SECTION D
RIPARIAN FUNCTION

INTRODUCTION

Mendocino Redwood Company conducted an assessment of riparian function in the Cottaneva Creek Watershed Analysis Unit (WAU) during the summer of 2004. 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 two to three 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 ongoing stream temperature monitoring. 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 Cottaneva Creek WAU.

LARGE WOODY DEBRIS RECRUITMENT AND IN-STREAM DEMANDS

METHODS

Short-term LWD recruitment potential (next 20-30 years) was evaluated in designated stream segments within the Cottaneva Creek 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 designated 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 2004 aerial photographs and field observations from the summer of 2004. 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 Species 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	Less than eight inches dbh (diameter at breast height)
2	Eight to 15.9 inches dbh
3	16 to 23.9 inches dbh
4	24 to 31.9 inches dbh
5	Greater than 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 Cottaneva Creek 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 provides some habitat or morphologic function in the stream channel (i.e. pool formation, scour, debris dam, bank stabilization, or gravel storage) and greater than four inches in diameter and six feet in length. 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 three pieces or more was recorded and the number of LWD accumulations in the stream survey reach was tallied.

LWD pieces were also classified into categories representing physical characteristics. These categories are: if the LWD piece was part of a living tree, root associated (i.e. does it have a rootwad attached to it), was part of the piece buried within stream gravel or the bank, or associated with a restoration structure. By assigning these attributes, the number of pieces in a segment which, for example, have a rootwad associated with the piece can be calculated. 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, because the dimensions and calculated volume for these pieces are not known they would represent a minimum dimension. There may likely be a significant amount of volume that is buried that we cannot measure. Also, these pieces are 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 the size requirements listed below in Table D-2.

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

Bankfull width (ft.)	Diameter (in.)	Length (ft.)		Minimum volume alternative* (yds^3)
0-10	13	1 or 1.5 times bankfull width**		1
10-20	16	1 or 1.5 times bankfull width**		3
20-30	18	1 or 1.5 times bankfull width**	OR	5
30-40	21	1 or 1.5 times bankfull width**		8
40-60	26	1 or 1.5 times bankfull width**		15
60-80	31	1 or 1.5 times bankfull width**		25
80-100	36	1 or 1.5 times bankfull width**		34

* A piece of LWD counts as a "key piece" if it does not meet the diameter and length criteria but exceeds this minimum volume.
** 1.0 times bankfull width if a rootwad is attached, 1.5 times bankfull width if not.

Debris jams (>10 pieces) were noted and total dimensions of the jam recorded. A correction factor is used to account for the void space within debris jams. Total number of pieces and number of key pieces were noted. Species and dimensions were not recorded for individual pieces contained in debris jams. All volume estimates and piece counts were separated in two groups, one not considering jams and one considering all LWD pieces in the segment, debris jams included. The percentage of total volume and total pieces per segment which was contained in debris jams was also calculated.

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

Bankfull width	Number of Key Pieces		
	Per 328 feet (100 m)	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, as 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 Cottaneva Creek WAU. The in-stream LWD demand is determined by stream segment considering the overall LWD recruitment, the stream segment LWD sensitivity rating (as determined in the Stream Channel and Fish Habitat Assessment for stream geomorphic units), and the level of LWD currently in the stream segment (on target or off target). Table D-4 shows how these three factors are used to determine the in-stream LWD demand.

Table D-4. In-stream LWD Demand

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

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

Moderate In-stream LWD Demand - this classification suggests that current riparian LWD recruitment conditions and in-stream LWD are at levels which are moderately sufficient for fish habitat and stream channel morphology requirements. Consideration must be given to these areas

to improve the LWD recruitment potential of the riparian stand. These areas may also be considered for supplemental LWD or stream structures placed in the stream channel.

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

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

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

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

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

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

We consider key LWD for determination of both in-stream 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 IN-STREAM DEMANDS

RESULTS

The large woody debris recruitment potential and in-stream LWD demand for the Cottaneva Creek 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 show in Table D-5 a, b, and c. The majority (59%) of the stream segments in the Cottaneva Creek WAU had a high LWD demand (see Map D-1).

Debris jams were fairly common throughout Cottaneva with an average of 20% of the total volume of large woody debris being consisting of debris jams. Only 20% of the segments in Cottaneva met the key piece target when debris jams were not included, but roughly 40% of the segments met the key piece target when debris jams were included.

LWD species composition was largely redwood dominated (Table D-5b) with a WAU-wide average of 73% of the total volume in each segment. This analysis was limited to pieces not contained within debris jams. Hardwoods (including alders) constituted roughly 10% of the average volume in Cottaneva.

The majority of the segments (68%) in the Cottaneva Creek WAU contained LWD that was not recently contributed to the stream. Only one segment contained a majority of LWD that was contributed within the past ten years. This may be a result of past riparian harvest or natural stand types. Needles to say, more LWD must be contributed to the stream channel in future years.

As shown in tables D-5 a, b and c, there is a need for large woody debris in most of the channel segments of the Cottaneva Creek WAU. Channel segments with LWD levels which are well below the target will need to be the priority for monitoring future recruitment and restoration work. Even the segments that met the target need LWD levels to be maintained to ensure LWD is providing fish habitat and morphological function in the stream channels.

Riparian recruitment potential in the Cottaneva Creek WAU is low (see Map D-1). The majority of the segments observed (62%) had a low recruitment potential (see Table D-1 for clarification). Middle Fork Cottaneva, however, had a higher proportion of segments with moderate recruitment potential. The low recruitment potential throughout the rest of Cottaneva is most likely due to past riparian harvest practices. As much as possible, these types of areas will have to be managed to attempt to provide for future stream LWD and habitat.

Table D-5 (a). Large Woody Debris Pieces

Stream Segment Name	ID	Functional LWD Pieces w/o Debris Jams	Functional LWD Pieces w/ Debris Jams	Number Debris Jams	Number Debris Accum.	Functional LWD (#/100m) w/o Debris Jams	Functional LWD (#/100m) w/ Debris Jams	Key LWD w/o Debris Jams	Key LWD with Debris Jams	Key LWD /100m w/o Debris Jams	Key LWD /100m w/Debris Jams
Mainstem Cottaneva	RC01	54	70	1	7	8.9	11.5	0	0	0.0	0.0
Mainstem Cottaneva	RC02	78	111	2	9	23.3	33.1	0	0	0.0	0.0
Mainstem Cottaneva	RC03	60	70	1	5	19.7	23.0	0	1	0.0	0.3
Mainstem Cottaneva	RC04	40	55	1	4	13.1	18.0	3	5	1.0	1.6
Mainstem Cottaneva	RC05	120	130	1	15	39.4	42.6	1	3	0.3	1.0
Mainstem Cottaneva	RC06	71	103	2	7	27.1	39.3	4	13	1.5	5.0
South Fork Cottaneva	RC07	45	65	2	4	18.5	26.7	0	1	0.0	0.4
Rockport Creek	RC08	63	73	1	6	23.0	26.6	9	12	3.3	4.4
South Fork Cottaneva	RC09	69	82	1	9	15.1	17.9	0	5	0.0	1.1
Slaughterhouse Gulch	RC10	53	53	0	5	34.8	34.8	5	5	3.3	3.3
Slaughterhouse Gulch	RC11	41	41	0	4	28.7	28.7	12	12	8.4	8.4
Slaughterhouse Gulch	RC12	52	65	1	5	43.7	54.7	3	11	2.5	9.3
South Fork Cottaneva	RC17	51	51	0	6	29.1	29.1	5	5	2.9	2.9
South Fork Cottaneva	RC18	73	84	1	9	36.8	42.4	8	14	4.0	7.1
South Fork Cottaneva	RC19	78	159	3	8	36.5	74.5	13	38	6.1	17.8
Rockport Creek	RC20	15	15	0	0	10.9	10.9	3	3	2.2	2.2
Kimball Creek	RC24	77	77	0	9	50.5	50.5	10	10	6.6	6.6
Rockport Creek	RC28	39	59	2	3	25.6	38.7	7	17	4.6	11.2
Rockport Creek	RC29	45	45	0	6	49.2	49.2	3	3	3.3	3.3
Rockport Creek	RC32	8	8	0	0	8.7	8.7	3	3	3.3	3.3
Powderhouse Creek	RC41	23	23	0	1	12.6	12.6	3	3	1.6	1.6
Powderhouse Creek	RC42	23	23	0	0	34.3	34.3	13	13	19.4	19.4
Unnamed Gulch	RC46	26	26	0	1	26.7	26.7	5	5	5.1	5.1
Gulch 3	RC49	24	24	0	1	23.2	23.2	8	8	7.7	7.7
Middle Fork Cottaneva	RC52	26	51	1	2	17.1	33.5	5	10	3.3	6.6
Middle Fork Cottaneva	RC53	55	55	0	7	36.1	36.1	3	3	2.0	2.0
Middle Fork Cottaneva	RC54	23	23	0	2	18.9	18.9	2	2	1.6	1.6

Table D-5 (a). Large Woody Debris Piece (continued)

Stream Segment Name	ID	Functional LWD Pieces w/o Debris Jams	Functional LWD Pieces w/ Debris Jams	Number Debris Jams	Number Debris Accum.	Functional LWD (#/100m) w/o Debris Jams	Functional LWD (#/100m) w/ Debris Jams	Key LWD w/o Debris Jams	Key LWD with Debris Jams	Key LWD /100m w/o Debris Jams	Key LWD /100m w/Debris Jams
Middle Fork Cottaneva	RC56	34	34	0	4	27.4	27.4	7	7	5.6	5.6
Middle Fork Cottaneva	RC60	41	56	1	6	44.8	61.2	3	6	3.3	6.6
Middle Fork Cottaneva	RC61	22	22	0	1	18.0	18.0	4	4	3.3	3.3
Upper Cottaneva	RC63	32	57	1	3	26.2	46.7	2	14	1.6	11.5
Upper Cottaneva	RC64	31	56	1	5	20.3	36.7	4	9	2.6	5.9
Upper Cottaneva	RC67	42	42	0	5	30.6	30.6	4	4	2.9	2.9

Table D-5 (b). Large Woody Debris Volume in Select Stream Segments of the Cottaneva Creek WAU.

Stream Segment 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	Total # of Debris Accumulations	% 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)
									RW	Fir	Alder	HW	Unk.	
Mainstem Cottaneva	RC01	44.27	51.68	7.3	8.5	7	14%	0%	26%	0%	30%	22%	21%	75-100%
Mainstem Cottaneva	RC02	51.68	73.9	15.4	22.0	9	30%	0%	37%	0%	29%	21%	13%	25-50%
Mainstem Cottaneva	RC03	39.48	62.81	12.9	20.6	5	37%	0%	29%	0%	9%	43%	19%	25-50%
Mainstem Cottaneva	RC04	72.89	247.89	23.9	81.3	4	71%	44%	75%	0%	0%	17%	8%	25-50%
Mainstem Cottaneva	RC05	126.64	134.97	41.5	44.3	15	6%	9%	59%	0%	4%	9%	28%	25-50%
Mainstem Cottaneva	RC06	172.23	280.56	65.7	107.0	7	39%	30%	88%	0%	2%	0%	9%	0-25%
South Fork Cottaneva	RC07	21.49	30.39	8.8	12.5	4	29%	0%	0%	0%	26%	0%	74%	50-75%
Rockport Creek	RC08	63.42	74.53	23.1	27.2	6	15%	53%	57%	0%	4%	0%	39%	25-50%
South Fork Cottaneva	RC09	89.61	142.94	19.6	31.3	9	37%	0%	60%	3%	23%	7%	7%	50-75%
Slaughterhouse Gulch	RC10	85.23	85.23	55.9	55.9	5	0%	53%	71%	4%	0%	0%	25%	0-25%
Slaughterhouse Gulch	RC11	108.13	108.13	75.8	75.8	4	0%	83%	92%	0%	0%	2%	6%	0-25%
Slaughterhouse Gulch	RC12	80.45	108.23	67.7	91.0	5	26%	20%	89%	1%	1%	0%	9%	0-25%
South Fork Cottaneva	RC17	67.81	67.81	38.7	38.7	6	0%	64%	74%	0%	3%	0%	23%	0-25%
South Fork Cottaneva	RC18	121.2	124.4	61.2	62.8	9	3%	48%	51%	0%	0%	0%	49%	0-25%
South Fork Cottaneva	RC19	178.9	1117.8	83.8	523.8	8	84%	70%	87%	0%	1%	0%	12%	0-25%
Rockport Creek	RC20	23.81	23.8	17.4	17.4	0	0%	39%	86%	14%	0%	0%	0%	0-25%
Kimball Creek	RC24	100.77	100.8	66.1	66.1	9	0%	40%	84%	0%	0%	0%	16%	0-25%
Rockport Creek	RC28	27.71	66.0	18.2	43.3	3	58%	55%	77%	0%	0%	7%	16%	0-25%
Rockport Creek	RC29	40.56	40.6	44.3	44.3	6	0%	47%	95%	1%	0%	0%	4%	0-25%
Rockport Creek	RC32	8.35	8.4	9.1	9.1	0	0%	66%	16%	0%	22%	0%	63%	50-75%
Powderhouse Creek	RC41	21.91	21.9	12.0	12.0	1	0%	48%	77%	0%	0%	0%	22%	0-25%
Powderhouse Creek	RC42	23.33	23.3	34.8	34.8	0	0%	85%	56%	0%	0%	0%	44%	0-25%
Unnamed Gulch	RC46	28.22	28.2	28.9	28.9	1	0%	55%	96%	0%	2%	0%	2%	0-25%
Gulch 3	RC49	20.57	20.6	19.8	19.8	1	0%	59%	89%	0%	0%	0%	11%	0-25%
Middle Fork Cottaneva	RC52	63.29	74.4	41.5	48.8	2	15%	57%	95%	0%	0%	0%	5%	0-25%
Middle Fork Cottaneva	RC53	42.08	42.1	27.6	27.6	7	0%	28%	73%	13%	0%	0%	14%	0-25%
Middle Fork Cottaneva	RC54	50.57	50.6	41.5	41.5	2	0%	34%	89%	7%	0%	0%	4%	0-25%

Table D-5 (b). Large Woody Debris Volume (continued)

Stream Segment 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	Total # of Debris Accumulations	% 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)
									RW	Fir	Alder	HW	Unk.	
Middle Fork Cottaneva	RC56	56.38	56.4	45.4	45.4	4	0%	63%	93%	2%	0%	0%	5%	0-25%
Middle Fork Cottaneva	RC60	33.67	42.9	36.8	46.9	6	22%	27%	92%	0%	0%	2%	6%	0-25%
Middle Fork Cottaneva	RC61	36.29	36.3	29.8	29.8	1	0%	60%	89%	0%	0%	0%	11%	25-50%
Upper Cottaneva	RC63	35.8	119.1	29.3	97.7	3	70%	37%	85%	0%	0%	5%	10%	25-50%
Upper Cottaneva	RC64	45.4	97.2	29.8	63.8	5	53%	46%	97%	0%	0%	0%	3%	0-25%
Upper Cottaneva	RC67	64.2	64.2	46.8	46.8	5	0%	40%	100%	0%	0%	0%	0%	0-25%
Middle Fork Cottaneva	RC70	29.0	103.7	38.0	136.0	3	72%	39%	89%	0%	0%	0%	11%	0-25%

Table D-5 (c). Select Physical Attributes[1] of LWD in the Cottaneva Creek WAU.

Stream Segment Name	Stream Segment ID#	Piece Count						Volume					
		Root Associated		Buried		Alive		Root Associated		Buried		Alive	
		#	%	#	%	#	%	Yd3	%	Yd3	%	Yd3	%
Mainstem Cottaneva	RC01	6	11%	13	24%	6	11%	6.1	14%	9.9	22%	9.4	21%
Mainstem Cottaneva	RC02	9	12%	28	36%	4	5%	12.3	24%	14.6	28%	6.0	12%
Mainstem Cottaneva	RC03	5	8%	13	22%	11	18%	3.8	10%	16.9	43%	11.9	30%
Mainstem Cottaneva	RC04	1	3%	11	28%	0	0%	0.3	0%	14.3	20%	0.0	0%
Mainstem Cottaneva	RC05	9	8%	20	17%	0	0%	14.5	11%	27.8	22%	0.0	0%
Mainstem Cottaneva	RC06	6	8%	8	11%	0	0%	18.8	11%	21.1	12%	0.0	0%
South Fork Cottaneva	RC07	0	0%	8	23%	5	14%	1.2	5%	1.8	8%	2.9	13%
Rockport Creek	RC08	4	6%	20	32%	0	0%	3.6	6%	27.3	43%	0.0	0%
South Fork Cottaneva	RC09	9	13%	13	19%	4	6%	9.6	11%	22.0	25%	9.7	11%
Slaughterhouse Gulch	RC10	1	2%	34	64%	0	0%	0.2	0%	50.3	59%	0.0	0%
Slaughterhouse Gulch	RC11	4	10%	15	37%	0	0%	51.0	47%	23.9	22%	0.0	0%
Slaughterhouse Gulch	RC12	6	12%	28	54%	1	2%	8.1	10%	43.9	55%	0.2	0%
South Fork Cottaneva	RC17	10	20%	16	31%	3	6%	30.0	44%	10.0	15%	15.7	23%
South Fork Cottaneva	RC18	0	0%	9	13%	0	0%	0.0	0%	19.4	16%	0.0	0%
South Fork Cottaneva	RC19	6	8%	19	24%	1	1%	23.1	13%	22.8	13%	1.0	1%
Rockport Creek	RC20	2	13%	1	7%	0	0%	3.0	13%	2.1	9%	0.0	0%

1 Debris jams are not included in this data set.

Table D-5 (c). Select Physical Attributes of LWD in the Cottaneva Creek WAU (continued)

Stream Segment Name	Stream Segment ID#	Piece Count						Volume					
		Root Associated		Buried		Alive		Root Associated		Buried		Alive	
		#	%	#	%	#	%	Yd3	%	Yd3	%	Yd3	%
Kimball Creek	RC24	0	0%	37	48%	0	0%	0.0	0%	44.3	44%	0.0	0%
Rockport Creek	RC28	4	10%	13	33%	1	3%	6.9	25%	6.3	23%	0.2	1%
Rockport Creek	RC29	2	4%	15	33%	2	4%	1.5	4%	19.6	48%	9.9	24%
Rockport Creek	RC32	2	25%	3	38%	0	0%	2.9	35%	3.9	47%	0.0	0%
Powderhouse Creek	RC41	1	4%	10	43%	0	0%	0.2	1%	10.6	48%	0.0	0%
Powderhouse Creek	RC42	0	0%	16	70%	0	0%	0.0	0%	16.9	72%	0.0	0%
Unnamed Gulch	RC46	3	12%	8	31%	1	4%	3.9	14%	10.1	36%	0.5	2%
Gulch 3	RC49	2	8%	7	29%	0	0%	2.5	12%	4.3	21%	0.0	0%
Middle Fork Cottaneva	RC52	3	12%	12	48%	0	0%	15.4	24%	21.6	34%	0.0	0%
Middle Fork Cottaneva	RC53	9	16%	11	20%	0	0%	11.1	26%	3.8	9%	0.0	0%
Middle Fork Cottaneva	RC54	2	9%	8	35%	0	0%	6.2	12%	31.6	62%	0.0	0%
Middle Fork Cottaneva	RC56	5	15%	9	26%	0	0%	10.3	18%	12.5	22%	0.0	0%
Middle Fork Cottaneva	RC60	3	7%	17	41%	0	0%	3.7	11%	13.4	40%	0.0	0%
Middle Fork Cottaneva	RC61	8	36%	6	27%	4	18%	25.4	70%	4.4	12%	21.1	58%
Upper Cottaneva	RC63	5	16%	1	3%	0	0%	8.0	22%	0.2	1%	0.0	0%
Upper Cottaneva	RC64	2	6%	7	23%	0	0%	5.9	13%	7.3	16%	0.0	0%
Upper Cottaneva	RC67	2	5%	14	33%	0	0%	7.0	11%	20.6	32%	0.0	0%
Middle Fork Cottaneva	RC70	0	0%	4	15%	0	0%	0.0	0%	7.5	26%	0.0	0%

1 Debris jams are not included in this data set.

Table D-6 shows the in-stream LWD quality rating for major streams and sections of stream or river in individual Calwater planning watersheds. This quality rating includes data from debris jams. Currently all the stream segments in Cottaneva Creek have a deficient LWD quality rating, except for South Fork and Upper Cottaneva.

Table D-6. In-stream LWD Quality Ratings for Major Streams and Sections of Streams or Rivers in Calwater Planning Watersheds for the Cottaneva Creek WAU.

Stream	Calwater Planning Watershed	In-stream LWD Quality Rating*
Mainstem Cottaneva	Cottaneva Creek	Deficient
Rockport Creek	Cottaneva Creek	Deficient
South Fork Cottaneva	Cottaneva Creek	Marginal
Middle Fork Cottaneva	Cottaneva Creek	Deficient
Upper Cottaneva	Cottaneva Creek	Marginal

* – includes debris jams

CANOPY CLOSURE AND STREAM TEMPERATURE METHODS

Many physical factors can influence stream temperature. These include: 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 correlate to forest management practices. Therefore, our analysis focused on present canopy cover conditions for consideration of future forest management actions.

Canopy closure, over watercourses, was estimated from field measurements and 2004 aerial photographs. Four canopy closure classes were determined using aerial photographs. These classes are shown in table D-7. Field measurements of canopy cover are used to calibrate the aerial photograph measurements. A map (D-2) was produced for the Cottaneva Creek WAU based on the aerial photograph interpretations.

Table D-7. Estimated levels of Canopy Closure 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%

In 2004, field measurements of canopy closure over select stream channels were performed. The field measurements were taken during the stream channel assessments in the Cottaneva Creek WAU. The field measurements consisted of estimating canopy closure over a watercourse using a spherical densitometer and a solar pathfinder. 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. Solar pathfinder

measurements were taken at one location in each segment sampled. The riparian stream canopy closure is shown in Map D-2.

Stream temperature has been monitored in the Cottaneva Creek WAU since 1996. Stream temperature was measured with continuous recording electronic temperature recorders (Stowaway, Onset Instruments). 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. Stream temperature monitoring probe locations are also shown on Map D-2 indicated by the site identification code (for example, 47-1). The number below the site identification code (in parenthesis) is the most recent three year average MWAT (maximum weekly average temperature) in degrees Celsius. Table D-8 describes the temperature monitoring locations.

Table D-8. Stream Temperature Monitoring Locations and Time Periods in the Cottaneva Creek WAU (see map D-2).

Temperature Station	Segment #	Stream Name	Years Monitored
47-1	RC3	Cottaneva Creek	95, 96, 99, 00, 01, 02, 03, 04
47-2	RC7	South Fork Cottaneva	94, 95, 00, 01, 02, 03, 04
47-3	RC6	North Fork Cottaneva	94, 95, 96, 99, 00, 01, 02, 03,04
47-7	RC5	Cottaneva Creek	02
47-8	RC52	Middle Fork Cottaneva	02, 03, 04
47-9	RC10	Slaughterhouse Gulch	02, 03, 04
47-10	RC19	South Fork Cottaneva	02, 03, 04
47-11	RC77	Tributary to Cottaneva	03, 04
47-23	RC32	Tributary to Rockport Creek	01
47-24	RC24	Kimball Creek	01, 02, 03, 04
47-25	RC12	Slaughterhouse Gulch	01, 02
47-26	RC60	Tributary to Middle Fork	01

Maximum, maximum weekly average temperatures (MWAT), and maximum weekly maximum temperatures (MWMT) were calculated for each temperature monitoring site and year. Maximum weekly average temperatures (MWATs) and maximum weekly maximum temperatures (MWMT) were calculated by taking a seven day average of the mean and maximum daily stream temperature.

Maximum and mean daily temperatures were calculated for each temperature monitoring site and year and are presented in graphs in Appendix D. 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. MRC uses two 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

Overall average canopy closure over watercourses is rated marginal in the Cottaneva Creek WAU (Map D-2 and Table D-9). All in-stream canopy observations were 70% or above with one exception at the mouth of Cottaneva Creek (54%), which is expected due to the wide channel width at that location.

Table D-9(a). Summary of 2004 Field Observations of Stream Canopy Closure for Select Stream Channel Segments of the Cottaneva Creek WAU.

	Average canopy %	Average Solar Pathfinder observations		
		Effective Shade	Topographic Shade	Canopy
Mainstem Cottaneva	89%	92%	8%	86%
Middle Fork Cottaneva	88%	97%	14%	85%
Rockport Creek	93%	90%	20%	89%
South Fork Cottaneva	88%	94%	12%	86%
Upper Cottaneva	90%	91%	10%	86%

Table D-9(b). 2004 Field Observations of Stream Canopy Closure for Select Stream Channel Segments of the Cottaneva Creek WAU.

Stream Name	Segment Number	Bankfull width (ft)	Mean Shade Canopy (%)	Solar Pathfinder Observations		
				Effective Shade (%)	Topographical Shading (%)	Canopy cover (%)
Mainstem Cottaneva	RC01	46	54%	78%	4%	82%
Mainstem Cottaneva	RC02	44	89%	86%	4%	40%
Mainstem Cottaneva	RC03	34.5	97%	93%	6%	94%
Mainstem Cottaneva	RC04	37	90%	99%	1%	72%
Mainstem Cottaneva	RC05	30	84%	84%	2%	88%
Mainstem Cottaneva	RC06	31	88%	91%	11%	98%
South Fork Cottaneva	RC07	39	92%	97%	4%	99%
Rockport Creek	RC08	13	94%	81%	12%	79%
South Fork Cottaneva	RC09	43	94%	99%	6%	96%
Slaughterhouse Gulch	RC10	12	96%	97%	19%	99%
Slaughterhouse Gulch	RC11	14.5	90%	95%	15%	75%
Slaughterhouse Gulch	RC12	16.3	79%	91%	28%	81%
South Fork Cottaneva	RC17	24	92%	95%	9%	97%
South Fork Cottaneva	RC18	23	70%	90%	5%	70%
South Fork Cottaneva	RC19	17	89%	96%	2%	85%
Rockport Creek	RC20	19.5	91%	no data	no data	no data
Kimball Creek	RC24	15	92%	82%	17%	76%
Rockport Creek	RC28	12	94%	92%	24%	94%
Rockport Creek	RC29	11	97%	96%	25%	95%
Rockport Creek	RC32	10.6	92%	no data	no data	no data
Powderhouse Creek	RC41	12	99%	99%	5%	100%
Powderhouse Creek	RC42	6.3	98%	97%	40%	99%
Unnamed Gulch	RC46	11	98%	95%	4%	98%
Gulch 3	RC49	9	96%	99%	5%	89%
Middle Fork Cottaneva	RC52	21	77%	95%	8%	85%

Table D-9(b) (continued). 2004 Field Observations of Stream Canopy Closure for Select Stream Channel Segments of the Cottaneva Creek WAU.

Stream Name	Segment Number	Bankfull width (ft)	Mean Shade Canopy (%)	Solar Pathfinder Observations		
				Effective Shade (%)	Topographical Shading (%)	Canopy cover (%)
Middle Fork Cottaneva	RC53	20	90%	96%	2%	76%
Middle Fork Cottaneva	RC54	21	86%	96%	10%	80%
Middle Fork Cottaneva	RC56	15	84%	100%	13%	66%
Middle Fork Cottaneva	RC60	13.5	86%	100%	13%	92%
Middle Fork Cottaneva	RC61	15	91%	90%	19%	90%
Upper Cottaneva	RC63	23	88%	92%	4%	89%
Upper Cottaneva	RC64	19	90%	84%	12%	83%
Upper Cottaneva	RC67	16.0	92%	97%	15%	85%
Middle Fork Cottaneva	RC70	14	90%	99%	10%	92%

Stream temperatures in the Cottaneva Creek WAU are at levels preferred by salmonids. Instantaneous maximum temperatures recorded at all sites typically do not exceed the maximum lethal ranges for coho salmon (23C^{o}) and steelhead trout (26C^{o}) (Brett, 1952). MWAT values for all sites are below the maximums for coho salmon (17-18 C^{o}) (Brett, 1952 and Becker and Genoway, 1979). See Tables D-10, D-11 and D-12.

Table D-10. Maximum Daily Temperatures by Year for the Cottaneva Creek WAU.

Station	1994	1995	1996	1999	2000	2001	2002	2003	2004
47-1	**	17.0	15.4	14.5	16.7	15.5	15.1	16.2	16.4
47-2	15.0	16.2	**	**	15.4	14.5	14.0	15.6	15.7
47-3	15.4	16.1	15.8	15.8	17.0	15.3	15.6	16.3	16.8
47-7	**	**	**	**	**	**	16.1	**	**
47-8	**	**	**	**	**	**	14.5	14.9	15.2
47-9	**	**	**	**	**	**	14.5	15.2	15.8
47-10	**	**	**	**	**	**	13.9	14.6	14.5
47-11	**	**	**	**	**	**	**	14.7	14.6
47-23	**	**	**	**	**	11.8	**	**	**
47-24	**	**	**	**	**	13.3	13.7	14.9	16.6
47-25	**	**	**	**	**	13.3	12.9	**	**
47-26	**	**	**	**	**	13.3	**	**	**

**data not collected

Table D-11. Maximum Weekly Average Temperature (MWAT) for the Cottaneva Creek WAU.

Station	1994	1995	1996	1999	2000	2001	2002	2003	2004
47-1	**	15.2	14.0	13.6	14.2	14.1	14.1	15.1	15.5
47-2	13.7	14.2	**	**	13.6	13.4	12.7	14.1	14.5
47-3	14.6	14.3	13.6	13.8	14.4	13.6	13.8	14.7	14.9
47-7	**	**	**	**	**	**	14.1	**	**
47-8	**	**	**	**	**	**	13.2	13.8	14.1
47-9	**	**	**	**	**	**	12.8	13.6	14.3
47-10	**	**	**	**	**	**	13.1	13.7	13.9
47-11	**	**	**	**	**	**	**	13.7	13.9
47-23	**	**	**	**	**	11.8	**	**	**
47-24	**	**	**	**	**	12.8	12.6	13.6	14.4
47-25	**	**	**	**	**	12.9	12.6	**	**
47-26	**	**	**	**	**	12.8	**	**	**

**data not collected

Table D-12. 7-Day Moving Average of the Daily Maximum (MWMT) for the Cottaneva Creek WAU.

Station	1994	1995	1996	1999	2000	2001	2002	2003	2004
47-1	**	16.0	14.9	14.3	15.1	14.7	14.6	15.7	15.9
47-2	14.8	15.3	**	**	14.5	13.9	13.6	15.1	15.3
47-3	15.2	15.3	14.8	14.7	15.2	14.6	15.2	16.0	16.1
47-7	**	**	**	**	**	**	15.4	**	**
47-8	**	**	**	**	**	**	14.1	14.5	14.7
47-9	**	**	**	**	**	**	13.9	14.5	15.1
47-10	**	**	**	**	**	**	13.7	14.5	14.2
47-11	**	**	**	**	**	**	**	14.1	14.3
47-23	**	**	**	**	**	11.8	**	**	**
47-24	**	**	**	**	**	13.0	13.3	14.1	16.3
47-25	**	**	**	**	**	13.1	12.8	**	**
47-26	**	**	**	**	**	13.2	**	**	**

** data not collected

Canopy cover in the Cottaneva Creek WAU is fair and temperatures are at levels that are acceptable for salmon and steelhead. Twenty-seven of the 34 segments surveyed in Cottaneva had bankfull widths of less than 30 feet. Of those 27 segments, only twelve of them (44%) had an average canopy cover of greater than 90% (target for less than 30 foot bankfull width). Fifteen of those segments (56%) had average canopy cover greater than 90%, but an effective shade value of less than 91%. The remaining seven segments (greater than 30 feet bankfull width), all of them except for one (86%) had an average canopy of greater than 70%. In summary, 62% of the segments surveyed were on-target for canopy cover in Cottaneva Creek.

Table D-13. Stream Shade Quality Ratings for Major Streams and River/Stream Segments in the Cottaneva Creek Planning Watersheds.

Stream	Temperature monitoring location at outlet	Most recent three year average MWAT (°C)	Percent of segments with on-target shade	Stream Shade Quality Rating
Mainstem Cottaneva	47-1	14.9	80%	MARGINAL
Middle Fork Cottaneva	47-8	13.7	14%	MARGINAL*
Rockport Creek	47-23	11.8	80%	MARGINAL
South Fork Cottaneva	47-2	13.8	56%	MARGINAL*
Upper Cottaneva	47-3	14.5	33%	MARGINAL*

Marginal due to the fact that greater than 70% of the stream segments surveyed had canopy values that were greater than 70%

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Appendix D

Figure T47-01. Mean and Maximum Daily Stream Temperatures During Summer 2004 at Cottaneva Creek (Site T47-01), Mendocino County, California.

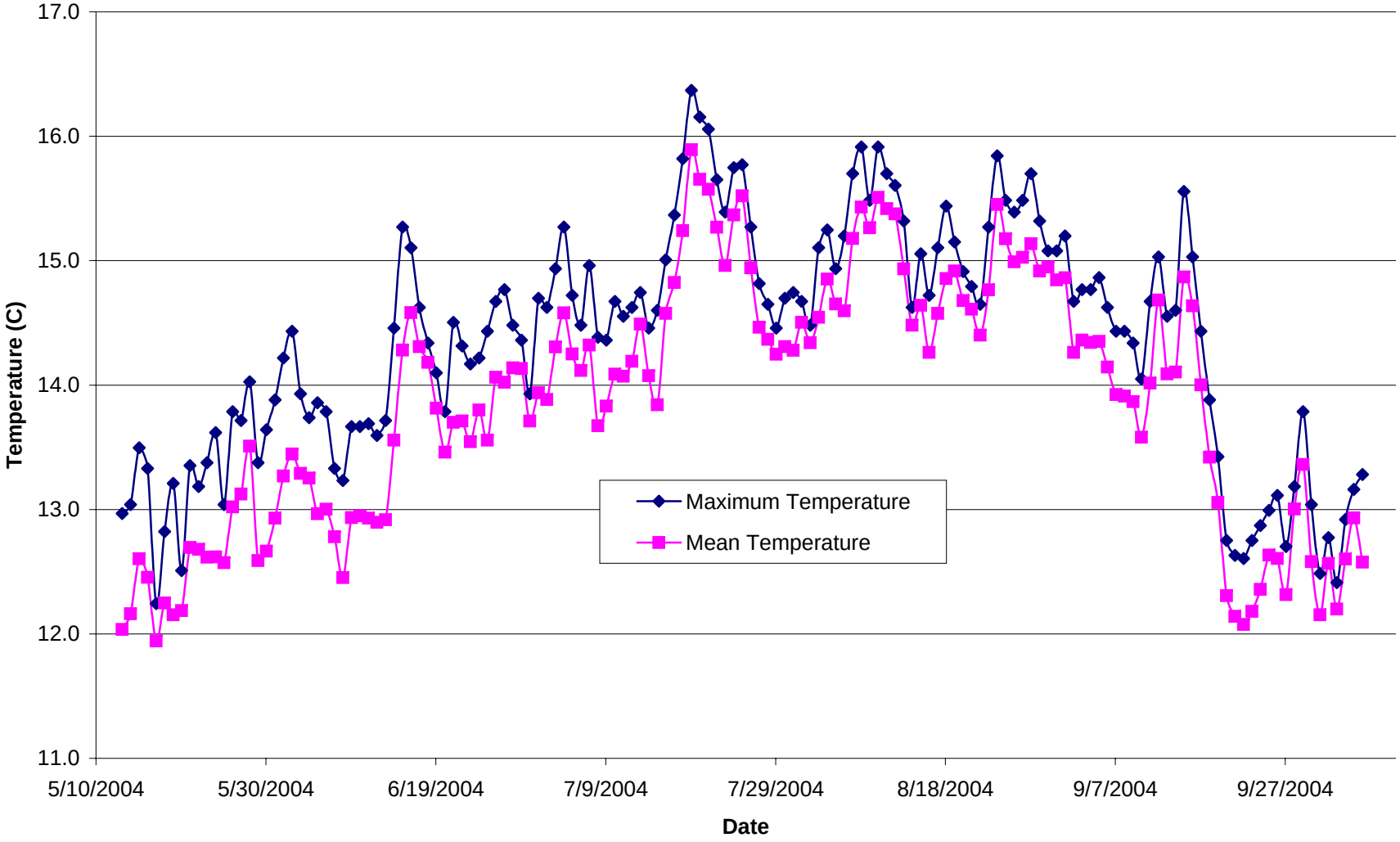


Figure T47-12. Mean and Maximum Daily Stream Temperatures During Summer 2004 at Hardy Creek (Site T47-12), Mendocino County, California.

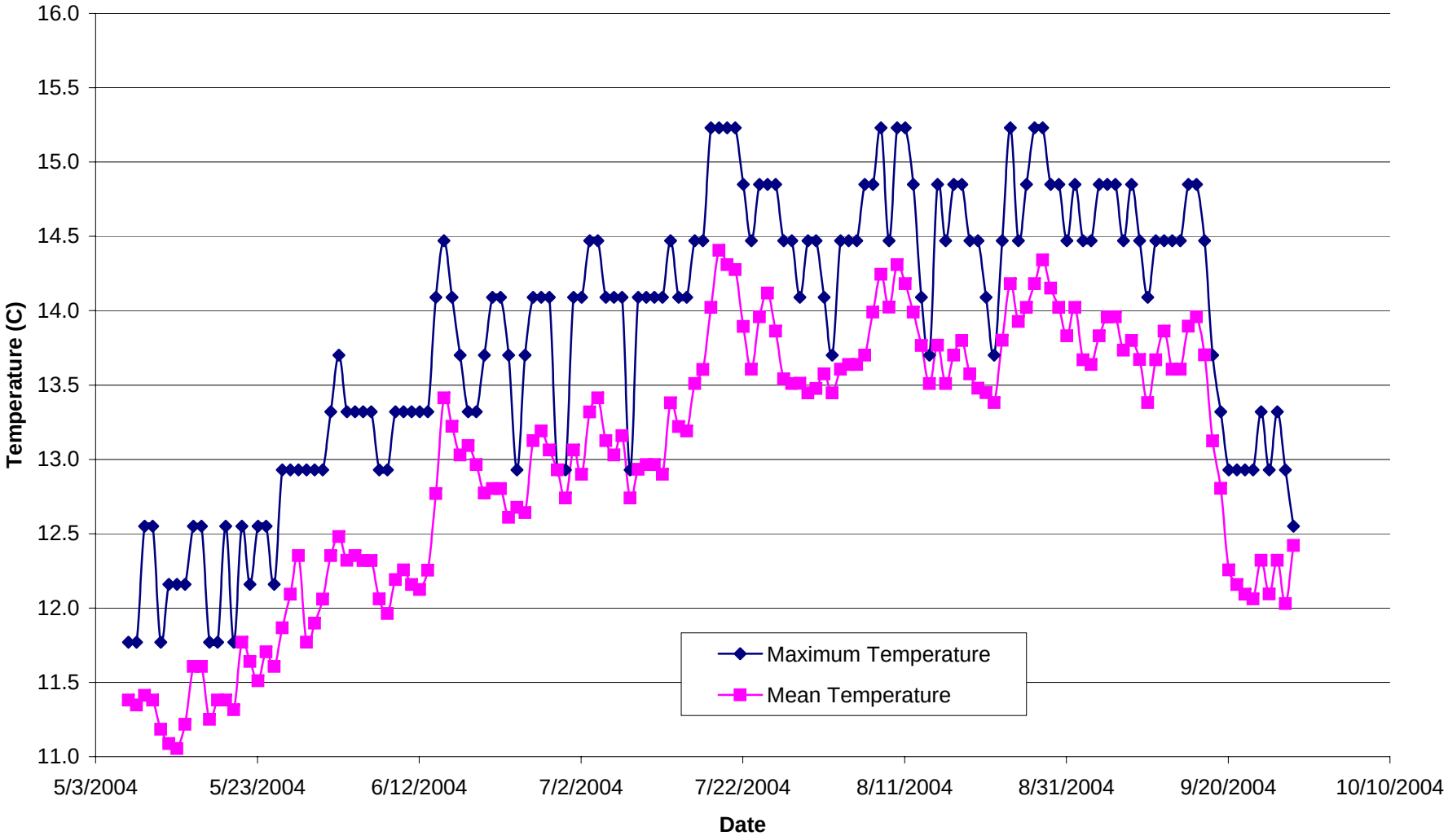


Figure T47-11. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2004 at Unnamed Tributary to Cottaneva Creek (Site T47-11), Mendocino County, California.

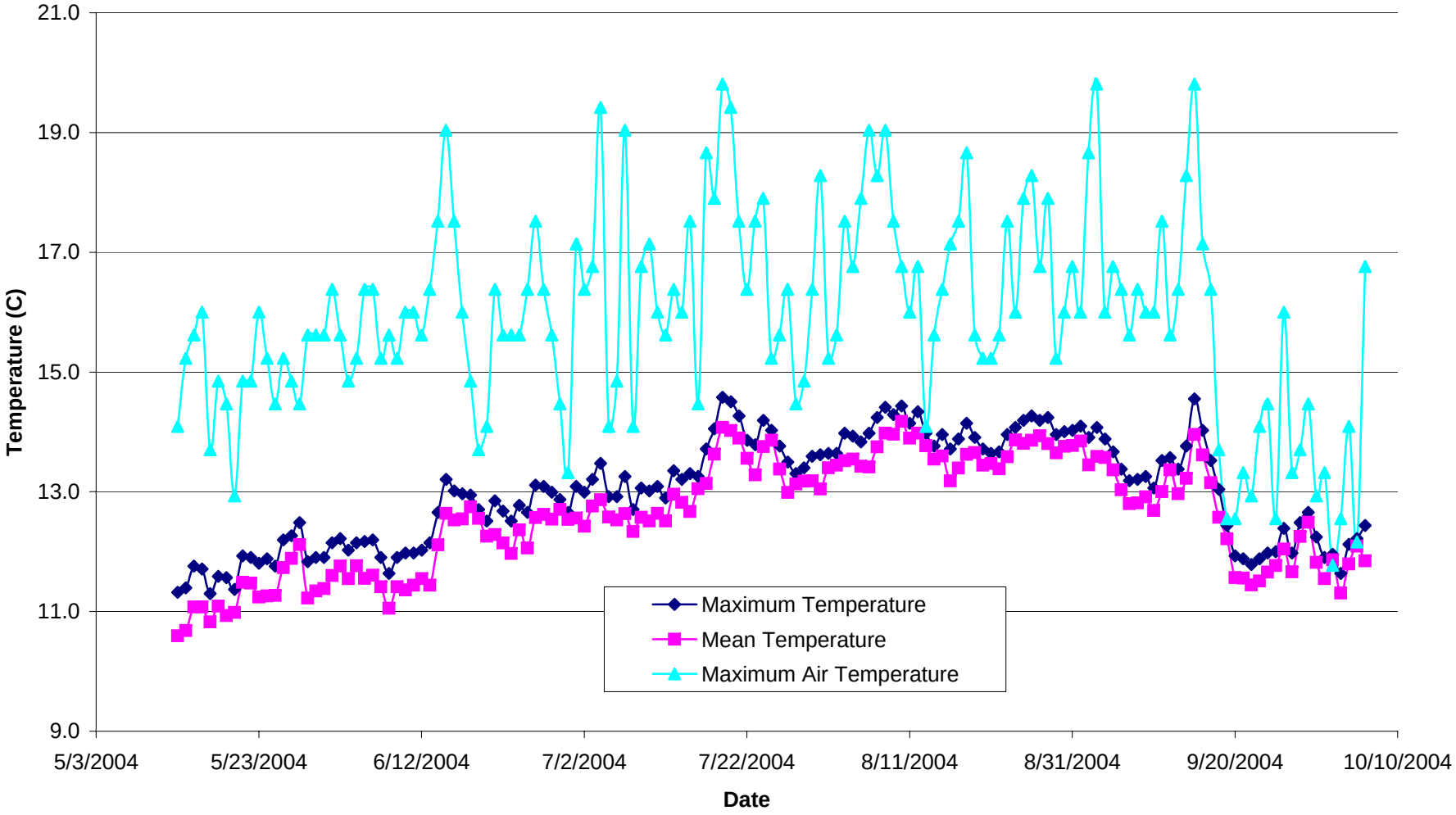


Figure T47-10. Mean and Maximum Daily Stream Temperatures During Summer 2004 at South Fork Cottaneva Creek (Site T47-10), Mendocino County, California.

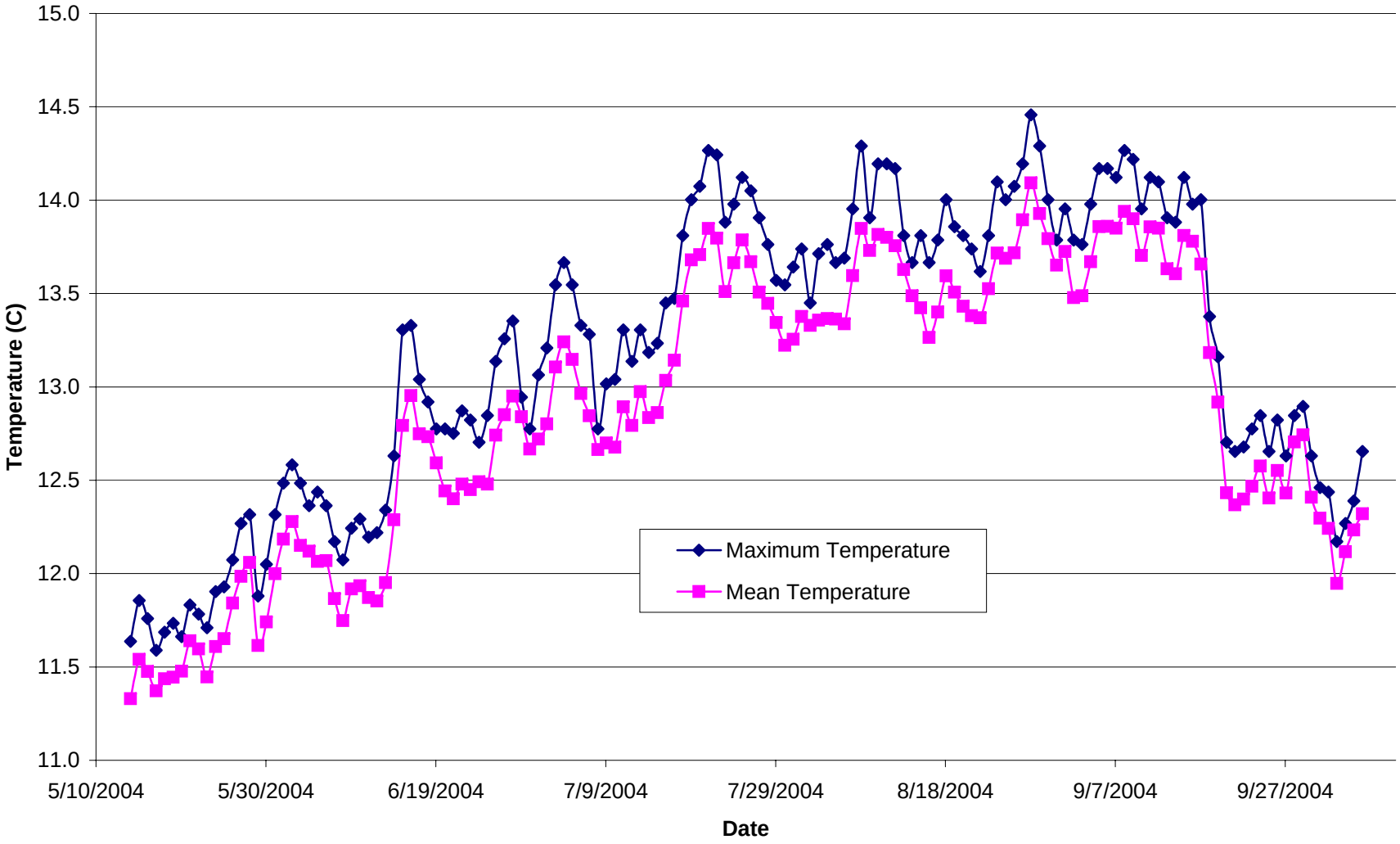


Figure T47-09. Mean and Maximum Daily Stream Temperatures During Summer 2004 at Slaughterhouse Gulch (Site T47-09), Mendocino County, California.

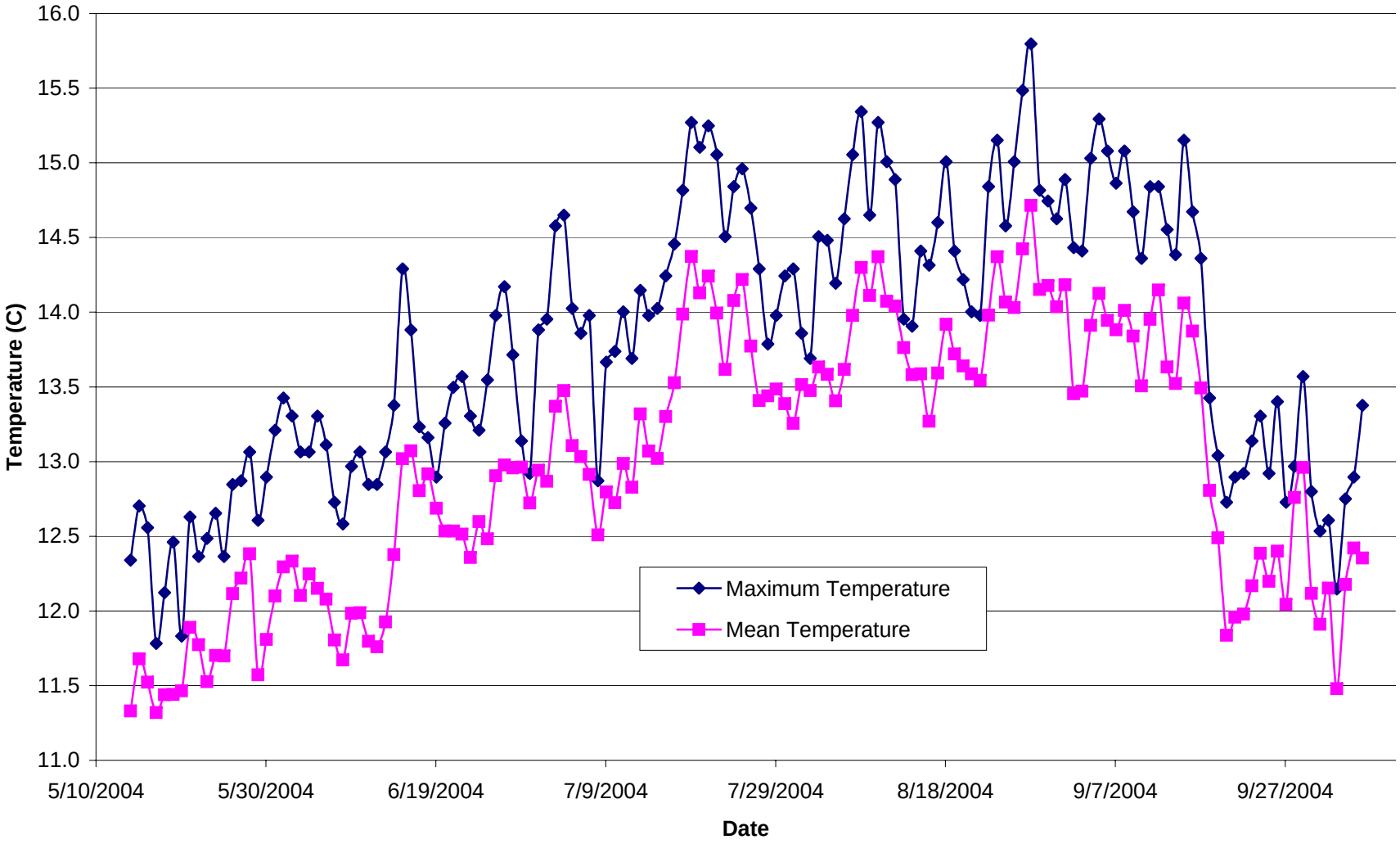


Figure T47-08. Mean and Maximum Daily Stream Temperatures During Summer 2004 at Middle Fork Cottaneva Creek (Site T47-08), Mendocino County, California.

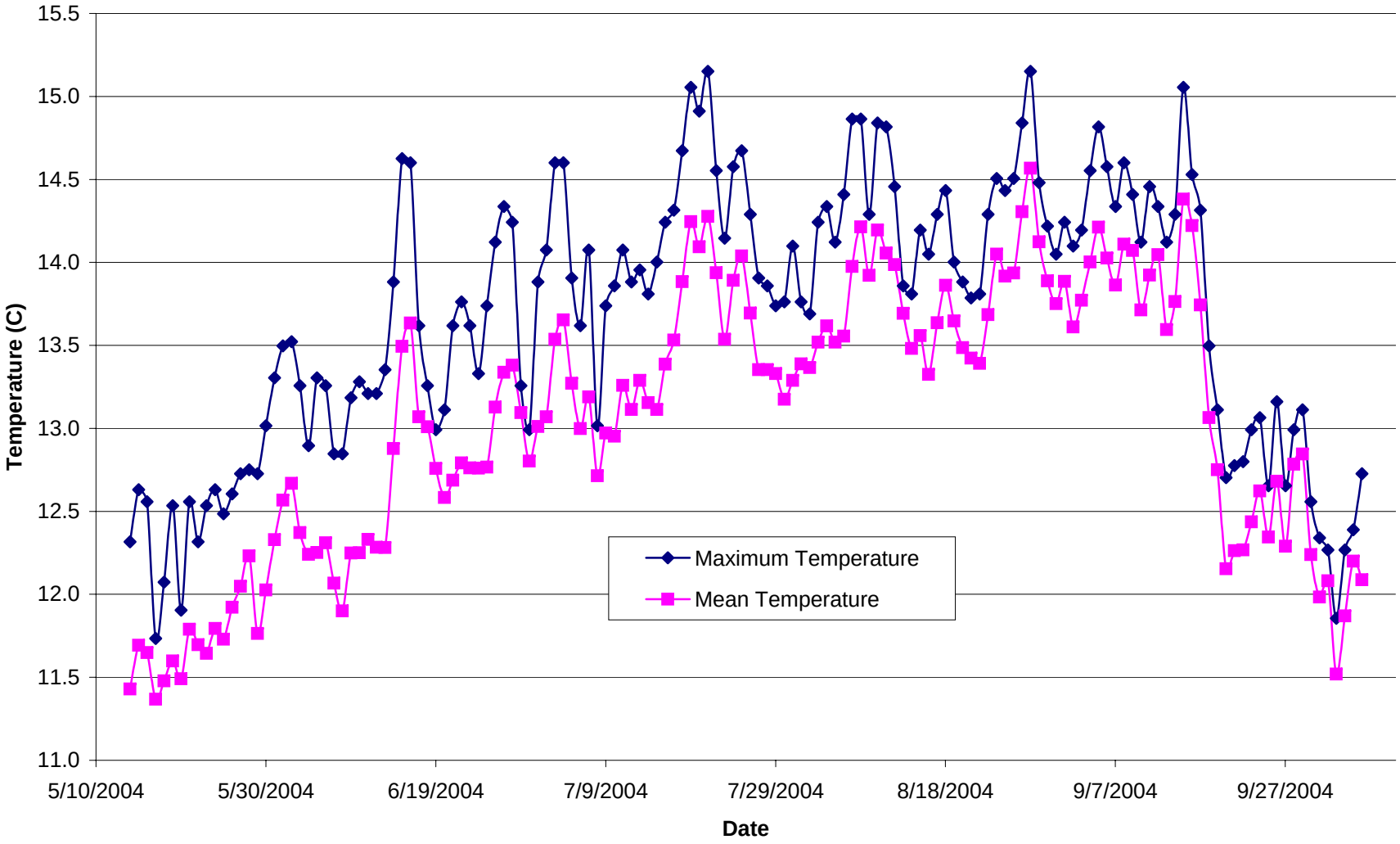


Figure T47-05. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2004 at Juan Creek (Site T47-05), Mendocino County, California.

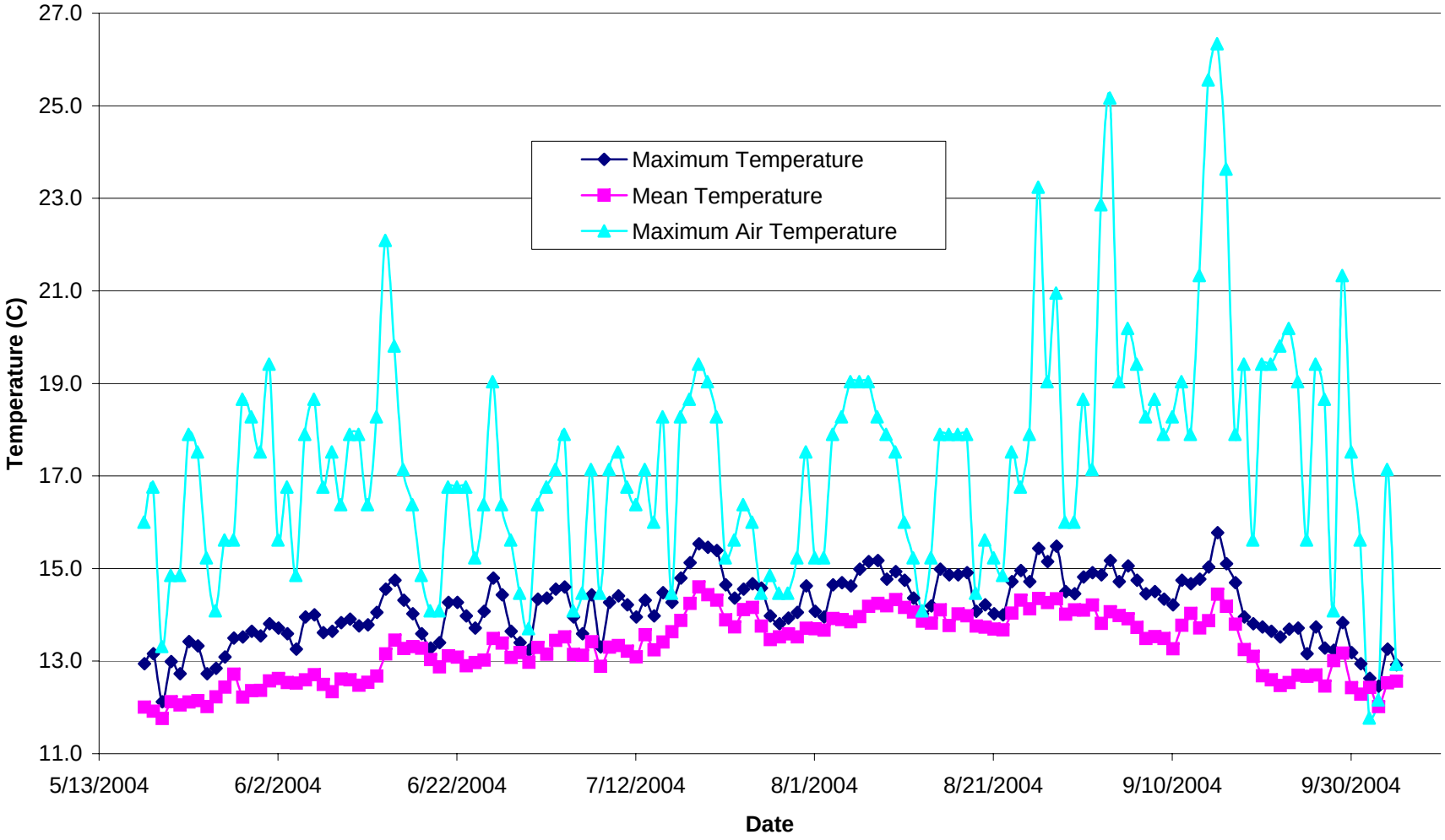


Figure T47-04. Mean and Maximum Daily Stream Temperatures During Summer 2004 at Hardy Creek (Site T47-04), Mendocino County, California.

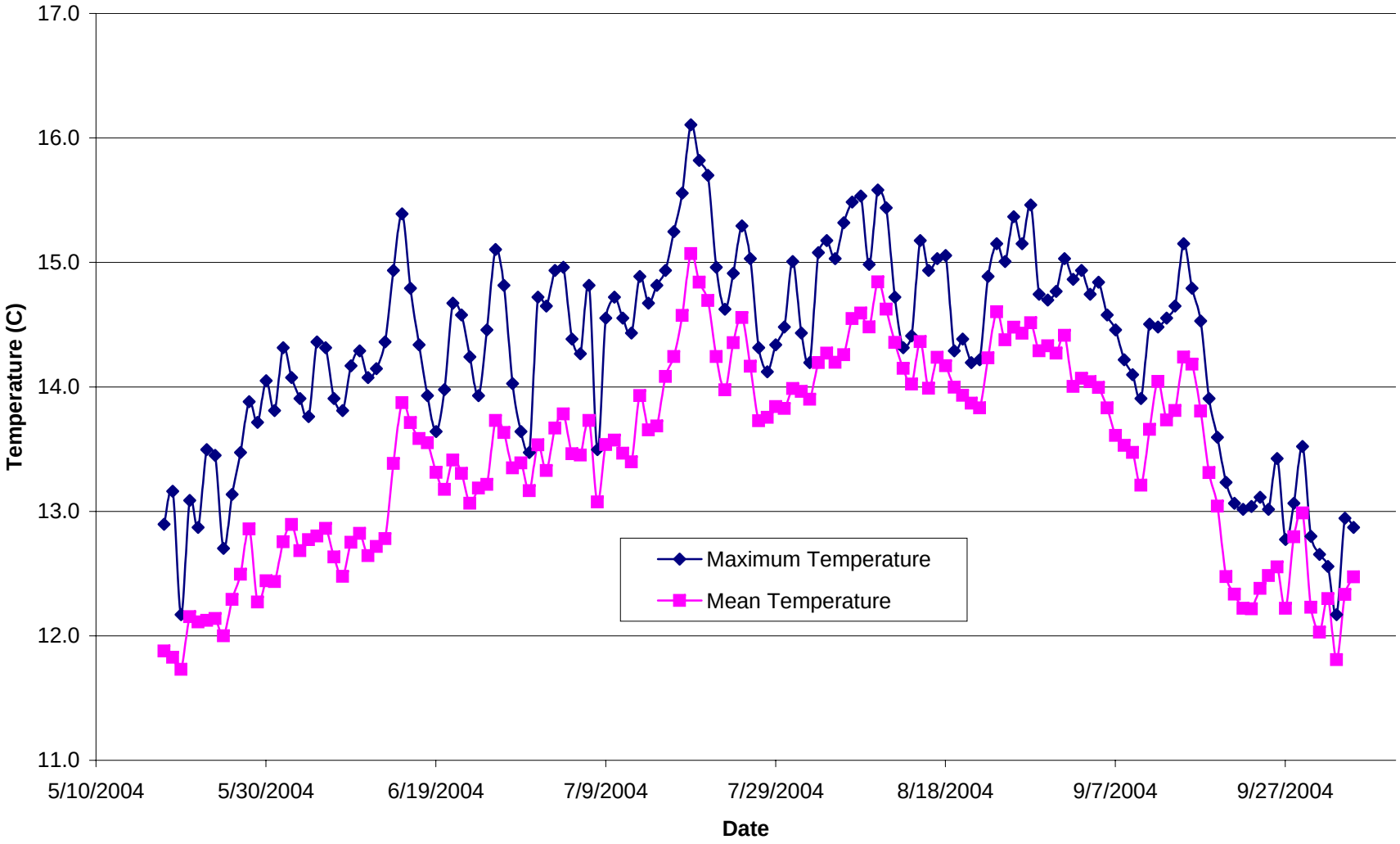


Figure T47-03. Mean and Maximum Daily Stream Temperatures During Summer 2004 at North Fork Cottaneva Creek (Site T47-03), Mendocino County, California.

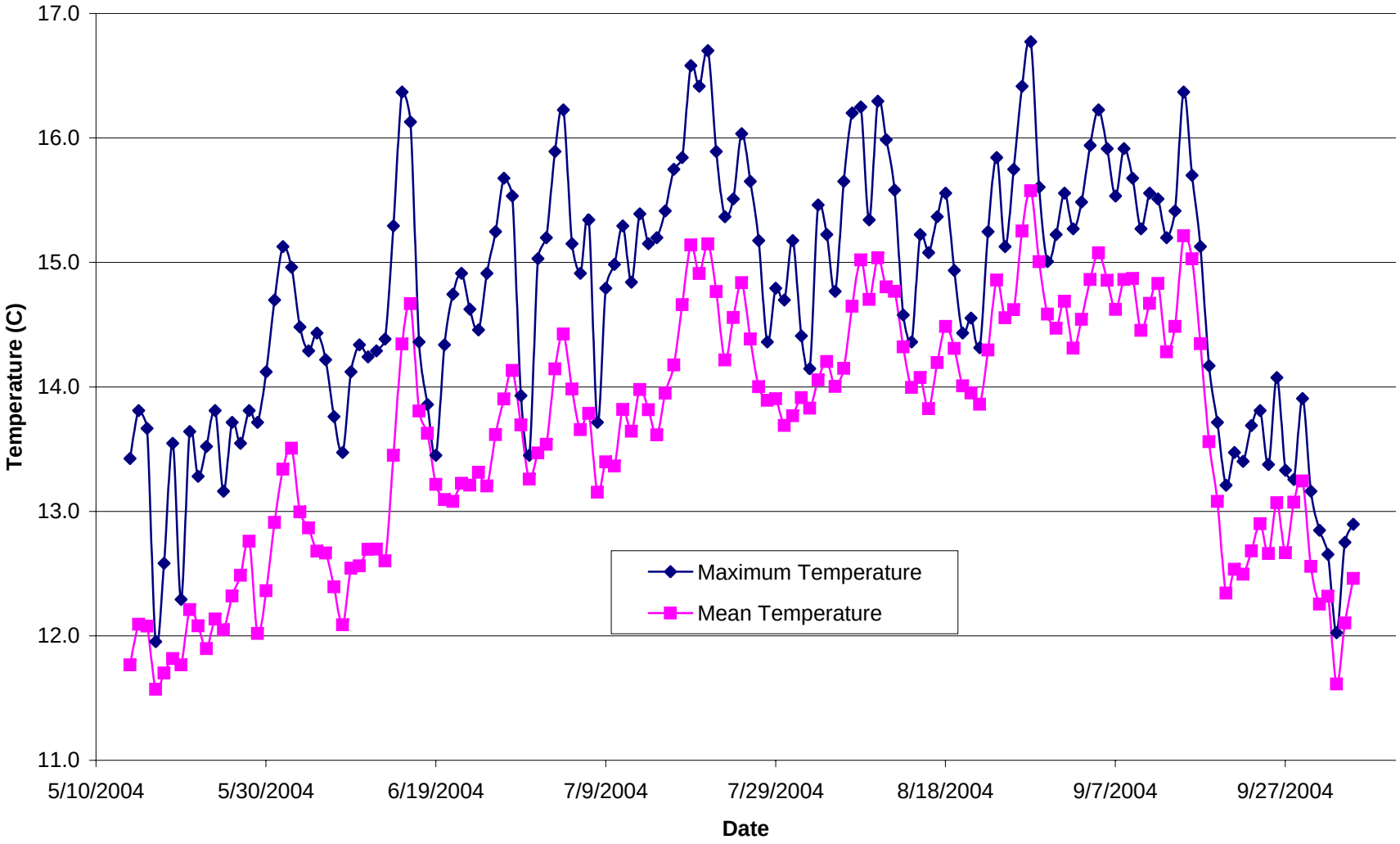


Figure T47-02. Mean and Maximum Daily Stream Temperatures During Summer 2004 at South Fork Cottaneva Creek (Site T47-02), Mendocino County, California.

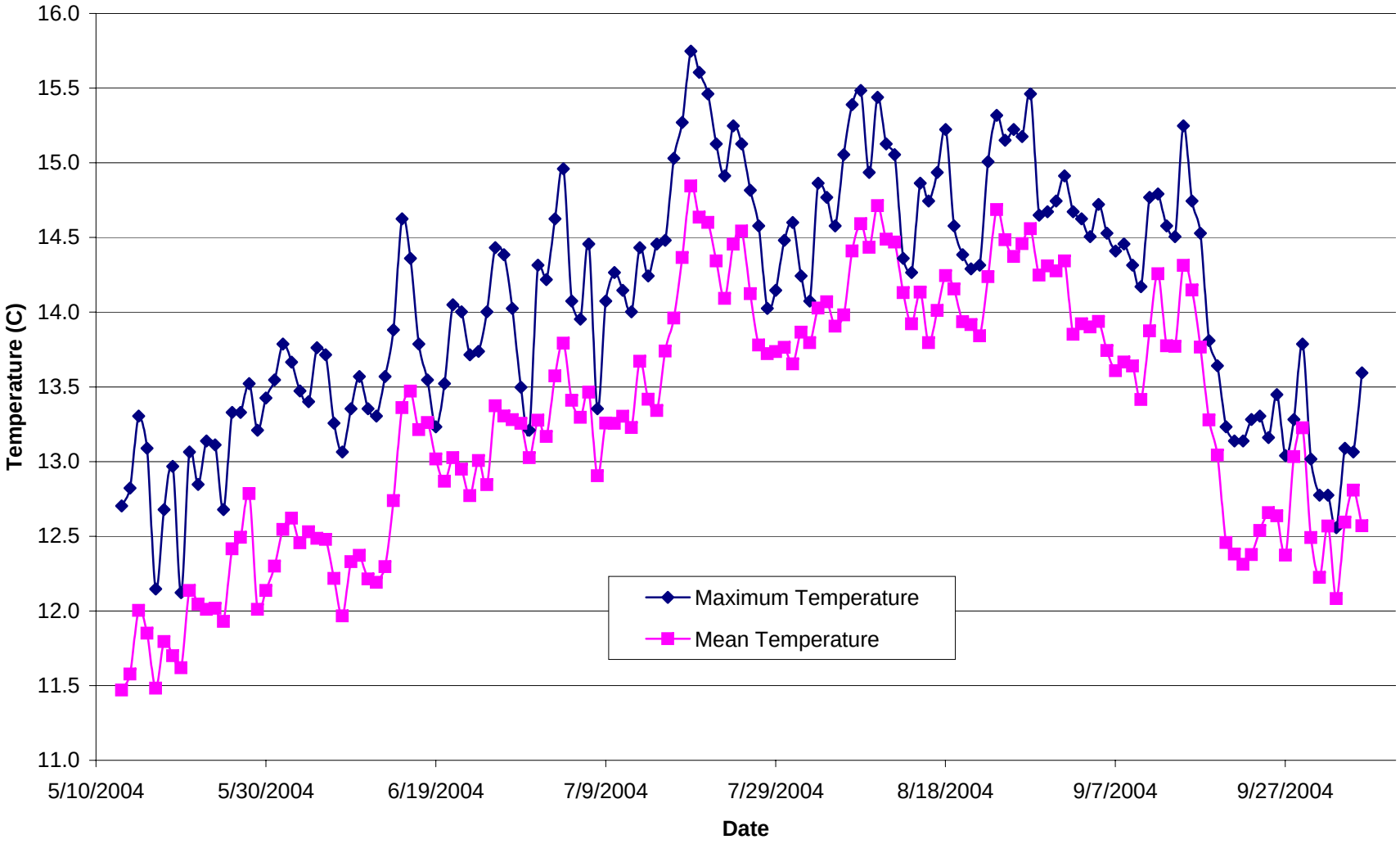
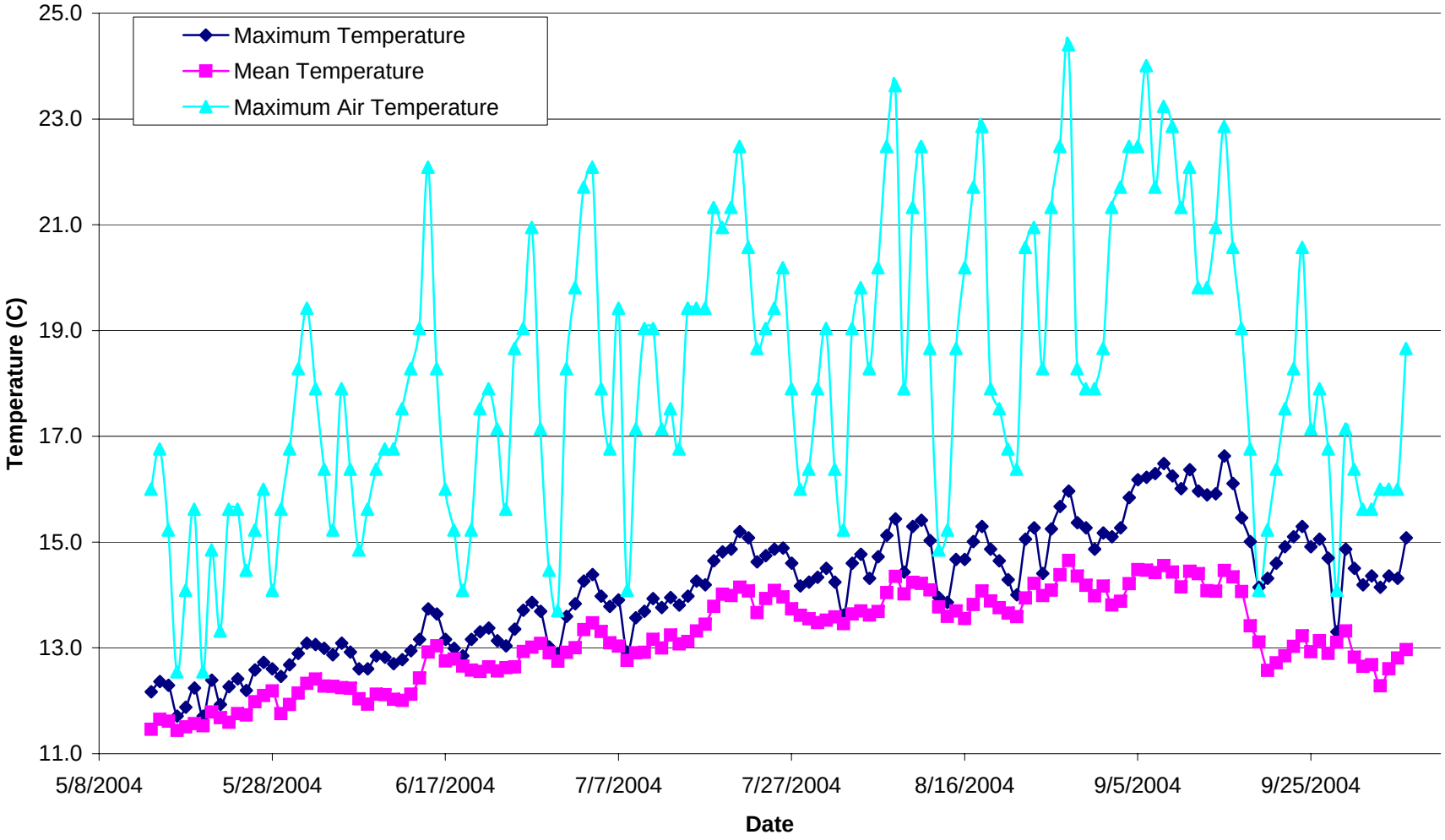


Figure T47-24. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2004 at Kimball Creek (Site T47-24), Mendocino County, California.



Cottaneva Creek Watershed Analysis Unit

Map D-1
Large Woody Debris Recruitment Potential and Demand

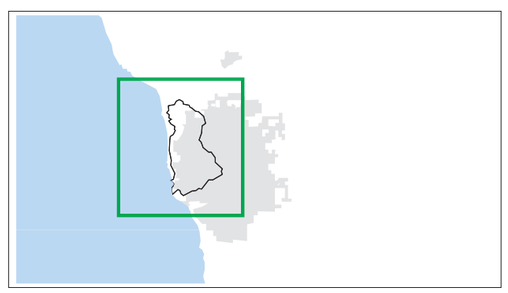
This map presents the large woody debris recruitment potential and in-stream large woody debris (LWD) demand for the streams on MRC lands in the Cottaneva Creek WAU. This map provides baseline information on the structure and composition of the riparian stand and the level of concern about current LWD conditions in the stream. It is based on the stream-side stand characteristics, amount of LWD in the stream and the sensitivity of the stream channel to LWD from aerial photograph interpretation of 2004 photographs and field observations in 2004. 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
- Cottaneva Creek Watershed Analysis Unit Boundary

Flow Class
- Class I
- Class II
- Class III



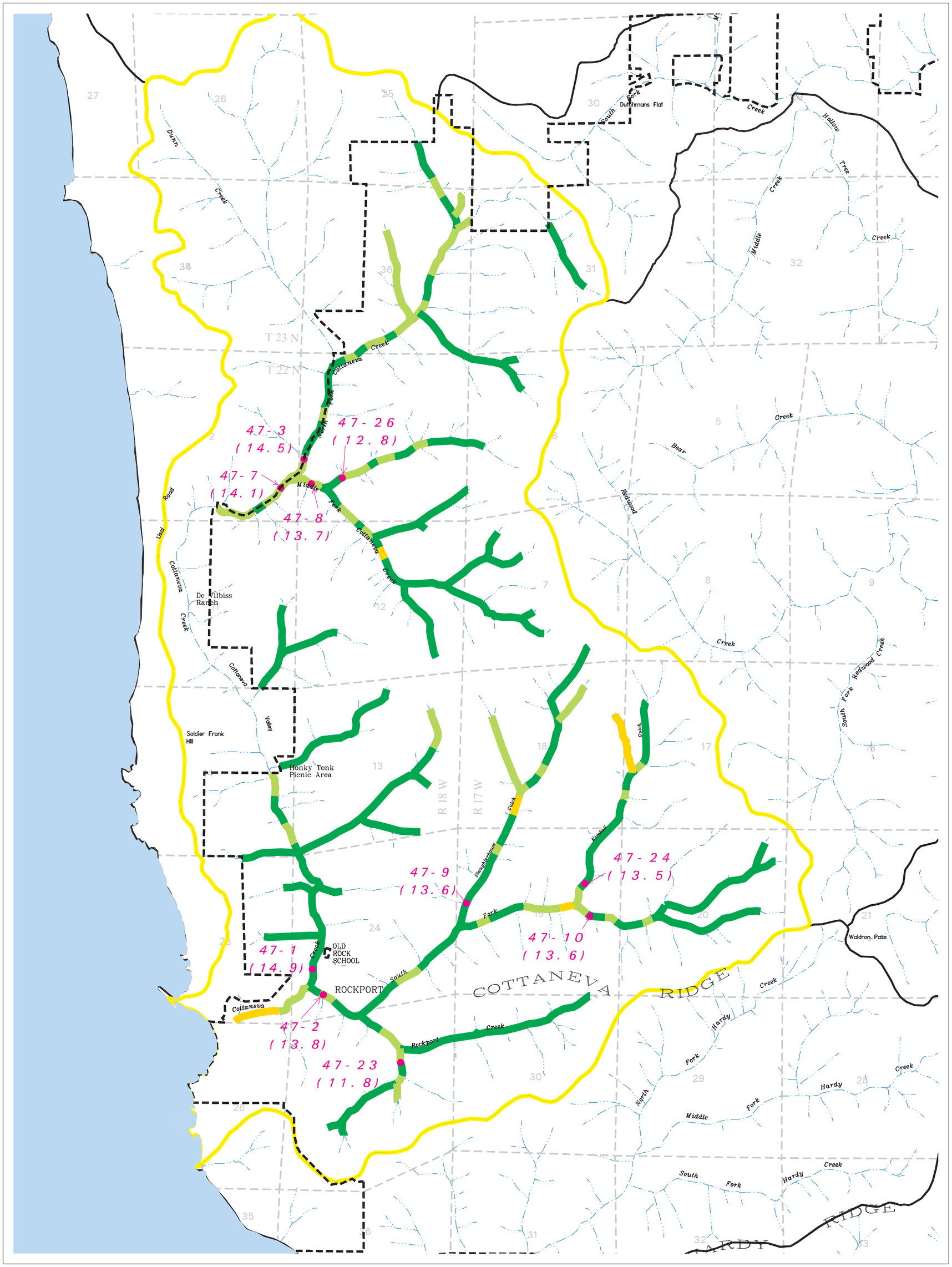
0 1/2 1 Mile

November 2005

Cottaneva Creek Watershed Analysis Unit

Map D-2
Stream Canopy Classification and Temperature Monitoring Locations

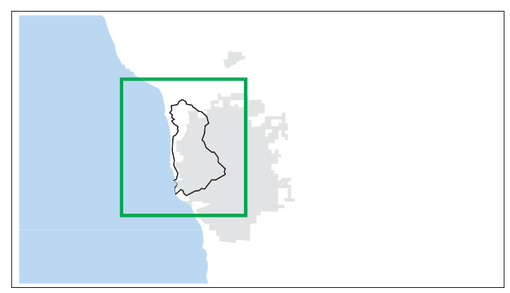
This map presents the canopy closure, over watercourses, for streams and rivers within the MRC ownership in the Cottaneva Creek WAU. The canopy was estimated for four canopy closure classes from 2004 aerial photographs and 2004 field observations. Stream temperature monitoring probe locations are also shown on this map indicated by the site identification code (for example, 47-1). The number in parenthesis below the site identification code is the most recent three year average MWAT (maximum weekly average temperature) in degrees Celsius.



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

- Temperature Monitoring Locations
- MRC Ownership
- Planning Watershed Boundary
- Cottaneva Creek Watershed Analysis Unit Boundary

Flow Class
- Class I
- Class II
- Class III



0 1/2 1 Mile

November 2005