SECTION D
RIPARIAN FUNCTION

INTRODUCTION

Mendocino Redwood Company conducted an assessment of riparian function in the Rockport Coastal Creeks Watershed Analysis Unit (WAU) during the summer of 2006. 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 evaluation. 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 Rockport Coastal Creeks WAU.

Three Calwater planning watersheds (Hardy, Juan and Howard Creeks) were surveyed within the Rockport Coastal Creeks WAU. A total of 33 stream segments totaling 5.3 miles (28,241 feet) were surveyed in 2006. The planning watershed abbreviations for Hardy, Juan and Howard Creeks are RH, RJ and RW, respectively.

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 Rockport Coastal Creeks 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 field observations from the summer of 2006. 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 Rockport Coastal Creeks 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 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**	OR	1
10-20	16	1 or 1.5 times bankfull width**		3
20-30	18	1 or 1.5 times bankfull width**		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 Rockport Coastal Creeks 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	In-channel LWD On Target / In-channel LWD Off Target	LOW	MODERATE	HIGH
LOW	On Target	LOW	MODERATE	HIGH
	Off Target	MODERATE	HIGH	HIGH
MODERATE	On Target	LOW	MODERATE	MODERATE
	Off Target	MODERATE	HIGH	HIGH
HIGH	On Target	LOW	MODERATE	MODERATE
	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	Over 80% of surveyed segments by length have low or moderate LWD demand
MARGINAL	50-80% of surveyed segments by length have low or moderate LWD demand OR over 80% of stream segments have at least half of the target key LWD pieces desired.
DEFICIENT	Less than 50% of surveyed segments by length have low or moderate LWD demand, and low numbers of 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.

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RESULTS

The large woody debris recruitment potential and in-stream LWD demand for the Rockport Coastal Creeks 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 (85%) of the stream segments in the Rockport Coastal Creeks WAU had a high LWD demand (see Map D-1).

Debris jams were fairly common throughout Rockport Coastal Creeks with an average of 31% of the total volume of large woody debris being consisting of debris jams, but they did not play a significant role in determining whether or not a stream segment exceeded the key piece target. Only 21% of the segments in Rockport Coastal Creeks met the key piece target when debris jams were not included. This percentage did not increase when debris jams were included in the key piece assessment.

LWD species composition was largely redwood dominated (Table D-5b) with a WAU-wide average of 90% of the total volume in each segment. This analysis was limited to pieces not contained within debris jams. Hardwoods (including alders) constituted roughly 4% of the average volume in Rockport Coastal Creeks.

The majority of the segments (97%) in the Rockport Coastal Creeks 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 Rockport Coastal Creeks 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 Rockport Coastal Creeks WAU is low (see Map D-1). The majority of the segments observed (72%) had a low recruitment potential (see Table D-1 for clarification). Only one segment in Hardy Creek (RH22) had a high recruitment potential. The low recruitment potential throughout the rest of Rockport Coastal Creeks 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	Function-al 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
Hardy Creek	RH01	37	37	0	4	12.1	12.1	3	3	1.0	1.0
Hardy Creek	RH03	45	45	0	5	16.3	16.3	5	5	1.8	1.8
Hardy Creek	RH05	85	85	0	26	38.7	38.7	5	5	2.3	2.3
Hardy Creek	RH09	78	78	0	30	29.7	29.7	0	0	0.0	0.0
Hardy Creek	RH10	66	91	1	35	21.8	30.1	1	5	0.3	1.7
Hardy Creek	RH11	78	143	2	30	31.0	56.9	0	0	0.0	0.0
Hardy Creek	RH22	67	87	1	15	28.9	37.5	15	17	6.5	7.3
North Fork Hardy	RH23	68	108	2	31	27.9	44.3	29	34	11.9	13.9
Juan Creek	RJ01	33	33	0	26	11.7	11.7	0	0	0.0	0.0
Juan Creek	RJ02	19	19	0	9	27.8	27.8	0	0	0.0	0.0
Juan Creek	RJ03	29	29	0	4	8.2	8.2	0	0	0.0	0.0
Juan Creek	RJ06	21	31	1	10	9.8	14.5	5	5	2.3	2.3
Juan Creek	RJ07	27	37	1	5	11.8	16.2	0	0	0.0	0.0
Juan Creek	RJ08	17	17	0	5	6.2	6.2	5	5	1.8	1.8
Juan Creek	RJ10	10	10	0	3	3.9	3.9	1	1	0.4	0.4
Juan Creek	RJ11	9	9	0	3	4.1	4.1	0	0	0.0	0.0
Juan Creek	RJ12	29	29	0	12	10.9	10.9	9	9	3.4	3.4
Juan Creek	RJ14	40	40	0	11	18.7	18.7	0	0	0.0	0.0
Juan Creek	RJ15	36	46	1	3	16.2	20.7	19	21	8.5	9.4
Juan Creek	RJ16	32	32	0	10	13.2	13.2	0	0	0.0	0.0
Juan Creek	RJ19	35	45	1	7	18.4	23.6	8	9	4.2	4.7
Little Juan Creek	RJ22	26	26	0	3	6.5	6.5	2	2	0.5	0.5
Little Juan Creek	RJ23	40	55	1	3	13.8	19.0	17	21	5.9	7.3
Little Juan Creek	RJ26	15	52	3	3	9.2	31.9	0	0	0.0	0.0

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
Little Juan Creek	RJ27	75	93	2	20	24.6	30.5	46	56	15.1	18.4
Little Juan Creek	RJ28	22	37	1	7	10.7	18.0	0	0	0.0	0.0
Howard Creek	RW01	32	32	0	24	12.3	12.3	4	4	1.5	1.5
Howard Creek	RW03	38	38	0	14	11.9	11.9	0	0	0.0	0.0
Howard Creek	RW05	33	63	2	17	14.4	27.6	0	0	0.0	0.0
Howard Creek	RW07	15	37	2	3	7.0	17.3	7	14	3.3	6.6
Howard Creek	RW10	53	68	1	25	18.7	24.0	19	24	6.7	8.5
Howard Creek	RW11	59	75	1	20	21.3	27.0	26	32	9.4	11.5
Howard Creek	RW14	58	92	3	23	21.1	33.5	0	0	0.0	0.0

Table D-5 (b). Large Woody Debris Volume in Select Stream Segments of the Rockport Coastal Creeks 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 Accum-ulations	% 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	
Hardy Creek	RH01	70.0	70.0	23.0	23.0	4	0%	53%	95%	0%	4%	0%	1%	0-25%
Hardy Creek	RH03	57.1	57.1	20.7	20.7	5	0%	37%	96%	3%	0%	0%	1%	0-25%
Hardy Creek	RH05	75.7	75.7	34.5	34.5	26	0%	33%	96%	4%	0%	0%	0%	0-25%
Hardy Creek	RH09	129.1	129.1	49.2	49.2	30	0%	0%	100%	0%	0%	0%	0%	0-25%
Hardy Creek	RH10	49.9	140.2	16.5	46.3	35	64%	8%	80%	16%	0%	0%	5%	No Data
Hardy Creek	RH11	74.5	934.5	29.6	371.5	30	92%	0%	75%	25%	0%	0%	0%	25-50%
Hardy Creek	RH22	61.0	107.3	26.3	46.3	15	43%	58%	84%	15%	0%	1%	0%	0-25%
North Fork Hardy	RH23	87.9	604.5	36.0	247.9	31	85%	83%	74%	20%	0%	0%	6%	50-75%
Juan Creek	RJ01	19.7	19.7	7.0	7.0	26	0%	0%	49%	6%	16%	11%	17%	0-25%
Juan Creek	RJ02	16.6	16.6	4.9	4.9	9	0%	0%	69%	0%	24%	7%	0%	0-25%
Juan Creek	RJ03	32.5	32.5	9.2	9.2	4	0%	0%	84%	0%	14%	0%	2%	25-50%
Juan Creek	RJ06	99.5	170.6	46.6	80.0	10	42%	74%	99%	0%	0%	0%	1%	0-25%
Juan Creek	RJ07	90.4	179.3	39.5	78.4	5	50%	0%	85%	10%	4%	0%	1%	25-50%
Juan Creek	RJ08	102.7	102.7	37.4	37.4	5	0%	78%	98%	0%	2%	0%	0%	0-25%
Juan Creek	RJ10	21.4	21.4	8.2	8.2	3	0%	33%	91%	3%	1%	0%	4%	0-25%
Juan Creek	RJ11	31.5	31.5	14.5	14.5	3	0%	0%	98%	0%	0%	0%	2%	0-25%
Juan Creek	RJ12	121.2	121.2	45.7	45.7	12	0%	66%	100%	0%	0%	0%	0%	0-25%
Juan Creek	RJ14	119.1	119.1	55.8	55.8	11	0%	0%	99%	0%	0%	0%	1%	0-25%
Juan Creek	RJ15	97.8	115.6	44.0	51.9	3	15%	90%	100%	0%	0%	0%	0%	0-25%
Juan Creek	RJ16	249.5	249.5	102.9	102.9	10	0%	0%	100%	0%	0%	0%	0%	0-25%
Juan Creek	RJ19	89.5	245.0	47.0	128.6	7	63%	67%	97%	1%	1%	0%	0%	0-25%
Little Juan Creek	RJ22	22.9	22.9	5.7	5.7	3	0%	37%	79%	0%	0%	9%	12%	No Data
Little Juan Creek	RJ23	58.4	236.2	20.2	81.5	3	75%	80%	96%	0%	0%	0%	4%	0-25%
Little Juan Creek	RJ26	130.2	774.7	79.9	475.0	3	83%	0%	100%	0%	0%	0%	0%	0-25%
Little Juan Creek	RJ27	185.7	367.0	60.9	120.4	20	49%	91%	98%	0%	0%	2%	1%	0-25%
Little Juan Creek	RJ28	48.2	359.3	23.4	174.6	7	87%	0%	87%	0%	0%	0%	13%	0-25%
Howard Creek	RW01	63.2	63.2	24.4	24.4	24	0%	52%	73%	5%	5%	14%	3%	25-50%

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	
Howard Creek	RW03	80.8	80.8	25.2	25.2	14	0%	0%	85%	0%	0%	11%	3%	0-25%
Howard Creek	RW05	405.7	929.1	177.4	406.3	17	56%	0%	100%	0%	0%	0%	0%	0-25%
Howard Creek	RW07	35.9	549.8	16.8	257.6	3	93%	93%	96%	4%	0%	0%	0%	0-25%
Howard Creek	RW10	58.4	111.7	20.6	39.4	25	48%	72%	95%	4%	0%	0%	1%	0-25%
Howard Creek	RW11	142.5	159.9	51.4	57.6	20	11%	88%	99%	1%	0%	0%	0%	0-25%
Rock Creek	RW14	115.6	461.1	42.1	168.1	23	75%	0%	100%	0%	0%	0%	0%	0-25%

Table D-5 (c). Select Physical Attributes[1] of LWD in the Rockport Coastal Creeks WAU.

Stream Segment Name	Stream Segment ID#	Piece Count						Volume					
		Root Associated		Buried		Alive		Root Associated		Buried		Alive	
		#	%	#	%	#	%	Yd^3	%	Yd^3	%	Yd^3	%
Hardy Creek	RH01	3	8%	17	46%	0	0%	25.3	36%	34.0	49%	0.0	0%
Hardy Creek	RH03	0	0%	28	62%	0	0%	0.0	0%	30.8	54%	0.0	0%
Hardy Creek	RH05	5	6%	42	49%	2	2%	14.1	19%	31.9	42%	1.2	2%
Hardy Creek	RH09	4	5%	43	55%	2	3%	8.6	7%	95.4	74%	0.5	0%
Hardy Creek	RH10	0	0%	22	33%	0	0%	0.0	0%	22.7	45%	0.0	0%
Hardy Creek	RH11	5	6%	42	54%	1	1%	10.9	15%	38.6	52%	0.2	0%
Hardy Creek	RH22	5	9%	32	55%	0	0%	13.0	11%	20.2	17%	0.0	0%
North Fork Hardy	RH23	4	6%	29	43%	0	0%	10.7	18%	43.6	71%	0.0	0%
Juan Creek	RJ01	3	4%	5	7%	4	6%	2.7	3%	3.3	4%	1.9	2%
Juan Creek	RJ02	2	6%	3	9%	3	9%	1.9	10%	2.6	13%	2.2	11%
Juan Creek	RJ03	4	21%	8	42%	4	21%	1.8	11%	9.3	56%	1.9	11%
Juan Creek	RJ06	6	21%	7	24%	1	3%	68.1	209%	12.7	39%	21.8	67%
Juan Creek	RJ07	11	52%	10	48%	0	0%	49.9	50%	42.5	43%	0.0	0%
Juan Creek	RJ08	7	26%	9	33%	0	0%	69.0	76%	55.1	61%	0.0	0%
Juan Creek	RJ10	1	6%	7	41%	0	0%	2.8	3%	17.0	17%	0.0	0%
Juan Creek	RJ11	4	40%	3	30%	0	0%	16.3	76%	15.9	74%	0.0	0%
Juan Creek	RJ12	6	67%	5	56%	0	0%	26.5	84%	14.7	47%	0.0	0%

1 Debris jams are not included in this data set.

Table D-5 (c). Select Physical Attributes of LWD in the Rockport Coastal Creeks WAU (continued)

Stream Segment Name	Stream Segment ID#	Piece Count						Volume					
		Root Associated		Buried		Alive		Root Associated		Buried		Alive	
		#	%	#	%	#	%	Yd^3	%	Yd^3	%	Yd^3	%
Juan Creek	RJ14	8	28%	19	66%	1	3%	61.3	51%	23.0	19%	20.7	17%
Juan Creek	RJ15	5	13%	22	55%	0	0%	36.2	30%	24.8	21%	0.0	0%
Juan Creek	RJ16	5	14%	12	33%	0	0%	20.5	21%	42.9	44%	0.0	0%
Juan Creek	RJ19	6	19%	11	34%	1	3%	15.0	6%	50.7	20%	1.0	0%
Little Juan Creek	RJ22	4	11%	14	40%	4	11%	9.0	10%	11.9	13%	1.4	2%
Little Juan Creek	RJ23	2	8%	23	88%	1	4%	2.6	11%	24.8	108%	0.8	4%
Little Juan Creek	RJ26	4	10%	13	33%	0	0%	84.0	144%	84.6	145%	0.0	0%
Little Juan Creek	RJ27	1	7%	48	320%	0	0%	2.3	2%	116.3	89%	0.0	0%
Little Juan Creek	RJ28	0	0%	15	20%	0	0%	0.0	0%	40.0	22%	0.0	0%
Howard Creek	RW01	0	0%	4	18%	1	5%	0.0	0%	13.1	27%	1.2	2%
Howard Creek	RW03	2	6%	11	34%	0	0%	7.1	11%	17.8	28%	0.0	0%
Howard Creek	RW05	5	13%	16	42%	0	0%	346.3	429%	305.5	378%	0.0	0%
Howard Creek	RW07	2	6%	6	18%	0	0%	10.5	3%	6.6	2%	0.0	0%
Howard Creek	RW10	2	13%	24	160%	1	7%	0.4	1%	37.7	105%	0.1	0%
Howard Creek	RW11	6	11%	31	58%	0	0%	81.0	139%	43.5	74%	0.0	0%
Rock Creek	RW14	2	3%	29	49%	0	0%	32.7	23%	21.3	15%	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 Rockport Coastal Creeks have a deficient LWD quality rating.

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

Calwater Planning Watershed	**Percent of segments† with low or moderate demand**	**Percent of segments† meeting at least half of the key piece target**	**In-stream LWD Quality Rating***
Hardy Creek	0%	25%	Deficient
Juan Creek	17%	33%	Deficient
Howard Creek	29%	43%	Deficient

† **-** normalized by segment lengths
* – 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 2006. A map (D-2) was produced for the Rockport Coastal Creeks WAU based on the field measurements of canopy. No aerial photographs were used to assess stream canopy.

In 2006, field measurements of canopy closure over select stream channels were performed. The field measurements were taken during the stream channel assessments in the Rockport Coastal Creeks WAU. The field measurements consisted of estimating canopy closure over a watercourse using a spherical densitometer and/or 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 Rockport Coastal Creeks WAU since 1996. Stream temperature was measured with continuous recording electronic temperature recorders (HOBO Pro, 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 Rockport Coastal Creeks WAU (see map D-2).

Temperature Station	Segment #	Stream Name	Years Monitored
47-04	RH01	Hardy Creek	92, 93, 94, 00 - Present
47-05	RJ01	Juan Creek	94, 95, 99, 00 - Present
47-06	RW01	Howard Creek	96, 97, 99, 00 - Present

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	Over 80% of surveyed watercourse segments have on-target effective shade.
MARGINAL	60-80% of surveyed watercourse segments have either (a) on-target effective shade or (b) over 70% canopy.
DEFICIENT	Less than 60% of surveyed watercourse segments have either (a) on-target effective shade or (b) less than 70% canopy.

CANOPY CLOSURE AND STREAM TEMPERATURE

RESULTS

Overall average canopy closure over watercourses is rated *on-target* in the Rockport Coastal Creeks WAU (Map D-2 and Table D-13). All in-stream canopy observations were 70% or above with one exception in Little Juan Creek (65%). Table D-9 lists shade and canopy data for all segments surveyed. Each segment typically has at least 2-3 densiometer measurements. The average of these values is presented in the mean canopy column. Solar pathfinder observations are not as frequently taken as canopy measurements due to the extra time required to set up and read the solar pathfinder. Occasionally, only solar pathfinder measurements were taken in a stream segment. The values in the last column of Table D-9 are an average of the solar pathfinder and mean canopy measurements.

Table D-9. 2006 Field Observations of Stream Canopy Closure for Select Stream Channel Segments of the Rockport Coastal Creeks WAU.

Stream Name	Segment Number	Solar pathfinder shade (%)	Average of densiometer readings (%)	Topography shading (%)	Mean Shade Canopy (%)	Bankfull width (ft)	Shade target (%)	Temp. station	Average MWAT (°C)	On-target for shade or temperature?	Average shade > 70%?
Hardy Creek	RH01		94		94	30	40	47-04	14	YES	YES
Hardy Creek	RH09		91		91	30	40	47-04	14	YES	YES
Hardy Creek	RH05		98		98	27	90	47-04	14	YES	YES
Hardy Creek	RH10		88		88	24	90	47-04	14	YES	YES
Hardy Creek	RH11		98		98	23	90	47-04	14	YES	YES
Hardy Creek	RH22		100		100	22	90	47-04	14	YES	YES
Hardy Creek	RH03		90		90	20	90	47-04	14	YES	YES
North Fork Hardy	RH23		88		88	15	90	47-04	14	YES	YES
Juan Creek	RJ01	99	94	1	97	37.7	40	47-05	13.9	YES	YES
Juan Creek	RJ02	92	81	2	86	29.5	90	47-05	13.9	YES	YES
Juan Creek	RJ03	75	65	12	70	46	40	47-05	13.9	YES	YES
Juan Creek	RJ06	90	97		94	35	40	47-05	13.9	YES	YES
Juan Creek	RJ07		80		80	24	90	47-05	13.9	YES	YES
Juan Creek	RJ08		80		80	30	40	47-05	13.9	YES	YES
Juan Creek	RJ10	100	98		99	31	40	47-05	13.9	YES	YES
Juan Creek	RJ11		76		76	23	90	47-05	13.9	YES	YES
Juan Creek	RJ12		100		100	30	40	47-05	13.9	YES	YES
Juan Creek	RJ14		100		100	20	90	47-05	13.9	YES	YES
Juan Creek	RJ15	100		18	100	19	90	47-05	13.9	YES	YES

Table D-9. 2006 Field Observations of Stream Canopy Closure for Select Stream Channel Segments of the Rockport Coastal Creeks WAU.

Stream Name	**Segment Number**	**Solar pathfinder shade (%)**	**Average of densiometer readings (%)**	**Topography shading (%)**	**Mean Shade Canopy (%)**	**Bankfull width (ft)**	**Shade target (%)**	**Temp. station**	**Average MWAT (°C)**	**On-target for shade or temperature?**	**Average shade > 70%?**
Juan Creek	RJ16		90		90	18	90	47-05	13.9	YES	YES
Juan Creek	RJ19		90		90	20	90	47-05	13.9	YES	YES
Little Juan Creek	RJ22	100	100	5	100	20	90	47-05	13.9	YES	YES
Little Juan Creek	RJ23	99	88	10	94	17	90	47-05	13.9	YES	YES
Little Juan Creek	RJ26	95	49	12	72	0	90	47-05	13.9	YES	YES
Little Juan Creek	RJ27	98	100	8	99	14	90	47-05	13.9	YES	YES
Little Juan Creek	RJ28		65		65	12	90	47-05	13.9	YES	YES
Howard Creek	RW01	90	90	6	90	33	40	47-06	14	YES	YES
Howard Creek	RW03		78		78	23	90	47-06	14	YES	YES
Howard Creek	RW05		90		90	19	90	47-06	14	YES	YES
Howard Creek	RW07		93		93	12.5	90	47-06	14	YES	YES
Howard Creek	RW10		80		80	15	90	47-06	14	YES	YES
Howard Creek	RW11		93		93	17	90	47-06	14	YES	YES
Rock Creek	RW14		90		90	12	90	47-06	14	YES	YES
Juan Creek	RJ16		90		90	18	90	47-05	13.9	YES	YES

Stream temperatures in the Rockport Coastal Creeks 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. Air temperature data is listed in Table D-13.

Table D-10. Maximum Daily Stream Temperatures (C^o) by Year for the Rockport Coastal Creeks WAU.

Station	2000	2001	2002	2003	2004	2005	2006	2007	2008
T47-04	16.4	15.6	15.2	16	16.1	15.5	15.7	15.6	15
T47-05	14.8	13.6	14.6	15.7	15.8	14.7	15.5	15.4	15.2
T47-06	16.4	15.4	14.1	15.6	**	15.4	16	16	14.8

**data not collected

Table D-11. Maximum Weekly Average Stream Temperature (MWAT C^o) for the Rockport Coastal Creeks WAU.

Station	2000	2001	2002	2003	2004	2005	2006	2007	2008
T47-04	13.8	13.8	13.4	14.1	14.5	14.1	14.3	14.3	13.5
T47-05	13	12.3	13.2	14.2	14.2	13.6	14.2	14.1	13.4
T47-06	13.8	13.4	13.2	13.9	**	13.9	14.4	14.3	13.4

**data not collected

Table D-12. 7-Day Moving Average of the Daily Maximum Stream Temperature (MWMT C^o) for the Rockport Coastal Creeks WAU.

Station	2000	2001	2002	2003	2004	2005	2006	2007	2008
T47-04	15.2	15.1	14.8	15.3	15.5	15.3	15.5	15.3	14.4
T47-05	13.9	13	14.1	15.2	15	14.5	15.3	15	14.5
T47-06	15.4	14.6	13.9	15.1	**	15.3	15.8	15.6	14.2

** data not collected

Table D-13. Maximum Weekly Average Air Temperature (MWAT C^o) for the Rockport Coastal Creeks WAU.

Station	2002	2004	2005	2006	2007	2008
T47-04A	**	**	14.2	**	**	14.4
T47-05A	**	15.6	14.3	14.6	15.2	14.8
T47-06A	**	**	14.1	14.2	14.8	14.4

** data not collected

Canopy cover in the Rockport Coastal Creeks WAU is fair and temperatures are at levels that are acceptable for salmon and steelhead. Twenty-four of the 33 segments surveyed in the Rockport Coastal Creeks WAU had bankfull widths of less than 30 feet. Of those 24 segments, only ten of them (42%) had an average shade-canopy cover of greater than 90% (target for less than 30 foot bankfull width). In summary, 42% of the segments surveyed in the Rockport Coastal Creeks WAU did not meet the canopy cover targets, but 100% were classified as on-target for the stream shade quality rating due to low stream water temperatures.

Table D-13. Stream Shade Quality Ratings for Major Streams and River/Stream Segments in the Rockport Coastal Creeks 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
Hardy Creek	47-04	14	100%	ON-TARGET
Howard Creek	47-06	14	100%	ON-TARGET
Juan Creek	47-05	13.9	100%	ON-TARGET

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Appendix D

Figure T47-04. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2008 at Hardy Creek (Site T47-04), Mendocino County, California.

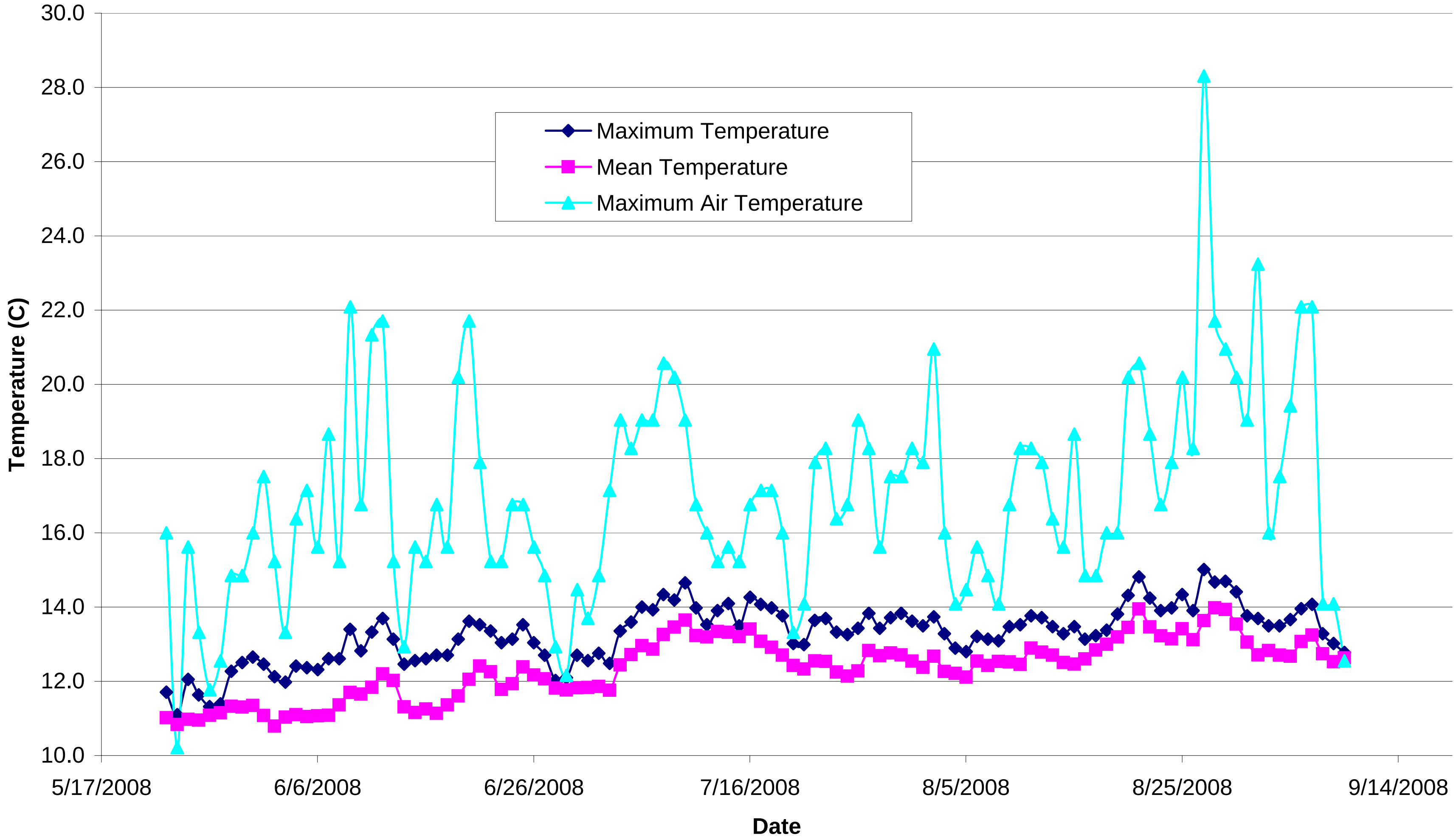


Figure T47-05. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2008 at Juan Creek (Site T47-05), Mendocino County, California.

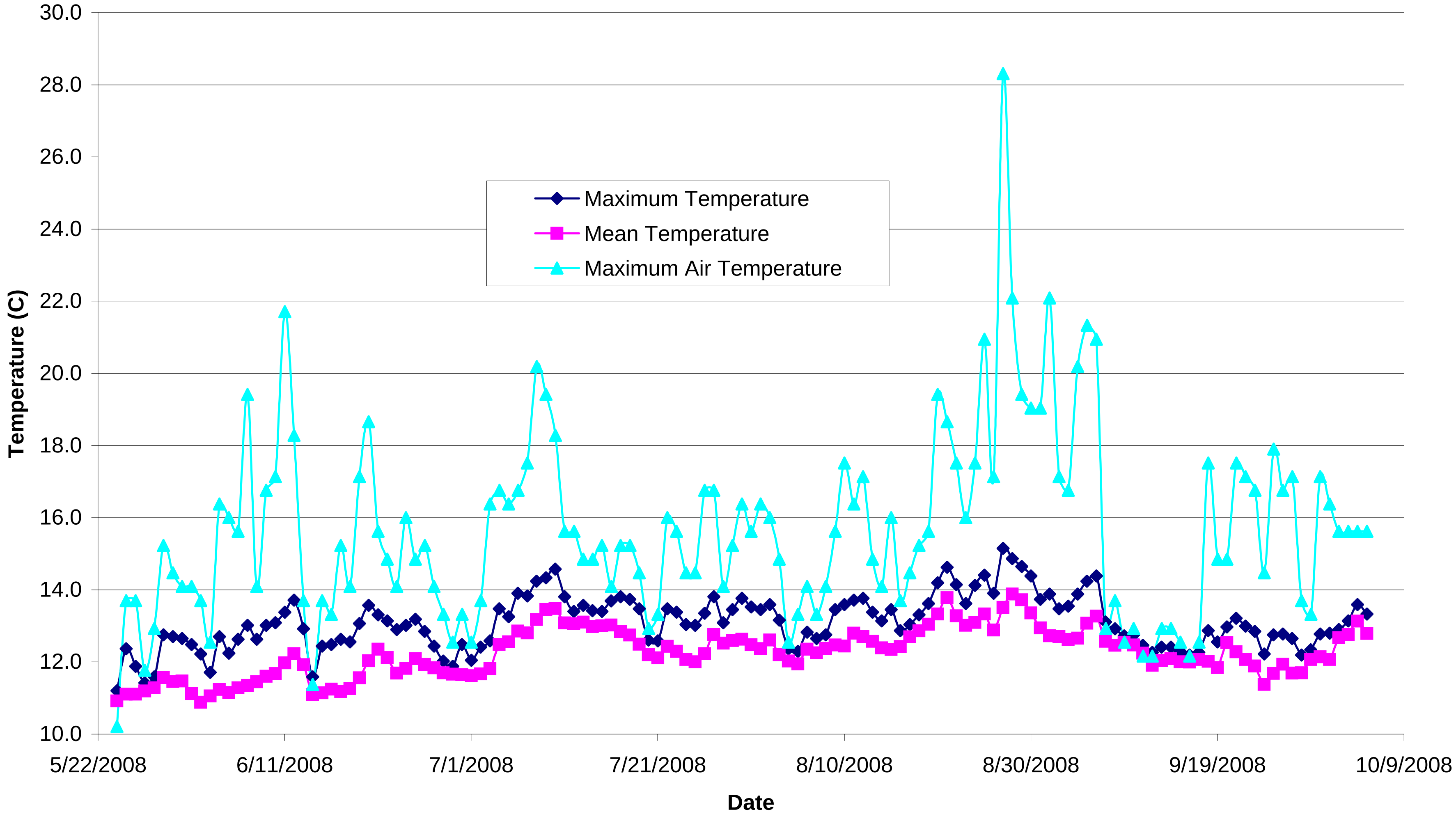


Figure T47-06. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2008 at Howard Creek (Site T47-06), Mendocino County, California.

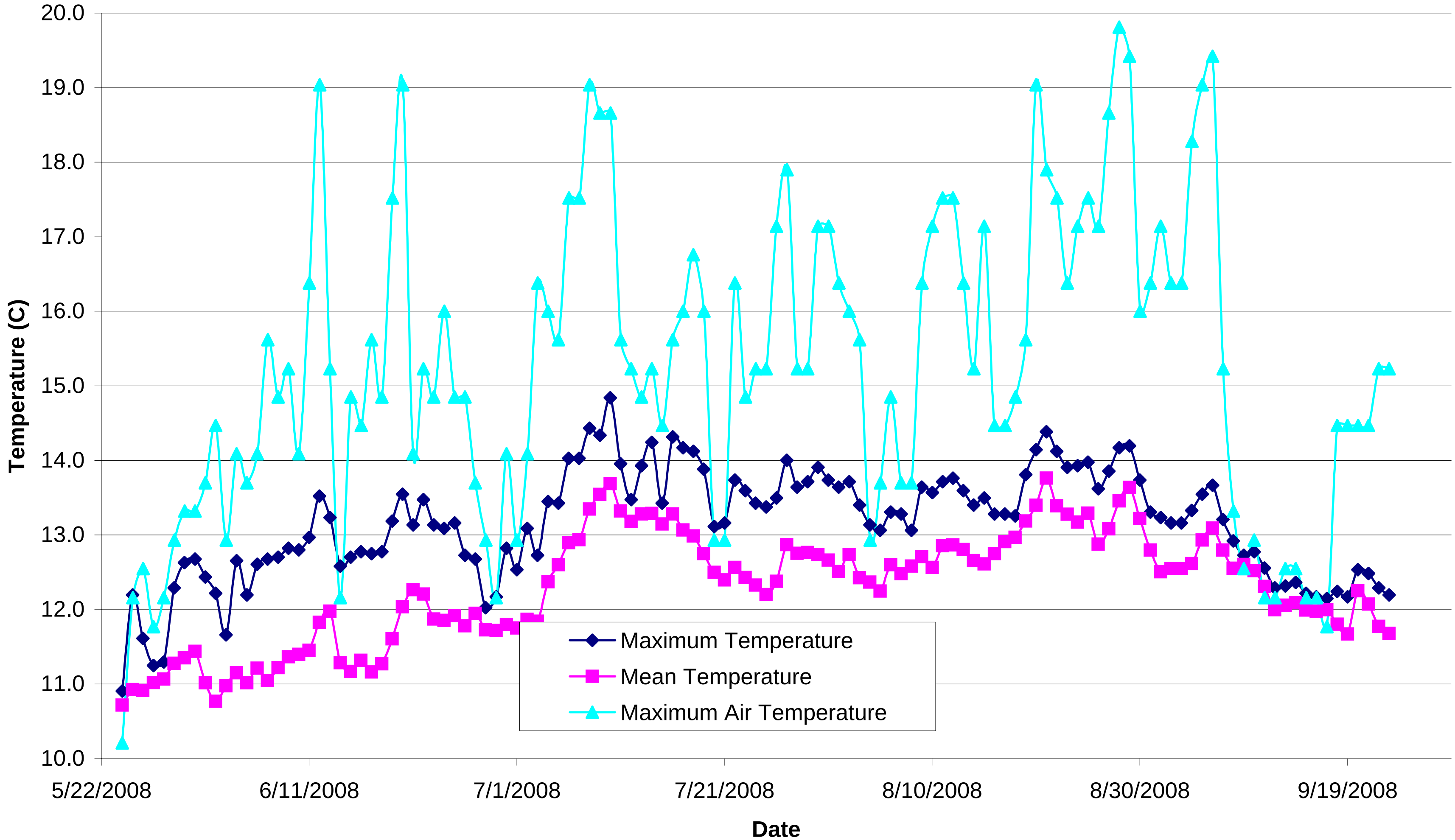
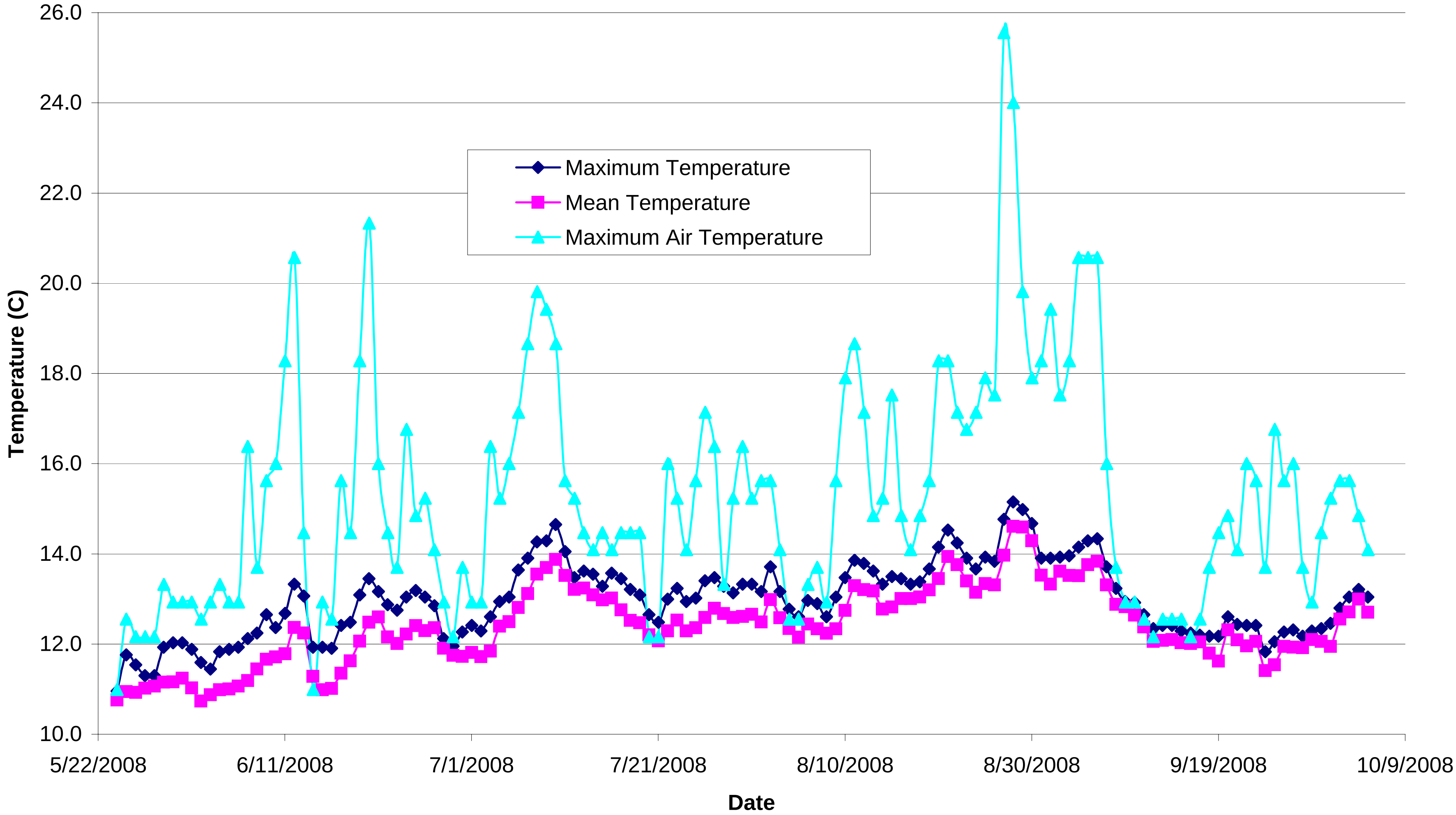
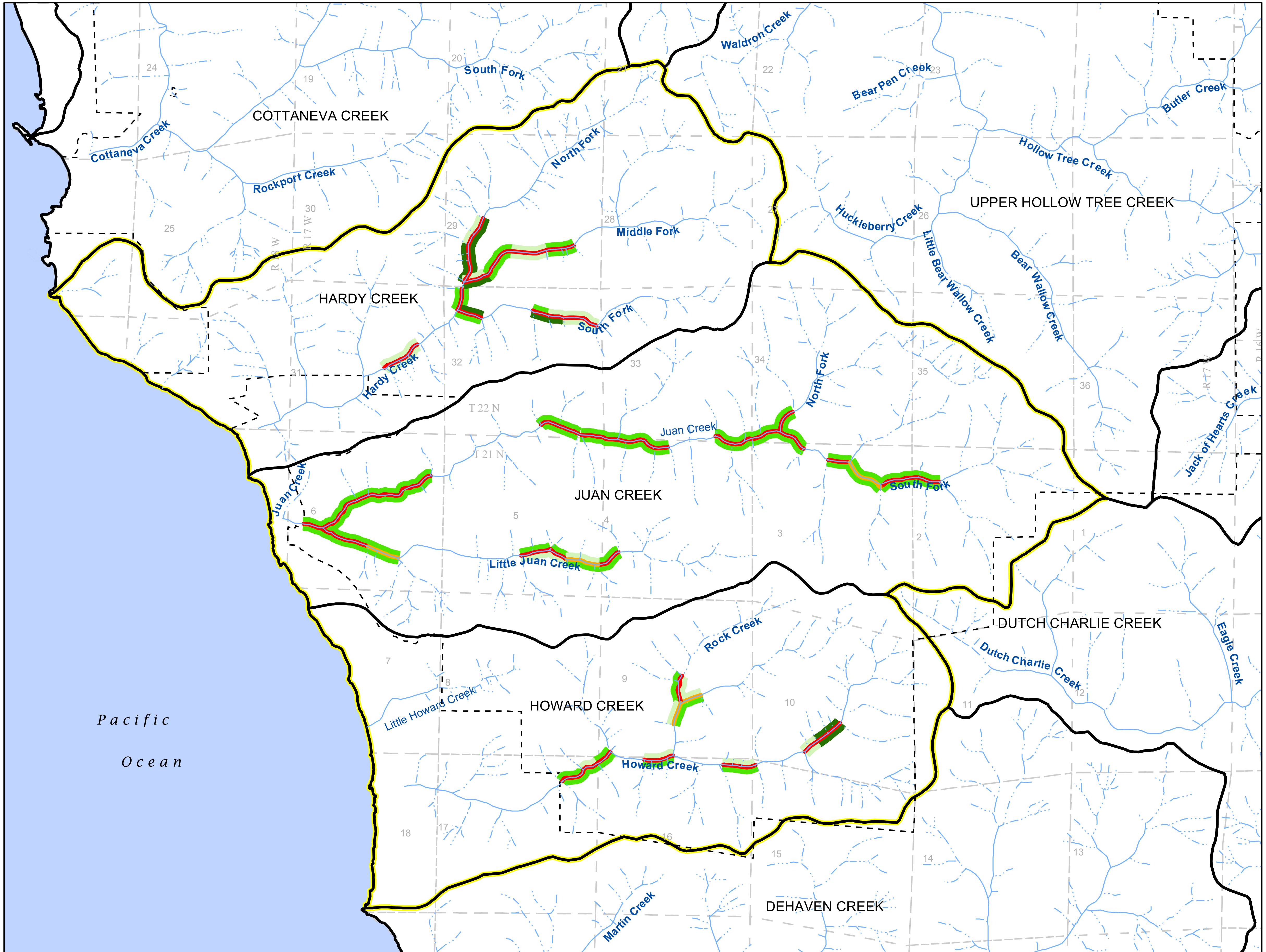


Figure T47-08. Maximum Daily Air Temperature and Mean and Maximum Daily Stream Temperatures During Summer 2008 at Middle Fork Cottaneva Creek (Site T47-08), Mendocino County, California.





Rockport Coastal Streams Watershed Analysis Unit

Map D-1
Large Woody Debris Recruitment Potential and Demand

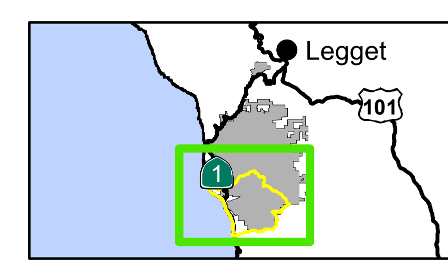
This map presents the large woody debris recruitment potential and in-stream large woody debris (LWD) demand for the streams on MRC lands in the Rockport Coastal Streams WAU. This map provides baseline information on the structure and composition of the riparian stand and the level of concern about current 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 2005. 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

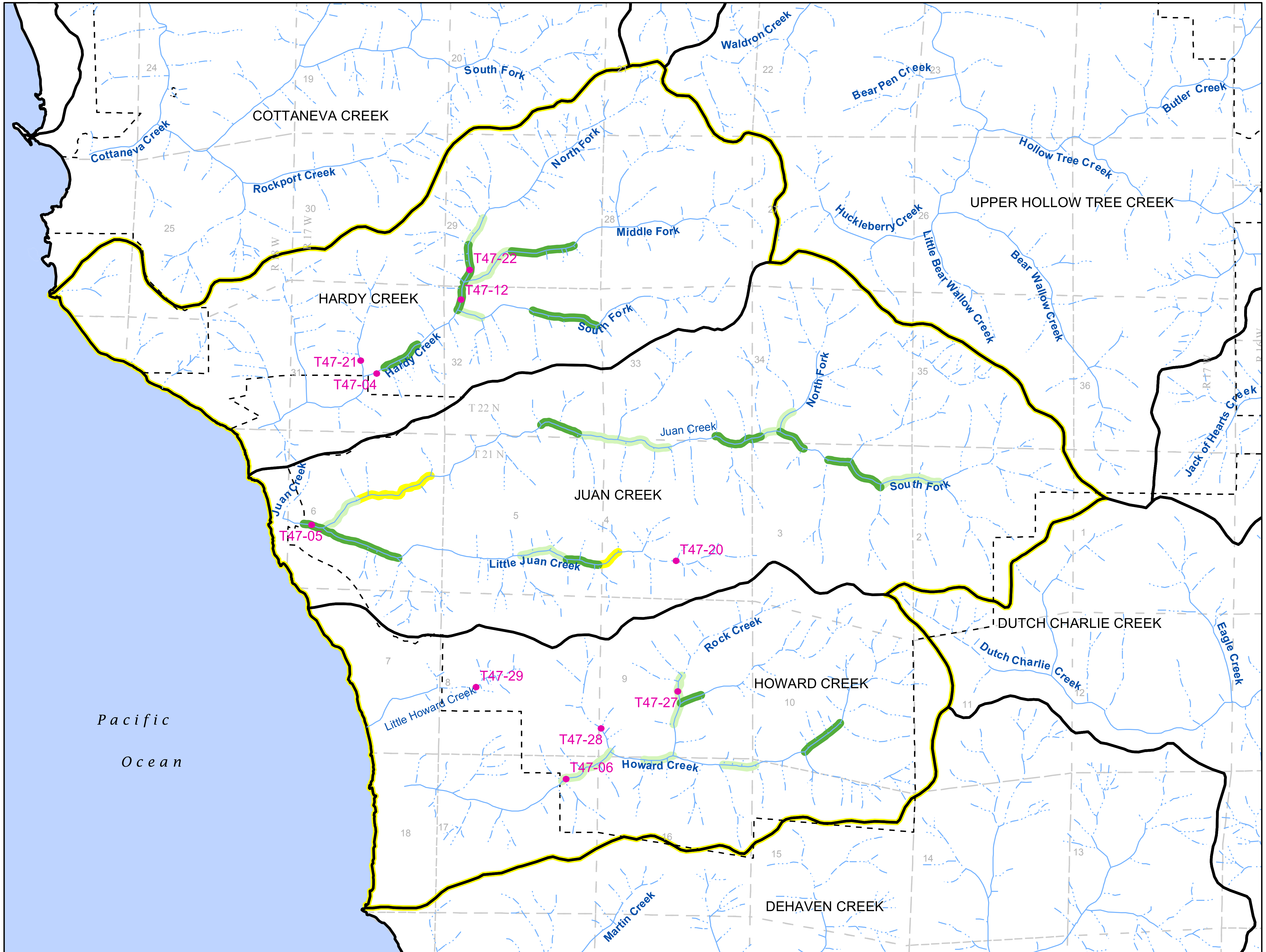
- MRC Ownership
- Planning Watershed Boundary
- Elk Creek Watershed Analysis Unit Boundary

Flow Class
- Class I
- Class II
- Class III



0 0.5 1 Miles

March 2011



Rockport Coastal Streams 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 Rockport Coastal Streams WAU. The canopy was estimated for four canopy closure classes from 2004 aerial photographs and 2005 field observations. The location of stream temperature monitored locations is also presented, these locations are monitoring each year during summer.

Stream Canopy Classes

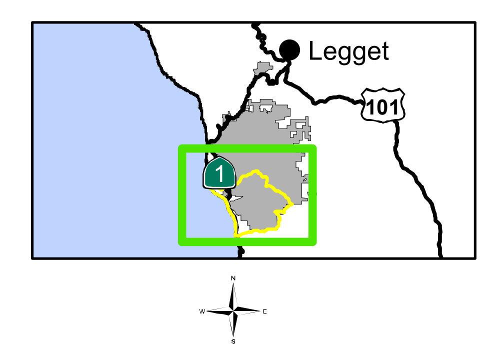
- > 90%
- 70-90%
- 40-70%
- 0-40%

Temperature Monitoring Locations

- MRC Ownership
- Planning Watershed Boundary
- Elk Creek Watershed Analysis Unit Boundary

Flow Class

- Class I
- Class II
- Class III



March 2011