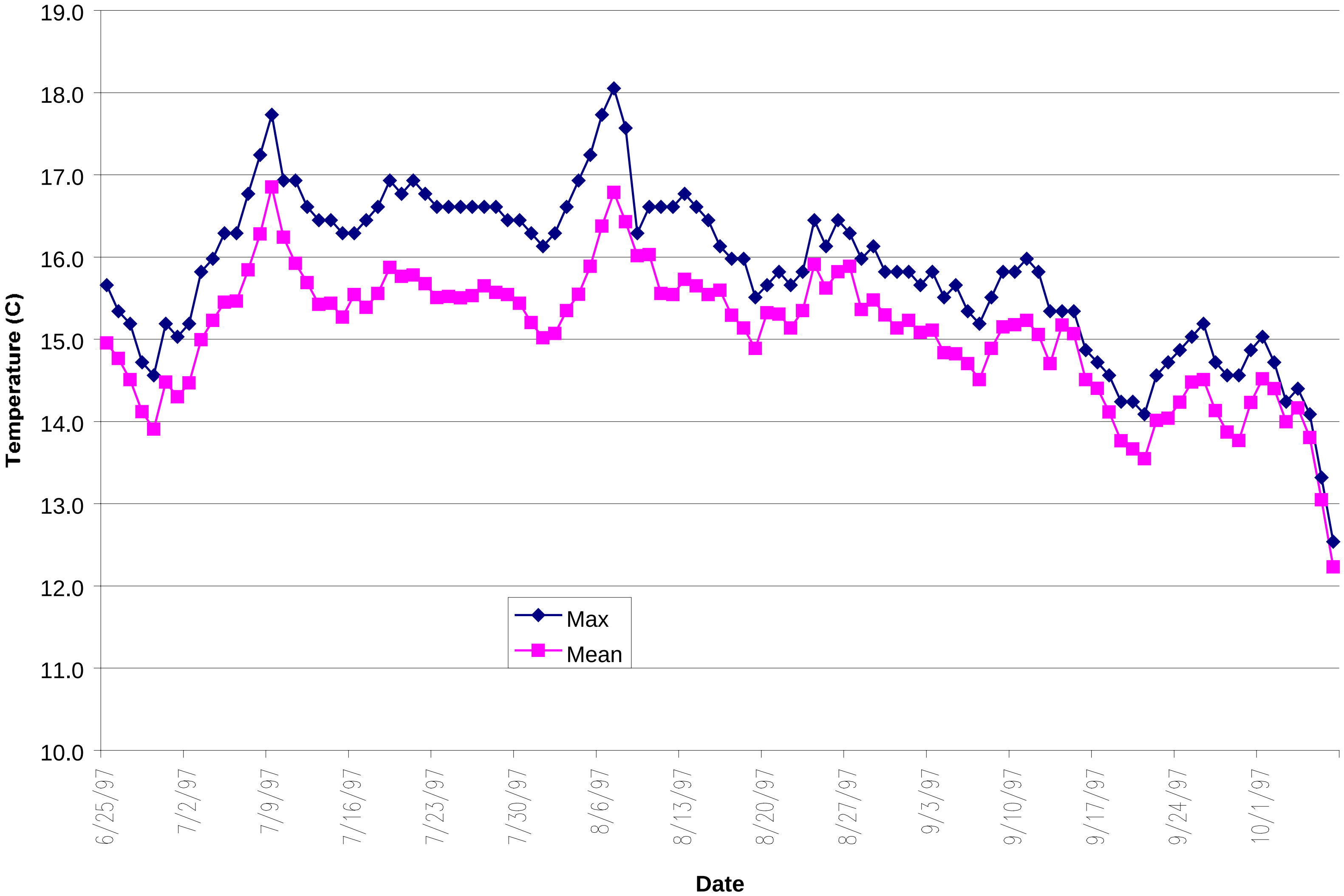


Figure 155. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Annapolis Falls Creek (Site 97-1), Sonoma County, California.

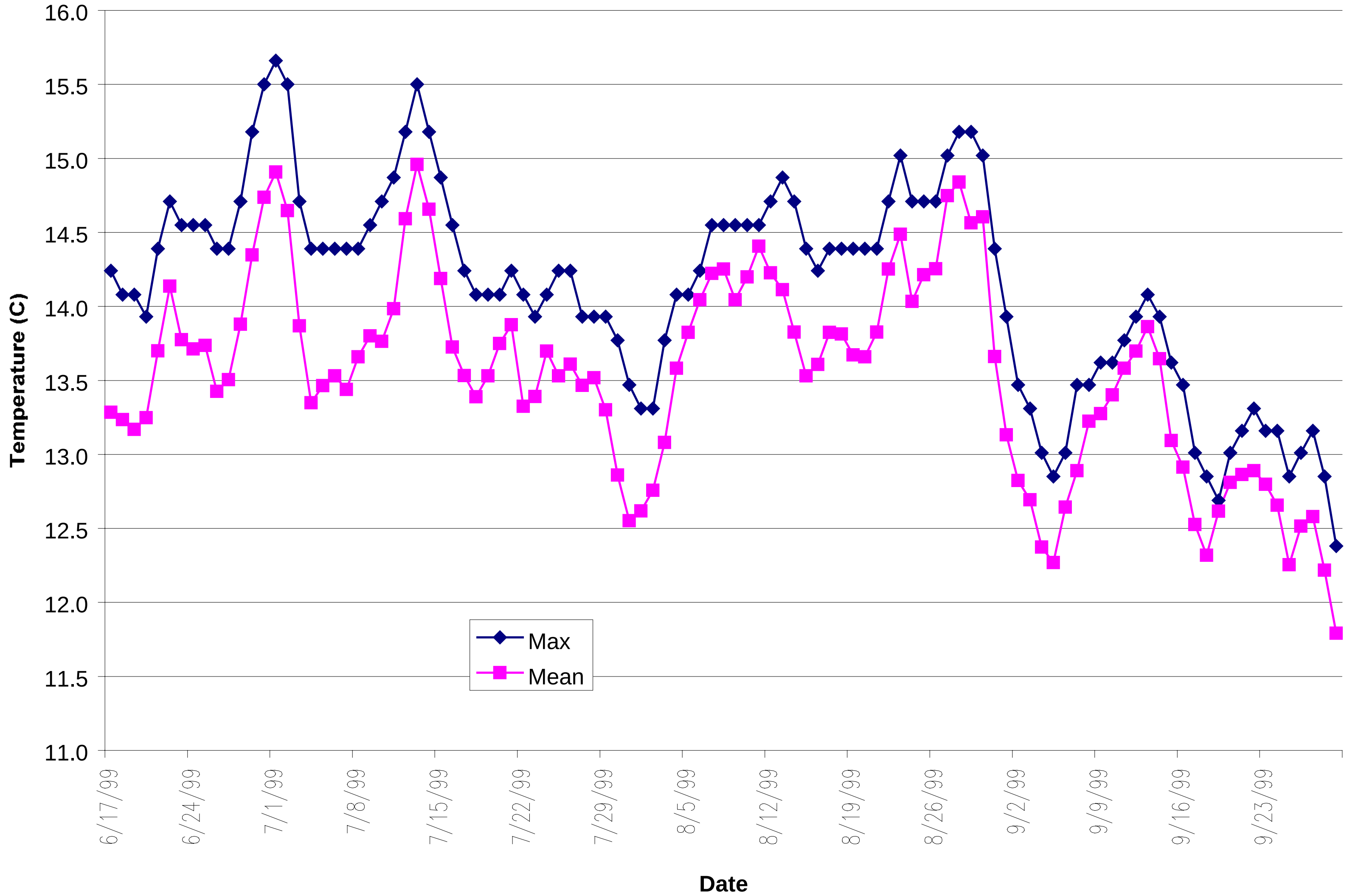
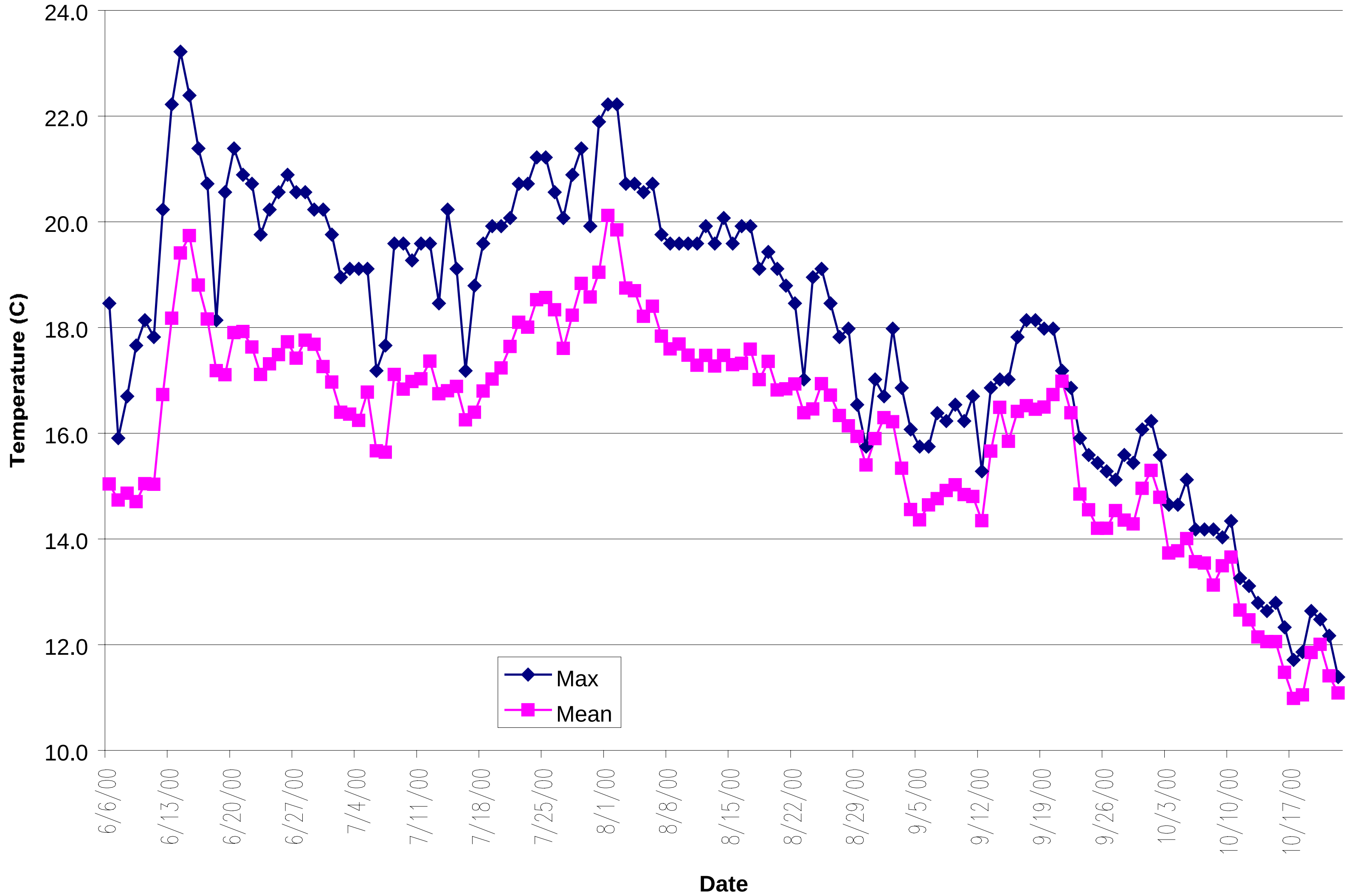
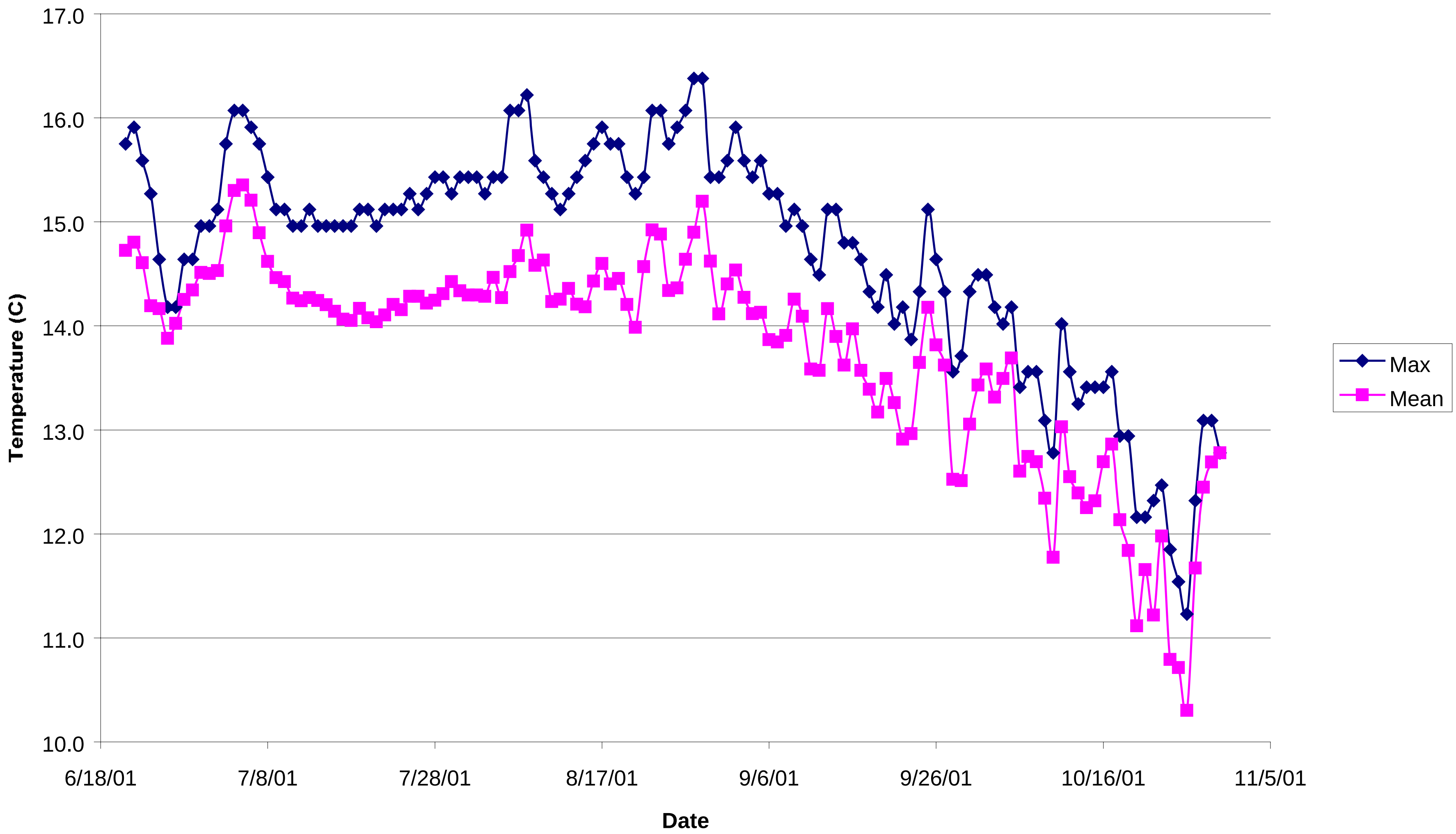


Figure 156. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Fuller Creek (Site 97-2), Sonoma County, California.

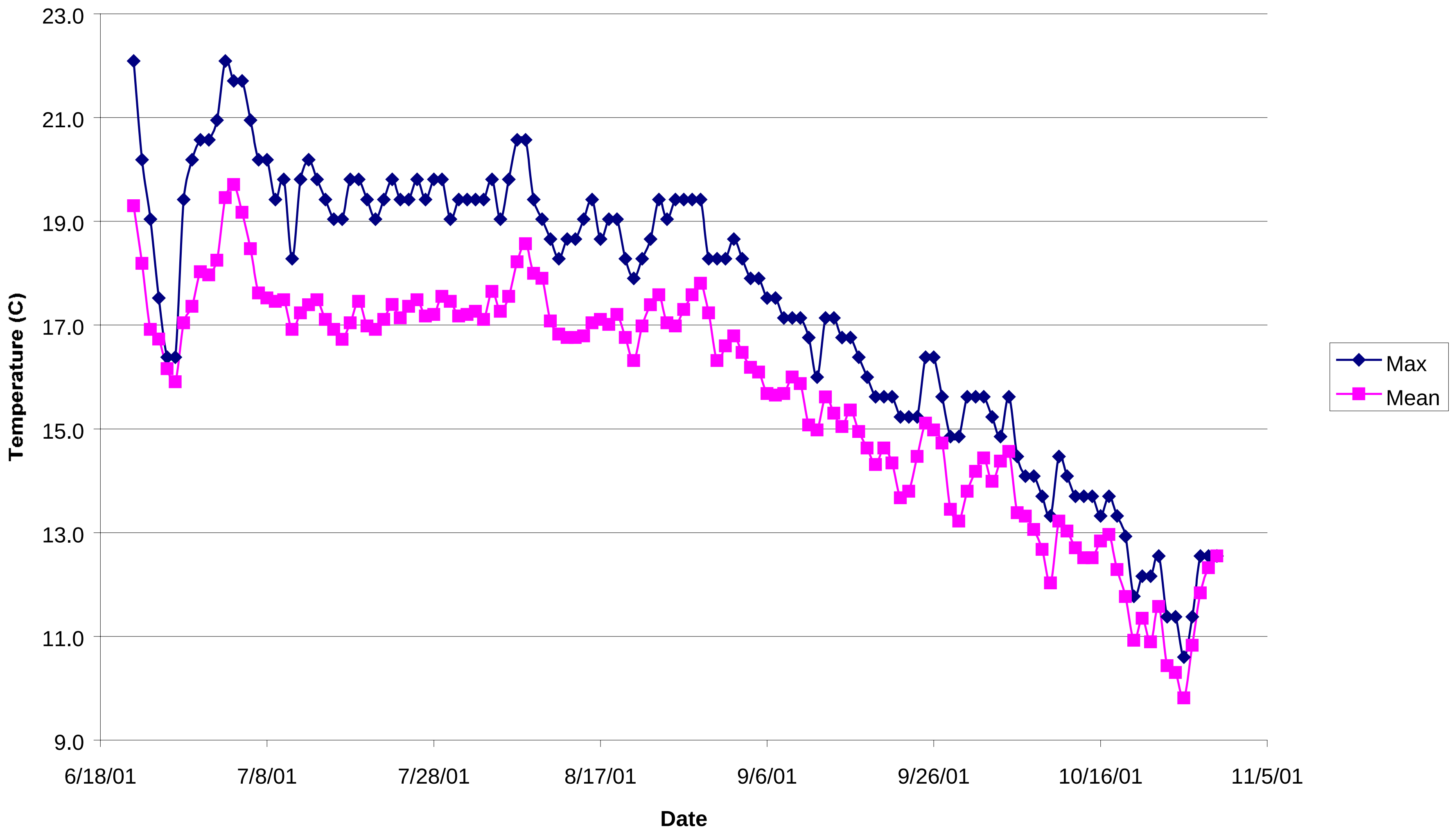
Figure 157. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Fuller Creek (Site 97-2), Sonoma County, California.



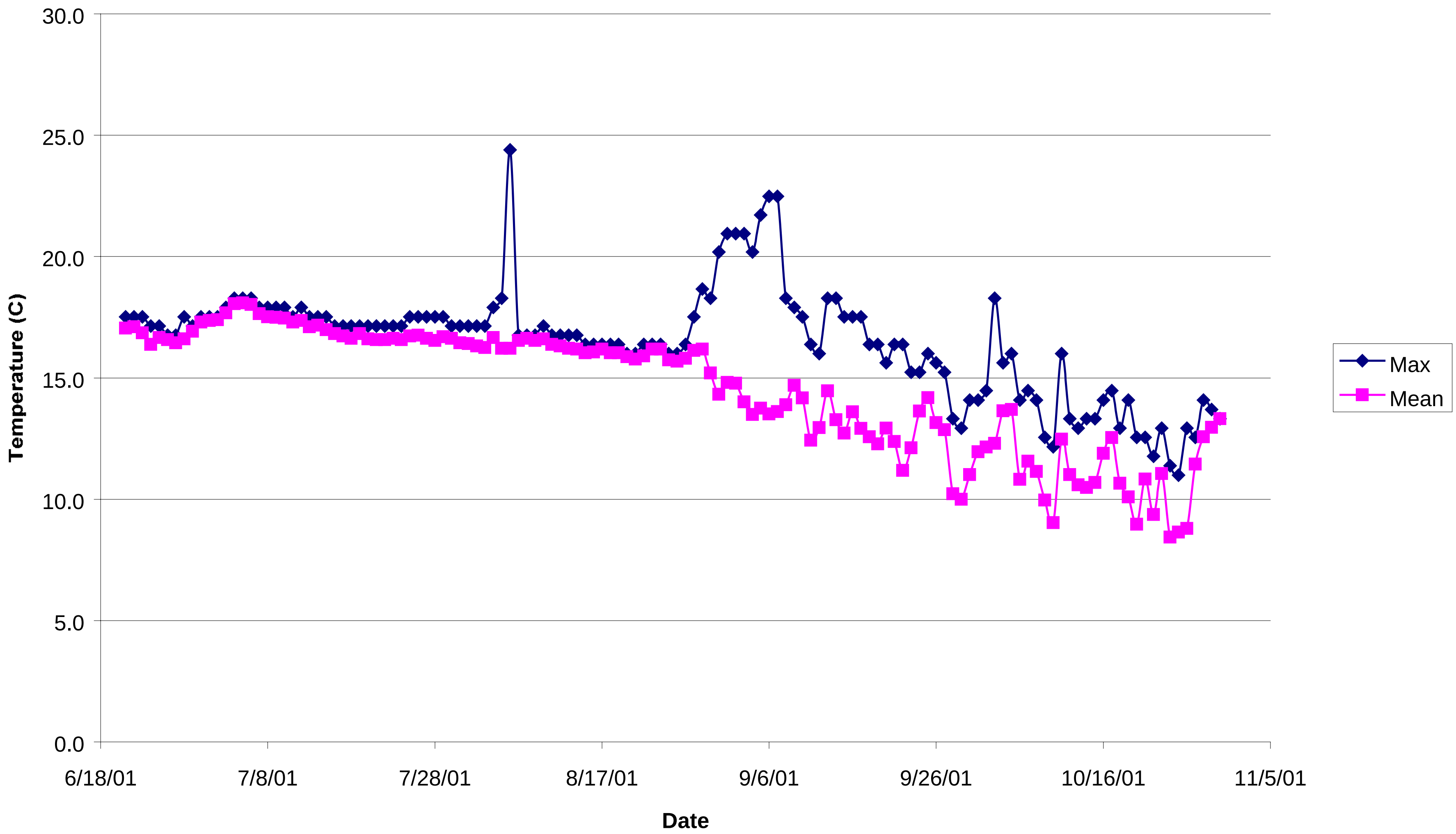
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Crocker Creek (Site 97-4), Sonoma County, California.



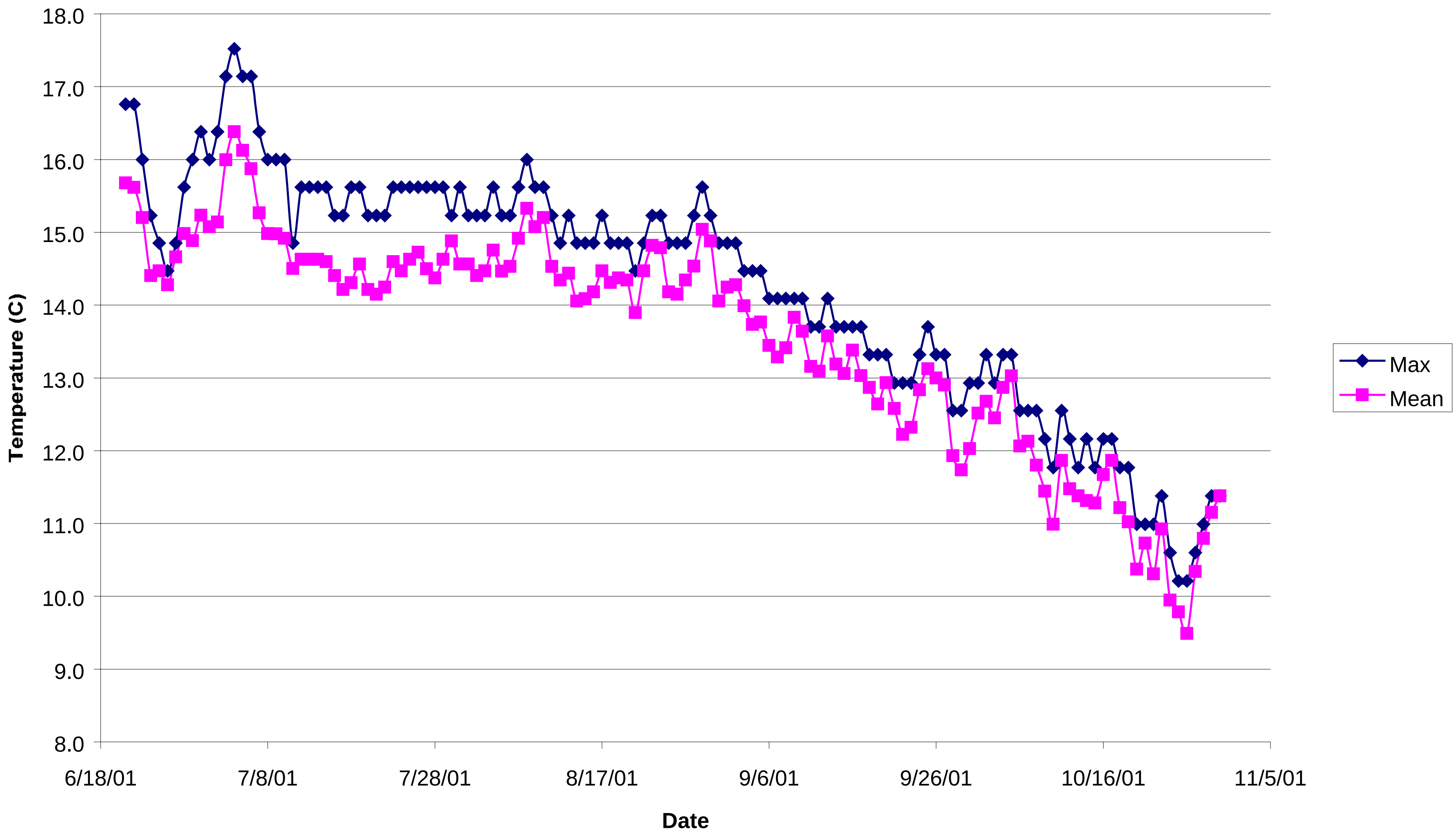
Mean and Maximum Daily Stream Temperatures During Summer 2001 at Fuller Creek (Site 97-2), Sonoma County, California.



Mean and Maximum Daily Stream Temperatures During Summer 2001 at Haupt Creek (Site 97-5), Sonoma County, California.



Mean and Maximum Daily Stream Temperatures During Summer 2001 at Tobacco Creek (Site 97-6), Sonoma County, California.



Mean and Maximum Daily Stream Temperatures During Summer 2001 at Unnamed tributary to Wheatfield Fork Gualala (97-20), Sonoma County, California.

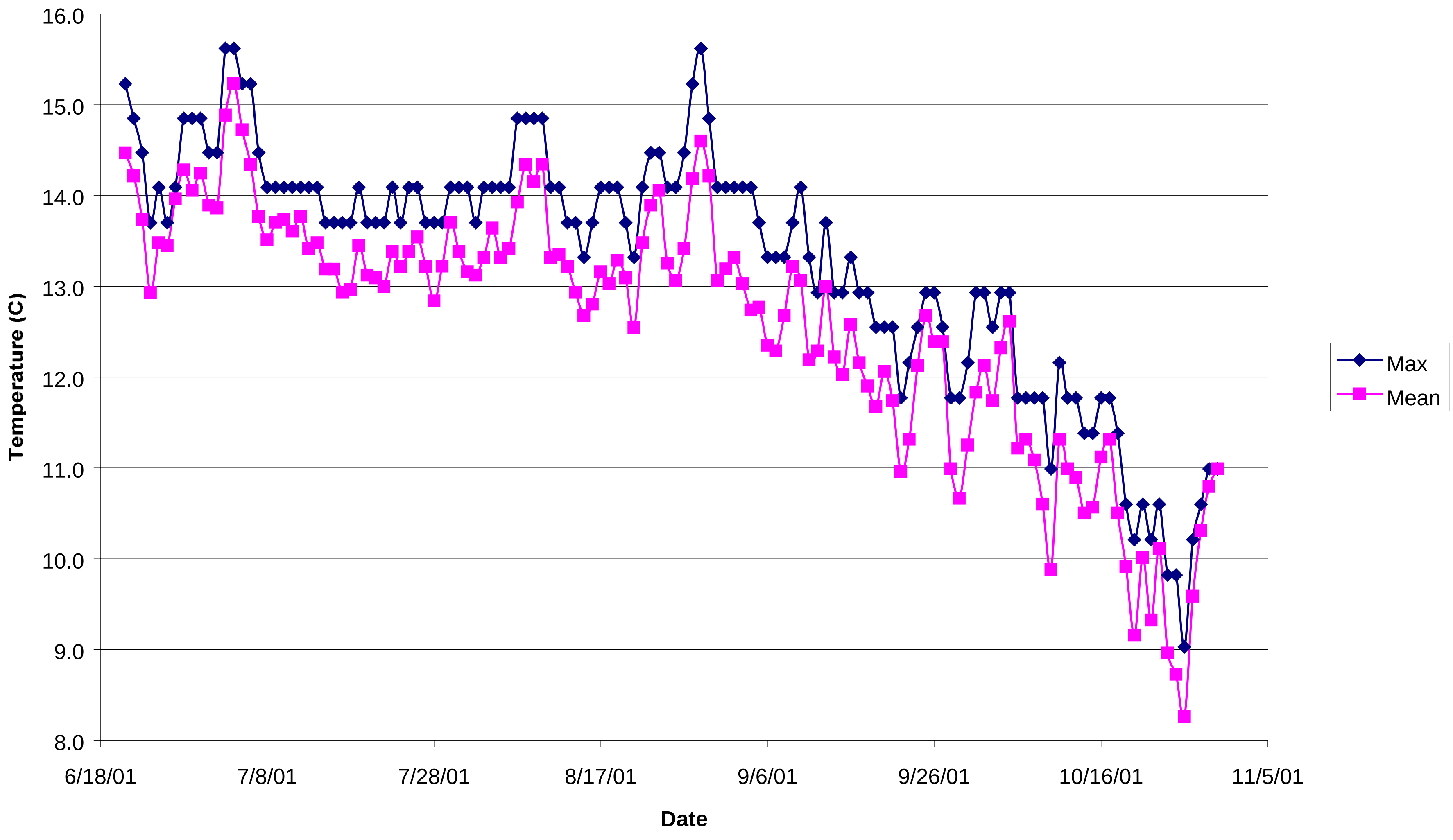


Figure T97-02. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2002 at Fuller Creek (Site T97-02), Sonoma County, California.

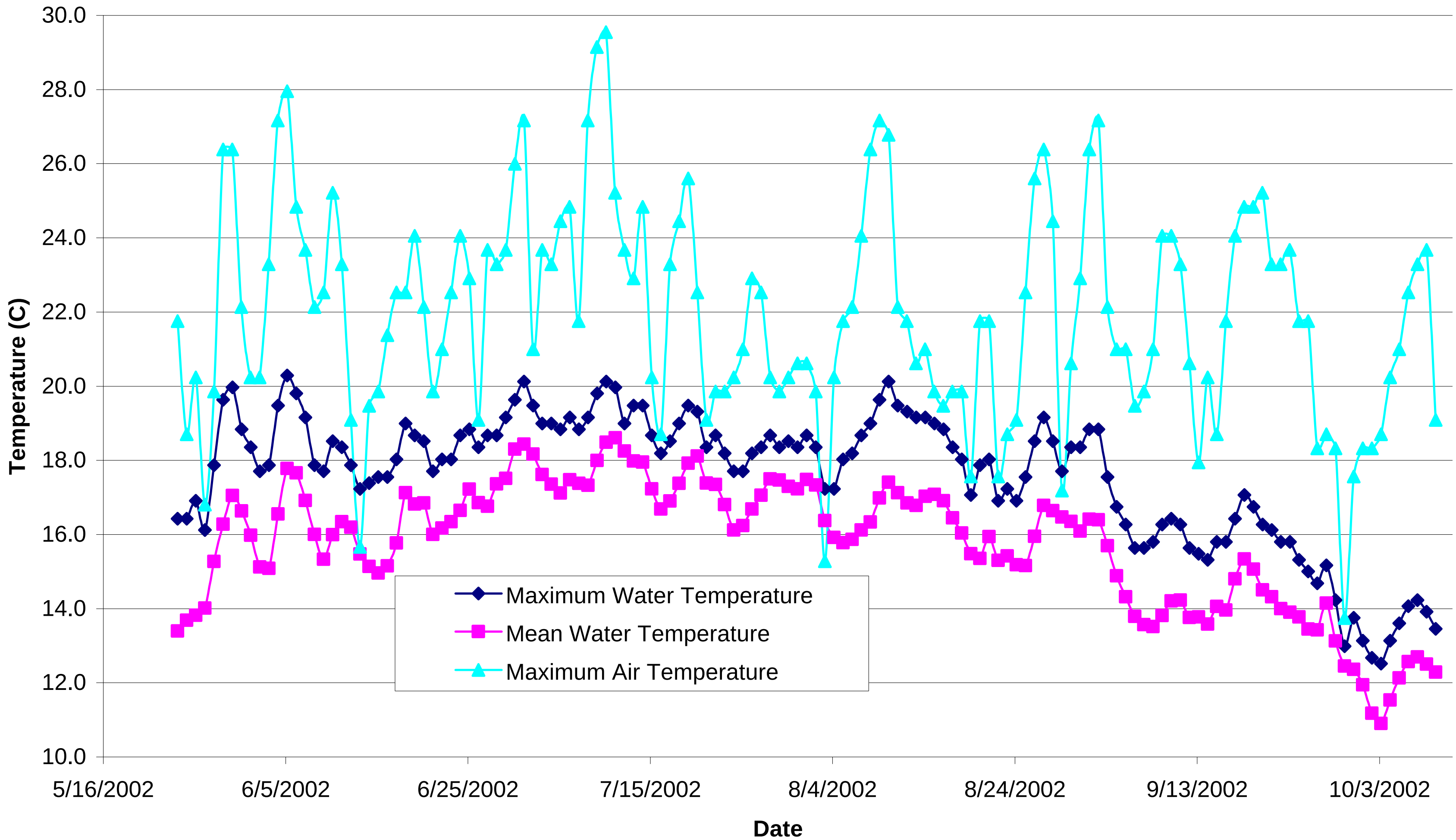


Figure T97-04. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Crocker Creek (Site T97-04), Sonoma County, California.

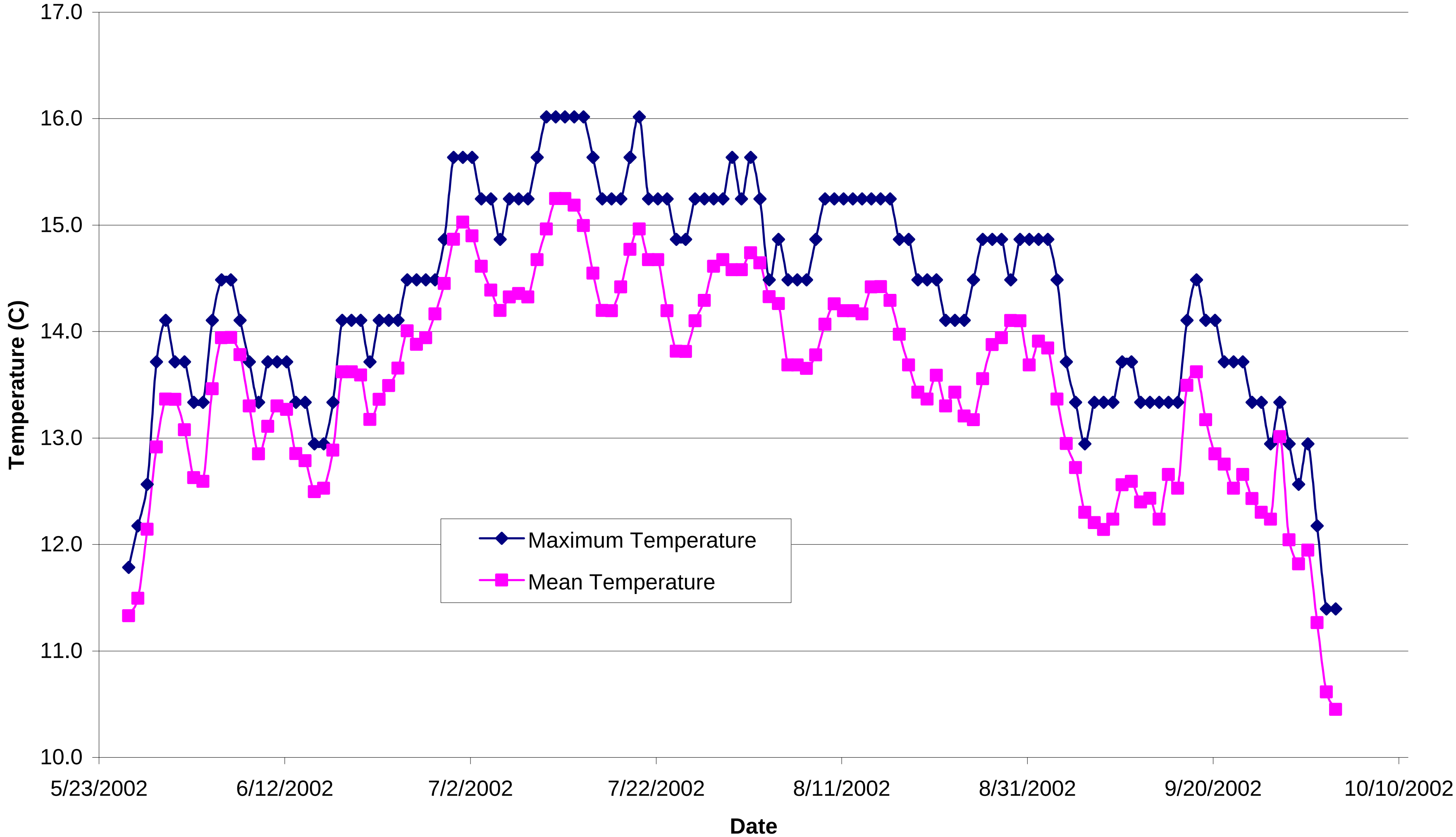


Figure T97-06. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Tobacco Creek (Site T97-06), Sonoma County, California.

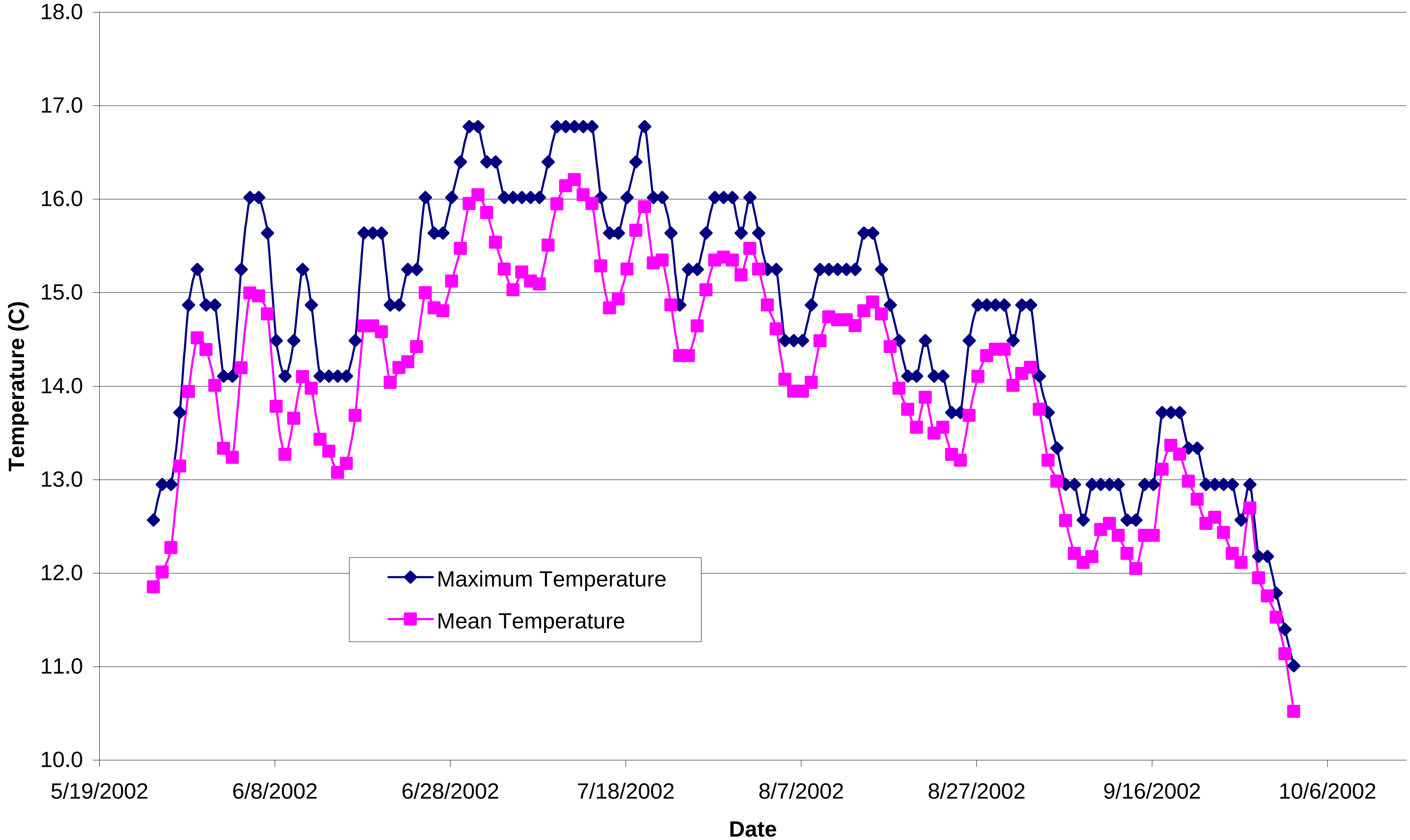


Figure T97-07. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Wheatfield Fork (Site T97-07), Sonoma County, California.

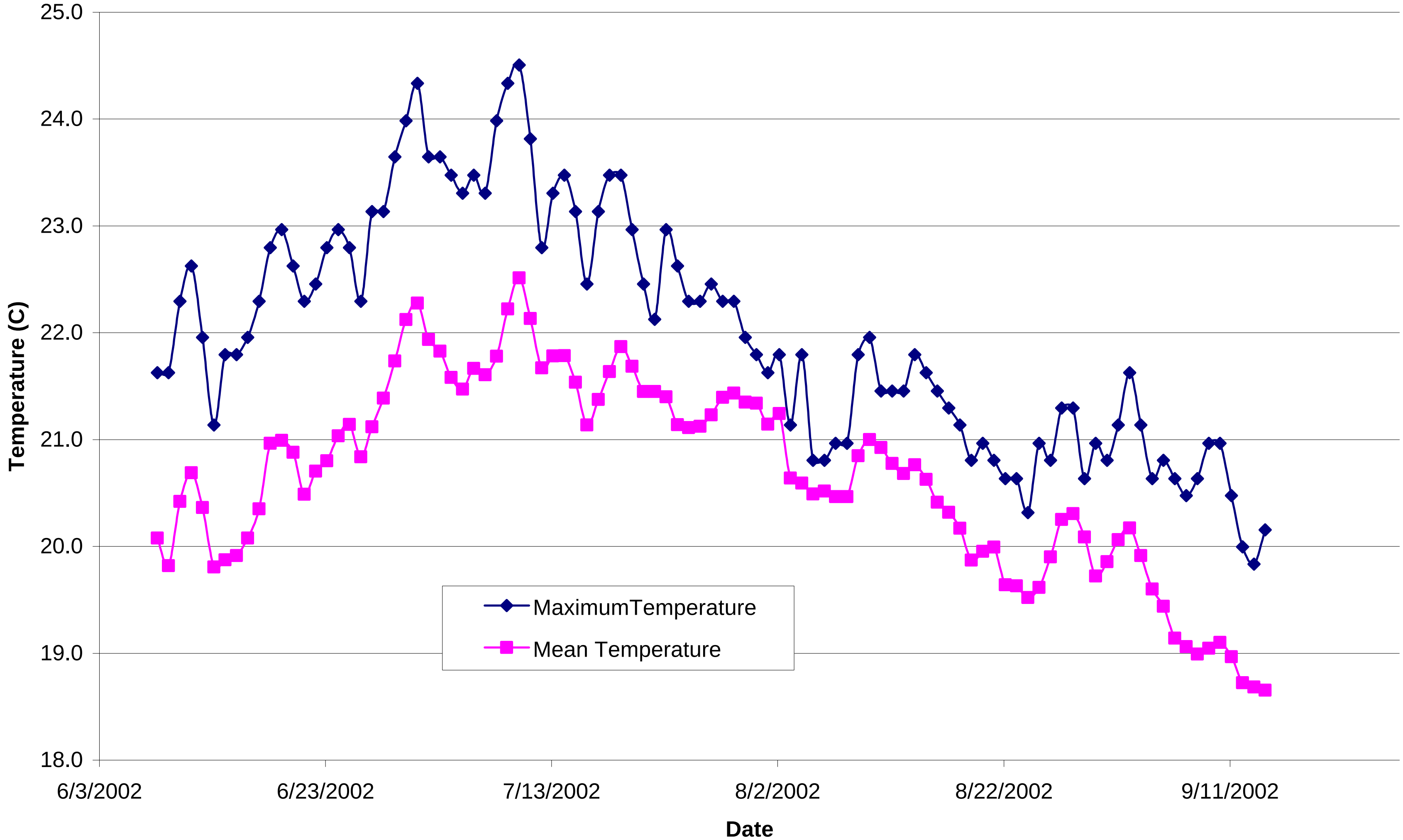


Figure T97-08. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Wheatfield Fork (Site T97-08), Sonoma County, California.