SECTION D
RIPARIAN FUNCTION

INTRODUCTION

Mendocino Redwood Company conducted an assessment of riparian function in the Northern Russian 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 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 instream 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 Northern Russian River WAU.

LARGE WOODY DEBRIS RECRUITMENT AND INSTREAM DEMANDS

METHODS

Short-term LWD recruitment potential (next 20-30 years) was evaluated in designated stream segments within the Northern Russian River WAU. Stream segments were designated in the stream channel condition assessment and are shown on map E-1 (Stream Channel Condition Module). Generally, stream segments were 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 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:

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 Northern Russian River WAU.

Vegetation Type	**Size and Density Classes**					
	Size Classes 1-2 (Young)		**Size Class 3 (Mature)**		**Size classes 4-5 (Old)**	
	Sparse (O, L)	**Dense (M, D, E)**	**Sparse (O, L, M)**	**Dense (D, E)**	**Sparse (O, L, M)**	**Dense (D, E)**
RW	Low	Low	Low	Moderate	Moderate	High
RD	Low	Low	Low	Moderate	Moderate	High
CH	Low	Low	Low	Moderate	Low	High
MH	Low	Low	Low	Low	Low	Moderate

LWD was inventoried in watercourses during the stream channel assessment. All “functional” LWD was tallied within the active channel and the bankfull channel for each sampled stream segment. Functional LWD 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) 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 following size requirement:

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-4.

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 Northern Russian 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-5 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	Channel LWD Sensitivity Rating: **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 – >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 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 DEMANDS

RESULTS

The large woody debris recruitment potential and in-stream LWD demand for the Northern Russian 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 proper function to the watercourses.

Current LWD loading is show in Table D-5 a, b, and c. LWD was determined to be sparse in all of these segments. None of the Ackerman Creek channels met the key piece LWD target. One of the segments in Jack Smith Creek exceeded the target while the other one had no key pieces at all. The majority of the stream segments in the Northern Russian River WAU had a high LWD demand (see Map D-1).

Debris jams were not common with the exception of the upper Jack Smith Creek site where 31.6% of the total pieces were found in debris jams. In the case of segment UJ3, Jack Smith Creek, 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 target. Debris accumulations are also sparse and didn't contain much of the total volume except for segment UU12 where 55.2% of the total volume was found in debris accumulations.

LWD species composition was largely hardwood dominated (Table D-5b). This analysis was limited to pieces not contained within debris jams. Redwood did prove to be common in a few segments, notably UL1 where it constituted 91.9% of the total volume. The forest stands common to this area are oak and grassland dominated and so that is what showed up in the survey. Unfortunately, hardwood breaks down relatively fast in streams and thus new LWD needs to be continuously recruited in order to maintain stream habitat.

All segments in the Northern Russian River WAU contained LWD that was not recently contributed to the stream. All inventoried segments fell into a 0-25% category for pieces recently contributed (<10 yrs). It did not appear that many of the LWD pieces had been contributed within the last 10 years. This may be a result of past riparian harvest or natural stand types and 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 Northern Russian River 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 segment 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 Northern Russian River WAU is low (See Map D-1). The open, oak/grassland dominated vegetation of the area results in hardwood dominated riparian stands. 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 in Select Stream Segments of the Northern Russian River WAU.

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
ACKERMAN CREEK	UL1	6	6	0	0	2.8	2.8	0	0	0.0	0.0
ACKERMAN CREEK	UU1	2	2	0	0	0.5	0.5	0	0	0.0	0.0
ACKERMAN CREEK	UU6	8	8	0	0	3.8	3.8	1	1	0.5	0.5
ALDER CREEK	UU10	17	17	0	1	10.4	10.4	2	2	1.2	1.2
ALDER CREEK	UU12	9	9	0	1	7.1	7.1	1	1	0.8	0.8
ALDER CREEK	UU13	7	7	0	0	7.0	7.0	1	1	1.0	1.0
JACK SMITH CREEK	UJ2	6	6	0	0	5.6	5.6	0	0	0.0	0.0

Table D-5 (b). Large Woody Debris Volume in Select Stream Segments of the Northern Russian River 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	Percent Volume in Debris Accum.	% 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.	
ACKERMAN CREEK	UL1	1.8	1.8	0.8	0.8	0%	0%	0.0%	92%	0%	0%	0%	8%	0-25
ACKERMAN CREEK	UU1	0.3	0.3	0.1	0.1	0%	0%	0.0%	0%	0%	0%	100%	0.0%	0-25
ACKERMAN CREEK	UU6	4.2	4.2	2.0	2.0	0%	0%	37.2%	4%	50.5 %	0%	68%	16%	0-25
ALDER CREEK	UU10	17.5	17.5	10.7	10.7	4%	0%	64.6%	30%	0%	0%	67%	3%	0-25
ALDER CREEK	UU12	2.1	2.1	1.7	1.7	55%	0%	48.9%	0%	0%	0%	100%	0%	0-25
ALDER CREEK	UU13	3.9	3.9	3.9	3.9	0%	0%	20.8%	0%	0%	0%	100%	0%	0-25
JACK SMITH CREEK	UJ2	1.7	1.7	1.6	1.6	0%	0%	0%						
JACK SMITH CREEK	UJ3	12.5	19.6	11.1	17.4	0%	36%	53%	56%	0%	6%	6%	2%	0-25

Table D-5 (c). Select Physical Attributes of LWD in the Northern Russian River WAU.

Stream Segment Name	Stream Segment ID#	Piece Count						Volume					
		Root Associated		Buried		Alive		Root Associated		Buried		Alive	
		#	%	#	%	#	%	Yd3	%	Yd3	%	Yd3	%
ACKERMAN CREEK	UL1	4	67%	2	33%	0	0%	1.2	66%	0.2	10%	0.0	0%
ACKERMAN CREEK	UU1	2	100%	0	0%	0	0%	0.3	100%	0.0	0%	0.0	0%
ACKERMAN CREEK	UU6	3	38%	1	13%	0	0%	1.3	32%	0.1	3%	0.0	0%
ALDER CREEK	UU10	3	18%	1	6%	1	6%	8.0	46%	0.3	2%	1.2	7%
ALDER CREEK	UU12	2	22%	0	0%	0	0%	1.3	60%	0.0	0%	0.0	0%
ALDER CREEK	UU13	3	43%	3	43%	1	14%	1.7	44%	0.6	15%	1.3	33%
JACK SMITH CREEK	UJ2	6	100%	0	0%	2	33%	1.7	100%	0.0	0%	0.9	53%
JACK SMITH CREEK	UJ3	1	3%	2	5%	0	0%	2.6	21%	3.5	28%	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 stream segments in Upper Ackerman Creek have a deficient LWD quality rating, while Jack Smith is marginal.

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

Stream	**Calwater Planning Watershed**	**Instream LWD Quality Rating**
Jack Smith Creek	Jack Smith Creek	Marginal
Ackerman Creek	Upper Ackerman	Deficient
Alder Creek	Upper Ackerman	Deficient

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 year 2000 aerial photographs. Four canopy closure classes were determined using aerial photographs. These classes are shown in table D-7. A map was produced for the Northern Russian River 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 2000, field measurements of canopy closure over select stream channels were performed. The field measurements were taken during the stream channel assessments in the Northern Russian 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. The riparian stream canopy closure is shown in Map D-2.

Stream temperature has been monitored in the Northern Russian River 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. 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 Time Periods in the Northern Russian River WAU (see map D-2).

Temperature Station	Segment #	Stream Name	Years Monitored
77-1	UJ2	Jack Smith Creek	96, 97, 99, 00, 01, 02, 03
83-1	UU6	Ackerman Creek	96, 97, 00, 02
83-2	UU10	Alder Creek	99, 00, 01, 03
83-3	UL2	Ackerman Creek	00, 01
83-4	UU5	Ackerman Creek	03

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. For streams 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 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

Canopy closure over watercourses is generally low in the Northern Russian River WAU (Map D-2 and Table D-9). Ackerman Creek has good canopy in the very lower and very upper sections. The area in between, however, has canopy closure in the 0-40% cover range. Lower Alder Creek is also very poor with increasing canopy in the upper sections. Because of the wide stream reaches and oak woodland dominated riparian areas this is probably expected. Jack Smith Creek has more generally good canopy closure levels (70-90%).

Table D-9. 2000 Field Observations of Stream Canopy Closure for Select Stream Channel Segments of the Northern Russian River WAU.

Stream Name	**Segment Number**	**Mean Shade Canopy (%)**
ACKERMAN CREEK	UL1	67
ACKERMAN CREEK	UU1	37
ACKERMAN CREEK	UU6	37
ALDER CREEK	UU10	37
ALDER CREEK	UU12	32
ALDER CREEK	UU13	43
JACK SMITH CREEK	UJ2	78
JACK SMITH CREEK	UJ3	66

Stream temperatures in the Northern Russian River WAU are at levels not preferred by salmonids. Though these streams are not in the coastal and should be expected to be a bit warmer. Instantaneous maximum temperatures recorded at all sites typically exceed the maximum lethal ranges for coho salmon (23C^{o}) and steelhead trout (26C^{o}) (Brett, 1952). MWAT values for all sites well exceed the maximums for coho salmon (17-18 C^{o}) (Brett, 1952 and Becker and Genoway, 1979). Ackerman Creek sites have especially high temperatures. See Tables D-10, D-11 and D-12.

Table D-10. Maximum Daily Temperatures by Year for the Northern Russian River WAU.

Station	1996	1997	1998	1999	2000	2001	2002	2003
77-1	22.1	22.5	**	20.5	20.3	19.3	20.2	21.1
83-1	30.9	26.9	**	**	26.0	**	24.3	**
83-2	**	**	**	23.7	31.7	23.4	**	22.1
83-3	**	**	**	**	33.6	23.4	**	**
83-4	**	**	**	**	**	**	**	23.3

**data not collected

Table D-11. Maximum Weekly Average Temperature (MWAT) for the Northern Russian River WAU.

Station	1996	1997	1998	1999	2000	2001	2002	2003
77-1	18.9	18.2	**	17.4	18.3	16.7	17.7	18.9
83-1	22.9	21.0	**	**	21.0	**	19.6	**
83-2	**	**	**	18.6	19.5	18.6	**	20.2
83-3	**	**	**	**	22.3	19.2	**	**
83-4	**	**	**	**	**	**	**	21.0

**data not collected

Table D-12. 7-Day Moving Average of the Daily Maximum (MWMT) for the Northern Russian River WAU.

Station	1996	1997	1998	1999	2000	2001	2002	2003
77-1	21.3	21.4	**	19.8	19.7	18.5	19.6	20.2
83-1	29.8	25.1	**	**	25.1	**	22.4	**
83-2	**	**	**	22.2	26.6	21.8	**	21.0
83-3	**	**	**	**	30.1	22.2	**	**
83-4	**	**	**	**	**	**	**	22.6

** data not collected

Canopy cover in the Northern Russian River WAU is moderate and temperatures are at levels that are not preferred by salmon, but tolerable for steelhead. Because of this, care should be taken to ensure that where possible shade along streams is provided. This would decrease the likelihood streams of further warming and potentially provide cooler water temperatures in the future.

Table D-13. Stream Shade Quality Ratings for Major Streams and River/Stream Segments in Calwater Planning Watersheds for the Northern Russian River WAU.

Stream	Calwater Planning Watershed	Stream Shade Quality Rating
Jack Smith Creek	Jack Smith Creek	Marginal
Ackerman Creek	Upper Ackerman	Deficient
Alder Creek	Upper Ackerman	Deficient

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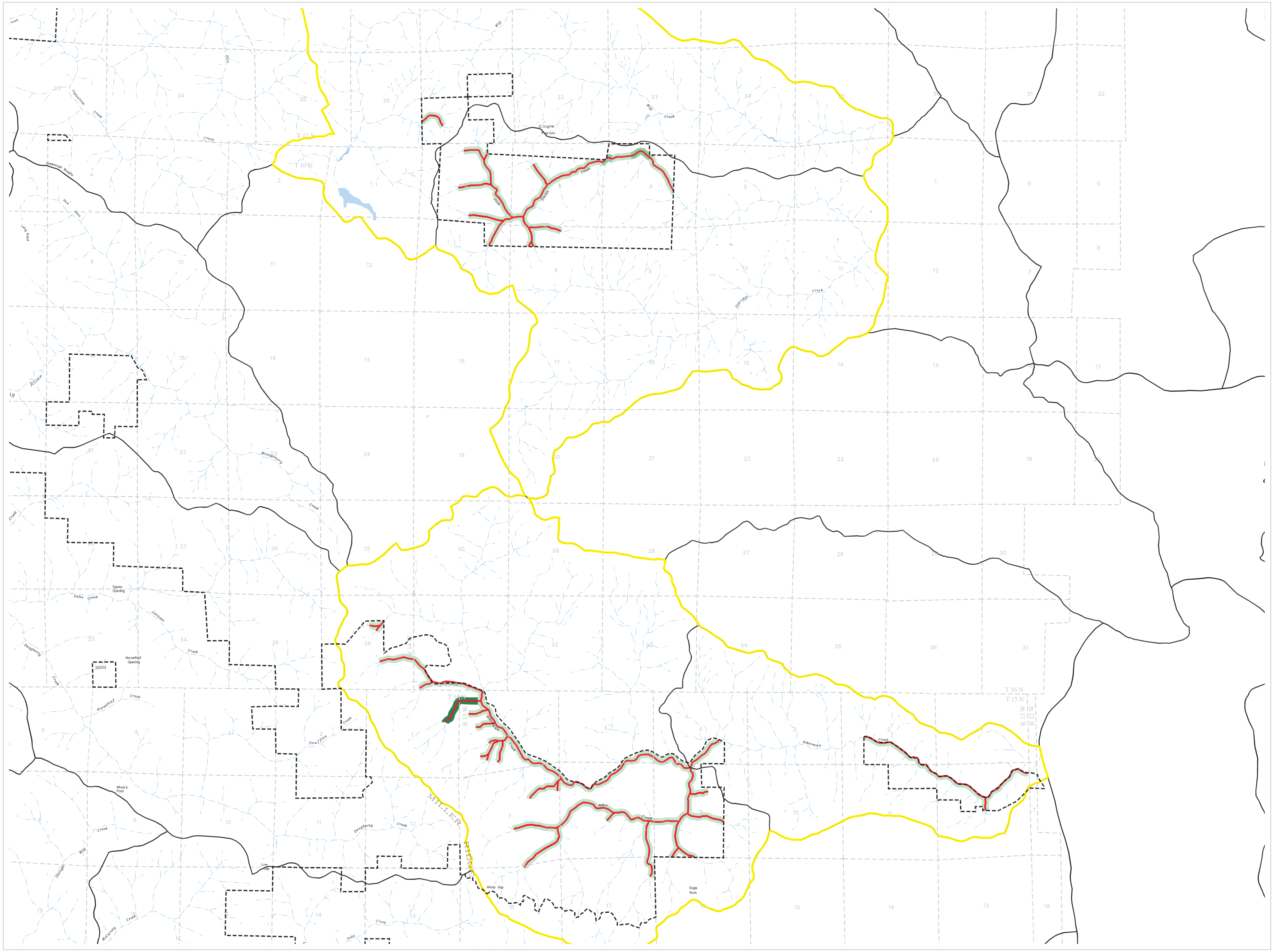
Appendix D



Northern Russian River Watershed Analysis Unit

Map D-1 Large Woody Debris Recruitment Potential and Demand

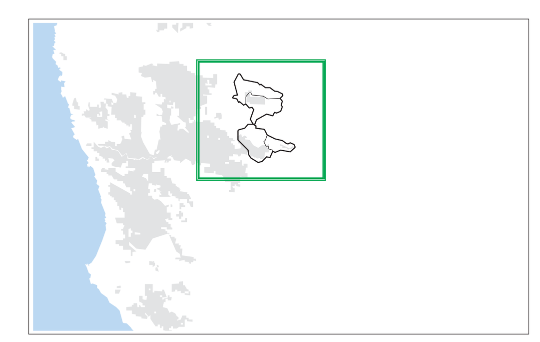
This map presents the large woody debris recruitment potential and in-stream large woody debris (LWD) demand for the streams on MRC lands in the Northern Russian WAU. This map provides baseline information on the structure and composition of the riparian stand and the level of concern about current LWD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

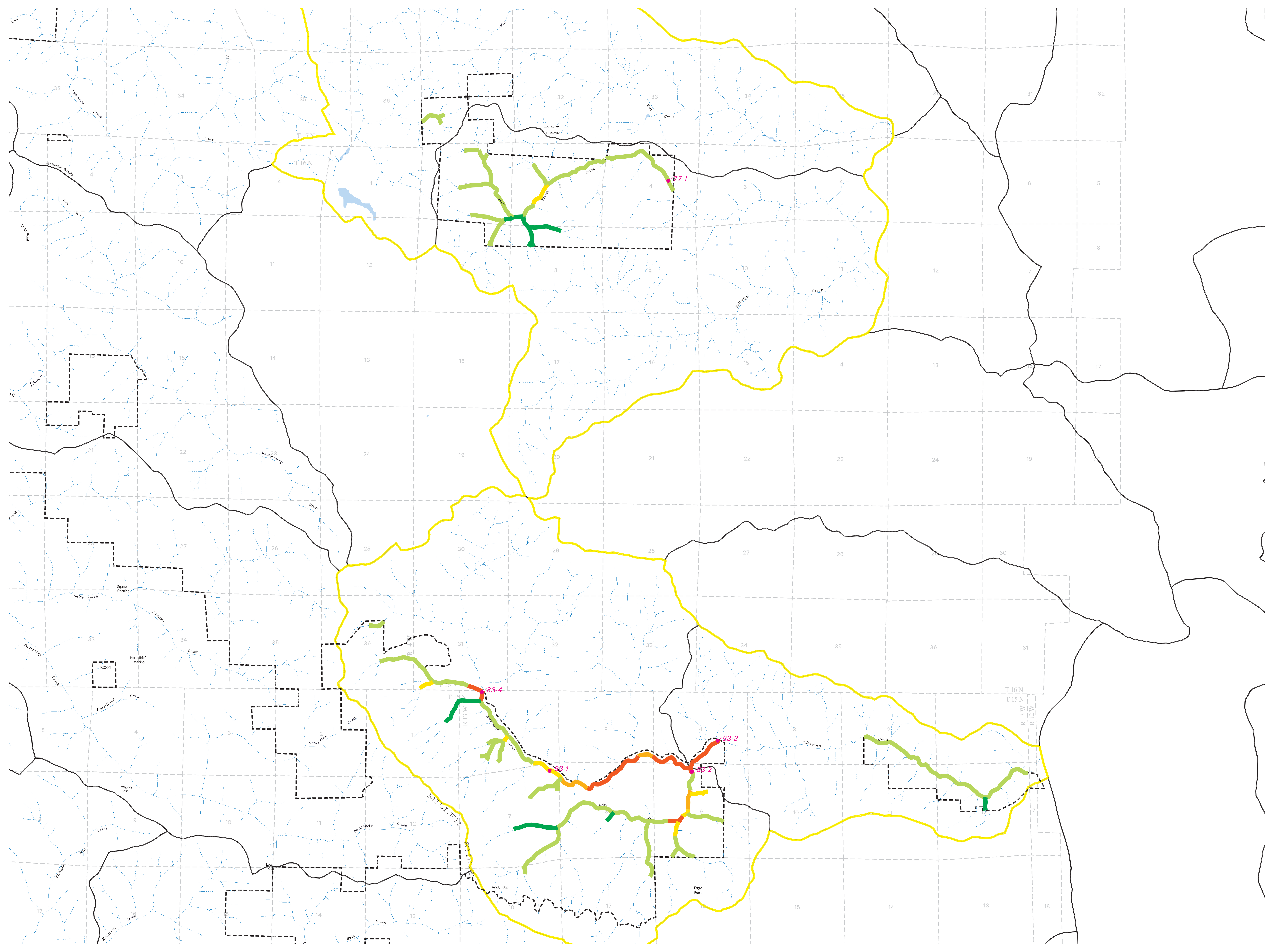
- MRC Ownership
- Planning Watershed Boundary
- Northern Russian River Watershed Analysis Unit Boundary

Flow Class
- Class I
- Class II
- Class III



0 1/2 1 Mile

November 2004



Northern Russian 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 Northern Russian WAU. The canopy was estimated for four canopy closure classes from 2000 aerial photographs and 2000 field observations. The location of stream temperature monitoring locations is also presented, these locations are monitored each year during summer.

Stream Canopy Classes

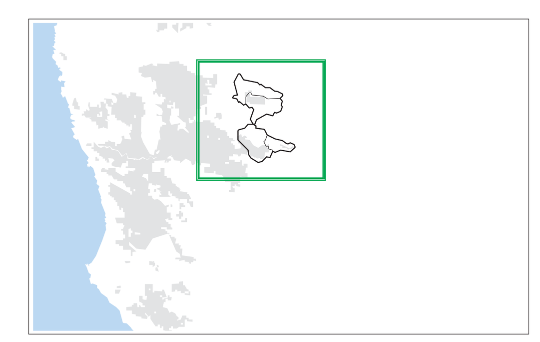
- > 90%
- 70-90%
- 40-70%
- 20-40%
- 0-20%

Temperature Monitoring Locations

MRC Ownership
Planning Watershed Boundary
Northern Russian River Watershed Analysis Unit Boundary

Flow Class

- Class I
- Class II
- Class III



0 1/2 1 Mile

November 2004

Figure T77-01. Mean and Maximum Daily Stream Temperatures During Summer 2003 at Jack Smith Creek (Site T77-01), Mendocino County, California.

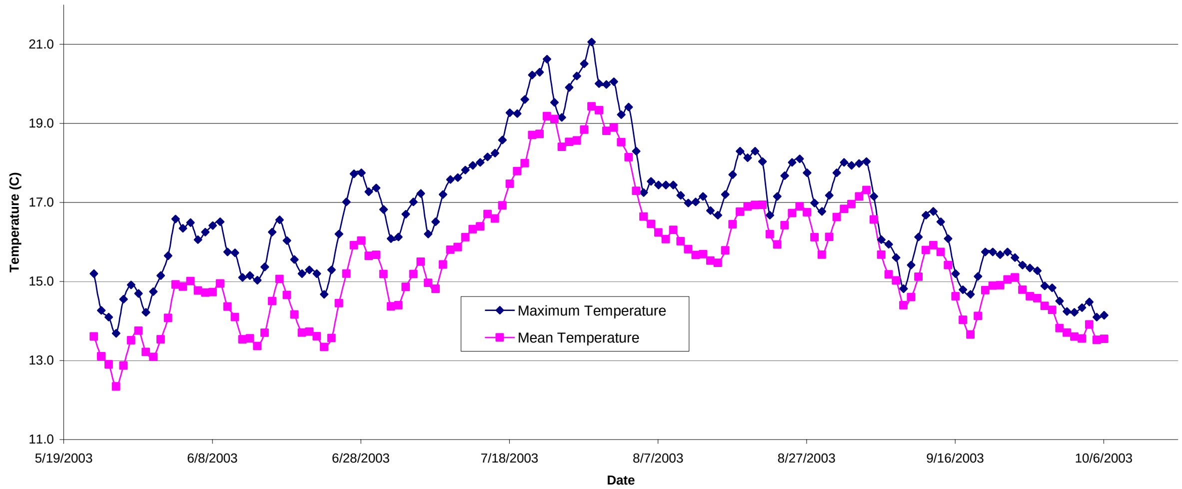


Figure T83-02. Mean and Maximum Daily Stream and Air Temperatures During Summer 2003 at Alder Creek (Site T83-02), Mendocino County, California.

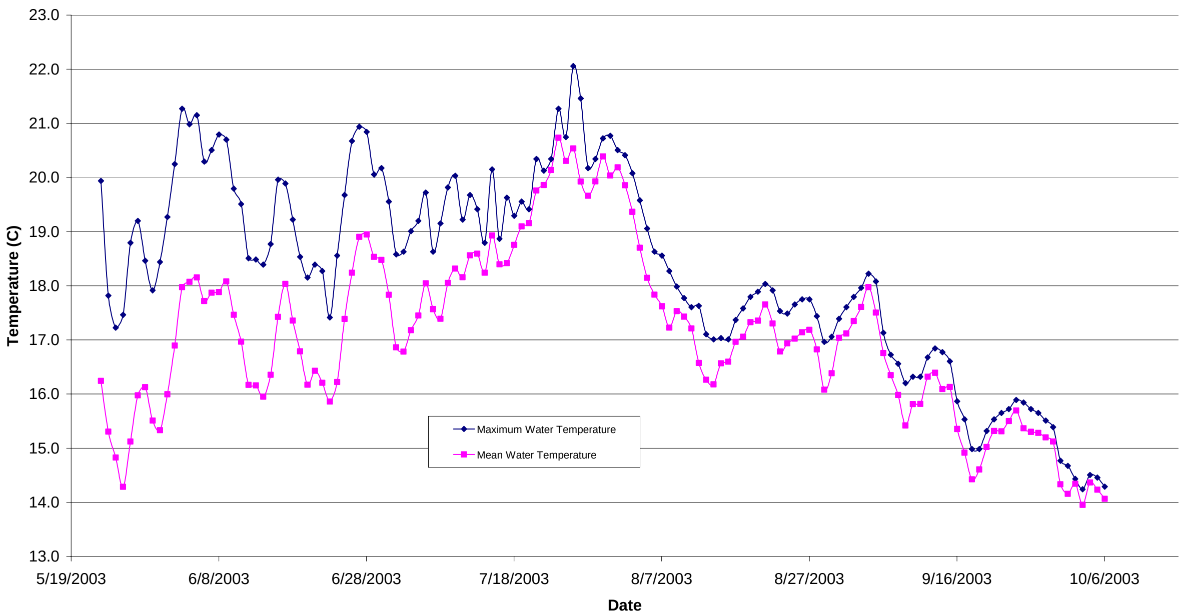


Figure T83-04. Mean and Maximum Daily Stream and Air Temperatures During Summer 2003 at Ackerman Creek (Site T83-04), Mendocino County, California.

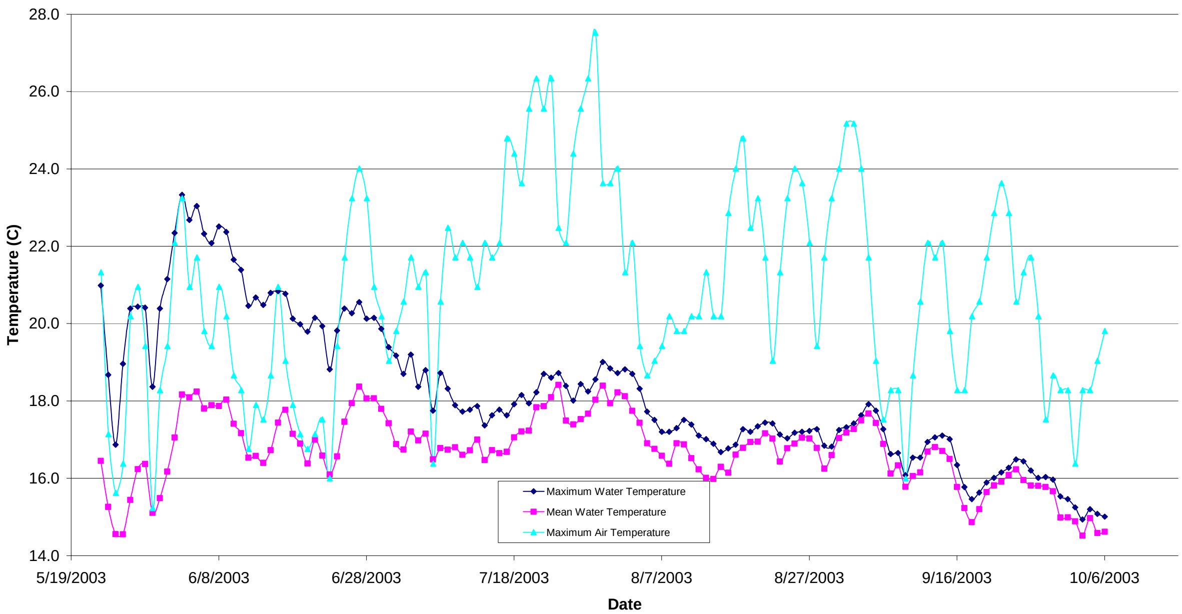


Figure T77-01. Mean and Maximum Daily Stream Temperatures During Summer 2002 at Jack Smith Creek (Site T77-01), Mendocino County, California.

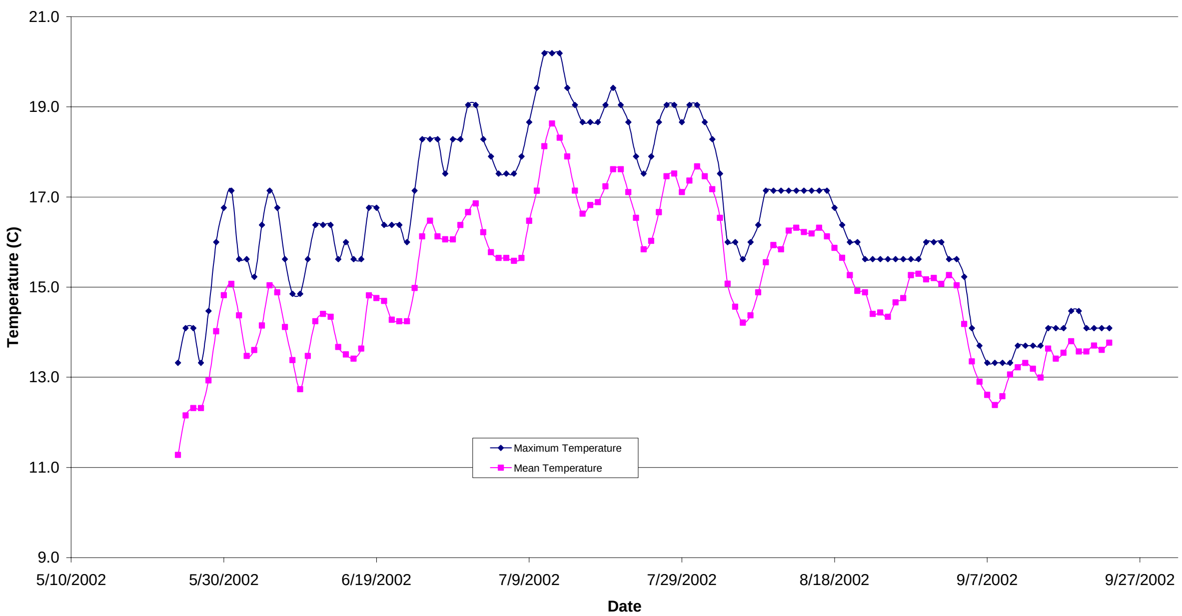


Figure T83-01. Mean and Maximum Daily Stream and Air Temperatures During Summer 2002 at Ackerman Creek (Site T83-01), Mendocino County, California.

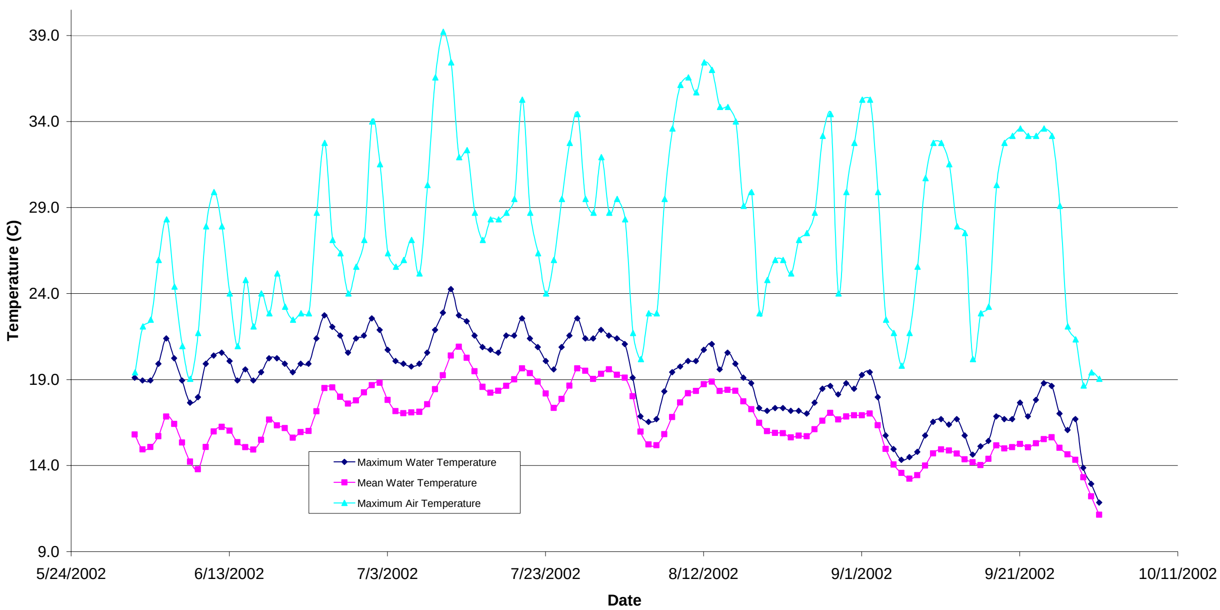


Figure 105. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Jack Smith Creek (Site77-1), Mendocino County, California.

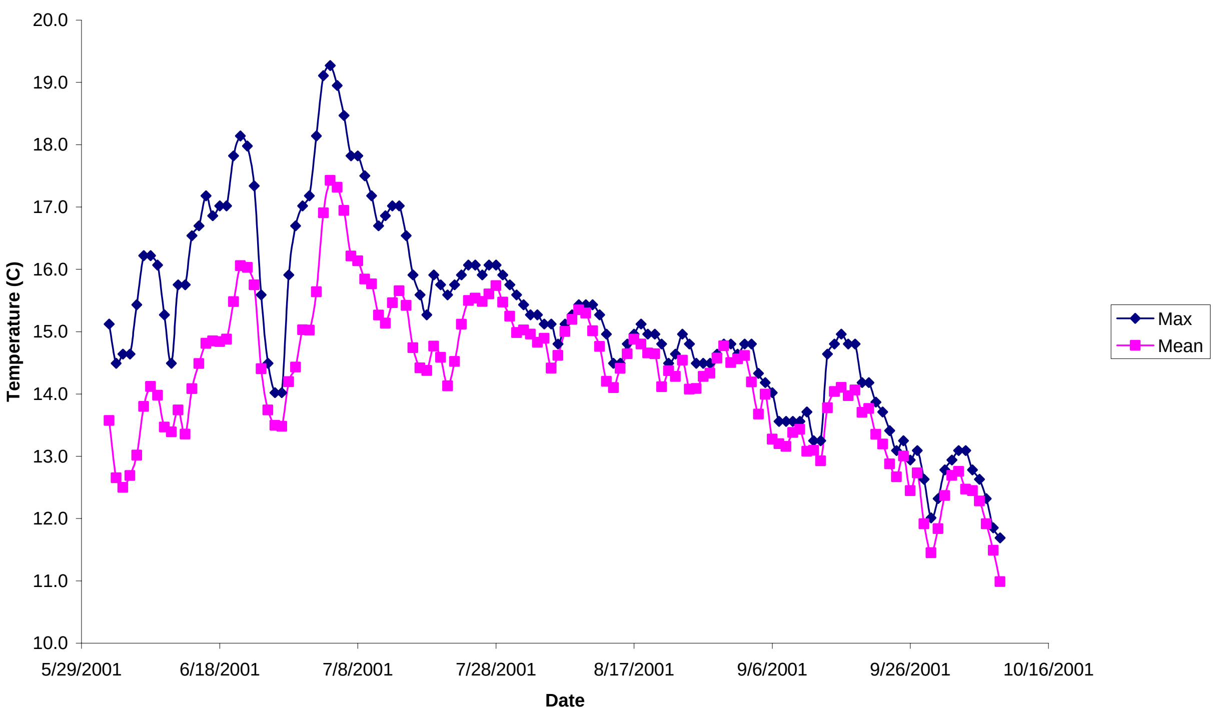


Figure 106. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Alder Creek (Site 83-2), Mendocino County, California.

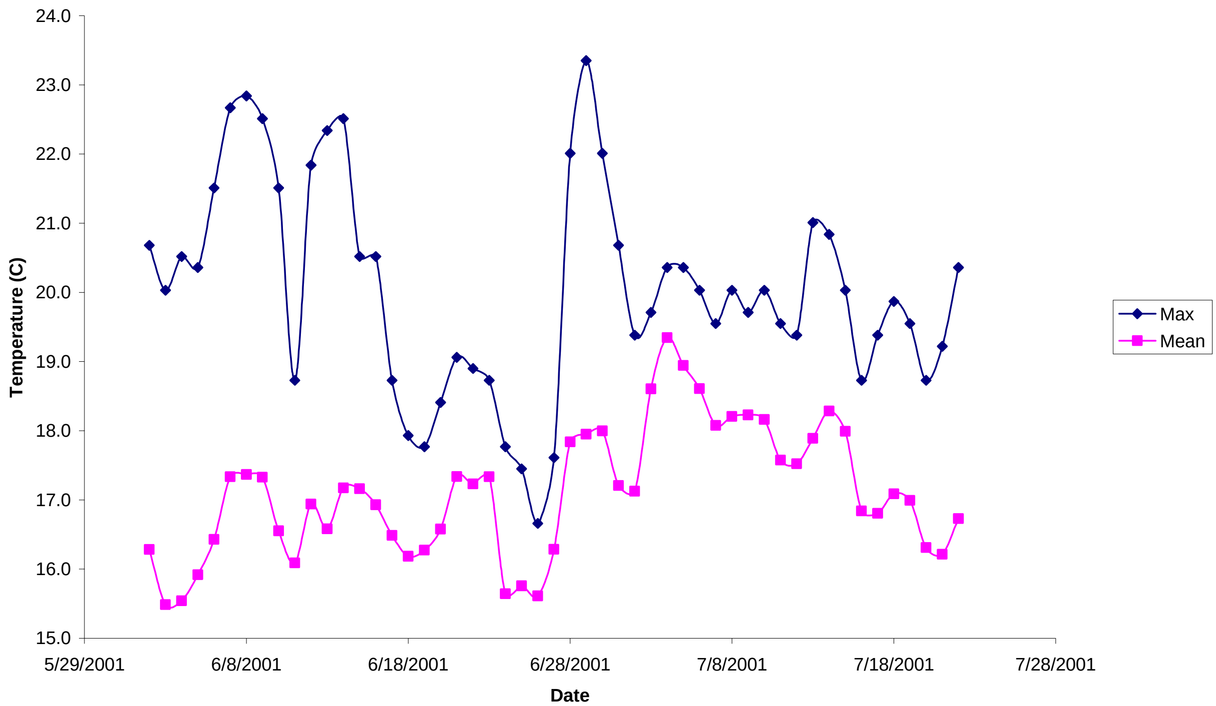


Figure 107. Mean and Maximum Daily Stream Temperatures During Summer 2001 at Ackerman Creek (Site 83-3), Mendocino County, California.

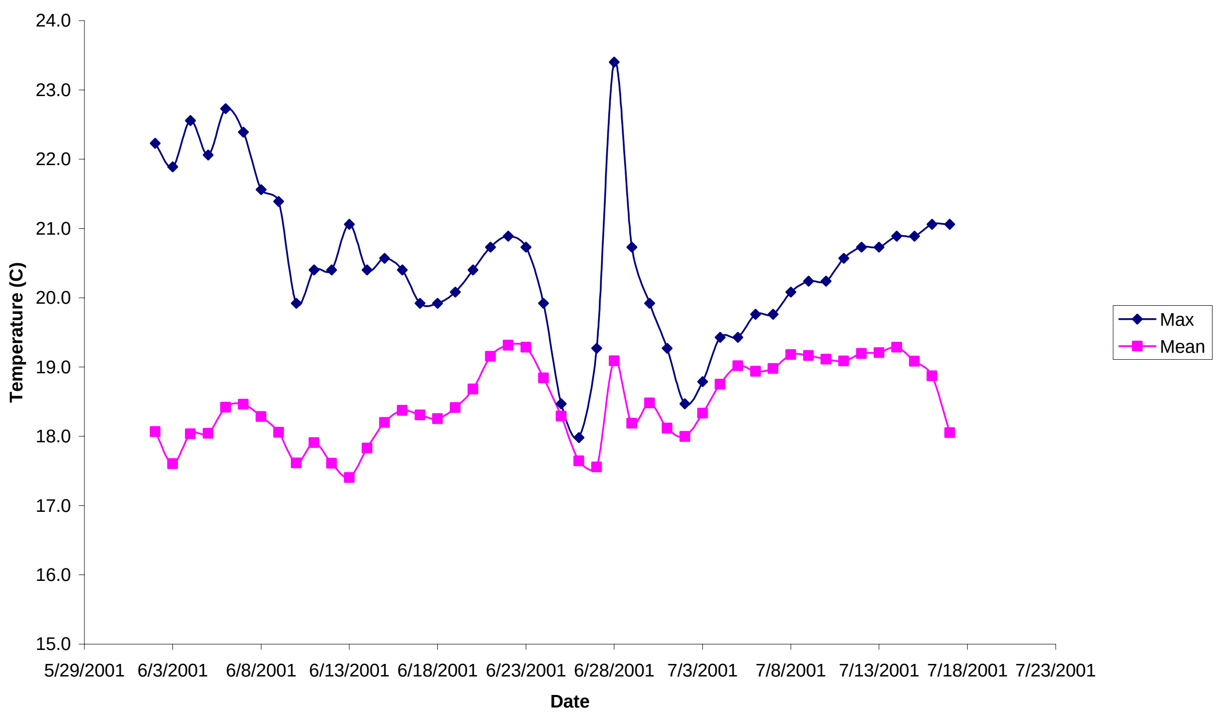


Figure 113. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Jack Smith Creek (Site 77-1), Mendocino County, California.

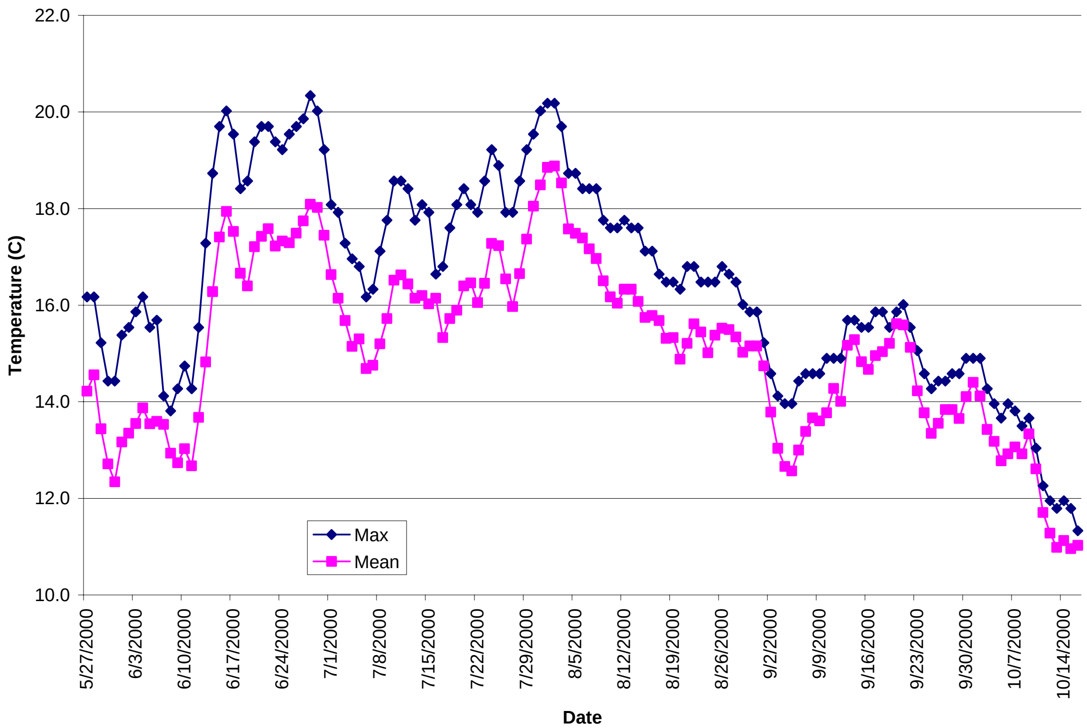


Figure 115. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Ackerman Creek (Site 83-1), Mendocino County, California.

Figure 117. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Alder Creek (Site 83-2), Mendocino County, California.

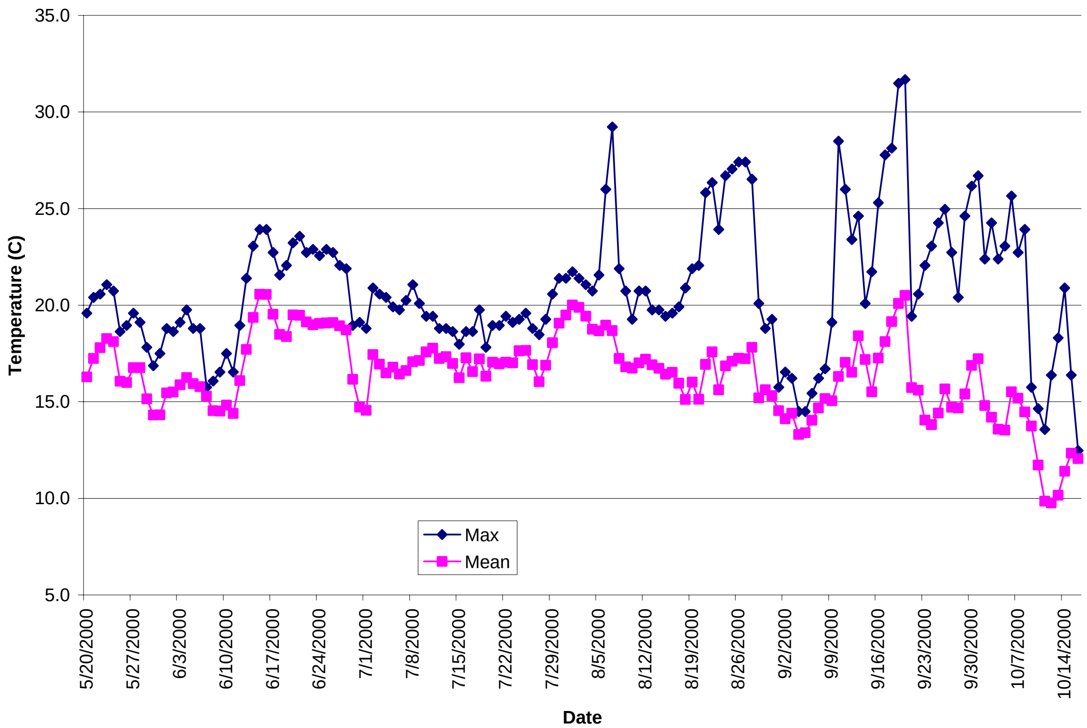


Figure 118. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Ackerman Creek (Site 83-3), Mendocino County, California.

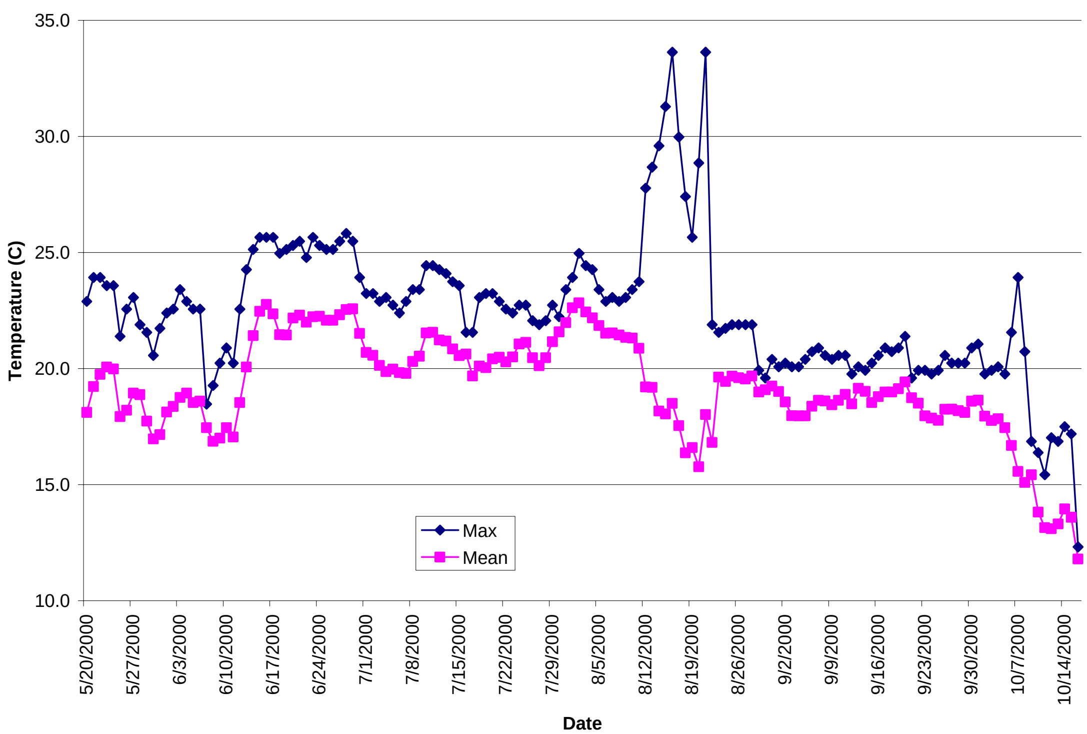


Figure 112. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Jack Smith Creek (Site 77-1), Mendocino County, California.

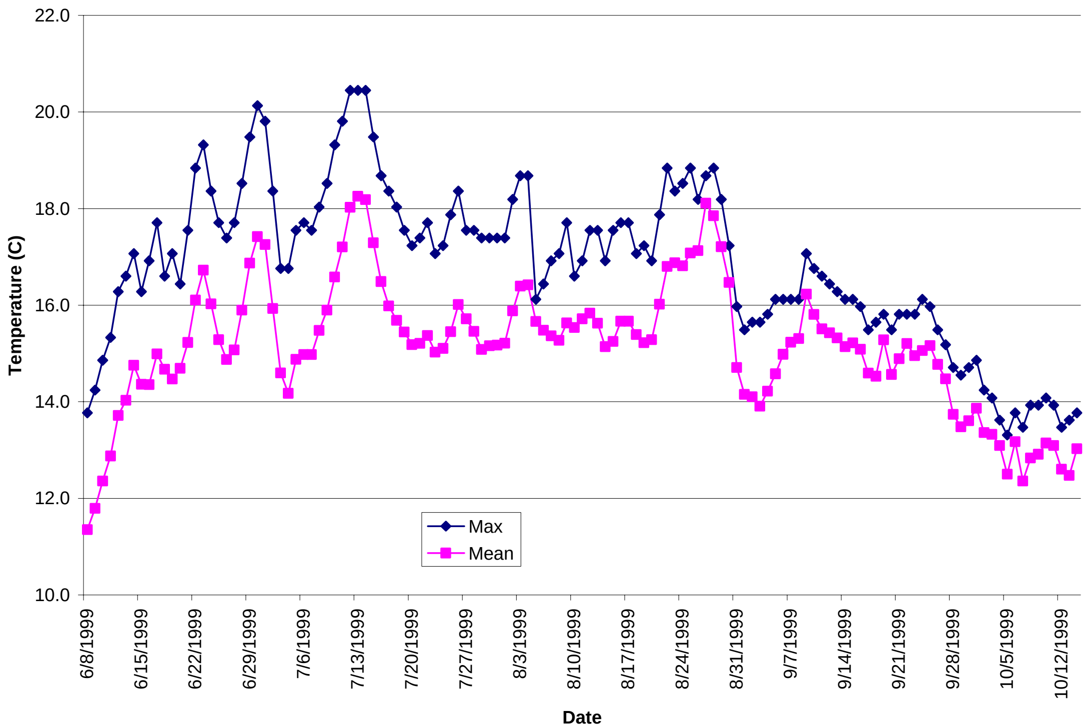


Figure 116. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Alder Creek (Site 83-2), Mendocino County, California.

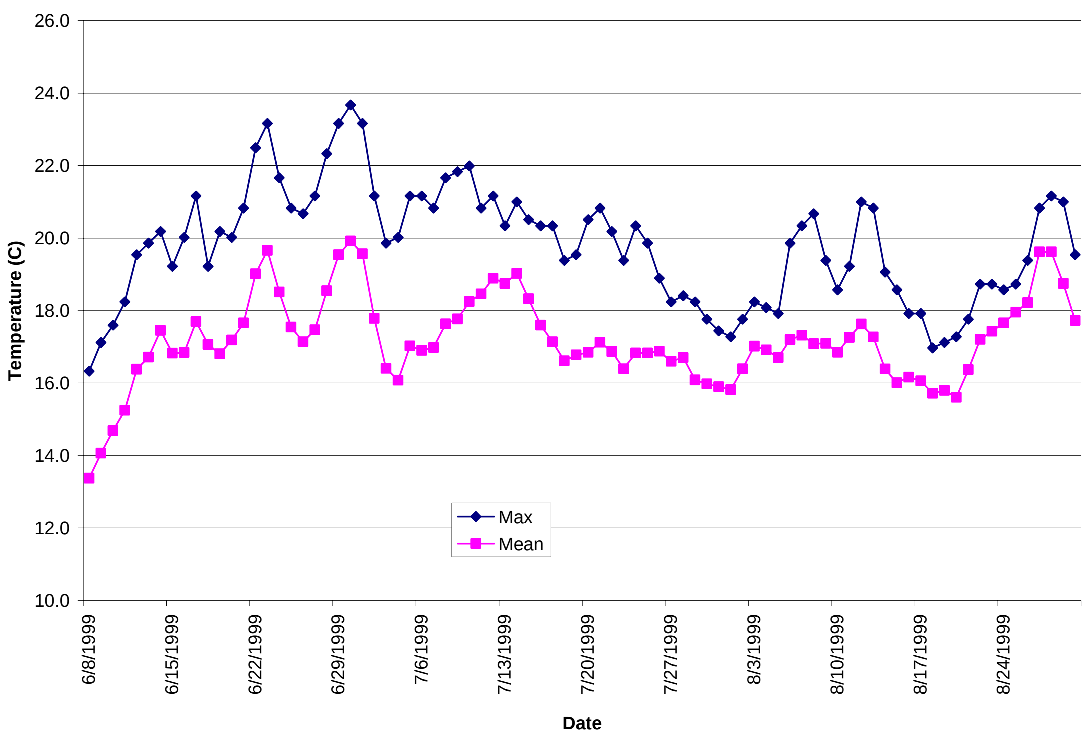


Figure 111. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Jack Smith Creek (Site 77-1), Mendocino County, California.

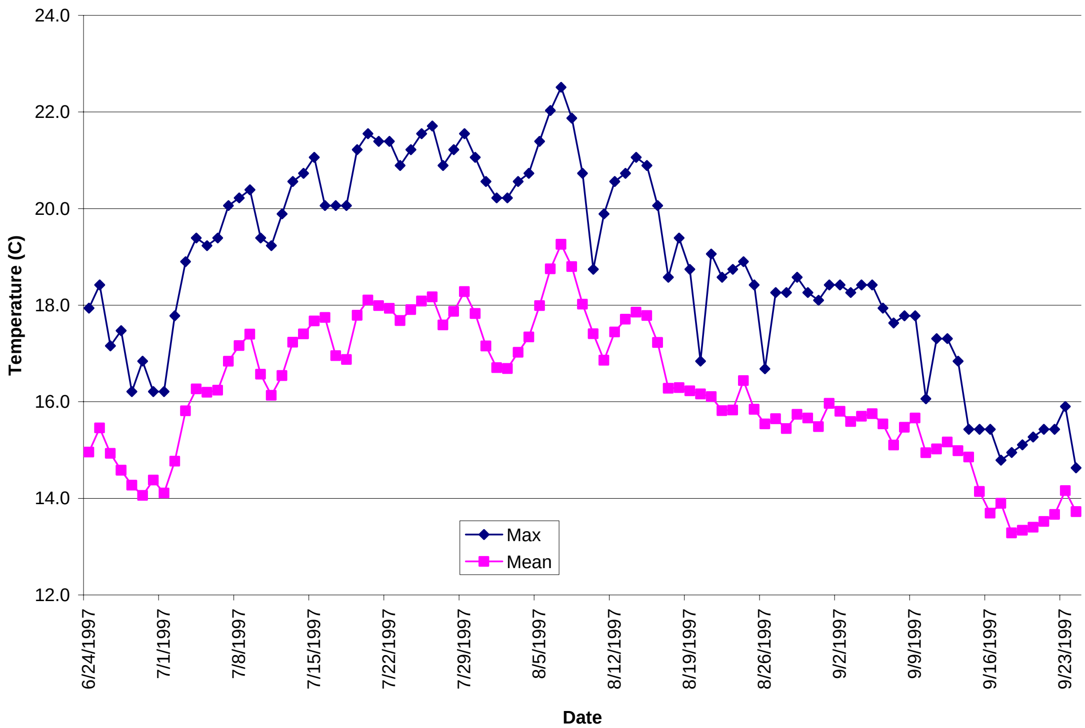


Figure 114. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Ackerman Creek (Site 83-1), Mendocino County, California.

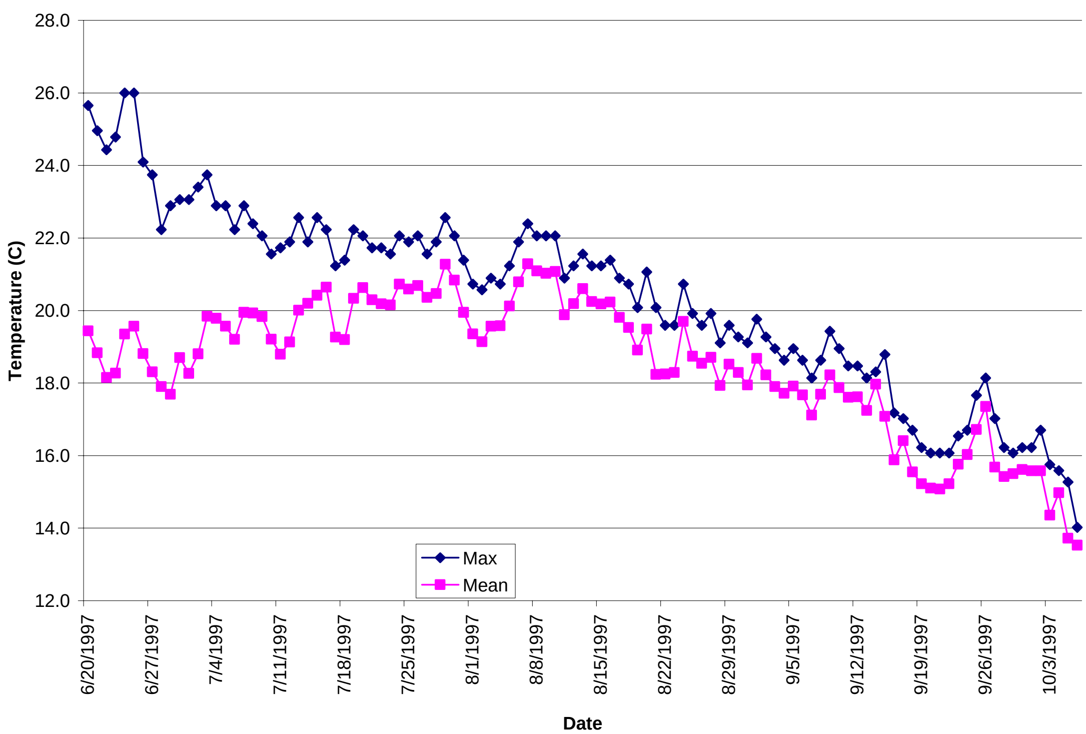


FIGURE 70. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT JACK SMITH CREEK (MAP NO.12; MONITORING SITE NO. 77-1), MENDOCINO CO., CALIFORNIA.

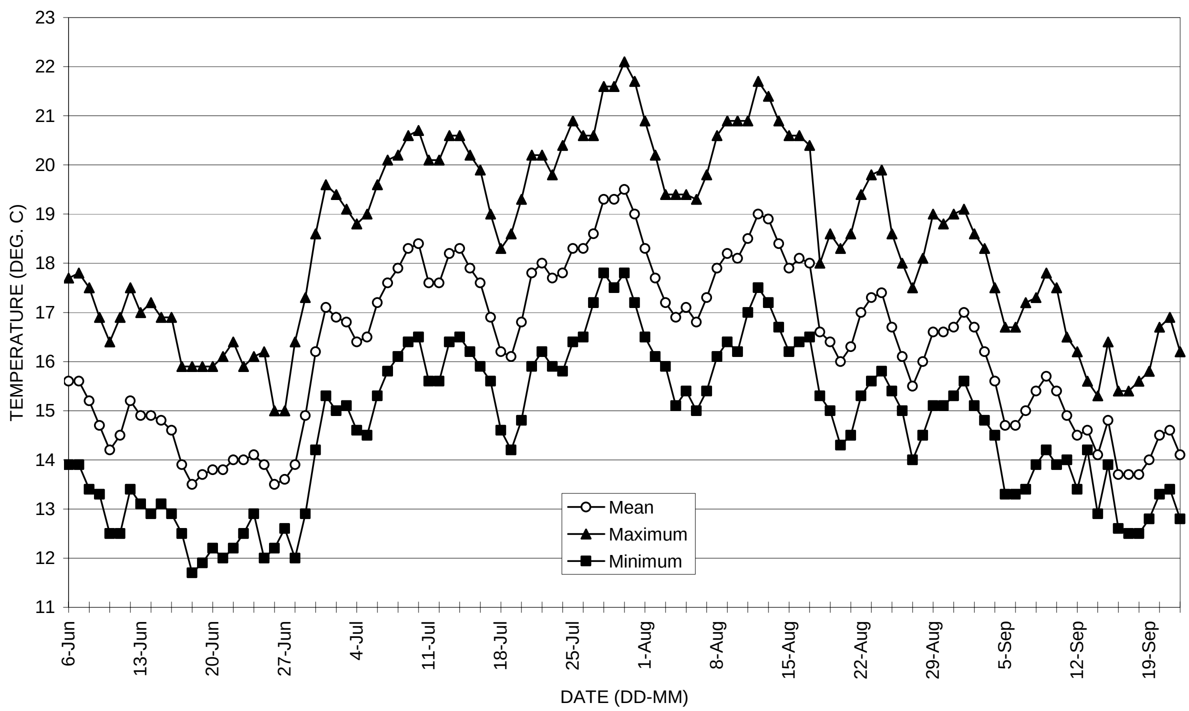


FIGURE 79. MEAN, MAXIMUM, AND MINIMUM DAILY STREAM WATER TEMPERATURES DURING SUMMER (JUNE-SEPTEMBER 1996) AT ACKERMAN CREEK (MAP NO. 16; MONITORING NO. 83-1), MENDOCINO CO., CALIFORNIA.