MENDOCINO
REDWOOD COMPANY, LLC

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North Coast Regional Water Quality Control Board
Mr. Matt St. John
5550 Skylane Boulevard, Suite A
Santa Rosa, CA 95403

2002 303(d) List Update
Reference # 109

October 1, 2001

Dear Mr. St. John:

Mendocino Redwood Company, LLC (MRC) requests that Greenwood Creek be removed from recommendation for the federal Clean Water Act 303(d) List for sediment and the 303(d) "Watch List" for temperature. We make this request based on the following reasons: 1) MRC voluntarily manages its lands with high standards for protection of watershed and aquatic values without the necessity of TMDL standards, 2) stream channel morphology and stream gravel measurements do not suggest sediment impaired conditions, 3) the turbidity information and drinking water concerns raise questions about the quality of the well adjacent to Greenwood Creek but do little to suggest sediment impairment of the watershed, and 4) stream temperature levels in the last 2 years 1999 and 2000, as observed near the outlet of the watershed, are not at levels of concern for coho salmon and steelhead trout.

1) Mendocino Redwood Company, LLC has voluntarily set a high standard of stewardship for management of the forest resources of its ownership including Greenwood Creek. The goals of this stewardship is to restore the forest by improving the number and size of redwood and Douglas fir trees, improving terrestrial wildlife habitat and improving the habitat for aquatic organisms (a copy of the MRC management plan and Option A are enclosed).

MRC's strategy related to water quality and aquatic habitat issues involve two components. First, policies and management guidelines have been developed to protect aquatic resources across the ownership. This guidelines include: a) increased tree and canopy retention and soil protection along streams, b) adapting the Weaver and Hagans, Handbook for Forest and Ranch Roads (1994) as the standard for road maintenance, construction and abandonment, c) eliminating the use of traditional clear-cut harvest and moving toward uneven-aged management using predominately selective harvest techniques (see aerial photographs enclosed), and d) use of a shallow landslide hazard model to determine harvest and road construction prohibitions to reduce sediment inputs from landslides. In addition to the property wide policies MRC develops site-specific management practices developed through a watershed analysis process. This process includes a 100% road inventory identifying sediment sources and a prioritization for treatment. The watershed analysis examines the hazards for mass wasting, road surface and fluvial erosion and riparian conditions in relation to affected resources of fish habitat and water quality. From this comprehensive watershed analysis land management prescriptions, restoration opportunities and monitoring is prescribed specific to individual watersheds.

MRC is in the process of completing watershed analysis on 70% of its ownership, covering approximately 160,000 acres, by the end of this year. MRC made the 303(d) listed watersheds as its priority for watershed analysis, however, analysis on Greenwood Creek has begun. Fieldwork on a road inventory for Greenwood Creek is almost complete with a final product expected in 2002. Stream monitoring stations have been established on Greenwood Creek and the watershed analysis is expected to be completed in 2002-2003. In the interim MRC has made considerable improvements to the watershed and its management. These include:

i) 1 temporary crossing changed to permanent bridge.
ii) 1 temporary bridge crossing will be changed to permanent bridge.
iii) Approximately 15 culverts armored with rip rap.
iv) Approximately 30+ rocked fords installed instead of culverts.
v) One watercourse diversion proposed to alleviate an erosional problem.
vi) Two culverts removed and ¾ mile road abandoned.
vii) Approximately 10 miles of roads constructed on or near ridge tops to convert from tractor logging to cable logging.
viii) One watercourse diversion completed to alleviate an erosional problem.
ix) Approximately 2 miles of road rocked to control erosion.
x) Continuous inspections of roads during winter period.
xi) Five culverts upgraded to pass 100-year floods.
xii) Approximately 15 miles of road re-shaped with rolling dips installed.
xiii) Three slide prone areas rip rapped to help control sliding.
xiv) No harvesting within Watercourse and Lake Protection Zone to help with water temperature.
xv) No harvesting on mapped slide areas.

MRC has voluntarily set high standards and practices for the management of aquatic resources on its ownership including Greenwood Creek. These high standards and practices including watershed analysis and monitoring will address sediment associated management issues in the watershed making the listing of Greenwood Creek on the 303(d) list and the development of a Total Maximum Daily Load unnecessary.

2) In September 2001 MRC conducted stream channel observations to determine the current condition of the stream channels, proportion of fine sediment in the bed and the quality of the spawning gravel. In addition to these observations the stream segments were monumented and established as long-term monitoring locations. The full write-up and data collected is enclosed.

The results of steam channel observations suggest a stable stream channel with a well armored bed with low shear stress along the channel margins. Despite this channel morphology a pool:riffle morphology is evident. Sediment samples show a low percentage of fine sediment in the bed and permeability observations at pool tail-outs are moderately good. These observations do not in my opinion support a listing of Greenwood Creek as a sediment-impaired watershed.

3) MRC is sympathetic with the concerns of The Elk County Water District about the quality of their drinking water. The Elk County Water District has claimed the need for a filtering system to handle the turbidity pollution of Greenwood Creek. However, background levels of turbidity in the Coast Range range from 20-234 NTUs in unmanaged watersheds as observed at Caspar Creek. These turbidity values, even in unmanaged watersheds are well above the 1 NTU standard suggested for drinking water.

It is unclear how much effect turbidity levels in the Elk County Water District well are affected by Greenwood Creek turbidity. There does not appear to be a correlation between both data sets. When turbidity levels are at the lowest in Greenwood Creek in the summer months (typically < 1 NTU), well turbidity is often above drinking standards (often greater than 5 NTUs). When storm flow turbidity is at its highest in Greenwood Creek the well often does not show corresponding high turbidity levels. It is these inconsistencies that suggest that there could be other factors affecting well turbidity.

Investigation of the daily turbidity information from the Elk County Water District (see L-P memo dated Dec. 10, 1997 enclosed) found that each turbidity reading above a range expected in unmanaged watersheds corresponded with an extreme storm event, typically greater than a 5 year return interval. It is during these storms that there is greater erosion and accessibility to sediment sources from high flood waters creating greater turbidity in managed or unmanaged watersheds.

4) When reviewing the stream temperature statistics from stream temperature monitoring done by MRC maximum weekly average temperature (MWAT) values hover around the 16-17 degree celsius (Table 3). The lower stream temperature monitoring location (84-1) in Greenwood Creek has shown a significant decline in temperature in the last 2 years. These water temperature values would not be of concern for steelhead trout or coho salmon. The upper stream temperature monitoring location (84-3) shows MWAT values higher than the lower site. The MWAT values at site 84-3 are at levels that are likely adequate for steelhead trout, but may be high for coho salmon. However, no recent information suggests that coho salmon use this upper portion of the watershed.

It is interesting that stream temperatures at the outlet of the Greenwood Creek watershed are lower than upstream. This is contrary to the usual physical process of water heating and transfer. Typically as water is heated there is little opportunity for heat loss in streams except through conduction and evaporation, which is usually minimal on a summer day as water travels downstream. Therefore the likely reason for lower stream temperatures are cool tributaries flowing into Greenwood Creek that lower water temperatures through dilution as the water travels downstream. Timber harvest practices are similar upstream and downstream in Greenwood Creek, so change in canopy probably does not account for the higher stream temperatures upstream (see aerial photographs enclosed). The likely source for higher stream temperatures upstream is higher air temperatures, as air temperature increases stream temperature increases as well. The farther that Greenwood Creek is from the coast the higher the summer daytime temperatures. MRC would like the Regional Water Quality Control Board to consider this when evaluating Greenwood Creek as a stream to watch for potential 303(d) listing.

Table 3. Summary of Stream Temperature Data from Mendocino Redwood Company Property in Greenwood Creek (see enclosed for locations).

Greenwood Creek Historical Temperature Data				Celsius	
Site ID	**Site Description**	**Year**	**MAX**	**MWAT**	**MWMT**
84-1	Lower@ property line	1992	20.0	17.0	19.2
84-1		1993	20.0	17.0	18.7
84-1		1995	20.8	17.1	19.4
84-1		1997	21.2	17.7	20.4
84-1		1999	19.8	15.7	18.7
84-1		2000	17.8	14.6	16.9
84-1		2001	**	**	**
84-3	Upper@ Maple Basin	1994	18.5	16.4	18.2
84-3		1995	20.6	17.7	19.3
84-3		1997	19.1	17.2	18.3
84-3		1999	20.4	16.7	19.0
84-3		2000	20.3	17.4	19.7
84-3		2001	**	**	**
** Probes not retrieved yet					

To conclude, MRC has submitted a considerable bit of information that suggests that Greenwood Creek is not a candidate for listing for sediment impairment on the Clean Water Act 303(d) list and removed from the "watch list" for temperature. Besides the technical observations submitted to you MRC is voluntarily managing its ownership with a high degree of stewardship attempting to improve aquatic habitat and water quality. MRC has provided a high level of cooperation in current and past interactions with the Regional Water Quality Control Board supplying monitoring data, access to MRC lands or other information requests. Given MRC's open policy with your agency a reasonable approach toward any concern the Regional Water Quality Control Board has about water quality issues on Greenwood Creek can be resolved in a voluntary and cooperative manner, without the need for a 303(d) listing.

Sincerely,

Christopher G. Surfleet
Hydrologist

Enclosures:

Aerial photographs of Greenwood Creek, 2000.
1997 memo, by Chris Surfleet on Greenwood Creek Turbidity
Stream channel observations for Greenwood Creek 2001
MRC memo on status of coho salmon in Greenwood Creek and supporting literature
Summary of 1997-2000 MRC stream temperature data for Greenwood Elk and Alder Creeks.
Mendocino Redwood Company, Option A
Mendocino Redwood Company Management Plan and Policies

Stream Channel Observations and Monitoring for Greenwood Creek September, 2001

As part of Mendocino Redwood Company's (MRC) watershed analysis protocol, long-term channel monitoring reaches were established in the Greenwood Creek Watershed Analysis Unit in September 2001. These reaches are monumented so that future surveys can be conducted at the exact same location of the stream. Thalweg profiles and cross-sections are surveyed from established benchmarks. In this manner, physical changes can be recognized over long periods of time. MRC currently has two long-term monitoring reaches in the mainstem of Greenwood Creek. One of these reaches starts at the lower property line in the Greenwood Commons area. The second reach is located higher in the watershed in the Maple Basin area. See map 1.

Methods

The stream monitoring segment for thalweg profile and cross-section surveys start at known reference points along the channel and continue upstream 20-30 bankfull channel widths in length. Cross section surveys were taken approximately every 5-8 bankfull channel widths along the segment. Benchmarks (a bolt in concrete) that mark the upstream and downstream ends of the monitoring segment were permanently monumented for future surveys. The beginning benchmark was given an arbitrary elevation of 100' and the rest of the profile was referenced to this. Benchmarks (nail in a tree) were also established for each cross-section and the elevation corresponded to the thalweg survey elevations. Distances and azimuths from these benchmarks to the start of a thalweg or a cross-section survey were recorded. By doing this it is possible to begin and end surveys in the exact same spot year after year. These also provide a place of "known" elevation that should not change over time. This will presumably increase accuracy and confidence in comparability of data between years.

Thalweg Profile

Working upstream, the thalweg depth (elevation) and distance along the stream was surveyed. The thalweg is the deepest point of the flowing channel, excluding any detached or "dead end" scours and/or side channels. These areas were excluded in the thalweg profile. Distance was measured in the surveys by stretching measuring tapes along the channel and then reading distance during the survey. In the absence of visually apparent changes in the channel profile, thalweg measurements were taken every 15-20 feet up the center tape.

As specific landmarks were encountered along the reach, (e.g. tributary channels, particularly large pieces of woody debris, permanent survey stakes, armored bend, or other features of interest) the recorder made note of their location and size. Where a channel split into two components, the surveyor decided which is the main channel and then continued moving upstream (making measurements) along that channel.

Cross Sections and D50

Approximately every 5-8 bankfull channel widths along the thalweg profile, the location for a cross section survey was monumented and recorded in the thalweg profile survey notes. The cross sections are placed in riffles in relatively straight reaches of channel. Cross sections were surveyed from above the bankfull channel margins on both banks. At least 3-4 cross sections were surveyed along each monitoring reach.

Cross-section rebar pins were established at both ends of the cross-section well above the bankfull channel margin to monument the cross-section location. The elevation and the distance from the left bank pin was measured at least every five feet or at any visually apparent topographic change along the cross section. At each cross section a pebble count was conducted, to determine the D50 of the cross section, by measuring 100 randomly selected pebbles along the transect.

Permeability

The stream gravel permeability was conducted using a stand-pipe as discussed in Terhune (1958) and Barnard and McBain (1994), an electric pump was used to create the water suction in the stand-pipe. The permeability measurements were taken at a depth of 25 centimeters the maximum depth of coho and steelhead spawning. A total of 26 permeability measurements were taken in each monitoring segment. The measurements were evenly distributed among all pool tail-outs in the segments, with any additional measurements taken in tail-outs behind the deepest pools. The measurement location in each tail-out was randomly selected from a 12-point grid in the tail-out. At each measurement location 5 permeability repetitions were taken with the median of these observations representing the permeability of the measurement location.

Bulk Gravel Samples

In the upper stream segment of Greenwood Creek two bulk gravel samples were taken of the stream bed. The lower segment of Greenwood Creek did not have bulk samples taken due to the large substrate size that precluded sampling. A 12 inch diameter sample was taken to a depth of 12 inches using a metal cylinder (known as a "McNeil" sampler). The samples were taken in pool tail-outs at the head of a riffle, the typical spawning location for salmonids. The first sample was taken in a location that was representative of gravel present in tail-outs in the segment. The second sample was taken in the pool tail-out that appeared as the best spawning location in the segment. This approach provided an indication of the spawning gravel quality throughout the segment and the quality at the best site in the segment. After the bulk gravel samples were collected the gravel was dried and sieved through 7 different size-class screens (50, 25, 12.5, 6.3, 4.75, 2.36, 0.85 mm). The weight of each gravel size class was determined for each of the bulk gravel samples using a commercial quality scale.

Data Analysis

Cross-sections were graphed in Excel and D50 values were displayed on the chart. A computer program (Longpro) developed by the USGS for Redwood National Park was used to analyze the thalweg profiles. This program converted the surveys into standardized data sets, and calculated the distribution, mean and standard deviation of residual water depths. This method results in the ability to statistically evaluate changes in the thalweg profile over time.

The median permeability measurement for each permeability site in the monitoring segment was used as representative of the site. To characterize the entire monitoring segment the natural log of the mean of the median permeability measurements was determined. The natural log of the permeability is used because of a relationship developed from data from Tagart (1976) and McCuddin (1977) (Stillwater Sciences, 2000) was used to estimate survival to emergence from permeability data. This relationship equates the natural log of permeability to fry survival ($r^2 = 0.85$, $p<10^{-7}$). This index needs further improvements, but is currently all we have for interpreting permeability information and biological implications. This relationship is:

$$\text{Survival} = -0.82530 + 0.14882 * \ln \text{permeability}$$

It is important to understand that the use of this survival relationship is only an index of spawning gravel quality in the segment. The permeability measurements are taken randomly in pool tail-outs and are not indicative of where a salmon may select to spawn. Furthermore, spawning salmon have been shown to improve permeability in gravel where a redd was developed by 30% to 70% (MRC, 2000). Therefore the survival percentage developed is only indicative of the quality of potential spawning habitat and not as an absolute number.

From the sieved bulk gravel samples the fredle index, geometric mean and percent fine particles less than sieve size classes were determined. The survival index for steelhead trout was calculated from the bulk gravel samples using the method described in Tappel and Bjorn (1983).

Results and Conclusion

The stream channels in both the upper and lower Greenwood Creeks would be classified as Bc4 (Rosgen, 1996) and pool:riffle morphology (Montgomery and Buffington, 1993). These channels have high width to depth ratios, but are only moderately entrenched (ratio of bankfull channel to floodprone channel of 1.4 –2.2) and have well armored beds as indicated by the high D84 of the pebble counts (Table 1 and attached data). The slope gradient on these segments are less than 2 percent that makes the channel more responsive to sediment inputs given the likelihood of lower stream power. However the stream channels are highly confined within canyon walls making sediment transport potential and stream power higher particularly for fine sediment. The moderate entrenchment allows ample room for floodwaters, with lower shear stress along the channel margins lowering bank erosion risk making these channels very stable, despite their high confinement.

Table 1. Channel Dimensions and Bed Size Classes for Representative Cross Sections of Upper and Lower Greenwood Creek, 2001.

Segment	Bankfull Mean Depth (ft)	Bankfull Width (ft)	Floodprone Width (ft)	Entrenchment Ratio	Bed D50 (mm)	Bed D84 (mm)
Upper Greenwood	3.0	35	50	1.4	38	105
Lower Greenwood	3.5	49	75	1.5	48	250

Spawning gravel quality as indicated by permeability and bulk gravel observations appears to be good in Greenwood Creek as indicated from samples from upper Greenwood Creek (Table 2 and attached data). Percent fines less than 0.85 mm were 5% and <1% for the representative tail-out and high quality tail-out samples respectively. The survival percentage calculated by the Tappel and Bjorn (1983) equations indicates 83% survival to emergence ratio for the representative tail-out and 100% survival to emergence ratio for the high quality tail-out samples.

The stream gravel permeability in the segment in upper Greenwood Creek was moderate, with a mean permeability across the segment of 5,059 cm/hr. Typically permeability readings of 10,000 cm/hr are very good, with permeability readings less than 1000 cm/hr as very poor. The observations in upper Greenwood Creek are in the middle of this range. Using the survival relationship developed from Tagart (1976) and McCuddin (1977) this represents a survival percentage of 44%, with a standard error of +/- 32%. This survival relationship is only an index of spawning gravel quality in the segment. The permeability measurements are taken randomly in pool tail-outs and are not indicative of where a salmon may select to spawn. Furthermore, spawning salmon have been shown to improve permeability in gravel where a redd was developed by 30% to 70% (MRC, 2000). Therefore the survival percentage developed is only indicative of the quality of potential spawning habitat and not as an absolute number.

Table 2. Observations of Bulk Gravel and Permeability Measurements for Upper Greenwood Creek Stream Segment, 2001.

Site	Percent <0.85mm	Geometric Mean (mm)	Fredle Index	Survival Percent (Tappel and Bjorn)	Permeability (cm/hr)
Representative tail-out	5%	6.8	0.6	83%	-
High Quality Tail-out	<1%	9.6	5.3	100%	-
Entire Segment	-	-	-	-	5,059

Many of the observations of the channel monitoring segments cannot be interpreted until subsequent years of data are collected. The parameters in the monitoring segments will be repeated in subsequent years and will provide the basis for interpretations on changes to the stream channel and corresponding aquatic habitat over time.

Literature Cited

Barnard, K. and S. McBain. 1994. Standpipe to determine permeability, dissolved oxygen, and vertical particle size distribution in salmonid spawning gravels. Fish Habitat Relationships Tech. Bull. No. 15. USDA- Forest Service. Six Rivers National Forest. Eureka. CA. 12 p.

McCuddin. M.E. 1977. Survival of salmon and trout embryos and fry in gravel-sand mixtures. M.S. Thesis, University of Idaho, Moscow.

Mendocino Redwood Company. 2000. Preliminary results of redd vs.non-redd permeabilities in the Garcia, Abion and North Fork Navarro Rivers. Company Report, Fort Bragg, CA.

Montgomery. D. and J. Montgomery. 1993. Channel classification, prediction of channel response, and assessment of channel condition. Washington State Timber/Fish/Wildlife report TFW-SH10-93-002. Washington.

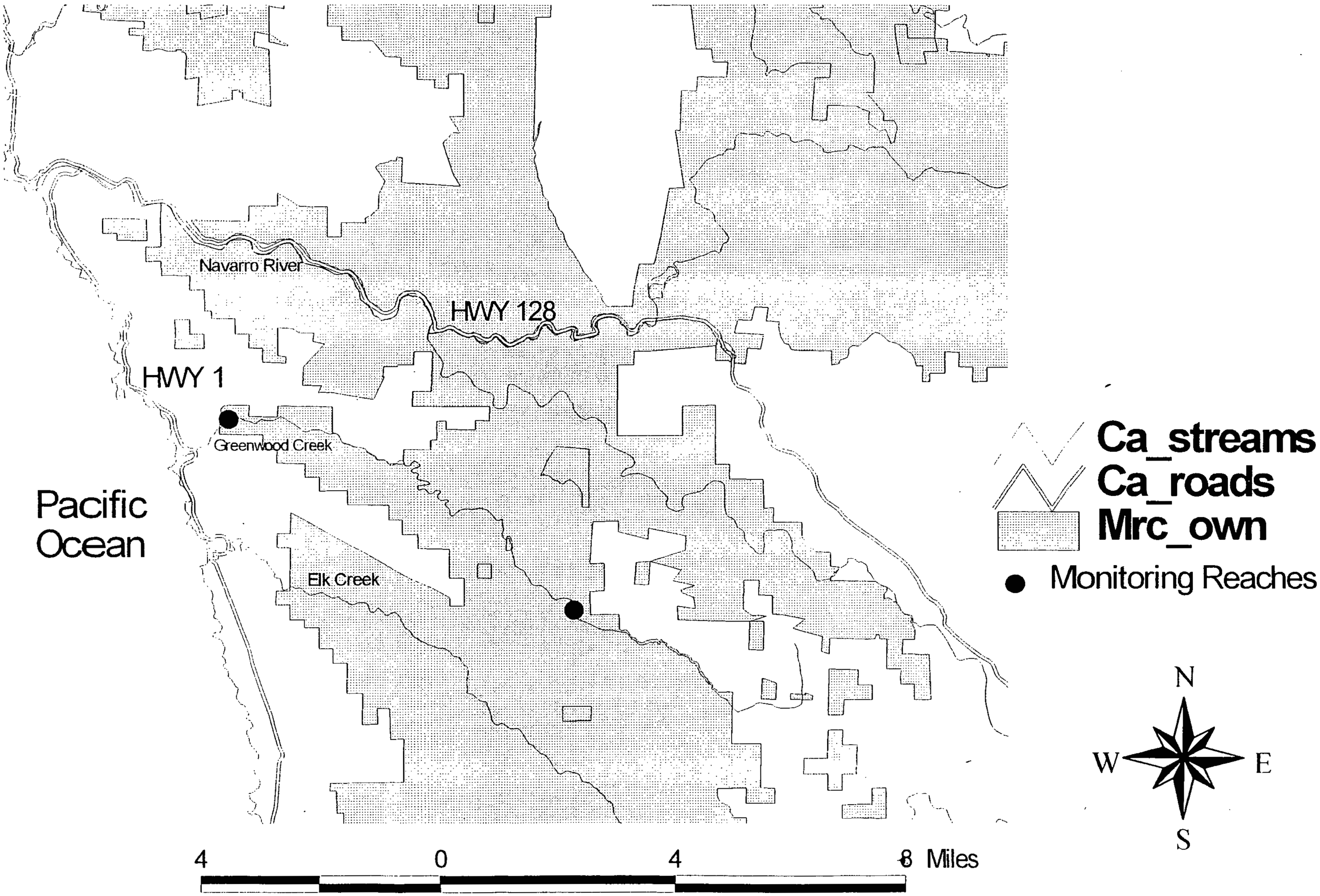
Rosgen. D. 1996. Applied river morphology. Wildland Hydrology, Pagosa Springs, CO.

Tagart, J.V. 1976. The survival from egg deposition to emergence of coho salmon in the Clearwater River, Jefferson County, Washington. M.S. Thesis, University of Washigton.

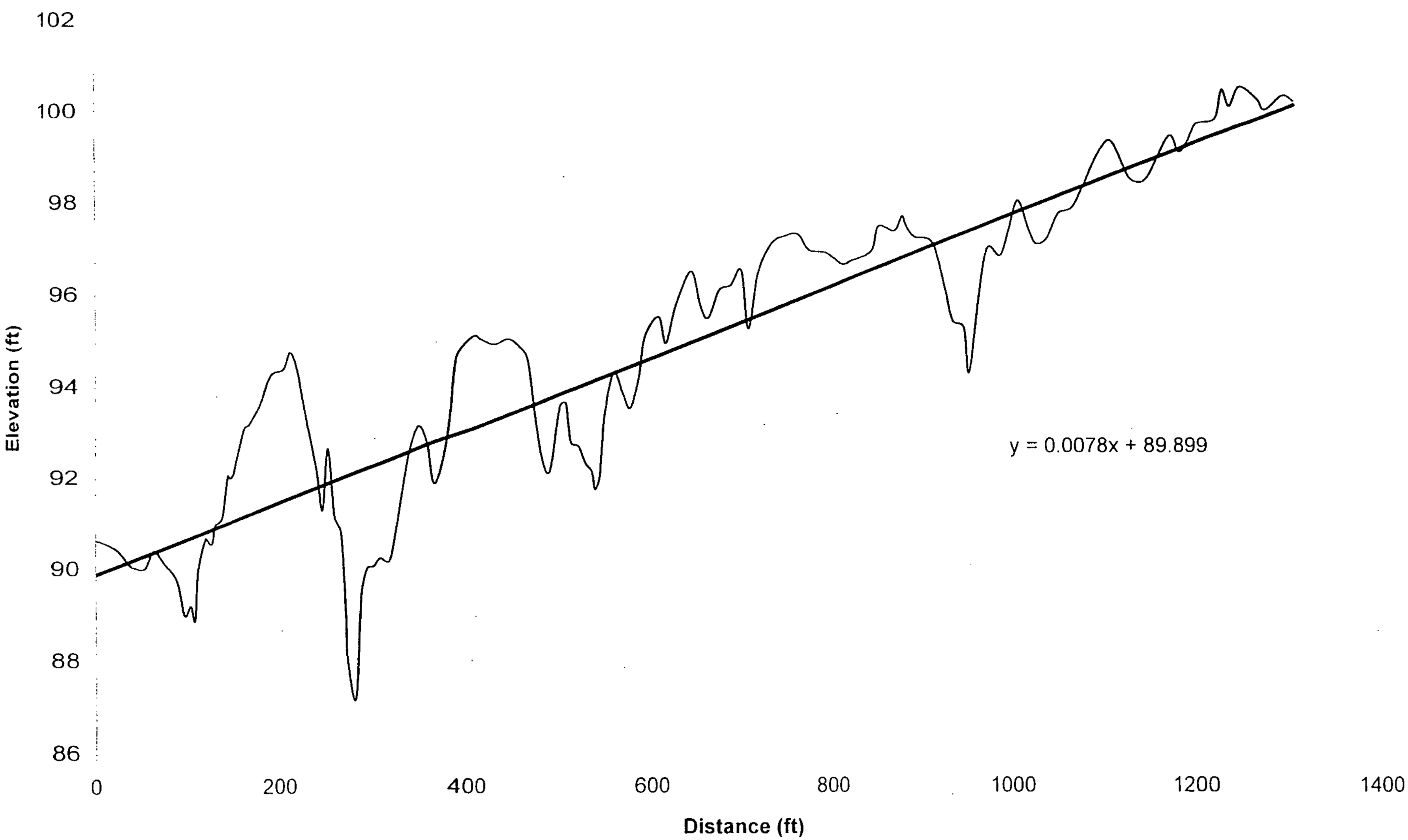
Tappel, P.D. and T.C. Bjorn. 1983. A new method of relating size of spawning gravel to salmonid embryo survival. North American Journal of Fisheries Management 3: 123-135.

Terhune. L. D. B. 1958. The Mark IV groundwater standpipe for measuring seepage through salmon spawning gravel. Fish Res. Bd. Canada, 15(5), pp. 1027-1063.

Greenwood Creek Long-term Channel Monitoring Reaches



Upper Greenwood Creek Thalweg Profile 9-21-01



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Report File: E:\ISAAC\GREENW~1\UPPERG~1\UPGRNTHS.TXT

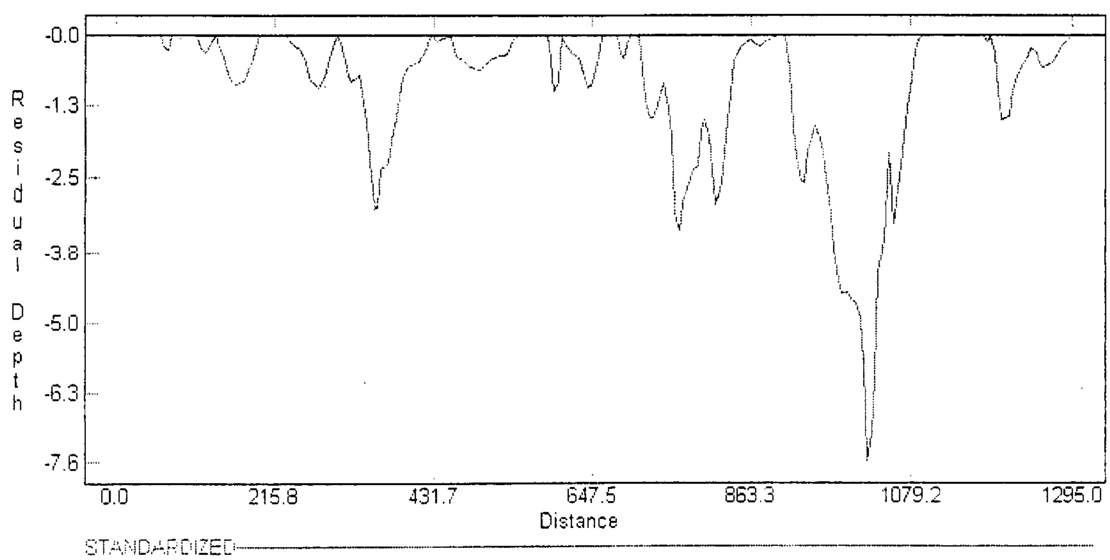
Long Profile Data File: E:\ISAAC\GREENW~1\UPPERG~1\UPGRNTHA.LPR
River Name:
Notes: Original Data file: E:\ISAAC\GREENW~1\UPPERG~1\UPGRNTHA.TXT
Measurement Units: U.S.

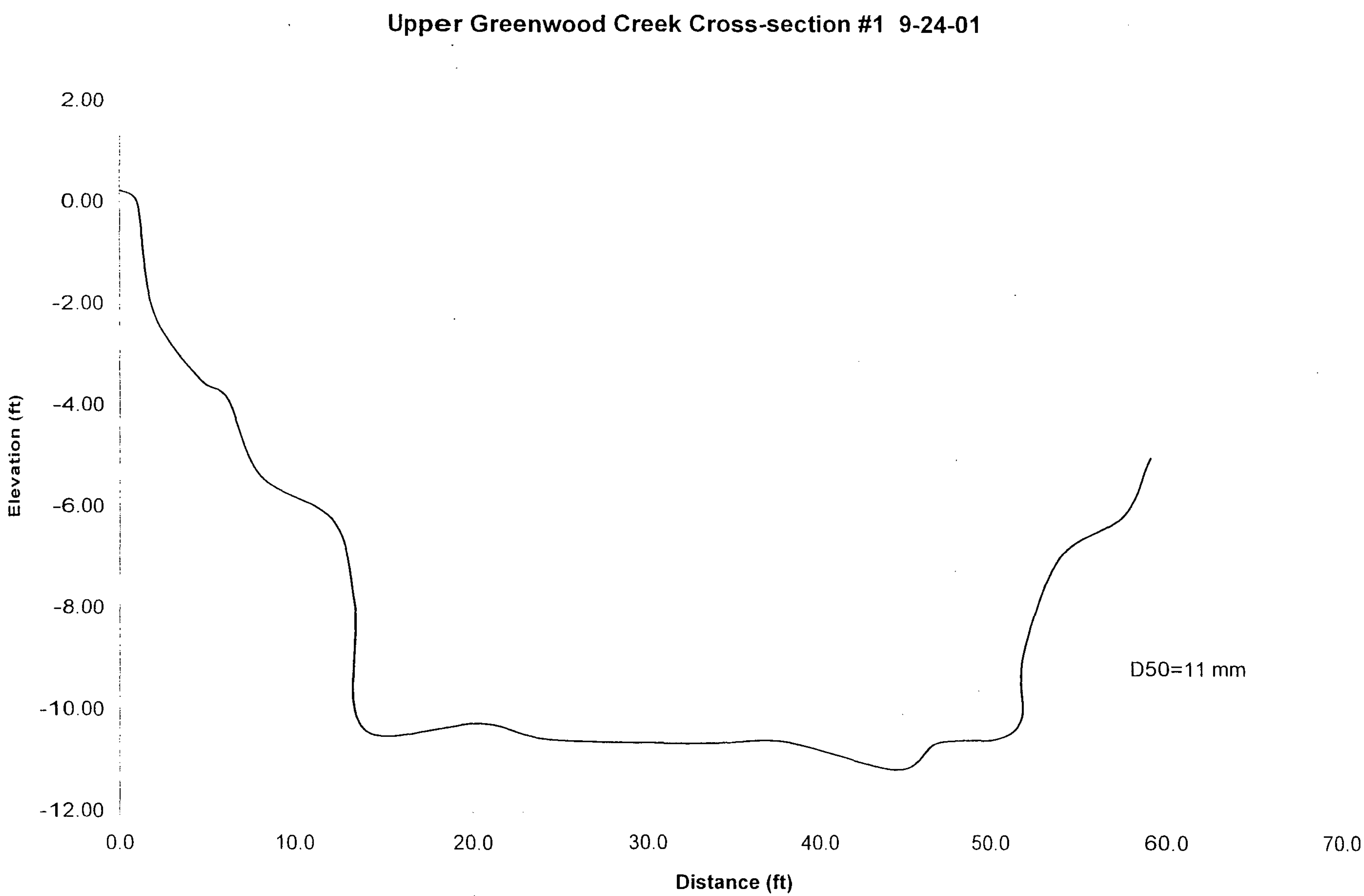
Top Elevation: 100.52
Bottom Elevation: 87.20
Reach Length: 1295.00

Standardized Statistics:
Number of data points in raw data: 133
Number of data points in Standardized data: 259

Reach Step Distance: 5.00

Max Residual Depth: 7.56
Mean Residual Depth: 0.91
Standard Deviation: 1.32





Upper Greenwood Creek Cross-section #1 9-24-01
2.00
0.00
-2.00
-4.00
-6.00
-8.00
-10.00
-12.00
Elevation (ft)
D50=11 mm
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
Distance (ft)

D50(mm) = 11

Pebble Count Form

Watershed: Upper Greenwood Date: 9/24/01

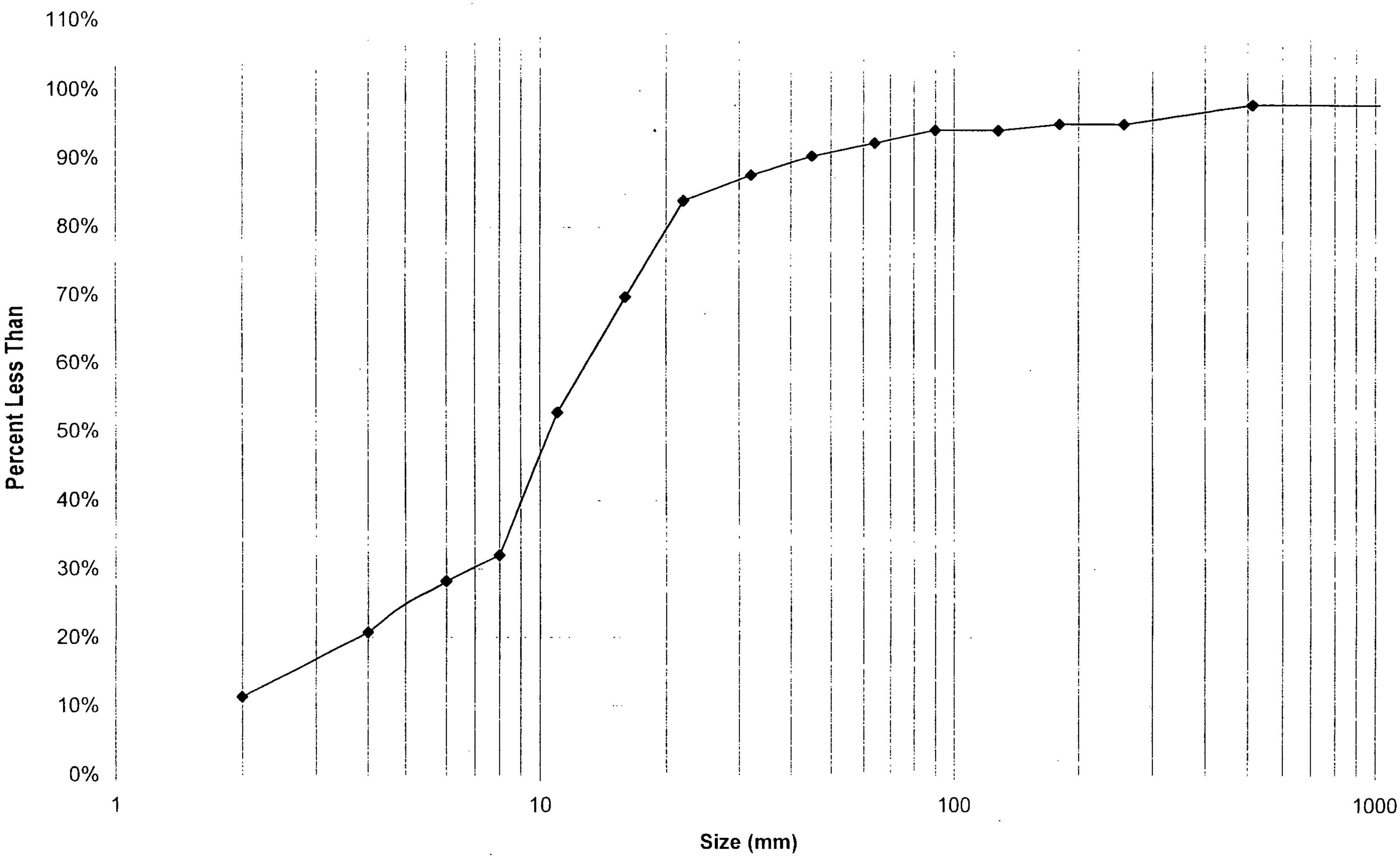
Stream Segment #: ____________

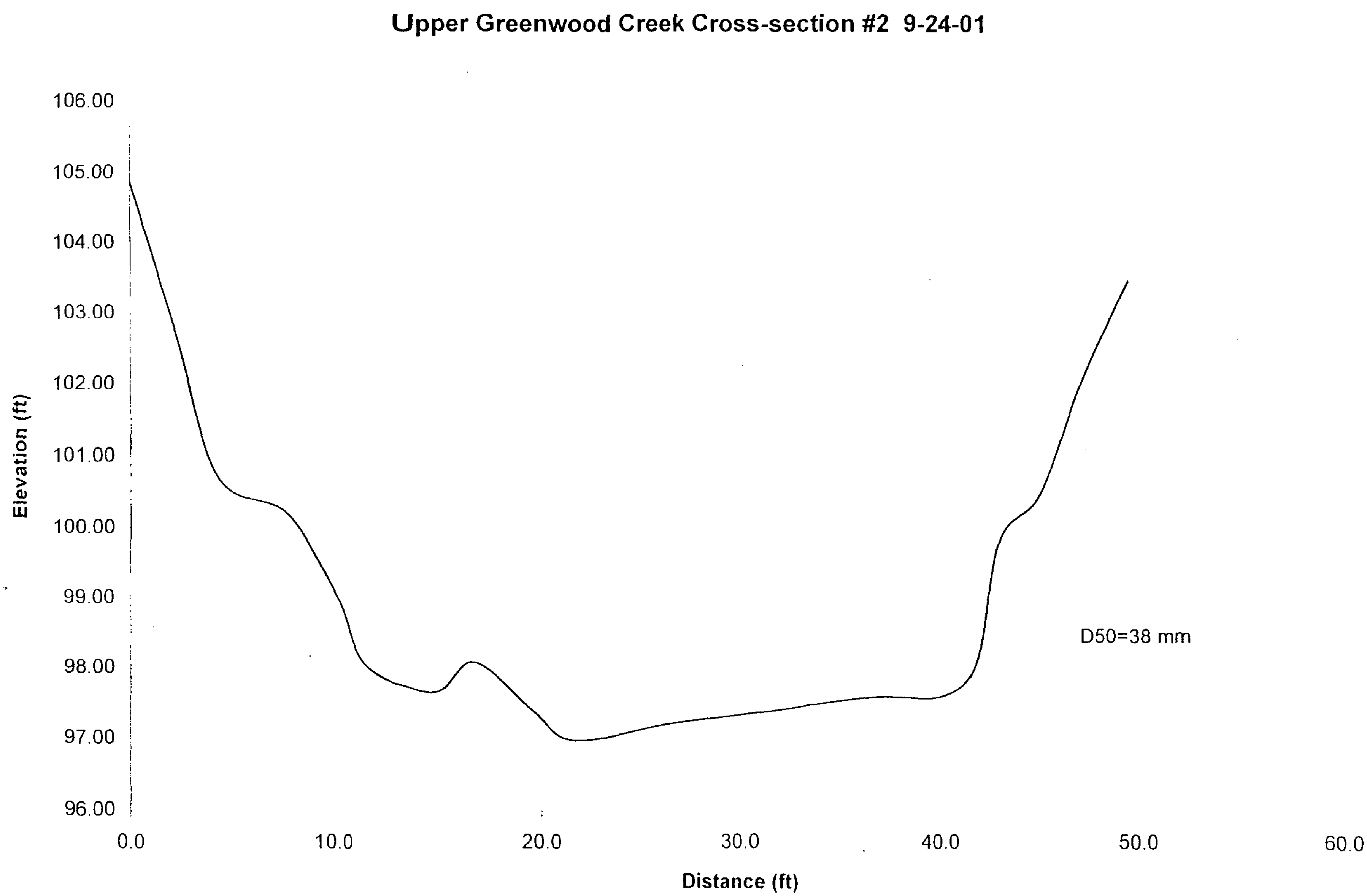
Location: X - section #1

Substrate Size Class (mm)		Talley	Number
Sand	<2	~~||||~~ ~~||||~~ ||	12
Very Fine Gravel	2-4	~~||||~~ ~~||||~~	10
Fine Gravel	5-6	~~||||~~ |||	8
Fine Gravel	7-8	||||	4
Medium Gravel	9-11	~~||||~~ ~~||||~~ ~~||||~~ ~~||||~~ ||	22
Medium Gravel	12-16	~~||||~~ ~~||||~~ ~~||||~~ |||	18
Coarse Gravel	17-22	~~||||~~ ~~||||~~ ~~||||~~	15
Coarse Gravel	23-32	||||	4
Very Coarse Gravel	33-45	|||	3
Very Coarse Gravel	46-64	||	2
Small Cobble	65-90	||	2
Medium Cobble	91-128		
Large Cobble	129-180	|	1
Very Large Cobble	181-256		
Small Boulder	257-512	|||	3
Medium Boulder	513-1024		
Large Boulder	1025-2048	|	1
Very Large Boulder	2049-4096	|	1

Mendocino Redwood Company, LLC

Upper Greenwood, X-Sec. 1, 9/24/01




Upper Greenwood Creek Cross-section #2 9-24-01
106.00
105.00
104.00
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
Elevation (ft)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
Distance (ft)
D50=38 mm

D50 (mm) = ~~39~~ 38

Pebble Count Form

Watershed: Upper Greenwood Date: 9-24-01

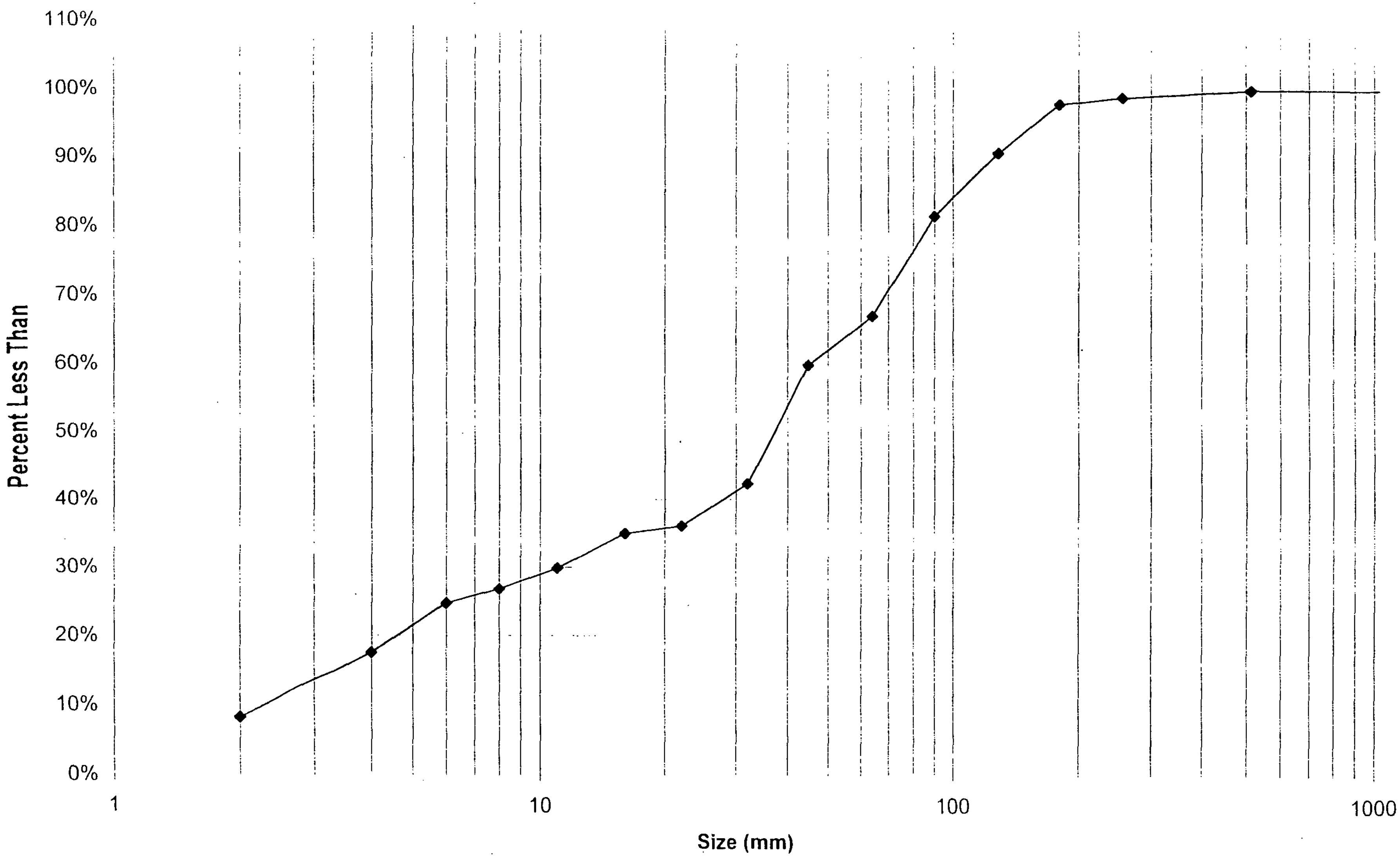
Stream Segment #: ______

Location: X-section #2

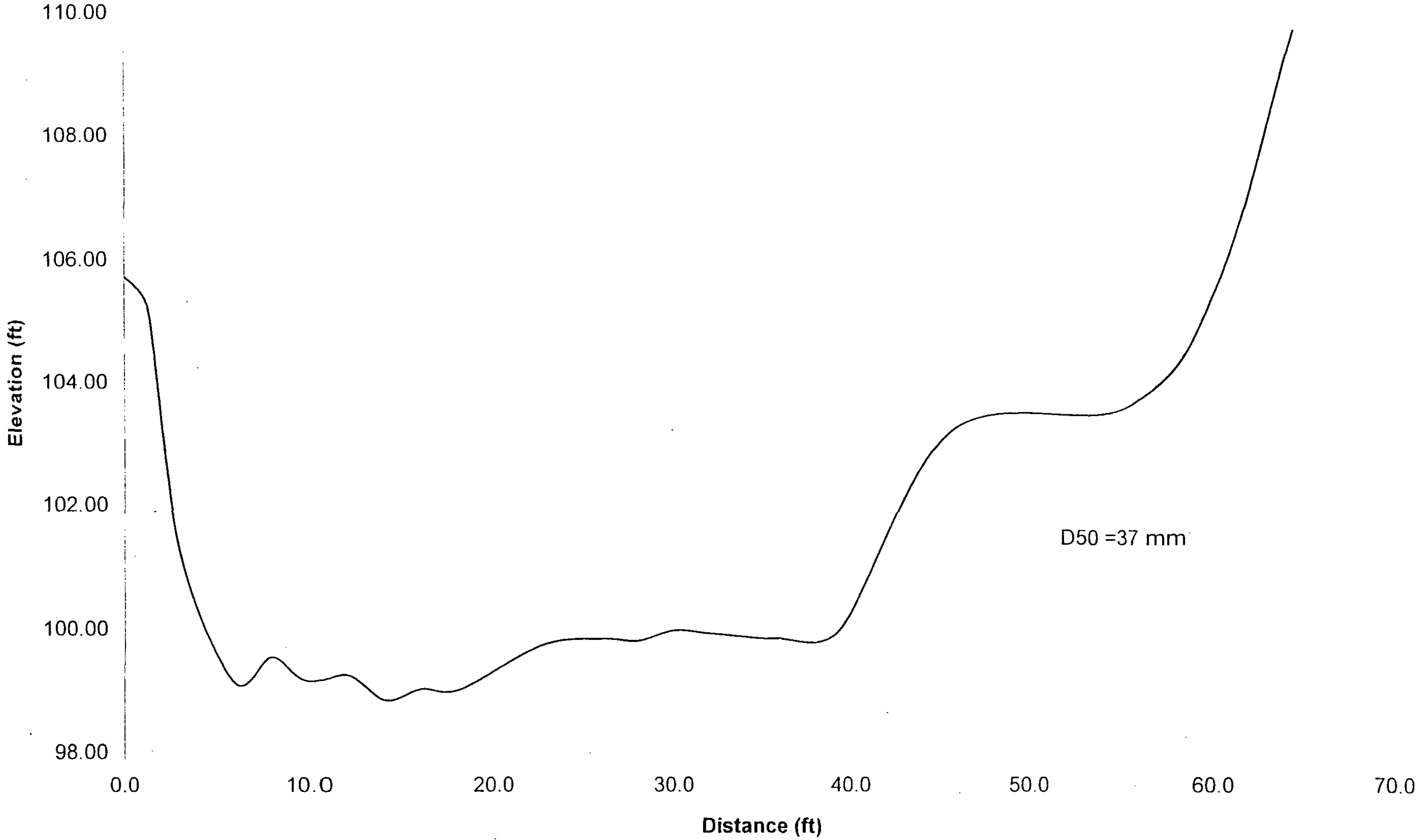
Substrate Size Class (mm)		Talley	Number
Sand	<2	卌 III	8
Very Fine Gravel	2-4	卌 IIII	9
Fine Gravel	5-6	卌 II	7
Fine Gravel	7-8	II	2
Medium Gravel	9-11	III	3
Medium Gravel	12-16	卌	5
Coarse Gravel	17-22	I	1
Coarse Gravel	23-32	卌 I	6
Very Coarse Gravel	33-45	卌 卌 卌 II	17
Very Coarse Gravel	46-64	卌 II	7
Small Cobble	65-90	卌 卌 IIII	14
Medium Cobble	91-128	卌 IIII	9
Large Cobble	129-180	卌 II	7
Very Large Cobble	181-256	I	1
Small Boulder	257-512	I	1
Medium Boulder	513-1024		
Large Boulder	1025-2048		
Very Large Boulder	2049-4096		

Mendocino Redwood Company, LLC

Upper Greenwood, X-Sec. 2, 9/24/01



Upper Greenwood Creek Cross-section #3 9-24-01



D50(mm) = 37

Pebble Count Form

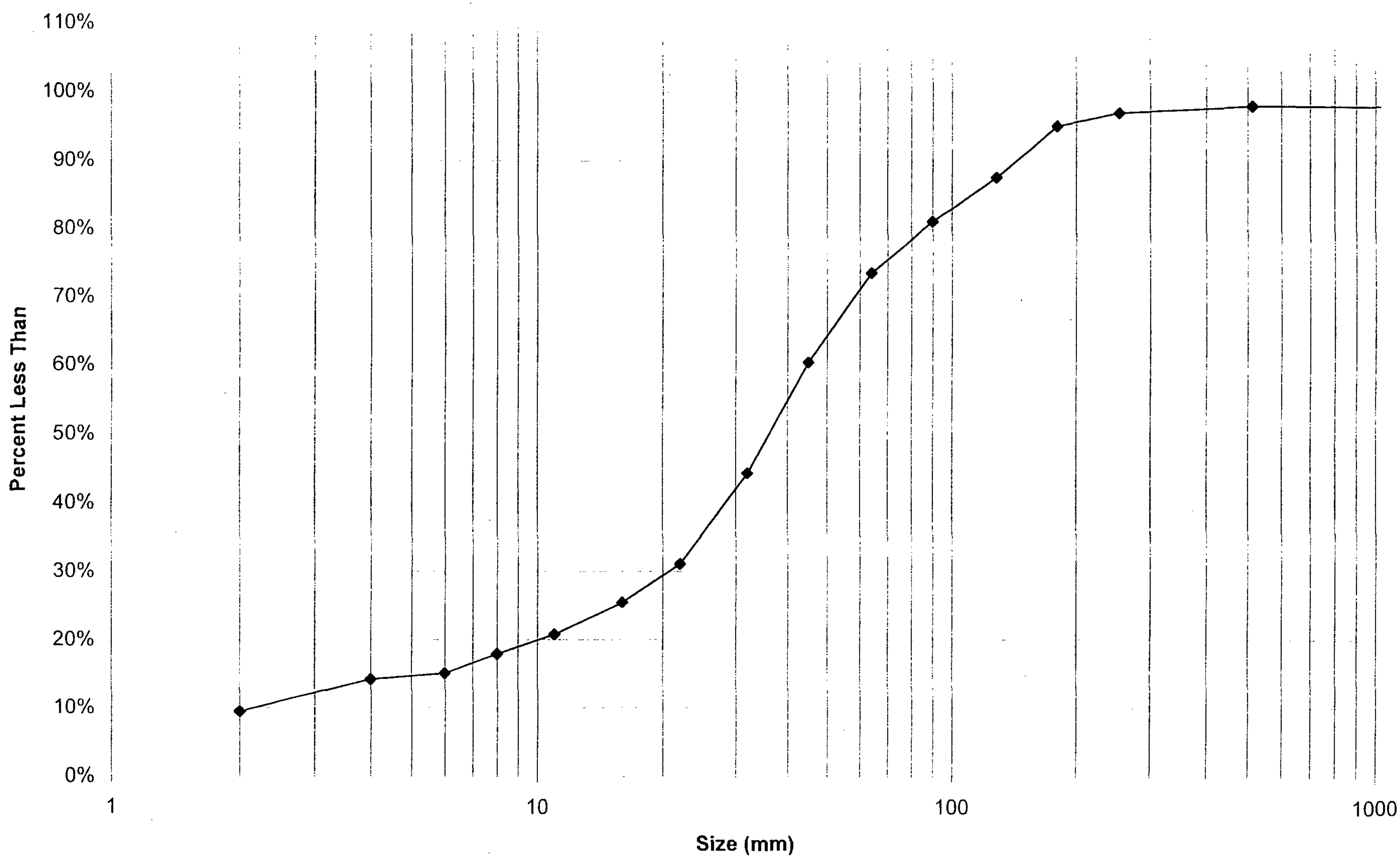
Watershed: Upper Greenwood Date: 9-24-01

Stream Segment #: ____________

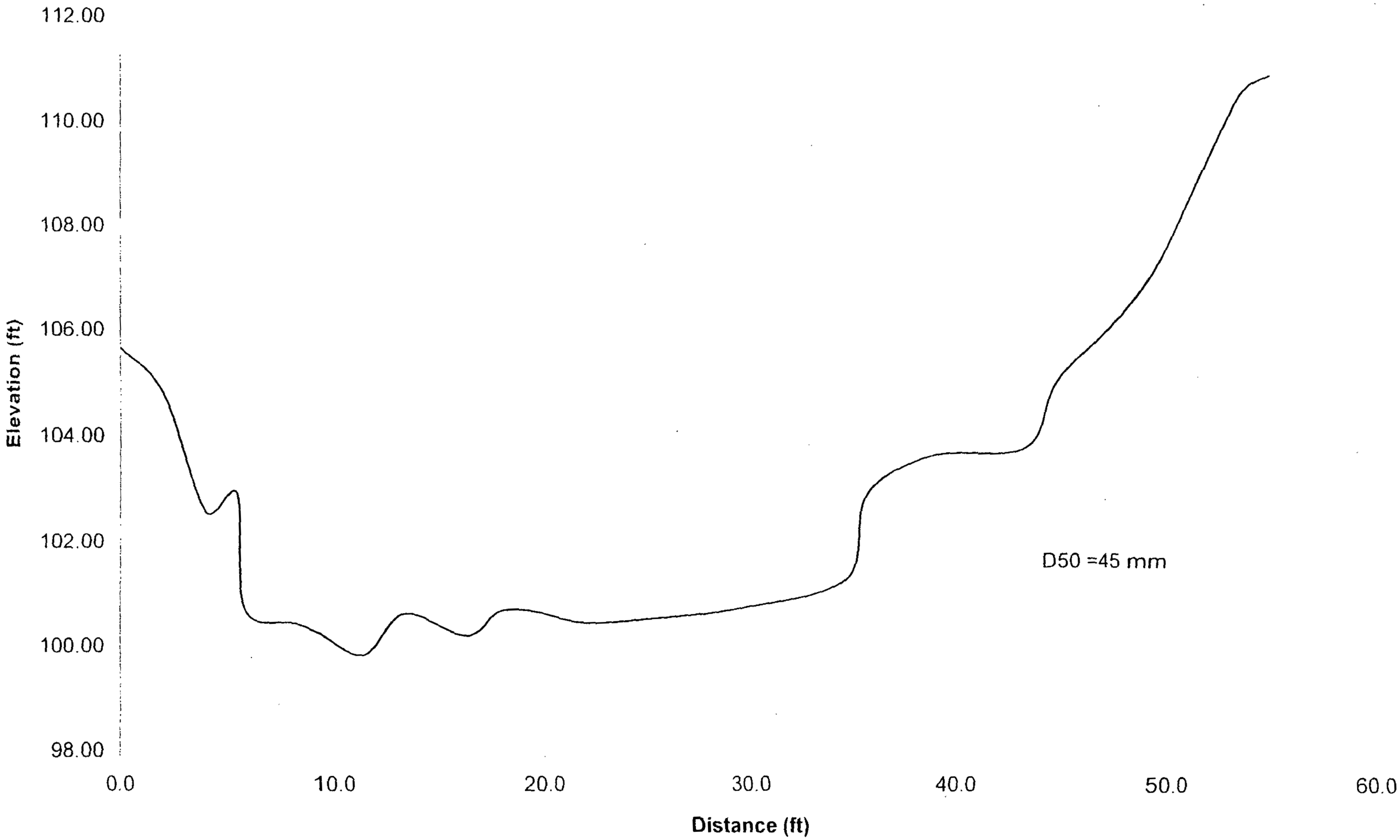
Location: X-section #3

Substrate Size Class (mm)		Talley	Number
Sand	<2	~~IIII~~ ~~IIII~~	10
Very Fine Gravel	2-4	~~IIII~~	5
Fine Gravel	5-6	I	1
Fine Gravel	7-8	III	3
Medium Gravel	9-11	III	3
Medium Gravel	12-16	~~IIII~~	5
Coarse Gravel	17-22	~~IIII~~ I	6
Coarse Gravel	23-32	~~IIII~~ ~~IIII~~ IIII	14
Very Coarse Gravel	33-45	~~IIII~~ ~~IIII~~ ~~IIII~~ II	17
Very Coarse Gravel	46-64	~~IIII~~ ~~IIII~~ IIII	14
Small Cobble	65-90	~~IIII~~ III	8
Medium Cobble	91-128	~~IIII~~ II	7
Large Cobble	129-180	~~IIII~~ III	8
Very Large Cobble	181-256	II	2
Small Boulder	257-512	I	1
Medium Boulder	513-1024		
Large Boulder	1025-2048	I	1
Very Large Boulder	2049-4096	I	1

Upper Greenwood, X-Sec. 3, 9/24/01



Upper Greenwood Creek Cross-section #4 9-21-01



D50(mm) = 45

Pebble Count Form

Watershed: Upper Greenwood   Date: 9 21 01

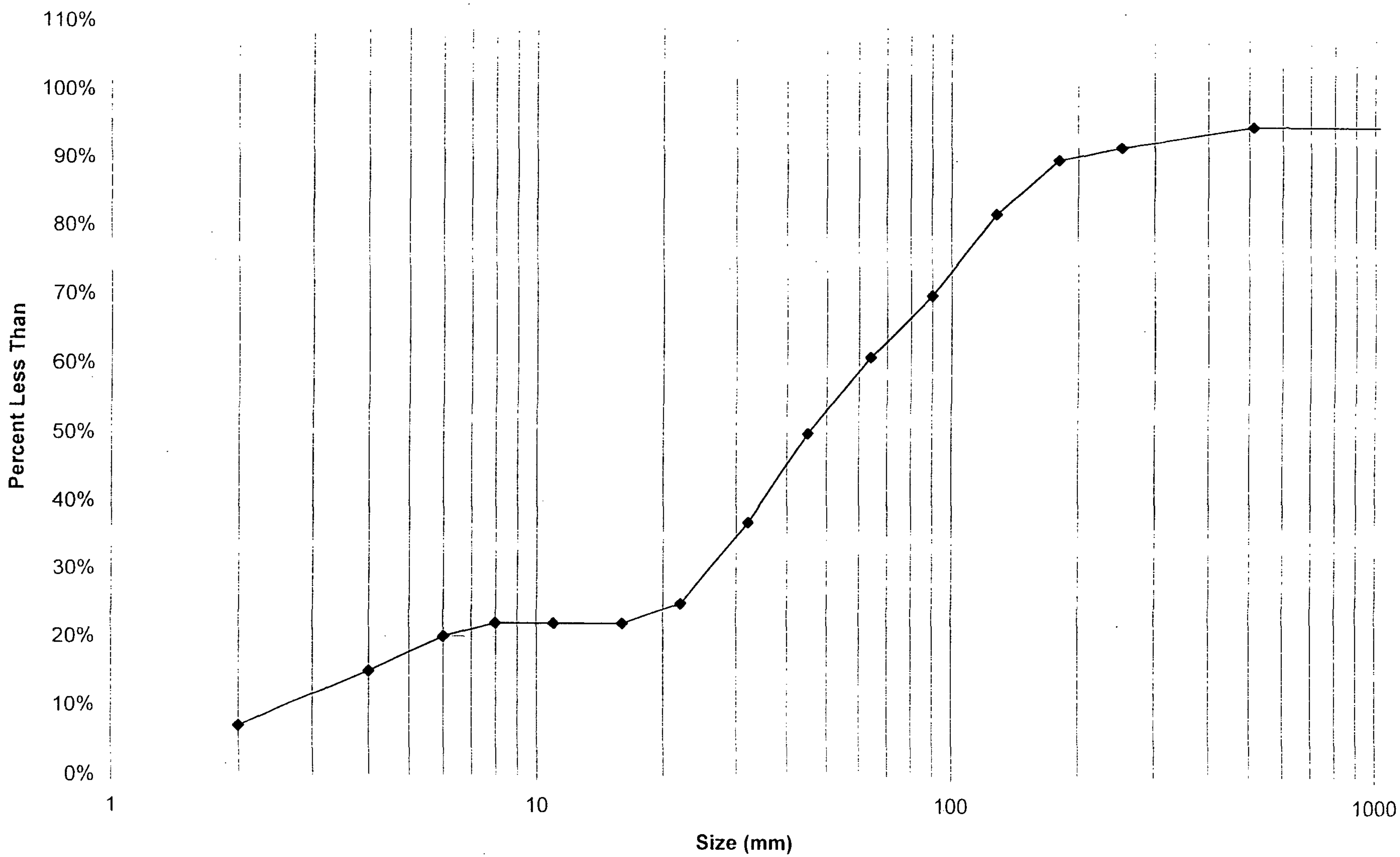
Stream Segment #: ______

Location: V-Sec 4 @ E.O.S.

Substrate Size Class (mm)		Talley	Number
Sand	<2	~~IIII~~ II	7
Very Fine Gravel	2-4	~~IIII~~ III	8
Fine Gravel	5-6	~~IIII~~	5
Fine Gravel	7-8	II	2
Medium Gravel	9-11		
Medium Gravel	12-16		
Coarse Gravel	17-22	III	3
Coarse Gravel	23-32	~~IIII~~ ~~IIII~~ II	12
Very Coarse Gravel	33-45	~~IIII~~ ~~IIII~~ III	13
Very Coarse Gravel	46-64	~~IIII~~ ~~IIII~~ I	11
Small Cobble	65-90	~~IIII~~ IIII	9
Medium Cobble	91-128	~~IIII~~ ~~IIII~~ II	12
Large Cobble	129-180	~~IIII~~ III	8
Very Large Cobble	181-256	II	2
Small Boulder	257-512	III	3
Medium Boulder	513-1024		
Large Boulder	1025-2048	III	3
~~Very Large~~ Boulder	2049-4096	II	2

Mendocino Redwood Company, LLC

Upper Greenwood, X-Sec. 4, 9/21/01



PERMEABILITY TEMPLATE
Mendocino Redwood Company, LLC

SITE: Upper Greenwood
Site #:

Date: 9/20/01

Crew: NL, DE
Sample Location: LT Channel Reach
NOTES:

Ambient Weather:

OUTPUT DATA HERE

STUDY SITE	Upper Greenwood	
DATE	09/20/01	
SITE LOCATION	LT Channel Reach	
ENTIRE SEGMENT	SURVIVAL PERCENT	44%
	STANDARD ERROR SURVIAL PERCENT	32%
	Mean of Sites' Median Permeability (cm/hr)	5,059 cm/hr
	STANDARD ERROR (of sites medians)	2208.47513
	Ln(MEAN of Median) PERMEABILITIES	8.5

ENTER DATA HERE — FOR SECOND MRC PERMEABILITY PUMP

Sample Water Temperature (C)	SAMPLE	REP	START GAGE READING (cm)	END GAGE READING (cm)	TIME (sec)	STAGE CHANGE (cm)	INFLOW (ml/s)	UNADJ. PERM. (cm/hr)	Vis. Corr.	ADJ. PERM. (cm/hr)	NOTES
11.5	1	1	0.0	1.7	30.1	1.7	3.7 ml/s	270 cm/hr	0.98	265 cm/hr	Tailout #1, Site #1
11.5		1	0.0	1.2	29.9	1.2	2.6 ml/s	175 cm/hr	0.98	172 cm/hr	Tailout #1, Site #1
11.5		3	0.0	1.3	30.1	1.3	2.8 ml/s	185 cm/hr	0.98	181 cm/hr	Tailout #1, Site #1
11.5		4	0.0	1.2	30.3	1.2	2.6 ml/s	175 cm/hr	0.98	172 cm/hr	Tailout #1, Site #1
11.5		5	0.0	1.4	30.0	1.4	3.0 ml/s	195 cm/hr	0.98	191 cm/hr	Tailout #1, Site #1
11.5	2	1	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.98	1 cm/hr	Tailout #1, Site #3
11.5		2	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.98	1 cm/hr	Tailout #1, Site #3
11.5		3	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.98	1 cm/hr	Tailout #1, Site #3
11.5		4	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.98	1 cm/hr	Tailout #1, Site #3
11.5		5	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.98	1 cm/hr	Tailout #1, Site #3
11.5	3	1	0.0	1.2	30.0	1.2	2.6 ml/s	175 cm/hr	0.98	172 cm/hr	Tailout #1, Site # 7
11.5		2	0.0	1.2	30.4	1.2	2.6 ml/s	175 cm/hr	0.98	172 cm/hr	Tailout #1, Site # 7
11.5		3	0.0	1.1	30.0	1.1	2.4 ml/s	160 cm/hr	0.98	157 cm/hr	Tailout #1, Site # 7
11.5		4	0.0	1.2	30.1	1.2	2.6 ml/s	175 cm/hr	0.98	172 cm/hr	Tailout #1, Site # 7
11.5		5	0.0	1.5	30.1	1.5	3.2 ml/s	220 cm/hr	0.98	216 cm/hr	Tailout #1, Site # 7
11.5	4	1	0.0	4.3	30.1	4.3	9.2 ml/s	825 cm/hr	0.98	809 cm/hr	Tailout #2, Site #4
11.5		2	0.0	5.2	30.0	5.2	11.2 ml/s	1,120 cm/hr	0.98	1,098 cm/hr	Tailout #2, Site #4
11.5		3	0.0	5.7	30.1	5.7	12.3 ml/s	1,230 cm/hr	0.98	1,205 cm/hr	Tailout #2, Site #4
11.5		4	0.0	5.6	30.1	5.6	12.0 ml/s	1,200 cm/hr	0.98	1,176 cm/hr	Tailout #2, Site #4
11.5		5	0.0	3.1	30.1	3.1	6.7 ml/s	575 cm/hr	0.98	564 cm/hr	Tailout #2, Site #4
11.5	5	1	0.0	12.6	32.7	12.6	24.9 ml/s	2,590 cm/hr	0.98	2,538 cm/hr	Tailout #2, Site #8
11.5		2	0.0	12.8	30.1	12.8	27.5 ml/s	2,850 cm/hr	0.98	2,793 cm/hr	Tailout #2, Site #8
11.5		3	0.0	13.7	30.0	13.7	29.5 ml/s	3,050 cm/hr	0.98	2,989 cm/hr	Tailout #2, Site #8
11.5		4	0.0	14.0	30.2	14.0	30.0 ml/s	3,100 cm/hr	0.98	3,038 cm/hr	Tailout #2, Site #8
11.5		5	0.0	14.9	30.0	14.9	32.1 ml/s	3,620 cm/hr	0.98	3,548 cm/hr	Tailout #2, Site #8
11.5	6	1	0.0	14.0	20.1	14.0	45.1 ml/s	5,620 cm/hr	0.98	5,508 cm/hr	Tailout #2, Site #12
11.5		2	0.0	15.0	20.2	15.0	48.0 ml/s	6,000 cm/hr	0.98	5,880 cm/hr	Tailout #2, Site #12
11.5		3	0.0	15.7	19.9	15.7	51.0 ml/s	7,100 cm/hr	0.98	6,958 cm/hr	Tailout #2, Site #12
11.5		4	0.0	15.4	20.0	15.4	49.8 ml/s	6,740 cm/hr	0.98	6,605 cm/hr	Tailout #2, Site #12
11.5		5	0.0	15.6	20.1	15.6	50.2 ml/s	6,860 cm/hr	0.98	6,723 cm/hr	Tailout #2, Site #12
12	7	1	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.97	1 cm/hr	Tailout #3, Site #2
12		2	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.97	1 cm/hr	Tailout #3, Site #2
12		3	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.97	1 cm/hr	Tailout #3, Site #2
12		4	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.97	1 cm/hr	Tailout #3, Site #2
12		5	0.0	0.1	30.0	0.1	0.2 ml/s	1 cm/hr	0.97	1 cm/hr	Tailout #3, Site #2
12	8	1	0.0	2.9	29.5	2.9	6.4 ml/s	540 cm/hr	0.97	521 cm/hr	Tailout #3, Site #5
12		2	0.0	2.8	29.9	2.8	6.1 ml/s	505 cm/hr	0.97	487 cm/hr	Tailout #3, Site #5
12		3	0.0	3.0	29.8	3.0	6.5 ml/s	550 cm/hr	0.97	531 cm/hr	Tailout #3, Site #5
12		4	0.0	3.5	29.7	3.5	7.6 ml/s	665 cm/hr	0.97	642 cm/hr	Tailout #3, Site #5
12		5	0.0	3.3	29.9	3.3	7.1 ml/s	605 cm/hr	0.97	584 cm/hr	Tailout #3, Site #5
12	9	1	0.0	0.4	30.0	0.4	0.9 ml/s	1 cm/hr	0.97	1 cm/hr	Tailout #3, Site #6
12		2	0.0	1.2	30.3	1.2	2.6 ml/s	175 cm/hr	0.97	169 cm/hr	Tailout #3, Site #6
12		3	0.0	1.3	29.9	1.3	2.8 ml/s	185 cm/hr	0.97	179 cm/hr	Tailout #3, Site #6
12		4	0.0	1.4	29.9	1.4	3.0 ml/s	195 cm/hr	0.97	188 cm/hr	Tailout #3, Site #6
12		5	0.0	1.1	30.1	1.1	2.4 ml/s	160 cm/hr	0.97	154 cm/hr	Tailout #3, Site #6
12	10	1	0.0	1.6	30.1	1.6	3.4 ml/s	240 cm/hr	0.97	232 cm/hr	Tailout #3, Site #11
12		2	0.0	1.9	29.9	1.9	4.1 ml/s	305 cm/hr	0.97	294 cm/hr	Tailout #3, Site #11
12		3	0.0	2.0	30.1	2.0	4.3 ml/s	320 cm/hr	0.97	309 cm/hr	Tailout #3, Site #11
12		4	0.0	1.8	29.9	1.8	3.9 ml/s	285 cm/hr	0.97	275 cm/hr	Tailout #3, Site #11
12		5	0.0	2.2	30.0	2.2	4.7 ml/s	360 cm/hr	0.97	347 cm/hr	Tailout #3, Site #11
13	11	1	0.0	8.5	30.0	8.5	18.3 ml/s	1,830 cm/hr	0.95	1,729 cm/hr	Tailout #4, Site #1
13		2	0.0	9.9	30.2	9.9	21.2 ml/s	2,220 cm/hr	0.95	2,098 cm/hr	Tailout #4, Site #1
13		3	0.0	10.1	29.2	10.1	22.4 ml/s	2,340 cm/hr	0.95	2,211 cm/hr	Tailout #4, Site #1
13		4	0.0	10.4	30.1	10.4	22.4 ml/s	2,340 cm/hr	0.95	2,211 cm/hr	Tailout #4, Site #1
13		5	0.0	11.3	30.3	11.3	24.1 ml/s	2,510 cm/hr	0.95	2,372 cm/hr	Tailout #4, Site #1
13	12	1	0.0	6.8	29.7	6.8	14.8 ml/s	1,480 cm/hr	0.95	1,399 cm/hr	Tailout #4, Site #4
13		2	0.0	7.1	29.9	7.1	15.4 ml/s	1,540 cm/hr	0.95	1,455 cm/hr	Tailout #4, Site #4
13		3	0.0	7.4	30.1	7.4	15.9 ml/s	1,590 cm/hr	0.95	1,503 cm/hr	Tailout #4, Site #4
13		4	0.0	8.2	29.9	8.2	17.7 ml/s	1,770 cm/hr	0.95	1,673 cm/hr	Tailout #4, Site #4
13		5	0.0	8.9	29.9	8.9	19.3 ml/s	1,940 cm/hr	0.95	1,833 cm/hr	Tailout #4, Site #4
13	13	1	0.0	15.6	14.8	15.6	68.2 ml/s	13,300 cm/hr	0.95	12,569 cm/hr	Tailout #4, Site #5
13		2	0.0	16.5	14.8	16.5	72.1 ml/s	15,270 cm/hr	0.95	14,430 cm/hr	Tailout #4, Site #5
13		3	0.0	16.4	15.1	16.4	70.3 ml/s	14,180 cm/hr	0.95	13,400 cm/hr	Tailout #4, Site #5
13		4	0.0	18.1	14.9	18.1	78.6 ml/s	19,880 cm/hr	0.95	18,787 cm/hr	Tailout #4, Site #5
13		5	0.0	17.3	14.9	17.3	75.1 ml/s	17,370 cm/hr	0.95	16,415 cm/hr	Tailout #4, Site #5
13	14	1	0.0	12.8	29.9	12.8	27.7 ml/s	2,870 cm/hr	0.95	2,712 cm/hr	Tailout #4, Site #12
13		2	0.0	12.8	30.0	12.8	27.6 ml/s	2,860 cm/hr	0.95	2,703 cm/hr	Tailout #4, Site #12
13		3	0.0	15.0	29.9	15.0	32.5 ml/s	3,700 cm/hr	0.95	3,497 cm/hr	Tailout #4, Site #12
13		4	0.0	14.7	29.8	14.7	31.9 ml/s	3,580 cm/hr	0.95	3,383 cm/hr	Tailout #4, Site #12
13		5	0.0	16.3	30.7	16.3	34.4 ml/s	4,080 cm/hr	0.95	3,856 cm/hr	Tailout #4, Site #12
12	15	1	0.0	8.8	15.0	8.8	38.0 ml/s	4,700 cm/hr	0.97	4,536 cm/hr	Tailout #5, Site #4
12		2	0.0	8.9	15.2	8.9	37.9 ml/s	4,690 cm/hr	0.97	4,526 cm/hr	Tailout #5, Site #4
12		3	0.0	9.1	15.2	9.1	38.7 ml/s	4,770 cm/hr	0.97	4,603 cm/hr	Tailout #5, Site #4
12		4	0.0	8.6	15.0	8.6	37.1 ml/s	4,610 cm/hr	0.97	4,449 cm/hr	Tailout #5, Site #4
12		5	0.0	9.2	14.9	9.2	39.9 ml/s	4,890 cm/hr	0.97	4,719 cm/hr	Tailout #5, Site #4
12	16	1	0.0	15.4	15.0	15.4	66.4 ml/s	12,580 cm/hr	0.97	12,140 cm/hr	Tailout #5, Site #6
12		2	0.0	16.9	15.1	16.9	72.4 ml/s	15,480 cm/hr	0.97	14,938 cm/hr	Tailout #5, Site #6
12		3	0.0	17.4	15.1	17.4	74.6 ml/s	17,020 cm/hr	0.97	16,424 cm/hr	Tailout #5, Site #6
12		4	0.0	17.8	15.1	17.8	76.3 ml/s	18,210 cm/hr	0.97	17,573 cm/hr	Tailout #5, Site #6
12		5	0.0	18.5	15.1	18.5	79.3 ml/s	20,440 cm/hr	0.97	19,725 cm/hr	Tailout #5, Site #6
12	17	1	0.0	17.3	15.0	17.3	74.6 ml/s	17,020 cm/hr	0.97	16,424 cm/hr	Tailout #5, Site #8
12		2	0.0	20.3	17.6	20.3	74.6 ml/s	17,020 cm/hr	0.97	16,424 cm/hr	Tailout #5, Site #8
12		3	0.0	17.9	14.9	17.9	77.7 ml/s	19,190 cm/hr	0.97	18,518 cm/hr	Tailout #5, Site #8
12		4	0.0	24.0	20.5	24.0	74.7 ml/s	17,090 cm/hr	0.97	16,492 cm/hr	Tailout #5, Site #8
12		5	0.0	18.6	15.2	18.6	79.2 ml/s	20,360 cm/hr	0.97	19,647 cm/hr	Tailout #5, Site #8
12	18	1	0.0	14.8	10.0	14.8	95.8 ml/s	42,800 cm/hr	0.97	41,302 cm/hr	Tailout #5, Site #11
12		2	0.0	14.3	10.1	14.3	91.6 ml/s	37,800 cm/hr	0.97	36,477 cm/hr	Tailout #5, Site #11
12		3	0.0	15.5	9.4	15.5	106.7 ml/s	83,500 cm/hr	0.97	80,578 cm/hr	Tailout #5, Site #11
12		4	0.0	14.9	9.9	14.9	97.4 ml/s	44,400 cm/hr	0.97	42,846 cm/hr	Tailout #5, Site #11
12		5	0.0	15.2	10.0	15.2	98.3 ml/s	45,300 cm/hr	0.97	43,715 cm/hr	Tailout #5, Site #11
13	19	1	0.0	9.2	29.8	9.2	20.0 ml/s	2,020 cm/hr	0.95	1,909 cm/hr	Tailout #6, Site #1
13		2	0.0	13.8	29.9	13.8	29.9 ml/s	3,090 cm/hr	0.95	2,920 cm/hr	Tailout #6, Site #1
13		3	0.0	16.1	30.0	16.1	34.7 ml/s	4,140 cm/hr	0.95	3,912 cm/hr	Tailout #6, Site #1
13		4	0.0	20.7	30.0	20.7	44.6 ml/s	5,620 cm/hr	0.95	5,311 cm/hr	Tailout #6, Site #1
13		5	0.0	20.0	29.9	20.0	43.3 ml/s	5,460 cm/hr	0.95	5,160 cm/hr	Tailout #6, Site #1
13	20	1	0.0	4.4	30.0	4.4	9.5 ml/s	850 cm/hr	0.95	803 cm/hr	Tailout #6, Site #4
13		2	0.0	4.8	29.9	4.8	10.4 ml/s	950 cm/hr	0.95	898 cm/hr	Tailout #6, Site #4
13		3	0.0	5.4	30.2	5.4	11.6 ml/s	1,160 cm/hr	0.95	1,096 cm/hr	Tailout #6, Site #4

SAMPLE 1	MEDIAN PERMEABILITY (cm/hr)	181 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	5 cm/hr	
	MEAN PERMEABILITY (cm/hr)	196	
	STANDARD DEVIATION	39	
	SURVIVAL PERCENT	0	-4%
SAMPLE 2	MEDIAN PERMEABILITY (cm/hr)	1 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	0 cm/hr	
	MEAN PERMEABILITY (cm/hr)	1	
	STANDARD DEVIATION	0	
	SURVIVAL PERCENT	0	-82%
SAMPLE 3	MEDIAN PERMEABILITY (cm/hr)	172 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	5 cm/hr	
	MEAN PERMEABILITY (cm/hr)	177	
	STANDARD DEVIATION	22	
	SURVIVAL PERCENT	0	-5%
SAMPLE 4	MEDIAN PERMEABILITY (cm/hr)	1,098 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	7 cm/hr	
	MEAN PERMEABILITY (cm/hr)	970	
	STANDARD DEVIATION	276	
	SURVIVAL PERCENT	0.22650114	23%
SAMPLE 5	MEDIAN PERMEABILITY (cm/hr)	2,989 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	8 cm/hr	
	MEAN PERMEABILITY (cm/hr)	2981	
	STANDARD DEVIATION	373	
	SURVIVAL PERCENT	0.375580918	38%
SAMPLE 6	MEDIAN PERMEABILITY (cm/hr)	6,605 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	9 cm/hr	
	MEAN PERMEABILITY (cm/hr)	6335	
	STANDARD DEVIATION	613	
	SURVIVAL PERCENT	0.493575096	49%
SAMPLE 7	MEDIAN PERMEABILITY (cm/hr)	1 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	0 cm/hr	
	MEAN PERMEABILITY (cm/hr)	1	
	STANDARD DEVIATION	0	
	SURVIVAL PERCENT	0	-82%
SAMPLE 8	MEDIAN PERMEABILITY (cm/hr)	531 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	6 cm/hr	
	MEAN PERMEABILITY (cm/hr)	553	
	STANDARD DEVIATION	61	
	SURVIVAL PERCENT	0.118377259	12%
SAMPLE 9	MEDIAN PERMEABILITY (cm/hr)	169 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	5 cm/hr	
	MEAN PERMEABILITY (cm/hr)	138	
	STANDARD DEVIATION	78	
	SURVIVAL PERCENT	-6%	
SAMPLE 10	MEDIAN PERMEABILITY (cm/hr)	294 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	6 cm/hr	
	MEAN PERMEABILITY (cm/hr)	291	
	STANDARD DEVIATION	43	
	SURVIVAL PERCENT	0.030637815	3%
SAMPLE 11	MEDIAN PERMEABILITY (cm/hr)	2,211 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	8 cm/hr	
	MEAN PERMEABILITY (cm/hr)	2124	
	STANDARD DEVIATION	241	
	SURVIVAL PERCENT	0.330735789	33%
SAMPLE 12	MEDIAN PERMEABILITY (cm/hr)	1,503 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	7 cm/hr	
	MEAN PERMEABILITY (cm/hr)	1572	
	STANDARD DEVIATION	178	
	SURVIVAL PERCENT	0.273233088	27%
SAMPLE 13	MEDIAN PERMEABILITY (cm/hr)	14,430 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	10 cm/hr	
	MEAN PERMEABILITY (cm/hr)	15120	
	STANDARD DEVIATION	2503	
	SURVIVAL PERCENT	0.609864538	61%
SAMPLE 14	MEDIAN PERMEABILITY (cm/hr)	3,383 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	8 cm/hr	
	MEAN PERMEABILITY (cm/hr)	3230	
	STANDARD DEVIATION	508	
	SURVIVAL PERCENT	0.394011567	39%
SAMPLE 15	MEDIAN PERMEABILITY (cm/hr)	4,536 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	8 cm/hr	
	MEAN PERMEABILITY (cm/hr)	4566	
	STANDARD DEVIATION	101	
	SURVIVAL PERCENT	0.43763416	44%
SAMPLE 16	MEDIAN PERMEABILITY (cm/hr)	16,424 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	10 cm/hr	
	MEAN PERMEABILITY (cm/hr)	16160	
	STANDARD DEVIATION	2847	
	SURVIVAL PERCENT	0.629126828	63%
SAMPLE 17	MEDIAN PERMEABILITY (cm/hr)	16,492 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	10 cm/hr	
	MEAN PERMEABILITY (cm/hr)	17501	
	STANDARD DEVIATION	1498	
	SURVIVAL PERCENT	0.6297376	63%
SAMPLE 18	MEDIAN PERMEABILITY (cm/hr)	42,846 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	11 cm/hr	
	MEAN PERMEABILITY (cm/hr)	48983	
	STANDARD DEVIATION	17882	
	SURVIVAL PERCENT	0.771813346	77%
SAMPLE 19	MEDIAN PERMEABILITY (cm/hr)	3,912 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	8 cm/hr	
	MEAN PERMEABILITY (cm/hr)	3842	
	STANDARD DEVIATION	1457	
	SURVIVAL PERCENT	0.415638569	42%
SAMPLE 20	MEDIAN PERMEABILITY (cm/hr)	803 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	7 cm/hr	
	MEAN PERMEABILITY (cm/hr)	832	

13		4	0.0	3.6	30.1	3.6	7.7 m/s	675 cm/hr	0.95	638 cm/hr	Tailout #6, Site #4
13		5	0.0	4.0	30.0	4.0	8.6 m/s	765 cm/hr	0.95	723 cm/hr	Tailout #6, Site #4
13	21	1	0.0	5.1	20.0	5.1	16.5 m/s	1,650 cm/hr	0.95	1,559 cm/hr	Tailout #6, Site #8
13		2	0.0	5.7	19.9	5.7	18.5 m/s	1,850 cm/hr	0.95	1,748 cm/hr	Tailout #6, Site #8
13		3	0.0	5.7	20.1	5.7	18.3 m/s	1,830 cm/hr	0.95	1,729 cm/hr	Tailout #6, Site #8
13		4	0.0	5.6	20.1	5.6	18.0 m/s	1,800 cm/hr	0.95	1,701 cm/hr	Tailout #6, Site #8
13		5	0.0	6.2	20.1	6.2	20.0 m/s	2,020 cm/hr	0.95	1,909 cm/hr	Tailout #6, Site #8
13	22	1	0.0	10.5	20.7	10.5	32.8 m/s	3,760 cm/hr	0.95	3,553 cm/hr	Tailout #6, Site #10
13		2	0.0	14.5	20.1	14.5	46.7 m/s	5,840 cm/hr	0.95	5,519 cm/hr	Tailout #6, Site #10
13		3	0.0	15.9	20.1	15.9	51.2 m/s	7,160 cm/hr	0.95	6,766 cm/hr	Tailout #6, Site #10
13		4	0.0	17.2	20.2	17.2	55.1 m/s	8,650 cm/hr	0.95	8,174 cm/hr	Tailout #6, Site #10
13		5	0.0	18.1	20.0	18.1	58.6 m/s	9,880 cm/hr	0.95	9,337 cm/hr	Tailout #6, Site #10
14	23	1	0.0	0.1	30.0	0.1	0.2 m/s	1 cm/hr	0.93	1 cm/hr	Tailout #7, Site #2
14		2	0.0	0.1	30.0	0.1	0.2 m/s	1 cm/hr	0.93	1 cm/hr	Tailout #7, Site #2
14		3	0.0	0.1	30.0	0.1	0.2 m/s	1 cm/hr	0.93	1 cm/hr	Tailout #7, Site #2
14		4	0.0	0.1	30.0	0.1	0.2 m/s	1 cm/hr	0.93	1 cm/hr	Tailout #7, Site #2
14		5	0.0	0.1	30.0	0.1	0.2 m/s	1 cm/hr	0.93	1 cm/hr	Tailout #7, Site #2
14	24	1	0.0	5.4	19.8	5.4	17.6 m/s	1,760 cm/hr	0.93	1,628 cm/hr	Tailout #7, Site #7
14		2	0.0	7.0	20.1	7.0	22.5 m/s	2,350 cm/hr	0.93	2,174 cm/hr	Tailout #7, Site #7
14		3	0.0	7.4	20.9	7.4	22.9 m/s	2,390 cm/hr	0.93	2,211 cm/hr	Tailout #7, Site #7
14		4	0.0	7.5	20.1	7.5	24.1 m/s	2,510 cm/hr	0.93	2,322 cm/hr	Tailout #7, Site #7
14		5	0.0	7.5	20.1	7.5	24.1 m/s	2,510 cm/hr	0.93	2,322 cm/hr	Tailout #7, Site #7
14	25	1	0.0	1.6	29.9	1.6	3.5 m/s	250 cm/hr	0.93	231 cm/hr	Tailout #7, Site #9
14		2	0.0	1.8	30.3	1.8	3.8 m/s	280 cm/hr	0.93	259 cm/hr	Tailout #7, Site #9
14		3	0.0	2.0	29.8	2.0	4.3 m/s	320 cm/hr	0.93	296 cm/hr	Tailout #7, Site #9
14		4	0.0	1.7	30.0	1.7	3.7 m/s	270 cm/hr	0.93	250 cm/hr	Tailout #7, Site #9
14		5	0.0	2.2	30.2	2.2	4.7 m/s	360 cm/hr	0.93	333 cm/hr	Tailout #7, Site #9
14	26	1	0.0	9.4	30.2	9.4	20.1 m/s	2,070 cm/hr	0.93	1,915 cm/hr	Tailout #7, Site #11
14		2	0.0	9.5	29.9	9.5	20.6 m/s	2,160 cm/hr	0.93	1,998 cm/hr	Tailout #7, Site #11
14		3	0.0	9.4	30.1	9.4	20.2 m/s	2,100 cm/hr	0.93	1,943 cm/hr	Tailout #7, Site #11
14		4	0.0	9.4	29.2	9.4	20.8 m/s	2,180 cm/hr	0.93	2,017 cm/hr	Tailout #7, Site #11
14		5	0.0	9.5	30.0	9.5	20.5 m/s	2,150 cm/hr	0.93	1,989 cm/hr	Tailout #7, Site #11

	STANDARD DEVIATION	176	
	SURVIVAL PERCENT	0.180040387	18%
SAMPLE 21	MEDIAN PERMEABILITY (cm/hr)	1,729 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	7 cm/hr	
	MEAN PERMEABILITY (cm/hr)	1729	
	STANDARD DEVIATION	125	
	SURVIVAL PERCENT	0.294153088	29%
SAMPLE 22	MEDIAN PERMEABILITY (cm/hr)	6,766 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	9 cm/hr	
	MEAN PERMEABILITY (cm/hr)	6670	
	STANDARD DEVIATION	2260	
	SURVIVAL PERCENT	0.497156799	50%
SAMPLE 23	MEDIAN PERMEABILITY (cm/hr)	1 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	0 cm/hr	
	MEAN PERMEABILITY (cm/hr)	1	
	STANDARD DEVIATION	0	
	SURVIVAL PERCENT	0	-83%
SAMPLE 24	MEDIAN PERMEABILITY (cm/hr)	2,211 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	8 cm/hr	
	MEAN PERMEABILITY (cm/hr)	2131	
	STANDARD DEVIATION	289	
	SURVIVAL PERCENT	0.330698772	33%
SAMPLE 25	MEDIAN PERMEABILITY (cm/hr)	259 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	6 cm/hr	
	MEAN PERMEABILITY (cm/hr)	274	
	STANDARD DEVIATION	41	
	SURVIVAL PERCENT	0.011611584	1%
SAMPLE 26	MEDIAN PERMEABILITY (cm/hr)	1,989 cm/hr	
	MEDIAN ln PERMEABILITY (cm/hr)	8 cm/hr	
	MEAN PERMEABILITY (cm/hr)	1972	
	STANDARD DEVIATION	42	
	SURVIVAL PERCENT	0.314950876	31%

McNeil Data Entry Sheet

All data entry is done in yellow boxes.
Enter the name or designator of sample location.
Enter the weight in lbs. and oz. for each size class.
Enter the date the McNeil sample was taken (preferrably day/mo.yr but yr. at the minimum)
Enter Permeability of site if known.
This workbook allows the entry of 100 McNeil samples
Go to Tally Sheet for tabular results.
(if two depths were sampled, the two depths need to be consecutive in the entryto be combined in the ta

Data Set Name: **Upper Greenwood** **Perm if Ap**

#

1 **Name:** **Bottom Tailout** **Date of Sample:** **9/20/01**

Size (mm)	lbs	oz
>50.8	25	7
>25.4	9	1
>12.5	7	11.5
>6.3	6	7
>4.75	2	6
>2.36	6	12
>0/85	6	0
<0.85	3	5

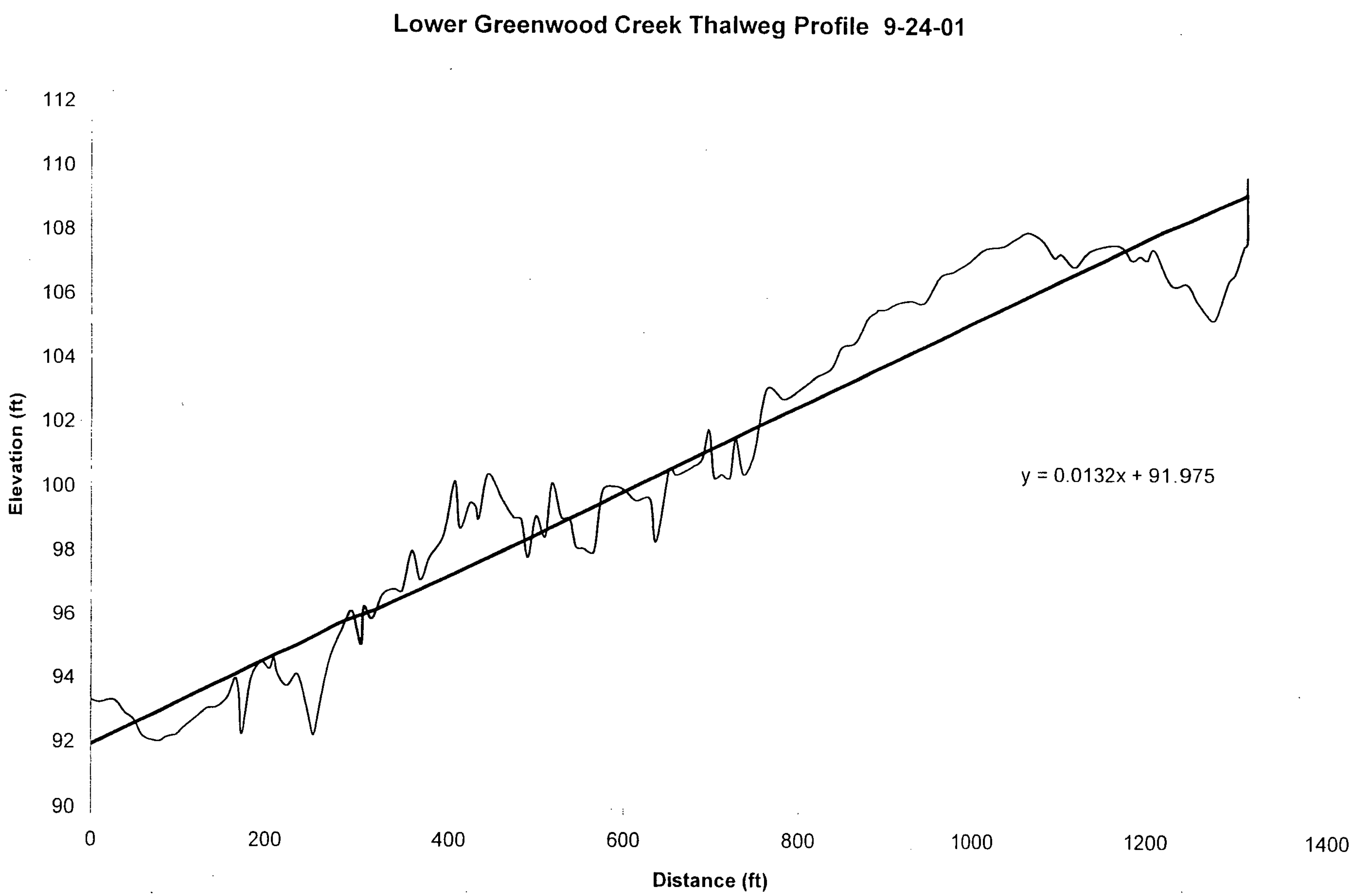
Perm if Ap

2 **Name:** **Upper Tailout** **Date of Sample:** **9/20/01**

Size (mm)	lbs	oz
>50.8	0	8
>25.4	10	15
>12.5	30	1
>6.3	10	14
>4.75	0	9
>2.36	0	4
>0/85	0	1
<0.85	0	2

Upper Greenwood

#	Name	Date	%>50.8 mm	%<50.8 mm	%<25.4 mm	%<12.5 mm	%<6.3 mm	%<4.75 mm	%<2.36 mm	%<0.85 mm	d84	d75	d25	d16	Geometric Mean (Dg)	D75/D25 (Sc)	Fredle Index (Dg/Sc)	TB Index
1	Bottom Tailout	37154	100%	62%	49%	37%	27%	24%	14%	5%	40.1	34.1	3.1	1.2	6.8	11.1	0.6	83
2	Upper Tailout	37154	100%	99%	79%	22%	2%	1%	0%	0%	15.9	12.1	6.6	5.8	9.6	1.8	5.3	100


Lower Greenwood Creek Thalweg Profile 9-24-01
Elevation (ft)
112
110
108
106
104
102
100
98
96
94
92
90
0
200
400
600
800
1000
1200
1400
Distance (ft)
y = 0.0132x + 91.975

Sep 27, 2001 - 7:28 a.m.
Report File: E:\ISAAC\STREAM~1\2001\GREENW~1\LOWERG~1\LOGRNTHS.TXT

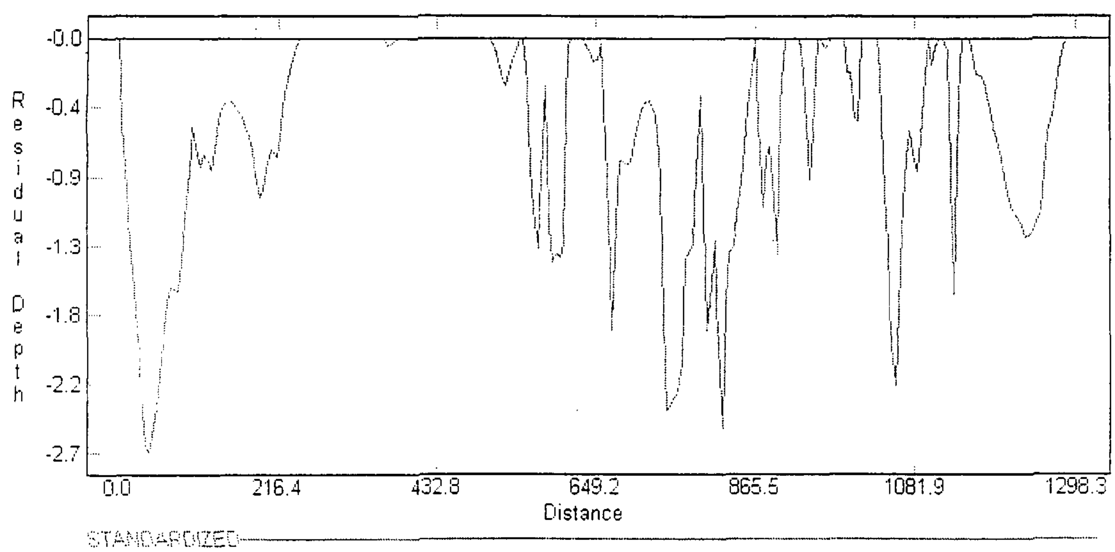
Long Profile Data File:
E:\ISAAC\STREAM~1\2001\GREENW~1\LOWERG~1\LOGRNTHA.LPR
River Name:
Notes: Original Data file:
E:\ISAAC\STREAM~1\2001\GREENW~1\LOWERG~1\LOGRNTHA.TXT
Measurement Units: U.S.

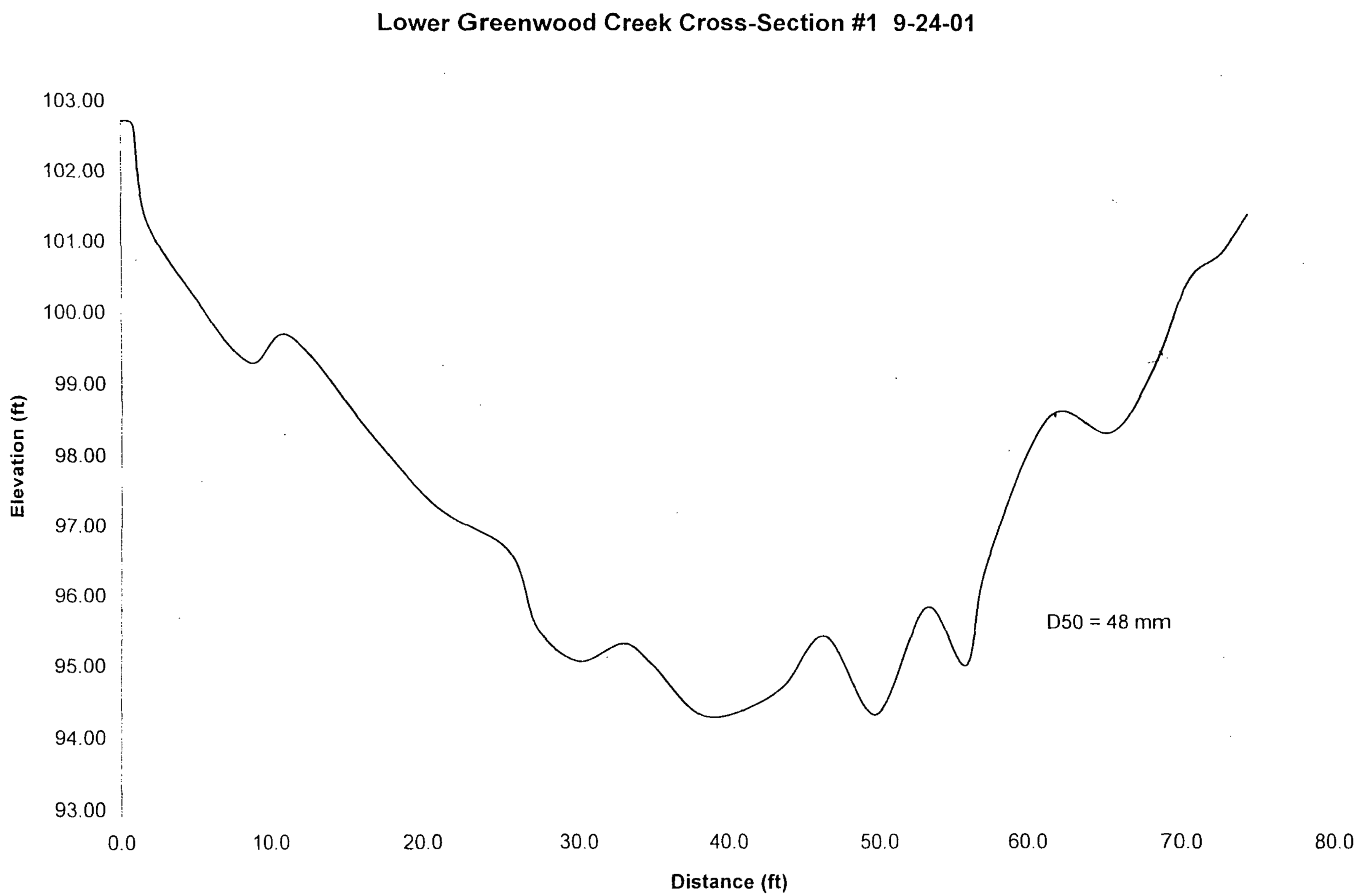
Top Elevation: 109.81
Bottom Elevation: 92.08
Reach Length: 1298.30

Standardized Statistics:
Number of data points in raw data: 120
Number of data points in Standardized data: 260

Reach Step Distance: 5.00

Max Residual Depth: 2.67
Mean Residual Depth: 0.60
Standard Deviation: 0.68





Lower Greenwood Creek Cross-Section #1 9-24-01
103.00
102.00
101.00
100.00
99.00
98.00
97.00
96.00
95.00
94.00
93.00
Elevation (ft)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
Distance (ft)
D50 = 48 mm

D50 (mm) = 48

Pebble Count Form

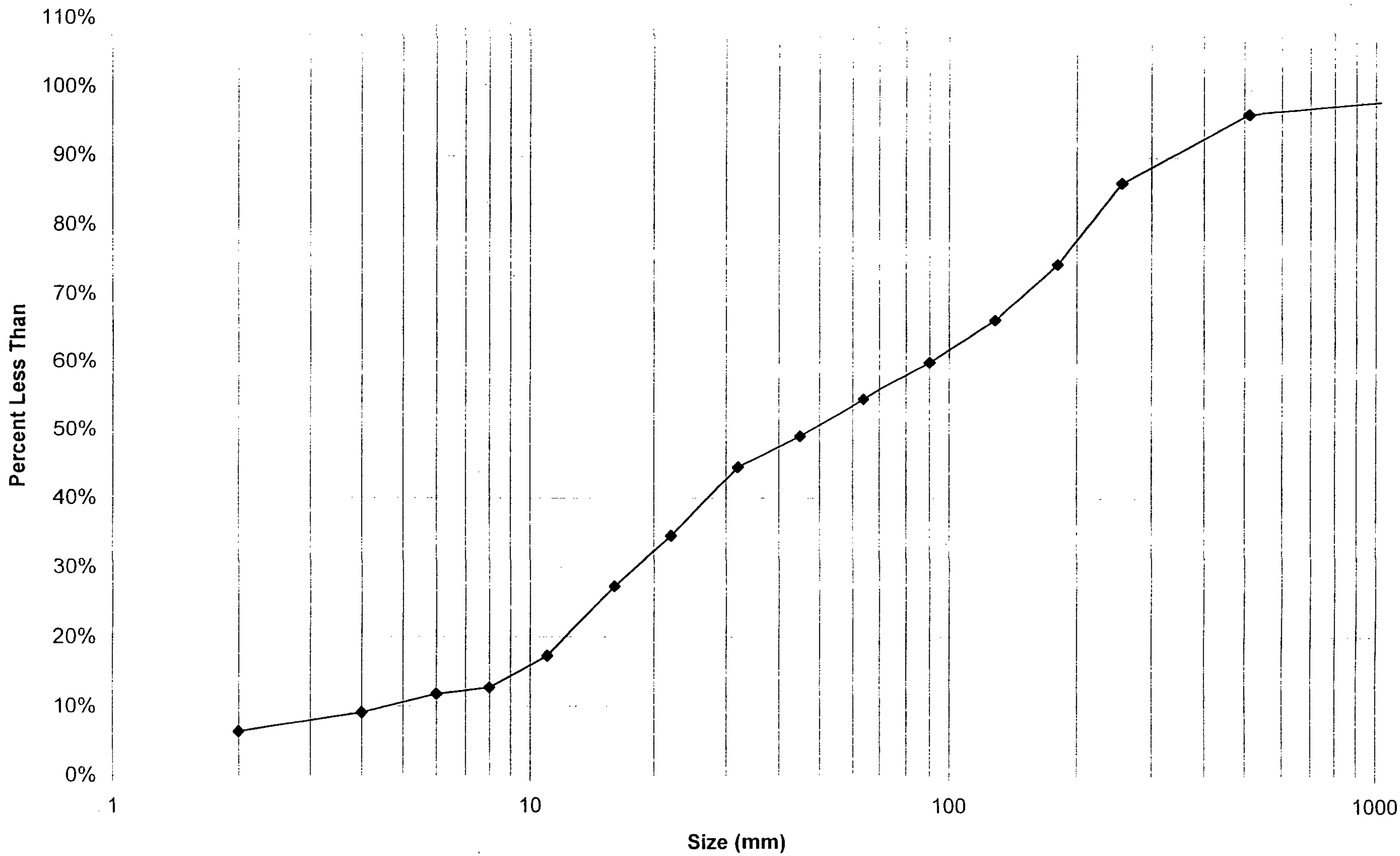
Watershed: Lower Greenwood   Date: 9/24/01

Stream Segment #:

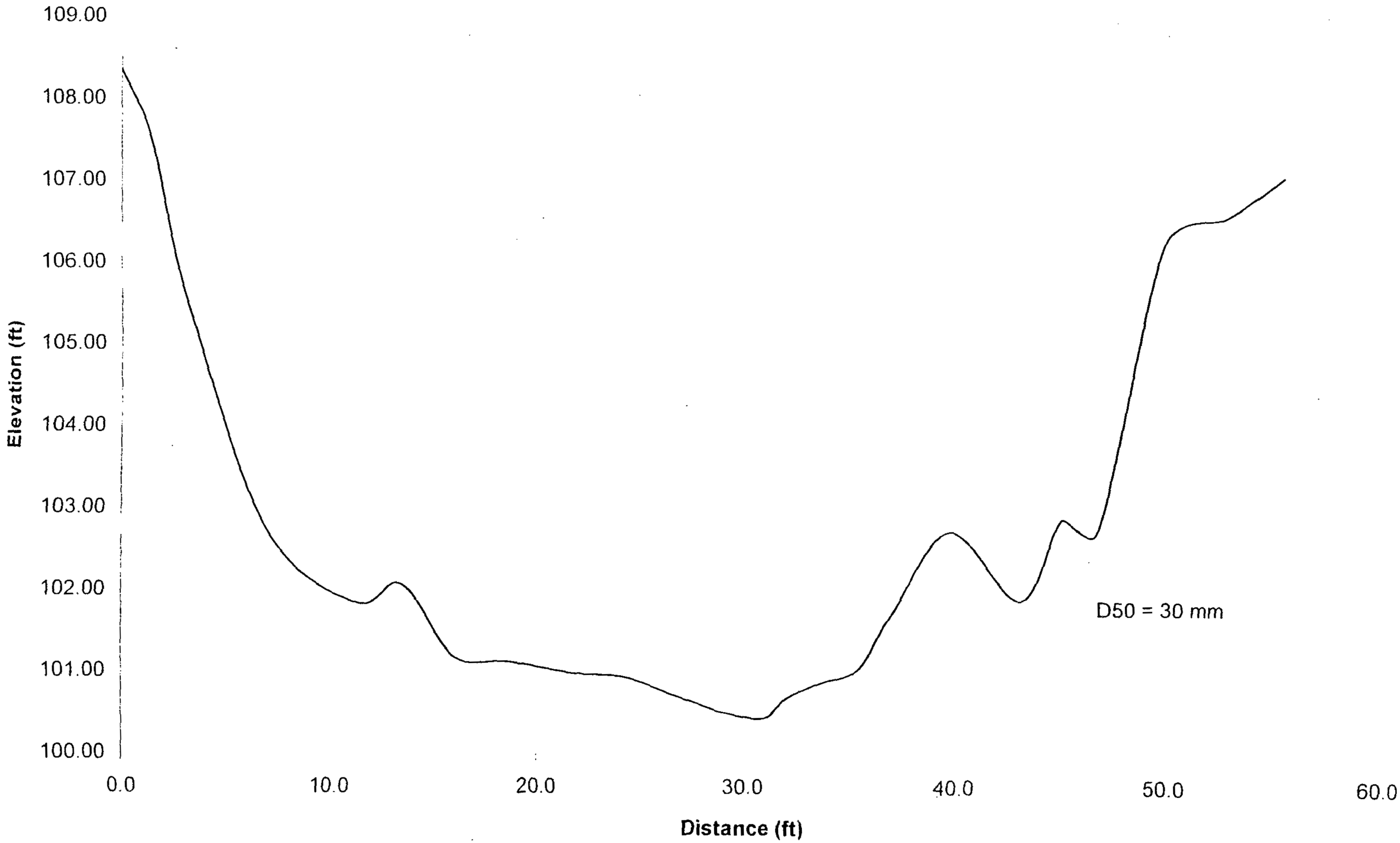
Location: X-section # 1

Substrate Size Class (mm)		Talley	Number
Sand	<2	HHH II	7
Very Fine Gravel	2-4	III	3
Fine Gravel	5-6	III	3
Fine Gravel	7-8	I	1
Medium Gravel	9-11	HHH	5
Medium Gravel	12-16	HHH HHH I	11
Coarse Gravel	17-22	HHH III	8
Coarse Gravel	23-32	HHH HHH I	11
Very Coarse Gravel	33-45	HHH	5
Very Coarse Gravel	46-64	HHH I	6
Small Cobble	65-90	HHH I	6
Medium Cobble	91-128	HHH II	7
Large Cobble	129-180	HHH IIII	9
Very Large Cobble	181-256	HHH HHH III	13
Small Boulder	257-512	HHH HHH I	11
Medium Boulder	513-1024	II	2
Large Boulder	1025-2048	II	2
Very Large Boulder	2049-4096		

Lower Greenwood, X-Sec. 1, 9/24/01



Lower Greenwood Creek Cross-section #2 9-24-01



D50 (mm) = 30

Pebble Count Form

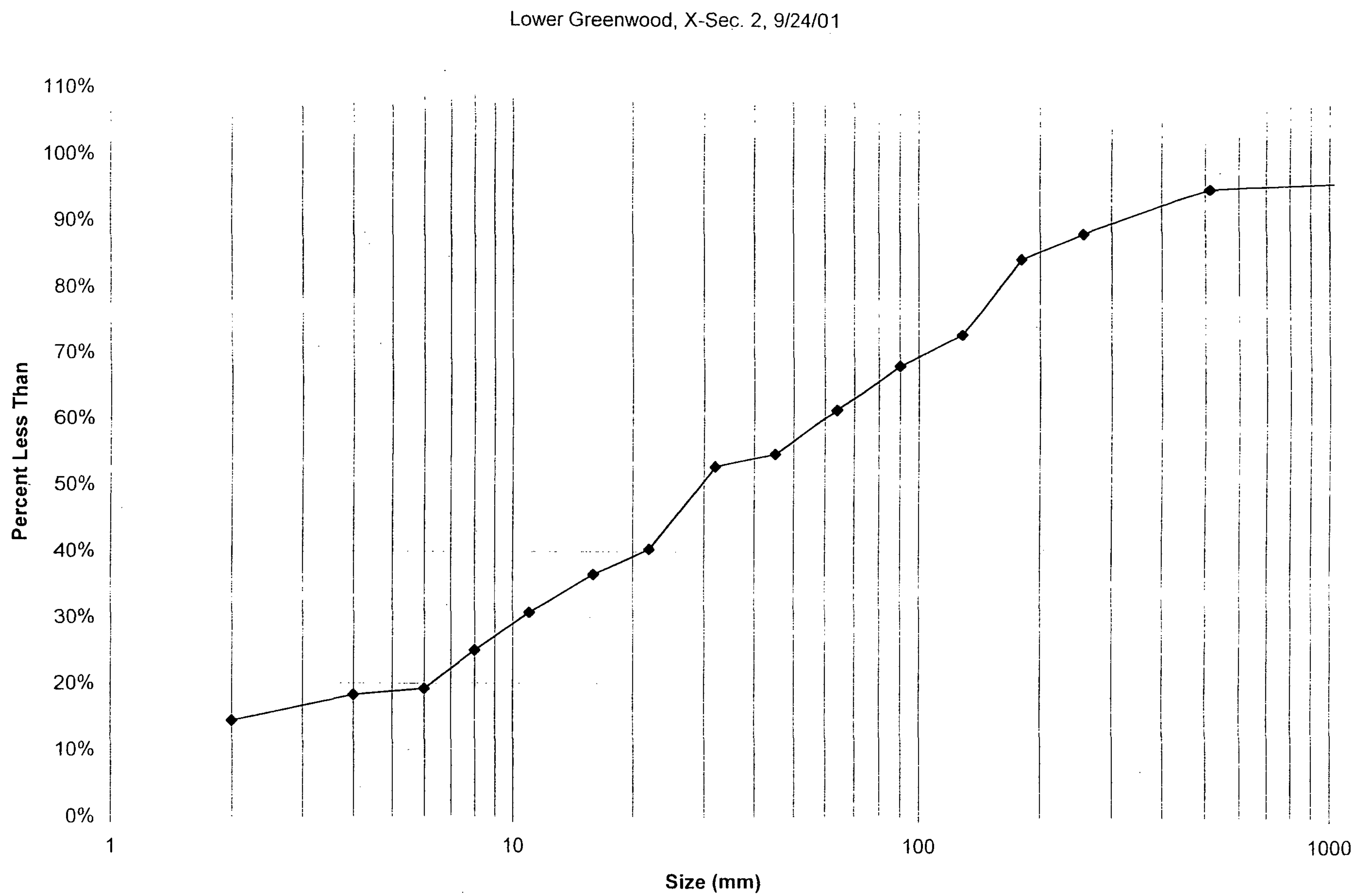
Watershed: Lower Greenwood Date: 9.24.01

Stream Segment #:

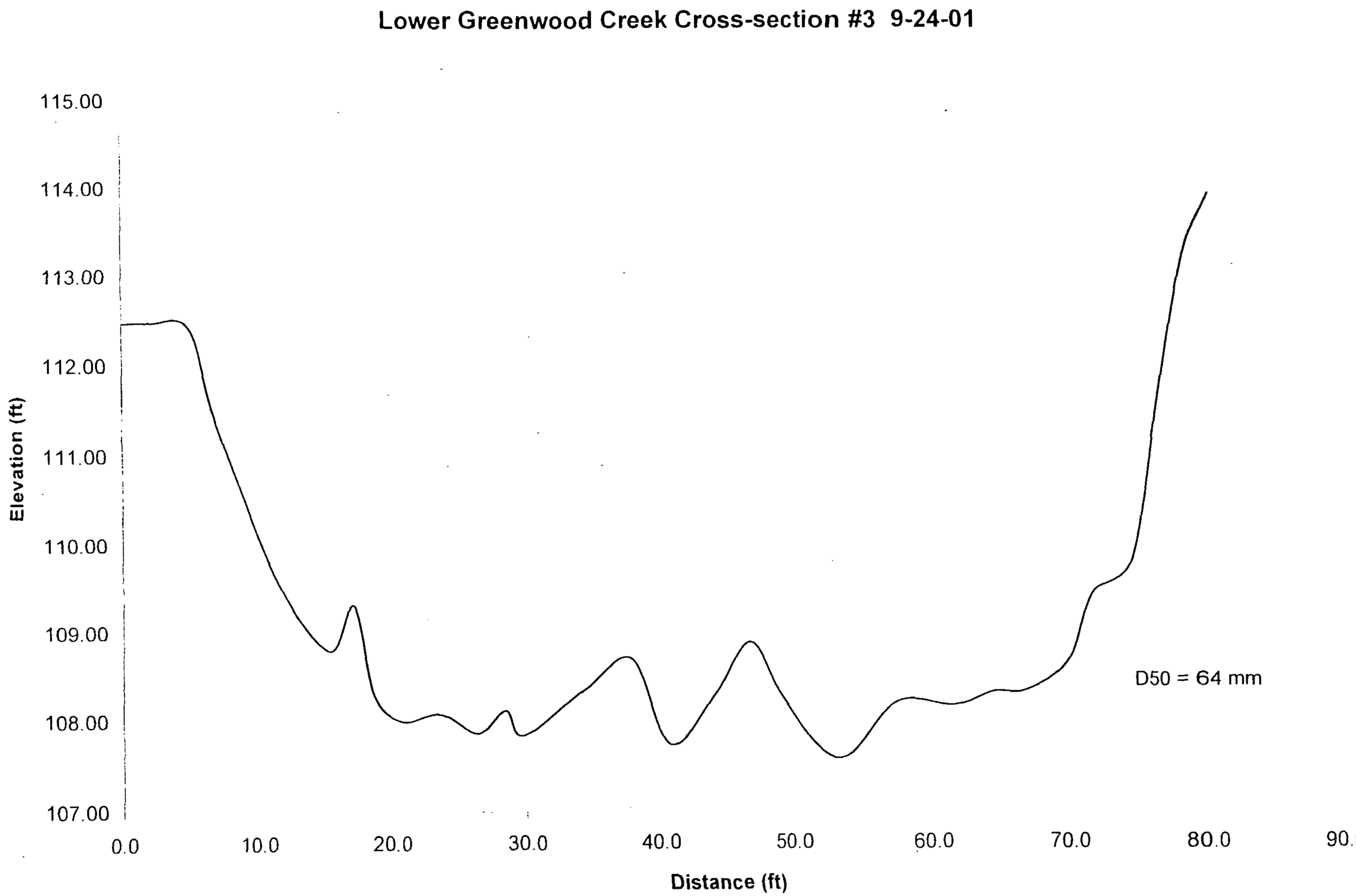
Location: X-Sec #2

Substrate Size Class (mm)		Talley	Number
Sand	<2	~~||||~~ ~~||||~~ ~~||||~~	15
Very Fine Gravel	2-4	||||	4
Fine Gravel	5-6	|	1
Fine Gravel	7-8	~~||||~~ |	6
Medium Gravel	9-11	~~||||~~ |	6
Medium Gravel	12-16	~~||||~~ |	6
Coarse Gravel	17-22	||||	4
Coarse Gravel	23-32	~~||||~~ ~~||||~~ |||	13
Very Coarse Gravel	33-45	||	2
Very Coarse Gravel	46-64	~~||||~~ ||	7
Small Cobble	65-90	~~||||~~ ||	7
Medium Cobble	91-128	~~||||~~	5
Large Cobble	129-180	~~||||~~ ~~||||~~ ||	12
Very Large Cobble	181-256	||||	4
Small Boulder	257-512	~~||||~~ ||	7
Medium Boulder	513-1024	|	1
Large Boulder	1025-2048	|||	3
Very Large Boulder	2049-4096	|	1

Mendocino Redwood Company, LLC



Lower Greenwood, X-Sec. 2, 9/24/01
110%
100%
90%
80%
70%
60%
50%
40%
30%
20%
10%
0%
Percent Less Than
1
10
100
1000
Size (mm)


Lower Greenwood Creek Cross-section #3 9-24-01
115.00
114.00
113.00
112.00
111.00
110.00
109.00
108.00
107.00
Elevation (ft)
0.0
10.0
20.0
30.0
40.0
50.0
60.0
70.0
80.0
90.0
Distance (ft)
D50 = 64 mm

D50 (mm) = 64

Pebble Count Form

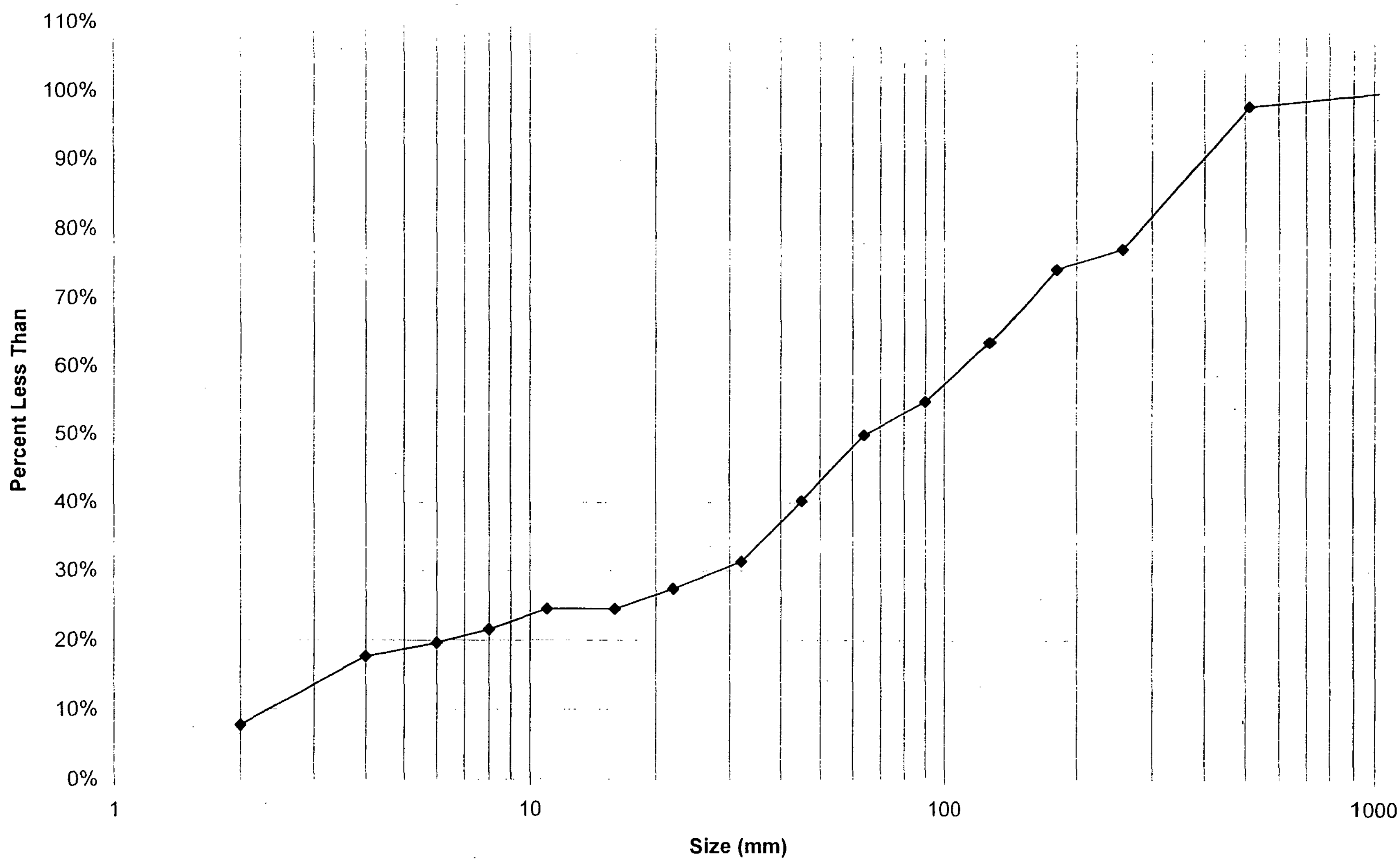
Watershed: Lower Greenwood Crk. Date: 9-24-01

Stream Segment #: ____________

Location: X-Section #3

Substrate Size Class (mm)		Talley	Number
Sand	<2	~~IIII~~ III	8
Very Fine Gravel	2-4	~~IIII~~ ~~IIII~~	10
Fine Gravel	5-6	II	2
Fine Gravel	7-8	II	2
Medium Gravel	9-11	III	3
Medium Gravel	12-16		
Coarse Gravel	17-22	III	3
Coarse Gravel	23-32	IIII	4
Very Coarse Gravel	33-45	~~IIII~~ IIII	9
Very Coarse Gravel	46-64	~~IIII~~ ~~IIII~~	10
Small Cobble	65-90	~~IIII~~	5
Medium Cobble	91-128	~~IIII~~ IIII	9
Large Cobble	129-180	~~IIII~~ ~~IIII~~ I	11
Very Large Cobble	181-256	III	3
Small Boulder	257-512	~~IIII~~ ~~IIII~~ ~~IIII~~ ~~IIII~~ I	21
Medium Boulder	513-1024	II	2
Large Boulder	1025-2048		
Very Large Boulder	2049-4096		

Lower Greenwood, X-Sec. 3, 9/24/01



RWQCB
REGION 1

OCT - 4 2001

☐ SAW ____ ☐ CRJ ____ ☐ ____
☐ RLT ____ ☐ LGR ____ ☐ KAD ____
☐ FCR ____ ☐ RSG ____ ☐ ____

MENDOCINO
REDWOOD COMPANY, LLC

Memorandum

date: October 1, 2001

from: John Andersen, Chris Surfleet

subject: **Greenwood Creek Coho Salmon**

A number of fish species are known to be found in the Greenwood Creek watershed. These include steelhead, sculpin, three spine stickleback, river lamprey, and pacific lamprey. The presence of coho salmon in the Greenwood Creek watershed is unclear. Mendocino Redwood Company has review nine sources of information to see what information is available concerning this species.

The first source used is titled Coho Salmon Habitat Impacts, Qualitative Assessment Technique for Registered Professional Foresters, prepared by the California Department of Fish and Game (CDFG) for the Board of Forestry (BOF), November 1994. Page 8 of this document discusses a list of streams historically known to produce coho salmon. This list is contained in Table 1 of the CDFG's petition to the BOF to list the coho salmon as a sensitive species. MRC contacted Marty Berback of CDFG in Sacramento to obtain this list. This list includes Greenwood Creek as a stream historically known to produce coho salmon, based on a literature review of a 1988 study by Hassler, Sullivan, and Stem titled Distribution of Coho Salmon in California, Annual Report to CDFG, Arcata CA, 24 pp. This report relied on a literature review by Sharon Griffin who consulted one of the sources listed below as to the presence of coho salmon. She apparently consulted the 1966 DFG Stream Survey of Greenwood Creek that stated no coho salmon were observed during the survey. It appears that she had inadvertently added coho salmon as a species found in Greenwood Creek. The survey stated the only species observed were steelhead and rainbow trout. A copy of the 1966 survey is enclosed.

The second source was a stream survey conducted by CDFG on April 13, 1966. The survey form resulted in the following information:

- Fish present: steelhead and rainbow trout.
- Remarks: "Continue to manage as a spawning and nursery for steelhead. A good place to stock with the fish from Fish Reserve.".

- Location of survey: Survey station at the mouth of Greenwood Creek, then the surveyor drove two miles up the creek and walked an additional two miles up the creek.. Name of the surveyor is not given.

During the course of looking for information regarding the anadromous fisheries barrier in Greenwood Creek, MRC found a DFG Fish Survey for Greenwood Creek that occurred on April 14, 1966. Apparently, DFG had visited the lower portion of Greenwood Creek on April 13, then drove to the headwaters on April 14, 1966. The report for both days (enclosed) states that Greenwood Creek is used by steelhead, native trout, and silver salmon while the report for the first day states steelhead and rainbow trout use Greenwood Creek.

The third source of information came from a paper titled Adult and Juvenile Anadromous Salmonid Migration Timing in California Streams, by Linda Fukushima and E.W. (Joe) Lesh, CDFG, Eureka, CA. July, 1998. The purpose of this paper is as follows:
"To aid planners in preparing for oil spills, monthly arrival times of spawning runs of adult anadromous salmonids and months when smolts outmigrate to the ocean at tidal inlets of California streams were compiled (Appendix 1). Only streams that empty directly into the ocean or Humboldt, San Francisco, or San Pablo bays are presented. The data were compiled from various publications and from interviews conducted with field biologists having personal knowledge of individual streams. Historical observations were included in cases where recent surveys have not been done or were inconclusive about the presence of salmonids. These data can be used by resource managers who are reviewing projects that may effect water flow in the lower parts of coastal streams, or near tidal inlets, when migrating salmonids, adults, or smolts may be present."

On page 139 in Appendix 1 of this report, the only salmonid listed as being present in Greenwood Creek is steelhead.

The fourth source of information is from a weekly newspaper article titled Down To Earth, A Mendocino County Life, by Maurice W. Tindall, 1978. This was an article written by Mr..Tindall for the Anderson Valley Advertiser, Boonville, CA. Many of his articles focused on fishing the many streams of the Mendocino Coast, dating back to 1898 when he was three years old. Here are some excerpts from his articles:

"There were two smaller streams on the Coast that were fine trout fishing but very tough access. Both were steelhead streams, but hook-bills (coho) didn't seem to run in them. One was Greenwood Creek right at the town (Elk now), and the mill was there at the mouth of the Creek. The Creek ran far back to its source on Signal Mountain.

"No hook-bills ever ran in Greenwood Creek that I know of. There was a high falls near the middle that the fish couldn't get over, but there was good fishing above them, and who can tell how fish first got there. Below the Falls, the fish were rainbows, but above there the fish were heavierest and had noticeable white tips on their fins."

The fifth source of information is from a draft Mendocino Redwood Company fish survey titled Summary of Fish Index Site Monitoring in Watersheds Within Mendocino Redwood Company's Ownership in Mendocino and Sonoma Counties: 1987-1996, prepared by Mendocino Redwood Company, May 1999. This study was conducted in response to the lack of information available on trends in juvenile salmonid densities in watersheds within the ownership of Louisiana-Pacific Corporation (now Mendocino Redwood Company). Data was collected from electrofishing sites starting in 1986 to develop baseline data of the salmonid densities, to observe changes over time, and to document distribution of fish species throughout the various watersheds. The Greenwood Creek watershed was sampled in 1990, 1992, 1993, and 1994. Various tables in this report show the fish species found in Greenwood Creek during these years. The species found include steelhead, sculpin, three spine stickleback, and the pacific lamprey. No coho salmon were found.

The sixth source is from a study titled Fish Distribution for Watersheds in Louisiana-Pacific's Coastal Mendocino/Sonoma Management Unit, 1994-96, Prepared by Wildlife & Fisheries Science Group, Louisiana-Pacific Corporation, December 1997. This study used electroshocking at nine different locations throughout the upper and lower Greenwood Creek to determine fish distribution and species. The results of this study are already on file at Water Quality. The only species found during this study were steelhead, sculpin, roach, and stickleback. No coho salmon were found. As a side note, this study is quoted in a National Marine Fisheries Service (NMFS) study as confirming current coho salmon populations in Greenwood Creek. The name of the NMFS study is Historical and Current Presence-Absence of Coho Salmon in the Central California Coast Evolutionarily Significant Unit, April 1999. MRC contacted the author of this report numerous times to discuss the discrepancy in the data. The author said all the information was in boxes and he would eventually dig it up. When MRC contacted him numerous times after that, he did not return phone calls. MRC then contacted the biologist who conducted the 1994-96 study. He confirmed that no coho salmon were found in Greenwood Creek at that time. The NMFS study also listed a source of data confirming historical presence of coho salmon. That source was, again, the Hassler study that was also a literature review.

A seventh source of information is the recently released Aquatic Species Distribution for Watersheds on Mendocino Redwood Company Forestlands, 2000. The primary objective of this study was to repeat the three year project (1994-96) conducted by LP. Secondarily, effort was made to install stations further up watersheds to determine how far anadromous fisheries are found. Thirdly, it was hoped that any major changes in the distribution of fish species could be detected from the historical data or future watershed assessment efforts. In Greenwood Creek this study looked at 10 sites in the upper and lower watersheds. Fish species present were determined through electrofishing at each site. Steelhead were found throughout the watershed but coho salmon were not found. See Section V for the complete report with detailed methodologies and results.

The eighth source of information is a personal communication with Wendy Jones, a retired DFG employee. During his career, which spanned over 40 years on the

Mendocino coast, he never knew coho salmon to be present in the Greenwood Creek watershed.

A ninth source of information is the report produced by Larry Brown and Peter Moyle titled Status of Coho Salmon in California, a report to the NMFS from the Dept. of Wildlife and Fisheries Biology, University of California, Davis. This report states that coho salmon have not been recently observed in Greenwood Creek. However, it does claim that Greenwood Creek has historically had coho salmon. The documentation for this claim was the literature review by Hassler (1988). A document that is discussed above.

Other sources of information have been brought forward by local concerned citizens regarding the presence of this species in the watershed. One of the sources is the withdrawn Sustained Yield Plan written by Louisiana-Pacific, the prior owner of MRC's forestlands. This document states that coho salmon are present in the Watershed Assessment Area for Greenwood Creek, which includes not only Greenwood Creek but other watercourses which flow directly into the Pacific Ocean. Because of the data that has been collected recently in Greenwood Creek, it was assumed that the writers of the SYP were referring to other watercourses other than Greenwood Creek. However, the SYP does state at one point that coho salmon are present in the upper and lower Greenwood Creek watershed. The RPF reviewed their sources and found that during the construction of the SYP, no one went to Greenwood Creek to sample the fish populations or distributions. The SYP conducted a literature review whereby they relied on the Hassler literature review. Hassler's literature review is discussed above.

Another source of information discussed by local concerned citizens is a publication titled Reminiscences of the Town with Two Names: Greenwood Also Known As Elk. According to members of the public, this publication discusses the presence of coho salmon in Greenwood Creek in the 1920s and 30s.

To sum this issue up, there is disconfirming evidence and confirming evidence as to the presence of coho salmon in Greenwood Creek. However, it is clear the coho have not been present in Greenwood Creek in recent times.

STREAM TEMPERATURES FOR WATERSHEDS ON MENDOCINO REDWOOD COMPANY'S TIMBERLANDS 1997-2000

BACKGROUND

Stream temperature is a key water quality parameter and one that can be altered as a result of streamside forest management practices. Concern over abnormal warming of stream temperatures as a result of streamside vegetation removal has generally focused on the impacts to coldwater inland fisheries (see Literature Review). The California Forest Practice Rules addresses the effects of streamside timber harvesting activities on water temperatures and dictates the implementation of Best Management Practices to minimize impacts on water quality within forested watersheds.

In summer 1997, Louisiana-Pacific continued intensive stream temperature monitoring within its forestlands in northern California. No temperature monitoring occurred during the summer of 1998 as Mendocino Redwood Company was in the process of purchasing this timberland. Monitoring continued in the summers of 1999 and 2000. The primary objectives of the stream temperature monitoring were to establish baseline temperature conditions and identify temperature limited stream segments. Primary assumption for stream temperature monitoring is that increases in stream temperature conditions are primarily affected by streamside shade canopy conditions, as they affect local air temperature, solar radiation, and relative humidity. Stream temperatures are monitored to obtain average water temperature conditions.

Priority for stream temperature monitoring was based on the amount of Mendocino Redwood Company's forestland within an individual watershed and baseline data needs for fish-bearing streams. Number of monitoring sites within a watershed was based on stream length and flow accumulation area. In longer streams (> 8 km), stream temperature monitoring sites were located in the lower, middle and upper reaches of the stream. On streams or tributaries that were shorter in length, lower and upper stream temperature monitoring sites were located. In certain cases, only one stream temperature monitoring recorder was placed on the lower part of the stream reach. Stream tributaries draining into the same sub-watersheds were monitored concurrently.

Stream water temperatures were monitored continuously (2-hour interval) during summer (June-September) each year using remote electronic temperature recorders. The stream temperature recorders were placed in shallow pools (< 1 m in depth) directly downstream of riffles. Placement of temperature recorders in these areas ensured monitoring water that was adequately mixed and prevented dewatering of the monitoring devices. Each data recorder was held in place with a 45 cm piece of rebar that was driven into the streambed substrate with a sledge hammer and a post driver. Plastic coated 12 gauge wire was used to attach the data recorders to the rebar stakes.

STREAM TEMPERATURES FOR WATERSHEDS ON MENDOCINO REDWOOD COMPANY'S TIMBERLANDS, 1997-2000

LITERATURE REVIEW

Temperature Fluxes In Small Forested Streams

Stream water temperature responds to the input of solar radiation and is directly proportional to stream surface area and inversely proportional to discharge (Sullivan et al. 1990). Wide streams receive more radiation than narrow ones. For the same surface area and energy input, the temperature change expected of a high-discharge stream will be less than that of a low discharge stream.

Other factors controlling stream water temperature include ground water inputs, air temperature, inflow from tributaries, and substrate type. The previously mentioned factors each involve specific energy transfer processes, such as radiation, evaporation, convection, conduction, and advection. The sum of these factors represents the net gain or loss of heat in a stream (Brown 1983). Heat gain or loss from evaporation or convection depends on the vapor pressure and gradients respectively between the water surface and air (Beschta et al. 1987). Conduction of heat between the water and the streambed depends on substrate type, with bedrock being the most conductive substrate. Advection occurs as tributaries of differing temperatures enter a stream.

Canopy cover is important in reducing the net gain of solar radiation in the summer, but less important in the winter. In winter, short days, low sun angles, and cloudy weather combine to keep stream temperatures low, regardless of canopy. In summer, long days, higher sun angles, clear skies, and low discharge are factors that can cause elevation of stream water temperatures. Several studies have shown that an intact streamside forest canopy will shade streams and minimize increases in summer water temperature. Brown and Krygier (1970), found diurnal variations in a well-shaded coastal Oregon stream to be less than 1°C. However, complete removal of a forest canopy has been shown to increase summer maximums 3-8°C (see review by Beschta et al. 1987). A comparison of 20 years of temperature records from Steamboat Creek basin, Oregon, was done for logged and unlogged streams. Hostetler (1991) found that streamside canopy cover was the trend variable most important to changes in stream temperature.

Thermal energy in streams is not easily lost through radiation, convection, advection and conduction (Beschta et al. 1987). Increases in stream water temperature are additive, and an alteration of shaded and unshaded reaches are not an effective strategy to minimize increased summer temperatures (Brown et al. 1971). Possible increases in stream temperature from streamside canopy removal can be predicted using formulas in Brown (1983).

Effects Of Stream Temperature On Aquatic Biota

The optimal temperature range for Pacific salmonids has been shown to range between 12 and 14°C (Brett 1952). Temperatures lethal to salmonids have been determined in the laboratory and range from 23-29°C (Beschta et al. 1987). These values were determined over long periods of time under different acclimation temperatures. Though these temperatures are possible in some small forested streams, they would generally only occur for short periods of time in the summer. In addition, cool water refugia may be found in deep pools (Matthews et al. 1994) and seeps. In a laboratory study, Combs and Burrows (1957) found the upper lethal limit for chinook salmon (*Oncorhynchus tshawytscha*) eggs to be 14-15.5°C. In some spring-spawning salmonids, egg development may overlap with harmful high summer temperatures (Beschta et al. 1987).

Increased water temperatures that are not lethal may also affect stream biota. The metabolic energy requirements of fish must be met before they will grow (Warren and Davis 1967). A reduced growth rate may occur at higher temperatures. As a fish's metabolic rate increases with temperature, dietary intake must also increase for growth to occur (Beschta et al. 1987). Increased water temperatures can also be conducive to the growth and virulence of fish pathogens harmful to fish (Beschta et al. 1987).

Timing of development and certain life history stages of salmonids (Holtby et al. 1989) and invertebrates (Moore 1980) can be affected by changes in stream temperature. Holtby et al. (1989) found emigration timing for coho salmon (*Oncorhynchus kisutch*) and chum salmon (*Oncorhynchus keta*) fry was strongly temperature dependent. Some evidence shows that early emergence, due to increased water temperatures, is associated with higher fry to smolt survival (Holtby et al. 1989). However, early emergence might have risks associated with increases in mortality within the marine environment (i.e., winter storms) (Hartman et al. 1987).

Water temperature changes can affect primary and secondary production in streams. Increases in water temperature have been shown to increase algal production (Phinney and McIntire 1965, Kevern and Ball 1965) and invertebrate production. Herbivore abundance may increase concurrently with algae, resulting in a higher rate of decomposition of allochthonus material, and, consequently, in increases in numbers of other invertebrates (Beschta et al. 1987). Larger populations of invertebrate fauna may benefit salmonids. Such changes in productivity come at the expense of lowered diversity, community stability (Gregory et al. 1987), and timing of emergence (Moore 1980). Salmonid fish prey heavily on emerging adults, and accelerated insect development may benefit fish by making more food available earlier in the year. However, for many salmonids the emergence of fry from spawning gravel and the onset of active feeding coincides with spring and early summer hatches of aquatic insects (Beschta et al. 1987).

Quality control procedures were developed and implemented to ensure accurate readings by the temperature data recorders and check for potential instrument errors. All temperature data recorders were calibrated pre- and post- data recording activities. Calibration of the temperature data recorders was accomplished by placing the equipment in five-gallon bucket of ice bath or sand for one hour. Temperature readings recorded by the data recorder were compared with the temperature readings of a certified reference thermometer (Cole-Parmer Instrument Company, Vernon Hills, Illinois) placed in the same medium in the bucket. Quality assurance goals were accomplished by training individuals for data recorder handling, calibration, deployment, in-stream placement of data recorders, and data synthesis.

Baseline data has already been established in the watersheds on Mendocino Redwood Company timberlands. Monitoring goals are to record stream temperatures in the same sites of the same streams every year. New sites may be added as the need arises. This will provide a good record of yearly temperature variations in individual streams and will allow for long-term trend monitoring. There will also be a focus on increasing efforts to gather information in Class II perennial streams. This will allow Mendocino Redwood Company to understand more of the stream network as it relates to temperature concerns.

The role of water temperature in the functioning of stream ecosystems is extremely complex. Trophic dynamics, behavior, growth, and development of stream biota are all affected by changes in water temperature. The effects of sub-lethal water temperatures on salmonids and invertebrates are difficult to distinguish, even with continuous stream temperature data. Negative effects of increased temperatures on salmonids may be offset by gains in primary and secondary production. The importance of temperature in aquatic ecosystems suggests that sound land management decisions (i.e., appropriate buffer strips) should be based on appropriate long-term monitoring programs.

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STREAM TEMPERATURES FOR WATERSHEDS ON MENDOCINO REDWOOD COMPANY'S TIMBERLANDS, 1997-2000

RESULTS

This report summarizes the temperature data collected from streams draining forested watersheds in Mendocino Redwood Company's coastal timberlands in Mendocino and Sonoma counties during the summers of 1997-2000. Stream temperature information presented in this report will be used to evaluate water quality limited stream segments, and develop and implement improved streamside management prescriptions in these problem areas.

Currently, established water quality standards and guidelines for stream temperature evaluation is lacking. Mean and maximum daily stream temperatures were reported for each data set. Maximum weekly average temperature (MWAT) and maximum weekly maximum temperature (MWMT) were calculated from these values. These weekly moving average temperatures are widely used as an indicator of long-term exposure. Absolute maximum temperatures are useful but these values may only occur briefly. Long-term exposure to lower levels of temperature may do more physiological damage than short-term exposure to higher temperatures because the fish may seek out cold water refugia.

Table 1 provides a list of all sites monitored from 1997-2000. Temperature reports are seperated by management unit. Tables 2-10 show maximum temperatures, MWAT, and MWMT for all sites. Figures 1-165 show daily fluctuation of maximum and mean temperatures.

Table 1. Temperature monitoring sites on Mendocino Redwood Company's timberlands in Mendocino and Sonoma counties, 1997-2000.

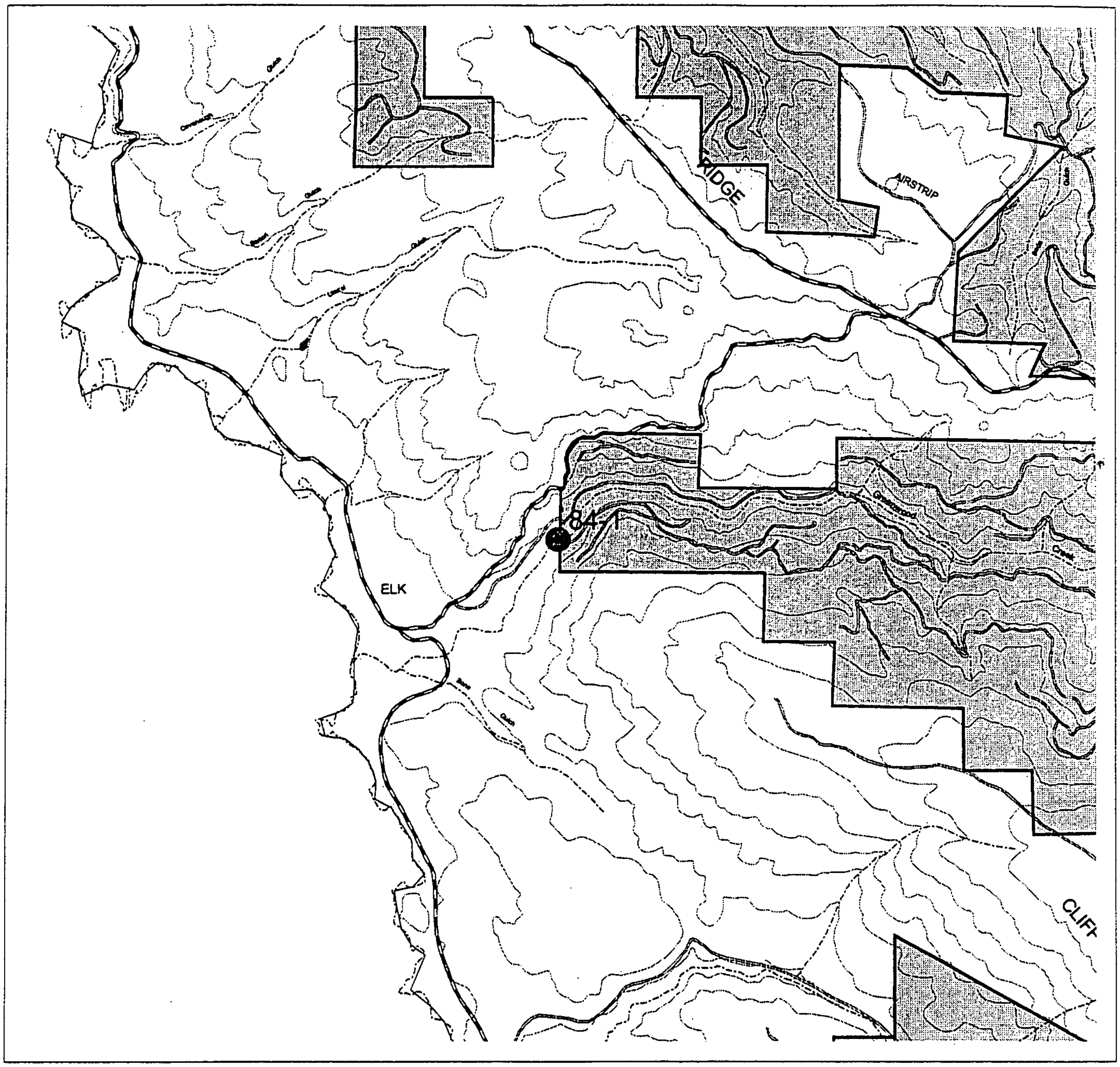
CWPW No.	Stream Name	Monitoring Site No.	Monitoring Year (s)
113.32032	Hollow Tree Creek @ property line	41-1	1999, 2000
113.32031	Redwood Creek	41-2	1999, 2000
113.32031	Bond Creek	41-3	1997, 1999, 2000
113.32080	Hollow Tree @ Bond Creek	41-4	1999, 2000
113.32030	Michaels Creek	41-5	1999, 2000
113.32030	Huckleberry Creek	41-6	1999, 2000
113.32030	Hollow Tree @ Huckleberry	41-7	1999, 2000
113.32080	Walters Creek	41-8	1997
113.32080	Waldron Creek	41-9	1997
113.12011	Cottoneva Creek @ Rockport	47-1	1999, 2000
113.12011	South Fork Cottoneva Creek	47-2	2000
113.12011	Cottoneva Creek @ middle fork confluence	47-3	1999, 2000
113.12012	Hardy Creek	47-4	2000
113.12013	Juan Creek	47-5	1999, 2000
113.12020	Howard Creek	47-6	1997, 1999, 2000
113.20015	North Fork Noyo River @ Northspur	70-1	1999, 2000
113.20015	Marble Gulch	70-2	1999, 2000
113.20013	Hayworth Creek @ confl. w/ NF Noyo	70-3	1999, 2000
113.20013	North Fork Hayworth Creek	70-5	1999, 2000
113.20013	Hayworth Crk. @ confl. w/ NF Hayworth	70-6	1997, 1999, 2000
113.20013	North Fork Noyo River @ Hayworth	70-7	1999, 2000
113.20014	Middle Fork NF Noyo River	70-8	1999, 2000
113.20014	North Fork Noyo River @ Middle Fork	70-10	1999, 2000
113.20015	Noyo River@ Northspur	70-11	1997, 1999, 2000
113.20011	Redwood Creek	70-12	1999, 2000
113.20010	Burbeck Creek	70-13	1997, 1999
113.20010	Upper Noyo Mainstem @ Burbeck	70-14	2000

CWPW No.	Stream Name	Monitoring Site No.	Monitoring Year (s)
113.30022	Big River @ WH Opening	74-1	2000
113.30022	Russel Brook	74-2	2000
113.30022	Big River @ PPN Gulch	74-3	1999
113.30033	East Branch NF Big River@ bridge x-ing	75-1	1997, 1999, 2000
113.30033	East Branch NF Big River above Frykman Gulch	75-3	1997
113.30040	Big River @ Black Fly Opening	76-1	1999
113.30040	Two Log Creek	76-2	2000
113.73020	Jack Smith Creek	77-1	1997, 1999, 2000
113.40013	Albion River@ duckpond	78-1	1997, 1999, 2000
113.40012	SF Albion River@ Mainstem Albion	78-3	1997, 1999, 2000
113.40012	SF Albion River@ Larmer Gulch	78-4	1999, 2000
113.40013	Albion River @ SF Confl.	78-5	1997, 1999, 2000
113.40010	Albion River-Upper property line	78-6	1997, 2000
113.40012	Trib. to Albion-New Site	78-8	2000
113.30013	South Fork Big River	79-1	1997, 1999, 2000
113.30013	Ramon Creek	79-2	1997, 1999
113.30012	Daugherty Creek @ property line	79-4	1997, 1999, 2000
113.30012	Daugherty Creek near Gates Crk.	79-5	1997
113.30013	North Fork Ramon Creek	79-8	2000
113.30012	Gates Creek	79-9	1997
113.50062	North Branch NF Navarro River	81-1	1999, 2000
113.50061	John Smith Creek	81-2	1997, 1999, 2000
113.50060	North Branch NF Navarro River	81-3	1999, 2000
113.50077	Marsh Gulch	82-1	1999, 2000
113.50075	Flynn Creek	82-2	1997, 1999, 2000
113.50073	Navarro River	82-3	1999, 2000
113.31015	Ackerman Creek @ Masonite Rd. 7.2 mile bridge	83-1	1997, 2000

CWPW No.	Stream Name	Monitoring Site No.	Monitoring Year (s)
113.31014	Alder Creek	83-2	1999, 2000
113.31015	Ackerman Creek @ Masonite Rd. 0.5 mile bridge	83-3	2000
113.61011	Greenwood Creek	84-1	1997, 1999, 2000
113.61010	Greenwood Creek	84-3	1997, 1999, 2000
113.50052	South Branch NF Navarro River	85-1	1999, 2000
113.50051	South Branch NF Navarro River	85-2	1999, 2000
113.50041	North Fork Indian Creek	86-1	2000
113.50041	North Fork Indian Creek	86-2	1999, 2000
113.62011	Elk Creek	87-1	1997, 1999, 2000
113.62010	South Fork Elk Creek	87-2	1997, 1999, 2000
113.62010	Elk Creek	87-3	1997
113.50043	Navarro River	88-1	1999, 2000
113.63011	Alder Creek	89-1	2000
113.63011	Alder Creek	89-2	1999, 2000
113.63012	Mallo Pass Creek	89-3	1999, 2000
113.70024	Garcia River @ Rolling Brook	93-1	1997, 1999, 2000
113.70024	Rolling Brook @ Mainstem	93-2	1997, 1999, 2000
113.70023	South Fork Garcia River @ Mainstem	93-4	1997, 1999, 2000
113.70023	Garcia River@ SF confl.	93-5	1999, 2000
113.70022	Garcia River @ upper prop. Line	93-6	1997, 1999
113.70023	Fleming Creek	93-7	1997, 2000
113.70023	South Fork Garcia River above Fleming Confl.	93-8	1999
113.70024	Rolling Brook	93-9	1997
113.70030	Schooner Gulch	94-1	1997, 1999, 2000
113.84033	Annapolis Falls Creek	97-1	1999
113.84032	Fuller Creek	97-2	1999, 2000
113.84033	Crocker Creek	97-4	1997
114.11041	Willow Creek @ Hunter's Camp	98-1	1999, 2000
114.11041	Willow Creek Upper	98-3	1999, 2000
114.11040	Freezeout Creek	98-4	1997, 1999, 2000

Table 9. Maximum, MWAT, and MWMT temperatures for sites in the South Coast Area (1997-2000).

Stream	Site ID	Year	Temperature (C^0)		
			Maximum	MWAT	MWMT
Greenwood Creek	84-1	1997	21.2	17.7	20.4
Greenwood Creek	84-1	1999	19.8	15.7	18.7
Greenwood Creek	84-1	2000	17.8	14.6	16.9
Greenwood Creek	84-3	1997	19.1	17.2	18.3
Greenwood Creek	84-3	1999	20.4	16.7	19
Greenwood Creek	84-3	2000	20.3	17.4	19.7
Elk Creek	87-1	1997	18.4	16.4	17.5
Elk Creek	87-1	1999	15.9	14.4	15.1
Elk Creek	87-1	2000	17.7	15.3	16.6
South Fork Elk Creek	87-2	1997	14.3	13.3	14.3
South Fork Elk Creek	87-2	1999	13.4	12.5	13.4
South Fork Elk Creek	87-2	2000	13.1	12	12.7
Elk Creek	87-3	1997	19.1	16.3	18.4
Alder Creek	89-1	2000	19.4	16.7	18.5
Alder Creek	89-2	1999	19.6	16.8	18.3
Alder Creek	89-2	2000	19.8	17.3	19
Mallo Pass Creek	89-3	1999	13.3	12.7	13
Mallo Pass Creek	89-3	2000	13.9	13.3	13.6



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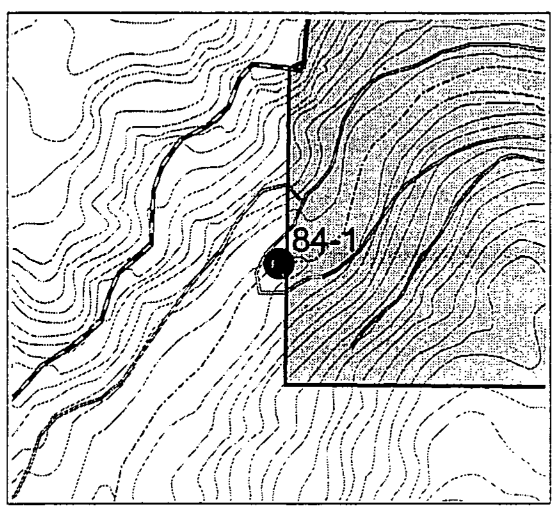
Mendocino Redwood Company
Stream Temperature Monitoring Sites 1997 - 2000

SITE ID: 84-1
STREAM NAME: Greenwood Creek
USGS QUAD: Elk
PLACEMENT DESCRIPTION:
At low water crossing



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Monitoring Site
Hydrography
Roads
Jeep Trail
Native
Rocked
Paved
MRC Ownership

N

MENDOCINO
REDWOOD COMPANY, LLC
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March 2001

Figure 119. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Greenwood Creek (Site 84-1), Mendocino County, California.

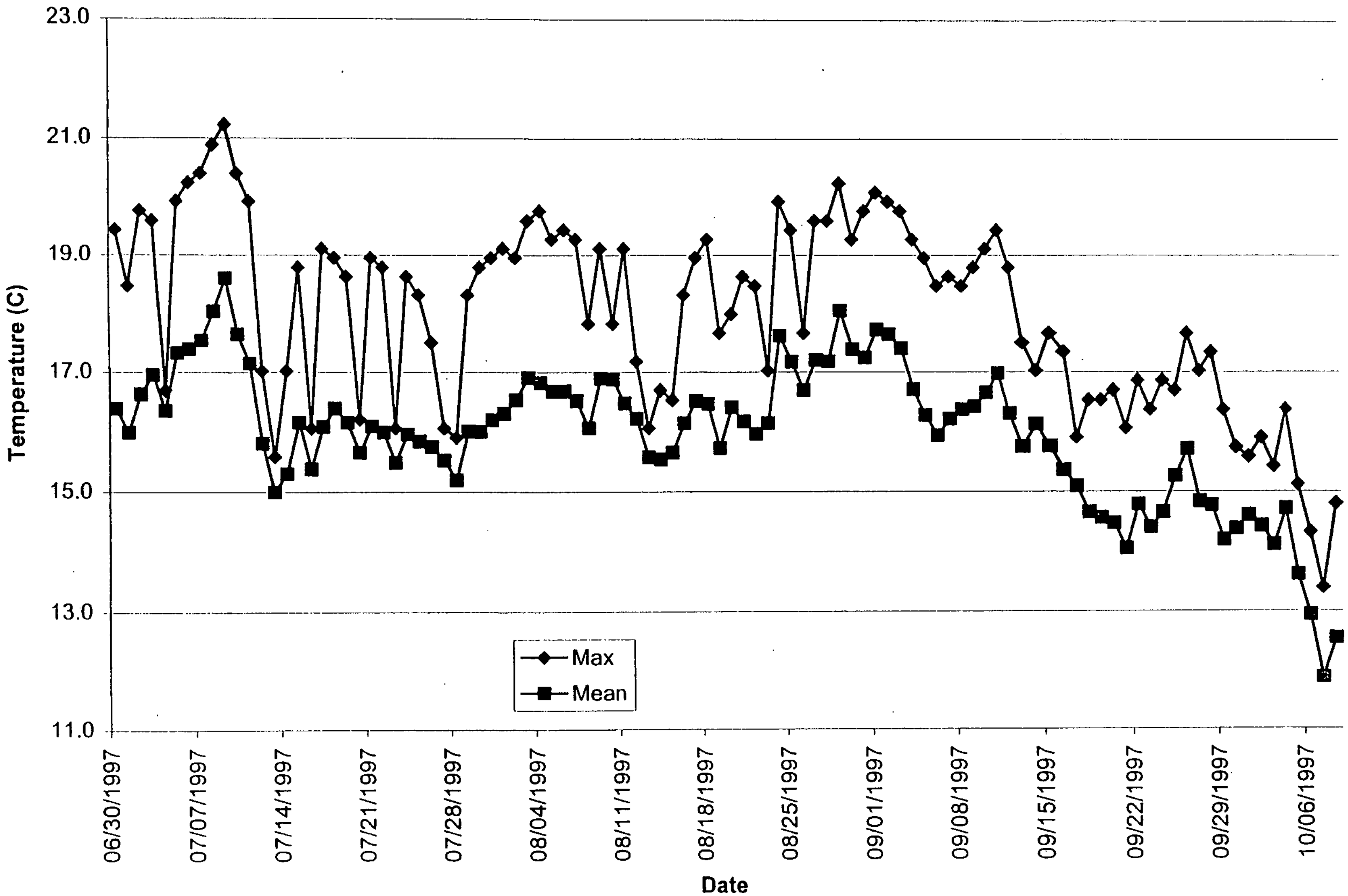


Figure 120. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Greenwood Creek (Site 84-1), Mendocino County, California.

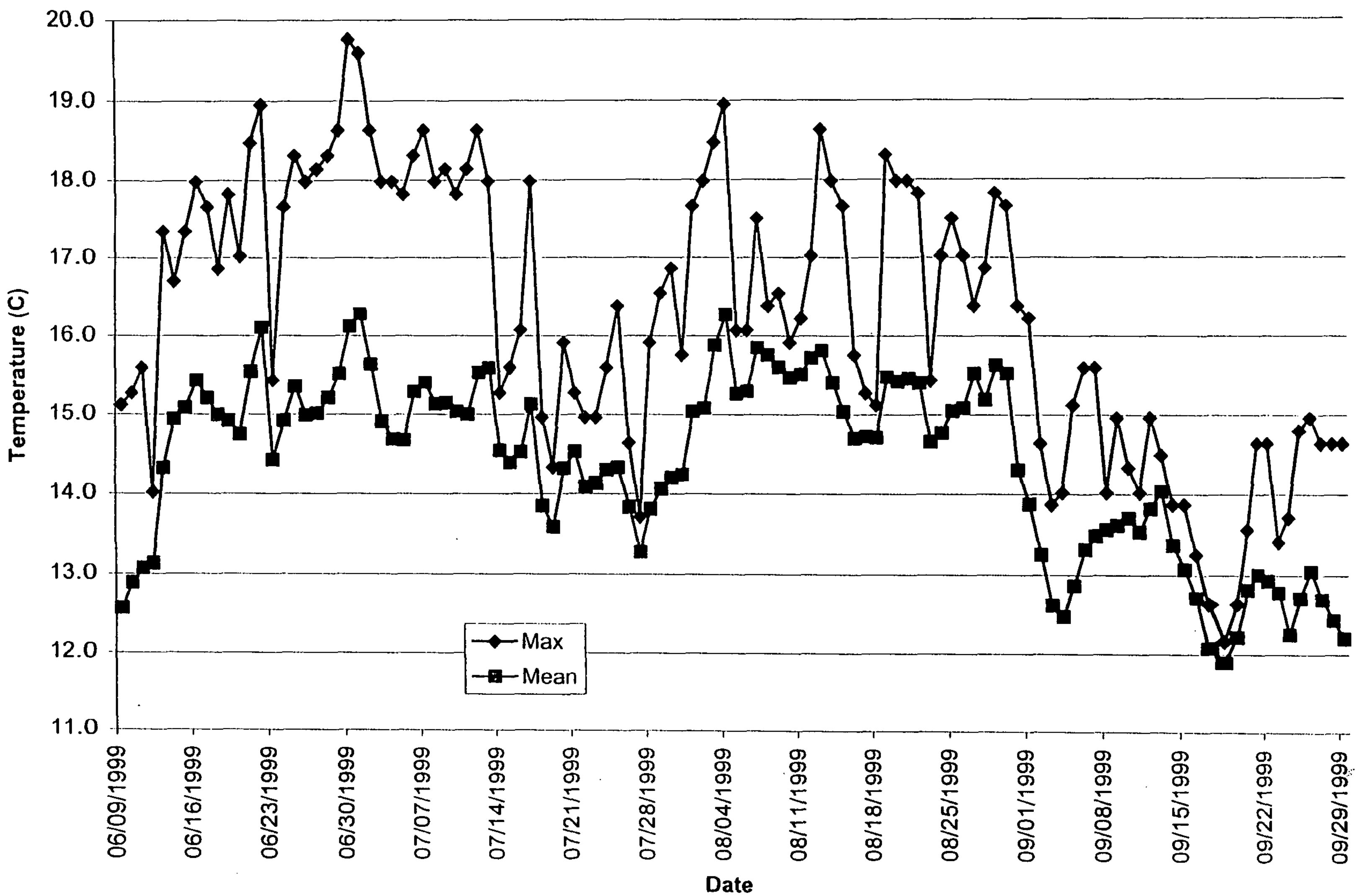
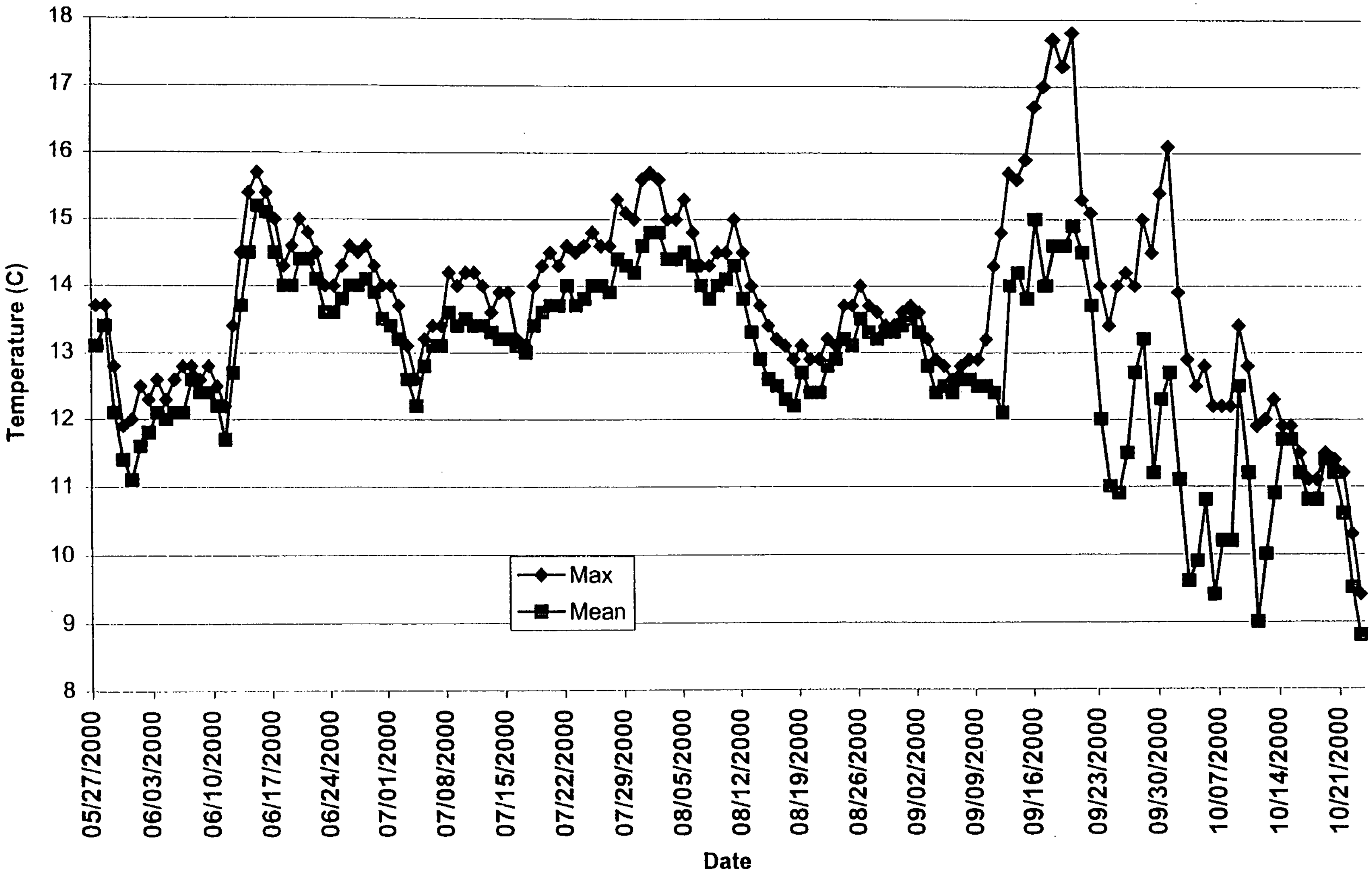
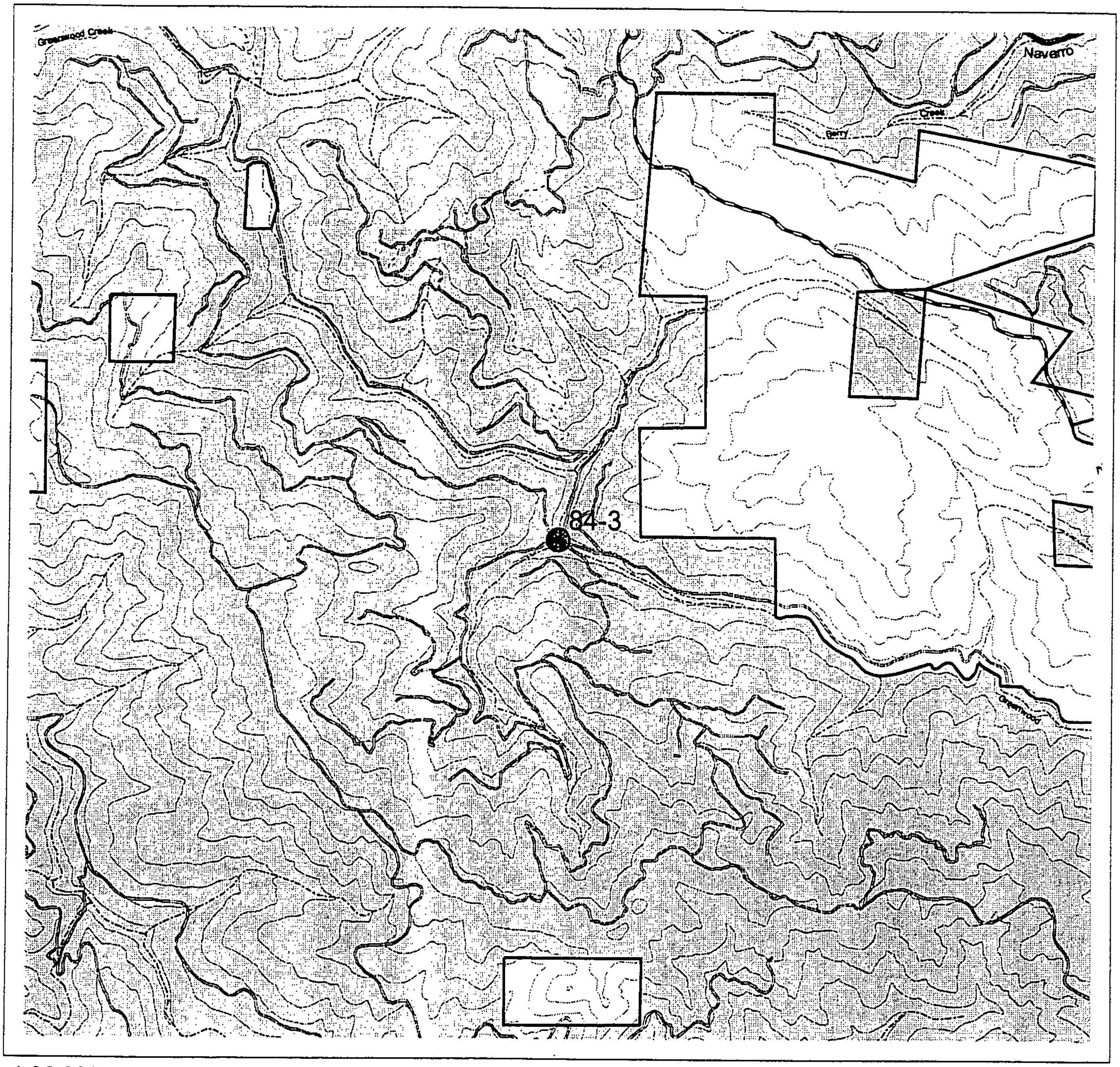


Figure 120a. Maximum and Mean Daily Stream Temperatures During Summer 2000 at Greenwood Creek (Site 84-1), Mendocino County, California.





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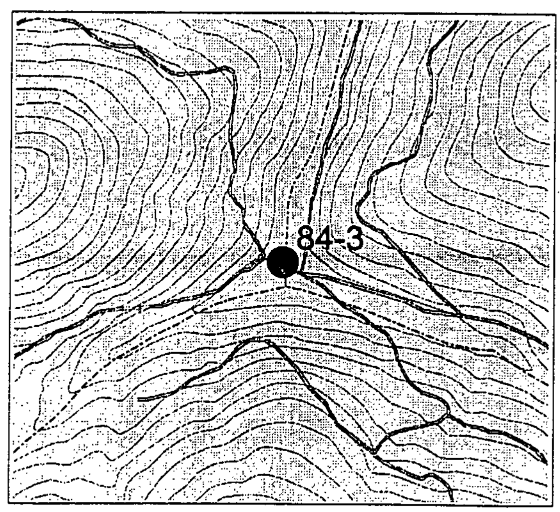
Mendocino Redwood Company
Stream Temperature Monitoring Sites 1997 - 2000

SITE ID: 84-3
STREAM NAME: Greenwood Creek
USGS QUAD: Cold Springs
PLACEMENT DESCRIPTION:
30' upstream of low water bridge crossing.



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Monitoring Site
Hydrography
Roads
Jeep Trail
Native
Rocked
Paved
MRC Ownership

N

MENDOCINO
REDWOOD COMPANY, LLC
Geographic Information System
March 2001

Figure 121. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Greenwood Creek (Site 84-3), Mendocino County, California.

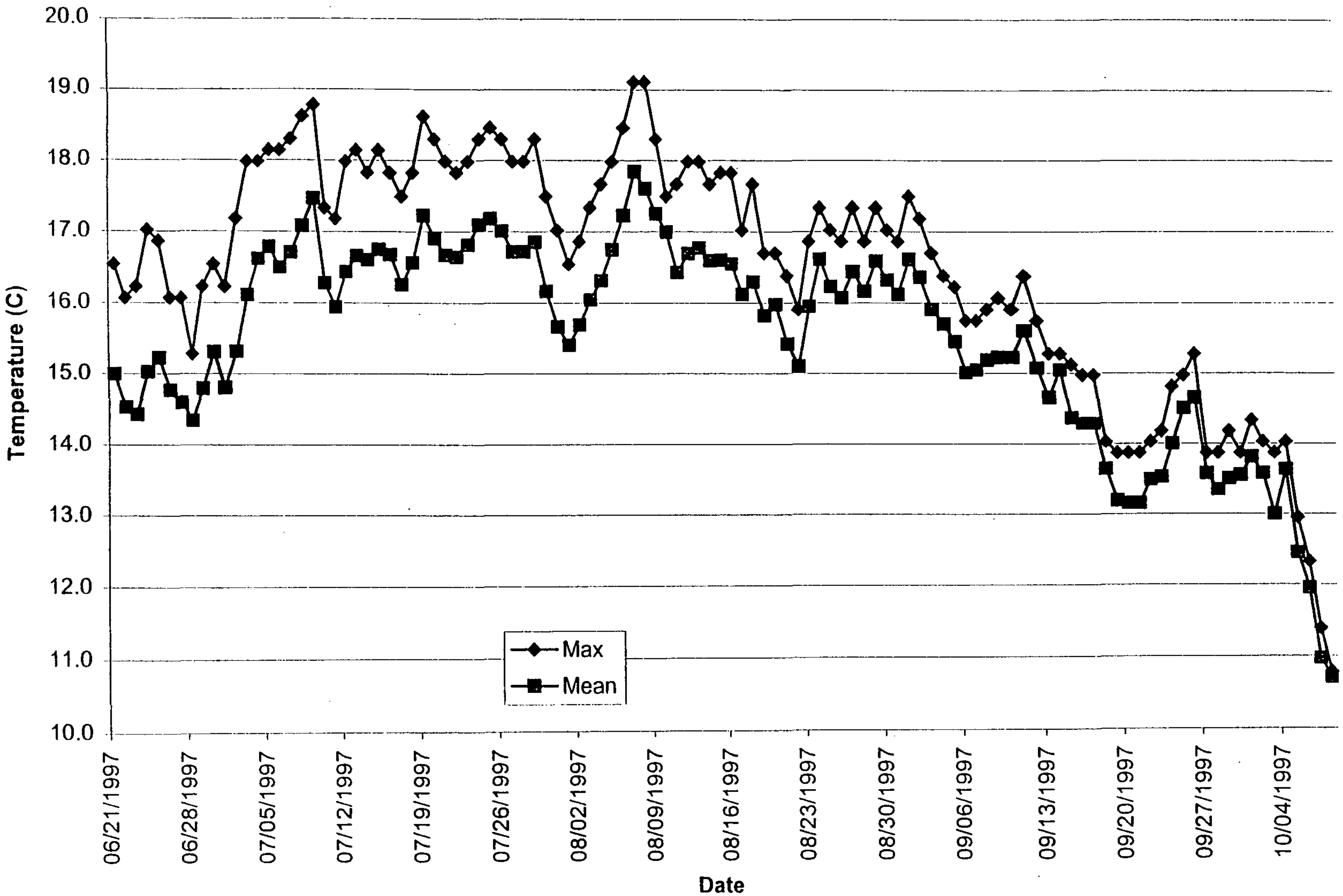


Figure 122. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Greenwood Creek (Site 84-3), Mendocino County, California.

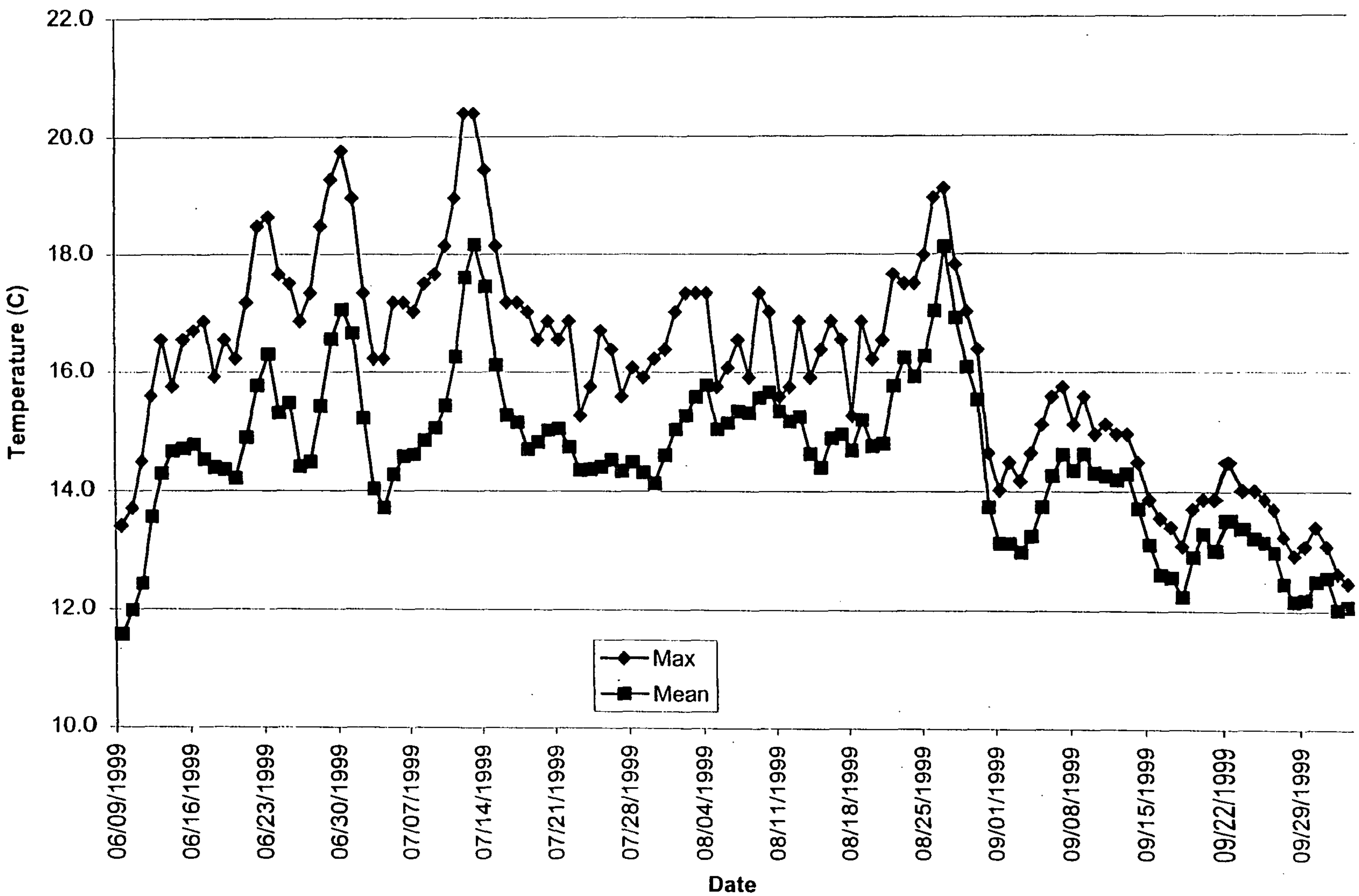
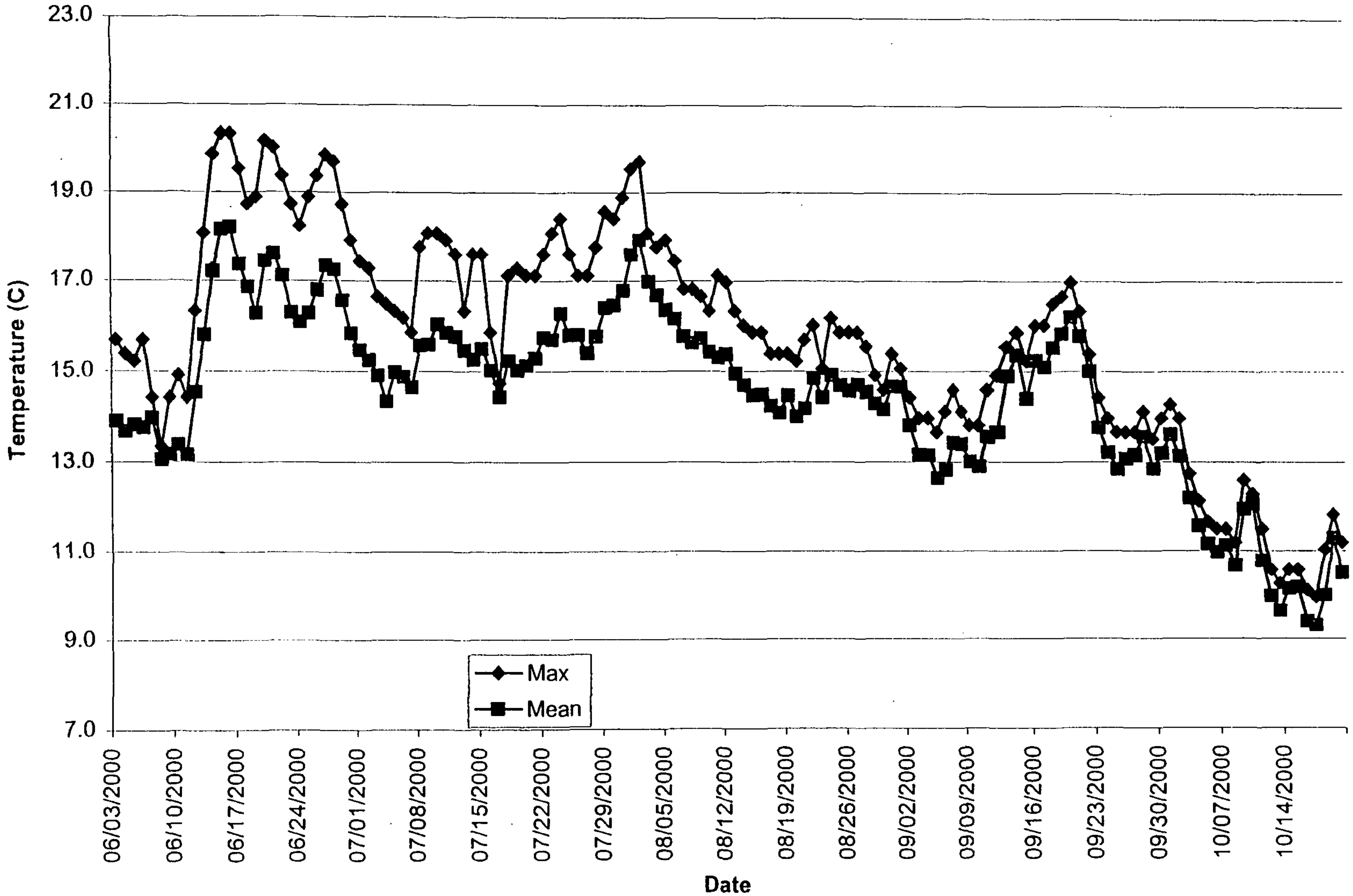
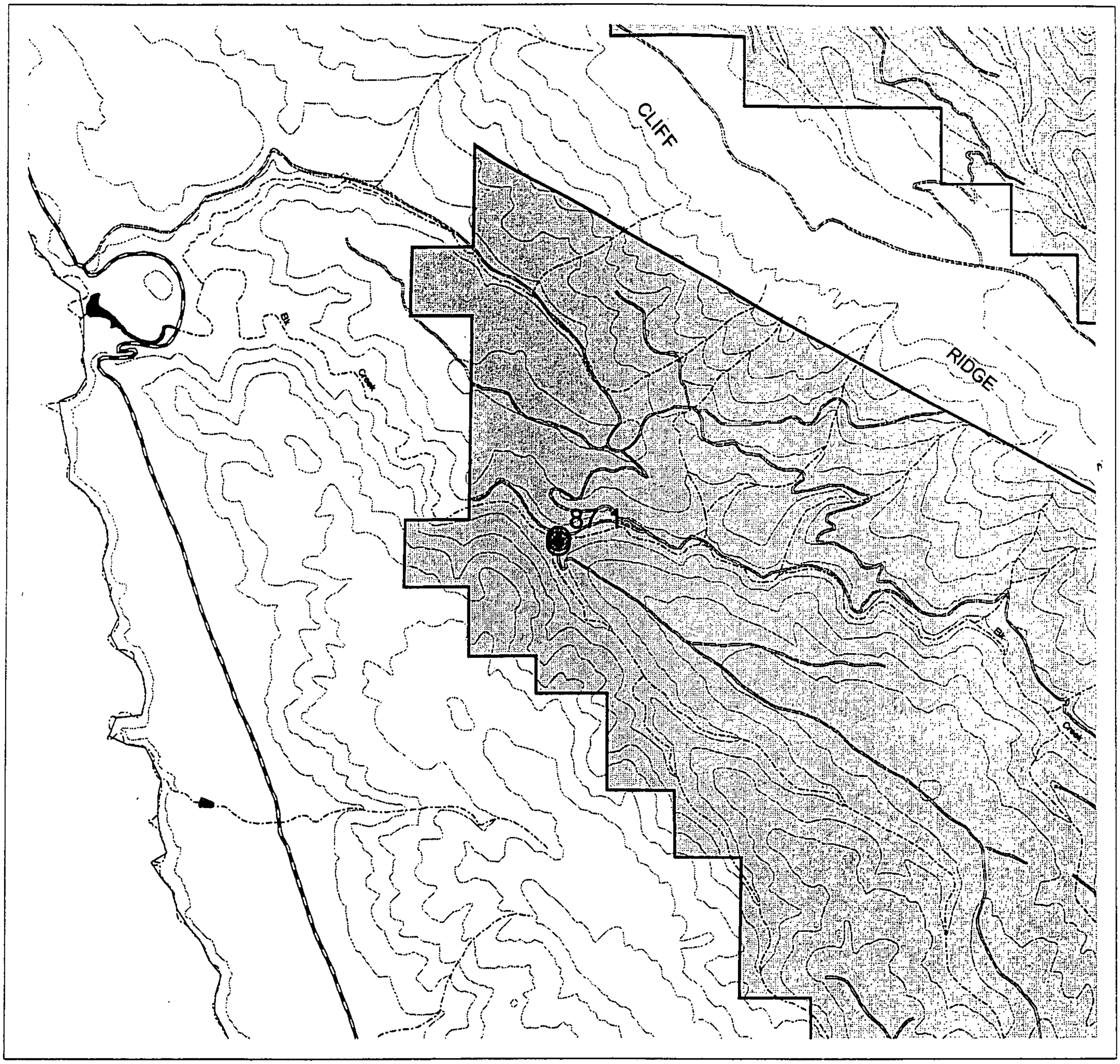


Figure 123. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Greenwood Creek (Site 84-3), Mendocino County, California.





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Mendocino Redwood Company
Stream Temperature Monitoring Sites 1997 - 2000

SITE ID: 87-1
STREAM NAME: Elk Creek
USGS QUAD: Mallo Pass Creek
PLACEMENT DESCRIPTION:
Property line

Monitoring Site
Hydrography
Roads
Jeep Trail
Native
Rocked
Paved
MRC Ownership

N

MENDOCINO
REDWOOD COMPANY, LLC
Geographic Information System
March 2001

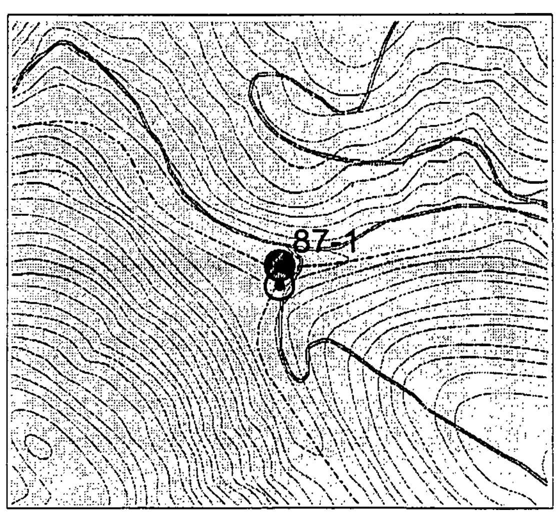

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Figure 124. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Elk Creek (Site 87-1), Mendocino County, California.

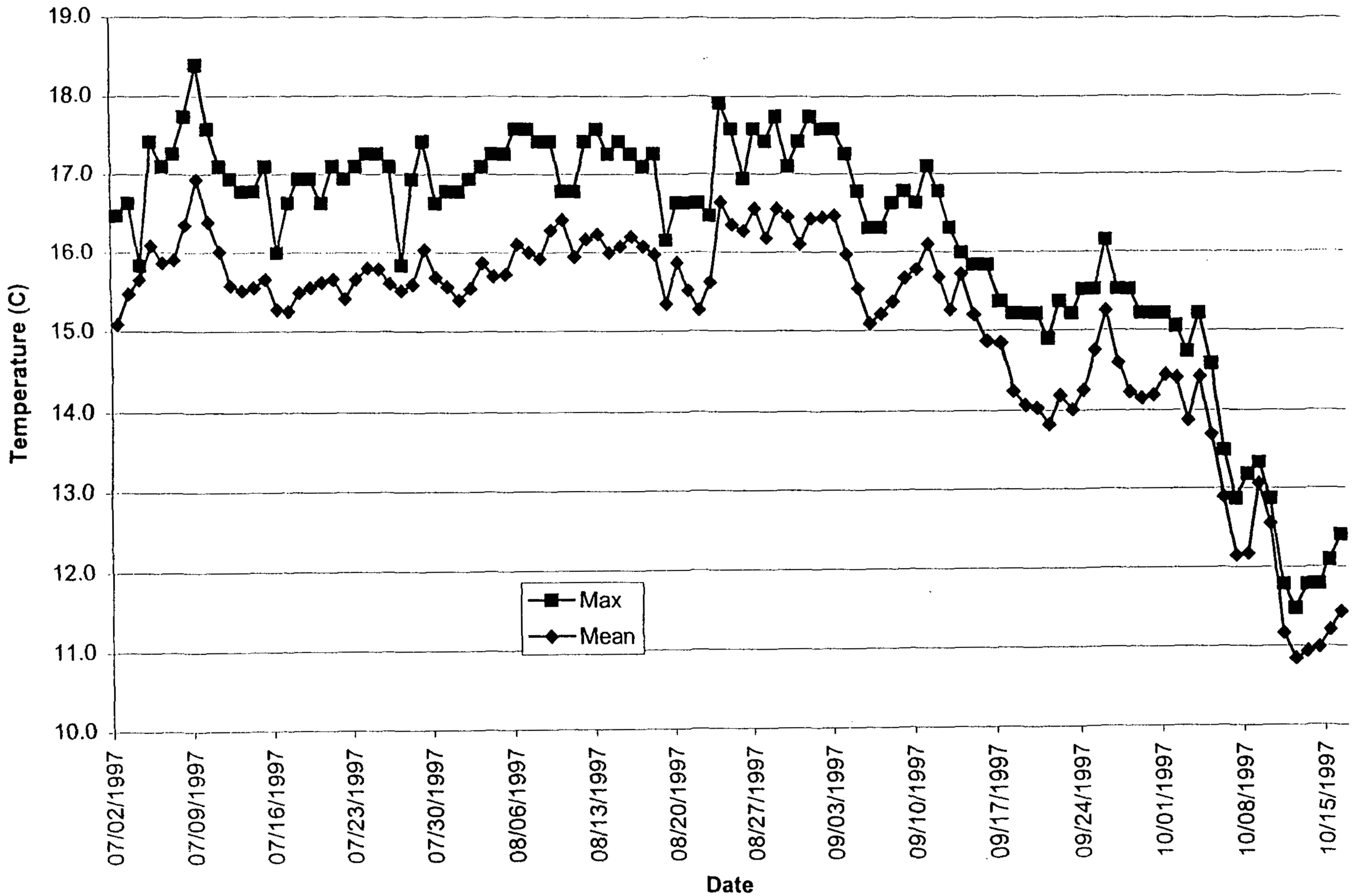


Figure 125. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Elk Creek (Site 87-1), Mendocino County, California.

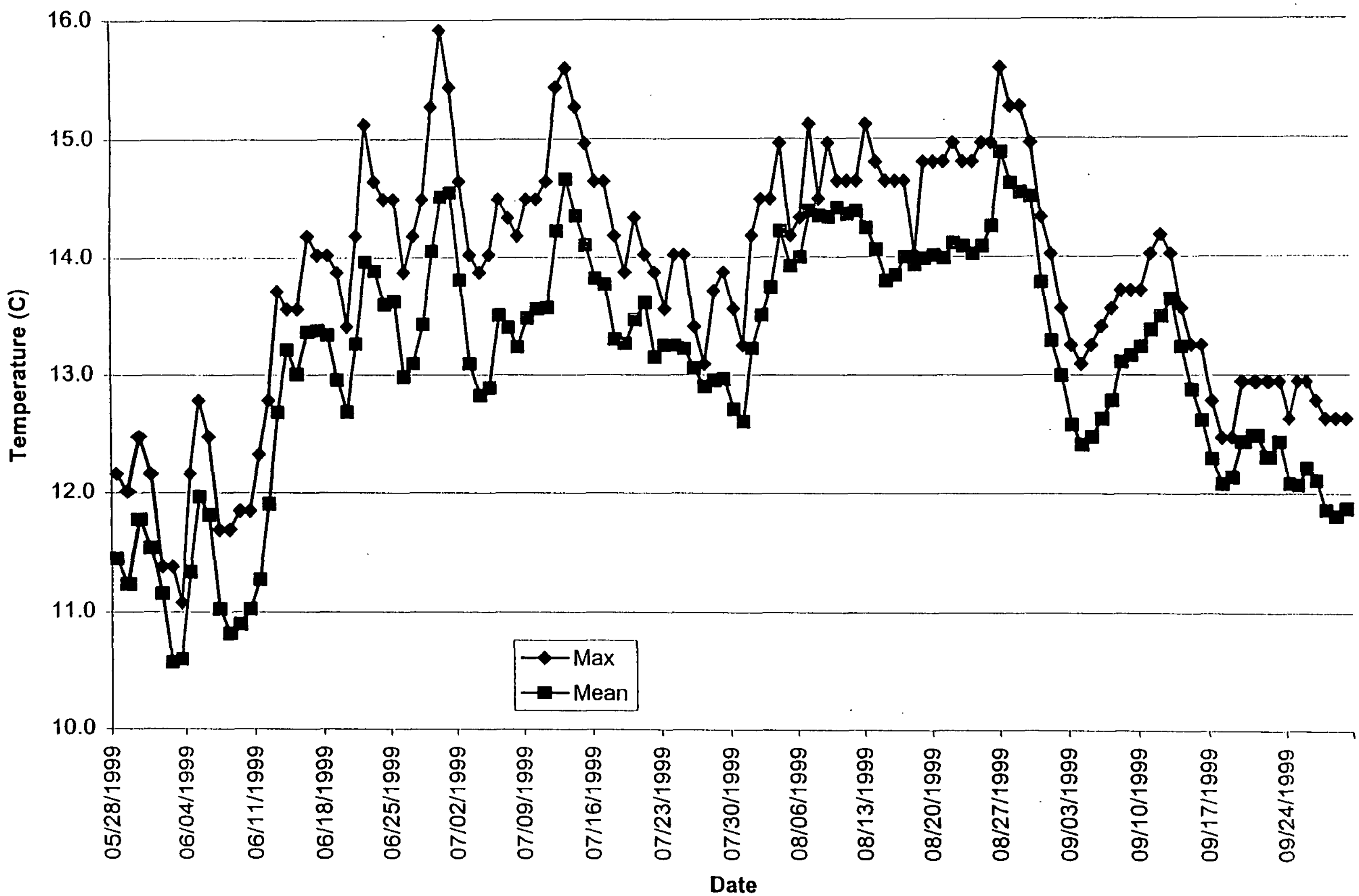
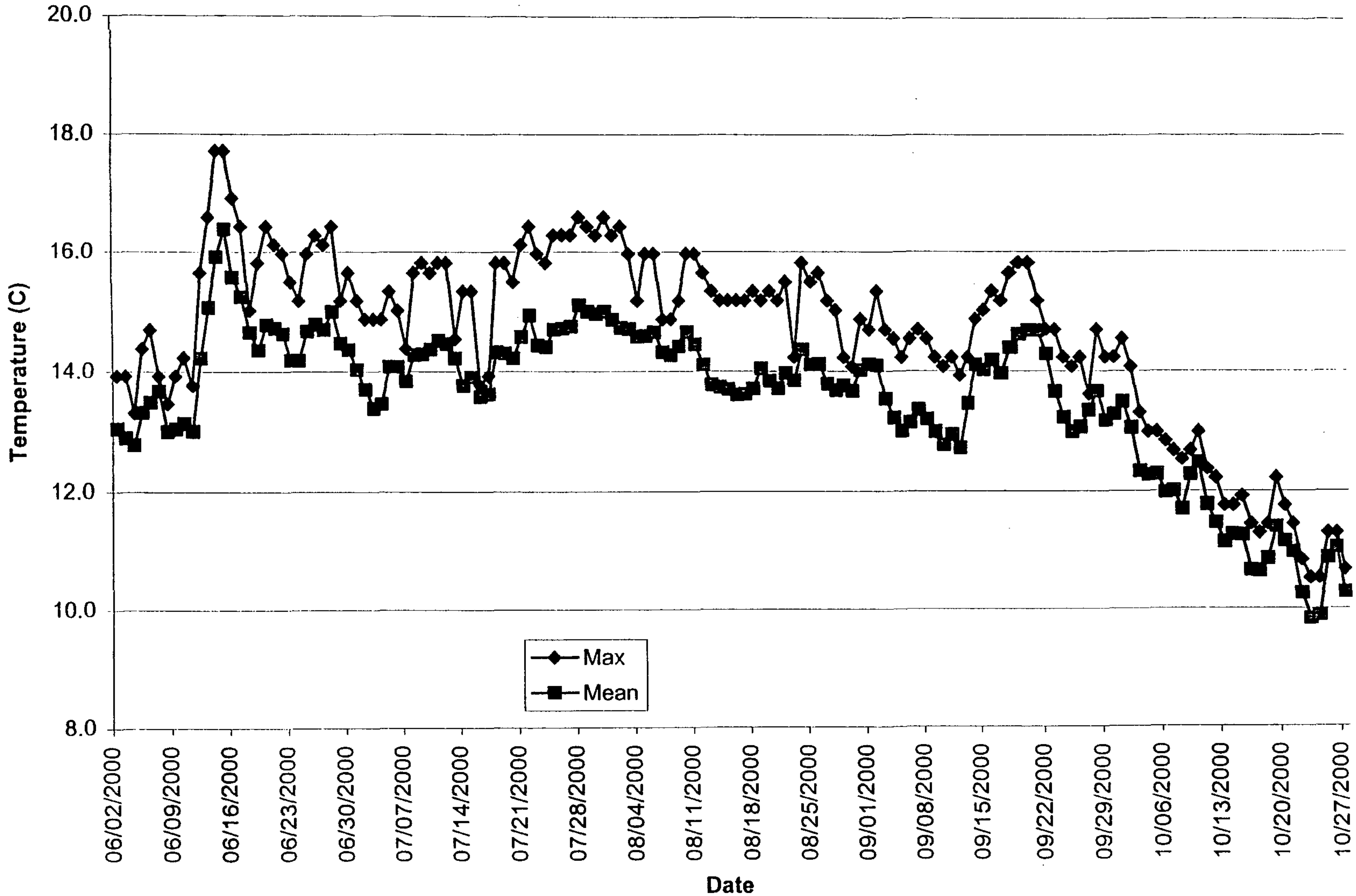
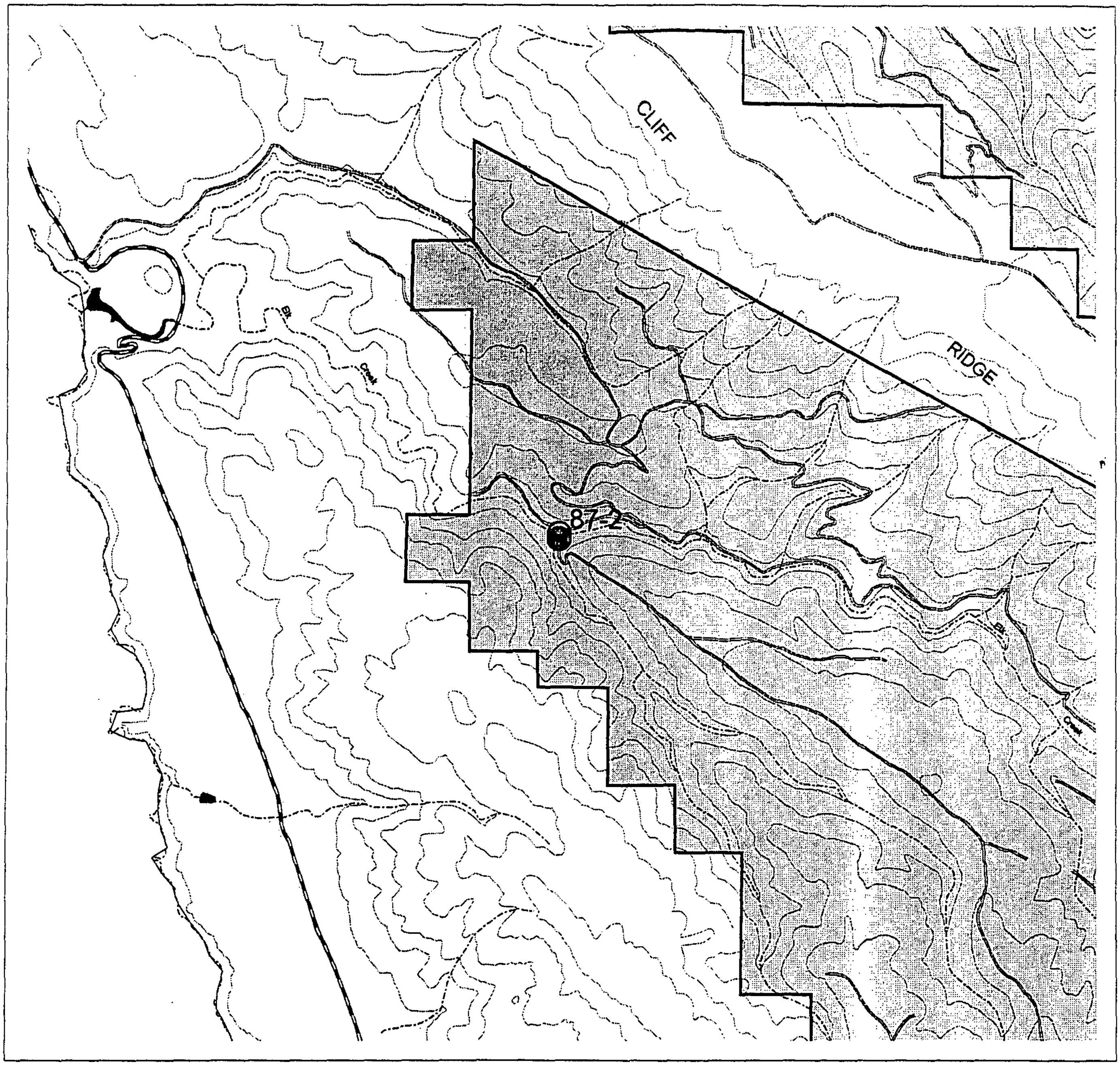


Figure 126. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Elk Creek (Site 87-1), Mendocino County, California.





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Mendocino Redwood Company
Stream Temperature Monitoring Sites 1997 - 2000

SITE ID: 87-2
STREAM NAME: South Fork Elk Creek
USGS QUAD: Mallo Pass Creek
PLACEMENT DESCRIPTION:
100' upstream from confluence of mainstem Elk Creek

Monitoring Site
Hydrography
Roads
Jeep Trail
Native
Rocked
Paved
MRC Ownership

N

MENDOCINO REDWOOD COMPANY, LLC
Geographic Information System
March 2001

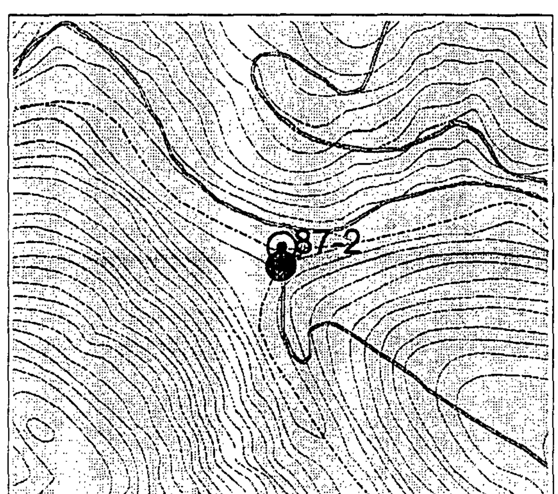

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Figure 127. Mean and Maximum Daily Stream Temperatures During Summer 1997 at South Fork Elk Creek (Site 87-2), Mendocino County, California.

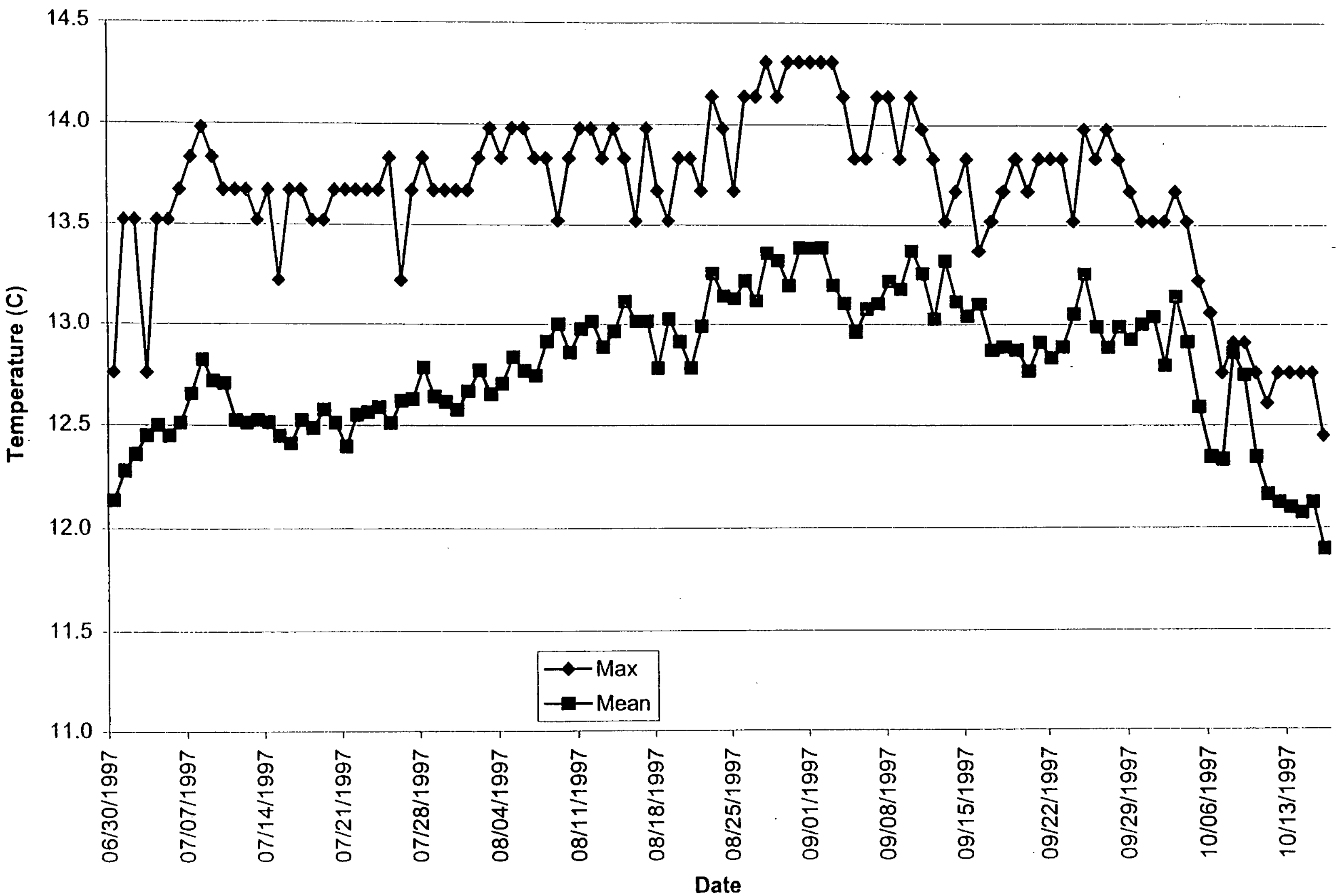


Figure 128. Mean and Maximum Daily Stream Temperatures During Summer 1999 at South Fork Elk Creek (Site 87-2), Mendocino County, California.

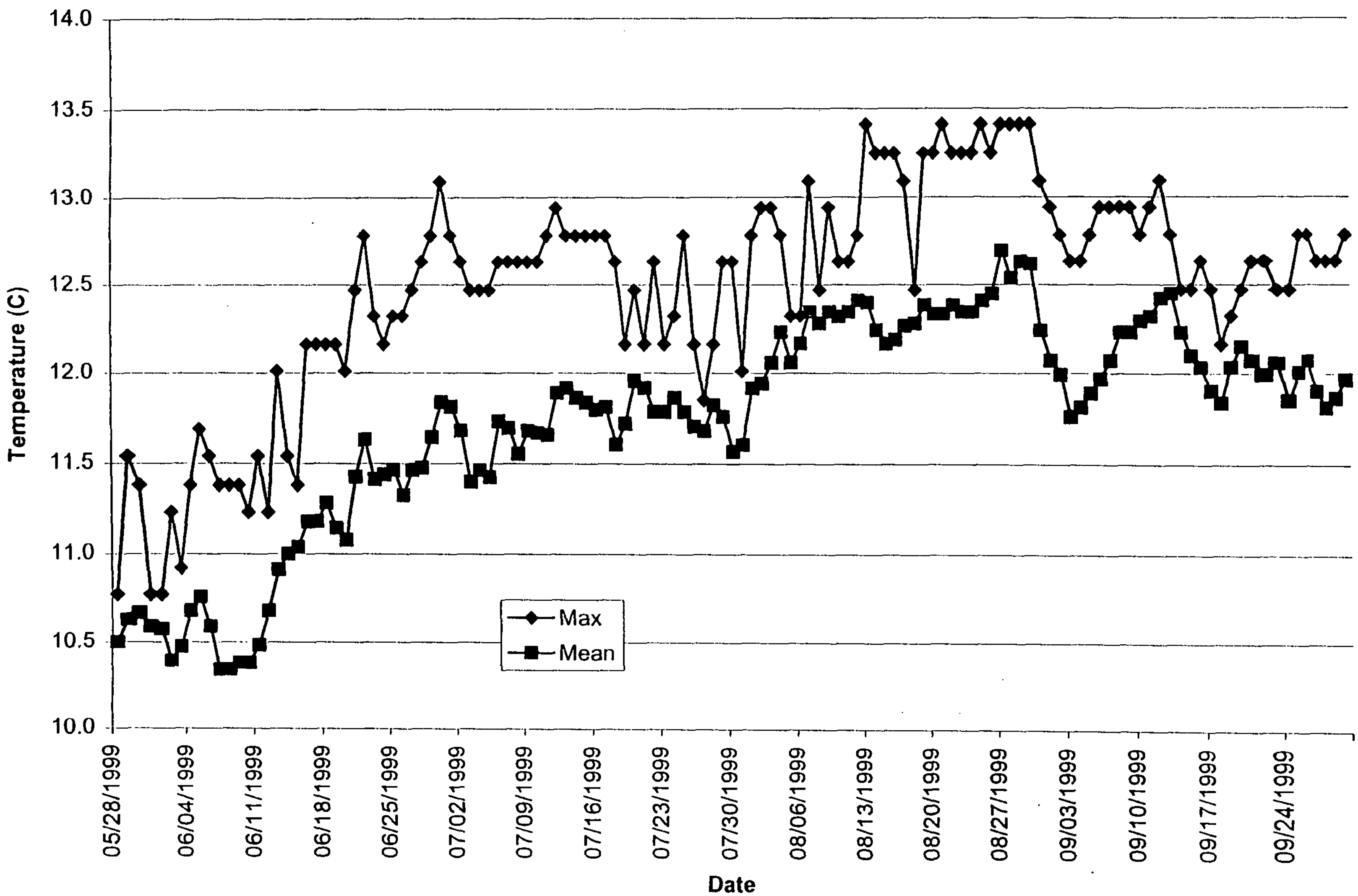
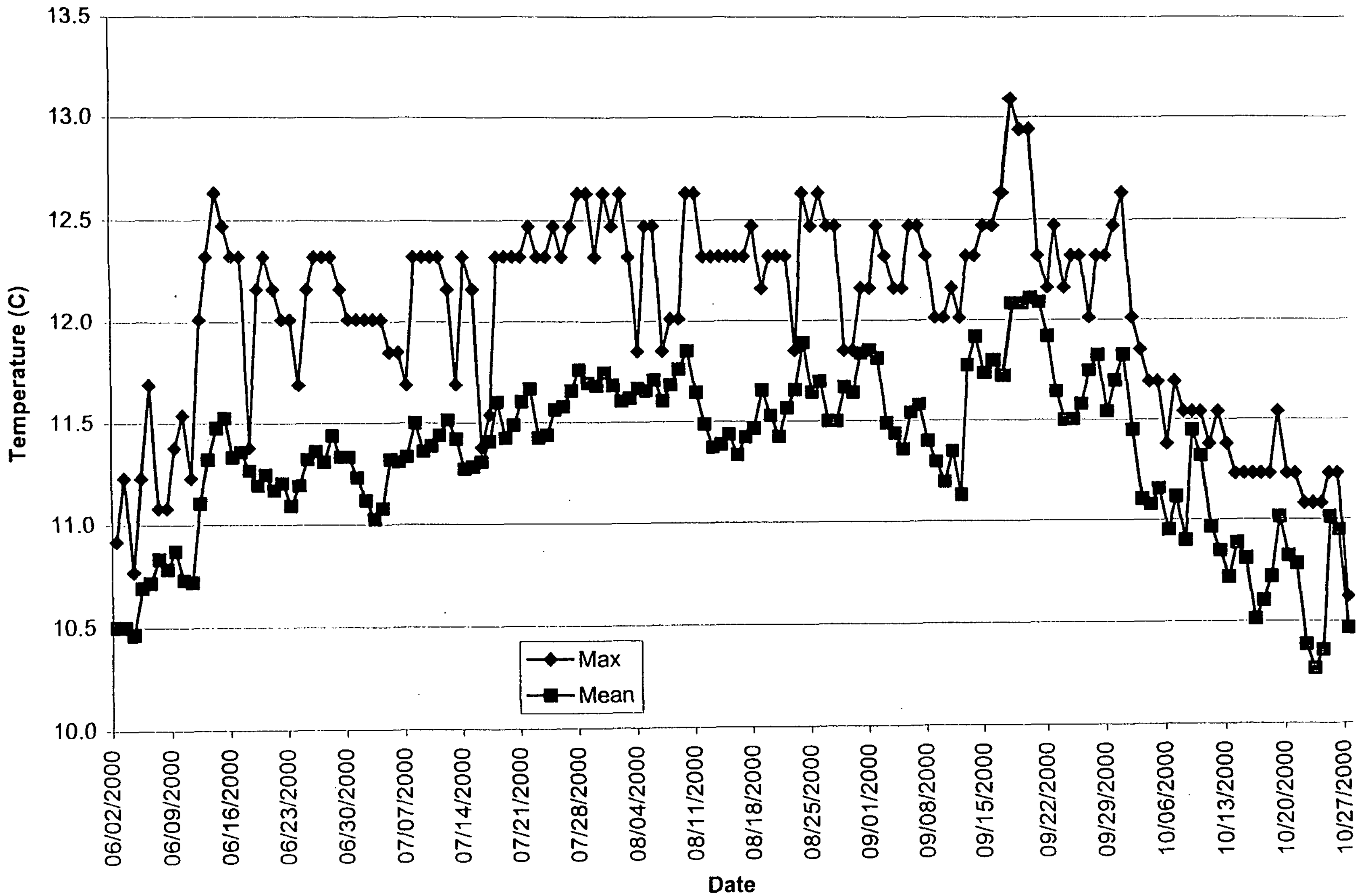
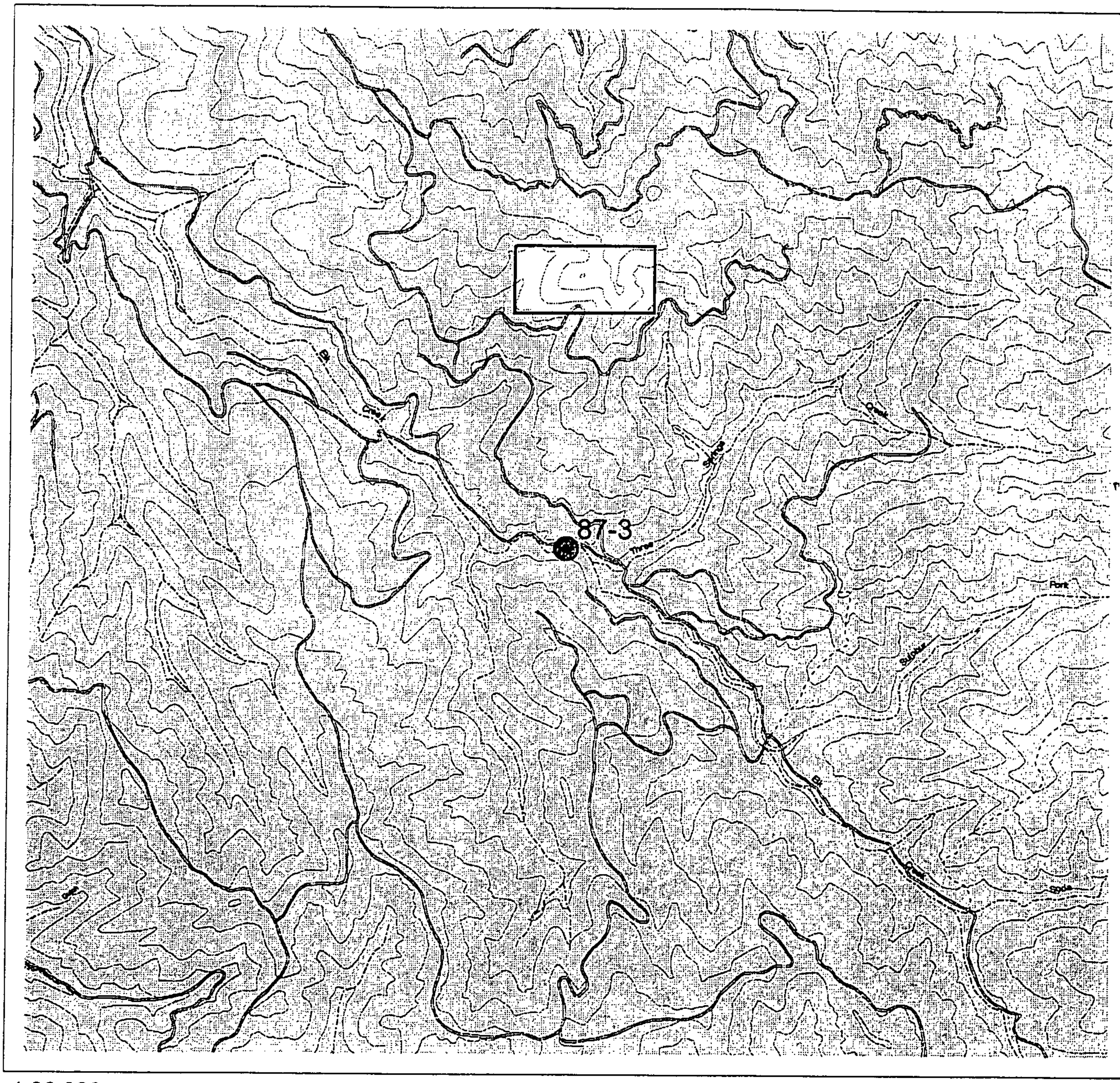


Figure 129. Mean and Maximum Daily Stream Temperatures During Summer 2000 at South Fork Elk Creek (Site 87-2), Mendocino County, California.





1:36,000

Mendocino Redwood Company
Stream Temperature Monitoring Sites 1997 - 2000

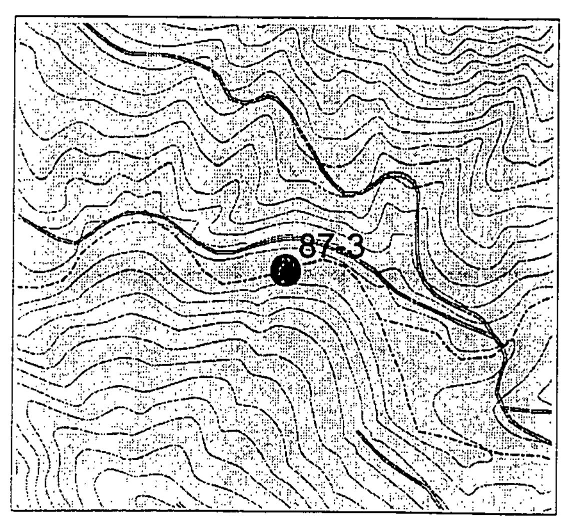
SITE ID: 87-3
STREAM NAME: Elk Creek
USGS QUAD: Cold Springs
PLACEMENT DESCRIPTION:

MENDOCINO
REDWOOD COMPANY, LLC
Geographic Information System
March 2001

- Monitoring Site
- Hydrography

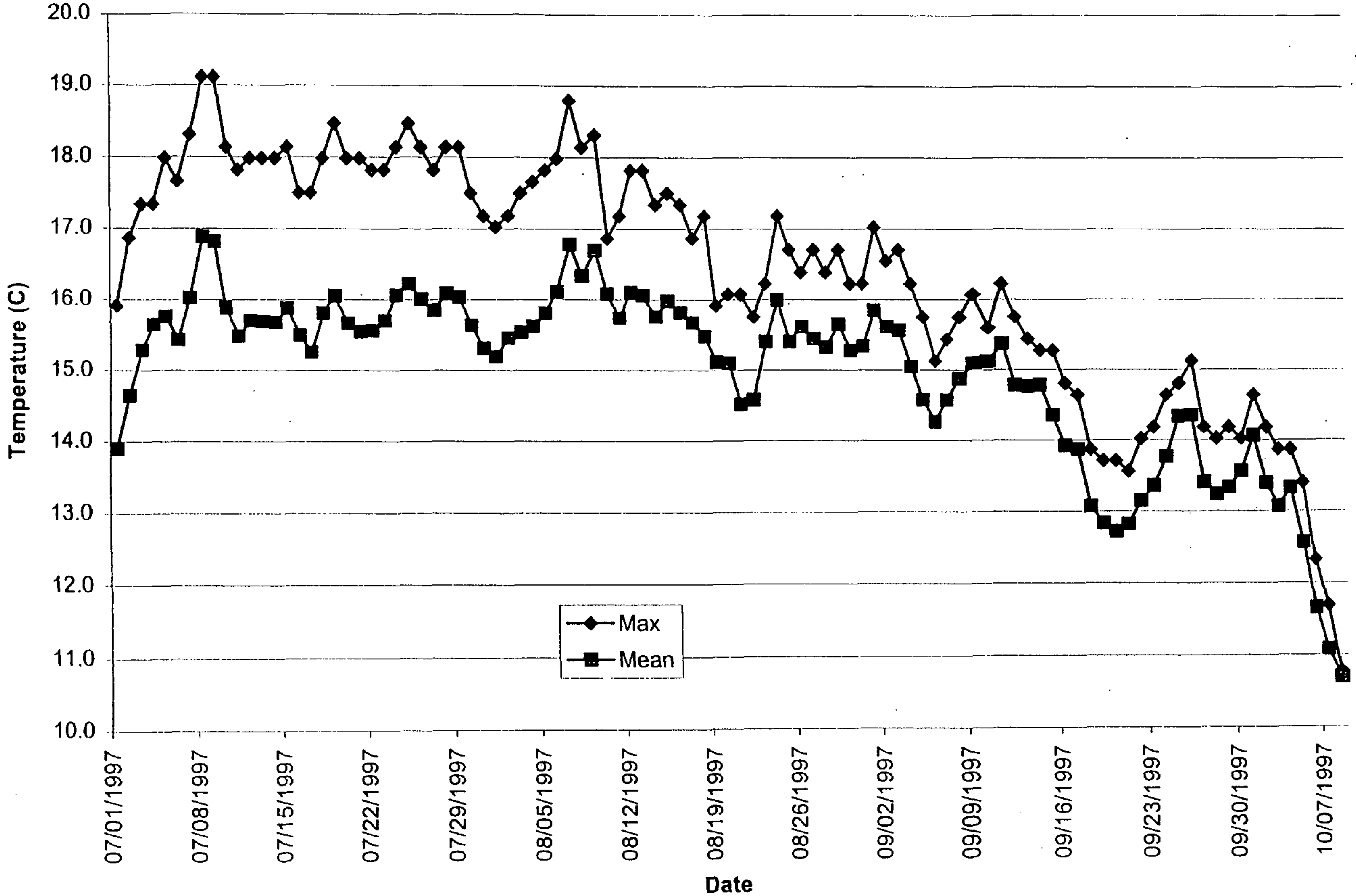
Roads
- Jeep Trail
- Native
- Rocked
- Paved
- MRC Ownership

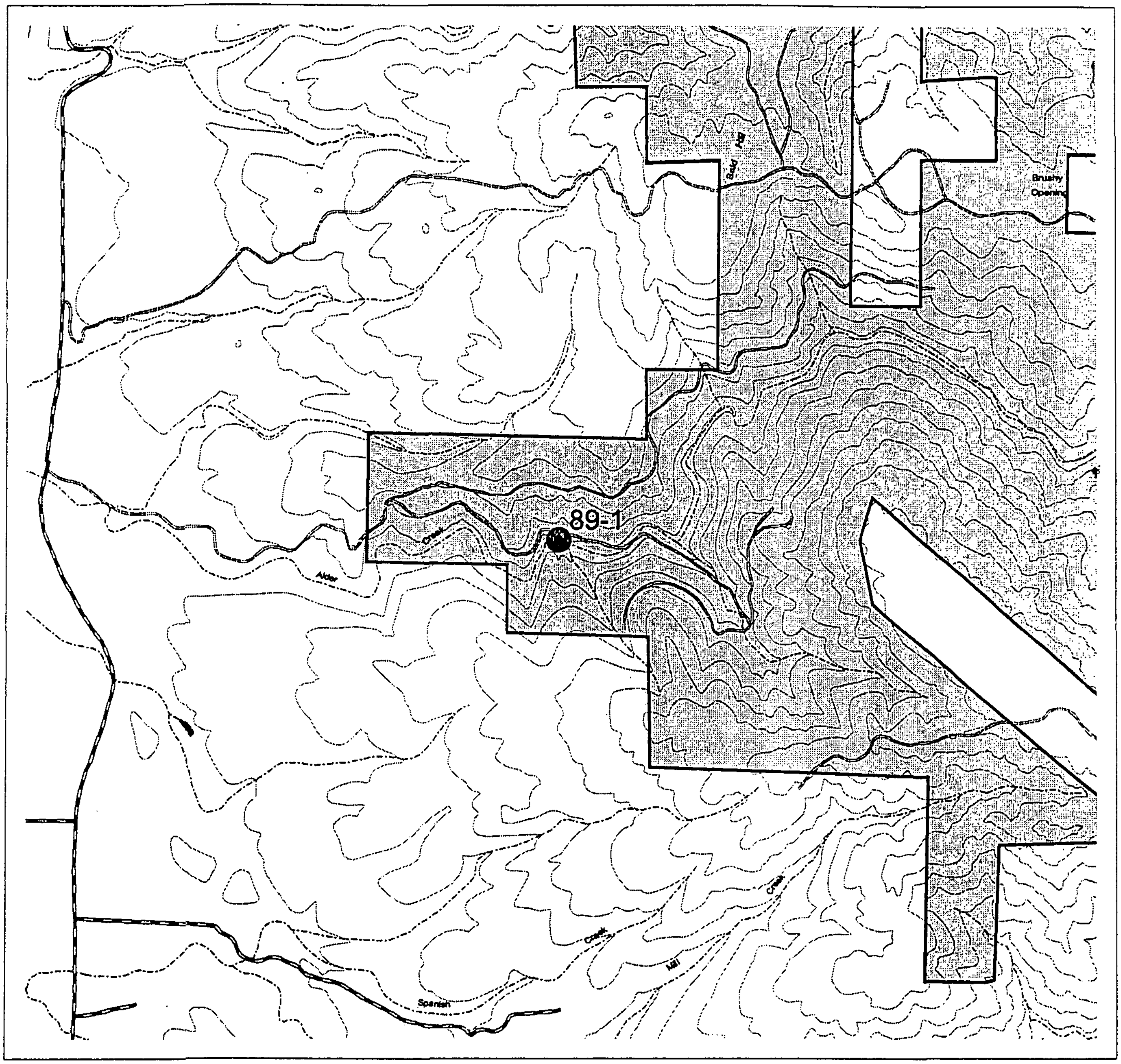
N



1:12,000

Figure 130. Mean and Maximum Daily Stream Temperatures During Summer 1997 at Elk Creek (Site 87-3), Mendocino County, California.





1:36,000

Mendocino Redwood Company
Stream Temperature Monitoring Sites 1997 - 2000

SITE ID: 89-1
STREAM NAME: Alder Creek
USGS QUAD: Point Arena
PLACEMENT DESCRIPTION:

MENDOCINO
REDWOOD COMPANY, LLC
Geographic Information System
March 2001

Monitoring Site
Hydrography
Roads
Jeep Trail
Native
Rocked
Paved
MRC Ownership

N

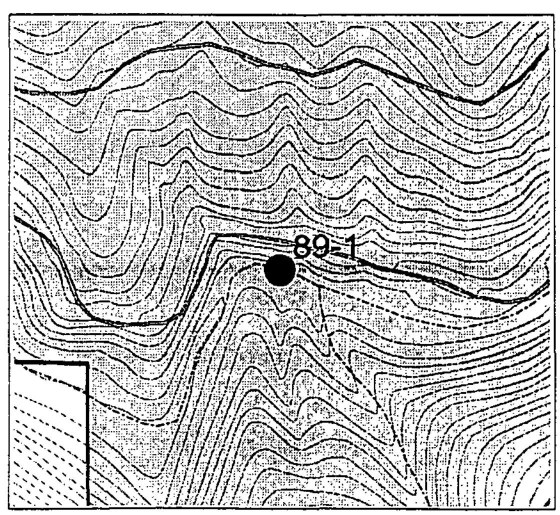


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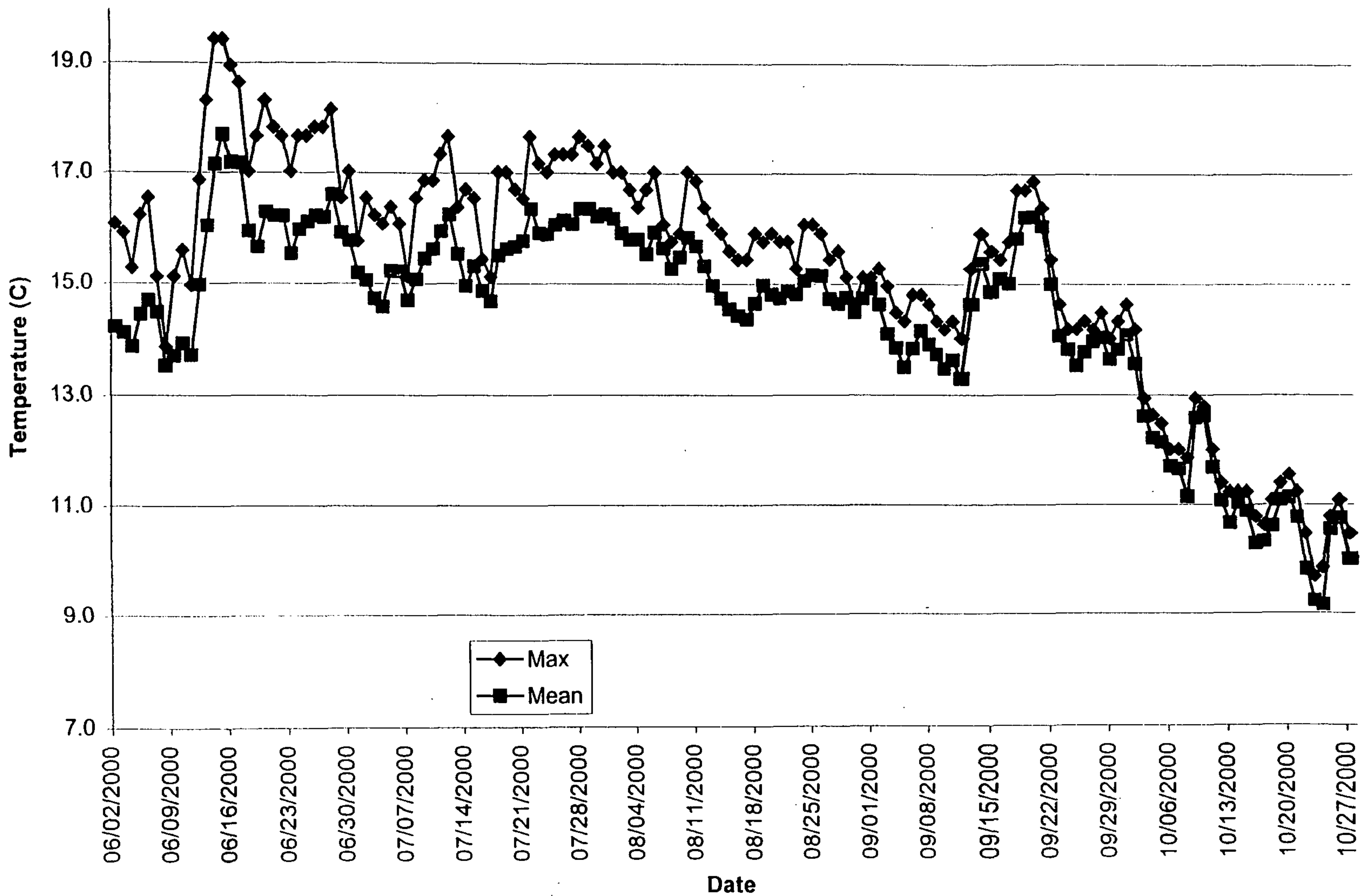
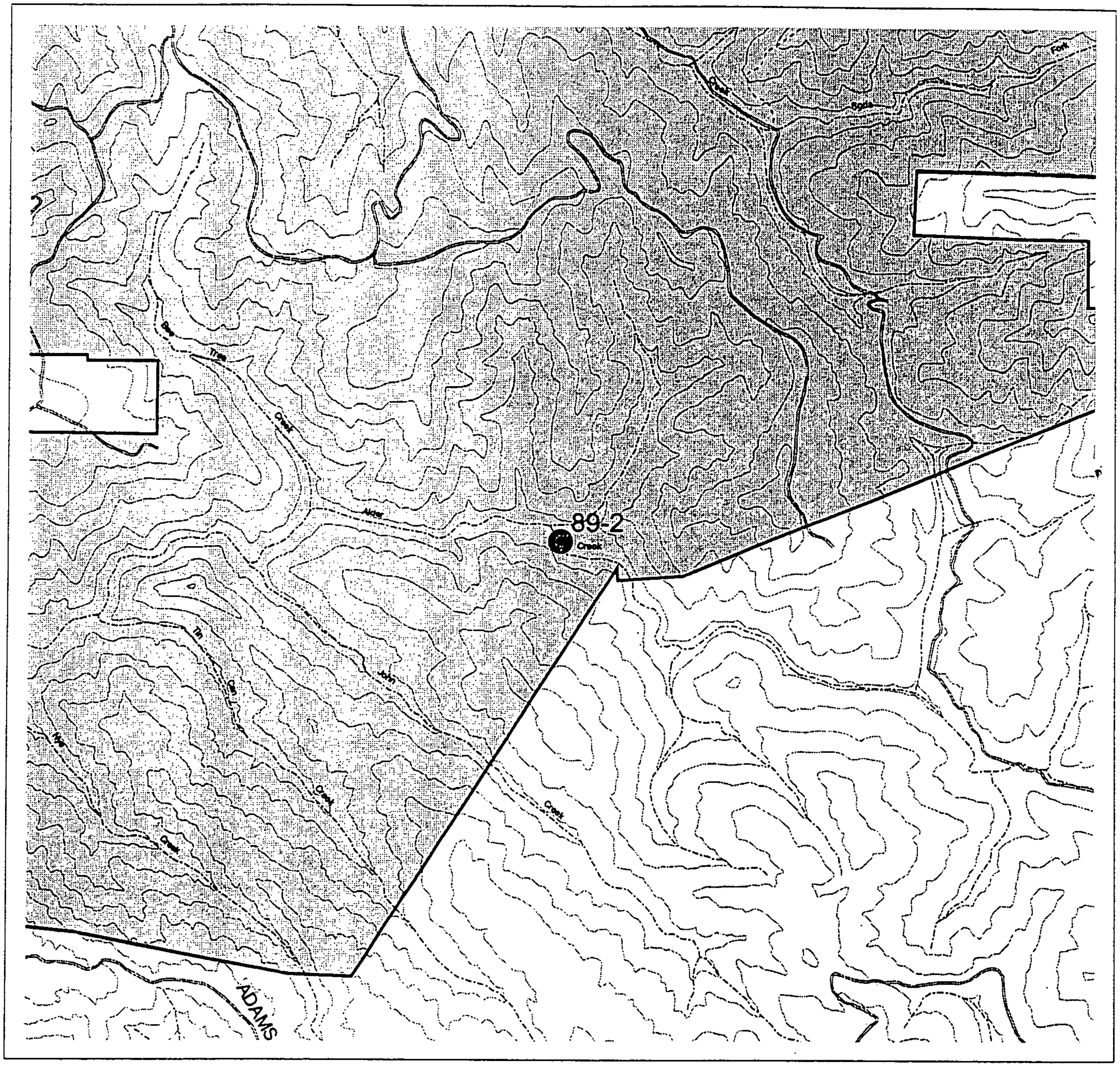
Figure 131. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Alder Creek (Site 89-1), Mendocino County, California.





1:36,000

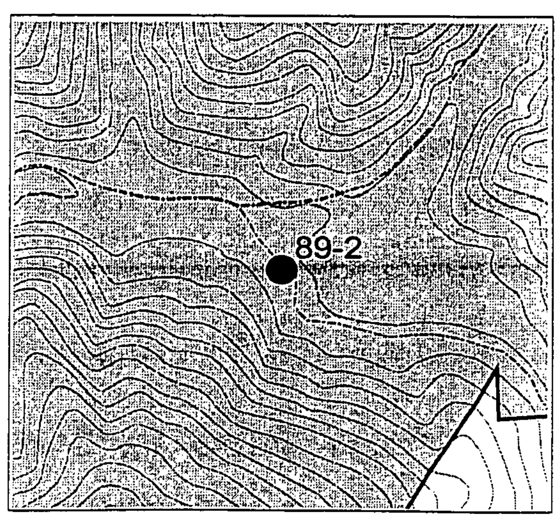
Mendocino Redwood Company
Stream Temperature Monitoring Sites 1997 - 2000

SITE ID: 89-2
STREAM NAME: Alder Creek
USGS QUAD: Cold Springs
PLACEMENT DESCRIPTION:
300' upstream of bridge.

Monitoring Site
Hydrography
Roads
Jeep Trail
Native
Rocked
Paved
MRC Ownership

N

MENDOCINO REDWOOD COMPANY, LLC
Geographic Information System
March 2001



1:12,000

Figure 132. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Alder Creek (Site 89-2), Mendocino County, California.

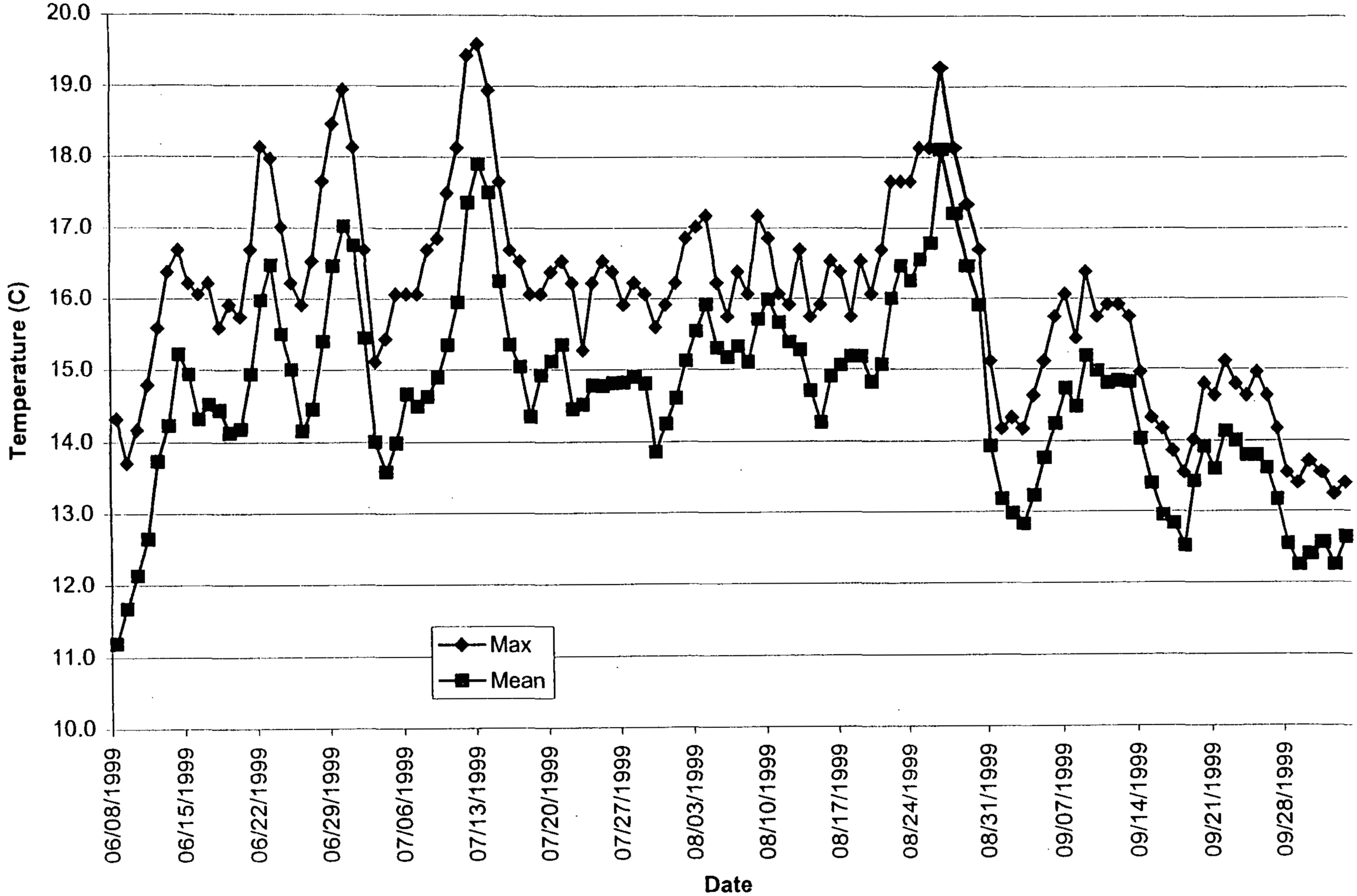
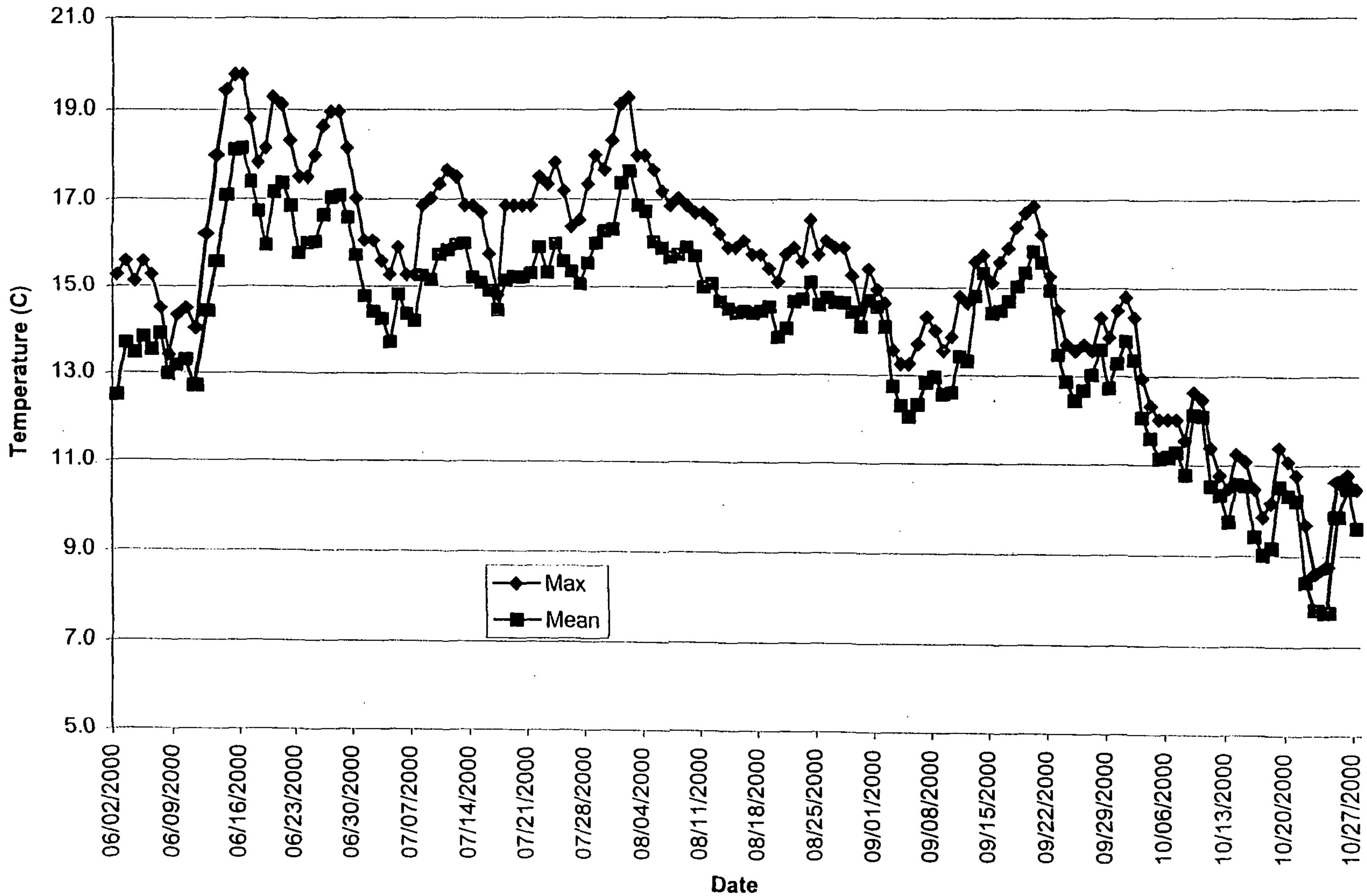
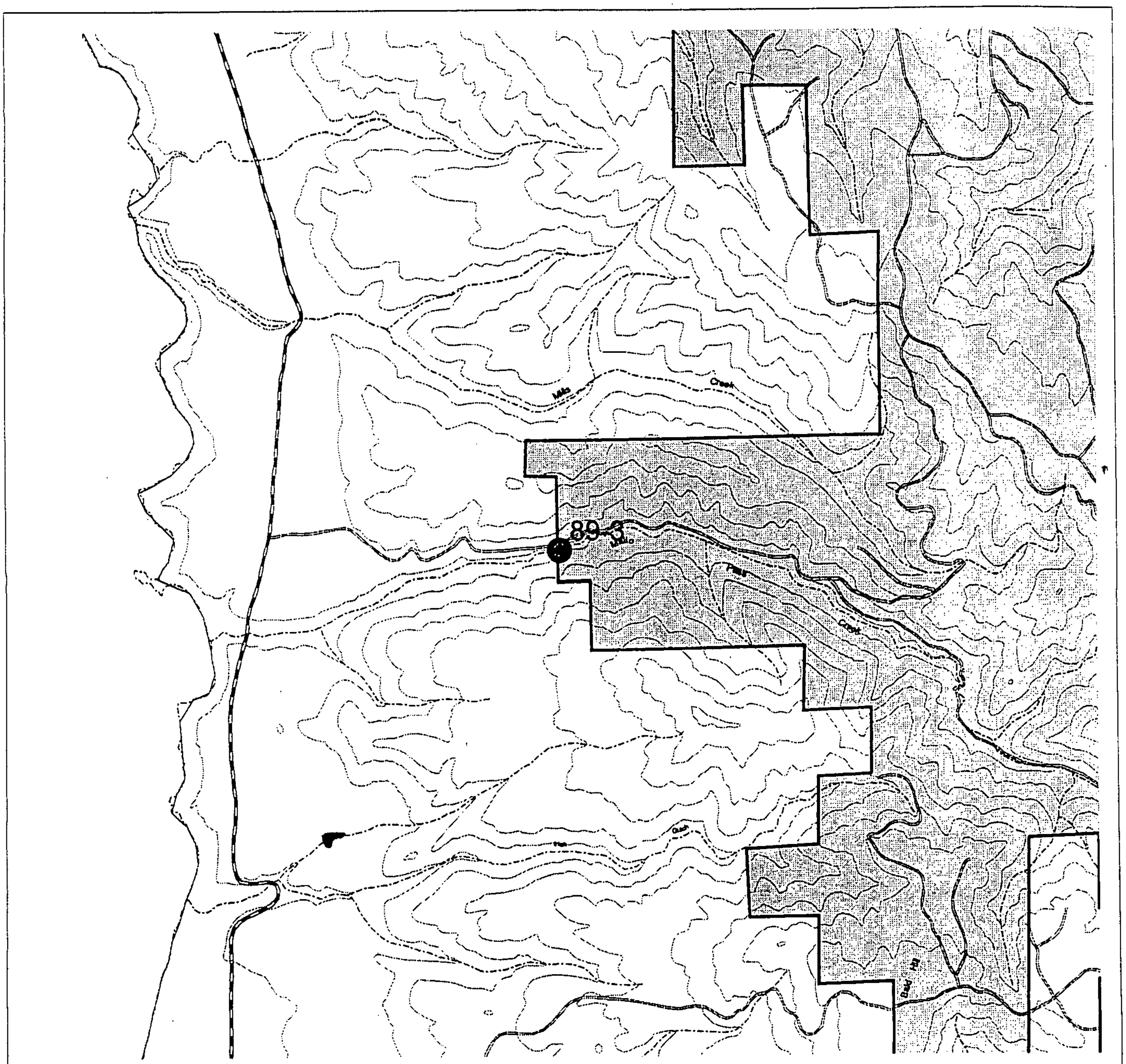


Figure 133. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Alder Creek (Site 89-2), Mendocino County, California.





1:36,000

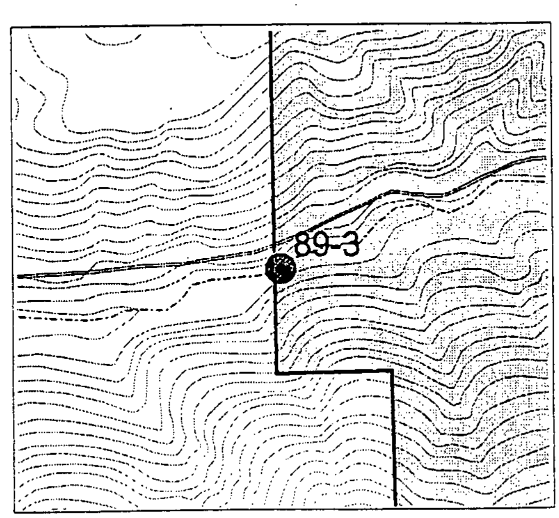
Mendocino Redwood Company
Stream Temperature Monitoring Sites 1997 - 2000

SITE ID: 89-3
STREAM NAME: Mallo Pass Creek
USGS QUAD: Mallo Pass Creek
PLACEMENT DESCRIPTION:
60' downstream from waterhole.

Monitoring Site
Hydrography
Roads
Jeep Trail
Native
Rocked
Paved
MRC Ownership

N

MENDOCINO
REDWOOD COMPANY LLC
Geographic Information System
March 2001



1:12,000

Figure 134. Mean and Maximum Daily Stream Temperatures During Summer 1999 at Mallo Pass Creek (Site 89-3), Mendocino County, California.

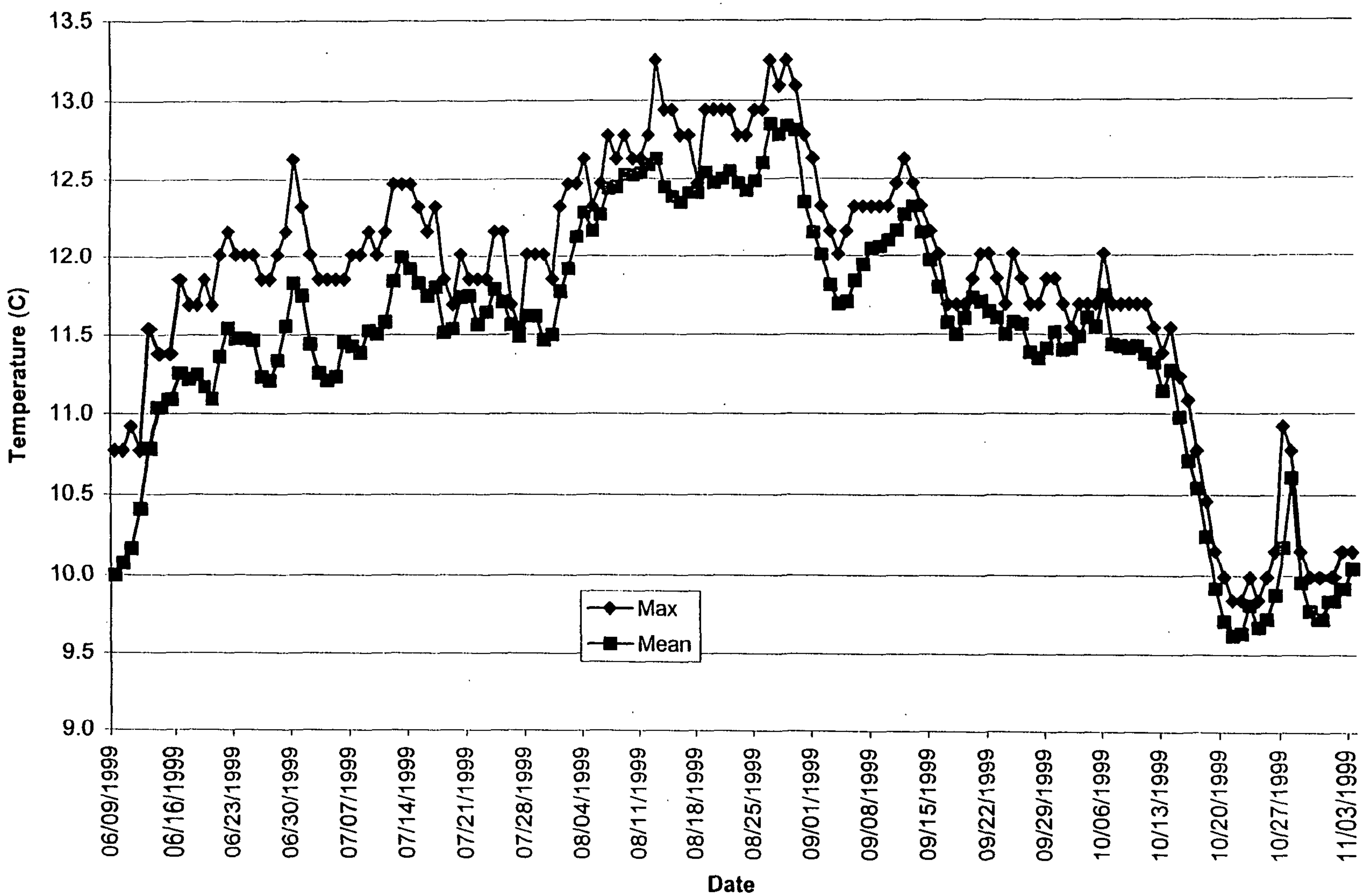
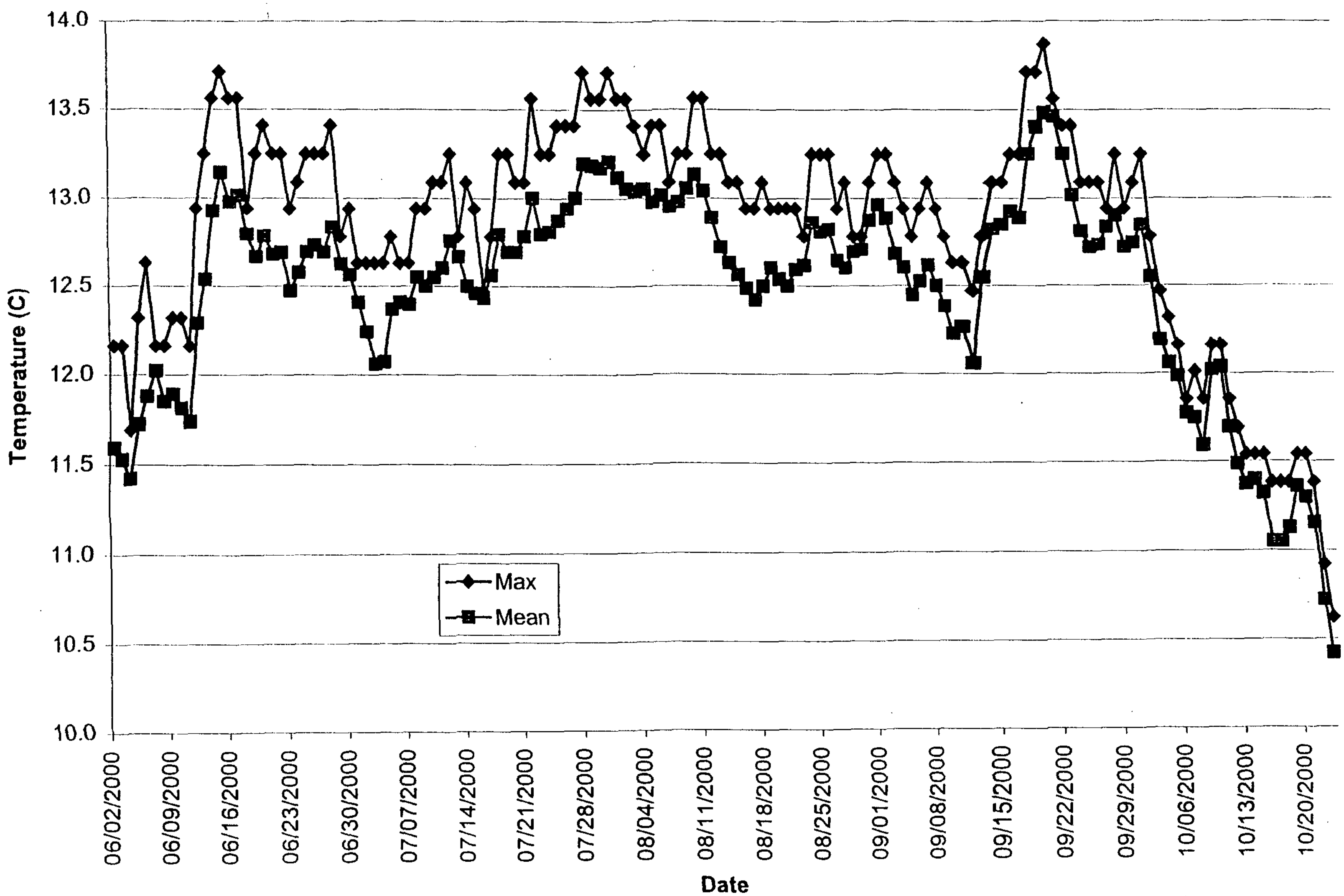


Figure 135. Mean and Maximum Daily Stream Temperatures During Summer 2000 at Mallo Pass Creek (Site 89-3), Mendocino County, California.



Louisiana-Pacific Corporation

Wildlife and Fisheries Science Group • Forest Resources and Fiber Procurement Div. (Western Region)

Date: December 10, 1997

To: North Coast Regional Water Quality Control Board

From: Chris Surfleet, Watershed Specialist

Subject: Greenwood Creek Turbidity Comments

The surface water turbidity measurements taken from Greenwood Creek were compared to turbidities measured in three unharvested watersheds of Caspar Creek in the Jackson Demonstration State Forest. The Caspar Creek watershed is in coastal Mendocino County and has similar soil characteristics, geology, topography and weather as Greenwood Creek allowing a reasonable comparison between the two watersheds.

The Caspar Creek data showed storm flow turbidity ranging from 20 to 234 NTU in the 1996 winter in unharvested watersheds. These turbidities were from storms which did not exceed a recurrence interval of about 1 year. Turbidity collected at Greenwood Creek for 1992-1993 and 1995-1997, were compared to these values (1994 was not available from public sources)(see attached Figure 1 and 2). Typically, only 2-4 observations per year at Greenwood Creek were higher than the highest turbidities from the unharvested Caspar Creek watersheds, with the exception of 1995 which had 9 higher observations (Figure 1). Further investigation found that almost every high turbidity reading occurred in extreme storms, usually greater than a 5 year recurrence interval (Figure 2). It is during these extreme storms that there are greater increases in stream bank erosion, landslides, surface erosion and bank topping floods creating greater sediment inputs whether a watershed is managed or unmanaged. The samples taken at Greenwood Creek are taken once daily, not continuously throughout storm events. Because of this it cannot be certainly stated that the infrequent high turbidity levels observed in Greenwood Creek are from a trend of watershed degradation due to sedimentation. The infrequent high turbidity could be simply higher levels due to discrete erosion events occurring during large storms.

At Caspar Creek it was learned that as drainage area increased so did turbidity. All of the drainage areas in the Caspar Creek study are much smaller than Greenwood Creek. It should be expected that Greenwood Creek would have higher turbidity than the smaller Caspar Creek watersheds, because of higher flows and greater sediment sources due to the larger drainage area.

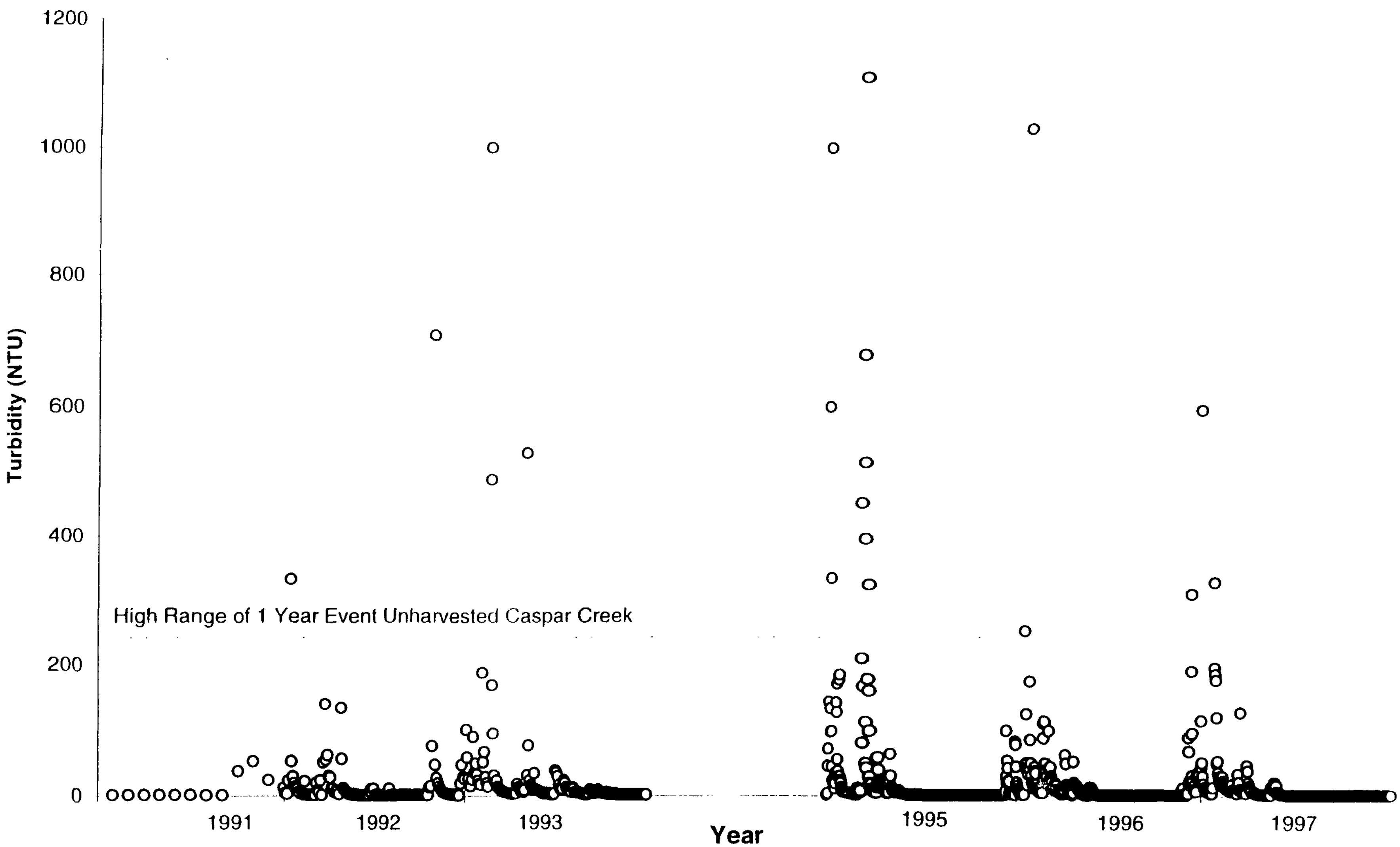
The Elk County Water District has claimed that a filtering system has been needed to handle the turbidity pollution of Greenwood Creek. If the well for the Elk County Water District is affected by Greenwood Creek turbidity levels, then the filter system would be necessary even if the watershed is not subject to timber harvesting activities. The turbidities in storm events for unharvested watersheds in Caspar Creek ranged from 20 to 234 NTUs. These are much higher than the 1 NTU standard suggested for drinking water.

It is unclear how much effect turbidity levels in the Elk County Water District well are affected by Greenwood Creek turbidity. There does not appear to be a correlation between the two data sets. When turbidity levels are at there lowest in Greenwood Creek in the summer months (typically < 1 NTU), well turbidity is often above drinking water standards (often greater than 5 NTUs). When storm flow turbidity is at its highest in Greenwood Creek the well often does not show corresponding high turbidity levels. It is these inconsistencies that suggest that there could be other factors affecting the well turbidity.

cc: Tom Schultz
Malcom Pious
Jim Lemieux

Attachment

Figure 1. Daily Turbidity for Greenwood Creek



Louisiana-Pacific Corporation

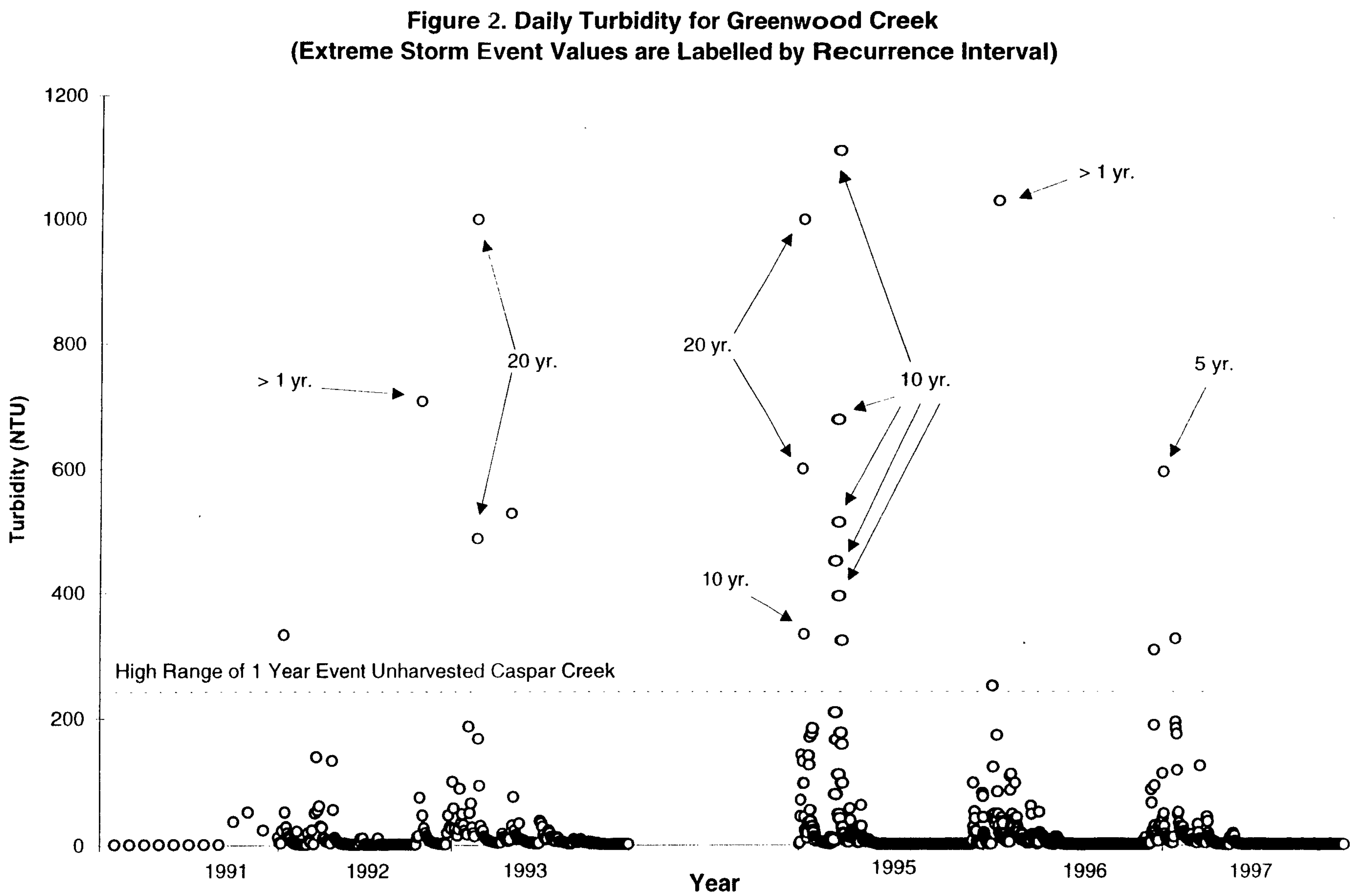


Figure 2. Daily Turbidity for Greenwood Creek
(Extreme Storm Event Values are Labelled by Recurrence Interval)
Turbidity (NTU)
1200
1000
800
600
400
200
0
> 1 yr.
20 yr.
20 yr.
10 yr.
> 1 yr.
5 yr.
10 yr.
High Range of 1 Year Event Unharvested Caspar Creek
1991
1992
1993
1995
1996
1997
Year

MENDOCINO
REDWOOD COMPANY, LLC

Transmittal

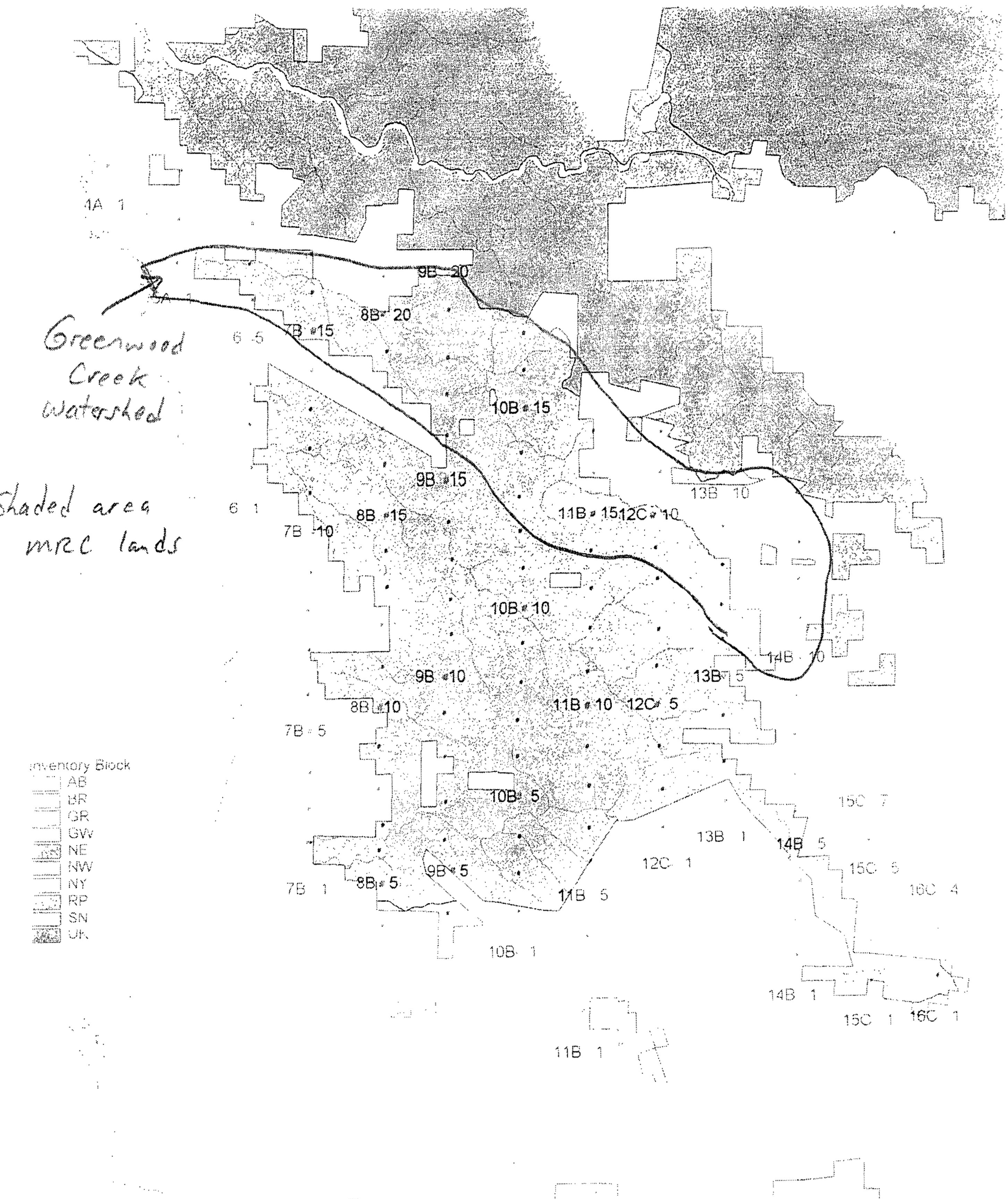
date: October 1, 2001

subject: Aerial Photographs for Greenwood Creek

Attached are aerial photographs and index covering most of Greenwood Creek, Mendocino County, California.

CS

Air Photo Index – South Coast (Greenwood Creek) Inventory Block

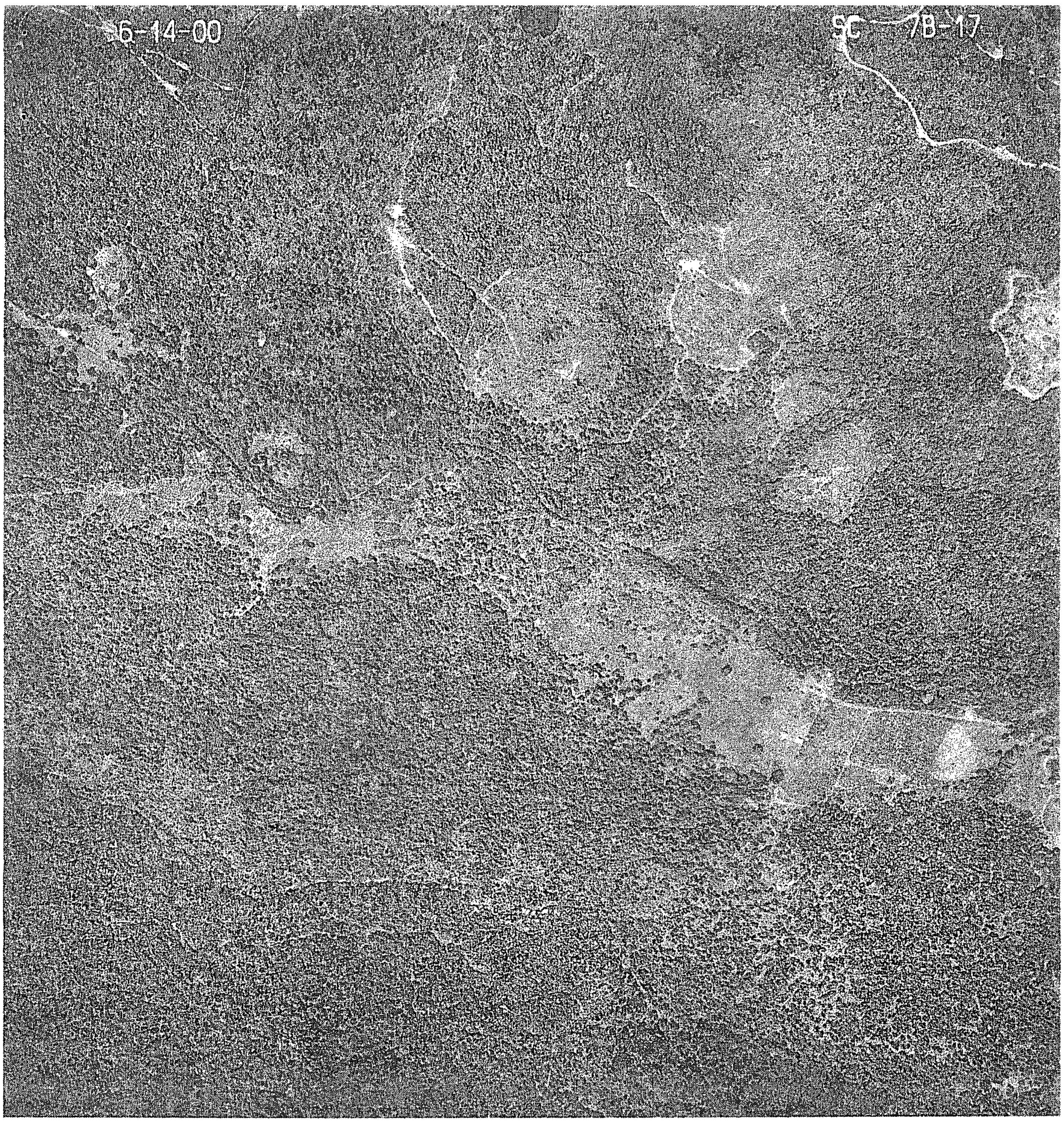



6-14-00
SC 5A-2


6-14-00
SC 6-6


6-14-00
SC 6-8


6-14-00
SC 7B-15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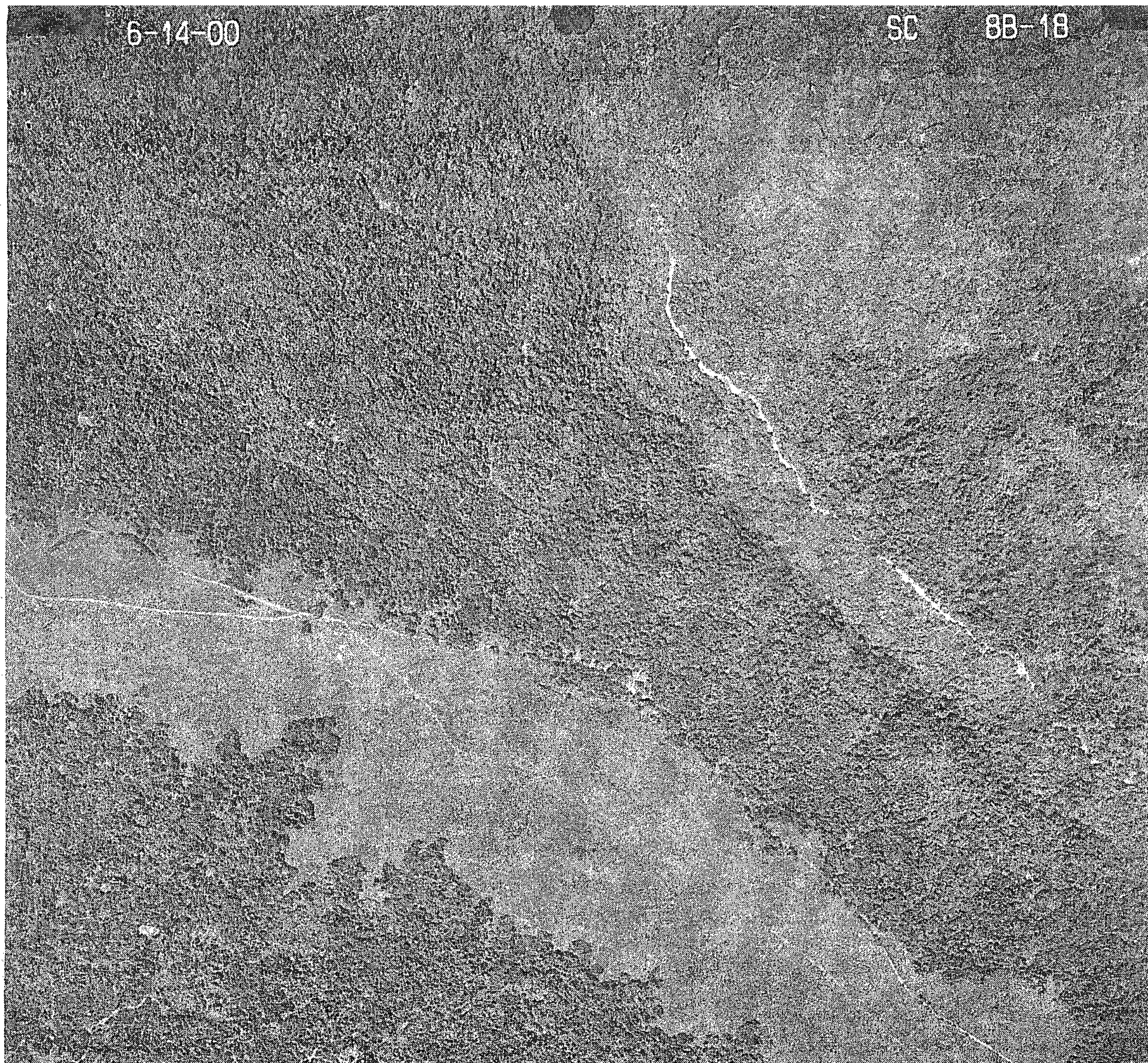
SC 7B-17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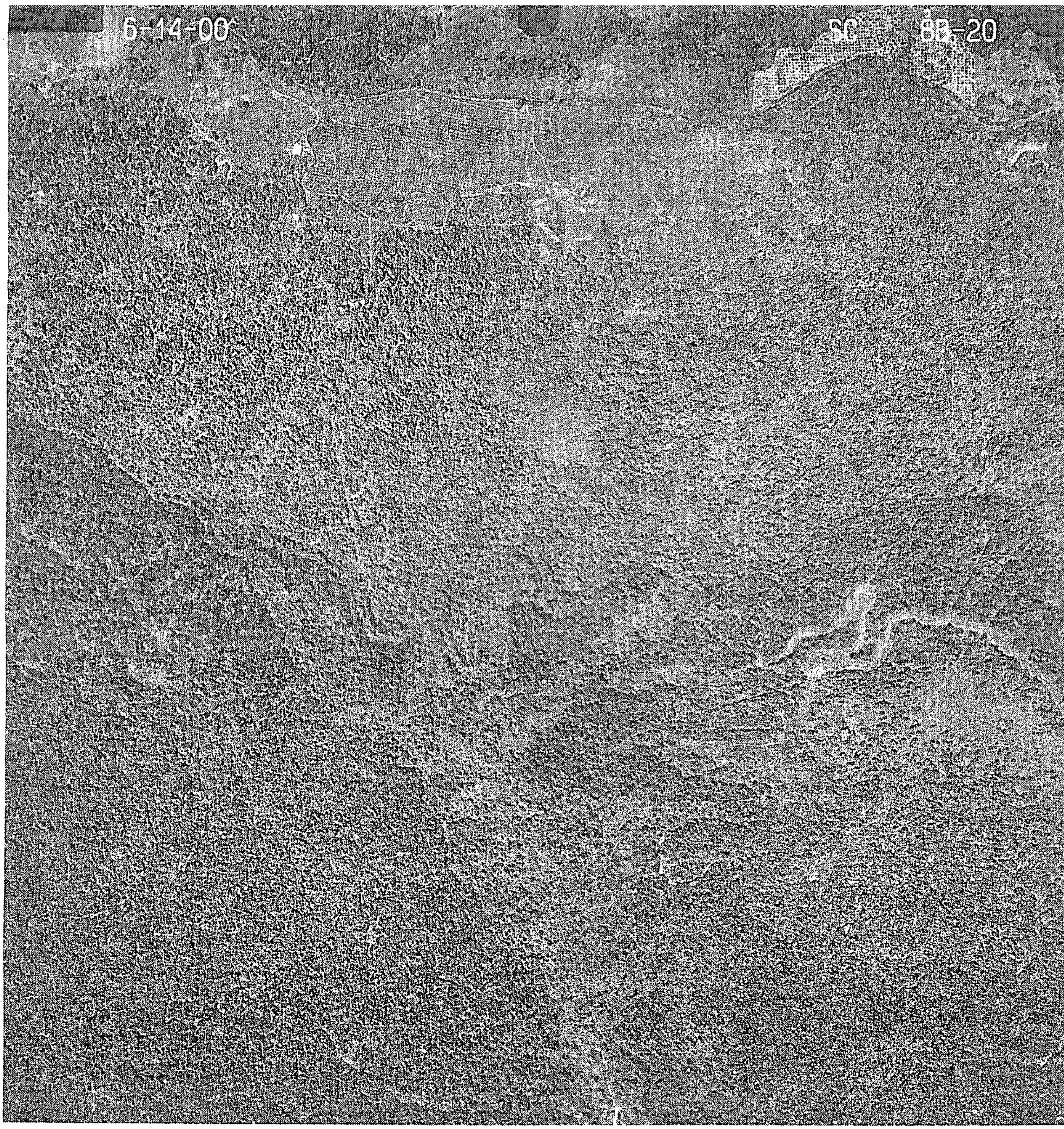
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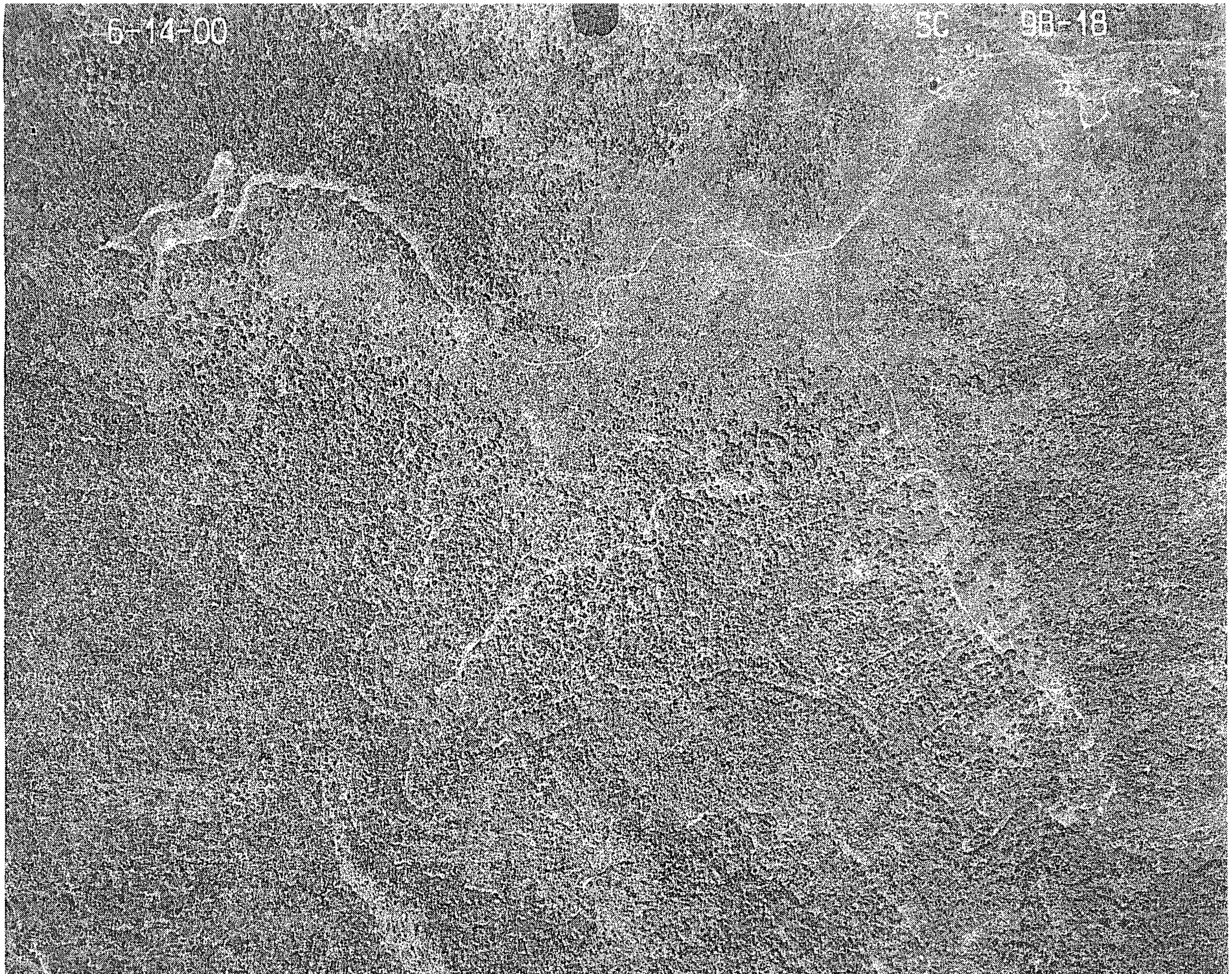
8B-20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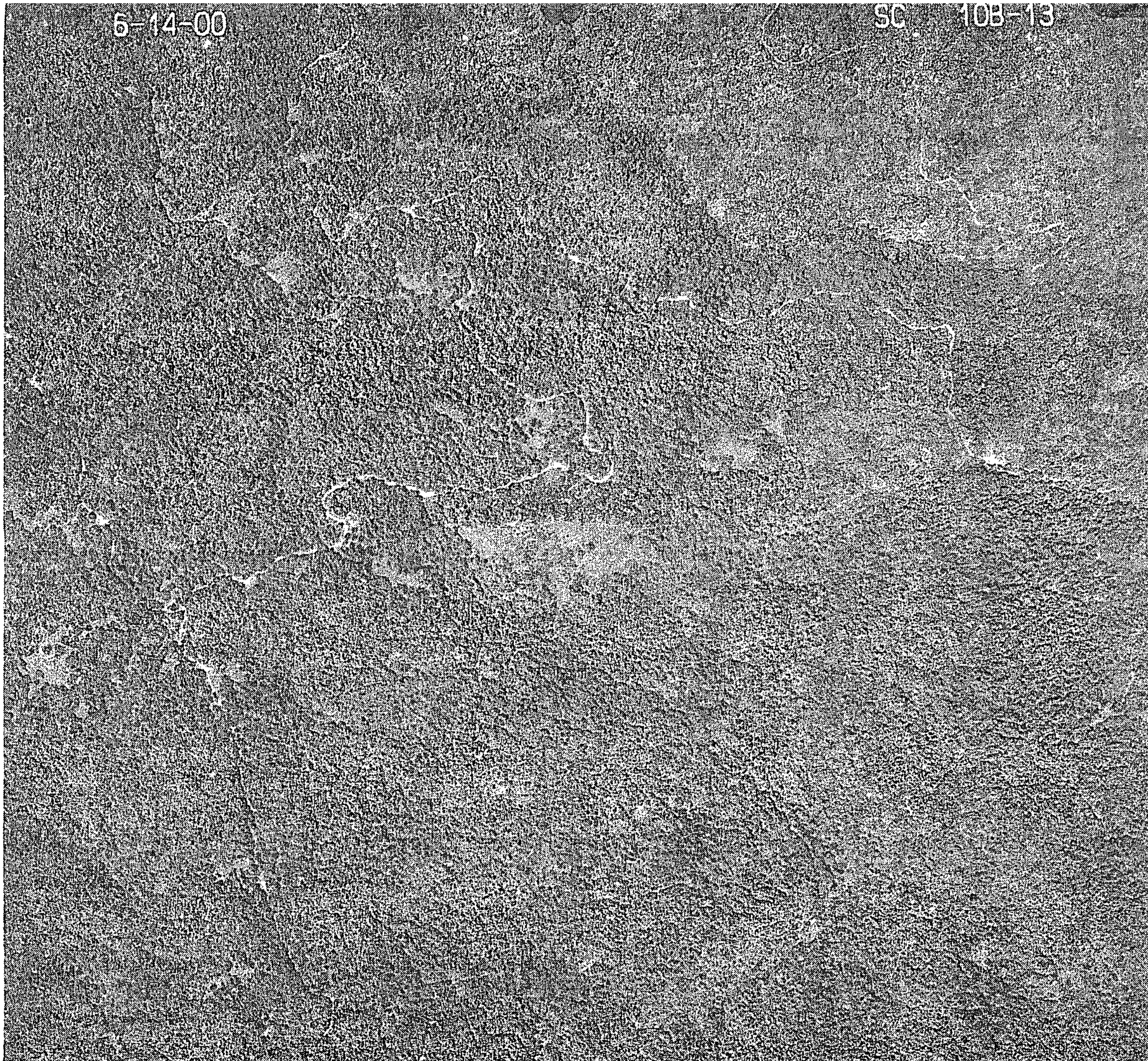
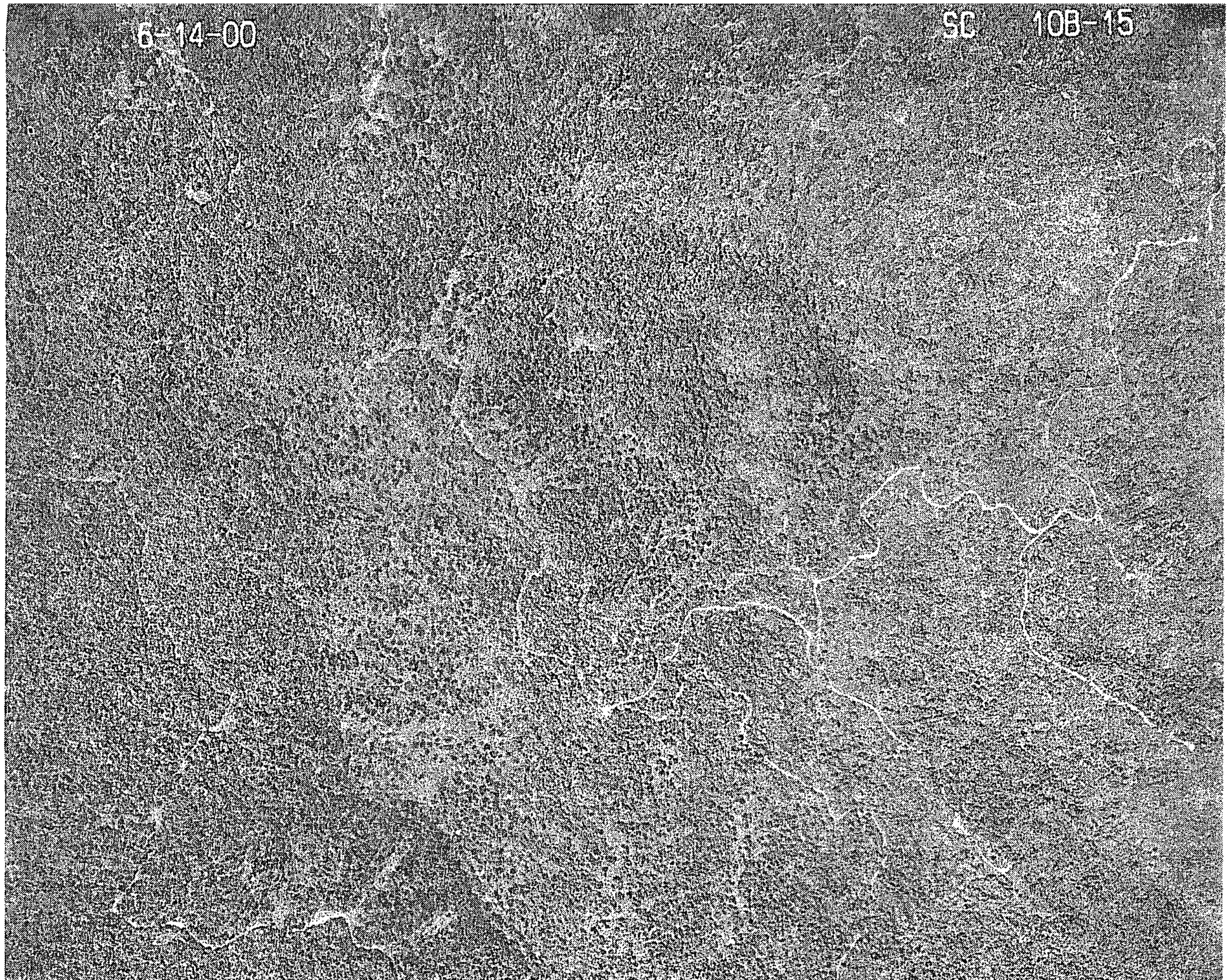
9B-18


6-14-00
SC 10B-13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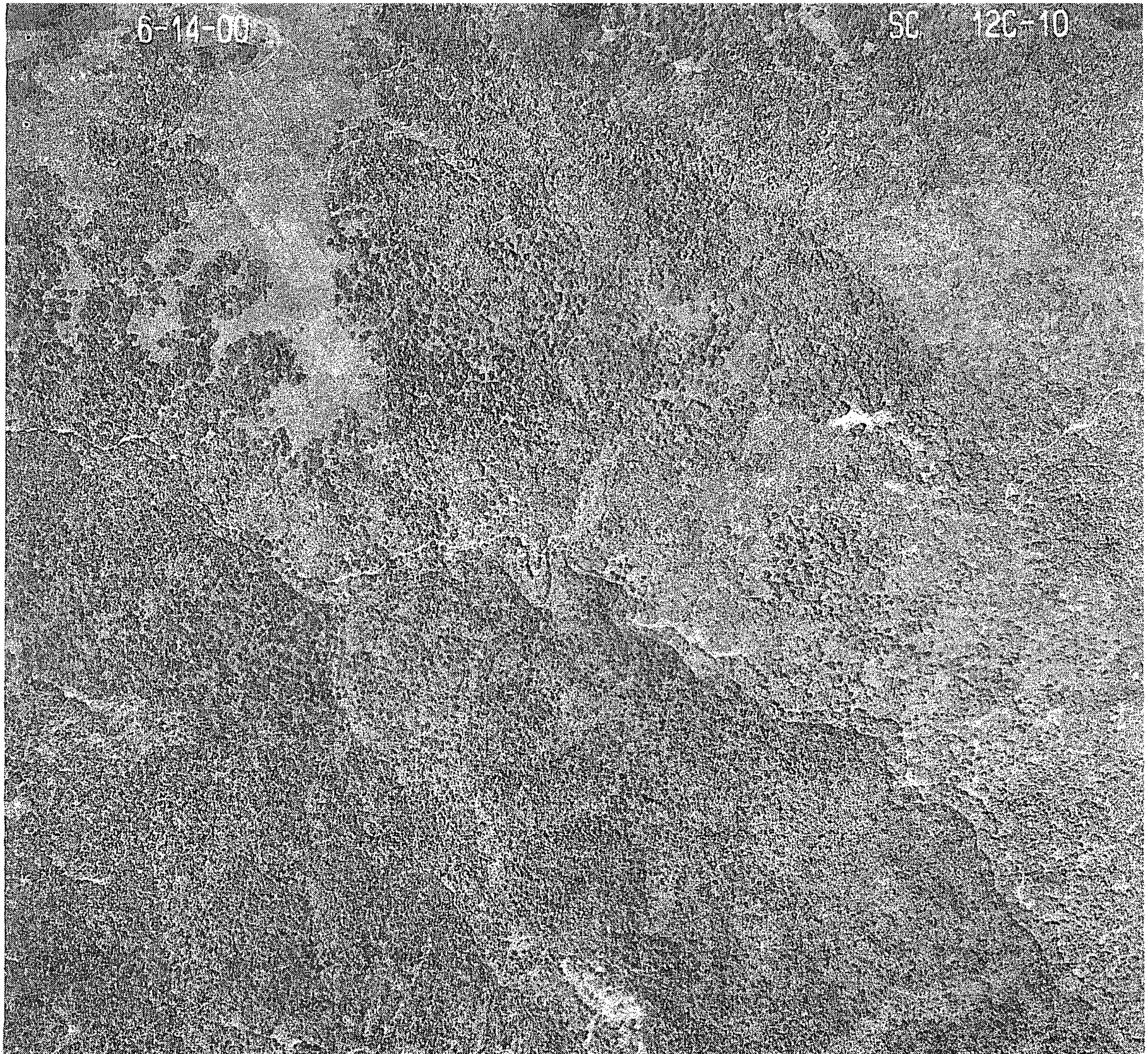
SC 10B-15


6-14-00
SC 11B-15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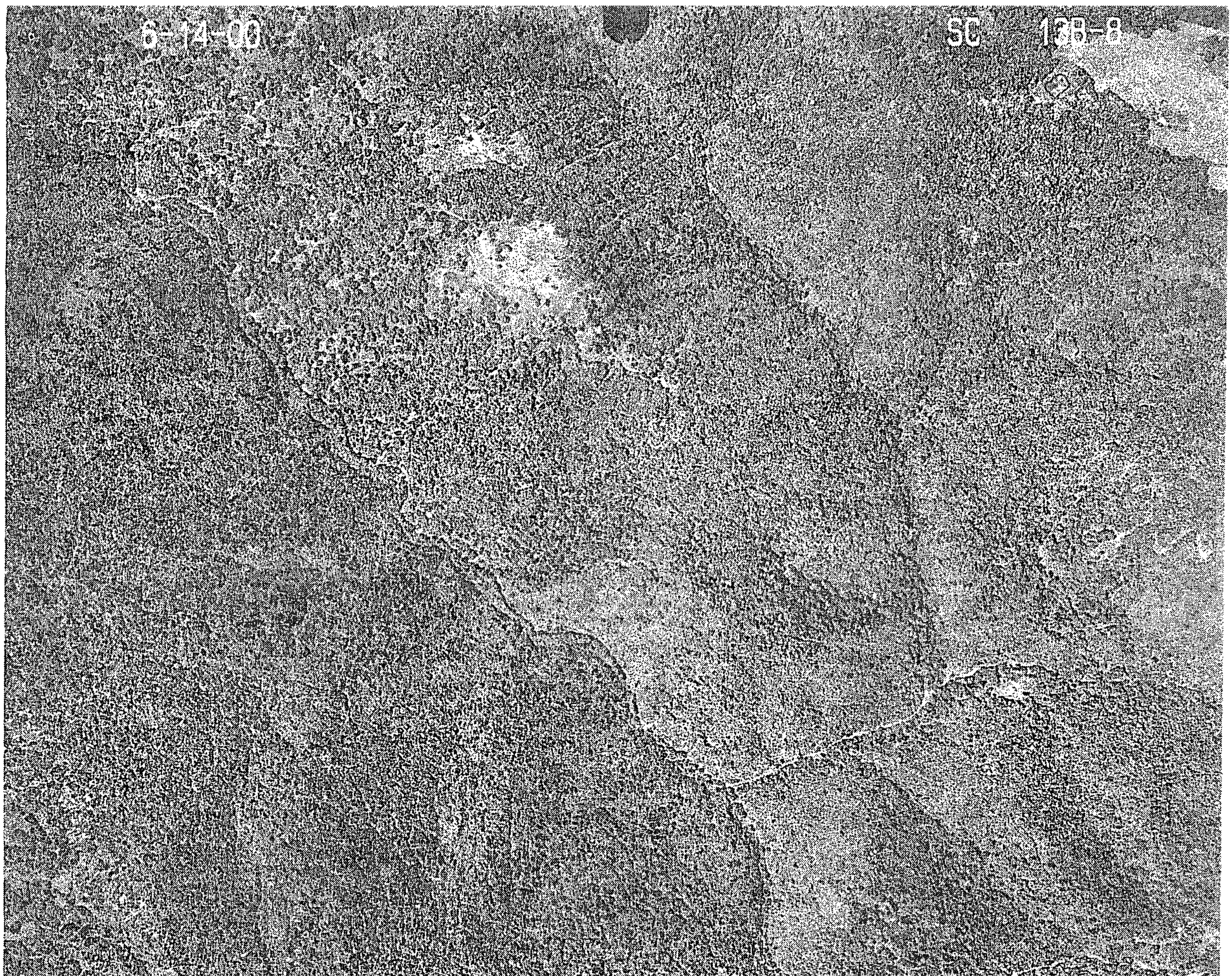
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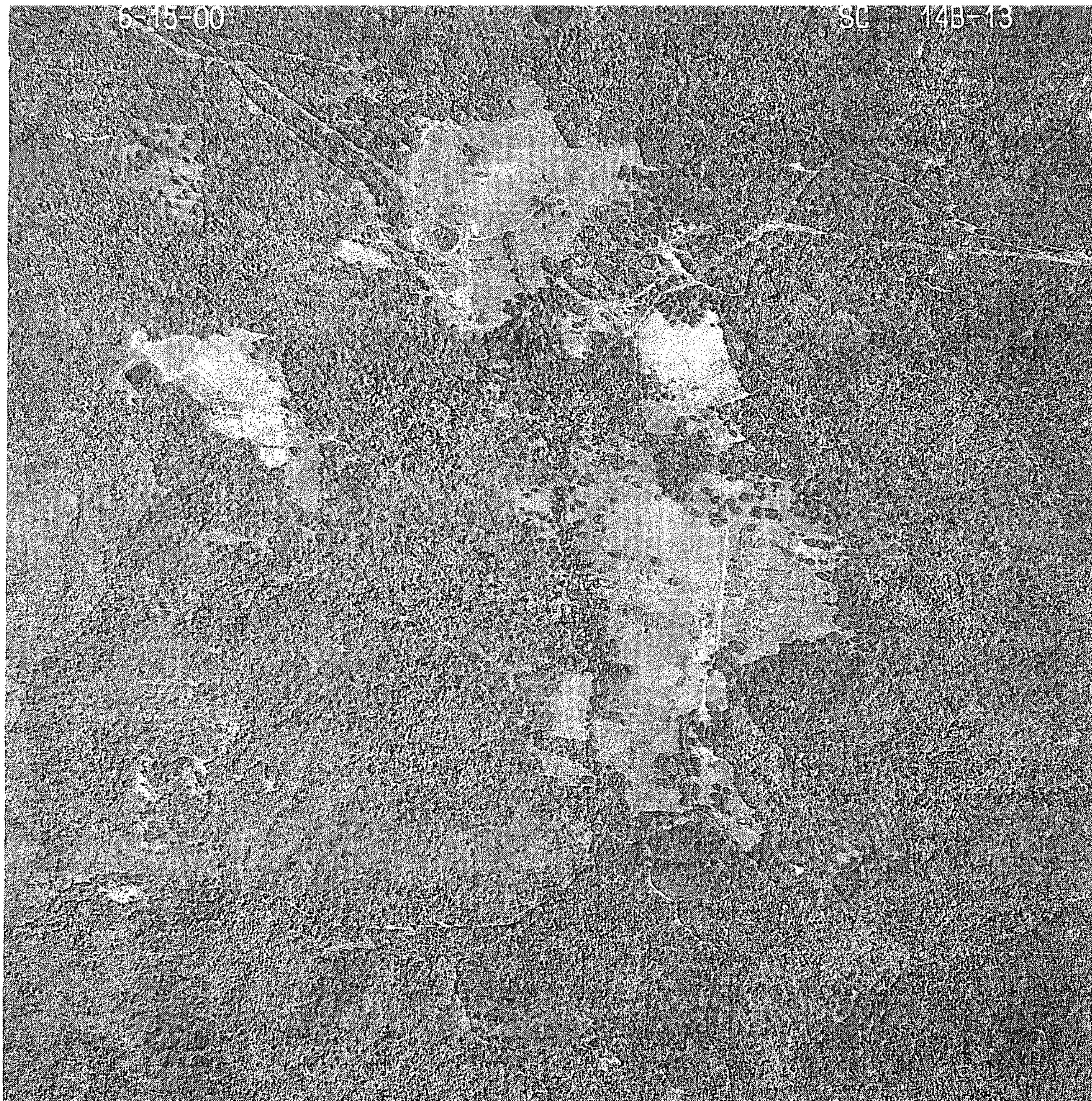
SC 13B-8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SC 14B-13

SUMMARY OF FISH INDEX SITE MONITORING IN WATERSHEDS WITHIN MENDOCINO REDWOOD COMPANY'S OWNERSHIP IN MENDOCINO AND SONOMA COUNTIES: 1987 – 1996.

MENDOCINO REDWOOD COMPANY
P.O. BOX 489
FORT BRAGG, CA 95437

DECEMBER 1999

Table 3-a. Survey parameters of fish index monitoring stations in the Garcia River, Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co. and the Russian River watershed, Sonoma Co., California. Summer and Fall 1994.

WATERSHED	MONITORING STATION LOCATION	MAP REF. (MONITORING STATION REF.)	SURVEY DATE MM/DD	SURVEY METHOD E=ELECTRO-FISHING; D=DIVER OBSVR.	SURVEY EFFORT (MIN.)	TOTAL STATION LENGTH (M)	MEAN WIDTH (M)	MEAN DEPTH (M)
GARCIA RIVER	S. FK. GARCIA R.- BELOW FLEMMING CR.	1-F (ES-16)	09/27	E	23.4	33.5	3.3	0.1
GARCIA RIVER	FLEMMING CR.- ABOVE CONFLUENCE	1-F (ES-17)	09/26	E	24.4	30.0	2.6	0.1
BIG RIVER	GATES CR.- LOWER	1-B (ES-3)	09/20	E	22.6	36.9	2.2	0.2
BIG RIVER	GATES CR.- UPPER	1-B (ES-4)	09/20	E	14.6	30.0	2.8	0.2
BIG RIVER	BIG R.- WILDHORSE OPENING	1-A (ES-2)	09/15	E	23.8	35.0	5.7	0.2
BIG RIVER	N. FK. BIG R.- EAST BRANCH	1-A (ES-1)	09/14	E	17.2	30.0	2.2	0.3
ELK CREEK	ELK CR.- LOWER	1-E (ES-14)	08/23	E	34.2	30.0	5.6	0.5
ELK CREEK	ELK CR.- UPPER	1-E (ES-15)	08/23	E	37.6	30.0	4.9	0.2
GREENWOOD CREEK	GREENWOOD CR.- LOWER	1-D (ES-12)	08/22	E	45.4	30.0	5.1	0.2
GREENWOOD CREEK	GREENWOOD CR.- UPPER	1-D (ES-13)	08/19	E	40.8	30.0	5.5	0.4
ALBION RIVER	MAINSTEM ALBION R.- LOWER	1-C (ES-5)	08/15	E	21.0	43.5	2.4	0.2
ALBION RIVER	MAINSTEM ALBION R.- AT CONFLUENCE	1-C (ES-6)	08/16	E	35.5	44.7	3.2	0.2
ALBION RIVER	MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	1-C ES-7)	08/16	E	56.1	48.0	2.5	0.2
ALBION RIVER	S. FK. ALBION R.- ABOVE CONFLUENCE	1-C (ES-8)	08/17	E	24.1	34.2	3.8	0.2
ALBION RIVER	S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	1-C (ES-9)	08/17	E	19.0	38.1	2.2	0.1
ALBION RIVER	S. FK. ALBION R.- NEAR LARMER GULCH	1-C (ES-10)	08/17	E	14.6	24.3	2.1	0.2
ALBION RIVER	RAILROAD GULCH	1-C (ES-11)	08/18	E	21.8	32.5	1.9	0.1
RUSSIAN RIVER	WILLOW CR.- UPPER	1-G (ES-19)	09/28	E	11	26.7	1.7	0.1

Table 3-b. Number of fish taxa, and observed and expected relative density of salmonids at fish index monitoring stations in the Garcia River, Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co. and the Russian River watershed, Sonoma Co., California. Summer and fall, 1994. [0.0] Indicates fish present in low abundance.

MONITORING STATION LOCATION	MONITORING STATION REF.	NO. OF FISH TAXA	OBSERVED RELATIVE DENSITY OF SALMONIDS (NO./ M2)		EXPECTED RELATIVE DENSITY OF SALMONIDS (NO./ M2)	
			STH	COH	STH	COH
S. FK. GARCIA R.- BELOW FLEMMING CR.	ES-16	1	0.6		0.7	
FLEMMING CR.- ABOVE CONFLUENCE	ES-17	1	1.0		1.1	
GATES CR.- LOWER	ES-3	2	0.9		0.9	
GATES CR.- UPPER	ES-4	3	0.2		0.2	
BIG R.- WILDHORSE OPENING	ES-2	3	0.3		0.4	
N. FK. BIG R.- EAST BRANCH	ES-1	2	0.7		0.8	
ELK CR.- LOWER	ES-14	3	0.4		0.6	
ELK CR.- UPPER	ES-15	1	0.8		1.2	
GREENWOOD CR.- LOWER	ES-12	4	0.6		0.7	
GREENWOOD CR.- UPPER	ES-13	1	0.6		0.8	
MAINSTEM ALBION R.- LOWER	ES-5	3	0.3	0.1	0.3	0.1
MAINSTEM ALBION R.- AT CONFLUENCE	ES-6	4	0.4	0.0	0.4	0.1
MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	ES-7	3	0.9		0.9	
S. FK. ALBION R.- ABOVE CONFLUENCE	ES-8	3	0.2	0.2	0.2	0.2
S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	ES-9	4	0.5	0.0	0.5	0.0
S. FK. ALBION R.- NEAR LARMER GULCH	ES-10	3	0.3	0.7	0.6	0.7
RAILROAD GULCH	ES-11	2	0.2	0.0	0.2	0.0
WILLOW CR.- UPPER	ES-19	1	0.6		0.7	

SPECIES ABBREVIATION: STH=STEELHEAD TROUT; COH=COHO SALMON.

Table 3-c. Relative biomass and length distribution of salmonids at fish index monitoring stations in the Garcia River, Big River, Elk Creek, Greenwood Creek and Albion River watersheds, Mendocino Co., and the Russian River watershed, Sonoma Co., California. Summer and Fall 1994.

MONITORING STATION LOCATION	MONITORING STATION REF.	RELATIVE BIOMASS OF SALMONIDS (G WET MASS/ M2)		LENGTH DISTRIBUTION OF SALMONIDS (MM) MEDIAN (N, RANGE)	
		STH	COH	STH	COH
S. FK. GARCIA R.- BELOW FLEMMING CR.	ES-16	1.8		69 (40- 113)	
FLEMMING CR.	ES-17	4.1		81 (38- 148)	
GATES CR.- LOWER	ES-3	5.1		69 (39- 153)	
GATES CR.- UPPER	ES-4	2.1		16 (40- 183)	
BIG R.- WILDHORSE OPENING	ES-2	1.1		56 (47- 175)	
N. FK. BIG R.- EAST BRANCH	ES-1	3.4		48 (43- 168)	
ELK CR.- LOWER	ES-14	3.3		63 (40- 173)	
ELK CR.- UPPER	ES-15	2.9		115 (41- 129)	
GREENWOOD CR.- LOWER	ES-12	2.6		90 (44- 132)	
GREENWOOD CR.- UPPER	ES-13	2.6		101 (37- 215)	
MAINSTEM ALBION R.- LOWER	ES-5	0.9	0.2	31 (33- 141)	5 (65- 79)
MAINSTEM ALBION R.- AT CONFLUENCE	ES-6	2.6	0.2	53 (36-153)	6 (69- 93)
MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	ES-7	2.2		103 (32- 145)	
S. FK. ALBION R.- ABOVE CONFLUENCE	ES-8	0.3	1.0	27 (55- 98)	30 (40- 96)
S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	ES-9	1.1	0.1	34 (38- 119)	1 (80- 80)
S. FK. ALBION R.- NEAR LARMER GULCH	ES-10	0.2	4.0	13 (36- 88)	35 (62- 95)
RAILROAD GULCH	ES-11	0.8	0.1	9 (50-110)	1 (83- 83)
WILLOW CR.- UPPER	ES-19	4.3		26 (42-142)	

SPECIES ABBREVIATION: STH=STEELHEAD TROUT; COH=COHO SALMON.

Table 4-a. Survey parameters of fish index monitoring stations in the Garcia River, Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co., and the Russian River watershed, Sonoma Co., California. Summer and Fall 1993. [--] Indicates data not recorded.

WATERSHED	MONITORING STATION LOCATION	MAP REF. (MONITORING STATION REF.)	SURVEY DATE MM/DD	SURVEY METHOD E=ELECTRO-FISHING; D=DIVER OBSVR.	SURVEY EFFORT (MIN.)	TOTAL STATION LENGTH (M)	MEAN WIDTH (M)	MEAN DEPTH (M)
GARCIA RIVER	S. FK. GARCIA R.- BELOW FLEMMING CR.	1-F (ES-16)	11/22	E	--	36	2.9	0.1
GARCIA RIVER	FLEMMING CR.- ABOVE CONFLUENCE	1-F (ES-17)	11/22	E	--	30	2.2	0.1
BIG RIVER	GATES CR.- LOWER	1-B (ES-3)	10/06	E	--	34.5	2.4	0.2
BIG RIVER	GATES CR.- UPPER	1-B (ES-4)	10/06	E	--	30.0	2.4	0.2
BIG RIVER	BIG R.- WILDHORSE OPENING	1-A (ES-2)	10/13	E	--	30.0	5.5	0.2
BIG RIVER	N. FK. BIG R.- EAST BRANCH	1-A (ES-1)	10/12	E	--	30.0	2.2	0.1
ELK CREEK	ELK CR.- LOWER	1-E (ES-14)	09/30	E	--	40.2	6.5	0.4
ELK CREEK	ELK CR.- UPPER	1-E (ES-15)	09/23	E	--	31.5	5.9	0.2
GREENWOOD CREEK	GREENWOOD CR.- LOWER	1-D (ES-12)	09/29	E	--	34.2	5.7	0.2
GREENWOOD CREEK	GREENWOOD CR.- UPPER	1-D (ES-13)	09/22	E	--	46.2	6.0	0.3
ALBION RIVER	MAINSTEM ALBION R.- LOWER	1-C (ES-5)	08/18	E	--	53.1	2.7	0.2
ALBION RIVER	MAINSTEM ALBION R.- AT CONFLUENCE	1-C (ES-6)	08/19	E	--	33.0	2.1	0.2
ALBION RIVER	MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	1-C (ES-7)	08/23	E	--	48.6	3.1	0.2
ALBION RIVER	S. FK. ALBION R.- ABOVE CONFLUENCE	1-C (ES-8)	08/20	E	--	34.8	3.4	0.2
ALBION RIVER	S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	1-C (ES-9)	08/30	E	--	38.1	2.1	0.1
ALBION RIVER	S. FK. ALBION R.- NEAR LARMER GULCH	1-C (ES-10)	08/30	E	--	24.0	3.1	0.4
ALBION RIVER	RAILROAD GULCH	1-C (ES-11)	09/02	E	--	30.0	2.1	0.1
RUSSIAN RIVER	WILLOW CR.- LOWER	1-G (ES-18)	11/11	E	--	33.9	3.1	0.4
RUSSIAN RIVER	WILLOW CR.- UPPER	1-G (ES-19)	11/11	E	--	30.0	2.3	0.1

Table 4-b. Number of fish taxa, and observed and expected relative density of salmonids at fish index monitoring stations in the Garcia River, Big River, Elk Creek, Greenwood Creek, and Albion River w Mendocino Co., and the Russian River watershed, Sonoma Co., California. Summer and Fall 1993.

MONITORING STATION LOCATION	MONITORING STATION REF.	NO. OF FISH TAXA	OBSERVED RELATIVE DENSITY OF SALMONIDS (NO./ M2)		EXPECTED RELATIVE DENSITY OF SALMONIDS (NO./ M2)	
			STH	COH	STH	COH
S. FK. GARCIA R.- BELOW FLEMMING CR.	ES-16	1	0.6		0.6	
FLEMMING CR.- ABOVE CONFLUENCE	ES-17	1	0.4		0.4	
GATES CR.- LOWER	ES-3	2	0.5		0.6	
GATES CR.- UPPER	ES-4	3	0.5		0.5	
BIG R.- WILDHORSE OPENING	ES-2	4	0.5		0.6	
N. FK. BIG R.- EAST BRANCH	ES-1	3	0.8	0.1	0.8	0.1
ELK CR.- LOWER	ES-14	3	0.3		0.3	
ELK CR.- UPPER	ES-15	1	0.5		0.5	
GREENWOOD CR.- LOWER	ES-12	3	0.5		0.5	
GREENWOOD CR.- UPPER	ES-13	2	0.4		0.5	
MAINSTEM ALBION- LOWER	ES-5	4	0.4	0.4	0.4	0.4
MAINSTEM ALBION- AT CONFLUENCE	ES-6	4	0.2	0.6	0.2	0.6
MAINSTEM ALBION- 1MI ABOVE CONFLUENCE	ES-7	4	0.4	0.1	0.4	0.1
S. FK. ALBION- ABOVE CONFLUENCE	ES-8	3	0.2	0.3	0.2	0.3
S. FK. ALBION- 1MI ABOVE CONFLUENCE	ES-9	4	0.3	0.5	0.3	0.5
S. FK. ALBION- NEAR LARMER GULCH	ES-10	3	0.1	1.1	0.1	1.4
RAILROAD GULCH	ES-11	2	0.2	0.2	0.3	0.2
WILLOW CR.- LOWER	ES-18	3	0.4		0.4	
WILLOW CR.- UPPER	ES-19	1	0.2		0.2	

SPECIES ABBREVIATION: STH=STEELHEAD TROUT; COH=COHO SALMON; CHK=CHINOOK SALMON; CTT=CUTTROAT TROUT.

Table 4-c. Relative biomass and length distribution of salmonids at fish index monitoring stations in the Garcia River, Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co., and the Russian River watershed, Sonoma Co., California. Summer and Fall 1993.

MONITORING STATION LOCATION	MONITORING STATION REF.	RELATIVE BIOMASS OF SALMONIDS (G WET MASS/ M2)		LENGTH DISTRIBUTION OF SALMONIDS (MM) N (RANGE)	
		STH	COH	STH	COH
S. FK. GARCIA R.- BELOW FLEMMING CR.	ES-16	1.6		61 (47- 100)	
FLEMMING CR.- ABOVE CONFLUENCE	ES-17	3.2		28 (45- 198)	
GATES CR.- LOWER	ES-3	5.3		103 (52- 138)	
GATES CR.- UPPER	ES-4	3.9		33 (53- 167)	
BIG R.- WILDHORSE OPENING	ES-2	2.6		81 (56- 170)	
N. FK. BIG R.- EAST BRANCH	ES-1	3.3	0.3	52 (49- 160)	6 (63- 73)
ELK CR.- LOWER	ES-14	3.4		84 (43- 143)	
ELK CR.- UPPER	ES-15	1.8		84 (59- 175)	
GREENWOOD CR.- LOWER	ES-12	3.0		94 (60- 178)	
GREENWOOD CR.- UPPER	ES-13	2.1		117 (46- 184)	
MAINSTEM ALBION R.- LOWER	ES-5	1.3	1.2	52 (39- 133)	51 (50- 84)
MAINSTEM ALBION R.- AT CONFLUENCE	ES-6	1.4	1.7	15 (37-108)	41 (51- 86)
MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	ES-7	1.2	0.2	63 (49- 85)	8 (54- 80)
S. FK. ALBION R.- ABOVE CONFLUENCE	ES-8	0.4	0.7	22 (44- 94)	35 (47- 73)
S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	ES-9	0.7	1.0	24 (37- 108)	36 (49- 70)
S. FK. ALBION R.- NEAR LARMER GULCH	ES-10	0.5	2.2	6 (39- 125)	83 (40- 97)
RAILROAD GULCH	ES-11	1.7	0.6	14 (46- 158)	13 (52- 68)
WILLOW CR.- LOWER	ES-18	2.8		38 (49- 165)	
WILLOW CR.- UPPER	ES-19	0.8		11 (55- 98)	

SPECIES ABBREVIATION: STH=STEELHEAD TROUT; COH=COHO SALMON.

Table 5-a. Survey parameters of fish index monitoring stations in the Garcia River, Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co., and the Russian River watershed, Sonoma Co., California. Summer and Fall 1992. [--] Indicates data not recorded.

WATERSHED	MONITORING STATION LOCATION	MAP REF. (MONITORING STATION REF.)	SURVEY DATE MM/DD	SURVEY METHOD E=ELECTRO-FISHING; D=DIVER OBSVR.	SURVEY EFFORT (MIN.)	TOTAL STATION LENGTH (M)	MEAN WIDTH (M)	MEAN DEPTH (M)
GARCIA RIVER	FLEMMING CR.- ABOVE CONFLUENCE	1-F (ES-17)	10/28	E	--	30.0	2.6	0.2
BIG RIVER	GATES CR.- LOWER	1-B (ES-3)	10/09	E	--	31.0	2.3	0.2
BIG RIVER	GATES CR.- UPPER	1-B (ES-4)	10/09	E	--	31.0	1.7	0.1
ELK CREEK	ELK CR. – LOWER	1-E (ES-14)	9/01	E	--	34.0	4.4	0.4
ELK CREEK	ELK CR. - UPPER	1-E (ES-15)	9/01	E	--	30.0	4.9	0.2
GREENWOOD CREEK	GREENWOOD CR.- LOWER	1-D (ES-12)	09/04	E	--	30.0	6.3	0.2
GREENWOOD CREEK	GREENWOOD CR.- UPPER	1-D (ES-13)	09/10	E	--	30.0	5.5	0.3
ALBION RIVER	MAINSTEM ALBION R.- LOWER	1-C (ES-5)	08/19	E	--	47.0	2.7	0.2
ALBION RIVER	MAINSTEM ALBION R.- AT CONFLUENCE	1-C (ES-6)	07/31	E	--	30.0	2.2	0.2
ALBION RIVER	MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	1-C (ES-7)	08/18	E	--	30.0	2.9	0.5
ALBION RIVER	S. FK. ALBION R.- ABOVE CONFLUENCE	1-C (ES-8)	07/31	E	--	30.0	2.9	0.2
ALBION RIVER	S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	1-C (ES-9)	08/18	E	--	30.0	2.1	0.2
ALBION RIVER	S. FK. ALBION R.- NEAR LARMER GULCH	1-C (ES-10)	08/18	E	--	21.0	2.0	0.3
ALBION RIVER	RAILROAD GULCH	1-C (ES-11)	06/19	E	--	30.0	1.5	0.1
RUSSIAN RIVER	WILLOW CR.- LOWER	1-G (ES-18)	11/10	E	--	38.5	2.4	0.1

Table 5-b. Number of fish taxa, and observed and expected relative density of salmonids at fish index monitoring stations in the Garcia River, Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co., And the Russian River watershed, Sonoma Co., California. Summer and Fall 1992.

MONITORING STATION LOCATION	MONITORING STATION REF.	NO. OF FISH TAXA	OBSERVED RELATIVE DENSITY OF SALMONIDS (NO./ M2)		EXPECTED RELATIVE DENSITY OF SALMONIDS (NO./ M2)	
			STH	COH	STH	COH
FLEMMING CR.- ABOVE CONFLUENCE	ES-17	1	0.6		0.6	
GATES CR.- LOWER	ES-3	2	0.3		0.3	
GATES CR.- UPPER	ES-4	3	0.8		0.8	
ELK CR. – LOWER	ES-14	4	0.3	0.3	NO DATA	NO DATA
ELK CR. – UPPER	ES-15	2	0.8	0.0	NO DATA	NO DATA
GREENWOOD CR.- LOWER	ES-12	3	0.2		0.2	
GREENWOOD CR.- UPPER	ES-13	2	0.4		0.5	
MAINSTEM ALBION R.- LOWER	ES-5	4	0.1	0.6	0.1	0.6
MAINSTEM ALBION R.- AT CONFLUENCE	ES-6	4	0.2	0.6	0.2	0.7
MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	ES-7	4	0.4	0.3	0.4	0.3
S. FK. ALBION R.- ABOVE CONFLUENCE	ES-8	3	0.2	0.9	0.2	1.0
S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	ES-9	3	0.3	0.5	0.3	0.6
S. FK. ALBION R.- NEAR LARMER GULCH	ES-10	3	0.2	1.6	0.2	1.6
RAILROAD GULCH	ES-11	1	0.7		0.7	
WILLOW CR.- LOWER	ES-18	3	0.2		0.2	

SPECIES ABBREVIATION: STH=STEELHEAD TROUT; COH=COHO SALMON.

Table 5-c. Relative biomass and length distribution of salmonids at fish population index stations in the Garcia River, Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co., and the Russian River watershed, Sonoma Co., California. Summer and Fall 1992.

MONITORING STATION LOCATION	MONITORING STATION REF.	RELATIVE BIOMASS OF SALMONIDS (G WET MASS/ M2)		LENGTH DISTRIBUTION OF SALMONIDS (MM) N (RANGE.)	
		STH	COH	STH	COH
FLEMMING CR.- ABOVE CONFLUENCE	ES-17	2.6	--	49 (42- 153)	--
GATES CR.- LOWER	ES-3	4.9	--	56 (46- 176)	--
GATES CR.- UPPER	ES-4	0.9	--	15 (41- 113)	--
ELK CR. -- LOWER	ES – 14	5.5	1.7	47 (31-176)	50 (63-84)
ELK CR. – UPPER	ES-15	3.8	0.2	115 (40-179)	5 (72-75)
GREENWOOD CR.- LOWER	ES-12	1.6	--	40 (57- 140)	--
GREENWOOD CR.- UPPER	ES-13	3.9	--	70 (54- 165)	--
MAINSTEM ALBION R.- LOWER	ES-5	1.2	1.3	14 (42- 165)	70 (44- 79)
MAINSTEM ALBION R.- AT CONFLUENCE	ES-6	1.2	1.5	10 (47- 120)	39 (48- 77)
MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	ES-7	0.8	0.5	37 (38- 108)	25 (45- 65)
S. FK. ALBION R.- ABOVE CONFLUENCE	ES-8	1.4	1.8	19 (38- 167)	77 (41- 74)
S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	ES-9	0.6	1.1	16 (39- 100)	33 (43- 68)
S. FK. ALBION R.- NEAR LARMER GULCH	ES-10	1.1	4.0	10 (36- 134)	69 (40- 127)
RAILROAD GULCH	ES-11	2.4	--	32 (33- 135)	--
WILLOW CR.- LOWER	ES-18	1.5	--	17 (55- 145)	--

SPECIES ABBREVIATION: STH=STEELHEAD TROUT; COH=COHO SALMON.

Table 7-a. Survey parameters of fish population index stations in the Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co., and the Russian River watershed, Sonoma Co. California. Summer and Fall 1990. [--] Indicates data not recorded.

WATERSHED	MONITORING STATION LOCATION	MAP REF. (MONITORING STATION REF.)	SURVEY DATE MM/DD	SURVEY METHOD E=ELECTRO-FISHING; D=DIVER OBSVR.	SURVEY EFFORT (MIN.)	TOTAL STATION LENGTH (M)	MEAN WIDTH (M)	MEAN DEPTH (M)
BIG RIVER	GATES CR.- LOWER	1-B (ES-3)	11/16	E	--	30.0	2.6	0.2
BIG RIVER	GATES CR.- UPPER	1-B (ES-4)	11/16	E	--	30.0	2.5	0.2
ELK CREEK	ELK CR. – LOWER	1-E (ES-14)	09/06	E	--	30.0	6.1	--
ELK CREEK	ELK CR. – UPPER	1-E (ES-15)	09/25	E	--	30.0	7.7	0.3
GREENWOOD CREEK	GREENWOOD CR.- LOWER	1-D (ES-12)	10/17	E	44.6	30.0	6.3	0.2
GREENWOOD CREEK	GREENWOOD CR.- UPPER	1-D (ES-13)	10/16	E	34.3	30.0	5.1	0.4
ALBION RIVER	MAINSTEM ALBION R.- AT CONFLUENCE	1-C (ES-6)	11/07	E	--	30.0	3.2	0.3
ALBION RIVER	MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	1-C (ES-7)	11/12	E	--	30.0	3.6	0.3
ALBION RIVER	S. FK. ALBION R.- ABOVE CONFLUENCE	1-C (ES-8)	11/07	E	--	30.0	2.0	0.1
ALBION RIVER	S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	1-C (ES-9)	11/12	E	--	30.0	2.4	0.2
ALBION RIVER	RAILROAD GULCH	1-C (ES-11)	06/08	E	--	30.0	1.9	0.1
RUSSIAN RIVER	WILLOW CR.- LOWER	1-G (ES-18)	10/06	E	39.7	59.8	2.4	0.2
RUSSIAN RIVER	WILLOW CR.- UPPER	1-G (ES-19)	10/05	E	--	30.0	1.4	0.1

Table 7-b. Number of fish taxa, and observed and expected relative density of salmonids at fish index monitoring stations in the Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co., and the Russian River watershed, Sonoma Co., California. Summer and Fall 1990. [0.0] Indicates fish present in low abundance.

MONITORING STATION LOCATION	MONITORING STATION REF.	NO. OF FISH TAXA	OBSERVED RELATIVE DENSITY OF SALMONIDS (NO./ M2)		EXPECTED RELATIVE DENSITY OF SALMONIDS (NO./ M2)	
			STH	COH	STH	COH
GATES CR.- LOWER	ES-3	2	0.4		0.4	
GATES CR.- UPPER	ES-4	3	0.1		0.1	
ELK CR. – LOWER	ES-14	3	0.3		NO DATA	
ELK CR. – UPPER	ES-15	1	0.4		NO DATA	
GREENWOOD CR.- LOWER	ES-12	3	0.3		0.3	
GREENWOOD CR.- UPPER	ES-13	2	0.6		0.6	
MAINSTEM ALBION- AT CONFLUENCE	ES-6	4	0.2	0.0	0.2	0.0
MAINSTEM ALBION- 1MI ABOVE CONFLUENCE	ES-7	4	0.2	0.0	0.2	0.0
S. FK ALBION- ABOVE CONFLUENCE	ES-8	2	0.2		0.2	
S. FK. ALBION- 1MI ABOVE CONFLUENCE	ES-9	2	0.2		0.2	
INDEX STATION- RAILROAD GULCH	ES-11	2	0.5	0.1	0.6	0.1
WILLOW CR.- LOWER	ES-18	3	0.2		0.2	
WILLOW CR.- UPPER	ES-19	2	0.4	0.4	0.4	0..4

SPECIES ABBREVIATION: STH=STEELHEAD TROUT; COH=COHO SALMON.

Table 7-c. Relative biomass and length distribution of salmonids at fish index monitoring stations in the Big River, Elk Creek, Greenwood Creek, and Albion River watersheds, Mendocino Co., and the Russian River watershed, Sonoma Co., California. Summer and Fall 1990.

MONITORING STATION LOCATION	MONITORING STATION REF.	RELATIVE BIOMASS OF SALMONIDS (G WET MASS/ M2)		LENGTH DISTRIBUTION OF SALMONIDS (MM) N (RANGE)	
		STH	COH	STH	COH
GATES CR.- LOWER	ES-3	2.3		33 (55- 120)	
GATES CR.- UPPER	ES-4	0.9		7 (65- 125)	
ELK CR. – LOWER	ES-14	2.5		55 (46-167)	
ELK CR. – UPPER	ES-15	3.1		93 (52-170)	
GREENWOOD CR.- LOWER	ES-12	1.9		60 (58- 147)	
GREENWOOD CR.- UPPER	ES-13	6.5		84 (54- 220)	
MAINSTEM ALBION R.- AT CONFLUENCE	ES-6	1.2	0.3	23 (42- 159)	2 (78- 96)
MAINSTEM ALBION R.- 1MI ABOVE CONFLUENCE	ES-7	0.3	0.1	19 (39-63)	2 (79- 91)
S. FK. ALBION R.- ABOVE CONFLUENCE	ES-8	0.6		12 (45-103)	
S. FK. ALBION R.- 1MI ABOVE CONFLUENCE	ES-9	0.5		12 (48- 75)	
RAILROAD GULCH	ES-11	2.8	1.1	31 (40- 151)	8 (68- 83)
WILLOW CR.- LOWER	ES-18	1.4		26 (60- 130)	
WILLOW CR.- UPPER	ES-19	3.1	1.3	18 (55- 135)	17 (52- 70)

SPECIES ABBREVIATION: STH=STEELHEAD TROUT; COH=COHO SALMON.

Down To Earth

A MENDOCINO COUNTY LIFE

By Maurice W. Tindall

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Preface

Down to Earth *was a weekly newspaper column written by Maurice Tindall for the* Anderson Valley Advertiser, *Boonville, California. It appeared between the years 1966 and 1977. The contents of this book are certain columns or extracts of columns that have been edited into an historical and narrative sequence. The material herein represents only a small amount of Judge Tindall's writings and future researchers are advised to go to the original newspapers for more Mendocino County history. Many thanks to Homer Mannix, editor and publisher of the* Anderson Valley Advertiser, *for permission to reprint this material.*

In addition to the newspaper columns, this book has work from two other sources. Pages 9 through 14 originally appeared in Mendocino County Remembered, Volume II, *published by The Mendocino Historical County Society, and used by permission. Pages 15 through 20 originally appeared in* Comptche *by Elsa Thompson, and also used by permission. A particular note of thanks is due to Elsa for her help and encouragement.*

Because it would have been financially exorbitant to reset type for this book, these writings have been photo-copied from the original printed material. The result has been of varied printing excellence. The reader might bear in mind, however, that what is important here is an intrinsic quality, a quality of love by a man for a geographic area, and a thankfulness that he was blessed to have lived there. This book is one way he decided to show that appreciation.

salmon, or anyway the most of them, and a great many of these animals have been shot by fishermen and some also by persons shooting for fun. Their numbers have been greatly decreased. Just a little unbiased thought would show how invalid most of the fishermens arguments are

There used to be a colony of sea-lions on Kents Point on Mendocino Bay but they have been mostly or all gone for many years. The last one I saw there was many years ago. I walked out and looked down in the channel and there was a small seal and he was picking up some kind of small fish. There were a great many of them and he was picking them up like grains of corn. I saw these same fish on the beach at little river, they looked like little cod and were thick in the water.

In those older days, every September the hook-bill salmon came into the Bay on their way to spawn and they sailed right by the colony of seals. No doubt some were caught but there were plenty left. I have caught several salmon in Big River that had been bitten and healed over and I am sure others have had that experience Also off Noyo I caught several that had plainly been bitten by sharks and once I caught a good sized shark on a salmon spoon, off Ten Mile Beach.

So there are lots of enemies of salmon, man being about the most deadly. In these later years in all the coastal streams the fishing has declined and in some cases almost vanished, and it wasn't the seals that cause it. It is like the man said one day in Noyo, a school of fish shows up out side and is surrounded by boats. In a day or two the school is gone, either caught or scattered.

Years ago the salmon would be brought into the Noyo wharfs in piles at times the floors would be covered with fine big king salmon and the price was ten cents per pound. When the price rose to fourteen cents we wondered if we could afford it, dollars were scarcer then. The number of seals was declining and so were the fish. Last year we were in Noyo to get some fish and they were out, but while we were there a boat came in with one fish and we bought it. We paid some thing over one dollar per pound.

The story of the seals so far has not been all written. The sea lions were here all the time but the salmon were only off shore for a few months. The killing of sea-lions by fishermen and other people did not help the fish, but it may have helped to cause the scarcity. Proponents of killing the seals will tell about them biting salmon in half and sometimes stripping them off the hooks but tales often get magnified in the telling. I fished many trips over several years and never saw a sea lion out there where we were fishing but of course we are sure they were there at times. There are great schools of squid and anchovies, and herring and other fish off the California coast.

Down south one was the Monterey sardine, and the great schools of thousands of tons are gone, the sea-lions didn't get them, it was the big seines. The people were warned that the sardines were being over-fished but the fishermen cried that so many would be out of work if fishing was curtailed. It is done now the warnings were ignored. Besides these food and bait fish there are a lot of trash fish that the seals can live on a good part of the year.

The sea-lions are said to be very fond of octopus and the belief seems to have good foundation. A friend saw a big sea lion killing a very large octopus off Albion a few years ago. He had it on the surface and was tearing it to pieces. Any animal that kills the octopus can't be wrong, for the old eight armed boy is himself a big eater.

My father and I were up to Agate Beach one time long ago and we saw a large octopus laying on the rocks by the shore. His arms what were left must have been eight or ten feet long. He was really chewed up so it can be imagined that a sea lion had fought him. He would have been bad for an abalone picker to have met up with.

Fishing

It might be well if we go back to 1896 when I was three years old and recount the adventures of a young fisherman, and somewhat the story of the trout since that time. We were at the Crawford ranch at Largo and a picnic was organized. It may have been the Fourth of July, and we were going in spring wagons and it could have been to Pieta Creek below Hopland which was a well known trout stream.

Anyway we got there and most of the young people went to fishing. I was given a short limb with a line and hook and placed at the waters edge to fish. I don't know how long I fished but after a time I saw a troutt laying near a rock and I pulled up my line and he was hooked on it. I have always thought maybe I had help in hooking that trout, but anyway it was the first one and may well have been the starter of many years on the trout streams and the implanting of riffling water in my blood streams.

It was after 1901 and we have moved to Mendocino when I caught my next trout on my own. I had been along when my father fished in the Albion River near Comptche and my mother & I walked along the road & picked up the fish as my father tossed them up on the bank. That was before we moved to Mendocino and he was working for Mr. Oppenlander. There seemed to be a lot of fish and we were kept busy picking them up. Over the years since the river has become a little brushy gulch, having been filled with tie making debris in 1909.

It was after 1900 and we had moved to Mendocino when I caught my next trout, a bona-fide one this time, about eight inches long. My folks and I and my teacher, Miss Lena Flanagan, drove out to the Company Ranch ond Big River. it was twelve miles and about an all day trip On the way back we stopped at Chester Fords' summer camp at the North Fork, now Mendocino Woodlands, for a picnic lunch There was quite an opening there, it had been logged off many years before, when the logs were floated down the river

Well anyway I got my pole and line rigged up and hurried back to the creek, just a few yards and cast into a little riffle just below the road crossing. An eight or nine inch siezed the bait as soon as it hit the water. A bolt of lightning could hardly had more effect. I laid him back in the grass the full length of my pole and line and then rushed to grab him.

From then on I was an earnest trout fisherman for all the rest of my days. Most any other fish is not ruled out and each trip has been a memorable experience. No matter where the fish were, whether in a woodland stream with its sparkling riffles or in a river lined with alders. As time went on and I grew older there were other kinds of fishing, but for our purposes now we will stick mostly with trout with maybe a few almon thrown in, for salmon are trout at one time and their habits of life are intermingled.

Anyone who has trolled at the second flat on Big River, with its steep timbered mountain sides and the deep green water with the leaping salmon, will never forget the picture, One year my mother taught at McKinley District, south of Point Arena and back of Iverson Landing.

I can remember many of the people, there were the Craigs, Walter and Leonard a well known sportsman in Point **Arena, and Eunice the sister., Mrs. Craig used to cut my** hair and remarked how fine it was then but time took its toll. **as years went on and sadly I am afraid many of thse people are gone.**

There was Annie and Bell Dougherty and brother Francis and a boy from farther back, Emil. I have an old clipping that some how survived the years. It tells about a boy, James McNamee, walked three miles to school every day. Jim has had a store in Anchor Bay for many years and it is gratifying to see him now and then. So many old friends are missing. There were thousands of quail in the open fields from Smedleys down to the coast. There were a lot to keep them off her chickens.

One time we were down at Schooner Gulch, it was two or three miles, I think it was and while the older folks visited, we younger ones fished for trout in a little stream that ran almost through the yard. We were lined up along the pool and all caught trout. I have forgotten just how many.

This memory and others has made me believe that steelhead trout and maybe some salmon run and spawn in all the smaller creeks on the Mendocino Coast. I have fished in many of them and found trout in any stream that had an open access to the ocean. For the story telling I am calling all the young fish trout, but it is sure that some of these fish are young hook-bill (dog) salmon.

King Salmon have been seen but rarely and it maybe that the water temperature is wrong or there maybe other reasons hat study will locate. After all these years there is a tremendous lot about trout, (all kinds) that we don't know for sure. To ell part of the story it looks like we will need to move more swiftly or else allow more space for the telling. Fish stories began with ancient man and are still going on, only we are making them bigger and better.

WHILE we were at the Smedley place we went on a picnic to the Point Arena Hot Springs. It was not too far over the hill to the Garcia River and the road ran up the river, crossing back and forth several times. The river flats were quite level and all the way to the Springs. Alders lined the bank in many place and the water ran in long shallow reaches. There was a hotel at the Springs and some deer in a small pasture. There were no guests at the time.

After everyone had a bath in the hot tubs, which were really warm, we drove back down the river for a lunch, and Jodie and I had to fish, we had some tackle and bait with us. We tried in the river but di dn't do any good, and then tried a small creek running in from the side. Those dark pools under logs and by old stumps were really alive with trout and we fished as long as we had time for

The Garcia was known for years as a fine salmon and steelhead stream, that iis for hook-bill salmon, king salmon as a rule do not run in these coastal streams, and there was good trout fishing all the way to the sources. The logging in later years ruined the fishing and made a waste-land of a beautiful river.

Modern logging with big Cats and lots of road building seem to have caused more destruction than the old way with donkey engines and less skid roads. Then too the acreage covered in the older days was less per year than in the last few years.

Years ago the Garcia was known for its fine steelhead fishing especially, and the lagoon would be lined with fishermen all during the season and thousands of fish were taken. About that time we were camped at Alder Creek in the summer looking for smelt and a friend told me to go down to the Garcia and see A. O. Stornetta about going through his place and fish for trout, the bar was open at Alder Creek that year and the trout had all gone out.

It was funny in a way, we were there in camp and a car load of fishermen would get out pull-on their boots and start off with rods and baskets and all. In a short while they would be back, load up and go. Almost before they were out of sight another carload would repeat the performance. They were not going to get any fish, we had already taken our turn the day before? The creek mouth was open and the stream low, it was too late in the season.

Well anyway I met A. O. as he was known, in his corral. He showed me his dairy and milk houses, he was well equipped, and he told me about his cows, there was quite a herd of them, and thus began a friendship that lasted many years until his passing.

Well anyway, I went on down to the lagoon and as I walked along the bank I could see trout swimming in the deep clear pools. There was quite a breeze blowing by then and it was hard to get the hook into the water but every bunch of weeds or rock out there seemed to have fish by it. The water was about knee deep and there was quite a lot of the flat. The trout limit was twenty five and I soon had my quota.

Really those fish were not trout but were young salmon, except there may have been some steelhead amongst them on their way to the ocean. The lagoon was a fine place for them to stay awhile and grow in size and it is possible they would run in the river until another migration time. We still have a lot to learn about the movements of these migratory fish

There was a big hook-bill run there in the earlier days, besides the steel heads and many local people had boats fitted with iron baskets to hold the fire, it was called "jack light". Pitch wood was used as that sort of light didn't scare the fish.. A. O. told me that one night they nearly sank the boat.

The smoked fish were a substantial article of food for winter and it could be there was a surplus for sale. In the last thirty years since logging started, the Garcia has had few if any fish runs and some people in Point Arena have been trying to raise fish and liberate them into the river, their location is ideal cool climate, clean water and some dedicated workers. So far the venture has been successful but it will take some years to evaluate how much so. If there are no unforseen troubles or accidents in raising, the project promises well.

There is one thing it will take many years for the s to wash out of the spawning beds so that natural propagation may resume, fish raising may fill the gap for now. There are other streams near the Parcia only smaller, and they too have been affected by logging in late years. Brush Creek near Manchester has runs of steelhead and Alder Creek a little farther on is the same. There are many fish in Alder Creek lagoon unless the bar opens.

For several years the season is closed during the summer months which is a big help to the fish especially if the bar opens. Formerly the fish ducks and summer campers had a field day. Sometimes the sand bar would close early there and in other streams would close and often stay closed, from May until December, this would mean a loss of untold numbers of fish.

We were at Alder Creek some years back looking for smelt, and a small boy came by with several nice trout on a string, and he was really proud. He said, "that pond is really fully of them", and it was, the fish couldn't get out to sea. I told him he had best eat the fish or put them away as it was unlawful to fish there at that time. When the bars were open and the fish could get away, there was no trouble as the tremendous loss of young fish from the lagoons could be avoided.

The Fish and Game people have never paid much attention to keeping the bars open and the matter has been brought to their attention for more than fifty years. Now the matter has become critical, but for some reason the bars stay open better than they used to.

Closing parts of the coastal streams during the summer is good management.

A week or two before school was out in McKinley District at the Smedleys I began counting the days until I could go home to Mendocino, and at last it came. I was to go home a few days early.

My mother went with me down to Iverson Landing to catch the stage. We had to leave early, before daylight and as I remember it was close to two miles. The Chinese cook at the landing gave us coffee and I will always remember it, he didn't spare the cream, it was very good although I was not a coffee drinker.

Iverson Landing was on a bluff as they all were, and used a wire chute. Only small vessels could come in and it is a miracle how they could get these ships into the anchorage and load them and then put out to sea. Even so many piled on the rocks and the danger of the Mendocino coast was well known to mariners every where. Their cargo was tan bark, posts, pickets, and lots of fir cordwood for the city market as wood was the main source of heat around the Bay.

My Uncle Charlie (C. W. Tindall) and a partner operated a store and had a schooner or two they operated in this business. One of their camps was out on what is now the Fish Rock Road. This was before 1900. Well anyway, the stage came along while it was still dark and Mr. Jackson from Mendocino could have been the driver. Those stages could have been called thorough braces, anyway they were two horse rigs. Some times the wind blew hard from the north and sometimes it rained, those big winter storms; but the stages always ran.

I remember one day Mr. Jackson drove into Mendocino and the north wind was howling. He had been all day facing it coming up the coast and he looked pretty well beat out. He said, "It was a terror". The roads were poor then and in places deep in mud in winter and sometimes a bridge would go out, but the mail always came through and maybe the stage would come later.

The old county road ran down and then out of every creek or river, like at the Navarro. The old road ran up over the hill to "Navarro" and then down into Salmon Creek which was a settlement then and a small mill. The Salmon Creek grade was very bad in winter and lots of rigs got stuck in the mud and had to have help.

The stream there was only a creek but it had lots of trout and no doubt had runs of migratory fish such as steelhead. It is doubtful if the salmon (hook-bills) ran there, too small.

The Navarro River was a fine stream for its entire length even to its smallest tributaries. Hookbills and steelhead both ran in great numbers, although it was harshly treated by the lumber industry, not as bad however as the Garcia.

The shiners run in the coastal rivers about like the perch. They run in May and June and in large schools. They get up to about six inches and are flat like the perch. They may be an important item of food for larger fish, although of poor quality for humans, soft and bony but they taste alright. Some fishermen put them away to troll in the Bay in September when the salmon run came.

Tide water runs up Big River for about four miles but I never saw any perch or shiners over a mile from the mouth, about the end of the "Boom sticks". One time Floyd Studebaker and I got onto a school of perch there at the Upper end under a platform and some drift. We baited with pieces of crab and hauled the perch out two at once many times. We caught fish until the novelty wore off. We told about it at the mill and a number of the men went up and laid in a supply of good crab bait, they would keep well if salted lightly.

Fish of various kinds came into Big River, there were the Perch and shiner, trout and salmon at different times and herring in March. In March if the river was right flounders would run near the mouth, below the old bridge. Some of the Chinese colony would generally locate them. They never seemed to catch much but they loved to fish and would spend hours at it. The method of catching the flounder was to use a light sinker and about six hooks baited with worms and just throw it out and wait for a while. When the line began twitching it was time to pull in. There could be several flounders hooked. They didn't make much fass. They were real good fish, really a sole, but not large; maybe eight inches long and flat, both eyes on the same side.

THERE WERE TWO SMALLER STREAMS ON THE Coast that were fine trout fishing but very tough of access. Both were steelhead streams, but hook-bills didn't seem to run in them. One was Greenwood Creek right at the town (Elk now), and the mill was there at the mouth of the Creek. The Creek ran far back to its source on Signal Mountain.

It was logged part way, to the Valenti Ranch, in the early days and then in later years logged by D. F. (Port) Lawson, with his high line and Multiple-spool yarder. With that equipment the logs were picked up and carried out directly over the railroad cars parked in the bottom of the canyon. Damage to the terrain was kept to a minimum.

Anyway in 1937 when we got home from Stockton I was very anxious to fish. When the season opened, which was May first with a limit of twenty-five. It was fine fishing although logging had been over for several years and the willows were very thick in places. What local fishing there was, didn't seem to hurt it. Maybe the fishermen hated to fight the brush and too, it was quite a walk to the fishing.

I tried all the ways and none were too easy. No hookbills ever ran in Greenwood Creek that I know of. There was a high falls near the middle that fish couldn't get over, but there was good fishing above them, and who can tell how fish first got there. Below the Falls the fish were rainbows, but above there the fish were heaviest and had noticeable white tips on their fins.

I caught lots of ten inch trout there but it was a struggle through the willows that came back after the logging. Some time it was hot and I had to pack my fish carefully to avoid losing them, one day climbing out it was a toss-up whether I got too hot or lost my fish and I was relieved when I came out on top and there was my car only a few yards away.

When logging was done, the track was torn up and things soon went back to the wild. Elk creek was only a few miles south and was one of the most beautiful streams

I have ever seen. It ran back and headed on Signal Mountain near Alder Creek. The logging there had been over long enough for the scars to heal and the timber was coming back. In one place on the track where the ground was soft I saw panther tracks every time I went over there.

It was a real hard trip in, the Vinegar Hill boys used horses the few times they went in and sometimes made a two day trip which was better. We tried it three ways, all bad but we caught lots of fish, all we wanted. The first time we went down from the Lucarelli Ranch, through Hamilton Opening a drop of about 4,000 feet altogether and the climb back was a real killer. We only fished a couple of hours and had our fish.

The second time we tried a new way, we went down from Lucarelli's and walked down the creek aways before starting to fish. The fishing was grand, lots of deep green riffles and plenty of big hungry trout. Lots were ten inches and some over. Then in the afternoon at an alloted time we started for the coast where the ladies were to meet us at the mouth of Elk Creek. We had ten or twelve miles to do and we wasted no time, we really stepped out for it meant staying all night if we didn't make it. We arrived at the coast road just at dark, we didn't make it by much, but we had a beautiful catch of trout. There was pleny of water even though it was mid-summer and the Valley streams were l v.

Then Alice's brother Don came up and he wanted to try it so we tried another way which wouldn't be so tough. We parked the car at the coast and we walked in about three miles. We caught plenty of trout, but hardly got to the ideal fishing. The first mile or more going in was an alluvial plain, sandy bottom and few riffles, we did catch several nice trout there from under cut banks. When we were done fishing we were nearly back to the car, a big saving in manpower That was the last time in but they were trips to remember in a different way.

I cannot say for sure about hook-bills there but I don't believe they run in either Elk or Greenwood Creeks but they both have good steelhead runs. Logging on the main stream has been over many years on Elk Creek and the headwaters of Alder Creek but what there was came in from the Manchrester Road. The later logging with D-8s seems to have caused more erosion than the old-time metods and I am told that controlled burns on steep rocky hillsides has caused a lot of erosion and that Elk Creek now is built up with rock and debris. It was a wonderrful wild country in 1945 and in time may come back into its own, but it may be a long time.

There are many small creeks that flow directly into the ocean with out a lagoon, such as the Malpass, Irish gulch and at Dark Gulch It can be well believed they all have steelheads. The hook-bills seem to prefer river with lagoons at their mouths this is true about the Garcia, the Albion, Navarro, Big River, Noyo, Pudding Creek (I think) and Ten Mile.

At Little River it is hard to say now but we can be sure it once was a trout stream. There is a little stream, runs through a culvert under the Highway south of Little River that has or had trout in it. They were evidently planted there and are not steelhead They were good sized and would washed out along with the Highway.

About a mile above Mendocino or a little more is a small creek, Jack Peters Gulch. It is a small deep gulch and has some nice trout in it. No doubt fish run in it as there is no bar. Railroad ties were made there at one time, and a short spur road ran back for aways. However it was seldom fished, even by he most hardy, as the brush was almost impossible.

On up another mile was or is Russian Gulch now a a well known State Park. This was a larger stream with a small harbor, and small ships came in even some years ago. Brown and Gray of Mendocino had a landing on the north side for ties and post and other timber products. The county road was like all the coast, it ran down into the bottom and crossed a small wooden bridge and up the other side and was quite a little grade, although short. It is a State Park now and has a safe beach as such go. For awhile there was a wharf on the south side and a small freighter made regular trips in to discharge and pick up local freight.

When we lived in Mendocino I fished in Russian Gulch many times. The fish were small but it was no trouble to catch fifty which was the limit. I know that big fish run in there, because I saw one go by and into a pool. It could have weighed six or seven lbs. and could have been either a hook-bill or a steelhead. I am inclined to think it was a steelhead. I fished for him but no response.

Russian Gulch was logged into split products probably one hundred years ago and there is some erosion evident in the sand beach which has filled in quite a bit. Now the timber and brush has grown in and there is a drive up the canyon of surpassing beauty. The fish are probably there as they have been better protected for many years, the limit now is ten and during the winter months. There is another stream at Caspar but it was dammed for the mill-pond and probably no fish, although when the mill closed the dam was blown out, thus eliminating a fine lesson in natural history, but the fish may run again.

There is much evidence of erosion in former years, as there is a large sand-bar and the bay is partly filled up. Also this is the place where I saw my first ship, many years ago. She was backed into the landing stern first and I remember mainly how she was rocking. My father and another man and I were standing on the wharf up on the bluff. That was before 1900.

Above Caspar the creeks are very small but it is possible some fish may run in them. South of the Noyo is a place which should be mentioned and it may still be running. It is the Wonacote Trout Farm and is just off the present Highway on the old road. That section is underlaid with water down only a few feet. Mr. Wonacott had a number of ponds and he sold trout to private ponds as well as having U-Catch-em there. It was a fine place to visit and see the fish and maybe catch a few. It was a fine place for the young beginner. The charge was by the lineal feet of fish..

Noyo is a fine fish stream although there has been logging on it for many years and dredging has been required at the mouth to keep the river open for the fishing fleet which has grown into a vast Armada in the last few years. The Noyo is also a harbor of refuge during the bad storms. The Coast Guard now is stationed there.

Sixty years ago the fishing boats were bringing in big catches all during the season, which started when the fish arrived off-shore and ended when they left for the Northern rivers.

The Noyo river is a short one as rivers go but is a good fish stream and shares a watershed with Pudding Creek just north of Fort Bragg. There, also is evidence of great erosion, not only in the large amount of sand at the mouth but it is the beginning of the Ten Mile Beach and its sand dunes. This particular formation has no doubt been going on for centuries and logging has only been an incident.

Pudding Creek has a definite Lagoon and is the location of an egg taking station. We are guessing there are all hook-bill salmon there but it likely that some steel-head run too. A lot of fish go past there and if a creek of that size runs that many fish, the larger rivers must run a great many fish, providing there are no other hindrances at sea such as large fleets of foreign ships off shore. That seems to be the case at this time.

The next river, Ten Mile is Ten miles farther north, it '- a good river for fish and is at the north end of Ten Mile Beach. There is almost unlimited sand and over the years a tremendous erosion. Some no doubt caused by logging.

There is a long lagoon but not very deep, we believe the mouth is open a good part if not all the time. Trilling is limited on account of the shallow water and lots of weeds, however, it is a good stream, for propagation of fish; heading as it does far back in the hills and cool clean water. There are two branches north and south Ten Mile road and together they drain a large territory, all good for fish.

Logging is still going on in old growth timber and no doubt will for some time and the same applies generally to most of the redwood lands.

Off Ten Mile Beach and the North Coast in general is a tremendous fishing area both commercial and sport. It runs mainly from Point Arena to Cape Mendocino and far out to sea. When the allacore run they are out fifty miles or more, although they do not count as the salmon do as tey do not come in with in two hundred miles part oft the time.

From Ten Mile the mountains run right down to the sea. There are many streams and most have trtout in them but there are no big salmon runs there. There are other fisheries important to the people sutch as smelt and rock fish and abalone.

It all makes a fine fishing "Hole" and needs cur protection now.

Trolling

In Big River after 1900 and I got to trolling on my own, which was a fairly early age, the salmon would show up in the Bay in September and some of the men would troll out there. I was never allowed out in the Bay which was probably just as well even though I got pretty good with oars. I finally did get to trolling in the river which would start three or fourr weeks after they entered the Bay. However the fish know, they were always on time and almost to the day and that was after being gone for four years.

It was a beautiful sight to see fish when the run got really stared. The forested hill-sides and the deep green water and the silvery fish leaping all up and down the river. They bit best early in the morning and there would be a little wind down the river. When they got to jumping during the day they would quit biting so much. There was some commercial fishing and nets were used sometimes but finally laws were passed and netting pretty well stopped although the boys were hard to convince and it took time to get them out of their unlawful ways. It seems odd that fish could be so well protected then and here in later years industry was allowed to ruin the streams and limit the fish runs down to almost nothing.

My father had the flats on Big River as far as the Boom and had quite a few cattle there, it was very good feed and ran for about three miles. One day we were coming down, it had to be by boat as there was no road. At the upper end of the first flat the river was quite deep and evidently fish schooled there, it was always a good place to troll through.

Nigger Nat was there and was fixing to put out a seine so we stopped to help him pull it. He had his grandson there to help but as it turned out he needed us. They ran the seine out in a loop in the river and we began to pull in the ends. Nothing happened for a few minutes and then the net began to pull hard, it was all we could do to bring it in. Anyway when we finally got it to shore there must have been a good two horse wagon load of salmon in it. Nigger Nat was very pleased with the haul and offered us all the fish we wanted and my father picked out one nice one which was all we wanted

Nigger Nat was a well known Negro who came to Mendocino in the early days as a young man He often said that he and Portuguese Frank were the first two white men on the Mendocino coast. Nat had some property and a house on the Ukiah Road just at the start of the Pygmy Forest which we called the Prairie. My father and I camped there several times when he was hauling fruit to the logging camps The spring water was black as ink but it tasted alright. I have forgotten Nigger Nats real name but he was well thought of in the community.

Trolling then was much different then. there was no season or limit. if a fisherman did extra good he quit or gave the extra ones away, Some would salt and smoke their fish and they were very good. John Vargas. a well known Portugese fisherman fished regularly and had fish to sell. The going price was fifty cents a fish or about seven or eight cents a pound, The fishing equipment was pretty standard. no one had rods or reels or outboard motors, that all came many years later. We used two lines and looped them to alder twigs one on each side.. They were on he twigs that so when a fish bit he could run with the line and not tear himself off.

Each line would be two hanks of green cotton line which was stocked by Jarvis and Nichols. We would never had over three or four spoon hooks as they ran into money at fifty cents each. Hammered brass was a favorite every year as was copper and silver. It seemed that whatever the fish started biting on, they would continue on for the whole season.

Mr. Blake who used to live at Comptche and owned the Ciro Ranch was an ardent fisherman and made himself a gold plated spoon which was a real killer It was expensive though as it took part of a five dollar gold piece to make it. Louis Anderson was another old timer who spent the last years of his life trolling on Big River. I hadn't seen him for years but we got reacquainted on the river. He too came from Comptche and when a boy had gone to school to my mother in Comptche. Also my father finally bought Mr. Blakes boat and I trolled with it a couple of seasons. It was fair sized but pulled very easy.

It might seem that I write a lot about Mendocino and Big River and the Coast but that is where I made a start in outdoor life and little of it has been forgotten. By the time I was twelve I was going pretty good, most always with other people and by sixteen I had been up and down most of the cliffs and the various islands. I had a bird egg collection of sorts and was always eager to add to it.

The Coast was a great place for hunting and fishing for anyone old enough to take part in it. The only time there wasn't much was in the winter when the weather was bad and freshets were running. There was trout fishing below the bridge in March when a school would be going out, we called them trout but they were probably young salmon on their way to the ocean. There were flounders there at the same time and herring if anyone had a net.

We helped Mr. Curtis pull a net there one year and he gave me all the herring I could use. Some trout came in the net but we threw those all back as it was illegal to net them. The perch ran in June and could be caught in quantities and it was a fine time for crabs using perch for bait

In the summer there was deer hunting and later there were lots of quail for those who could go after them. Of course there was always rock-fishing and abalones most all the time, weather permitting. No especially low tide was needed and hardly anyone needed to get wet. For the first few years I wasn't allowed to go fishing off the rocks unless there were older people along but later I got to going on my own. I have always appreciated the good fortune that allowed me to return from those trips, not every one did.

There was good trout fishing in Russian Gulch only they were small and in Jack Peters gulch except there the brush was almost impassable. I will always believe that steelhead are native to those small coastal streams. Steelhead fishing as we know it now was not done then. About the only time there was any steelhead fishing was when someone got onto a run and then spoon hooks were used. One time someone found a school at the upper end of the boom sticks and some good fishing was had for a few days.

Many now-a-days won't know about the boom sticks and it might be in order to tell about them. Near the mill was the tie landing or wharf where the barge loads of ties from the camps up river were loaded into the little cars that carried them out to the Point to be loaded on ships for foreign ports. The boom sticks started there and ran up the river and were fastened to the south shore by piling.

The booms were logs chained together, end to end hewed flat on the top side. The saw logs after being rafted down the river were contained in various compartments inside the boom or enclosure and were there sorted and made ready to go up into the mill. The logs were floated onto a little flat car and were pulled up an incline to the log deck in the mill. Mr. Brien handled the logs there and had each log in place as the car was pulled up. He was there for many years, winter and summer.

Next to the tie landing was a protected area at the end of the booms with board walk ways and it was there that local people tied their boats as well as out on the river side. Many had boats there and they were of all styles and sizes and colors to suit each owners ideas. Along the boom sticks was a fine place to set crab nets as they ran along about the center of the river and over the deeper water. The nets had to be watched though as some of the mill boys were not above pulling a net if the owner was away, it was a sort of game.

I got too trusting and lost half a sack and from then on was more careful. At the upper end of the booms was one that swung out so the Maru could get through and nearby was a gap where the row boats could cross. It was a fine set up for everybody and during the salmon season there could be a lot of people especially on Sunday when people were not working.

The trollers would work from the mill down past the bridge which was a beautiful stretch of river and then along the deep water across from the second flat. From the end of the booms along the first flat was also a favorite. Right at the south end of the first flat and near the end of the booms was quite a deep place and lots of times a fish would grab the spoon almost as soon as it was thrown in.

There was a lot of river on up above but not many went above the waterspout at the upper end of the second flat. Across from the second flat was a big bend of deep clean water, a beautiful spot and a favored place to troll. It seemed if the fish bit at all it would be there.

Salmon

WE ARE NOW INTO APRIL and the steelhead fishing is over and the sport fishing for salmon has started. The so-called "trout" season will open soon in some district inland waters. We are not looking at the planted ponds and lakes where catchable fish are planted from time to time. The silver salmon (hook-bills) have spawned weeks ago and the young ones are on their way to the ocean. The young steelhead will soon follow them.

In the north from the Eel River on up there are king salmon and others which began their spawning run into the rivers last September and those fish hatching will be in the ocean soon, if not already. It is an unending cycle of fish running into rivers and spawning, so we can start our fish story in September of last year when the salmon runs in the northern streams for their new year to start. At the same time the Alaskan run is about over, they started early and ran through the summer months.

We have never heard just when those fingerling salmon come out of the rivers of Alaska and into Bristol Bay and others but anyway they come out into the salt-water in untold millions and start feeding on the vast supply of marine sea life. This is known in part as plankton and is extremely rich and the fish grow rapidly to where they can feed on food fish such as anchovies.

The scientists have found that the young salmon, older ones also, circle in the north Pacific travelling leisurely and feeding for about four years When they become mature fish. Some kinds weigh six or seven pounds and others like the kings will run anywhere from eight pounds up to very heavy weights.

Fishing out of Noyo with my friend Joe, I have landed a number of fish over forty pounds. The very large ones, over sixty pounds are hard to land on commercial tackle because they tear off the hook but I remember seeing one in Noyo that weighed eighty pounds and it was surely a beautiful fish.

It is a marvel how those fish can circle in the vast northern Pacific over distances of thousands of miles and yet at the appointed time almost to the day they complete their circling and arrive at the mouth of the river they left maybe four years before. That is wonderful and exact planning and we must admit to a higher intelligence. This part the scientists have been unable to figure out, sharp as they are. So far they are in clined to believe there is some sort of built in radar and having to do with currents of the ocean and electric impulses in the salt water. There is really a lot of electric current in salt water, it will eat up fish-hooks in a short time.

THE ALASKAN story of the fish has been one of great depletion of resources. As the industry grew and caneries multiplied and the fish became scarcer, the fishermen put out deeper and tighter nets even to stopping the runs altogether. It looked like the industry was doomed. Most everyone in later years has seen pictures of the salmon runs in Alaskan rivers or the movies of bear catching them.

At first it was like the buffalo, the fish were running somewhere else, then it was decided the eagles were catching them, and a bounty was put on eagles, then the damage was laid to the bear. Still the fish became scarcer and it was said the trout were eating the eggs and so families made their winters grub stake by what they called "trout tailing". They got so much a trout tail and probably ate trout until they were tired of them. From what we have read and heard of trout fishing in Alaska to try and catch them out would seem like a fantastic and impossible idea, but no more so than some we have heard in more recent years.

Well anyway things got pretty bad and Uncle Sam stepped in. The depth and placing of nets was regulated and so were fish traps. The fishermen had finally got to almost completely stopping the runs. Then certain days of the week were set to allow the fish to run until it was figured enough spawners had gone by to keep up the stock. In a few years conditions improved but a new peril developed and still exists to some extent.

In late years Russian ships have been working off the coast and have been catching a lot of fish of various kinds and processing them right there on the ship. It seems about time that the United States should extend its territorial limits out to 200 miles, as they have done down Ecuador way. Then too the Russian drag boats are said to be quite active not too far from U.S. waters. With ships and airplanes as they are the oceans have become much smaller places as far as man goes and he has much more efficient tackle, like the drag boats our own included. They cause a tremendous waste of sea life on the bottom.

THIS is the time of year when the hook-bill salmon (silvers) are up in the rivers and ready to work into the small streams and make their spawning beds. About December 20th on for a couple of weeks is their regular time for spawning and year by year they won't miss it very much unless there are other factors like no rain which can happen any year, or floods at the wrong time.

The steelhead are mostly a little later but it all depends on whether there is enough water in the streams, often the water is too low for them to run on up out of the river (that is the hook-bills), and they be forced to spawn farther down, and then if the rains come in volume the eggs will either be washed away or buried in gravel.

There are many hazards to the fish other than the fishermen. We have watched the hook-bill, as I like to call him, for seventy five years and I believe I have seen most all of it. The steelhead not quite so many years and the observations more spotty, the steelhead history is more complicated and but few fishermen have any knowledge past their own favorite pools or stream.

Beginning with the year 1900 when my father would buy a fish for fifty cents from someone who had extras (there was no limit or season then), there has been a lifetime of interest in fish and an admiration for the deep green waters and in season the leaping silvery forms of the fish.

There are many the same and a list would be long. John Vargas was one who most always had an extra fish, Nigger Nat fished a lot and made it a business during the season for the salmon. Steelhead fishing was mostly unknown as we have it today and was only by spells when someone would locate a school, mostly trout size. Then if several fishermen were there to keep them interested, the fishing would be fast and everyone would soon have what they wanted, and they would run from trout size up to two lbs or some better.

After two or three years I got hold of some proper tackle, and by the time I was twelve or so I had a boat part time and was pretty good on oars. For the next several years I fished on my own. My father had cattle on the river flats up to the Boom which was about three miles and two years he raised potatoes so he went up the river often during part of the year and I went whenever school allowed, and I just as well went every time for on the days I didn't get to go my mind was on the river and not on the school books.

Well anyway, those were fine years in Mendocino and I grew rapidly. During the winter and spring there wouldn't be much on the river, but in the summer and fall there would be a lot going on. Many people had row-boats and on Sunday on good days many would be on the river, just to ride or on picnics. Then there were crabs to catch and many people had nets and it was no trouble to catch a dozen either off the old bridge or off the boom-sticks and many would cook their catch right there on the river. Crabs were best when cooked in ocean water.

The fish would run into the Bay and there were several who fished out there when the weather permitted. I was not allowed out on the Bay, it was hard to get a boat and maybe it was just as well. Things can go wrong quickly on the ocean but I would have gone if a chance came up.

October first or a little later the fish would begin entering the river and then every one that could get away or had a boat was trolling especially on Sunday when people were mostly free. Working men worked six days a week and ten hours a day, so that curtailed their fishing somewhat. There were no out-board motors then, and everyone pulled with oas, which was much better although more work...

Our standard equipment was an alder limb on each side to loop the line on, and those were carefully trimmed out and should last at least a season. There was a green cotton line that all the stores carried and two hanks made one line with a little over so when a fish grabbed the spoon he would have room to run a little, else he might tear off if snubbed too short. The spoons were pretty standard year by year and were well polished. Number six hammered brass or copper and silver and a few others at times.

The day had not come when fishermen offered plugs and flies and dragged them behind a motor. It seemed the fish got more particular and did not bite so good. Well, anyway, we could seldom afford more than two or three spoons and the fish would bite the same spoons all seasn, it seemed mostly to depend on how clear the water was.

When we left the Coast and moved to Peachland District which was on a fork of the Navarro, there was an end to the trolling. We caught what fish we wanted to eat with spears.

About 1906 there was a dam on Indian Creek and the salmon couldn't make it over, but there were some big runs on the Valley streams and into the Rancheria. Finally some one blew out the Dam and then the silvers began to run on Indian Creek and some years they were rolling on every riffle.

There was no good road from the Valley to the Coast and fish were a luxury except in the winter. There were some nets used at times and they could get a lot of fish. It can be presumed that many were smoked and sold, smoked hook-bill being a very fine article.

When the Highway was opened down the Navarro in 1925, it gave Valley people an easy access to the Coast and also opened the steel-head fishing down the river and many hundreds of those fish were taken each year for many years.

Nobody paid much attention to the hook-bills then, the steel-heads were much better fish and anyway they ran later into the spawning beds, usually about January 25th or soon after. We speared them but let the females go until they were pretty well spawned out. Every morning there would be more males there and we could catch two or maybe three before they were scared off.

Fifty years, looking back is quite a while but we well remember when the fish houses in Noyo were piled with big king salmon every day and everyone was busy. We bought them for a while for ten cents a lb.

That was after the Navarro River road was opened and Valley people had a good way out to the coast. Before that we had to go by Flynn Creek and Comptche or by the Navarro Ridge and they were just fair at the best.

Well anyway, it is time now for the hook-bills to run in a few days and maybe they are already at the mouths of the rivers, from the Gualala on the south to the Ten Mile north of Fort Bragg. At Pudding Creek just north of Fort Bragg is an egg taking station, and the run has seemed to hold up well over the years, maybe because the logging was done many years ago and a recovery has been possible. It was a different kind of logging too, not so much soil was moved.

We always called these salmon "hook-bills" on account of their nose which hooks rapidly when they enter fresh water. They were also called "dog" salmon because it seems factual they are poison to dogs. It would be interesting to know the true name of these fish.

Steelheads also run in these coastal streams, in the fall and winter but their habits are different and it was only about fifty years ago that any were caught by hook and line. A local man, Don McGimsey was probably the first to find out steelheads could be caught by hook and line. He would go down to a pool just below the bridge and come back with one or two good sized fish, they ran about twelve lbs. more or less.

After the word got around and the road was opened down the river there was an inrush of fishermen especially from Napa County and hundreds of fish were caught each year. The fishing has died off in later years for some reason and there will be only a few cars parked along, where there used to be a hundred.

We of the mountains had to get our fish with spears which method doesn't get too many fish, is more sport than might seem, then too we gave the fish a chance to spawn out.

These hook-bill salmon were also called dog salmon locally because old-timers will tell how the dogs in the Rancherias got cleaned out when someone brought in some hook-bills. Most of the tribes were well inland and in the Valleys where the hook-bill did not run, also there would have been few dogs. Steel-head and king salmon seem to have no adverse effect.

Of all the coastal streams Big River is the most scenic. Even when the mill was on the flat it did not detract from the river view. From the old Bridge there was a view of the dense timber, on one side and the white cabins, on the other with the towering stacks and the log ponds.

That stretch of the river was deep green and in the fall salmon would be leaping, high in the air and falling back with a splash. There was another stretch opposite second flat, quite a long one, deep green water and the forest rising up the steep mountain side. It was one of the favorite trolling spots maybe as much for the scenery as for the sight of the silvery fish leaping all along the bend, sometimes five or six in the air at one time and there are several instances of fish leaping into the boat.

In Big River in the fall someone might discover a school of steelhead from one to five lbs and there would be good fishing from the boom sticks at the mill until the school moved. I remember one day Tuffy Packard found a school of steel-head by a rock just above the old bridge and was doing alright, he hooked a fish nearly every time he cast in. By the time word got out and the first panting fishermen got there with tackle, the fish were about done and were moving out, but Tuffy had a nice catch of fish. Maybe from two to five or six lbs.

Then one day I was trolling up on the Bend opposite second flat and some boys were fishing from a log raft and they caught grilse which are small salmon, as fast as they could bait and cast in. There were some who trolled in the Bay at this time of year when the run started.

There were seals over on Kents's Point but there must have been plenty of fish for all. My folks couldn't see me going out in the Bay, probably with good reason although there were no trollers lost. In the fall, fishermen's eyes were on the Bay and th coming run was soon spottd.

Fish and Game in 1906

When I first came in—1906, there was plenty of fish and game; Anderson Valley and its hills were a boy hunters Paradise. Indian Creek was a famous trout stream, steel-head fishing with its attendant depletion had not begun. There was just local spearing for fish to eat.

The County Road through the Valley was lined with picket and rail fences which furnished plenty of shelter for quail, and the traveler often flushed covey (bands) as he drove along. They were not hunted so very hard, neither were the gray squirrels, that in the fall were barking from every pepperwood gulch or making daring leaps from limb to limb in the black oak forests

Pa Sanders up in Peachland liked fried squirrel, and every so often in the fall he would walk around the road to the school house and get two. He would shoot only those that would fall in the road. There were many quail in the hills, they lived around goose-berry patches or near springs.

Deer or hogs, of course were the real hunting. Most every family had a "deer dog", here in the valley a cross of hound and shepherd was very popular. A good one was beyond price as was a "hog dog".

Most deer hunting was in the chamise country except winter hunting for fresh meat. Doe killers were well known and were not welcome in the real hunting camps Shoot at a doe and the buck got away, although some does were killed. Fat buck rib stew was an institution. One time I saw Jeff Vestal when he had just returned from Nip and Tuck. He said, "They had fourteen big bucks in one pile."

There was a lot of traping for hides then and "George V" was one of the most noted; and quoted. George caught lots of varimints and in the winter you could smell him coming. No doubt the traping of so many predators helped the game and the inacessability helped the trout

Through-out the years, the supply of fish and game has risen and fallen, nature took care of things. Now with smaller limits and "Managing", plus civilization??; fish and game as we knew it is about gone; soon we hang up the rifle and put aside the rod. We few old ones left had it; we also are about gone.

in our modern days there are more deadly dangers to the animals and fish and birds and even ourselves than erosion could dream, and for protection we must depend on the very people that unleash them in the first place. Well anyway there is always hope that springs anew. The birds (some) are back after being scarce for four year. 'Funny thing there is a robin and chippy birds and some small ones, but no English sparrows.

Fishing Rivers and Streams

Once again we have that day of days when all those who are fond of the woods and streams and the outdoors hit out for their favorite fishing place. They will have counted their flies and put the rod together and swished it around to the peril of dishes on the table or any family present.

Maybe if the weather has been right the ardent fisherman has been out on the lawn casting into an imaginary riffle and in his mind seeing a great trout rise and take the fly. Another may not care for casting but he will watch carefully over his box of angleworms. All too many poor souls will go down to the store and buy a jar of salmon eggs and a package of gut hooks. Probably there is no sport in the world more ancient or none having such a variety of tackle to choose from.

We can begin with the old and imperishable story of the small boy who had a bent pin with a piece of string and a willow pole. He was supposed to be coming in with a fine string of fish while the older sportsman with all his fine tackle and expensive apparel got skunked. It is an old and favorite story but like many fish stories, not too factual. Sometimes though a fisherman will stand out in the picture. Many years ago we added to our somewhat meager income by keeping fishermen, giving them food and lodging, although it is doubtful if many could sleep the night before a fishing trip. The fishing was very good but some could catch only a few, while others aimed at filling a basket. Sometimes a fisherman or woman would come in with only a few fish but full of stories of flowers & scenery. The limit was twenty five and I encouraged people to stay within it. I also showed them the difference between twenty five minnows and a limit of good ones.

There was a man and wife there, he couldn't sleep and was up walking around in the night. He couldn't believe he was going trout fishing and really catch some fish. They were from the east. The next day he was back before noon with a limit of fair fish and babbling in wonderment about the things he had seen. His wife stayed at the house and visited. The man wondered around for a while alking about his morning. Finally he gave in and asked if it would be alright if he went and caught some for his wife, as she didn't fish. He was a supremely happy man and came back many times.

One day I took a guest away down stream to start him in. He had about everything that could be used in trout fishing, even a rosewood paddle to stun them with. He said he got pleasure all winter making up tackle for the coming season. He used a barbless hook and the first thing he did was release an eight inch trout. He said it wasn't big enough to keep. I told him he migh not get many fish that way but he said that would be alright. When he came in that evening he had eleven trout that nearly filled his basket.

Another time I fished myself down in that part of stream. There were some fishing there so I rode Juno quite aways on down so as to leave them plenty of room. I used a fish killer outfit that Bill Oppenlander showed me how to make years before. I was only a little while getting a imit and started back. I came to two men I had passed and they wandered why I quit so soon. They looked at my fish and at once wanted to know what I had used. They were not our people so I told them "brown hackle" and they at once started digging in their fly books, they may have forgotten that fisherman seldom if ever tell the whole truth, if any at all.

Farther up the creek I came to a nice looking young man standing by a clear hole around ing a salmon egg float around, there wasn't a fish in sight. He asked if he could see my fish and then said, "My if I could only catch some like that." We looked through his tackle and I made him a "fish killer" and told him to drop it by a big rock where the current was running in under it. At once a good trout grabbed on and he came out with about an eight inch fish. When I rode on he was still thanking me. I often wondered if he ran into the two I told about the brown hackle.

We kept fishermen for several years and while there was some work to it during May and June there was also a lot of pleasure and we made some lasting friendships.

One year at the beginning it came to a Saturday when people came the most. The last threatening rain and we were pretty well filled up but they kept coming. The last was an attorney from San Francisco with four friends. I told them we were absolutely full up, but they said it was late and they had nowhere to go so we brought in all the automobile cushions and bedded them down in the living room. Then it did rain.

The next day was wet but all went fishin. One man and I wet to the head of Indian Creek and fished down and the local teacher fished down the north fork. Although most didn't catch too many the three of us had over 300 and nice fish. We poured all the combined catch into a wash tub and they were inches deep. We had plenty to eat and every one had a limit to take home.

In the years before and after 1910 we seemed to have a better flow of water especially on the Navarro watershed. That would include Anderson Creek past Boonville and Indian and Conn Creeks down the Valley. There were salmon runs out past Yorkville and no doubt in many of the smaller branches when there was water enough at the right time.

The water would rise enough so that hook-bills could come up and be spawning by December 15th or 20th and even a little later after the Holidays. Steelhead would show up in Indian Creek and start spawning about January 25th and we would be glad to see them as we would have had but little fish for almost the whole year. There was no good road out to the coast then, and trips were taken only in the summer. It was then that we began to buy salmon, when we did go over, and they were ten cents per pound.

After the river highway was opened about 1925 it was lots easier to get to the coast. A person could make it over and back in one day and we could catch the hook-bills down at the mouth of the river by trolling just as we caught them years before on Big River. After the road was built it opened-up a lot of the river to steelhead fishing and thousands were caught.

The hook-bills were fine when fresh from the ocean. they call them silver salmon now and it may be the right name. They were strong when they got up into the spawning grounds and the males turned very red, but if skinned before cooking they turned out very well.

Through many persistently bad years of low rain fall in the 1920's the hook-bill run was slowed down greatly and fishing wasn't so good but by early in 1930's the rainfall improved and again we had big runs of the silver salmon.

For some reason hook-bills do not run in some streams. In others they seem to have always run, and in good years, in veritable hordes. There is no doubt that we need action, and lots of it and as fast as possible.

It would seem better to protect the run in a stream such as the Navarro by a part time closures and offering protection, and removal of remaining debris which might create hazards to spawning riffles.

Many years ago there was a dam on Indian Creek near Philo and there was no run up that stream. Some one blew out the dam and in just a few years, about 1920 there were big runs every year for a long time. They were the first fish in and I used to pick out a good one when I happened to be on the creek I generally shot them with a twenty two, when the water was low enough to get them out.

Steelhead could run almost any time, they could jump over the lower obstructions and log drifts seldom stop them. If the water can get through the steelhead will find a way. About the only thing that will stop them is a very large and tightly built dam with leaves and fine brush mixed in. In that case they must spawn below the obstruction, and until another flood removes it.

Much work has been done in the past to clean out barriers which could stop the fish. We could use more attention to our waterways. The hook-bill won't try too hard to surmount or go through these obstructions but the steel-head is more vigorous and is able to swim up a waterfall if the water is solid and he can jump some surprising piles of trash if there is enough water.

Anyone who has tried to put in a wire or brush dam knows how hard it is to hold them with a fence or a barrier. They will actually tear it down unless the work is very well done.

In some of those bad fish years from 1925 to 1940 or even later we had poor fall rains and the fish had hardly enough water to swim. Down in the main Navarro the fish would leave trails over the riffles where they had knocked off the moss in their frantic efforts to get up stream. Some years they wouldn't make it and would be forced to lay their eggs down there in deeper water and of course those would be lost in later floods.

Then during those years the bar at the mouth was often closed from spring until late fall and the fish would be laying there in the breakers trying their best to come in. If the bar did break or as sometimes happened was dug out by hand, there would be a tremendous rush of fish in and in a few hours they would be far on their way to the headwaters.

Looking back over the years we can see where a careless lack of attention almost lost us the fish runs entirely. Now it would seem a good idea to bring the runs back would be to quit doing what caused the trouble and let Nature heal the wounds that we caused.

Trout

Many years ago the trout season opened in April; then in later years it was May 1st with a limit of fifty. Roads were not so good and many were closed to automobile during the winter months and would be barely passable by the opening day. There were only a few cars then and they had few horse-power and the tires were fabric and not much tread. When balloon tires came out people thought they had something and then demountable rims too.

Well; anyway; the streams back in the hills were hard to reach unless by saddle-horse or afoot and no one had to go to that much trouble unless they were really keen to fish. Only there rests in every fisherman's mind the thought of a place where no one had ever been or some place away out in back that few if any went to; that place where there were lots of big fish and where they would bite like wolves.

Actually there was very good fishing near town; it was just the idea of going away back. Some of the streams back in the hills like the North Fork of Indian creek or Owens Creek and others were seldom fished and then very lightly.

Fishermen then used bait a lot and would only try the better places and for the larger fish. The result was that a lot of fish were left to grow and many of the larger fish would escape and would sooner or later head for the sea. Some times a fisherman would catch what he wanted in a quarter of a mile or what would lie between two trail crossings. Then too the fish would be on the move and some places were good at different times.

One time about 1909 a couple of fishermen walked into the head of Indian Creek from near Ukiah, it is many miles and over a mountain. When they came out at our place they had full baskets and had hardly touched the fishing. A half mile or less of stream would produce enough fish for a family for supper or breakfast and a heaping platter of fried trout was a sight to be remembered and food fit for kings. really enough reason for going. The good fishing lasted longer then. there would be a good flow of water in July or August, better than there is now in May.

One time I walked out the Ridge to the Walker claim; about four miles and fished down Owens Creek to the Owens Opening trail crossing. Part way down there had been a big slide land dammed up the creek into a deep hole. I had quite a few fish by then so I sat on a log and rested and still fished a while. I figured I caught a fish a minute and soon finished filling my basket. The pond was teeming with fish of all sizes. There were some good sized ones there but they were very wild. It was a three mile walk home and I remember there were baked beans on the stove. my folks were all gone. I have liked baked beans ever since.

All the coastal streams were full of trout and the tributaries of the Russian were the same. The main river was not so good as there were a great many predator fish. However at one time some german brown trout were planted and must have multiplied somewhat because a fisherman friend found good fly fishing below the Talmage bridge. He didn't advertise it and had some good trips. As I remember the german browns were tried because they are somewhat of a predator themselves. Before the Eel River water was turned in, the river used to go dry in spots above the bridge. About the only way for rainbows to survive would be for them to make for tidewater as soon as they left the smaller creeks.

Those good days of fishing as we knew them are pretty well gone now but we can still remember as if it were yesterday the cool bright mornings on the rippling mountain creeks and the sun getting warm on the water. There would be an occasional bird song and the rattle of the pileated wood-pecker drilling in some snag for his daily worm. Then there was the little thrush with the mighty voice I always thought of him as the "bell-bird" on account of that voice. During the day maybe a squirrel would cross on a high limb or a redwood lily would blaze in a sunny spot on the creek flat.

The rivers on all the north coast have been problems since time began.

When the white man first came and lumbering started the logging was close in and the rivers were used to float logs into the mill-ponds. There was but little power available and the logs had to be moved into the water by hand — that is by jack-screws and crude horse power winches. In order to log in this manner all debris had to be cleaned out of the way, so we had an era of clean logging and but little movement of the soil.

Later on, the logging moved back from the coast and the bull teams had their day. After that the little donkey engine came into use with railroad transportation either to deeper water or direct to the mill pond. Every river or creek had its own problems.

Big River was a good example of the different methods used, also the Navarro. These rivers had in some part of the watershed a sample of all the methods used in getting out timber, even to the tan-bark and posts and railroad ties. Little River and Salmon Creek had smaller watersheds but logs were moved down them to the mills.

It took more than thirty years for the operations to move back from the coast and the railroads then came into general use. On Big River then, the activities were back to the Lagoon and above Mr. Burkes tie camp. During many earlier years ties were needed and often the tie makers came after the logging and cleaned up all remaining timber. This was especially true on The Albion. Ralph Byrnes ran a tie camp between Melbuorne and Comptche and many thousands of ties were made there as well as on adjacent lands.

That was in 1909.

Early in 1920s The Albion finished logging in Mill Creek and moved out leaving much timber uncut and a vast amount of ties. This country later burned in a colossal fire and the loss must have run into many thousands, one fourteen foot tree burned completely at Live Oak Springs. It was felled but had too much wave for ties. It was beautiful wood and a total loss of several thousand feet of timber.

The well remembere Comptche fire was on the head waters of the Albion and was well fed by many years of tie making. It about wiped out Haslett Ridge along with the Cameron ranch where I spent so many boyhood days. On Big River and farther back were logging camps at intervals.

Ed Boyles camps were well known to Coasters as were those of the Mallorys and Al Johnson. The logs in these camps were tiered up in the river and were supposed to go out with the first real high water. These high waters were known as freshets. The movements of the logs was of great interest to Coast people, for the living of many families depended on those logs getting to the mill-pond.

There was surprising little damage to the river banks by those log runs because the willows and alders just flattened down and then came back upright when the winter was over.

On Big River the logs were stopped by bulkheads at the "Boom" about three miles up the river and almost at the end of tidewater and then rafted down by the "Maru". There many well remembered men that worked on the rafting.

The Historical Society has many booklets dealing with this period of Mendocino County history and pictures too of big logs and high spidery railroad trestles. They are of very moderate cost and the money earned goes into the Museum Fund.

Well anyway, those logs came down Big River on the train from Boles Camp at the Lagoon and nearby areas. This was about 1907 or eight. The cars ran out on a long trestle and at first were rolled off by jack screws. It was not a healthy operation. Then some one got a real bright idea.

They slanted the track toward the water and when the train came in they would switch the engine to the rear, take off the binders (carefully) and then the engine shoved the loaded cars out on the slanted trestle. There would be a grand cascade of logs into the river. These logs were added to those that came down on the freshet and would be enough altogether for a year's run of the mill and the cause of much prosperity, in the town.

Lou Poland lived at the Boom and George Jarvis and Percy Daniels ran the Maru. Over the years many other local men worked on the river. The Maru was a little squaw scow with a paddle wheel on the stern and a donkey engine for power. One time at the mill a man told me he turned all the bolts and nuts on that paddle wheel, and by hand. There were hundreds of them.

The logs would be in a big jam at the Boom and the pile was a mile or more long. The men worked on the out going tide and the logs would be worked loose at the lower end then roped together cross-ways and the current would keep the raft heading down river.

Each log had a wooden peg driven in and the connecting line half hitched around each one and a longer and heavier line would run the length of the raft. When they had the raft made up they would go with the tide and when it turned, the raft would be tied up to wait the next outgoing tide. It took a day or two and maybe more to get the raft to the log-pond where Mr. Brien and his men took over.

At first the logs were short and ready for the mill but later on they brought in long logs and sawed them in the pond to the required length with a gas powered drag saw. Mr. Simon Fraser ran that saw and I was there the first day it worked. Mr. Fraser had on slick shoes and spent a lot of his time climbing out of the water. It was very funny to a small boy

I got him by some grassy tussocks and I still remember how he came flopping out; I really set back on him.

Since then and after the Highway was built down the river I have been there many times. Always in the fall I could hardly wait for the hook-bills to start

One coldy windy morning the fish were biting like wolves, and I caught my limit of three; right in front of a game Warden who was casting from the bank. North of the river mouth is Blacksmith Rock, it was a fine place for rock-fishing, although that part of the beach is not quite as accessible as the south part

That was a favorite place with Jim Peterson and the Dutro Boys. I saw Marion "Kid" Dutro land a 14 lb. bull-head there one day. It had a legal sized abalone inside; besides a lot of odds and ends.

Ralph Brown and I used to do a lot of fishing there. Ralph would start fishing while I tended to the abalones first. Ralph would nevertake more than one he said that was all he and Millie needed.

The Navarro Beach

Some of the folks down by Navarro by the Sea, have been pretty much interested in the mouth of the Navarro River. Anderson Valley people should hope that any differences are amicably settled, and with Justice to all paries; because they all like to go down there and further; it was Anderson Valley's soil that made the beach in the first place.

I was down there yesterday, there was no one around, but I was welcomed by some very arrogant bantam roosters and some friendly dogs. The ocean was muddy for more than a mile out with more A. V. soil fresh down from the hills.

Through the coming years, if things don't change on the water-shed; there is going to be a lot more go down there and part of it will go to furher filling up the river So, if looks like Anderson Valley has a very definite interest in the well-being of Navarro by the Sea, and its beautiful mountain sides; to say nothing of the sand beach itself.—My first visit to the Navarro was more than unforgettable; I was about nine years old at the time.

My father decided we would go down there trout fishing. The night before there was the big deal of getting some hooks and lines from the Jarvis and Nichols store across the street, and digging a good supply of worms. We left very early in the morning, as we went by horses and cart and the trip would take nearly three hours.

We started fishing at the mill, and there I wanted to stay, as the water there was alive with "shiners"; a small perch like fish, and they were biting. However we went on up river, the going was pretty slow on account of the vines and brush. We came upon a boat and tried it out for a little but leaked badly and soon sank; but no harm as the river had become more shallow.

As I remember we caught quite a few trout, and I was head-man with a 14 incher.

The Navarro Beach itself is a favorite with Valley people, it is or was of easy access and a good place for picnics. As I remember at that time we had to walk a little way from the hotel; and also it seems to me that most everyone was careful about litter. There were few enough people then that litter could be buried.

It is quite evident now-a-days that there is too much of it for that method of disposal. Far too many dispose of their litter by just walking away from it.

Also, with the amount of travel, these days, there is the problem of rest rooms; along with a water supply. The parking area is not very large, and there are but few

RWQCB
REGION 1

OCT - 4 2001

☐ SAW ____ ☐ CRJ ____ ☐
☐ RLT ____ ☐ LGR ____ ☐ KAD ____
☐ FCR ____ ☐ RSG ____ ☐ ____

NAME OF STREAM Greenwood Creek

REMARKS—GENERAL ESTIMATE—RECOMMENDED MANAGEMENT

continue to manage as a spawning + nursery for steelhead

A good place to stock with the fish from fish rescue

NAME OF SURVEYOR

88864 12-58 1M SPO

Field F

California Department of Fish and Game

STREAM SURVEY

NAME OF STREAM Greenwood Creek CO. Mendo

DATE 9-13-66 EXTENT OBSER. drive 3 mile up walk next 3 mi up

TRIB. TO Pacific Ocean

RELATION TO OTHER WATERS

WATERSHED AND IMMED. DRAINAGE BASIN (Type: Terrain; Soil; Cultivation; Vegetation; Shade) V shaped at head - U shaped for last 5 mi redwoods

WIDTH 15-100' ave 30'

DEPTH 9"-6' ave 18"

FLOW 66 cfs at mouth (est)

VELOCITY rapid thru out

BOTTOM (Bedrock, Boulder, Rubble, Gravel, Sand, Mud, Silt, Organic Debris) 10% / 15% / 25% / 40% / 10% /

SPAWNING AREAS good & bountiful ē gravel pea sized - 2" loose not silted in at all

POOLS 50% 50% riffles well shaded long deep pools - formed by action of current 40' wide 70' long 2'-6' deep

SHELTER some logs - under cut banks mostly shade from trees on bank

FG 734

AME OF STREAM Greenwood Creek

ARRIERS AND DIVERSIONS None were noted some logs had fallen into stream due to logging no problem accessible to fish for 2C stream miles

OOD Flying insects were abundant

STATION DATA

TATIONS	No. 1	No. 2	No. 3
Location of Station	Mouth		
Width	20'		
Depth	8" ave		
Bottom	rubble		
Spawn. Area	none		
Flow	6 cfs		
Velocity	T C (R) S	T C R S	T C R S
Stream Condition	muddy due to rain		
Water Temp.			
Air Temp.			
Time and Date	9-13 - 1330		
Weather	Sunny		
Altitude	sea level		

TATIONS	No. 4	No. 5	No. 6
Location of Station			
Width			
Depth			
Bottom			
Spawn. Area			
Flow			
Velocity	T C R S	T C R S	T C R S
Stream Condition			
Water Temp.			
Air Temp.			
Time and Date			
Weather			
Altitude			

NAME OF STREAM Greenwood Creek

FISH PRESENT: Species SH/RT

Size

Abundance

Success

Condition

Nat. Propagation

Other Remarks Stream too muddy due to recent rain to see many fish - some small fry were seen

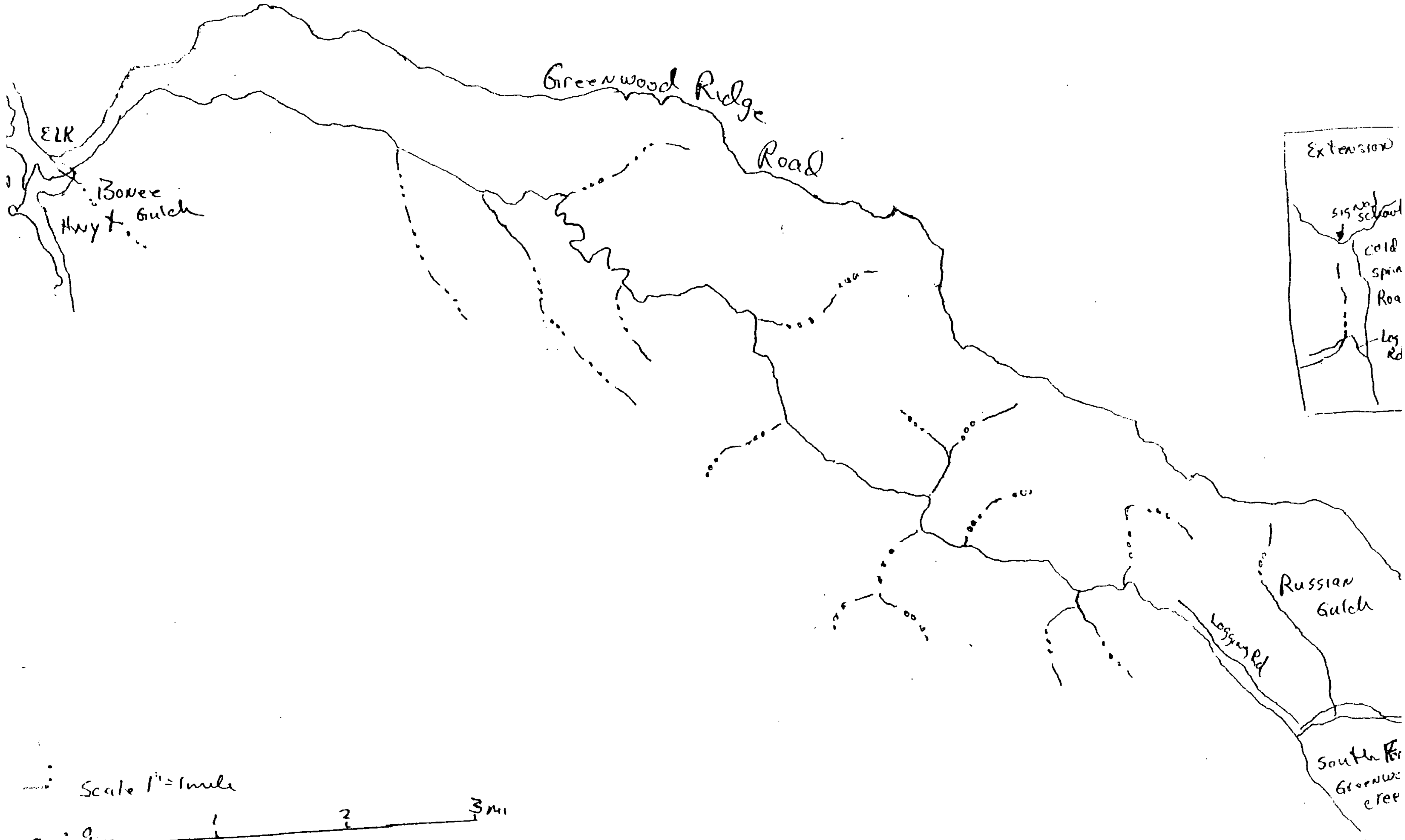
FISHING INTENSITY: lite - moderate

ACCESSIBILITY AND REMARKS ON ROUTE (Road or Trail, Mileage and Time) A logging road - entrance thru mill at Elk accessible by car 2 mi. jeeps can go further - An abandoned log road can be followed on foot due to washouts. most of way to ~~sea~~ head

ADDITIONAL DATA (Aquatic Plants, Winter Conditions, Pollution, Springs, Other Vertebrates, Other Recreational Use, Ownership, Posted or Open, Past Stocking, Other Names, Names and Accuracy of Maps, Sketch Map, Photograph, Other References.)

Moss was seen - no pollution
springs were very numerous
posted - except at mouth
past stocking - none known

Greenwood Creek



From Navarro Quad 15 min

CALIFORNIA DEPARTMENT OF FISH AND GAME

STREAM SURVEY

FILE FORM No.

NAME GREENWOOD CREEK COUNTY Mendocino

STREAM SECTION FROM mouth / headwaters TO 4 miles upstream, and 1.2 miles below falls(approx. 5.5 m LENGTH 9.5 mile

TRIBUTARY TO Pacific Ocean TWP. 14N R. 17W SEC. 35

OTHER NAMES none known RIVER SYSTEM Greenwood Creek

SOURCES OF DATA Personal observations, local warden, Larry Redfern, and local residents.

EXTENT OF OBSERVATION
Include Name of Surveyor, Date, Etc.
LOCATION
RELATION TO OTHER WATERS
GENERAL DESCRIPTION
Watershed
Immediate Drainage Basin
Altitude (Range)
Gradient
Width
Depth
Flow (Range)
Velocity
Bottom
Spawning Areas
Pools
Shelter
Barriers
Diversions
Temperatures
Food
Aquatic Plants
Winter Conditions
Pollution
Springs
FISHES PRESENT AND SUCCESS
OTHER VERTEBRATES
FISHING INTENSITY
OTHER RECREATIONAL USE
ACCESSIBILITY
OWNERSHIP
POSTED OR OPEN
IMPROVEMENTS
PAST STOCKING
GENERAL ESTIMATE
RECOMMENDED MANAGEMENT
SKETCH MAP
REFERENCES AND MAPS

EXTENT OF OBSERVATION - On April 13, 1966, Dave Netherby and Kevin Rockwood drove up this creek 2 miles from the mouth. We then walked upstream an additional 2 miles. On April 14, 1966, we drove up to the headwaters and drove along the stream for 5.5 miles from the headwaters.

LOCATION - From the mouth of the River to 4 miles upstream and from the headwaters to 1.2 miles below the falls.

RELATION TO OTHER WATERS - Greenwood Creek is an important spawning and nursery area for steelhead and silver salmon. It is accessible to anadromous fish for approximately 12 stream miles, for the stream runs continually up to Russian Gulch, 2 miles from the ~~mouth~~ headwaters.

GENERAL DESCRIPTION -

Watershed - The watershed area consists of first and second growth redwood forests with a few meadows interspersed. Vegetation consists of redwoods, alder and brush along the banks.

Immediate Drainage Basin - The basin ranges from a steep V-shaped canyon to a wide U-shaped canyon. The stream discharges in a WNW direction. The bottom is chiefly a flattened lens-shape throughout most of the area. The vegetation on the stream side edges is abundant, consisting of brush and grasses.

Altitude - The altitude ranges from sealevel at the mouth to 1,600 feet at the headwaters.

Gradient - Moderate.

Width - The width varies from 2 feet at the headwaters to 100 feet at the mouth, with the average through out the accessible stream being 25 feet.

Depth - Range from 6 inches at the headwaters to 8 feet at the mouth. The average depth for riffles is 12 inches, for pools is 2 feet.

Flow - Continual throughout the year. It was estimated at 66 cfs at the mouth following several days of rain.

Velocity - Rapid throughout.

Bottom - The bottom consists of bedrock (10%), boulder (10%), rubble (30%), gravel (35%), sand (10%), and mud and silt (5%).

Spawning areas - Excellent and abundant with long stretches of loose gravel from pea sized to 2 inches. The spawning areas do appear to be better suited for Steelhead, for most of the gravel is pea-sized.

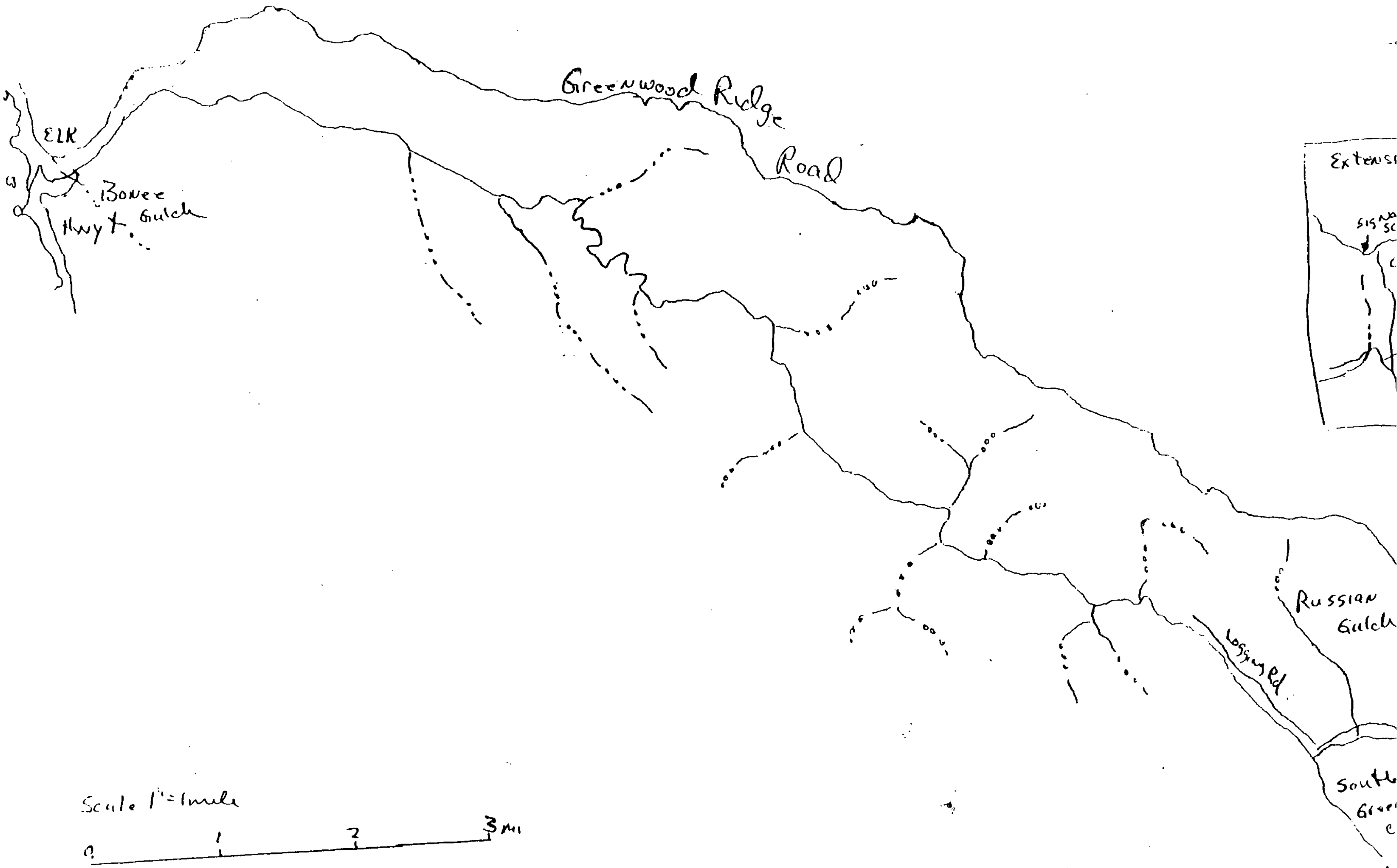
Pools - The pools average 40 feet wide, 60 feet long, and 2 feet deep.. They are caused by digging action of the current flowing around or over boulders and log jams. They are shaded from above by the alder and redwood, which line the banks. Overhanging logs and brush also offer shelter. The frequency is - pools-60%, riffles-40%.

Shelter - The shelter along the pool consists of boulders, overhanging logs, undercut banks and overhanging terrestrial plants. These cover approximately 50% of the creek as a whole and 75% of the pools.

FG 712

Barriers - A series of three falls - 12 feet, 5 feet, and 15 feet constitute the upstream barrier to anadromous fish 2 miles below Russian Gulch or 4 miles from the headwaters.
A log jam ½ mile below these falls are a partial barrier to anadromous fish. This log jam is approximately 25 yards long. Three log jams in the 1¼ mile above the falls offer potential barriers, but are unimportant since they are above the upstream limits.
Three photographs were taken of the falls and one was taken of the log jam below the falls.
Diversion - None observed.
Aquatic Plants - Green and brown algae, watercress and watermint make up the majority of the aquatic plants.
Winter Conditions - Unknown.
Pollution - None observed.
Springs - Springs are abundant throughout the entire length of Greenwood Creek, averaging 6-8 per mile.
FISHES PRESENT AND SUCCESS - Steelhead and silver salmon use this creek as a spawning and nursery area. However local residents state that very few were observed during the past year. The water was too muddy due to recent rains to see very well.
Local residents state that native trout also live in Greenwood Creek.
OTHER VERTEBRATES - Sheep, deer, frogs, salamanders, coons, snakes, and predatory birds reside in the area.
FISHING INTENSITY - Moderate to heavy. This is one of the better Steelhead streams in the area.
ACCESSIBILITY - Greenwood Creek is accessible by car for approximately 3 miles from the mouth by a logging road. This road is accessible by foot for most of the length of the stream with a few washouts. This road is what used to be the railroad bed back in 1902 when this area was first logged. The logging road can be approached by driving through the sawmill in Elk.
The headwaters can be approached by taking the Greenwood Ridge Road to the Cold Springs Road and then turning west on a logging road. This road is accessible by car for several miles, but a 4-wheel drive jeep would be able to go much further. It is accessible by foot down to the mouth.
OWNERSHIP - Most of this land is owned by the Crofoot Brothers of Ukiah, California and all of the land from ½ mile from the mouth is posted.
PAST STOCKING - None Known.
GENERAL ESTIMATE AND RECOMMENDED MANAGEMENT - Greenwood Creek is an excellent spawning and nursery area for Steelhead and salmon and should continue to be managed as such. Removal of existing log jams and supervision of logging in the area is recommended.

Greenwood Creek



From Navarro Quad 15MIN

FROM DFG PETITION TO BOF TO LIST COHO SALMON AS A SENSITIVE SPECIES.

TABLE 1

List of streams historically known to produce coho salmon. Type of evidence (SS = stream survey, FR = fish rescue operation, CC = carcass count, AT = adult trap, JT = juvenile trap, LIT = literature search, OT = other), and source. Streams were listed as they occur on the California coast from north to south. Only the most recent field sighting was included. Compilations of file reports and personal communications were only cited when no other source was available. Numbers of fish sighted are described in Appendix B and B-1. Hatchery returns are not included. Sources followed by an asterisk were obtained from the Preserve Design Diversity Database (1989) maintained at U.C. Davis by Peter Moyle, rather than directly from the source listed. This entire table comes from Brown and Moyle (1991a).

Drainage	Stream	Method	Source
SF Winchuck River	SF Winchuck River	FR	Shapovalov 1940
Illinois River			
WF Illinois River	Broken Kettle Creek	LIT	Hassler 1988
WF Illinois River	Elk Creek	LIT	Hassler 1988
EF Illinois River	Dunn Creek	SS	P. Moyle, unpubl. data
Smith River	Smith River	LIT	Hassler 1988
	Rowdy Creek	FR	Kimsey 1953
Rowdy Creek	Dominic Creek	LIT	Hassler 1988
Rowdy Creek	Savoy Creek	LIT	Hassler 1989
Rowdy Creek	Copper Creek	LIT	Hassler 1988
	Morrison Creek	FR	Kimsey 1953
	Jaqua Creek	OT	Hallock et al. 1952
	Mill Creek	OT	Hallock et al. 1952
Mill Creek	EF Mill Creek	LIT	Hassler 1988
Mill Creek	WF Mill Creek	LIT	Hassler 1988
Mill Creek	Bummer Lake Creek	SS	Burns 1971
	MF Smith River	LIT	Hassler 1988
MF Smith River	Hardscrabble Creek	LIT	Hassler 1988
MF Smith River	Myrtle Creek	LIT	Hassler 1988
MF Smith River	NF Smith River	LIT	Hassler 1988
NF Smith River	Peridotite Creek	LIT	Hassler 1988
NF Smith River	Still Creek	LIT	Hassler 1988
NF Smith River	Diamond Creek	LIT	Hassler 1988

MF Smith River	Eighteen Mile Creek	LIT	Hassler 1988
MF Smith River	Patrick Creek	LIT	Hassler 1988
Patrick Creek	Twelve Mile Creek	LIT	Hassler 1988
Patrick Creek	Shelly Creek	LIT	Hassler 1988
Patrick Creek	Eleven Mile Creek	LIT	Hassler 1988
Patrick Creek	Ten Mile Creek	LIT	Hassler 1988
Patrick Creek	WF Patrick Creek	LIT	Hassler 1988
MF Smith River	Monkey Creek	LIT	Hassler 1988
MF Smith River	Siskiyou Fork	LIT	Hassler 1988
MF Smith River	Packsaddle Creek	LIT	Hassler 1988
MF Smith River	Griffin Creek	LIT	Hassler 1988
MF Smith River	Knopki Creek	LIT	Hassler 1988
	SF Smith River	LIT	Hassler 1988
SF Smith River	Craigs Creek	LIT	Hassler 1988
SF Smith River	Coon Creek	LIT	Hassler 1988
SF Smith River	Hurdy Gurdy Creek	SS	P. Moyle, unpubl. data
SF Smith River	Jones Creek	LIT	Hassler 1988
Jones Creek	Muzzle Loader Creek	LIT	Hassler 1988
SF Smith River	Buck Creek	LIT	Hassler 1988
SF Smith River	Quartz Creek	LIT	Hassler 1988
SF Smith River	Eight Mile Creek	LIT	Hassler 1988
Eight Mile Creek	Williams Creek	LIT	Hassler 1988
SF Smith River	Prescott Fork	LIT	Hassler 1988
Coastal (Lake Earl)	Jordan Creek	OT	Hallock et al.1952
Coastal (Lake Earl)	Yonkers Creek	LIT	Hassler 1988
Coastal	Elk Creek	LIT	Hassler 1988
Coastal	Wilson Creek	FR	Kimsey 1953
Klamath River	Estuary	OT	Gibbs and Kimsey 1955
	Hunter Creek	FR	Kimsey 1953
Hunter Creek	Salt Creek	LIT	Hassler 1988
Salt Creek	High Prairie Creek	FR	Kimsey 1953
Hunter Creek	Mynot Creek	FR	Kimsey 1953
	Richardson Creek	LIT	Hassler 1988
	Saugep Creek	LIT	Hassler 1988
	Waukell Creek	LIT	Hassler 1988
	Hoppaw Creek	FR	Kimsey 1953
	Turwar Creek	FR	Kimsey 1953
	McGarvey Creek	OT	Hallock et al.1952

Table 1. continued

Drainage	Stream	Method	Source
	Tarup Creek	LIT	Hassler 1988
	Omagar Creek	LIT	Hassler 1988
	Blue Creek	LIT	Hassler 1988
Blue Creek	WF Blue Creek	LIT	Hassler 1988
Blue Creek	Nickowitz Creek	LIT	Hassler 1988
Blue Creek	Crescent City Fork	LIT	Hassler 1988
	Ah Pah Creek	LIT	Hassler 1988
Ah Pah Creek	SF Ah Pah Creek	SS	D. McCleod, unpubl. data
	Bear Creek	LIT	Hassler 1988
	Tectah Creek	LIT	Hassler 1988
	Pecwan Creek	LIT	Hassler 1988
	Mettah Creek	LIT	Hassler 1988
	Roach Creek	LIT	Hassler 1988
	Miner's Creek	LIT	Hassler 1988
	Pine Creek	LIT	Hassler 1988
Pine Creek	Little Pine Creek	LIT	Hassler 1988
	Bluff Creek	LIT	Hassler 1988
	Slate Creek	LIT	Hassler 1988
	Red Cap Creek	LIT	Hassler 1988
	Boise Creek	LIT	Hassler 1988
	Irving Creek	SS	A. Olson, unpubl. data
	Camp Creek	LIT	Hassler 1988
	Dillon Creek	LIT	Hassler 1988
	Ukonom Creek	LIT	Hassler 1988
	Independence Creek	SS	A. Olson, unpubl. data
	Clear Creek	LIT	Hassler 1988
	Elk Creek	LIT	Hassler 1988
Elk Creek	EF Elk Creek	SS	A. Olson, unpubl. data
	Indian Creek	LIT	Hassler 1988
Indian Creek	SF Indian Creek	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
Indian Creek	EF Indian Creek	LIT	A. Olson, unpubl. data
Indian Creek	Mill Creek	SS	A. Olson, unpubl. data
	China Creek	SS	D. Maria, unpubl. data*
	Thompson Creek	LIT	Hassler 1988
	Seiad Creek	LIT	Hassler 1988
	Grider Creek	SS	D. Maria, unpubl. data*
Grider Creek	West Grider Creek	LIT	Hassler 1988
	Horse Creek	LIT	Hassler 1988
Horse Creek	Buckhorn Creek	LIT	Hassler 1988
Horse Creek	Middle Creek	LIT	Hassler 1988
Horse Creek	Salt Gulch	LIT	Hassler 1988
	Barkhouse Creek	LIT	Hassler 1988
	Beaver Creek	LIT	D. Maria, unpubl. data*
	Humbug Creek	LIT	Hassler 1988
	Cottonwood Creek	LIT	Hassler 1988
	Shasta River	LIT	Hassler 1988
Shasta River	Big Springs Creek	LIT	Hassler 1988
	Willow Creek	LIT	Hassler 1988
	Bogus Creek	LIT	Hassler 1988
	Shasta River	AT	Coots 1958
	Klamathon Racks	AT	Bryant 1937
	Fall Creek	OT	Coots 1957
<u>Trinity River (trib. to Klamath River)</u>	Trinity River	LIT	Hassler 1988
	Scottish Creek	LIT	Hassler 1988
	Mill Creek	LIT	Hassler 1988
	Hostler Creek	LIT	Hassler 1988
	Supply Creek	LIT	Hassler 1988
	Campbell Creek	LIT	Hassler 1988
	Tish Tang A Tang C	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
	Horse Linto Creek	SS	P. Moyle, unpubl. data
	Willow Creek	LIT	Hassler 1988
	SF Trinity River	LIT	Hassler 1988
SF Trinity River	Eltapom Creek	LIT	Hassler 1988
SF Trinity River	Pelletreu Creek	LIT	Hassler 1988
SF Trinity River	Hayfork Creek	LIT	Hassler 1988
Hayfork Creek	Olsen Creek	LIT	Hassler 1988
SF Trinity River	Butter Creek	LIT	Hassler 1988
SF Trinity River	Rattlesnake Creek	LIT	Hassler 1988
	New River	LIT	Hassler 1988
	Manzanita Creek	LIT	Hassler 1988
	NF Trinity River	LIT	Hassler 1988
EF NF Trinity R.	Indian Creek	LIT	Hassler 1988
	Canyon Creek	LIT	Hassler 1988
	Browns Creek	LIT	Hassler 1988
	Rush Creek	SS	D. Painter, pers. comm.*
	Deadwood Creek	LIT	Hassler 1988
<u>Salmon River</u>	Salmon River	LIT	Hassler 1988
<u>(trib. to Klamath</u>	Wooley Creek	LIT	Hassler 1988
<u>River)</u>	Nordheimer Creek	LIT	Hassler 1988
	NF Salmon River	LIT	Hassler 1988
NF Salmon River	North Russian Cr.	LIT	Hassler 1988
NF Salmon River	South Russian Cr.	LIT	Hassler 1988
	SF Salmon River	LIT	Hassler 1988
SF Salmon River	Knownothing Creek	LIT	Hassler 1988
SF Salmon River	Methodist Creek	LIT	Hassler 1988
SF Salmon River	EF SF Salmon River	SS	D. Maria, pers. comm.*
EF SF Salmon R.	Taylor Creek	LIT	Hassler 1988
<u>Scott River</u>	Tomkins Creek	LIT	Hassler 1988
<u>(trib. to Klamath</u>	Kelsey Creek	LIT	Hassler 1988
<u>River)</u>	Canyon Creek	LIT	Hassler 1988
	Shackleford Creek	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
Shackleford Creek	Mill Creek	LIT	Hassler 1988
	Kidder Creek	LIT	Hassler 1988
Kidder Creek	Patterson Creek	LIT	Hassler 1988
	Etna Creek	LIT	Hassler 1988
	French Creek	LIT	Hassler 1988
French Creek	Miners Creek	LIT	Hassler 1988
	Sugar Creek	LIT	Hassler 1988
	EF Scott River	LIT	Hassler 1988
EF Scott River	Big Mill Creek	LIT	Hassler 1988
	SF Scott River	LIT	Hassler 1988
Redwood Creek	Redwood Creek	FR	Kimsey 1953
	Prairie Creek	FR	Kimsey 1952
Prairie Creek	Little Lost Man Cr.	OT	Hallock et al. 1952
Prairie Creek	Lost Man Creek	OT	Hallock et al. 1952
Prairie Creek	May Creek	OT	Hallock et al. 1952
Prairie Creek	Godwood Creek	SS	Burns 1971
Prairie Creek	Boyes Creek	OT	Hallock et al. 1952
Prairie Creek	Browns Creek	LIT	Hassler 1988
Prairie Creek	Streelow Creek	LIT	Hassler 1988
	Tom McDonald Creek	LIT	Hassler 1988
	Bridge Creek	LIT	Hassler 1988
	Coyote Creek	LIT	Hassler 1988
	Panther Creek	LIT	Hassler 1988
	Lacks Creek	LIT	Hassler 1988
Big Lagoon	Big Lagoon	OT	Bailey and Kimsey 1952
Stone Lagoon	McDonald Creek	FR	Kimsey 1953
	Fresh Creek	LIT	Hassler 1988
Little River	Little River	OT	Hallock et al. 1952
	SF Little River	LIT	Hassler 1988
SF Little River	Lower SF Little R.	LIT	Hassler 1988
SF Little River	Upper SF Little R.	LIT	Hassler 1988
Coastal	Strawberry Creek	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
Mad River	Mad River	FR	Kimsey 1952
	Warren Creek	LIT	Hassler 1988
	Lindsay Creek	OT	Hallock et al. 1952
Lindsay Creek	Squaw Creek	FR	Kimsey 1953
Lindsay Creek	Grassy Creek	OT	Hallock et al. 1952
Lindsay Creek	Mather Creek	LIT	Hassler 1988
	Hall Creek	LIT	Hassler 1988
Hall Creek	Mill Creek	LIT	Hassler 1988
Hall Creek	Noisy Creek	OT	Hallock et al. 1952
	Camp Bauer Creek	OT	Hallock et al. 1952
	Leggit Creek	LIT	Hassler 1988
Leggit Creek	Kelly Creek	LIT	Hassler 1988
	Powers Creek	LIT	Hassler 1988
	Quarry Creek	LIT	Hassler 1988
Quarry Creek	Palmer Creek	LIT	Hassler 1988
	NF Mad River	FR	Shapovalov 1940
NF Mad River	Sullivan Creek	LIT	Hassler 1988
NF Mad River	Long Prairie Creek	LIT	Hassler 1988
	Dry Creek	LIT	Hassler 1988
	Cañon Creek	SS	L. Preston, unpubl. data
	Maple Creek	LIT	Hassler 1988
	Black Creek	LIT	Hassler 1988
	Boulder Creek	LIT	Hassler 1988
Humboldt Bay	Janes Creek	OT	Hull 1987
	Jolly Giant Creek	OT	Hull 1987
	Jacoby Creek	OT	Hull 1987
	Rocky Gulch Creek	LIT	Hassler 1988
	Cochran Creek	OT	Hull 1987
	Freshwater Creek	OT	Hull 1987
Freshwater Creek	Ryan Creek	LIT	Hassler 1988
Freshwater Creek	McCready Gulch	LIT	Hassler 1988
Freshwater Creek	Little Freshwater C	LIT	Hassler 1988
Freshwater Creek	Cloney Gulch	LIT	Hassler 1988
Cloney Gulch	Falls Gulch	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
Freshwater Creek	Graham Gulch	LIT	Hassler 1988
	Martin Slough	LIT	Hassler 1988
	Elk River	OT	Hallock et al. 1952
Elk River	NF Elk River	LIT	Hassler 1988
Elk River	SF Elk River	LIT	Hassler 1988
SF Elk River	Little SF Elk River	LIT	Hassler 1988
	College of Redwoods Creek	LIT	Hassler 1988
	Salmon Creek	LIT	Hassler 1988
Eel River	estuary	OT	Puckett 1977
	below Van Duzen R.	OT	Murphy and DeWitt 1951
	Salt River	SS	Mills 1983
Salt River	Russ Creek	LIT	Hassler 1988
Salt River	Reas Creek	SS	Mills 1983
	Rohner Creek	SS	Mills 1983
	Price Creek	FR	Shapovalov 1941
	Howe Creek	SS	Mills 1983
Howe Creek	Atwell Creek	SS	Mills 1983
	Dinner Creek	FR	Shapovalov 1940
	Jordan Creek	OT	Hallock et al. 1952
Eel River	near Pepperwood	FR	Shapovalov 1940
	Shively Creek	SS	Mills 1983
	Bear Creek	CC	G. Flosi, unpubl. data
	Chadd Creek	CC	G. Flosi, unpubl. data
	Larabee Creek	SS	Mills 1983
Larabee Creek	Carson Creek	CC	G. Flosi, unpubl. data
	Newman Creek	FR	Shapovalov 1940
	Jewett Creek	SS	Mills 1983
	Kekawaka Creek	LIT	Hassler 1988
	Outlet Creek	CC	G. Flosi, unpubl. data

Table 1. continued

Drainage	Stream	Method	Source
Outlet Creek	Bloody Run Creek	SS	W. Jones, pers. comm.
Outlet Creek	Long Valley Creek	CC	Brown and Moyle 1991
Outlet Creek	Reeves Canyon Creek	CC	G. Flosi, unpubl. data
Outlet Creek	Ryan Creek	CC	G. Flosi, unpubl. data
Outlet Creek	Rowes Creek	SS	W. Jones, pers. comm.
Outlet Creek	Mill Creek	SS	W. Jones, pers. comm.
Mill Creek	Willits Creek	CC	G. Flosi, unpubl. data
Willits Creek	Dutch Henry Creek	SS	W. Jones, pers. comm.
Outlet Creek	Broaddus Creek	CC	G. Flosi, unpubl. data
Outlet Creek	Haehl Creek	CC	G. Flosi, unpubl. data
Outlet Creek	Baechtel Creek	CC	G. Flosi, unpubl. data
	Indian Creek	SS	Mills 1983
Tomki Creek	Rocktree Creek	SS	Mills 1983
Tomki Creek	String Creek	SS	Mills 1983
Tomki Creek	Tarter Creek	SS	Mills 1983
Van Duzen River	Van Duzen River	SS	Brown and Moyle 1991
(trib. to Eel River)	Palmer Creek	OT	Hallock et al. 1952
	Wolverton Gulch	SS	Mills 1983
	Yaeger Creek	SS	Mills 1983
Yaeger Creek	Cooper Mill Creek	OT	Hallock et al. 1952
Yaeger Creek	Wilson Creek	SS	Mills 1983

Table 1. continued

Drainage	Stream	Method	Source
Yaeger Creek	Lawrence Creek	CC	G. Flosi, unpubl. data
Lawrence Creek	Shaw Creek	CC	G. Flosi, unpubl. data
	Cuddeback Creek	FR	Shapovalov 1941
	Fielder Creek	OT	Hallock et al. 1952
	Cummings Creek	SS	Brown and Moyle 1991
	Hely Creek	OT	Hallock et al. 1952
	Root Creek	LIT	Hassler 1988
	Grizzly Creek	OT	Hallock et al. 1952
Grizzly Creek	Stevens Creek	LIT	Hassler 1988
	Hoaglund Creek	LIT	Hassler 1988
	Little Larabee Cr.	LIT	Hassler 1988
South Fork Eel River	SF Eel River	SS	Nielsen et al. 1991
(trib. to Eel River)	Bull Creek	JT	S. Downie, unpubl. data
Bull Creek	Squaw Creek	CC	G. Flosi, unpubl. data
Bull Creek	Albee Creek	LIT	Hassler 1988
Bull Creek	Mill Creek	LIT	Hassler 1988
	Canoe Creek	SS	Brown and Moyle 1991
	Bridges Creek	FR	Shapovalov 1941
	Elk Creek	FR	Shapovalov 1940
	Salmon Creek	FR	Shapovalov 1940
	Bear Butte Creek	FR	Shapovalov 1940
	Fish Creek	FR	Shapovalov 1940
	Anderson Creek	CC	G. Flosi, unpubl. data
	Dean Creek	FR	Shapovalov 1940
	Redwood Creek	JT	S. Downie, unpubl data
Redwood Creek	Seely Creek	SS	Mills 1983
Redwood Creek	Miller Creek	SS	Mills 1983

Table 1. continued

Drainage	Stream	Method	Source
Redwood Creek	China Creek	SS	Mills 1983
Redwood Creek	Dinner Creek	SS	Mills 1983
	Sprowel Creek	SS	L. Brown, pers. obs.
Sprowel Creek	Warden Creek	LIT	Hassler 1988
Sprowel Creek	Little Sprowel Cr.	LIT	L. Brown, pers. obs.
Sprowel Creek	WF Sprowel Creek	LIT	Hassler 1988
	EB SF Eel River	JT	S. Downie, unpubl. data
EB SF Eel River	Squaw Creek	SS	Mills 1983
	Durphy Creek	FR	Shapovalov 1941
	Milk Ranch Creek	SS	Mills 1983
	Low Gap Creek	SS	Mills 1983
	Indian Creek	CC	Nielsen et al. 1991
	Piercy Creek	CC	Nielsen et al. 1991
	Standley Creek	SS	Mills 1983
	McCoy Creek	SS	Mills 1983
	Bear Pen Creek	SS	Mills 1983
Bear Pen Creek	Cub Creek	SS	Mills 1983
	Red Mountain Creek	SS	Mills 1983
	Wildcat Creek	SS	Mills 1983
	Hollowtree Creek	CC	Nielsen et al. 1991
Hollowtree Creek	Mule Creek	SS	Mills 1983
Hollowtree Creek	Walters Creek	LIT	Hassler 1988
Hollowtree Creek	Redwood Creek	CC	Nielsen et al. 1991
Hollowtree Creek	Bond Creek	LIT	Hassler 1988
Hollowtree Creek	Michaels Creek	SS	Nielsen et al. 1991
Hollowtree Creek	Waldron Creek	SS	Mills 1983
Hollowtree Creek	Huckleberry Creek	SS	Nielsen et al. 1991
Hollowtree Creek	Butler Creek	SS	Nielsen et al. 1991
	Cedar Creek	LIT	Nielsen et al. 1991
	Rattlesnake Creek	SS	Mills 1983

Table 1. continued

Drainage	Stream	Method	Source
Rattlesnake Creek	Cummings Creek	SS	P. Baker, pers. comm.*
	Ten Mile Creek	CC	G. Flosi, unpubl. data
Ten Mile Creek	Grub Creek	SS	Mills 1983
Ten Mile Creek	Streeter Creek	CC	G. Flosi, unpubl. data
Ten Mile Creek	Big Rock Creek	SS	Mills 1983
Ten Mile Creek	Mud Springs Creek	SS	Mills 1983
Ten Mile Creek	Mill Creek	SS	Mills 1983
Ten Mile Creek	Cahto Creek	SS	Mills 1983
	Fox Creek	SS	Mills 1983
	Elder Creek	SS	Brown and Moyle 1991
	Jack of Hearts Cr.	CC	Nielsen et al. 1991
	Deer Creek	SS	Mills 1983
	Little Charlie Cr.	LIT	Hassler 1983
	Dutch Charlie Creek	CC	G. Flosi, unpubl. data
	Redwood Creek	CC	Nielsen et al. 1991
	Kenny Creek	SS	Mills 1983
	Haun Creek	LIT	Hassler 1983
	Rock Creek	SS	Mills 1983
	Bear Creek	SS	Mills 1983
	Taylor Creek	SS	Mills 1983
Middle Fork Eel River	MF Eel River	LIT	Hassler 1988
(trib. to Eel River)	Mill Creek	SS	Mills 1983
Mill Creek	Grist Creek	SS	Mills 1983
	Rattlesnake Creek	SS	Mills 1983
NF of MF Eel River	Rock Creek	SS	Mills 1983
North Fork Eel River (trib. to Eel River)	Bluff Creek	SS	Mills 1983
Coastal	Guthrie Creek	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
Bear River	Bear River	LIT	Hassler 1988
	Bonanza Gulch	LIT	Hassler 1988
	SF Bear Creek	LIT	Hassler 1988
SF Bear Creek	Hollister Creek	LIT	Hassler 1988
Coastal	McNut Gulch	LIT	Hassler 1988
Mattole River	Mattole River	LIT	G. Peterson pers.
	NF Mattole River	LIT	Hassler 1988
	Mill Cr. (Petrolia)	LIT	Hassler 1988
	Clear Creek	LIT	Hassler 1988
	Conklin Creek	LIT	Hassler 1988
	McGinnis Creek	LIT	Hassler 1988
	Indian Creek	LIT	Hassler 1988
	Squaw Creek	LIT	Hassler 1988
	Pritchard Creek	LIT	Hassler 1988
	Granny Creek	LIT	Hassler 1988
	Saunders Creek	LIT	Hassler 1988
	Woods Creek	LIT	Hassler 1988
	Upper NF Mattole R.	LIT	Hassler 1988
			comm.
Upper NF Mattole R	Rattlesnake Creek	LIT	Hassler 1988
Upper NF Mattole R	Oil Creek	LIT	Hassler 1988
Oil Creek	Devils Creek	LIT	Hassler 1988
	Honeydew Creek	LIT	Hassler 1988
Honeydew Creek	Bear Trap Creek	LIT	Hassler 1988
	Dry Creek	LIT	Hassler 1988
	Middle Creek	LIT	Hassler 1988
	Westlund Creek	LIT	Hassler 1988
	Gilham Creek	LIT	Hassler 1988
	Fourmile Creek	LIT	Hassler 1988
	Sholes Creek	LIT	Hassler 1988
	Marrow Creek	LIT	Hassler 1988
	Grindstone Creek	LIT	Hassler 1988
	Mattole Canyon	LIT	Hassler 1988
	Blue Slide Creek	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
	Bear Creek	LIT	Hassler 1988
Bear Creek	SF Bear Creek	SS	L. Preston, unpubl. data
	Big Finley Creek	LIT	Hassler 1988
	Eubank Creek	LIT	Hassler 1988
	Bridge Creek	LIT	Hassler 1988
	McKee Creek	LIT	Hassler 1988
	Vanbankin Creek	LIT	Hassler 1988
	Mill Creek	LIT	Hassler 1988
	Baker Creek	LIT	Hassler 1988
	Thompson Creek	LIT	Hassler 1988
<u>Coastal</u>	Whale Gulch Creek	OT	Sommerstrom 1984
<u>Coastal</u>	Indian Creek	OT	Murphy 1950
<u>Coastal</u>	Jackass Creek	OT	Sommerstrom 1984
<u>Coastal</u>	Usal Creek	FR	Kimsey 1953
Cottoneva Creek	Cottoneva Creek	OT	Sommerstrom 1984
	SF Cottoneva Creek	LIT	Hassler 1988
	NF Cottoneva Creek	LIT	Hassler 1988
<u>Coastal</u>	Hardy Creek	OT	Sommerstrom 1984
<u>Coastal</u>	Juan Creek	OT	Sommerstrom 1984
	Little Juan Creek	LIT	Hassler 1988
<u>Coastal</u>	Howard Creek	SS	T. Taylor, unpubl. data*
<u>Coastal</u>	DeHaven Creek	OT	Murphy 1950
<u>Coastal</u>	Wages Creek	OT	Sommerstrom 1984
<u>Ten Mile River</u>	Ten Mile River	OT	Sommerstrom 1984
	NF Ten Mile River	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
NF Ten Mile River	Mill Creek	LIT	Hassler 1988
NF Ten Mile River	Little NF Ten Mile	LIT	Hassler 1988
	SF Ten Mile River	LIT	Hassler 1988
SF Ten Mile River	Smith Creek	LIT	Hassler 1988
SF Ten Mile River	Campbell Creek	LIT	Hassler 1988
SF Ten Mile River	Churchman's Creek	LIT	Hassler 1988
SF Ten Mile River	Redwood Creek	CC	Nielsen et al. 1991
	MF Ten Mile River	LIT	Hassler 1988
MF Ten Mile River	Bear Haven Creek	LIT	Hassler 1988
Pudding Creek	Pudding Creek	CC	Nielsen et al. 1991
	Little Valley Creek	LIT	Hassler 1988
Noyo River	Noyo River	CC	Nielsen et al. 1991
	SF Noyo River	LIT	Nielsen et al. 1991
SF Noyo River	Kass Creek	LIT	Nielsen et al. 1991
SF Noyo River	NF SF Noyo River	CC	Nielsen et al. 1991
SF Noyo River	Parlin Creek	CC	Nielsen et al. 1991
	Little NF Noyo R.	SS	Burns 1971
	Duffy Gulch	LIT	Hassler 1988
	NF Noyo River	LIT	Hassler 1988
NF Noyo River	Marble Gulch	LIT	Hassler 1988
NF Noyo River	Haysworth Creek	LIT	Hassler 1988
NF Noyo River	MF NF Noyo River	LIT	Hassler 1988
	Olds Creek	LIT	Hassler 1988
	Redwood Creek	LIT	Hassler 1988
Hare Creek			
Hare Creek	SF Hare Creek	LIT	Hassler 1988
	Bunker Gulch Creek	LIT	Hassler 1988
Coastal	Jug Handle Creek	SS	T. Taylor, unpubl. data*
Caspar Creek	SF Caspar Creek	CC	Nielsen et al. 1991
	NF Caspar Creek	SS	Nielsen et al. 1991
Coastal	Doyle Creek	LIT	Hassler 1988
Coastal	Russian Gulch	OT	Bartley et al. 1991

Table 1. continued

Drainage	Stream	Method	Source
Big River	Big River	OT	Sommerstrom 1984
	Little NF Big River	LIT	Hassler 1988
Little NF Big River	EB Little NF Big R	LIT	Hassler 1988
Little NF Big River	Berry Gulch	LIT	Hassler 1988
	Two Log Creek	LIT	Hassler 1988
	Tramway Gulch	LIT	Hassler 1988
	NF Big River	LIT	Hassler 1988
NF Big River	EB NF Big River	LIT	Hassler 1988
NF Big River	Chamberlain Creek	LIT	Hassler 1988
Chamberlain Creek	Arvola Gulch	LIT	Hassler 1988
NF Big River	James Creek	LIT	Hassler 1988
James Creek	NF James Creek	LIT	Hassler 1988
	SF Big River	LIT	Hassler 1988
SF Big River	Ramon Creek	CC	Nielsen et al.1991
SF Big River	Daugherty Creek	LIT	Hassler 1988
Daugherty Creek	Johnson Creek	LIT	Hassler 1988
Coastal	Little River	LIT	Hassler 1988
Coastal	Buckhorn Creek	LIT	Hassler 1988
Albion River	Albion River	OT	Sommerstrom 1984
	SF Albion River	LIT	Hassler 1988
	Railroad Gulch	LIT	Hassler 1988
	NF Albion River	LIT	Hassler 1988
	Marsh Creek	LIT	Hassler 1988
Big Salmon Creek	Big Salmon Creek	LIT	Hassler 1988
	Little Salmon Cr.	LIT	Hassler 1988
	Hazel Gulch	LIT	Hassler 1988
Navarro River	Navarro River	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
	NF Navarro River	LIT	Hassler 1988
NF Navarro River	NF Flynn Creek	LIT	Hassler 1988
NF Navarro River	SB NF Navarro R.	LIT	Hassler 1988
SB NF Navarro River	Bridge Creek	LIT	Hassler 1988
NF Navarro River	NB NF Navarro River	LIT	Hassler 1988
NB NF Navarro R.	Little NF Navarro	LIT	Hassler 1988
NB NF Navarro R.	John Smith Creek	LIT	Hassler 1988
	Mill Creek	LIT	Hassler 1988
	Indian Creek	LIT	Hassler 1988
Indian Creek	NF Indian Creek	LIT	Hassler 1988
Indian Creek	Gut Creek	LIT	Hassler 1988
	Indian Creek		
	Dick Creek	LIT	Hassler 1988
	Rancheria Creek	FR	Kimsey 1953
Rancheria Creek	Ham Canyon Creek	LIT	Hassler 1988
Rancheria Creek	Horse Creek	LIT	Hassler 1988
Rancheria Creek	Minnie Creek	LIT	Hassler 1988
Rancheria Creek	Camp Creek	LIT	Hassler 1988
Camp Creek	German Creek	LIT	Hassler 1988
Coastal	Greenwood Creek	LIT	Hassler 1988
Coastal	Mallo Pass Creek	LIT	Hassler 1988
Elk Creek	Elk Creek	LIT	Hassler 1988
	Three Springs Cr.	LIT	Hassler 1988
	Soda Fork	LIT	Hassler 1988
	Sulphur Fork	LIT	Hassler 1988
Coastal	Brush Creek	OT	R. Snyder,pers. comm. cited in Snider (1985)
Coastal	Garcia River	SS	Pister 1965
Schooner Gulch	Schooner Gulch	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
	NF Schooner Gulch	LIT	Hassler 1988
Coastal	Fish Rock Gulch	LIT	Hassler 1988
Coastal	Gualala	SS	Pister 1965
Gualala River	NF Gualala River	OT	Sommerstrom 1984
NF Gualala River	Doty Creek	LIT	Hassler 1988
Gualala River	SF Gualala River	LIT	Hassler 1988
SF Gualala River	Franchini Creek	LIT	Hassler 1988
SF Gualala River	Sproule Creek	LIT	Hassler 1988
SF Gualala River	Marshall Creek	LIT	Hassler 1988
Gualala River	Wheatfield Fork	LIT	Hassler 1988
Wheatfield Fork	Fuller Creek	SS	P. Baker, pers. comm.*
Wheatfield Fork	Haupt Creek	SS	P. Baker, pers. comm.*
Wheatfield Fork	House Creek	LIT	Hassler 1988
Coastal	Fort Ross Creek	SS	P. Baker, pers. comm.*
Coastal	Russian Gulch	LIT	Hassler 1988
Russian Gulch	Middle Branch	LIT	Hassler 1988
Russian Gulch	East Branch	LIT	Hassler 1988
Russian River	Russian River	LIT	Hassler 1988
	Willow Creek	SS	B. Cox, pers. comm.
	Sheephouse Creek	LIT	Hassler 1988
Sheephouse Creek	unnamed trib.	LIT	Hassler 1988
	Freezeout Creek	LIT	Hassler 1988
	Austin Creek	LIT	Hassler 1988
Austin Creek	Kidd Creek	LIT	Hassler 1988
Austin Creek	Ward Creek	SS	P. Baker, pers. comm.*

Table 1. continued

Drainage	Stream	Method	Source
Austin Creek	East Austin Creek	SS	B. Cox, pers. comm.
East Austin Creek	Gilliam Creek	SS	B. Cox, pers. comm.
East Austin Creek	Gray Creek	SS	P. Baker, pers. comm.*
	Dutch Bill Creek	FR	Kimsey 1953
	Hulbert Creek	FR	Kimsey 1953
	Mark West Creek	SS	B. Cox, pers. comm.*
Dry Creek		FR	Kimsey 1952
Dry Creek	Mill Creek	FR	Kimsey 1953
Mill Creek	Wallace Creek	FR	Kimsey 1953
Dry Creek	Peña Creek	FR	Kimsey 1953
Dry Creek	Warm Springs Creek	OT	B. Cox, pers. comm.
	EF Russian River	LIT	Hassler 1988
	WF Russian River	LIT	Hassler 1988
WF Russian River	York Creek	LIT	Hassler 1988
WF Russian River	Forsythe Creek	SS	W. Jones, pers. comm.
Forsythe Creek	Mill Creek	SS	W. Jones, pers. comm.
Forsythe Creek	Seward Creek	SS	W. Jones, pers. comm.
Seward Creek	Eldridge Creek	SS	W. Jones, pers. comm.
Seward Creek	Jack Smith Creek	SS	W. Jones, pers. comm.
WF Russian River	Salt Hollow Creek	LIT	Hassler 1988
WF Russian River	Rocky Creek	LIT	Hassler 1988
WF Russian River	Mariposa Creek	LIT	Hassler 1988
WF Russian River	Fisher Creek	LIT	Hassler 1988
WF Russian River	Corral Creek	LIT	Hassler 1988
Coastal	Scotty Creek	LIT	Hassler 1988

Table 1. continued

Drainage	Stream	Method	Source
Salmon Creek	Salmon Creek	SS	B. Cox, pers. comm.
	Finley Creek	SS	P. Baker, pers. comm.*
	Coleman Creek	SS	P. Baker, pers. comm.*
	Fay Creek	SS	P. Baker, pers. comm.*
	Tannery Creek	LIT	Hassler 1988
Walker Creek	Walker Creek	SS	Emig 1984
	Salmon Creek	LIT	Hassler 1988
	Arroyo Sausal Cr.	LIT	Hassler 1988
Lagunitas Creek	Lagunitas Creek	SS	Emig 1985
	Olema Creek	SS	B. Cox, pers. comm.
	Nicasio Creek	LIT	Hassler 1988
	Devil's Gulch Cr.	SS	Emig 1985
	San Geronimo Cr.	SS	Emig 1985
Bolinas Lagoon	Pine Gulch Creek	SS	B. Cox, pers. comm.
Coastal	Redwood Creek	SS	B. Cox, pers. comm.
San Francisco Bay tributaries	Alameda Creek	OT	John Hopkirk,pers. comm., cited in Leidy 1984
	San Pablo Creek	OT	letter to Paul Needham from Willis Evans,cited in Leidy 1984
	Walnut Creek	OT	Leidy 1983
	San Anselmo Creek	OT	Fry 1936
	Corte Madera Creek	OT	Leidy 1984
	Mill Valley Creek	OT	Leidy 1984

Table 1. continued

Drainage	Stream	Method	Source
Sacramento River	Sacramento River	OT	Fry 1973
	Feather River	OT	Painter et al. 1977
Coastal	San Gregorio Creek	SS	L. Ulmer, pers. comm.*
Coastal	Pescadero Creek	SS	L. Ulmer, pers. comm.*
Coastal	Butano Creek	LIT	Hassler 1988
Coastal	Gazos Creek	LIT	Hassler 1988
Coastal	Waddell Creek	SS	L. Ulmer, pers. comm.*
Coastal	Scott Creek	AT	D. Strieg, pers. comm.
Scott Creek	Big Creek	AT	D. Strieg, pers. comm.
Coastal	San Vicente Creek	LIT	Hassler 1988
San Lorenzo River	San Lorenzo River	OT	Johansen 1975
	Hare Creek	LIT	Hassler 1988
Coastal	Soquel Creek	LIT	Hassler 1988
Coastal	Aptos Creek	LIT	Hassler 1988
Coastal	Carmel River	LIT	Hassler 1988
Coastal	Big Sur River	LIT	Hassler 1988

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ADULT AND JUVENILE ANADROMOUS SALMONID MIGRATION TIMING IN CALIFORNIA STREAMS

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When oil spills occur in the vicinity of coastal stream mouths, chemical dispersants cannot be used if smolt or adult stages of salmonids are present. To aid planners in preparing for oil spills, monthly arrival times of spawning runs of adult anadromous salmonids and months when smolts outmigrate to the ocean at tidal inlets of California streams were compiled (Appendix 1). Only streams that empty directly into the ocean or Humboldt, San Francisco, or San Pablo bays are presented. The data were compiled from various publications and from interviews conducted with field biologists having personal knowledge of individual streams. Historical observations were included in cases where recent surveys have not been done or were inconclusive about the presence of salmonids. These data can also be used by resource managers who are reviewing projects that may affect water flow in the lower parts of coastal streams, or near tidal inlets, when migrating salmonids, adults or smolts, may be present.

Chinook salmon, *Oncorhynchus tshawytscha*; coho salmon, *O. kisutch*; and steelhead, *O. mykiss*, are the most abundant anadromous salmonids in California. The coastal cutthroat trout, *O. clarki clarki*, is also anadromous and found in small coastal streams from the Eel River in Humboldt County north to Alaska (Emmett et al.[1] 1991). Information on its migrations was not detailed enough for inclusion in Appendix 1. Pink salmon, *Oncorhynchus gorbuscha*; chum salmon, *Oncorhynchus keta*; and sockeye salmon, *Oncorhynchus nerka*, do not normally spawn in California and are not included.

Chinook salmon have 4 distinct runs in California. Runs are named after the season when they migrate from the ocean to fresh water for spawning: fall, late-fall, winter, and spring. The Sacramento River is used by all runs and is the only one to have late-fall and winter runs. Some other rivers also have more than 1 run. Most small coastal rivers have only a fall run.

Coho salmon have only 1 run and are most common in small coastal streams. They are not found in the Sacramento or San Joaquin River systems, but are found in small numbers in other tributaries to San Francisco Bay.

[1]Emmett, R.L., S.A. Hinton, S.L. Stone, and M.E. Monaco. 1991. *Distribution and abundance of fishes and invertebrates in West Coast estuaries, volume II: Species life history summaries.* ELMR Report No. 8, NOAA/NOS Strategic Environmental Assessments Division, Rockville, Maryland, USA.

Steelhead spawning migrations are complicated by the fact that adult steelhead nay be entering rivers to spawn or, unlike salmon, returning to the ocean following pawning. As a result, steelhead may be migrating year-round in larger rivers. Most California streams have only a winter steelhead run that migrates for spawning during all, winter, and early spring. In addition to the winter run, the Klamath, Eel, and Mad rivers also have summer runs migrating for spawning during spring, summer, nd early fall (Busby et al.[2] 1996). Unlike most rivers, the largest run in the Klamath River is the fall run.

Detailed information about outmigrating smolts is incomplete for most small oastal rivers and in many cases shows only the time when smolts entered the estuary, ot the time when they actually migrated into the ocean. Residence time in an estuary s a function of species, run, and stream conditions. Generally, stream residence mes are <1 year for chinook salmon, ≤1.5 years for coho salmon, and 1–6 years for eelhead. Unlike migrating adult salmonids that are often the target of anglers, smolts re usually small and difficult to see and attract no special attention. Generally, utmigration patterns are the same as for the geographically nearest stream of a similar ze for which information is shown.

For most species of salmonids, the peak spawning migration is in fall and winter. Most chinook salmon smolts outmigrate in spring and summer. Coho salmon smolts utmigrate from March to July and usually peak between mid-April and mid-May.

Some runs of salmonids are listed as threatened or endangered. Sacramento iver winter-run chinook salmon are listed by both the State of California and the ederal government as endangered (California Code of Regulations, Title 14; Federal egister, 50 CFR 17.11). Coho salmon in central California are listed by California s endangered and by the Federal government as threatened. Coho salmon in outhern Oregon and northern California are listed by the Federal government as reatened. Coastal cutthroat trout and summer-run steelhead are species of special oncern (Moyle et al.[3] 1989). For a detailed listing of the status of coho for West oast states and selected rivers, see Weitkamp et al.[4] (1995). See Busby et al.[2] 1996 r a complete listing for steelhead.

Probably the most important environmental factors affecting the timing for both turning adult salmon migration and smolt outmigration, especially for small coastal reams, is the condition of the river mouth and the amount of runoff from rainfall. Many small coastal streams are closed entirely by sand bars that build across their mouths during periods of low rainfall and mild ocean conditions in summer. Barnhart and Young[5] (1986) describe conditions for the Mattole River that are typical of conditions for many small coastal streams and stress the importance of estuaries to salmonids. The first major upstream migrations coincide with large increases in stream flow, especially in streams with low summer flows (Shapovalov and Taft 1954). Heavy rainfall and subsequent runoff removes the bar and provides a pathway for migrating fish. Freshwater runoff may provide olfactory clues to attract migrating adult salmon into the stream. Heavy runoff also serves to 'flush' smolts trapped in an estuary into the ocean.

The largest populations of salmon are found in the Klamath and Central Valley river systems. Migrating adult spawners can exceed 100,000 fish in the Klamath River and 150,000 in Central Valley rivers (PFMC[6] 1995). The Smith and Eel rivers also support large numbers of salmon, but in many of the streams in Appendix 1, the number of spawning adults is low, perhaps fewer than 100 fish.

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[2] Busby, P.J., T.C. Wainwright, G.J. Bryant, L. Lierheimer, R.S. Waples, F.W. Waknitz, and I.V. Lagomarsino. 1996. Status review of West Coast steelhead from Washington, Oregon, Idaho, and California. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-27.

[3] Moyle, P.B., J.E. Williams, and E.D. Wikramanayake. 1989. Fish species of special concern of California. Contract Number 7337, California Department of Fish and Game, Inland Fisheries Division, Sacramento, California, USA.

[4] Weitkamp, L.A., T.C. Wainwright, G.J. Bryant, G.B. Milner, D.J. Teel, R.G. Kope, and R.S. Waples. 1995. Status review of coho salmon from Washington, Oregon, and California. U.S. Department Commerce, NOAA Technical Memorandum NMFS-NWFSC-24.

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[5] Barnhart, R. and D. Young. 1986. Mattole Estuary habitat management plan. Sikes Act Project Number CA-056-WHA-A4. Available in the Humboldt Room, Humboldt State University Library, Arcata, California, USA. Call letters: SH222C3B371985.

[6] PFMC (Pacific Fishery Management Council). 1995. Review of 1994 Ocean Salmon Fisheries. Portland, Oregon, USA.

ppendix 1. Timing of adult salmonid spawning migration and smolt outmigration to the cean for 143 California streams, listed from north to south. Key to symbols and abbreviations: O–coho salmon, SH–steelhead, CH–chinook salmon, Λ–adult, Λ_F–adult fall run, Λ_{LF}–adult te-fall run, Λ_w–adult winter run, Λ_{sp}–adult spring run, Λ_{su}–adult summer run, S–smolts, –indicates peak run time, R.–river, G.–gulch, C.–creek.

tream	Sp.	A	S	O	N	D	J	F	M	A	M	J	J
mith R	CO					Λ^*	Λ^*	Λ					
										S	S^*		
	SH				Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w			
		Λ_{SU}	Λ_{SU}	Λ_{SU}								Λ_{SU}	Λ_{SU}
	CH		Λ_F	Λ_F	Λ_F								
lamath R.	CO		Λ	Λ^*	Λ^*								
								S	S	S^*	S^*	S	S
	SH		Λ_w	Λ_w	Λ_w	Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w	Λ_w		
		Λ_{SU}	Λ_{SU}	Λ_{SU}						Λ_{SU}	Λ_{SU}	Λ_{SU}	Λ_{SU}
								S	S	S	S	S	
	CH	Λ_F	Λ_F^*	Λ_F									Λ_F
										Λ_{SP}	Λ_{SP}^*	Λ_{SP}	Λ_{SP}
		S	S	S				S	S	S	S	S^*	S^*
edwood C.	CO		Λ	Λ	Λ^*	Λ^*	Λ	Λ					
									S	S^*	S	S	
	SH				Λ_w	Λ_w	Λ_w^*	Λ_w^*	Λ_w^*				
										Λ_{SU}	Λ_{SU}	Λ_{SU}	Λ_{SU}
		S	S	S	S					S^*	S^*	S	S
	CH			Λ_F	Λ_F								
		S	S	S	S					S	S	S	S
ittle R.	CO			Λ	Λ^*	Λ^*	Λ	Λ					
	SH				Λ_w	Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w			
									S	S^*	S^*		
	CH			Λ_F	Λ_F								
Mad R.	CO			Λ	Λ^*	Λ^*	Λ	Λ					
									S	S	S^*	S	
	SH			Λ_w	Λ_w	Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w			
										Λ_{SU}	Λ_{SU}	Λ_{SU}	Λ_{SU}
	CH		Λ_F	Λ_F	Λ_F								
acoby C.[a]	CO			Λ	Λ^*	Λ^*	Λ	Λ					
	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w	Λ_w		
reshwater C.[a]	CO			Λ	Λ^*	Λ^*	Λ	Λ					
	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w	Λ_w		
	CH			Λ_F	Λ_F								
lk R.[a]	CO			Λ	Λ^*	Λ^*	Λ	Λ					
	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w	Λ_w		
	CH			Λ_F	Λ_F								
el R.	CO			Λ	Λ^*	Λ^*	Λ	Λ					
									S	S^*	S^*	S^*	S

Appendix 1. (continued)

Stream	Sp.	A	S	O	N	D	J	F	M	A	M	J	J
Eel R.	SH		Λ_w	Λ_w	Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w	Λ_w	Λ_w	Λ_w	
		Λ_{SU}	Λ_{SU}	Λ_{SU}					Λ_{SU}	Λ_{SU}	Λ_{SU}	Λ_{SU}	Λ_{SU}
		S	S	S	S					S	S	S	S
	CH			Λ_F	Λ_F	Λ_F	Λ_F						
									Λ_{SP}	Λ_{SP}	Λ_{SP}	Λ_{SP}	
										S	S	S	S
Mattole R.	CO			Λ	Λ^*	Λ^*	Λ	Λ					
									S	S^*	S		
	SH				Λ_w	Λ_w	Λ_w^*	Λ_w^*	Λ_w^*	Λ_w			
		S	S										S
	CH			Λ_F	Λ_F	Λ_F							
										S	S	S	S
Whale Gulch	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Bear Harbor	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Jackass C	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Usal C.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Cottaneva C.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Hardy C.	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Juan C.	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Howard C.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
DeHaven C	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Wages C.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Chadbourne G.	SH					Λ_w	Λ_w^*	Λ_w^*	Λ_w	Λ_w			
								S	S	S^*	S^*	S	
Kibesillah C.	SH					[illegible]	[illegible]	[illegible]	[illegible]	[illegible]			

lix 1. (continued)

	Sp.	A	S	O	N	D	J	F	M	A	M	J	J
adiah C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
le R.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
	CH			Λ_F^*	Λ_F^*	Λ_F							
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
g C.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH				Λ_W	Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
R.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH				Λ_W	Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
	CH			Λ_F^*	Λ_F^*	Λ_F							
								S	S	S^*	S^*	S	
.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
ll C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
dle C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
C.[b]	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
C.[b]	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
n G.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
	CO			Λ	Λ	Λ^*	Λ^*	Λ					
									S	S^*	S^*	S	

Appendix 1. (continued)

Stream	Sp.	A	S	O	N	D	J	F	M	A	M	J	J
Big R.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
	CH			Λ_F^*	Λ_F^*	Λ_F							
								S	S	S^*	S^*	S	
Little R.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Dark G.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Albion R.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Big Salmon C.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
	CH			Λ_F^*	Λ_F^*	Λ_F							
								S	S	S^*	S^*	S	
Little Salmon C.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
	CH			Λ_F^*	Λ_F^*	Λ_F							
								S	S	S^*	S^*	S	
Navarro R.	CO			Λ	Λ	Λ^*	Λ^*	Λ					
								S	S	S^*	S^*	S	
	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
	CH			Λ_F^*	Λ_F^*	Λ_F							
								S	S	S^*	S^*	S	
Greenwood C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Elk C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Mallo Pass C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Irish G.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Alder C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Brush C.	SH					Λ_W	Λ_W^*	Λ_W^*	Λ_W	Λ_W			
								S	S	S^*	S^*	S	
Garcia R.	CO			Λ	Λ	Λ^*	Λ^*	Λ					

MENDOCINO

REDWOOD COMPANY

MANAGEMENT PLAN, POLICIES and TARGETS

August 2000

The complete text of this report and additional information about the Mendocino Redwood Company can be found on our Web Site:

www.mrc.com

If you would like to give feedback to Mendocino Redwood Company on any aspect of this report, feel free to contact us at 707-962-2807, or use the contact form available at the Web Site location.

Table of Contents

Our Purpose

Mendocino Redwood Company was formed with the idea that it is possible to manage a large block of productive forestland utilizing high standards of environmental stewardship and at the same time to operate as a successful business.

To us, **managing forestland with a high degree of environmental stewardship means that as each decade of MRC management passes:**

1. The inventory of redwood, Douglas-fir, and other conifer trees on our property will improve.
2. The habitat available to land-based species will improve.
3. The habitat available to aquatic-based species will improve.
4. The species composition present on our land will begin to more closely resemble the composition of forestlands and wildlife before commercial timber harvest removal.

Operating as a successful business means:

5. Being a business that people will want to work for.
6. Being a business that the community is proud of.
7. Being a business that is known for producing quality products and keeping its word.
8. Being a business that earns a return on the capital invested in the business over time.

Introduction

The Mendocino Redwood Company (MRC) began operations on June 30, 1998 with the purchase of 232,000 acres of timberland in California. The purpose of the company, presented on the previous page, was written in October of 1998 with input from many employees. This Management Plan has been completed to provide details on where we are today with our purpose, policies, plans, and targets. It is meant to give employees, neighbors, regulators, and other interested members of our larger community a concise, "user-friendly" summary of where we are going and how we will monitor progress.

MRC OPERATIONAL POLICIES

- Are written to supplement the California Forest Practice Rules.
- Are meant as internal guidance for areas where MRC will operate with a higher degree of environmental sensitivity or urgency than is currently required by law.
- Are followed in all situations except where forest conditions are unique or pose a threat to safety and therefore warrant a deviation from the policy. In these cases all changes from policy will be approved by Director of Stewardship, Chief Forester, and Forestlands Manager.
- Are meant to be unambiguous and measurable.

Each of the eight components of the company's purpose is explored in a separate section. These sections contain data tables, operational policies, plans, and targets. At the end of the document we have included an example of scorecards, policy summaries, maps, and a glossary to help explain some of the forestry terminology.

MRC's intent is to restore and maintain forestlands for long-term ecological, social, and economic vitality. In addition to its own internal monitoring, MRC is actively pursuing independent, third party validation of its timberland management practices. As more research and information becomes available we will publish updates to this Management Plan.

MRC OPERATIONAL TARGETS

- Are consistent with the components of Our Purpose.
- Are monitored to measure progress.
- Are used in recognizing and rewarding employees.
- Are verifiable by outside organizations.

1. Inventory of Conifer Trees

Introduction: The Mendocino Redwood Company owns 232,000 acres of land in California: 220,000 in Mendocino County and 12,000 acres in Sonoma County. (See Map on following page) Approximately 98% of our lands are forested. The balance is covered with grass, water, brush, or other non-timber vegetation. These forests include a variety of conifer and hardwood species as shown by watershed management area in the chart below.

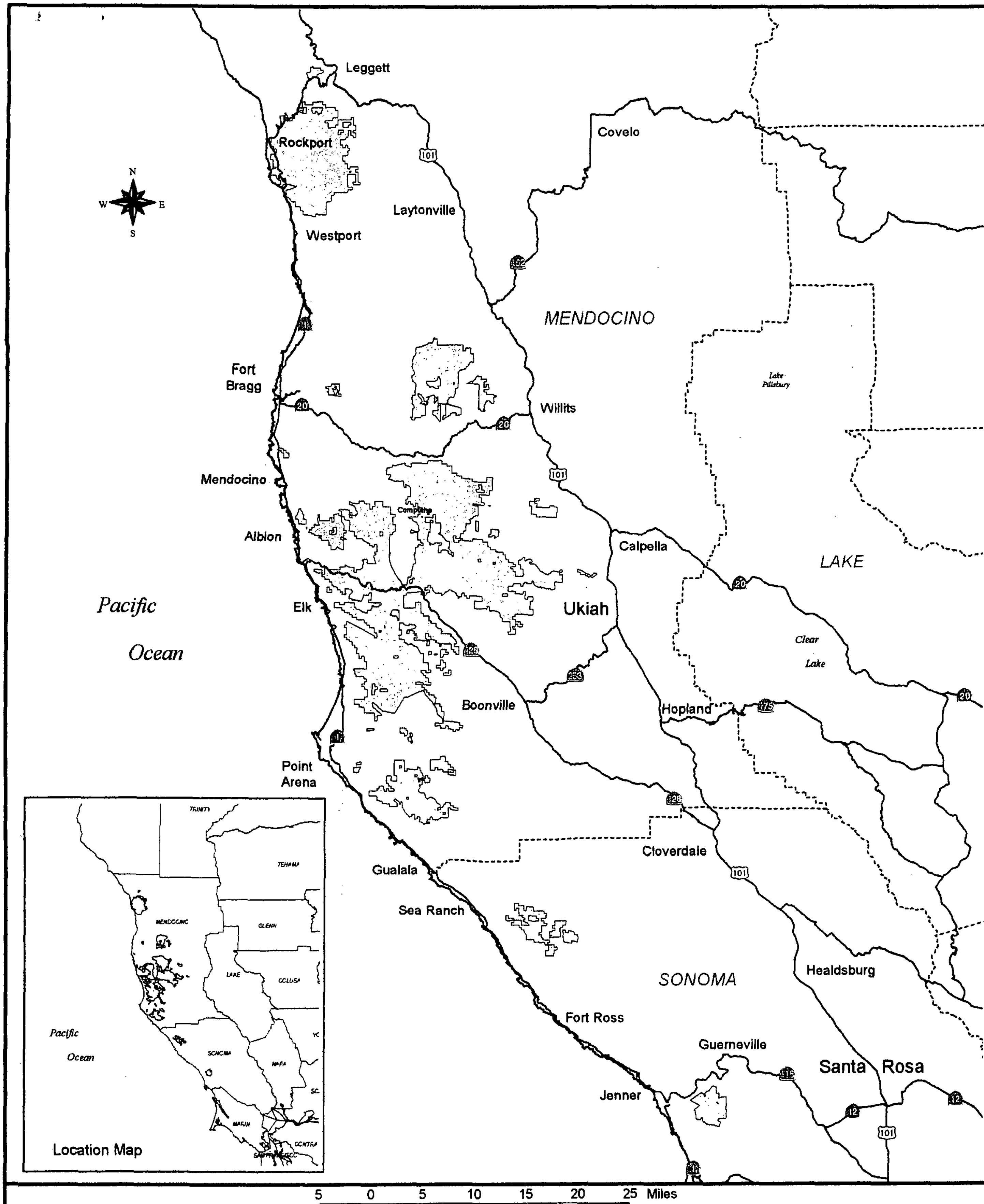
Number of Trees
Estimate of Trees Greater Than 10" dbh* (as of 1/1/00)

Watershed Area	Total Acres	Total Trees	Redwood	Doug-fir	Tanoak	Madrone	Other Species
Albion	16,473	1,083,000	559,000	202,000	241,000	43,000	38,000
Big River	34,333	1,897,000	757,000	308,000	663,000	120,000	49,000
Garcia	15,687	1,136,000	397,000	212,000	379,000	59,000	89,000
Southcoast **	34,429	2,713,000	1,017,000	631,000	837,000	146,000	82,000
Navarro East	29,733	1,644,000	642,000	265,000	571,000	116,000	50,000
Navarro West	24,986	1,553,000	718,000	303,000	418,000	64,000	50,000
Noyo ***	19,388	2,175,000	760,000	301,000	1,030,000	73,000	11,000
Rockport	39,036	2,981,000	854,000	537,000	1,328,000	214,000	48,000
Sonoma	12,242	807,000	390,000	86,000	286,000	18,000	27,000
Ukiah	5,717	334,000	80,000	97,000	90,000	30,000	37,000
Total	232,024	16,323,000	6,174,000	2,942,000	5,843,000	883,000	481,000

* dbh = diameter breast height, approximately 4.5' off the ground
** The Southcoast Inventory Block includes the Greenwood Creek, Elk Creek and Alder Creek watershed areas.
*** The Noyo Watershed Area has been updated during July 2000.

History: Prior to the 1850s, MRC forestlands were largely untouched late successional redwood and Douglas-fir mixed forests supporting communities of Native Americans (such as the Pomo, Yuki, Cahto, Wilaki, and Sinkyone). The grounding of the trading ship, *Frolic*, led to discovery of these lands by white settlers from San Francisco. A sawmill, constructed in 1852 at Big River, was the beginning of the redwood lumber industry on the Mendocino Coast of California.

Companies such as the Union Lumber Co., Albion Lumber Co., Mendocino Lumber Co., Rockport Redwood Co., L.E. White L.C., Holms Lumber Co., and Southern Pacific Land Company were some of the early owners of what now comprise MRC forestlands. Harvesting started at the mouths of watersheds and progressed up-stream and up-slope to the ridgelines. Initial logging activities generally consisted of a regimen of burn, clearcut, and burn again, followed by logs being dragged



Mendocino Redwood Company, LLC
OWNERSHIP

downhill to the nearest stream. Logs were transported to mills via the river systems. Later entries into these forests, and forests further inland, were commonly accomplished with steam donkeys (steam driven cable machines), and railroads. During the 1940s, crawler tractors and trucks replaced the railroads. Clearcutting continued to be a common harvest method. In response to tax laws in the 1940s and 1950s, many stands were managed to remove 70% of the stocking, typically the larger, healthier trees. Subsequent owners managed the lands to maximize fiber output and the success of their mill investments. As a result of this ownership history, a significant portion of the MRC acreage is at reduced levels of conifer stocking with trees in smaller diameter size classes.

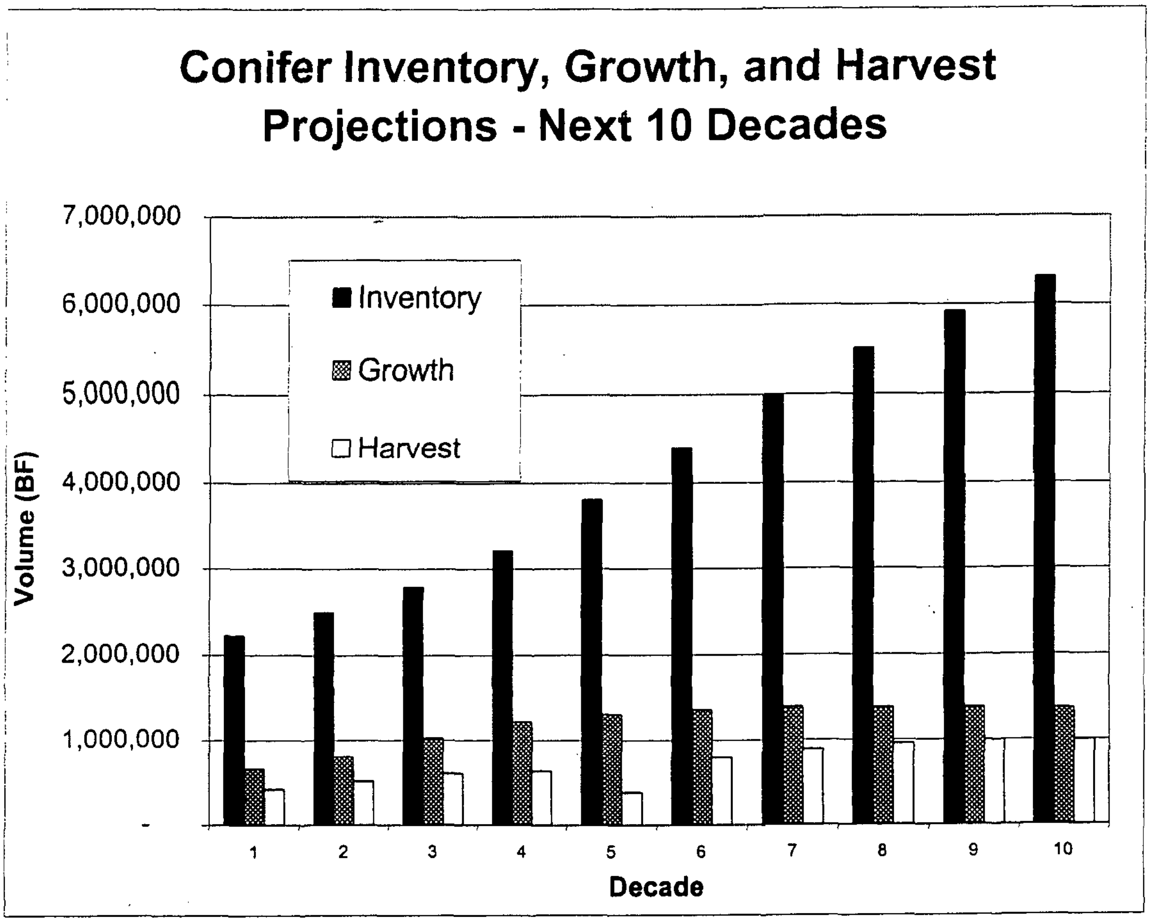
Inventory Target: MRC's inventory target is to reverse this historical trend and improve the quantity and quality of redwood, Douglas-fir, and other conifer trees on these forestlands as indicated in the table below.

MRC Inventory Target
Redwood, Douglas-fir and other Conifers - Board Feet*

	Current	By End of First Decade	By End of 5th Decade	By End of 10th Decade
	2000	2010	2060	2100
Total Redwood, Douglas-fir, and other Conifer Inventory				
Total Inventory 10" dbh and greater trees (billions of board feet)	2.30	2.53	4.61	6.80
Inventory per Acre 10" dbh and greater trees (thousand board feet per acre)	9.9	10.9	19.9	29.4

* A Board Foot is approximately 1 foot by 1 foot by 1 inch of wood, a common term used to determine the volume in the trunk of a tree; it is systematically adjusted during tree measuring (scaling) for flare and bark.

This objective calls for a doubling of the board foot inventory of conifers on our forestlands by the end of the 5th decade. These decade targets are based on estimates of conifer growth which average of between 2.9% to 3.8% per year. Simply put, this increase in inventory is achieved over time by growing more each year than we harvest. The following chart shows the results of modeled simulation of the growth of conifer inventory by decade. These model projections are based on real data from the redwood region calibrated to MRC lands and use conservative growth estimates.



Total Inventory: To achieve these or even more accelerated inventory growth targets, MRC needs accurate estimates of total inventory and growth to determine harvest levels and to plan silvicultural (planting, thinning and vegetation control) activities. The current inventory data for the MRC acreage is based on collection activities over the past five years. During this time, a variety of techniques have been used to increase the level of accuracy in the watershed management areas on the property. These have included satellite imagery, vegetative typing by foresters, and stand-specific ground-based cruises.

Between 1995 and 1997, the forestlands (under prior ownership) were classified into stands that represent similar vegetative types such as mature redwood, open canopy Douglas-fir, hardwood, and brush. Field inventory plots (numbering over 6,500) were used to determine timber volume estimates by vegetation types over four major inventory blocks across the ownership. Since that time, the four blocks were split into ten watershed management areas indicated in the chart on page 5. In 1998 and 1999, the Garcia, Southcoast, Albion, and West Navarro watershed management areas were the focus of an inventory monitoring project aimed at achieving higher levels of accuracy for the smaller geographic areas. This project involved the installation of over 2,000 new inventory plots and included the collection of data regarding downed logs, snags, and old growth trees in addition to traditional inventory data collection.

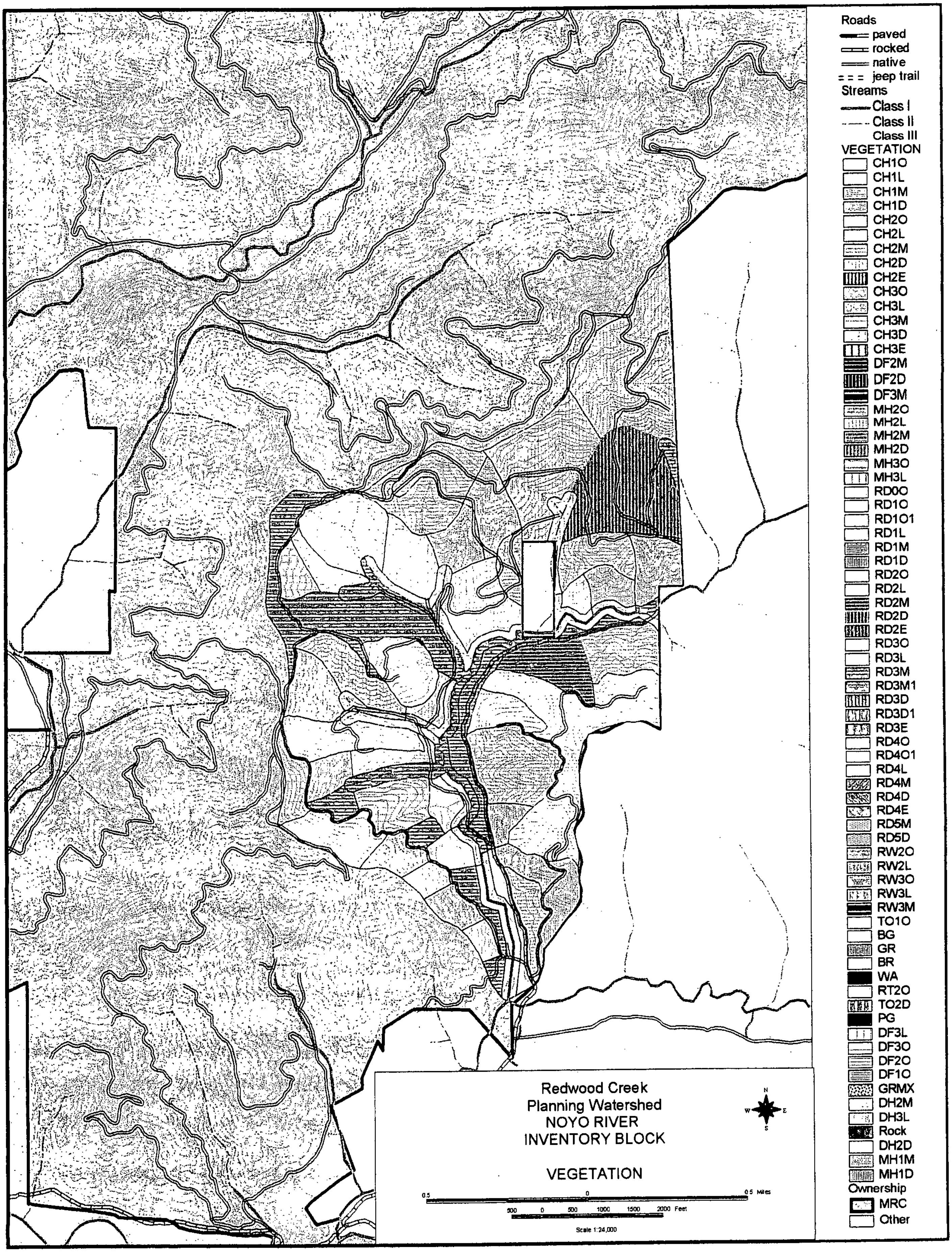
Total Inventory* by Watershed Management Area

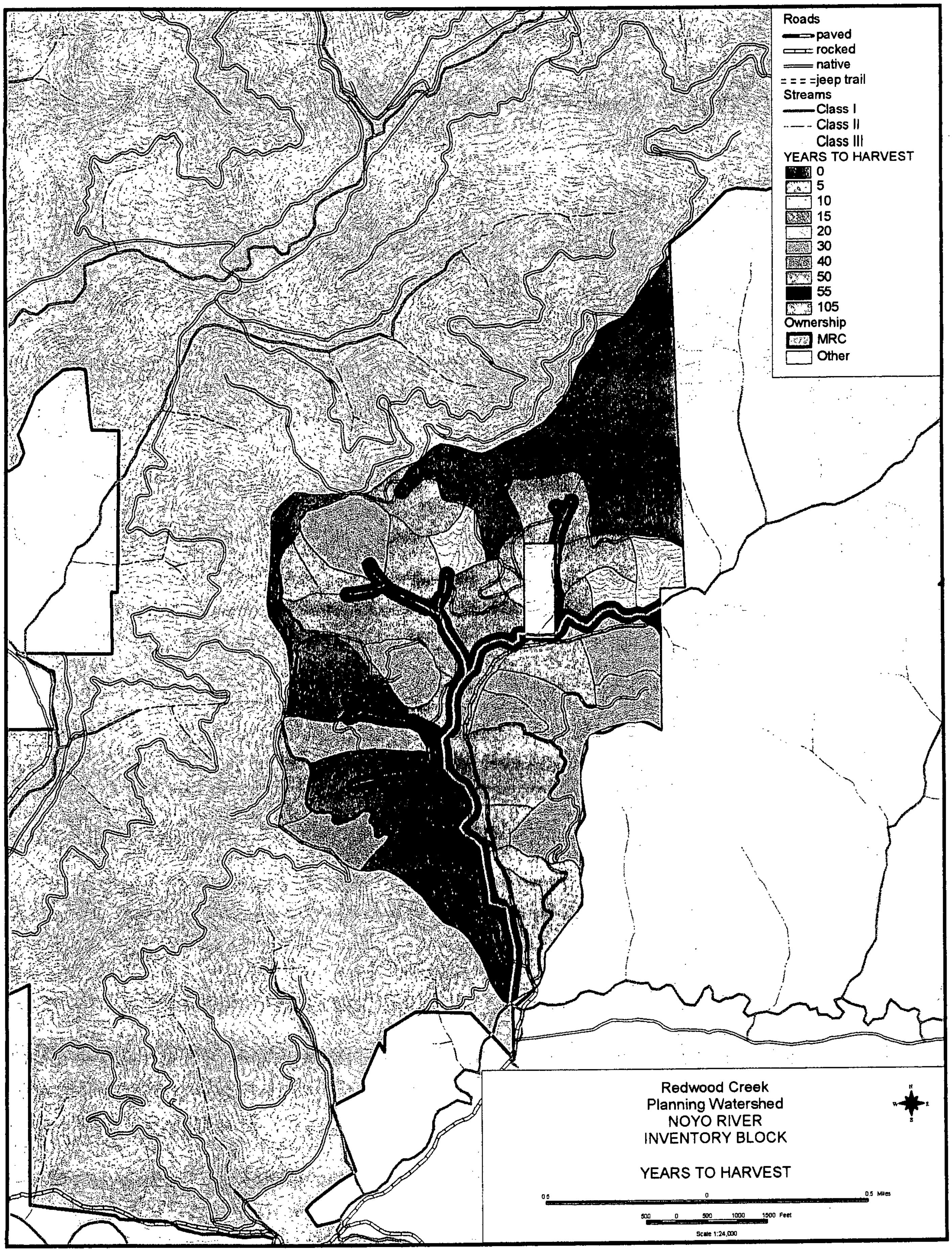
Watershed Area	Most Recent Year Inventory Remeasured	**Conifer**** Board Feet (millions)	**Hardwood ***** Board Feet**** (millions)
Albion	1999	344	25
Big River	1996	276	65
Garcia	1998	113	35
Southcoast	2000	423	84
Navarro East	1996	202	56
Navarro West	1999	268	58
Noyo	2000	157	46
Rockport	1996	377	154
Sonoma	1996	112	26
Ukiah	2000	38	19
Total		2,310	568

* *Net Inventory is calculated less bark, rot and breakage*
** Conifer species include redwoods, firs and pines
*** Hardwood species include tanaok, madrone, chinquapin, black oak, etc.
**** There are approximately 8 tons/mbf average for hardwoods

Landscape Planning: During the last half of 1999 and first half of 2000, MRC has implemented a method of inventory calculation and monitoring that further increases the precision of total inventory numbers and the ability to plan for cumulative harvest impacts across the landscape. The focal units are the 85 California Planning Watersheds found within MRC property and depicted on the maps in Appendix A. Focusing on the smaller watershed areas facilitates the creation of landscape-wide planning and monitoring. This "Landscape Planning" will incorporate numerous factors to determine harvest effects on growth, forest structure, and biodiversity.

The Landscape Planning methodology divides each planning watershed into stands. Each stand is typically 20 to 40 acres, grouped by common features such as vegetation, harvest design, and sensitivity (such as proximity to a watercourse). The stands are mapped and each stand accumulates a set of data, also known as stand attributes. As time progresses, this data will include harvest and management history, wildlife and aquatic features, community values, and other data. Measurements of tree characteristics and general forest structure are taken in a large sample of stands to provide confidence in the total inventory at the watershed level. Through August of 2000, 23 of the total 85 planning watersheds have been mapped for stands with upgraded inventory data. All of the remaining planning watersheds will be complete by the end of 2001. The following two maps demonstrate how one planning watershed, Redwood Creek in the Noyo, is divided into stands and stand data layers. Explanations for the vegetation classifications are in Appendix B.


Redwood Creek
Planning Watershed
NOYO RIVER
INVENTORY BLOCK
VEGETATION
Scale 1:24,000
Roads
paved
rocked
native
jeep trail
Streams
Class I
Class II
Class III
VEGETATION
CH1O
CH1L
CH1M
CH1D
CH2O
CH2L
CH2M
CH2D
CH2E
CH3O
CH3L
CH3M
CH3D
CH3E
DF2M
DF2D
DF3M
MH2O
MH2L
MH2M
MH2D
MH3O
MH3L
RD0O
RD1O
RD1O1
RD1L
RD1M
RD1D
RD2O
RD2L
RD2M
RD2D
RD2E
RD3O
RD3L
RD3M
RD3M1
RD3D
RD3D1
RD3E
RD4O
RD4O1
RD4L
RD4M
RD4D
RD4E
RD5M
RD5D
RW2O
RW2L
RW3O
RW3L
RW3M
TO1O
BG
GR
BR
WA
RT2O
TO2D
PG
DF3L
DF3O
DF2O
DF1O
GRMX
DH2M
DH3L
Rock
DH2D
MH1M
MH1D
Ownership
MRC
Other


Roads
paved
rocked
native
jeep trail
Streams
Class I
Class II
Class III
YEARS TO HARVEST
0
5
10
15
20
30
40
50
55
105
Ownership
MRC
Other
Redwood Creek
Planning Watershed
NOYO RIVER
INVENTORY BLOCK
YEARS TO HARVEST

Tree Growth: Growth of the forest is estimated by calculating the growth of new trees in harvest areas, the growth of new trees in non-harvested areas, and the diameter and height growth on existing trees. Growth estimates take into account tree species, individual tree conditions, competition, harvest and other kinds of tree mortality. Projections of growth are also based on soil quality, temperature, moisture, slope, and elevation.

The model CRYPTOS (Cooperative Redwood Yield Research Project) is currently used to simulate growth across MRC forestlands, to help determine appropriate harvest levels, and to update annual inventory. Growth data in this model was originally obtained from plots installed across the redwood region from 1930 to 1980. MRC is in the process of further calibrating the CRYPTOS model with data gathered from over 200 permanent growth plots in various watershed areas across its ownership. These plots provide the ability to better represent actual growth conditions on MRC lands.

Growth varies widely by stand. Young stands with small trees may not have any measurable volume, and although they may be growing rapidly, show zero volume growth. Stands that have trees that are 25 to 50 years old may be growing in excess of 10%. Growth rates slow down as stands approach maturity. Estimates of total growth for the ownership are weighted averages of growth rates for individual stands.

Conifer growth estimates for MRC forests show the total conifer tree inventory growing at an average annual rate of 2.9% per year or an average of 66 MMbf/year over the next five years. A rough estimate of region-wide hardwood growth rates is 4% per year. The hardwood rates have been studied less than conifer growth. We expect to refine our estimates of both conifer and hardwood growth through the measurement of the permanent growth plots.

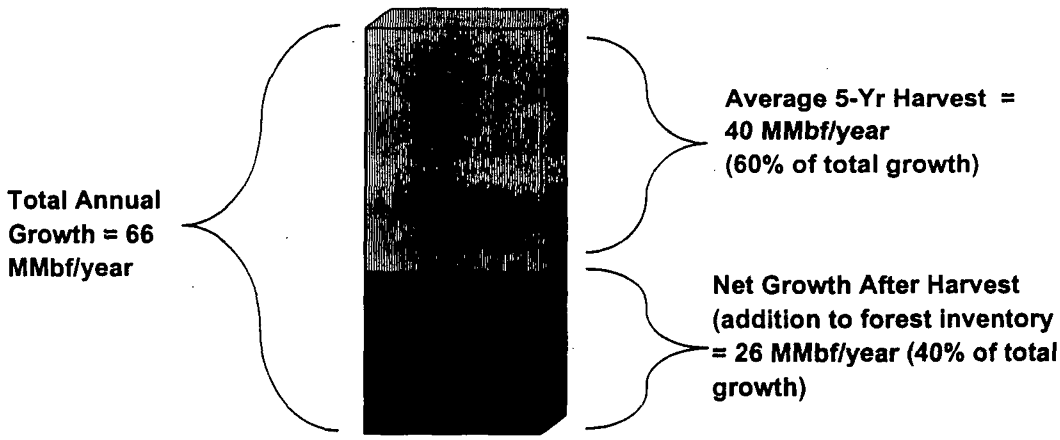
Total MRC Lands - Average Conifer Growth Estimate Next 5 Years		
	Volume	% of Inventory
Conifers	66 million Bf/year	2.9%
Per Acre Average	280 Bf/acre/year	

Harvest Levels: Annual harvest on MRC forestlands is determined by reviewing impacts on individual stands, watersheds, and on the total 232,000 acre landscape.

> ## MRC HARVEST POLICY
>
> - Harvest less conifer than we grow on our forestlands.
> - Disperse harvest activity over the landscape to prevent concentrating impacts.
> - Retain and recruit the older stand component in the forest with more advanced structure.
> - Operate without traditional clearcutting (for all new plans since the fall of 1998); all harvests will retain elements of the original stand such as snags, green trees, stand structure, and other features important for a variety of functions for biotic organisms.
> - Well-stocked conifer stands (greater than 135 square feet conifer basal* area) will have a minimum basal area retention post harvest of 50% of the original conifer stand.
>
> * *basal area: Cross sectional area of all stems of a species in a geographical area taken at dbh (4.5' height)*

Each individual stand (generally defined by MRC to be between 20 and 40 acres) being considered for harvest must meet certain trigger and retention conditions (See following silviculture discussion and tables). These internal guidelines are written to maintain intact forested areas, to protect ecological structure on multiple scales, to achieve a gradual conversion to uneven aged stands with larger, older trees, and to return tanoak dominated stands back to redwood and Douglas-fir. The trigger and retention conditions combined with inventory targets and landscape-specific sensitivities limit the forested areas available for annual harvest. In each watershed, annual harvest is constrained to avoid detrimental cumulative impacts of harvest during any five-year period.

Conifer Annual Growth = 66 MMbf/year



Conifer Harvest by Watershed Area 1999		
Watershed Area	1999 Volume Harvested	Percent of Conifer Inventory
Albion	8.8	2.6%
Big River	3.6	1.3%
Garcia	0.7	0.6%
Southcoast	6.8	1.6%
Navarro East/Ukiah	3.0	1.3%
Navarro West	4.1	1.5%
Noyo	4.5	2.9%
Rockport	7.8	2.1%
Sonoma	1.0	0.9%
Total	40.3	1.7% (Weighted Average)

Each area forester uses a variety of factors to decide where to harvest within a particular watershed area. These include previous harvesting activities in the stand and surrounding stands, conditions of road systems, historical and underlying erosion conditions, wildlife concerns, proximity to high priority road restoration work, and the health of the trees in the stand. The targeted annual volume is approximately 2% of total conifer inventory. The specific percentage depends on the conditions present in each watershed management area. The table shows annual harvest volumes and harvest as a percent of inventory for 1999 by watershed area.

The landscape planning process, in which tree inventories, wildlife attribute features, and other landscape data are geographically referenced to stands, gives the area foresters better information to determine the levels and locations for annual harvest and other management activities.

With this tool, a forester is able to plan specific harvest areas by year for as many as 50 years. Multiple year harvest planning allows for evaluation of potential harvest impacts on water quality, upslope species habitats, road de-activation, stand improvement practices, and prioritization of restoration work. Much of this is accomplished by the overlay of data, such as baseline watershed analysis work, on stand maps. (See discussion on pages 32-34). The initial Landscape Planning assessment will be completed for the Ukiah, Noyo, Southcoast, Rockport and Big River watershed areas by the end of 2000, and the balance of the property by the end of 2001.

LANDSCAPE PLANNING allows foresters to assess the following at a stand level in determining location and volume of harvest:

- Total Trees by Species
- Inventory Targets
- Stream Locations
- Streamside Protections
- Wildlife Tree Retention
- Snag Retention
- Chronic Erosion Areas
- Road Systems
- Slope and Instability Potential
- High Priority Sediment Control Projects
- Species Protections and Habitat Targets
- Old Growth Protection
- Preservation of Oak Woodlands and Other Special Areas

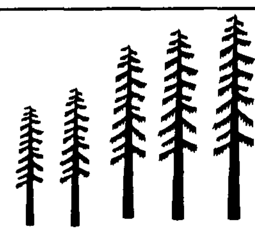
Silviculture: Silviculture is the science of managing aspects of forest composition and growth. Silviculture treatments include a variety of activities such as harvesting, planting, thinning, and brush management that impact the stocking and growth of a forest stand as well as the habitat provided by the stand.

Currently, the vast majority of MRC acreage is in the young forest types. One of the company's objectives is to move significantly more of the acreage into older and larger size class stands by the end of the 5th decade as shown in the table below. To achieve this and other goals, MRC developed and implemented a set of trigger and retention policies for different kinds of harvest logic. MRC foresters prescribe classic uneven-aged harvest, such as selection, to conifer stands with healthy stocking (greater than 120 square feet conifer basal area per acre). Watercourse and lake protection zones (WLPZs) are targeted for high retention selection harvest to promote the growth of larger trees. MRC foresters prescribe even-aged management, such as variable retention, in order to restore stands from hardwood overstory dominance to conifer overstory dominance. MRC has discontinued the use of traditional clearcutting on its properties.

MRC Targeted Forest Conditons

	Percent of Acres		*Percent of Acres*
	Standing Conifer Volume		Wildlife Classification
	>25 mbf/acre	15-25 mbf/acre	>=WHR 4B* (>=16" QMD**)
Current	7%	29%	32%
After 5th Decade	20%	75%	55%

	Total Volume - MBF	
	Conifer Trees in Larger Size Classes	
	24" - 32" dbh	> 32" dbh
Current	622,000	606,200
After 5th Decade	1,076,700	1,362,500



* WHR is a classification system for "Wildlife Habitat Relationship" calculated by using a quadratic mean diameter (QMD) of all trees greater than 5" dbh (15 years old +).

** QMD, quadratic mean diameter is calculated by pooling stem diameters of all stems in the sample including conifers and hardwoods, squaring the diameters, summing up the squared diameters, and then computing the square root. QMD is used because it gives more weight than a simple arithmetic mean to the larger diameter trees.

Variable retention is an interim hardwood removal silviculture with a harvest pattern designed to maintain presence of structure for ecological functionality on the landscape. Variable retention leaves from 10% to 40% of the original stand intact. In 20 years, MRC expects the restoration of stands back to conifer dominance will be largely completed and selection harvest regimes, with 50% or more original stand retention, will become the predominant silviculture practiced on MRC forestlands.

Explanations of the silvicutural activities and guidelines for company foresters are set out in the following tables.

Descriptions of Different Silvicultural Harvest Prescriptions Used by MRC

Prescription	Description	California Forest Practices Rules Ref. and Label
Uneven-Aged Management		
Single Tree Selection	To establish and maintain multi-storied, uneven-aged stands of redwoods and Douglas-fir by harvesting individual trees more or less uniformly throughout the stand. Provides space for growth of remaining trees and space for growth of new trees.	913.2(a)(2)(A) "Selection System"
Group Selection (Conifer & Mixed)	To establish and maintain multi-storied, uneven-aged stands of redwoods and Douglas-fir by harvesting trees in small (< 2.5 acre) groups. Width of groups is commonly twice tree height of surrounding mature trees to maintain forest influence.	913.2(a)(2)(B) "Group Selection"
High Retention Selection	To accelerate stand development of large trees and closed canopy by harvesting individual trees targeted to result in the growth of larger trees and to create and maintain special habitat elements such as decadent trees, snags, and downed logs.	913.2(a)(2)(A) "Selection System"
Commercial Thinning	To promote timber growth, increase average stand diameter, and improve forest health.	913.3(a) "Commercial thinning"
Transition	To develop an uneven-aged stand from an even-aged stand or a stand with unbalanced or irregular stocking. Involves removal of trees individually or in small groups to create a balance of different stand structure and natural reproduction.	913.2(b) "Transition"
Even-Aged Management		
Variable Retention	To rotate stands with poorly stocked conifer volume and relatively high volumes of hardwood, dispersed and/or aggregated retention of 10% to 40% or more of the existing stand to provide for vigorous growth of remaining stand combined with pockets of undisturbed trees to provide for ecological functionality, habitat structure, and forest complexity.	913.6 "Alternative Prescription" "AP/Clearcut"
Seed Tree Removal Step	This step harvests a portion of the seed trees left in an earlier entry and after a fully stocked stand of regenerated trees has become established.	913.1(c)(2) "Seed Tree Removal Step"
Shelterwood Removal Step	This step harvests a portion of the overstory of trees left in an earlier entry for wind and soil stability and after a fully stocked stand of regenerated trees has become established.	913.1(d)(3) "Shelterwood Removal Step"
Rehabilitation	To rehabilitate poorly stocked conifer stands experiencing excessive hardwood competition and allow for site prep and conifer regeneration and transition into well-stocked stand of conifers.	913.4(b) "Rehabilitation"

Targeted Pre-Harvest Conditions on MRC Forestlands				
Prescription	Species	Pre-Harvest Conifer Basal Area (Square Feet per Acre)		Other Key Pre-Harvest Factors
Uneven-Aged Management		Lower Limit	Upper Limit	
Single Tree Selection	Conifer/Mixed	120	None	
Group Selection	Conifer	120	None	20% of the Stands' Area May Meet Stocking Standards Using the Point Count Method. The Remaining 80% Must Meet the Pre Harvest Basal Area Trigger (120 sf per acre).
Group Selection	Mixed	90	None	Hardwood basal area greater than 50 sf/acre. 20% of the Stands' Area May Meet Stocking Standards Using the Point Count Method. The Remaining 80% Must Meet the Pre-Harvest Basal Area Trigger (90 sf per acre).
High Retention Selection	Conifer/Mixed	260	None	Basal Area Present for 70% Absolute Canopy Cover
Commercial Thinning	Conifer	120	None	Will Not Be Applied to a Stand That Has Been Selectively Harvested Within 10 Years
Transition	Conifer/Mixed, Mixed/Hardwood	60	100	
Even-Aged Management*				
Variable Retention	Mixed	25	135	Greater Than 60 sf ba/acre Hardwoods**
Seed Tree Removal	Conifer/Mixed	15	50***	Regeneration @ 300 Point Count
Shelterwood Removal	Conifer/Mixed	25	100***	Regeneration @ 300 Point Count
Rehabilitation	Mixed/Hardwood	None	50	Less than 300 point count. Greater Than 50 sf ba/acre Hardwoods

Note: These recommended silvicultural harvest prescriptions are expected to result over time in an increase in more mature forest types, which is the goal of MRC. If a forester determines that a different silvicultural prescription would better achieve the goals of MRC, then that prescription can be used after consultation with the Chief Forester, Forestlands Manager, or Stewardship Director.

* The majority of even-aged management is used in hardwood dominated stands to rotate the stands back to planted conifers.

** Due to the variability of hardwood inventory across MRC's forest lands, the pre-harvest hardwood basal area may vary as much as 30% for this prescription.

*** Pre-dominant conifer basal area.

MRC Targets For Stocking, Retention and Re-entry Specifications			
Silviculture	**Post Harvest Stocking Levels**	**Retention Conifer Basal Area (Square Feet of Basal Area per Acre)**	**Time before next harvesting activities**
Uneven-Aged Management			
Single Tree Selection	All Age, evenly distributed	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years (15 year average)
Group Selection (Conifer)	Less Than 20% of Pre-Harvest Stand in Clearings	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years (15 year average)
Group Selection (Mixed)	Less Than 20% of Pre-Harvest Stand in Clearings	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years (15 year average)
High Retention Selection	Greater Than 70% Absolute Canopy Closure, Six Trees At Least 32" dbh or Greater Per Acre, If LWD Deficient, then Permanent Retention per Operating Policy	Greater Than 200 sf ba and Greater Than 75% sf ba of Pre-Harvest Stand	At Least 15 Years
Commercial Thinning	Equal to or Greater Average Tree Diameter Than in Pre-Harvest Stand	> 110 sf ba	Transition to Selection 10-20 Years
Transition	Less Than 20% of Pre-Harvest Stand in Clearings	> 50 sf ba	Transition to Selection 20-30 Years
Even-Aged Management			
Variable Retention	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	Approximately 10% to 40% Depending on the Acreage Retention	Transition to Selection 30-60 Years
Seed Tree Removal Step	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	Greater Than 10 sf ba, if Pre-Harvest Stocking is Less Than 75 sf ba; Greater Than 50 sf ba if Pre-Harvest Stocking is Greater Than 75 sf ba	Transition to Selection 30-60 Years

MRC Forestlands - Estimated Silviculture Applications		
Silviculture	Next 5-Years % Total Harvested Acres	Fifth Decade Average % Total Harvested Acres
Uneven-aged	55%	95%
Even-aged	45%	5%

Regeneration: Regeneration activities on MRC lands include tree planting, site preparation work, pre-commercial thinning, and brush removal work. Regeneration work is designed to improve conditions for the growth of new trees on a site that has been harvested and where openings are left in the forest canopy. In the 1998/1999 winter season, MRC planted 550,000 redwood and Douglas-fir seedlings and in the 1999/2000 winter season, MRC planted 619,000 seedlings.

Plans for the next 5-year period are to continue to plant genetically appropriate trees where harvest activities have left forest openings. In order to prepare for adequate future seedling supplies, MRC is identifying high quality redwood stands for seed sources. This will be accomplished using the landscape planning database. Several MRC foresters will be selecting three or more stands in each of three zones to flag for seed crop development. Harvest in these stands will be designed to improve redwood cone production.

Annual Tree Planting Winter of 1999/2000

	Redwood	Douglas-fir	Total
Albion	12,900	15,150	28,050
Big River	34,700	29,300	64,000
Southcoast/Garcia	60,200	60,200	120,400
Navarro East/Ukiah	35,700	30,000	65,700
Navarro West	7,600	5,600	13,200
Noyo	78,100	75,300	153,400
Rockport	93,600	72,400	166,000
Sonoma	2,800	5,400	8,200
Total	325,600	293,350	618,950

Site preparation includes removal of a portion of the post-harvest slash material, brush, and in some cases stumps, with the use of mechanical, manual, or burning techniques. The majority of tanoak slash is treated by whole tree yarding and moving limbs and tops to burn piles. MRC plans for 400 to 500 acres of site preparation on an annual basis. Burning is tightly restricted to areas with heavy slash concentrations and is generally spot burning rather than broadcast burning.

Pre-commercial thinning is typically prescribed on 300 to 500 acres annually to reduce stand density. Pre-commercial thinning enhances the growth potential of trees in forested stands where excessive competition for light, nutrients, and water is occurring due to the close spacing of trees.

Brush removal work includes the use of mechanical and chemical means to control the growth of woody plant species. The use of herbicides, especially Tryclopyr commonly know as Garlon, on MRC land has been unpopular with the neighbors adjacent to our properties.

MRC HERBICIDE POLICY

- Herbicides will be used only to address ecological imbalance on the forestlands (e.g. suppression of conifers by tanoak sprouts) with the goal of reducing and eliminating their use over time.
- Herbicides will only be applied by hand to control specific vegetation.
- MRC will actively work with BLM, USFS, CDF, California State Parks, and other public agencies to control invasive exotics.
- MRC will not apply herbicides within 150' of Class I streams, 100'of Class II streams, and within 25' of either side of a Class III watercourse if there is any moisture present.
- To ensure that no herbicides are present in the watercourses, MRC will work in partnership with the Regional Water Quality Control Board to test stream water downstream from herbicide application.
- MRC will notify neighboring landowners when applying herbicides within 300 feet of their property line.
- MRC will work with the County Agricultural Commissioner to ensure contractor operations are in compliance with all federal and state rules, regulations, and worker safety requirements.
- MRC will work with Native American groups to issue permits for safe gathering activities buffered from any herbicide application areas.

In 1999, MRC, in conjunction with an external watershed science consultant, designed experiments and received permitting to test nine products as alternatives to Garlon. Trials for these products as well as over ten kinds of manual and mechanical removal techniques began in the fall of 1999. Some results will be available as early as the fall of 2000 although additional research and testing will continue for the next several years.

In addition to testing and implementing alternatives to traditional industrial herbicides, MRC is also committed to reducing, and eventually eliminating the total use of herbicides on its ownership. To reach this target, MRC foresters are beginning to review each watershed area and characterizing stands as to the need and priority for herbicide application, the potential use of alternatives, and the transition away from the need for herbicides. When these characterizations are completed, MRC will have the data to set targets for the timing of its reduction and elimination of herbicides.

Herbicide Use Stand Characterization

I. No Need to Use Herbicides
- Treatment Completed
- High Conifer Stocking
- Watercourse Zones
- Not Targeted for Conifer Recapture
- Opportunity for Single-Step Manual Release

II. Herbicide Application On Recent Harvests
- Variable Retention
- Past Clearcuts
- Seed Tree/Shelterwood Removal
- Transition
- Rehabilitation

III. Herbicide Application For Tanoak Overstory
- High growing site with excessive competition
- High opportunity for release

IV. Control of Exotic Invasives
- Pampass Grass
- Eucalyptus
- French and Scotch Broom
- Yellow Star Thistle

Herbicide Alternative Trials Treatments Being Tested

Tanaok Stump and Frill* Applications
- Neem Tree Oil
- Eucalyptus Oil
- Camphor Oil
- Vinegar
- Bleach
- Sodium Chlorate
- Ammonium Sulfamate
- Black Walnut Oil
- Manual Single and Double Girdling
- Girdling With Reduced Herbicide Levels

Tanoak Stump Covers
- 10 ml Plastic
- 20 ml Plastic
- Weed Block Fabric
- Slash

2-Year and 4-Year Old Tanoak Brush
- Manual with Chainsaw - Once
- Manual with Chainsaw - Twice
- Manual with Chainsaw - "Designer Thin"
- Fertilize Conifer
- Ammonium Sulfamate Application
- Scythe (Fatty Acid) Application

* Frill involves tree girdling and chemical injection

Fire Prevention and Protection: Preventing fires on the forestlands is an important priority for all employees and logging contractors at MRC. Forestry personnel make regular rounds to inspect the adequacy of fire tools and prevention practices for the on-site logging subcontractors. These include adequate clearings or fire-retardant blankets around yarder cable blocks, spark arresters on chain saws, and fire trails. Pre-harvest meetings are held with contractors to address important fire prevention issues such as fire safety, access, fuel humidity, and the company policy regarding smoking and warming fires. Concentrations of logging debris, particularly logging related slash piles on landings are located along fire control ridges and are scheduled for burn or disposal within one year.

MRC meets annually with the local Battalion Chiefs and CDF engineers. This allows CDF personnel to become familiar with all primary road access to MRC property. MRC maintains a "call down" list of critical MRC employees and their emergency phone numbers. MRC also provides significant funding for a county-wide aerial patrol, which is completed daily during the peak fire season. All primary access roads are regularly maintained and open for fire truck access on MRC forestlands. MRC employees are provided fire-fighting equipment in their vehicles and trained to efficiently direct fire response traffic. A company-wide communication system provides for effective and quick response. Important helicopter landings are being inventoried and GPS coordinates recorded for emergency response. Where access to available water is limited for fire fighting-tenders, MRC is developing water systems with holding tanks and rapid fill capabilities.

MRC FIRE PROTECTION POLICY

- A phone list is maintained identifying who to contact if a fire should occur. Lists will be distributed periodically to employees as well as contractors.
- Meetings and tours with the local CDF Battalion Chiefs are coordinated on an annual basis.
- MRC participates in county-wide aerial fire patrol.
- Every attempt is made to dispose of slash piles within one year.
- Mainline road systems are maintained to allow access to the property.
- New employees receive training in fire suppression practices.

2. Land-Based Habitat

Over 150 federal or state threatened, endangered, or special concern (TES) species have been identified as potentially occurring on MRC ownership. This list includes 94 species of plants, one reptile, four amphibians, seven invertebrates, 10 fish, 12 mammals, and 35 birds. MRC timberlands are home to many other unlisted mammals, fish, reptiles, amphibians, birds and other species. This section will address the land, or terrestrial-based species and MRC's objectives for improving habitat for these species. The next section of this plan will address aquatic species.

Of the land-based TES species, 19 have been observed on MRC ownership and an additional eight species are likely to be found on

Wildlife Population Survey Work Priorities

Continued Northern Spotted Owl Surveys
- Understand habitat requirements
- Vegetation sampling around known nest sites
- Radio telemetry surveys for habitat use info

Increased Marbled Murrelet Surveys
- Radar surveys for mapping potential habitat
- Understand distribution on ownership

Sooted Track Plate Surveys
- Information on American Martens
- Information on Pacific Fishers

Reptile and Amphibian Work
- Baseline data for riparian work
- Develop data collection protocols
- Information on Yellow-legged frogs, Northern Red-legged frogs, Tailed frogs, Western Toads and Bull Frogs.
- Identification of salamander habitat and the role of salamanders in the ecology of the redwood forest

Songbird Surveys
- Understand distribution on ownership
- Develop data collection protocols

MRC BREEDING RAPTOR POLICY

- **To protect breeding raptors in proposed operating areas:**
  - -The RPF, or designee, will complete a documented inspection for nests, white wash, and other signs during on-the-ground inspections of the THP areas during THP design and layout .
  - -The RPF, or designee, will target specific retention of trees that have the characteristics attractive for raptor nesting.
  - -If raptor sign is detected during preparation or operation of a THP, the company biologist will be called for internal consultation.
  - -During pre-operative meetings with the Licensed Timber Operators (LTOs) MRC will alert the LTO to protective measures and concerns for breeding raptors.
  - -Fallers will be advised to look up in the tree prior to falling and check for raptor nests. If a nest, or other sign, is observed the faller will suspend operations in the immediate vicinity of the nest until reviewed by MRC personnel.
  - -Active raptor nests will be buffered a minimum of 300' throughout the breeding season.

the property given the availability of suitable habitat. Formal survey work on the ownership has included Northern Spotted Owl, Marbled Murrelet, American Peregrine Falcon, Red Tree Vole, Goshawk, and Southern Torrent Salamander. Some important results include establishing the presence of over 100 Northern Spotted Owl activity centers and one Marbled Murrelet nest site.

MRC RARE & ENDANGERED PLANT POLICY

- For each THP, MRC will determine the likelihood of impact on plants of concern. Initially this will involve working with the Native Plant database and/or a consulting botanist to identify likely habitats and develop survey protocols where appropriate.

In addition to increasing the baseline survey data for species populations, MRC targets certain habitat elements that have beneficial impacts to many land-based species. The maintenance and improvement of these elements are expected to promote biological diversity across the landscape and protect species sensitive to logging operations. The targeted elements include snags, downed large woody debris, mature conifer forest habitat, old growth trees, hardwoods, connectivity, and acreage with unique habitat such as decadence, wetlands, springs, cliffs, and caves.

Currently, MRC is engaged with a variety of federal and state agencies (National Marine Fisheries, United States Fish & Wildlife, California Department of Fish & Game) as well as external consultants for technical assistance in determining targets for these habitat elements. Discussions have centered on reviewing site potential, species recovery projections, and recruitment to achieve targeted element levels. MRC is drawing from a variety of literature and experience in the redwood region to assist with these discussions. It is likely that within two years, MRC will produce a Habitat Conservation Plan (HCP) to summarize the outcome of this technical work, and formalize a long-term commitment to habitat improvement work. The following sections detail the current MRC policies for protection and enhancement of these habitat features.

Land-Based Habitat Elements Priorities
Snags
Downed Logs
Mature Conifer Forest
Old Growth Trees
Hardwoods
Unique Habitats
Connectivity

MRC SNAG POLICY

- All snags will be retained except in cases where they pose safety or excessive fuel loading hazards.
- Permanent conifer and hardwood snag retention and recruitment, of size and distribution to be biologically meaningful, will be a part of every timber harvest plan.
- On a THP by THP basis, either before or after harvest activities, MRC will capture and map snag locations and record tree morphology as part of a long-term monitoring project.
- If snag density is deficient, live cull trees or deformed green trees will be recruited.
- In WLPZs and other wildlife emphasis areas (Northern Spotted Owl sites, unique areas) recruit a minimum of 2-3 snags/acre (min 16"d.b.h., 10' length) averaged over 40 acres.
- In general forested areas, recruit a minimum of 1-2 snags/acre (min 16"d.b.h., 10' length) averaged over 40 acres.

Standing Snags: MRC defines snags as standing dead or partially dead trees greater than 16 inches dbh and taller than 10 feet. The availability of standing snags is critical for cavity-dependent wildlife populations such as several species of woodpeckers, wood ducks, spotted owls, many songbirds, bats, and fishers. Information on the abundance and condition of snags was collected as part of the inventory update process in 1998 and 1999.

Average Snags Per Acre By Watershed Area

	Average Number of Snags/Acre >= 16" dbh, 10' length		
	conifer	hardwood	total
Albion	0.56	0.19	0.75
Garcia River	0.85	0.63	1.48
Navarro West	0.49	0.36	0.85
South Coast	1.01	0.29	1.30
Total	0.75	0.35	1.10

The collected information indicates the current average snag density across a four-watershed area (approx. 96,000 acres) of about 1 snag/acre. MRC's objective is to have a greater presence of snags. The target is to retain 2 to 3 snags per acre averaged over 40 acres in riparian areas. The target in other forested areas is 1 to

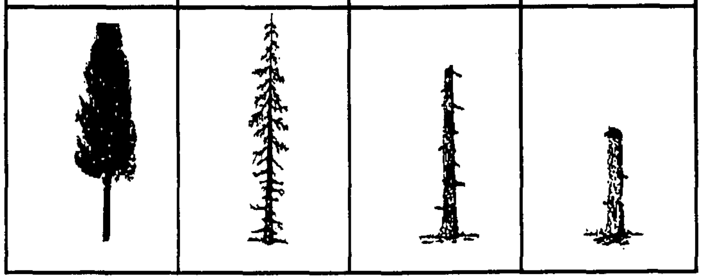
2 snags/acre averaged over 40 acres. Snag selection includes a variety of tree species and diameters. When snags are deficient in an area, live cull trees with desired size and deformations are recruited for future snags. In some cases, consideration of worker safety may cause departures from the landscape-wide guidelines.

Beginning in the fall of 1999, MRC foresters began to capture and map snag locations and morphology as part of a long-term monitoring project. This work will be followed in the next few years by species population studies in conjunction with the California Department of Fish and Game.

MRC SNAG SURVEY

Species	
DBH	inches
Total Height	feet

Wildlife Tree/Snag Condition Class (Circle One)			
0	1	2	3



Cavities		
Goosepen?	Large (>5" diameter) nesting cavity?	Small (<5" diameter) nesting cavity?

Other Features				
Platform Nest Present?	Granary?	Number of Horizontal Branches > 6"	Top Condition	Old Growth?

Large Woody Debris on the Forest Floor: MRC defines large woody debris (LWD) as downed logs or fallen trees greater than 16 inches in diameter at the large end and longer than 10 feet. The LWD provides a moist microclimate for various plant and animals including mosses, invertebrates, and amphibians. It also provides feeding substrate for invertebrates and for the mammals and birds that feed on the invertebrates and fungi living in and on the logs. As the wood decays, the downed logs also contribute nutrients to the forest floor. LWD has also been part of the ongoing inventory program.

Baseline data collection in four of the watershed areas (approx. 96,000 acres) shows healthy amounts of downed woody debris. Targeted LWD density is 5 to 7 downed logs > 16" large end diameter per acre randomly distributed across the landscape. To achieve this target, LWD is retained and recruited during timber harvesting operations, retained from windfall, and increased by a program to return logs from cull decks (old decks of logs sitting along roads resulting from past utilization practices) to the woods. LWD accumulation is monitored by company biologists and foresters to avoid problems associated with creation of fire hazards or pest infestations.

Large Woody Debris on the Forest Floor
By Watershed Area

	Average Number of Downed Logs/Acre >= 16" diam. Large end, 10' length		
	conifer	hardwood	total
Albion	8.76	0.43	9.19
Garcia River	15.29	0.60	15.89
Navarro West	9.00	0.39	9.39
South Coast	8.71	5.35	14.06
Total	9.87	2.21	12.08

MRC LWD POLICY

- All large woody debris (LWD) in WLPZs will be retained with the exception of removal due to road obstruction or moved for riparian and stream restoration work.
- In WLPZs, MRC will recruit a minimum of 7 downed logs/acre (min 16"avg. diameter, 10' length) averaged over 40 acres.
- In general forested areas, MRC will recruit and retain a minimum average of 5 downed logs/acre (min 16"avg. diameter, 10' length) averaged over 40 acres.
- All unmerchantable logs generated from current operations will be returned to the forest floor prior to removal of equipment.
- Unmerchantable logs, left from past operations, will be returned to the forest floor or watercourse enhancement projects when equipment is available in the area.

Mature Conifer Forest: Mature forest habitat contains relatively dense canopy closure, an overstory of trees with greater than 24" d.b.h., and the presence of forest structure such as snags and downed woody debris. This kind of habitat is not prevalent on MRC lands or other private timberland ownerships in the area. Currently, there are about 16,000 acres of mature forest habitat on MRC lands. The targeted amount of this habitat is over 70,000 acres by the end of the fifth decade. The company's silvicultural prescription policies, harvest policies within the WLPZs (approximately 22,000 acres) and Northern Spotted Owl buffer zones (approximately 9,000 acres) are designed to encourage development of more mature forest on MRC lands. The landscape planning process described in the first section of this management plan will allow for much more specific planning and monitoring for the amount of mature conifer forest present in the different watershed areas.

MRC UN-HARVESTED OLD GROWTH STAND POLICY

- MRC will preserve all previously un-harvested stands displaying old growth and late successional characteristics (Forest Stewardship Council Type I)
  - No harvesting will occur in these stands.
  - MRC will pursue conservation easements to permanently protect these Type I Old Growth stands.

MRC PREVIOUSLY HARVESTED OLD GROWTH STAND POLICY

- MRC will preserve the character and functionality of all previously harvested stands with at least 6-15 old growth trees or more per acre, approximately 25% of the original tree density (Forest Stewardship Council Type II)
  - In some cases, single tree selection harvesting may be done in these stands.
  - Residual Old Growth trees will be protected per policy.

Old Growth Trees: MRC developed protection measures for three kinds of old growth. MRC lands contain approximately 130 acres of stands that have never been harvested that contain significant old growth characteristics. These stands are preserved from harvest and will be protected with a conservation easement. MRC lands contain approximately 1,250 acres of stands that have previously been harvested but could contain at least 6-15 old growth trees per acre, or approximately 25% of the

MRC RESIDUAL OLD GROWTH TREE POLICY

- MRC will preserve individual Old Growth trees, conifers and hardwoods, that have significant habitat values or provide unique biological function within the forest. These Old Growth Trees are remnant trees from the primary forest, established prior to 1800 AD which will be difficult, if not impossible to replicate within the MRC forest landscape. They include:
  - Any redwood tree, 48" dbh and larger, established prior to 1800.
  - Any Douglas fir tree, 36" dbh and larger, established prior to 1800.
  - Any tree established prior to 1800 with a preponderance of species-specific Old Growth characteristics, regardless of diameter. (See Table on Next Page)
  - Any tree established prior to 1800 which cannot be replaced in size and function within 80-130 years, regardless of diameter or presence of Old Growth characteristics.

original old growth stand. The residual old growth trees and late successional characteristics of these stands are protected and only silviculture, such as thinning from below, is allowed to enhance or extend these stands. MRC lands are estimated to contain up to 50,000 residual old growth trees. These trees are preserved based on a policy that protects by age, size, function, and characteristics specific to particular species. Individual trees are marked, recorded, and digitized as foresters and inventory personnel visit stands across the ownership.

<u>Redwood Old Growth Characteristics</u>

Trees generally in the upper 20% diameter class of the species on site
Deep, plate-like bark patterns, fire resistant
Flattened or irregular crowns, highly complex structure
Highly reiterated crowns(multiple sprouting, replicated growth patterns)
Large limbs, in excess of 6-8 in diameter
Crown debris accumulation
Platforms
Cavities, partial snag formation
High presence of complex lichens and moss
Cat-facing or basal burn cavities

<u>Douglas-fir Old Growth Characteristics</u>

Trees generally in the upper 20% diameter class for the species on site
Bark deeply fissured, thick and fire resistant
High presence of lichens and moss, where crown soils present, ferns
Large lateral limbs in excess of 8-10 inches in diameter
Flattened, irregular crowns with lower limbs with signs of decay and crown thinning
Conks
Partial sagging in tops
Broken out tops
Crown debris accumulation
Trees along the margins of pioneer vegetation types which reoccupied the sites following disturbances, normally will have limbs extending nearly to the ground, and are often wind shaped.

<u>Hardwood Old Growth Characteristics (Tanoak, Live Oak, Black Oak, Madrone, Laurel, Chinquapin)</u>

Trees generally are in the upper 20% diameter class for the species on site
Flattened or irregular crowns, highly complex structure
Multiple branching crowns with few large well developed main limbs
Large limbs, in excess of 4-12 inches in diameter
Crown debris accumulation
Platforms
Cavities, partial snag formation
Crown die- back

Hardwoods: The role of hardwoods in a properly functioning conifer forest is often discounted because the hardwood species have not provided commercial returns to timberland owners. MRC has policies to protect a natural balance of hardwoods on its forestlands, to retain a representation of hardwood trees such as Tanoak, California Black Oak, Pacific Madrone, Live Oak, Alder, Laurel, and Chinquapin, and to retain concentrated stands of hardwood species where site conditions are unsuitable for conifer species.

MRC HARDWOOD POLICY

- Every timber harvest plan will be reviewed for the retention of any hardwood trees that enhance wildlife habitat.
- Every THP will retain all of the trees of the true oak species (> 18" dbh) present prior to harvest with the exception of incidental removal for safety, road right of way, or yarding corridors.
- The objective across the forestlands is to restore the natural balance between conifer and hardwood, which will vary depending on site. Hardwood retention will be 15% of the total post harvest basal area, provided that hardwoods comprised at least 15% of the basal area prior to harvest.

Unique Habitats: Many wildlife species use special habitat types for nesting, cover, and foraging activities. In addition to hardwood trees, these include wetlands, springs, cliffs, and caves. Wetland areas such as seeps and springs provide important habitat for plants, invertebrates, and amphibians adapted to cool, moist conditions. These and other unique habitat types found on the property (cliffs, talus slopes, serpentine barrens, burrows, caves, mine shafts, meadows, coastal bluff scrub, coastal dunes) will be protected by site-specific buffer zones to avoid any adverse impacts of harvesting or other forest management activities.

Unique Habitat Areas Current Retention

	Current
No Harvest Acres	
Un-Harvested O.G.(FSC Type I)	130
Oak Woodlands	4,800
Navarro Strip	230
Conservation Easement	90
Protected Groves	13
Pygmy Forest	150
Total Acreage	5,413
High Retention Selection Harvest	
Prev. Harvested O.G.(FSC Type II)	1,250
Streamside Buffer Zones	21,400
Marbled Murrelett Management	1,400
State Park and other buffer zones	380
Total Acreage	24,430
Buffered Areas	
seeps, springs, cliffs, caves, talus slopes, serpentine barrens, burrows, mine shafts, meadows, coastal bluff scrub, coastal dunes	

Connectivity: Unique areas, such as oak woodlands and streamside buffer zones currently provide some connectivity on MRC forestlands. Connectivity for different species at appropriate spatial scales will be a part of the future harvest planning process for each watershed. Forest fragmentation and loss of cover will be evaluated with the landscape planning process as logic and metric values by species are developed.

3. Aquatic-Based Habitat

Anadromous salmonids (salmon that are born and raised in freshwater, move to the ocean to mature, and return to freshwater to reproduce) such as Chinook salmon, Coho salmon, and Steelhead have been the focus of surveys over different watersheds on MRC lands. Sampling has been done through electrofishing and snorkeling techniques, outmigrant trapping and winter carcass surveys. This work gives MRC a current look at the distribution of these species throughout streams within the ownership and in some cases will allow for tracking of life-stage trends.

Fish & Fish Habitat Sampling Activities on MRC Lands

Carcass Surveys

Albion 1998-99

Electrofishing

Albion 1998-99
Flynn Creek 1999
Hollow Tree 1999
Throughout Ownership 2000/2003

Stream Temperature Monitoring

Throughout Ownership 1999/2000

Habitat Assessment

Hollow Tree 1999	Willow Creek 2000
Navarro 1999	Big River 2000
Albion 1999	Gualala 2000

Thalwag and Cross-Section Profiles (Spawning Gravel Assessment)

Garcia 1998	Elk Creek 1999
Albion 1998	Willow Creek 2000
Noyo 1998	Ackerman Creek 2000
Hollow Tree 1999	Big River 2000
Navarro 1999	

Outmigrant Trapping

Hollow Tree 2000/2001
Cottoneva 2000/2001
Greenwood Creek 2001
Elk 2001

California Department of Fish and Game Steelhead Research and Monitoring Program (SRAMP) began collecting baseline information using outmigrant trapping, carcass surveys, and electrofishing in the Noyo River in 1999. Other watersheds within MRC forestlands have been utilized as sites for DNA collection by company biologists and other participating agencies used to develop a genetic database compiled by Bodega Marine Lab and National Marine Fisheries Service (NMFS) scientists. The UC Davis John Muir Institute for the Environment funded by California Department of Transportation continues to conduct research on salmonids and habitat use in the Navarro River watershed. MRC supports and encourages outside researchers and universities to help further the research in California coastal watersheds for the benefit of the fisheries resource.

In addition to increasing the baseline survey data for species such as Coho salmon, Chinook salmon, Steelhead trout, aquatic amphibians, and macro invertebrates, MRC targets the habitat elements that have beneficial impacts to these and other aquatic-based species. The maintenance and improvement of these elements, combined with controlling the harvest activities upslope, are expected to improve fish species numbers over time. Targeted habitat elements include large woody debris, stream temperatures, canopy/shade, coarse and fine sediment, water flow, nutrients and barriers to migration. Restoration work is directed to enhance these elements by identifying limiting habitat factors in the Watershed Analysis work (see following section), and biological survey work.

Aquatic-Based Habitat Elements Priorities
Large Woody Debris
Stream Temperature
Canopy/Shade
Coarse and Fine Sediment
Water Flow
Nutrients
Barriers to Migration

As with the land-based habitat protections, MRC is currently engaged with a variety of federal and state agencies (National Marine Fisheries Service, United States Fish & Wildlife Service, California Department of Fish & Game) as well as external consultants for technical assistance in determining targets for these habitat elements. It is likely that within two years, MRC will produce a Habitat Conservation Plan (HCP) to summarize the outcome of this technical work, and formalize a long-term commitment to habitat improvement work. This habitat plan will draw heavily on the ongoing watershed analysis work, road survey work, harvest protective measures, and restoration programs described in following sections.

Watershed Analysis: Several of the watercourses on the MRC ownership have been listed as quality impaired by the State Water Resources Control Board and the U.S. E.P.A. (Section 303d, Clean Water Act) and are in need of restoration activities. These watercourses are listed due to concerns that accelerated sediment production and, in some cases, elevated water temperatures, have adversely affected salmonid habitat. As a result of these listings, a company hydrologist, fisheries biologist and a team of geologists and fisheries technicians have been actively engaged in watershed analysis.

Watersheds are a fundamental unit of ecosystems that can be used effectively to evaluate cumulative impacts on fish and other aquatic resources. The purpose of the intensive watershed analysis work is to provide baseline data to monitor stream conditions that will allow MRC to determine the mitigations needed for any harvest plan, to prioritize road repair, stream restoration, and to monitor long term trends.

Mapped data, such as mass wasting areas, stream reaches with high temperatures, and stream reaches lacking in large woody debris can be combined into the landscape planning process to integrate high levels of protection into harvest management planning. SHALSTAB (Shallow Slope Stability Model) maps are used as predictors of shallow-seated landslides. These maps have been integrated into the landscape planning process to increase tree retention in stands with moderately high or greater risk. (See SHALSTAB stand map on following page)

By understanding restoration priorities and the locations of high risk roads and stream crossings, foresters can combine the restoration work and harvest work while equipment is present in any one watershed area. (See following stand map on high priority road projects) Watershed analysis also enables MRC to establish more sophisticated improvement targets and to monitor progress.

MRC Watershed Analysis Work
Clean Water Act Section 303(d)
Threatened or Impaired Waterbodies

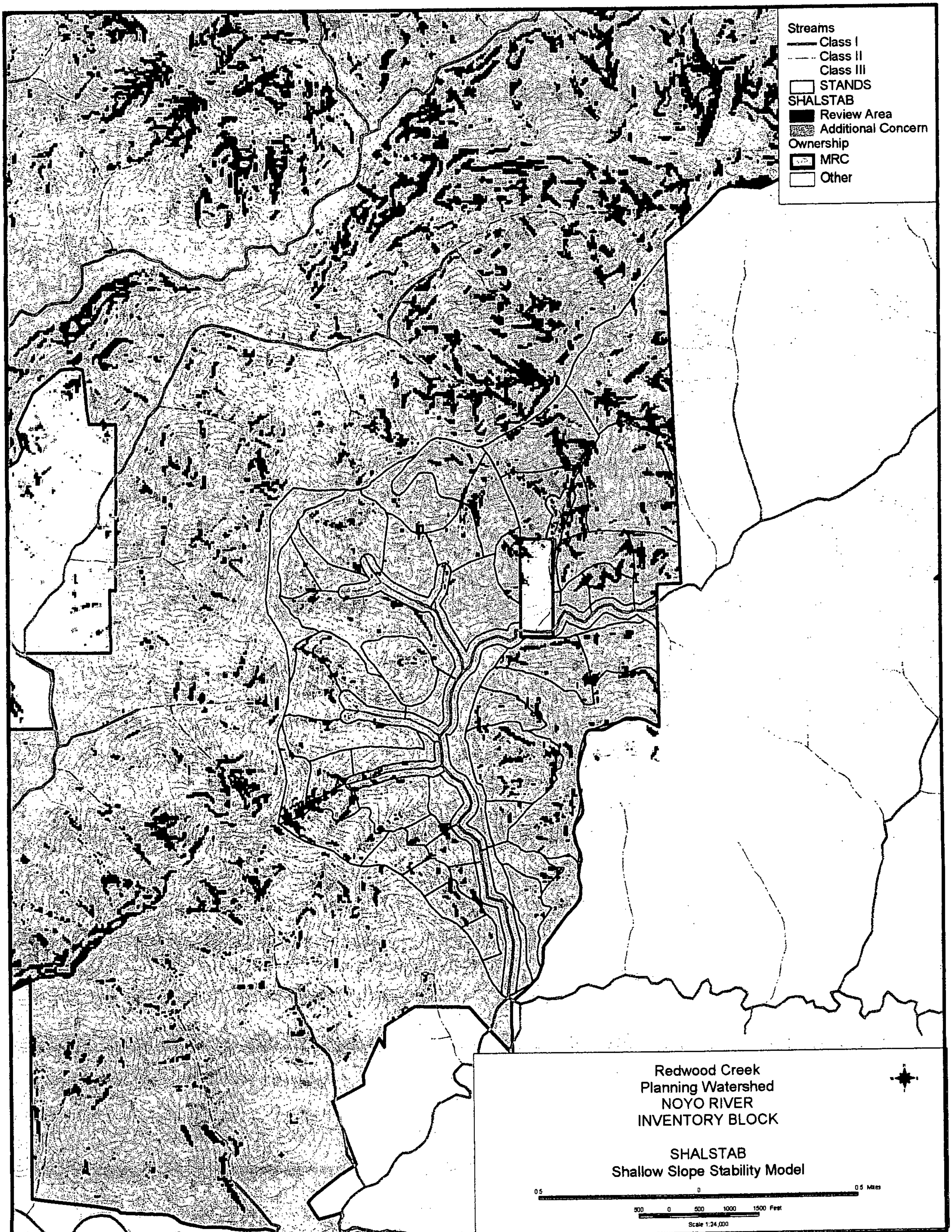
Watershed	MRC Acreage	MRC as % Total Watershed Acreage	Target Date to Complete Watershed Analysis	Area of Major Concern
Garcia River	11,500	16%	*completed*	Sediment and Temperature
Noyo River	20,000	28%	*completed*	Sediment
Albion River	15,500	54%	*completed*	Sediment
Willow & Freezeout Creeks	4,575	22%	2001	Pilot Project with Board of Forestry to Assess Rule Proposals
Hollow Tree Creek	19,000	69%	2001	Sediment and Temperature
Navarro River	55,000	27%	2001	Sediment and Temperature
Big River	34,500	45%	2001	Sediment
Gualala River	8,000	3%	2001	Sediment
Russian River	11,000	1%	2001	Sediment

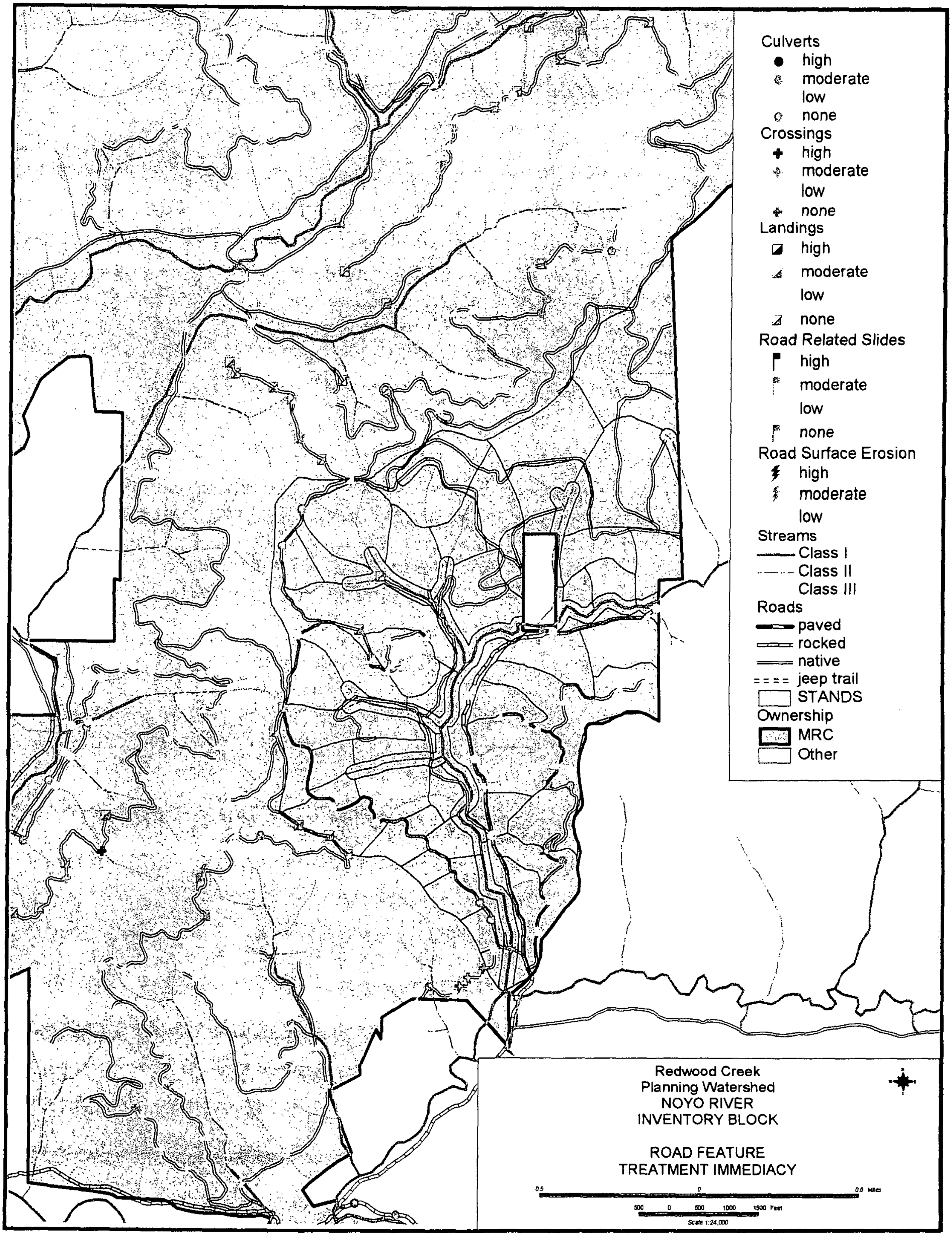
MRC WATERSHED ANALYSIS OBJECTIVE

- Intensive field watershed analysis (also know as "Level II") will be completed on all 303d listed watersheds (70% of MRC forestlands) by the end of 2001.

This analysis includes assessments of:

- Mass wasting inventory and map units.
- Analysis of road erosion and road erosion hazard.
- Stream channel condition.
- Riparian function and condition for shade and large woody debris recruitment potential.
- Fish habitat conditions.
- Potential salmonid distribution and habitat.


Streams
Class I
Class II
Class III
STANDS
SHALSTAB
Review Area
Additional Concern
Ownership
MRC
Other
Redwood Creek
Planning Watershed
NOYO RIVER
INVENTORY BLOCK
SHALSTAB
Shallow Slope Stability Model


Culverts
high
moderate
low
none
Crossings
high
moderate
low
none
Landings
high
moderate
low
none
Road Related Slides
high
moderate
low
none
Road Surface Erosion
high
moderate
low
Streams
Class I
Class II
Class III
Roads
paved
rocked
native
jeep trail
STANDS
Ownership
MRC
Other
Redwood Creek
Planning Watershed
NOYO RIVER
INVENTORY BLOCK
ROAD FEATURE
TREATMENT IMMEDIACY
0.5 0 0.5 Miles
500 0 500 1000 1500 Feet
Scale 1:24,000

Road Improvements: MRC owns and manages approximately 1,800 miles of forest roads. The company budgeted over $3 million per year in 1999 and 2000 to upgrade and relocate historic roads. This effort is based on the belief that road improvement will have the largest and most immediate positive impact on reducing sediment in the streams. Improperly designed roads and road crossings, whether being actively used or not, are the primary sources of man-made stream sediment on MRC lands. Past road building practices still contribute to chronic sediment loading. Priorities for road projects are based on the volume of sediment that can potentially be controlled, and the risks of imminent failure to the road or drainage structures. These measurements are part of the road survey that and used as part of the watershed analysis work.

MRC ROAD SURVEY OBJECTIVE

- All MRC roads will be inventoried, mapped, associated sediment sources assessed, and mitigation work identified and prioritized by December 2003.
- Site-specific upgrade projects for road stabilization, road removal, and other prescriptions to address sediment sources will be developed, implemented, and monitored.

MRC ROAD POLICY

- Construction/reconstruction of roads will follow guidelines in the 1994 Handbook For Forest and Ranch Roads by Weaver and Hagans.
- All construction/reconstruction of roads will meet water quality standards developed in MRC's watershed analysis work to control sediment delivery, protect stream bank stability, and provide passage for fish in all life stages in Class I streams.
- Rocked fords, rolling dips and out-sloping will be used where possible; watercourse crossings will be sized to pass 100 year flood requirements.
- The condition of culverts, bridges, and all other erosion control structures will be monitored on an annual basis. Additional monitoring of identified projects or trouble spots will occur during the winter and major storm events.
- A long-term road management plan will be developed to cover ongoing monitoring and maintenance for temporary, seasonal, and permanent roads.

Sediment reduction is an integral part of the preparation of each Timber Harvest Plan (THP) and is specifically targeted in several ongoing restoration projects outside harvest areas. These projects often involve cooperative work with conservation organizations and government agencies. MRC's Garcia project includes approximately 8.75 miles of road improvements, recommended and managed by a group led by Trout Unlimited. Other road projects are in the North Branch Navarro, South Fork Albion, Ackerman Creek, and Schooner Gulch where MRC will work to leverage its own funds by accessing various grant funding sources.

Road Improvement Representative Project Cost List			
	Cost Range $		
	Low	High	Per
Relocate or close roads next to stream beds or with unstable slopes.	20,000	85,000	Mile
Remove excess perched material on roads or landings.	1,500	20,000	Mile
Provide improved drainage such as waterbars to direct surface runoff.	800	2,000	Mile
Install upgraded culverts.	5,000	40,000	Mile
Install upgraded watercourse crossings.	7,000	80,000	Each
Construct sediment ponds.	500	2,500	Each
Outslope roads to reduce erosion.	1,500	20,000	Mile
Rocking of road surfaces to reduce erosion.	15,000	30,000	Mile
Implement road inspection surveys.	40	220	Mile

Streamside Protections: Key aquatic habitat elements are protected with policies that direct management activities in WLPZ (Watercouse and Lake Protection Zones) (see policies on following page). Silviculture activities in these zones are restricted to High Retention Selection that requires high conifer stocking before harvesting is considered. A practical result of MRC's restrictive streamside policies is that MRC will delay harvest in most stream zones for the next 20 years.

Large woody debris (LWD) in streams influence the scour of streambeds thereby creating pools and gravels favorable for salmonid rearing, overwintering, and spawning. LWD also acts to store and slowly release stored stream sediment through the stream network. To improve recruitment of LWD in streams, MRC permanently retains larger trees near stream channels, restricts removal of downed logs in streamzones, and works with the California Department of Fish and Game to place larger log pieces and root wads into stream channels. To maintain and improve streamside temperatures MRC implements canopy closure guidelines, stream buffer zone policies, and riparian vegetation restoration work. To control the flow of fine and coarse sediment into streams, MRC restricts operations in unstable areas, restricts winter harvesting, covers bare mineral soil, and most importantly reconstructs and de-activates roads with high potential for sediment input or failure.

MRC Streams and Stream Classifications		
	Miles on MRC Lands	**Definition**
Class I	520	Year-round water flow, fish bearing stream
Class II	460	Adequate water flow for nonfish aquatic species
Class III	720 (estimate)	Seasonal flow, no aquatic species

MRC STREAMSIDE POLICY

- At least 70% absolute canopy cover within the WLPZs (Watercourse and Lake Protection Zones) will be retained or recruited. (ref. High Retention Selection retention specifications)
- Where watershed analysis indicates there is high or moderate in-stream large woody debris (LWD) demand, any harvest activity in the WLPZ will recruit and permanently retain 20 trees per 330 feet of lineal Class I watercourse (10 each side) and 10 trees per 330 feet of lineal Class II watercourse (5 each side) that have the greatest potential for LWD input. Greatest potential for LWD input is defined by: disposition (likelihood to fall in the watercourse), distance to the stream, size, and species. Priority will be given to the largest 20% diameter trees within 60' of the watercourse. These retention standards will be held constant so long as scientific research indicates that the policy is necessary. (ref. High Retention Selection retention specifications)
- Sanitation salvage logging will not be conducted in WLPZ or ELZ buffer areas.
- 20-Year minimum interval between harvest activities in WLPZ.
- All large woody debris (LWD) in the watercourse and WLPZ will be retained. No salvage logging of LWD.
- Foresters are encouraged to look, with guidance from biologists, for ways to put more LWD into the stream channel.
- Foresters are encouraged to develop increased filter capacity in these zones including thinning, pruning, lopping, and revegetating slides.
- Any current or future livestock leases will include mitigation measures to protect streamsides and avoid riparian damage.

MRC UNSTABLE AREAS POLICY

- Foresters will first use Division of Mines and Geology landslide maps, past Timber Harvest Plans and the SHALSTAB (Shallow Slopé Stability) model as tools to identify potentially unstable areas.
- SHALSTAB maps will be included in the THP and sites will be reviewed in the field by the RPF (Registered Professional Forester) preparing harvest plans.
- No harvest, road, or landing construction activity will occur in areas identified in the field as having a significant likelihood of sediment delivery to a watercourse from mass wasting unless a site-specific assessment is conducted and operations approved by a registered geologist, with the exception of cable or helicopter harvesting that retains over 50% of the pre-harvest basal area.

MRC EXPOSED SOIL POLICY

- In WLPZs, 100 square feet of exposed mineral soil will require mulching, cover with slash, and/or seeding.
- In WLPZs, roads assessed and identified with capacity for significant discharge of sediment will require mulching, cover with slash, and/or seeding.

MRC EQUIPMENT POLICY

- Equipment is excluded from WLPZs for all Class I, II and ELZs (Equipment Limitation Zones) for all Class III streams with exception of use on existing trails with no sign of instability.
- When equipment is used in WLPZs or ELZs, trails and landings will be packed with slash and debris following completion of operations.

MRC WATER DRAFTING POLICY

- Water drafting for timber operations from within a channel zone of a Class I watercourse will meet the following standards:
  - -Speed of water entering intake pipe will be less than .33 feet per second.
  - -All approaches to drafting locations will be rocked.
  - -Intakes will be screened with mesh, perforated plate or pipe having openings of 3/32" or smaller.
  - -Water usage will be restricted so as to keep flows above critical levels.
  - -Modifications to drafting locations will minimize removal/disturbance to the streambank, streambed, and existing vegetation.

Logging Methods: During 1998 and 1999, MRC harvested approximately 80% of its conifer volume for the year by cable yarder and the balance by tractor or helicopter. Cable yarding techniques result in less soil disruption, less erosion potential, and less road and skid trail construction. The company will continue to emphasize cable yarding over other methods, and expects the percentage of cable yarding to remain at or close to 1998-99 levels in the future. MRC also restricts winter logging operations to protect aquatic habitat. (See policy below).

Restoration Projects:
Restoration projects on MRC properties are a mix of company and cooperatively sponsored activities. MRC is fortunate to have interested conservation groups and government agencies willing to assist in stream restoration work. In addition to the road work previously discussed, the focus of these projects has been assessment studies, adding structure to the streams (large woody debris and boulders), and improving stream-side vegetation. The following tables show the variety of projects ongoing in 2000 and MRC is exploring ways to increase their number in the future.

MRC WINTER HARVESTING POLICY (Nov. 15 - April 1)

- Cable yarding on rocked landings may be conducted if sediment movement can be avoided.
- Loading and hauling on rocked roads and landings will not be conducted during periods of rainfall or when roadside ditches are flowing with surface runoff, or when roads are saturated and cannot support the heavy loads. At first sign of measurable rain, trucks in the woods will make their final trip out and trucks not yet in the woods will be asked to return home for the day
- Operations during extended periods of dry weather (prior to two inches of seasonal rainfall) might include logging and hauling on non rocked roads.

MRC Restoration and Assessment Projects – 2000

Watershed /Location	Project	MRC Partner	Status
North Branch/ North Fork Navarro & Flynn Creek	• Fish Habitat Inventory • Fish Habitat Improvement • Riparian Tree Planting • Fish habitat inventory • Fish habitat improvement • Riparian tree planting	California Department of Fish and Game, and California Conservation Corps	• Planting began in February 1999 • Stream work began in May, 1999, ongoing in 2000
Daughtery Creek (Big River)	• Fish Habitat Inventory • Fish Habitat Improvement • Riparian Tree Planting	California Department of Fish and Game, and California Conservation Corps	• Planting began in February 1999 • Stream work began in summer, 1999
Hollow Tree Creek (and Waldron Creek)	• Fish Habitat Improvement • Spawning Surveys, and Juvenile Population Studies	California Department of Fish and Game, and California Conservation Corps	• Spawning survey completed • Fish habitat work began July 1999 • 10 Loads of cull logs will be shipped from Juan Creek for habitat improvement in summer 2000
Albion River, So. Fork Albion	• Fish habitat improvement • Riparian Tree Planting	California Department of Fish and Game, and California Conservation Corps.	• Tree planting completed winter of 1999 • Fish habitat improvement will include root wads and other large wood debris (LWD) for stream structure. • Completed

Watershed /Location	Project	MRC Partner	Status
Noyo River, Redwood Creek, Middle Fork Noyo River	• Fish Habitat Assessment • Fish Habitat Improvement	California Department of Fish and Game, California Conservation Corps	• Fish habitat assessment started May 1999 • Fish habitat improvements ongoing
Garcia River	• Stream Channel Morphology Monitoring • Stream Temperature Monitoring • LWD Surveys Spawner Surveys	California Department of Forestry, through the Mendocino County Resource Conservation District	• Stream surveys began in 1998 • Spawner surveys, Winter 1998-9 • Stream surveys continued in 1999. • Report completed in 2000
South Fork of the Garcia River	• Road Assessment and Rehabilitation • In Stream Structure Work • Coho Rearing Habitat Improvement	Trout Unlimited and Craig Bell	Proposal submitted to Department of Fish and Game, work started in 2000
Schooner Gulch	• Road Rehabilitation and Sediment Source Reduction.	Moat Creek Managing Agency	Permits still pending, to be started late Summer 2000
Russell Brook, Mettick, and Ramon Creeks (Big River)	• Inner Gorge Erosion Stabilization and Stream Bank Protection	Mendocino Fisheries Program, E Center	Proposal submitted to U.S. Fish and Wildlife, funding pending, work to be done Summer 2000
Beaver Pond Gulch (Big River)	• Fish passage Barrier Removal • Stream Bank Stabilization	Mendocino Fisheries Program, E Center	Proposal submitted to State, funding pending, work being completed Summer 2000
South Branch North Fork Navarro	• Fish Habitat Improvement • Riparian Tree Planting	California Department of Fish and Game, and California Conservation Corps	Stream work to be completed in 2000 Planting started in 1999 and to be completed in 2000

Watershed /Location	Project	MRC Partner	Status
Dutch Henry Creek (Navarro River)	• Road assessment	Mendocino County Resource Conservation District, Dan Sicular	Assessments to start in 2000
Little North Fork of South Fork Albion River	• Road Upgrades and Sediment Control • Fish Passage Barrier Removal	California Department of Fish and Game	Work completed in Summer 2000
Ackerman Creek, 5-Mile Culvert	• Channel Improvement • Fish Passage Barrier Removal	California Department of Fish and Game	Work completed in Summer/Fall 2000
North Fork Navarro	• Road Upgrades and Sediment Control	California Department of Fish and Game	Work completed in Summer/Fall 2000

4. Species Composition

Human activities have profoundly changed MRC's forestlands over the past 150 years. One of the most significant of these changes has been the alteration of the historical tree species composition. Past harvest operations focused on the easiest and most valuable trees, generally large redwood and Douglas-fir. Few reforestation efforts existed following these harvests, and repeated burning was frequently used to attempt to convert forestland into grazing lands. The net result of these past high-grading and conversion activities is a current imbalance in species composition. About half of MRC's lands have a much higher percentage of hardwood in forested stands than existed before commercial logging activities. In these stands hardwoods typically make up the dominant overstory species. One of MRC's objectives is to return the lands to the mix that originally existed on the ownership where hardwoods were typically an understory species.

Tanoak is by far the most common and abundant hardwood. It is a stump-sprouting species and competes vigorously in commercially harvested areas. Hardwoods make up about 36% of the basal area on MRC lands and the hardwood tree or "stem" count percentage is almost 50% (there is much less basal area per stem for hardwood than conifer). Over 80% of the hardwood present is tanoak. MRC's objective is to reduce, but not eliminate, tanoak from its ownership. Retention of a proportion of hardwoods, especially Madrone and true oaks, is desirable for wildlife habitat. The targeted level for hardwood retention in the long term is about 15% of standing basal area.

Comparison of Conifer and Hardwood Densities
Current Estimates (6/00)

Watershed Area	**Conifer** Basal Area (average square feet per acre)	**Hardwood** Basal Area (average square feet per acre)	% Hardwood of Total Basal Area
Albion	135	27	17%
Big River	58	31	35%
Garcia	76	48	39%
South Coast	105	58	36%
Navarro East	51	31	38%
Navarro West	85	45	35%
Noyo	83	52	39%
Rockport	70	59	46%
Sonoma	73	38	34%
Ukiah	53	58	52%
Weighted Average	79	45	36%

MRC is working to minimize harvesting disturbance and use of chemicals currently in dealing with the excess tanoak volume. Finding solutions that work is important to MRC because restoration of the historic mix of tree species is the first step towards a more comprehensive move towards re-establishing the composition of pre-settlement forestlands and wildlife/fish dependent species.

During 1999, MRC experienced a net loss of over $1.5 million on the harvest of 70,000 tons of tanoak and restoration of the acreage into redwood and Douglas fir. Any increase in the level of this harvest, necessary to reverse the species mix trend, becomes cost-prohibitive over time. A promising development, however, is the conversion of tanoak into a value-added hardwood flooring product. In the last eighteen months, MRC, in partnership with its associated mills and distribution business, has invested in engineering and equipment to restart the Willits sawmill and develop remanufacturing capability for hardwood flooring. The first commercial quantities of product are currently being prepared to go to market in the Fall of 2000. The flooring will be made of tanoak, which will be marketed under the trade name of California Chestnut Oak (a name for tanoak used more commonly in the 1940's and 1950's).

Species	Side Hardness (lb)
Aspen	350
Black Cottonwood	350
American Chestnut	540
Yellow – Poplar	540
Red Alder	590
Silver Maple	700
Giant Chinquapin	730
Bigleaf maple	850
Black Ash	850
Cherry	950
Black Walnut	1010
Southern red oak	1060
California black oak	1100
Oregon ash	1160
California – laurel	1270
Northern red oak	1290
Eastern White Oak	1370
California Chestnut Oak	**1410**
Sugar Maple	1450
Pacific Madrone	1460
Oregon white oak	1660

MENDOCINO
FOREST PRODUCTS CO., LLC
California Chestnut Oak Flooring

Sawmill Production
= 3 MMsf

Appearance Grades
= 3 (Country, Vintage, Classic)

Sizes - All Side and End Matched
= 2 1/4", 3 1/4", 4"

Annual Sales
= $ 5 MM plus

5. Employees

MRC can only achieve its objectives with the help of dedicated employees. To retain and attract creative, motivated people, the company is committed to providing a safe workplace, attractive pay and benefits, opportunities for personal development, and a chance to impact MRC's strategies and goals.

MRC Employees	
# Full-Time	**51**
# Part-Time	**28**
Total Annual Payroll	**$2.4 Million**
# With RPF License	**19**
# With Advanced Degrees	**6**
# With College Degrees	**42**

MRC currently employs 51 full-time and 28 part-time employees. This group includes people with a wide variety of scientific backgrounds and expertise. Over the next decade, the company would like to expand this expertise as well as the diversity of its team to meet challenges raised by the goals of this plan.

MRC Safety Statistics

	1999	Jan-July 2000	Target
Recordable	3	3	0
First Aid	25	17	0

1999 OSHA Recordable :	Poison Oak , sore wrist, sore back
1999 First Aid:	20 tick bites, one sore back, one bee sting, 3 hand lacerations/bruises
2000 OSHA Recordable :	Back injury in office, finger laceration with stitches, fainting in woods
2000 First Aid:	17 tick bites, one sore shoulder

MRC's associated mills and businesses employ an additional 454 full-time and 20 to 30 part-time and seasonal workers with an annual payroll over $17 million. These companies, Mendocino Forest Products (MFP) and Mendocino Wood Specialties (MWS), are dependent on MRC for a large portion of their raw materials.

6. Community

From the day it was formed, improved community relationships have been important goals for MRC. MRC is stepping into a set of relationships, many of which have been damaged by past practices and lack of good communication. MRC is committed to building trust with the community over time based on open, honest and responsive communication. To that end, MRC will continue to respond to inquiries in as prompt a manner as possible. MRC encourages people to make arrangements to visit its forestlands and see how this plan is taking shape on the ground.

MRC has set-up Community Action Teams at each of its locations to respond to requests for local community organization donations and sponsorship. These teams are made up of a representative committee of local employees that meet once every month to review local needs for cash, materials, or labor.

Some of MRC's forestlands are adjacent to public and private roads, neighbors, railroads, and parks. Approximately 17,000 acres on the ownership are managed with special sensitivity to the impacts any silivicultural activities may have on the viewsheds and aesthetic quality for adjacent neighbors.

Important Community Issues

- Clean water sources
- Neighbor notification
- Access to property for recreation, education
- Access to property for mushrooms, firewood
- Community donations
- Viewsheds
- Historical sites on the property
- Archeological sites on the property
- Use of herbicides on the property
- Health of the forest ecosystem
- Health of fisheries
- Health of wildlife
- Protection of unique areas
- Viability of company
- Over-Harvesting
- Cumulative Impacts
- Housing subdivisions
- Cultivation of marijuana
- Old growth
- Employment
- Fire protection
- Yield taxes
- Shared use of roads

High Community Impact Retention and Viewshed Acres

	Current
Coastal Zone Areas	8,300
Neighbors	3,800
County Road Buffers	2,800
Visual Corridors	1,100
State Park Buffers	380
Skunk RR Buffer	260
Navarro Strip	230
Total Acreage	16,870

MRC PUBLIC ACCESS POLICY

- MRC encourages cooperative education and research projects on its ownership.
- MRC properties are open at designated times and locations for the following additional activities:
- Hiking, camping, picnicking, firewood cutting, bicycling, horseback riding, cross-country running, hunting, fishing, and collection of burls, mushrooms, greens, and basket making materials
- Written permits and/or leasing arrangements (obtained by calling the Calpella office 707-485-8731 or Fort Bragg office 707-962-2800) are required for all of the above in order to shelter wildlife, prevent road damage or sedimentation, shield watercourses, educate individuals about safety issues, and to allow the company protection from personal liability claims.

Neighbors and other community members take a strong interest in what is happening on MRC forestlands. This interest comes from a heartfelt desire to ensure the lands will remain a vital community resource well into the future. This interest also comes from a desire to protect a variety of individual and group educational and recreational uses that are available on MRC properties.

The public access policy for the MRC lands is to encourage cooperative education and research on its ownership. MRC is also open to a variety of other activities including hiking, camping, picnicking, firewood cutting, bicycling, horseback riding, running, hunting, fishing, and collection of burls, mushrooms, greens, and basket making materials. Written permits and/or leasing arrangements are required for all of these activities in order to shelter wildlife, prevent road damage or sedimentation, shield watercourses, educate individuals about safety issues, and to allow the company protection from personal liability claims.

MRC DOMESTIC WATER SOURCE POLICY

- Foresters will protect sources of domestic water by providing a no-harvest and/or a High Retention Selection Harvest buffer.

In addition to the direct employment of over 500 people, MRC and its two associated companies, MFP, and MWS purchase products and services from over 90 local suppliers located in Mendocino County. The value of these contracts is more than $ 20 million.

Most contracts are involved in logging and hauling operations. MRC is partnering closely with these contractors to ensure that company policies and forest stewardship objectives are carried out in all aspects of operations on the ground. Partnering activities include joint training programs and greater involvement of contractors with timber harvest planning and layout.

Mendocino Companies (MRC, MFP, & MWS) Major Local Vendors & Contractors

	Approx. Number of Major Local Vendors/ Contractors	Approx. Value of Annual Purchases $ millions
Logging	12	14.7
Reforestation	10	2.1
Roads	12	3.5
Operating Supplies	60	1.5
Total	94	21.8

MRC CONTRACTOR TRAINING POLICY

- All contractors and employees of MRC will receive training on company policies as they relate to particular forest management activities.
- Whenever possible, pre-harvest inspection meetings will include the logging contractor as well as the MRC representative.
- Information will be clearly communicated to logging contractors (e.g.abbreviated THP and color-coded maps when appropriate to eliminate any confusion over following management policies and exemplary stewardship practices).

As MRC improves forest inventories and wildlife habitat, these successes will contribute to the stability and diversity of employment in our communities. Employment opportunities will be related directly to the forest products industry and value-added products. The impacts will also be indirect with the benefits of restored fisheries, recreation and tourism.

The company pays a yield tax of approximately $13 for each thousand board feet of timber harvested as well as property taxes. Yield and property taxes amount to about $ 1.1 million annually.

7. Quality Products

MRC currently produces approximately 40 MMbf of conifer logs per year, sells 85% of these logs to mills of its associated company, Mendocino Forest Products (MFP), and the balance to other sawmills in northern California. MRC currently produces about 100,000 tons of tanoak logs per year, sells 26,000 tons to the Willits hardwood flooring operation and the balance to firewood and chip producers in California.

Conifer Log Quality Measures		
2000 Year-To-Date	Board Feet	%
Logs to the Ukiah Mill		
Total Mismanufacture	3,760	0.0408%
Logs to the Fort Bragg Mill		
Total Mismanufacture	230	0.0051%

Hardwood "Merchantibiliy" Target		
	2000 ytd	Target
Tanoak Logs to the Willits Mill		
% Merchantable to Flooring Mill	58.5%	50.0%

Reliable delivery of high quality logs to customers is an important component of MRC's long-term viability. Quality control means delivering logs that meet customer specifications with a minimum of wood or fiber loss. Damage of logs in the woods can cause significant loss in product recovery and undo years of valuable fiber growth. Logging contractors receive penalties to payments based on any mismanufactured logs received. One objective is to close the feedback loop and let logging contractors know immediately about quality targets, improvements, and issues. MRC is adding a bucking program to facilitate removal of customized log sizes from the woods.

Sustainable, exemplary forest management practices will serve MRC's customers well. MRC is pursuing the certification of its forest practices as one method of promoting high levels of environmental stewardship. MRC hopes third-party certification of its forestry operations will create a greater demand for its products over time.

MRC is also exploring development of non-timber sources of revenue from its lands. Traditionally, timberland owners have derived a small amount of revenue, through hunting leases, grazing leases, and contracts for the removal of small volume products such as greenery for Christmas wreaths. Of potentially more significance is a growing field for non-extractive "conservation" products. MRC is currently researching and investing in pilot projects for carbon offsets and conservation easements to further assess the potential of these innovative areas.

8. Business Return

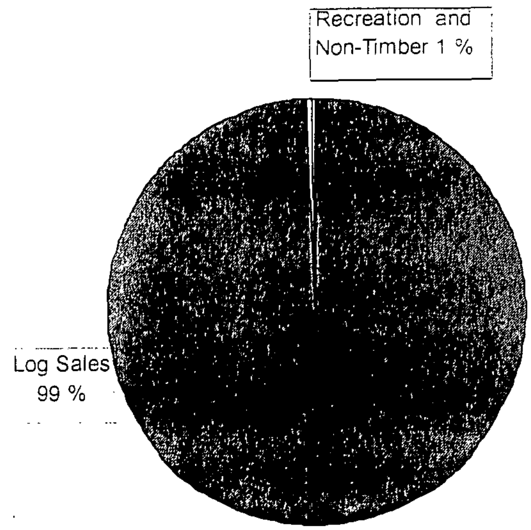
MRC does not expect to generate a significant return to its owners during the first decade. However, we are determined to demonstrate that a high level of environmental stewardship is good business and will result in fair profits over time.

Revenues for the business come largely from log volumes sold at market rates to local mills. Other revenues come from recreational leases, and non-timber sales of rock, burls, and other products.

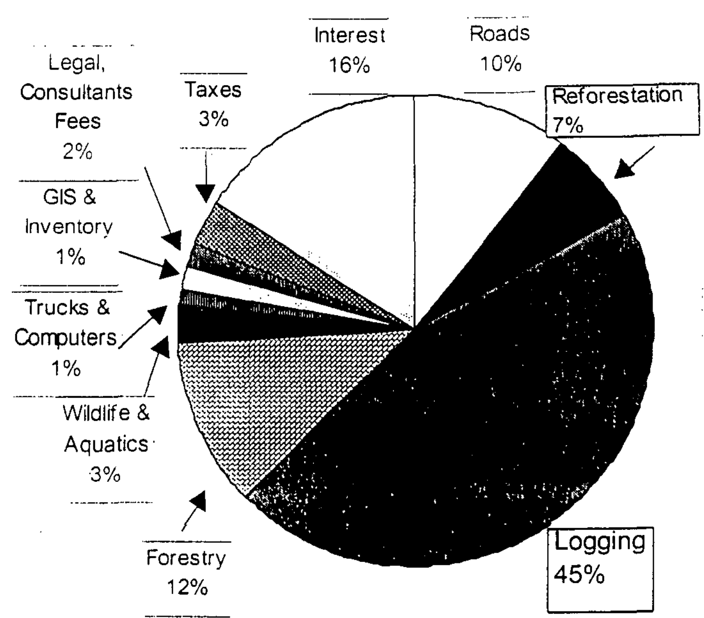
Expenses covered by these revenues include contracted logging costs, road improvements, forestry work, wildlife and aquatics restoration work, taxes, legal, and insurance.

The breakout for our 2000 budgeted revenues and expenses are shown in the adjacent pie charts.

2000 Sources of Revenues



2000 Expenses



Monitoring

Monitoring is an integral part of MRC's stewardship. It is the way the company ensures that its policies are being followed and its goals are being met. MRC's monitoring process includes:

- Specific Measures
- Meaningful Targets
- Constant Adjustment of Policies In Light of Trends in the Data
- Education of Employees
- Involvement of the Public
- Review of Completed THPs
- Analysis of Business Factors

The focal unit for longer term stewardship monitoring will parallel the landscape planning process and attribute trends will be reported by the 85 California Watershed Planning Areas (See attached sample report for Redwood Creek). These reports will include the key measures for inventory, land-based habitat improvements, aquatic-based habitat improvements, and species mix targets. Where appropriate, the watershed planning units will be combined for area and company reporting. This monitoring program will incorporate state and federal requirements associated with the Option A, watershed analysis, and potentially HCP monitoring and reporting.

Each Registered Professional Forester (RPF) is responsible for review of his or her completed THPs and part of the THP review includes filing a report and questionnaire. (See attached two-page report). These reports assess the way site specific management activities implement stewardship policies and contribute to stewardship targets. They provide the Chief Forester, Stewardship Director, and Timberlands Manager with a coaching and continuing education tool to use with area foresters and support staff.

Another monitoring report keeps track of the business targets for safety, quality, community, and financial success. (See attached sample report)

MENDOCINO
REDWOOD COMPANY, LLC

Redwood Creek

Larger Watershed Area: NOYO

MRC Acres in Watershed:

Total Acres in Watershed: Date of Report

Percent Ownership in Watershed:

Categories	Current Conditions	Desired Future Conditions 2050	Planned Management Activities	Trends from Monitoring Activities
Inventory Harvest Volume, Conifer, Hardwd Harvest Silviculture, acres Conifer Inventory Mmbf Conifer Inventory/Acre % Acres > 25 Mbf/acre Volume > 24" dbh % Acres >=WHR 4B	This column is for measurable resource descriptors that are used as a basis for management strategies.	This column is to identify watershed goals (targets) for the measurable resource descriptors.	This column is an extremely brief summary of the planned management activities that will allow us to achieve targets. For inventory, it might be a graph showing assumptions of timber inventory, growth, and harvest by decade, or silviculture acres by decade.	This column is for displaying results of monitoring activities that display trends towards achieving goals (targets).
Land-Based Habitat Snags/Acre Downed Logs/Acre Acres Mapped O.G./snags Connectivity Factor (tbd)				
Aquatic Habitat LWD Stream Temperature Sediment -Fine Sediment - Coarse Watershed Analysis Complete Road Survey Complete Ongoing Restoration Projects				
Tree Species % Basal Area Conifer				

Forester THP Performance Evaluation

RPF: ________________________ Silvicultural System(s) ________________

THP Name: ________________________ Harvesting System(s) ________________

THP Number: ________________________ Acres Logged: ________

Date: ____________

1. Was the THP written to comply with Option "A" policies? Any exceptions to these policies?

2. Was the THP implemented as written? Specify variations?

3. Was the leave stand, retention areas, advanced regeneration protected as planned?

4. What is the approximate basal area of the post harvest stand?

5. What percent of the pre-harvest stand was protected for retention?

6. What percent of the total THP area, or area adjacent to the plan, was a riparian zone? If included in the THP, was the riparian zone harvested? Were the Option "A" post-harvest minimum stocking and shade canopy standards retained?

7. Approximately how many snags, green wildlife trees and large residuals were retained post harvest?

8. How many acres of the plan (non riparian) were either retained from harvest because of wildlife species or protected plant habitat?.

9. Were the riparian zones and stream channels protected as planned?

10. Was the construction of skid trails or the re-opening of skid trails minimized?

11. Were the resulting yarder roads of acceptable width?

Forester THP Performance Evaluation

Page 2 of 2

RPF: ______________________________

Silvicultural System(s) ____________________

THP Name: ______________________________

Harvesting System(s) ____________________

THP Number: ______________________________

Acres Logged: ________

Date: ____________

12. Post harvest, were the roads properly outsloped, berms removed, rolling dips or water bars properly installed?

13. Were any roads narrowed?

14. Were any perched fills pulled back?

15. Were any culverts removed, repaired, or replaced?

16. Were the retention areas protected? Did the location of retention areas create logging problems?

17. Could the new road location have been improved?

18. Number of miles of road restoration (Storm proofing)?

19. Number of miles of road de-activated?

20. Was the logging and road system significantly changed from the last entry?

21. What post harvest treatment will be needed to achieve establishment of a new stand?

22. Where any areas of the plan protected or mitigated in consideration of archeological or aesthetic resources?

MENDOCINO
REDWOOD COMPANY, LLC

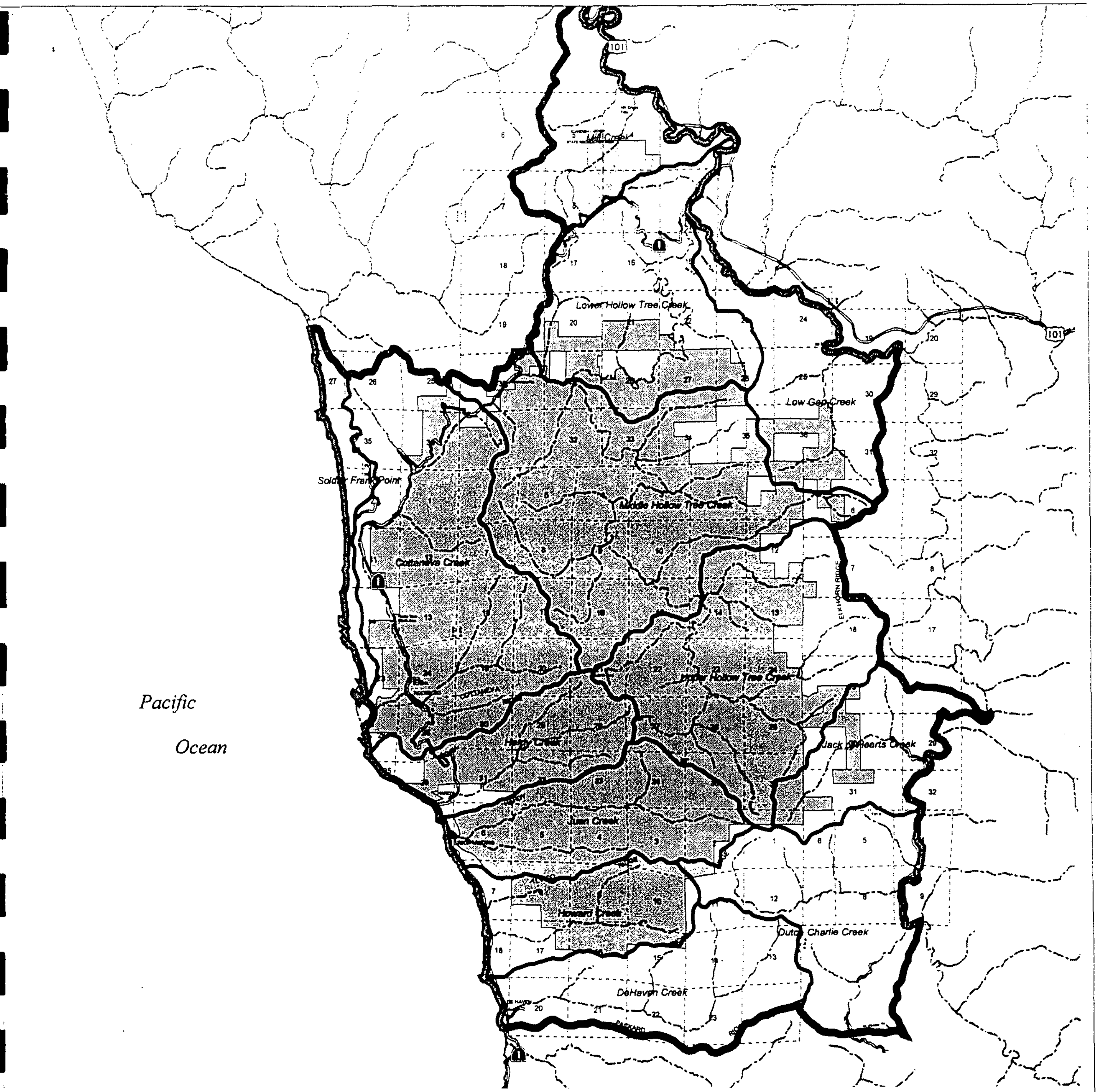
Mendocino Redwood Company

Date of Report

Key Categories	Current Conditions	Target	Planned Management Activities	Trends
Employees				
Safety Incident Rate Turnover				
Community				
% Local Annual Purchases Attitude Survey				
Product Quality				
% Mismanufacture % Revenue Non-Timber Products				
Financials				
Net Income/Total Debt				

APPENDIX A:

WATERSHED MANAGEMENT AREAS AND CALIFORNIA PLANNING WATERSHED MAPS

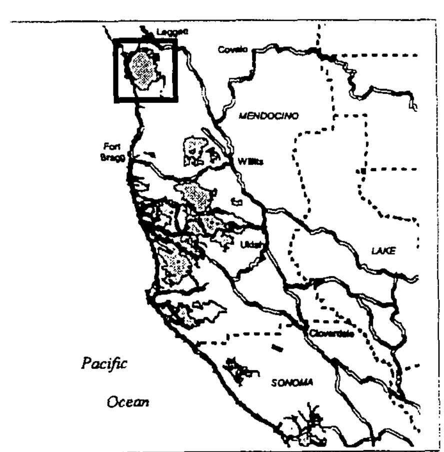


Rockport Inventory Block

N W E S

1 0 1 2 Miles

Scale 1:150,000



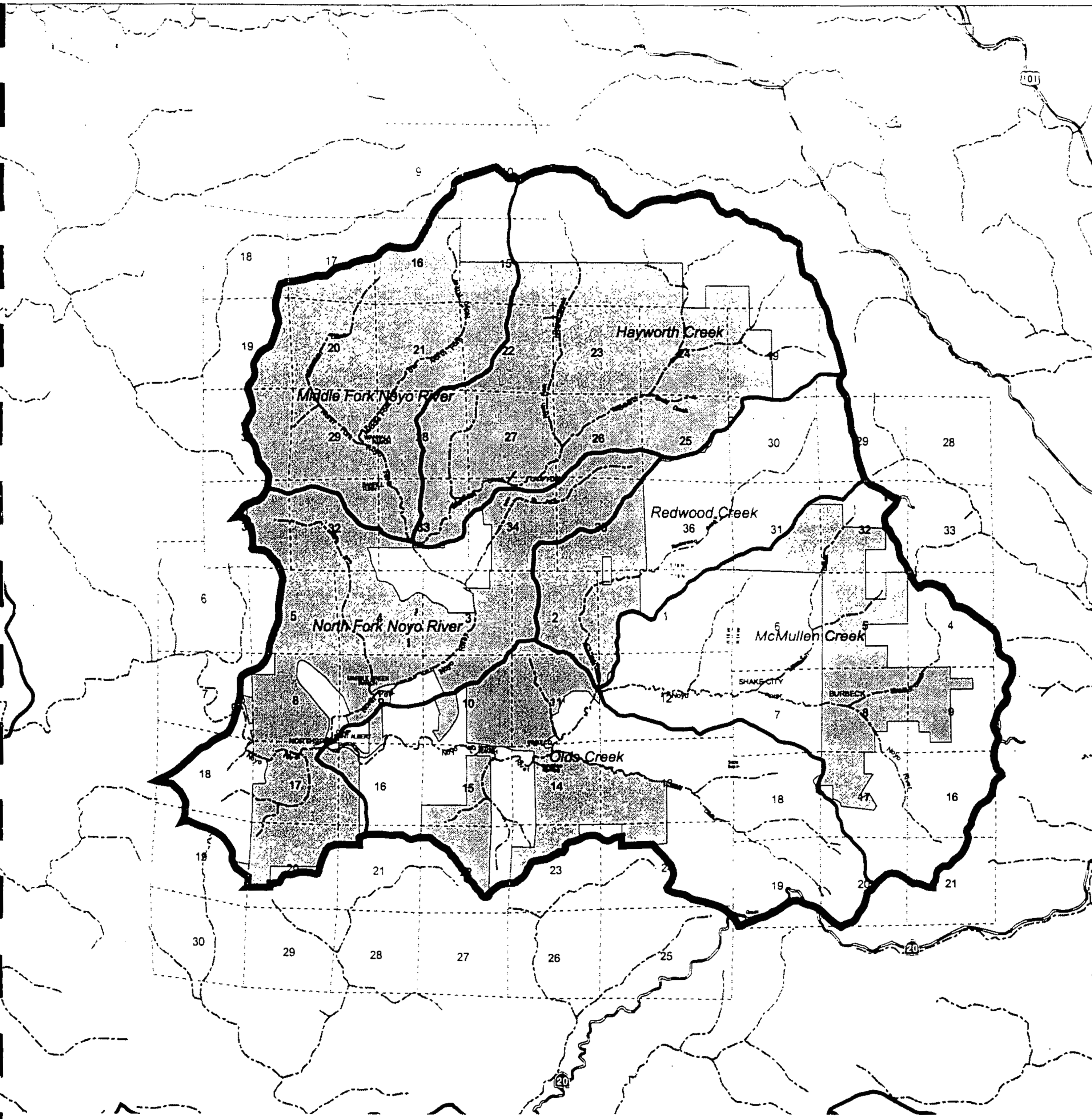
Paved Roads

Streams

CALWATER Planning Watershed Boundary

Inventory Block Boundary

MRC Ownership



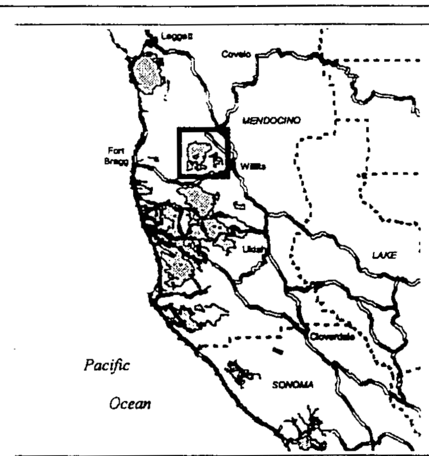
Noyo Inventory Block

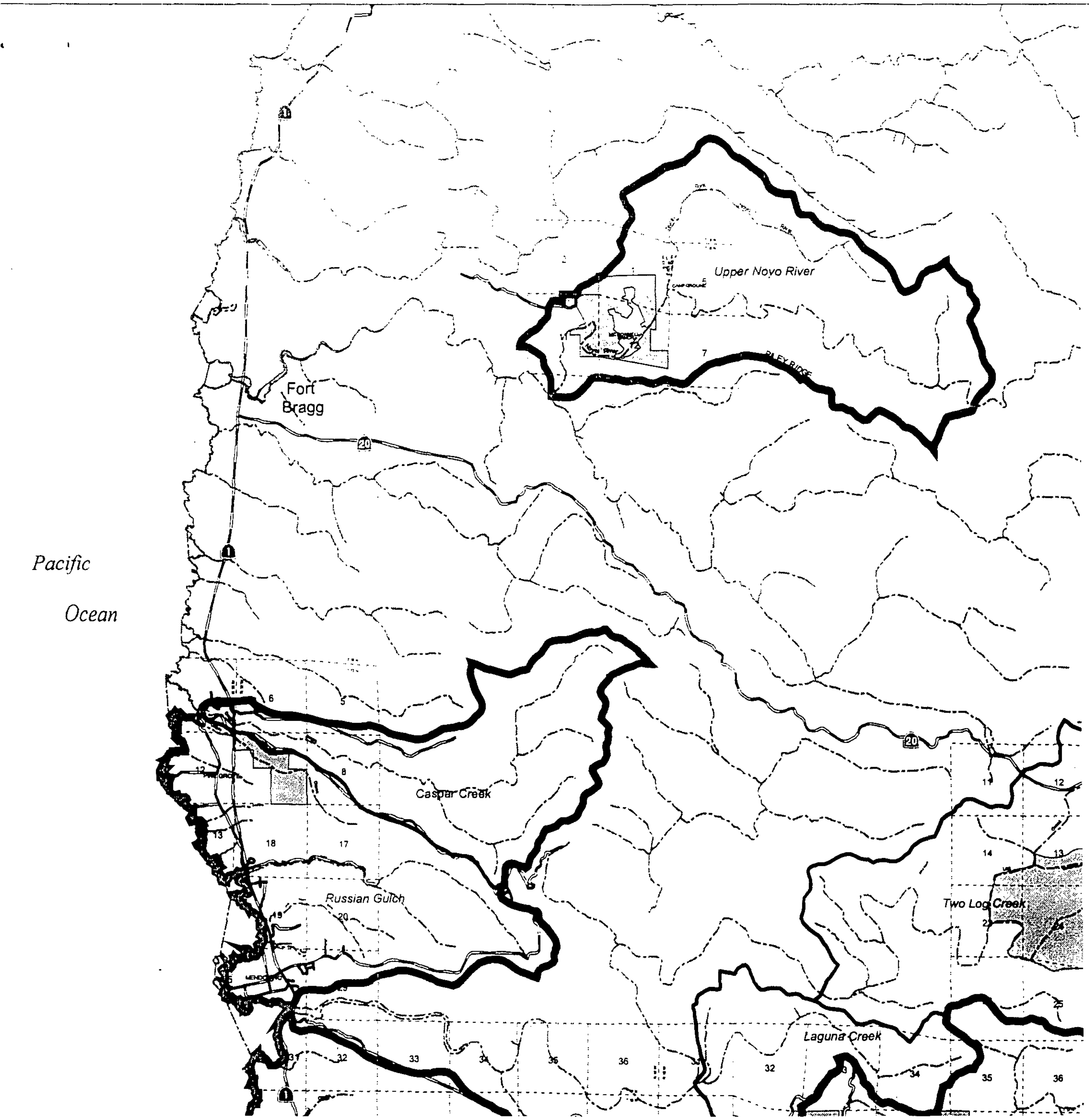
N
W E
S

1 0 1 2 Miles

Scale 1:100,000

- Paved Roads
- Streams
- CALWATER Planning Watershed Boundary
- Inventory Block Boundary
- MRC Ownership



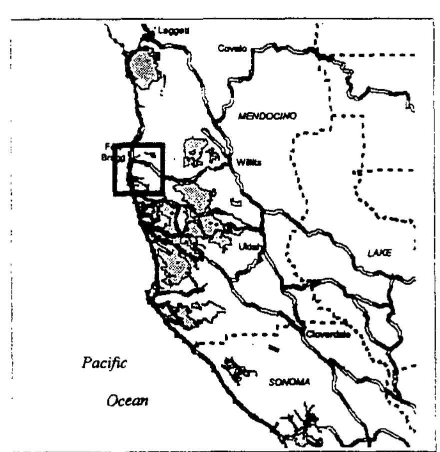


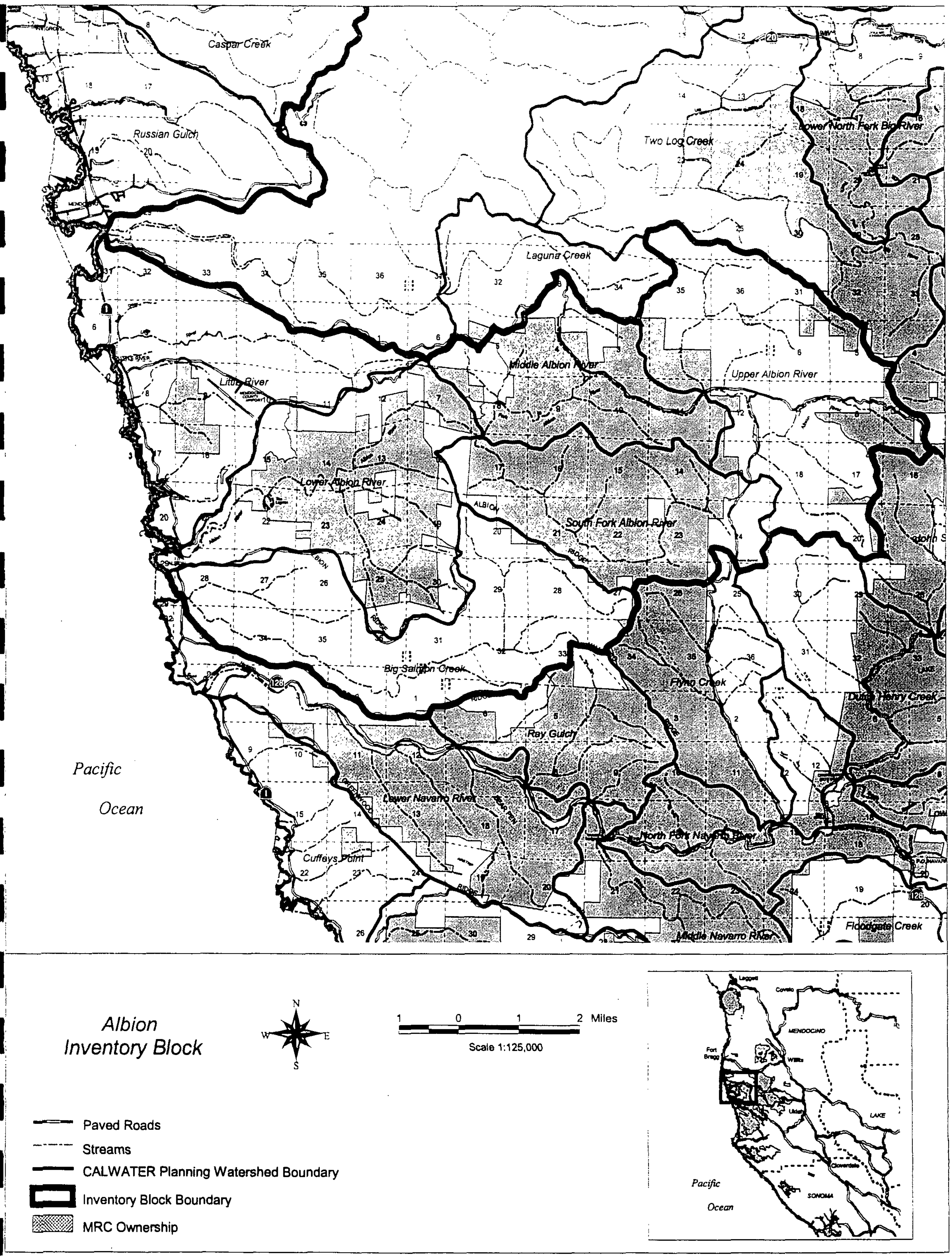
Albion Inventory Block

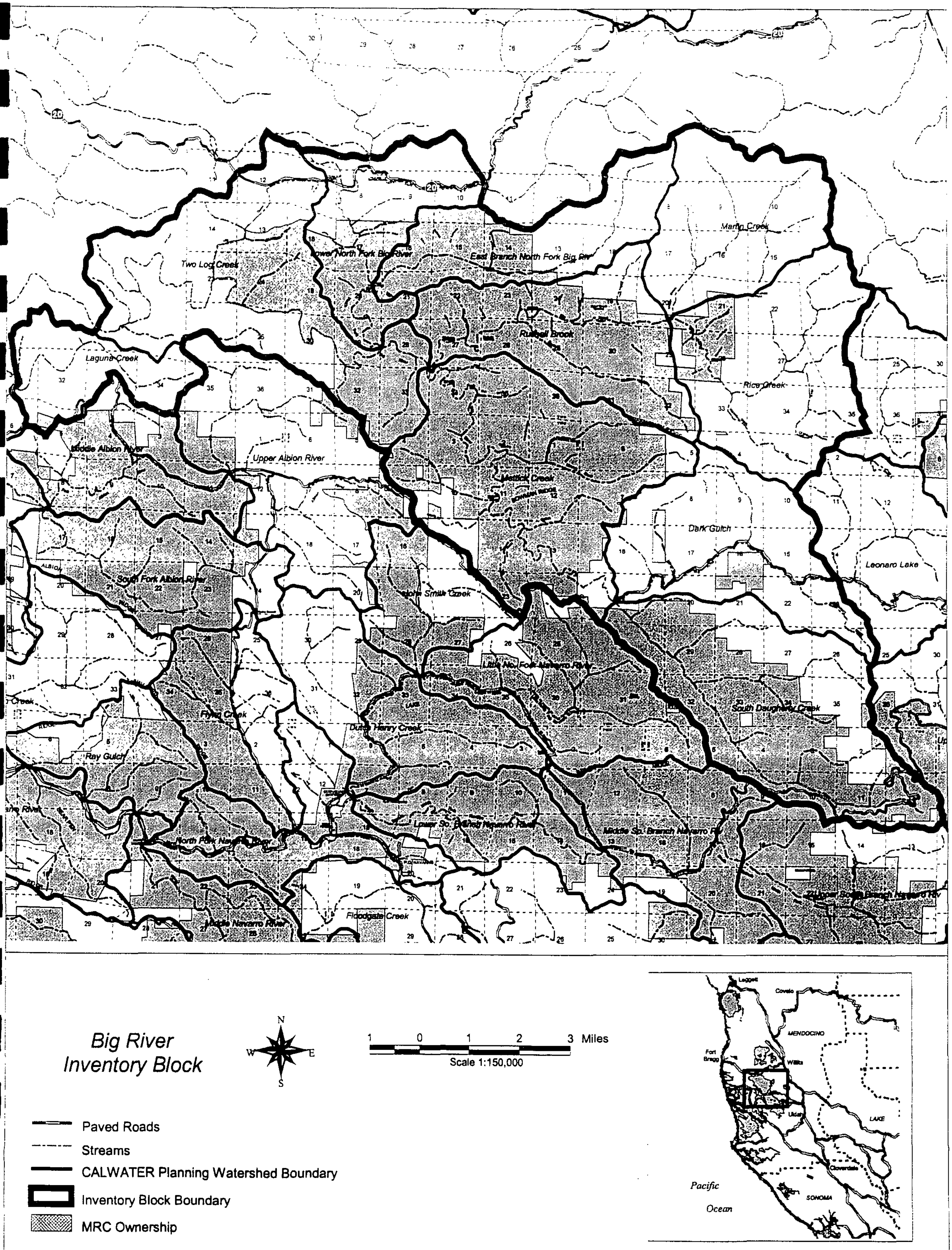
N S E W

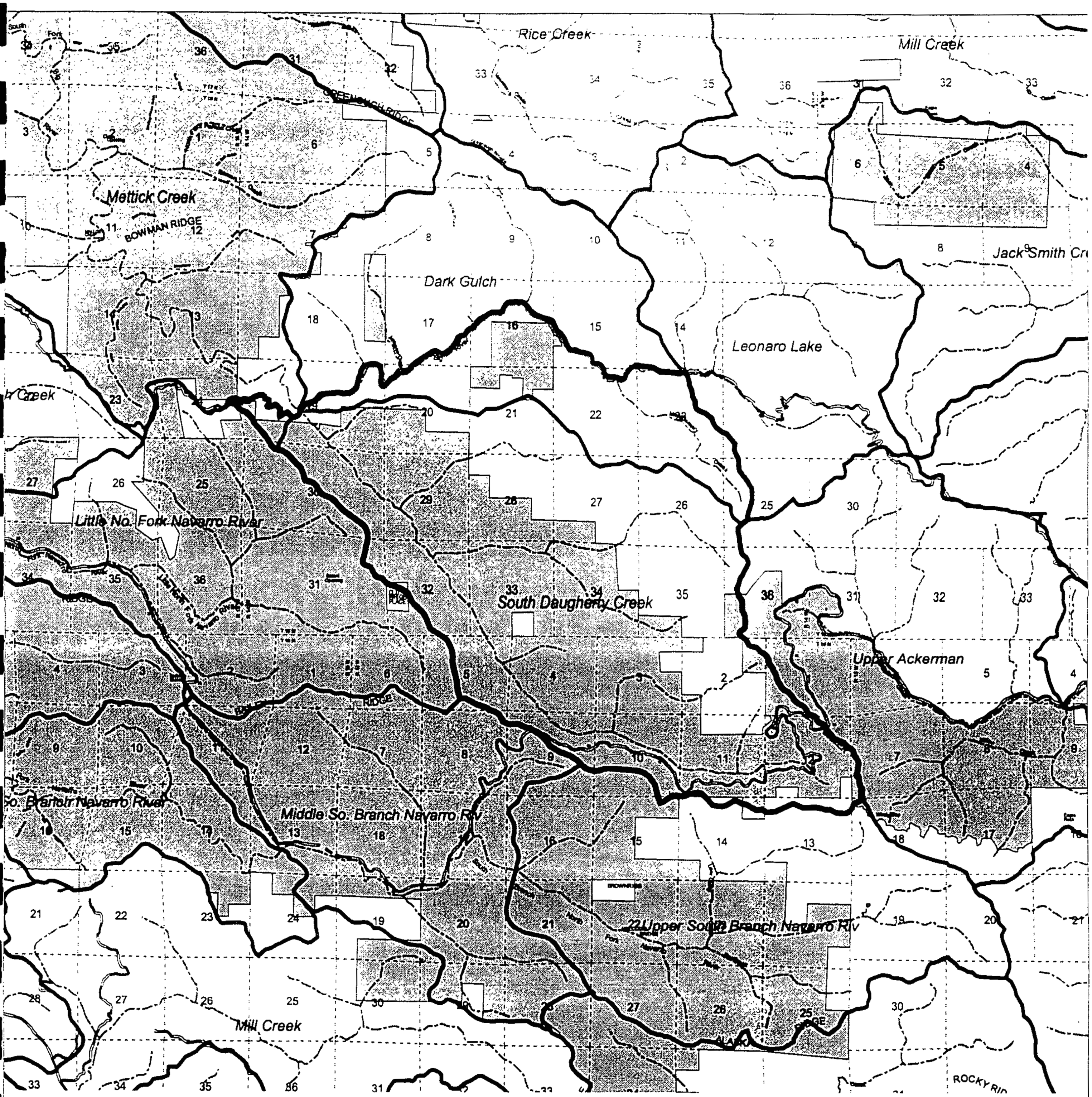
1 0 1 2 Miles
Scale 1:125,000

Paved Roads
Streams
CALWATER Planning Watershed Boundary
Inventory Block Boundary
MRC Ownership




Caspar Creek
Russian Gulch
Two Log Creek
Lower North Fork Big River
Laguna Creek
Middle Albion River
Upper Albion River
Little River
Lower Albion River
South Fork Albion River
Big Salmon Creek
Flynn Creek
Dutch Henry Creek
Ray Gulch
Lower Navarro River
North Fork Navarro River
Cuffeys Point
Middle Navarro River
Floodgate Creek
Pacific
Ocean
Albion
Inventory Block
N
S
E
W
1 0 1 2 Miles
Scale 1:125,000
Paved Roads
Streams
CALWATER Planning Watershed Boundary
Inventory Block Boundary
MRC Ownership
MENDOCINO
LAKE
SONOMA
Fort Bragg
Pacific
Ocean


Big River Inventory Block
N
W
E
S
1 0 1 2 3 Miles
Scale 1:150,000
Paved Roads
Streams
CALWATER Planning Watershed Boundary
Inventory Block Boundary
MRC Ownership
Two Log Creek
East Branch North Fork Big Riv
Martin Creek
Laguna Creek
Rice Creek
Middle Albion River
Upper Albion River
Dark Gulch
Leonard Lake
South Fork Albion River
Little No. Fork Navarro River
South Daugherty Creek
Flynn Creek
Dutch Henry Creek
Ray Gulch
Lower So. Branch Navarro River
Middle So. Branch Navarro Riv
North Fork Navarro River
Middle Navarro River
Fiddlegate Creek
Leggett
Covelo
MENDOCINO
Fort Bragg
Willits
Ukiah
LAKE
Cloverdale
SONOMA
Pacific
Ocean

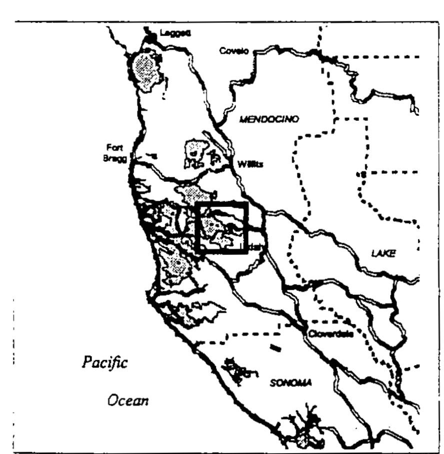


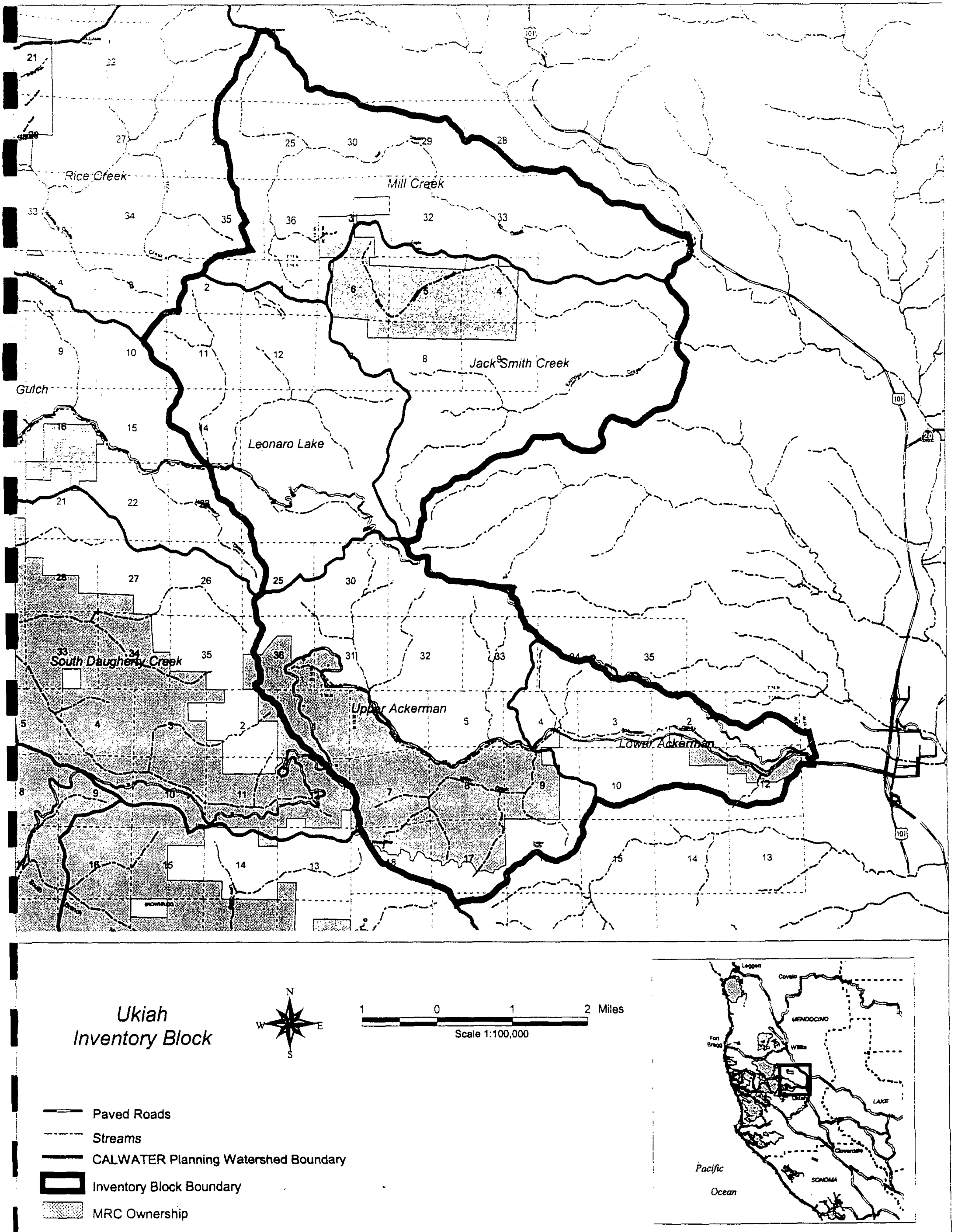
Big River Inventory Block Daugherty Creek Financial Tract

N
W E
S

1 0 1 2 Miles
Scale 1:100,000

- Paved Roads
- Streams
- CALWATER Planning Watershed Boundary
- Inventory Block Boundary
- MRC Ownership





Rice Creek
Mill Creek
Jack Smith Creek
Gulch
Leonaro Lake
South Daugherty Creek
Upper Ackerman
Lower Ackerman
101
20
Ukiah
Inventory Block
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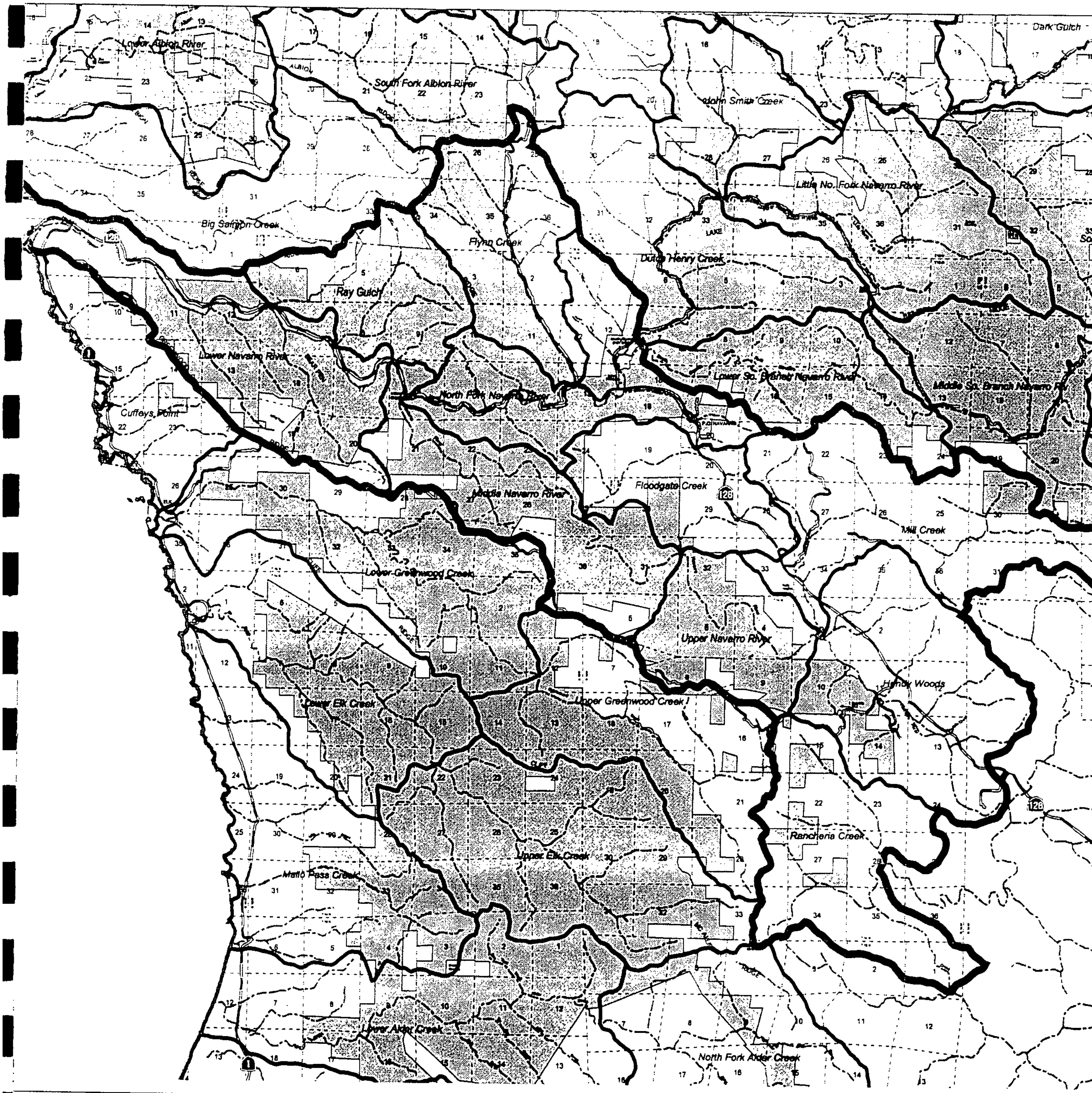
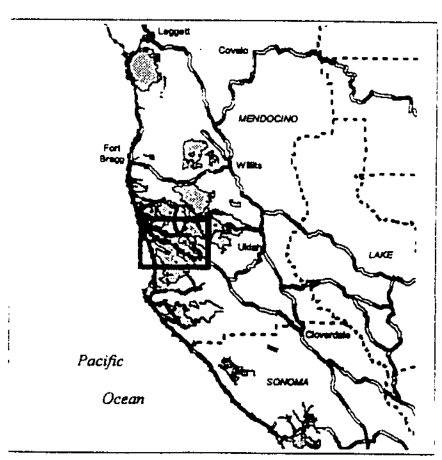
Scale 1:100,000
Paved Roads
Streams
CALWATER Planning Watershed Boundary
Inventory Block Boundary
MRC Ownership
Leggett
Covelo
MENDOCINO
Fort Bragg
Willits
LAKE
Cloverdale
SONOMA
Pacific
Ocean



Navarro West Inventory Block



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Scale 1:150,000

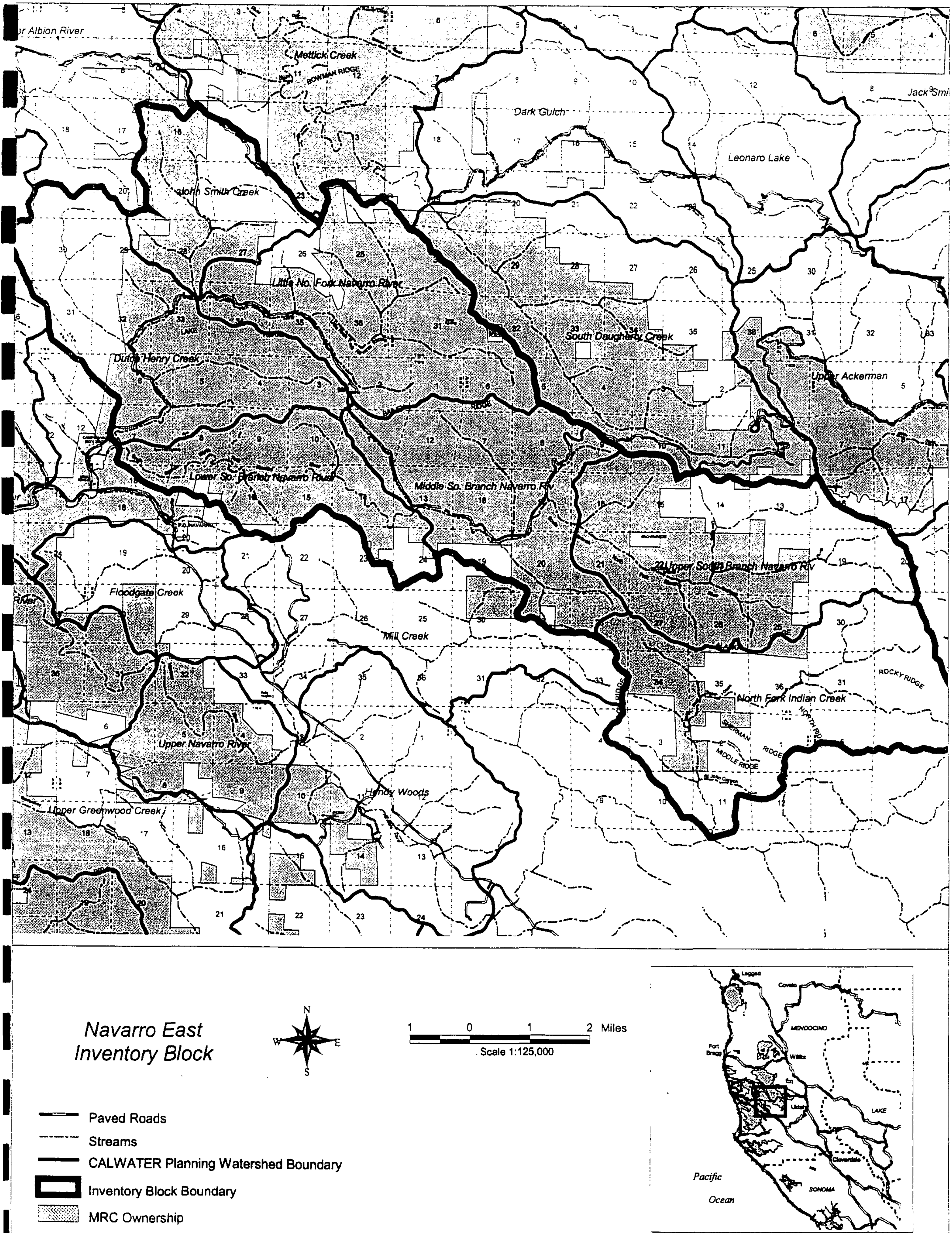
Paved Roads

Streams

CALWATER Planning Watershed Boundary

Inventory Block Boundary

MRC Ownership



Albion River
Mettick Creek
BOWMAN RIDGE
Dark Gulch
Jack Smi
Leonard Lake
John Smith Creek
Little No. Fork Navarro River
South Daugherty Creek
Upper Ackerman
Dutch Henry Creek
Lower So. Branch Navarro River
Middle So. Branch Navarro Riv
Upper South Branch Navarro Riv
Floodgate Creek
Mill Creek
ROCKY RIDGE
North Fork Indian Creek
NORTH RIDGE
SHERMAN RIDGE
MIDDLE RIDGE
Upper Navarro River
Hendy Woods
Upper Greenwood Creek
Navarro East
Inventory Block
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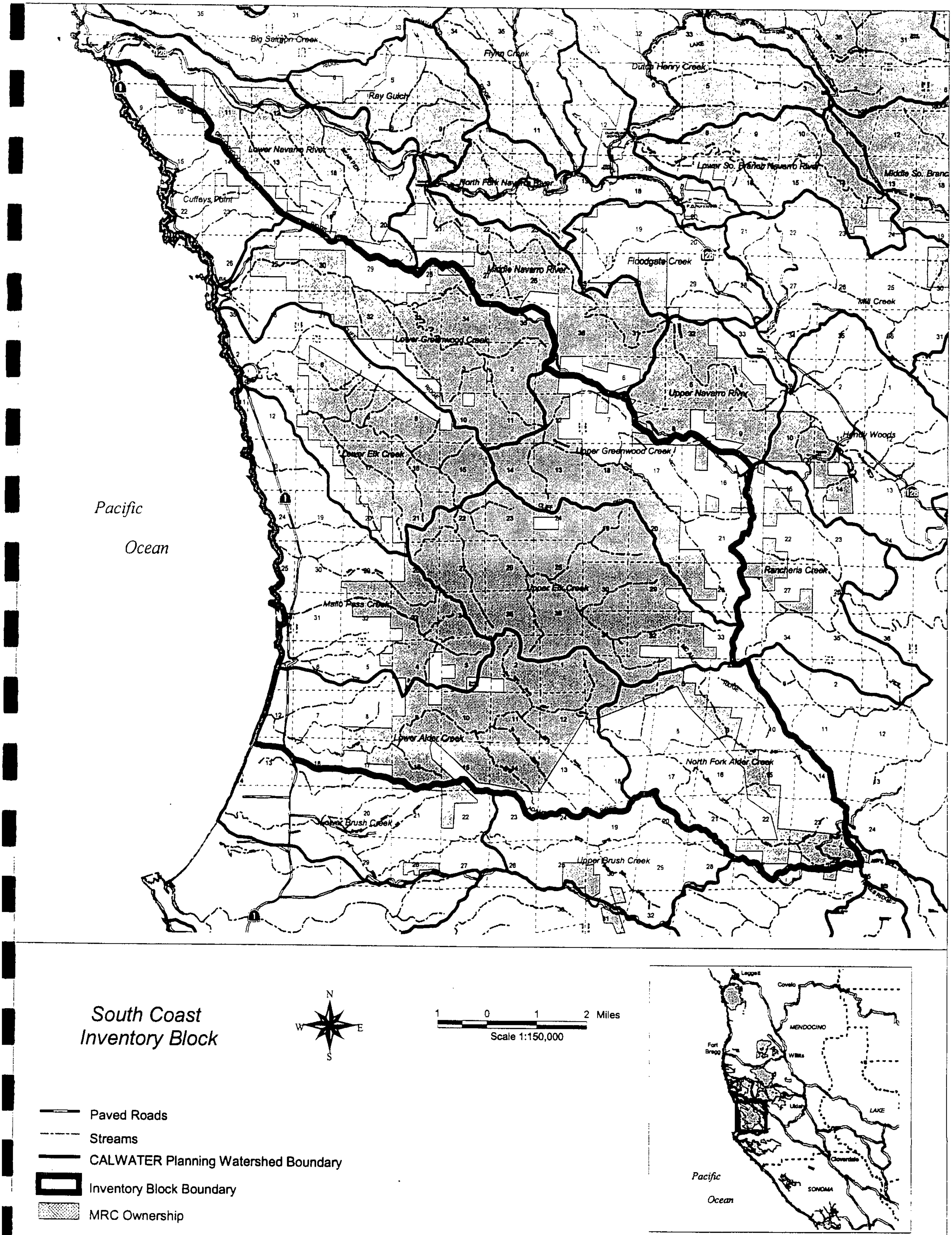
Scale 1:125,000
Paved Roads
Streams
CALWATER Planning Watershed Boundary
Inventory Block Boundary
MRC Ownership
Leggett
Covelo
MENDOCINO
Fort Bragg
Willits
Ukiah
LAKE
Cloverdale
SONOMA
Pacific
Ocean



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Big Salmon Creek
Flynn Creek
Dutch Henry Creek
Ray Gulch
Lower Navarro River
North Fork Navarro River
Lower So. Branch Navarro River
Middle So. Branc
Cuffeys Point
Floodgate Creek
Middle Navarro River
Mill Creek
Lower Greenwood Creek
Upper Navarro River
Hendy Woods
Upper Greenwood Creek
Lower Elk Creek
Rancheria Creek
Upper Elk Creek
Mallo Pass Creek
Lower Alder Creek
North Fork Alder Creek
Lower Brush Creek
Upper Brush Creek
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CALWATER Planning Watershed Boundary
Inventory Block Boundary
MRC Ownership
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Fort Bragg
Willits
Ukiah
LAKE
Cloverdale
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Pacific
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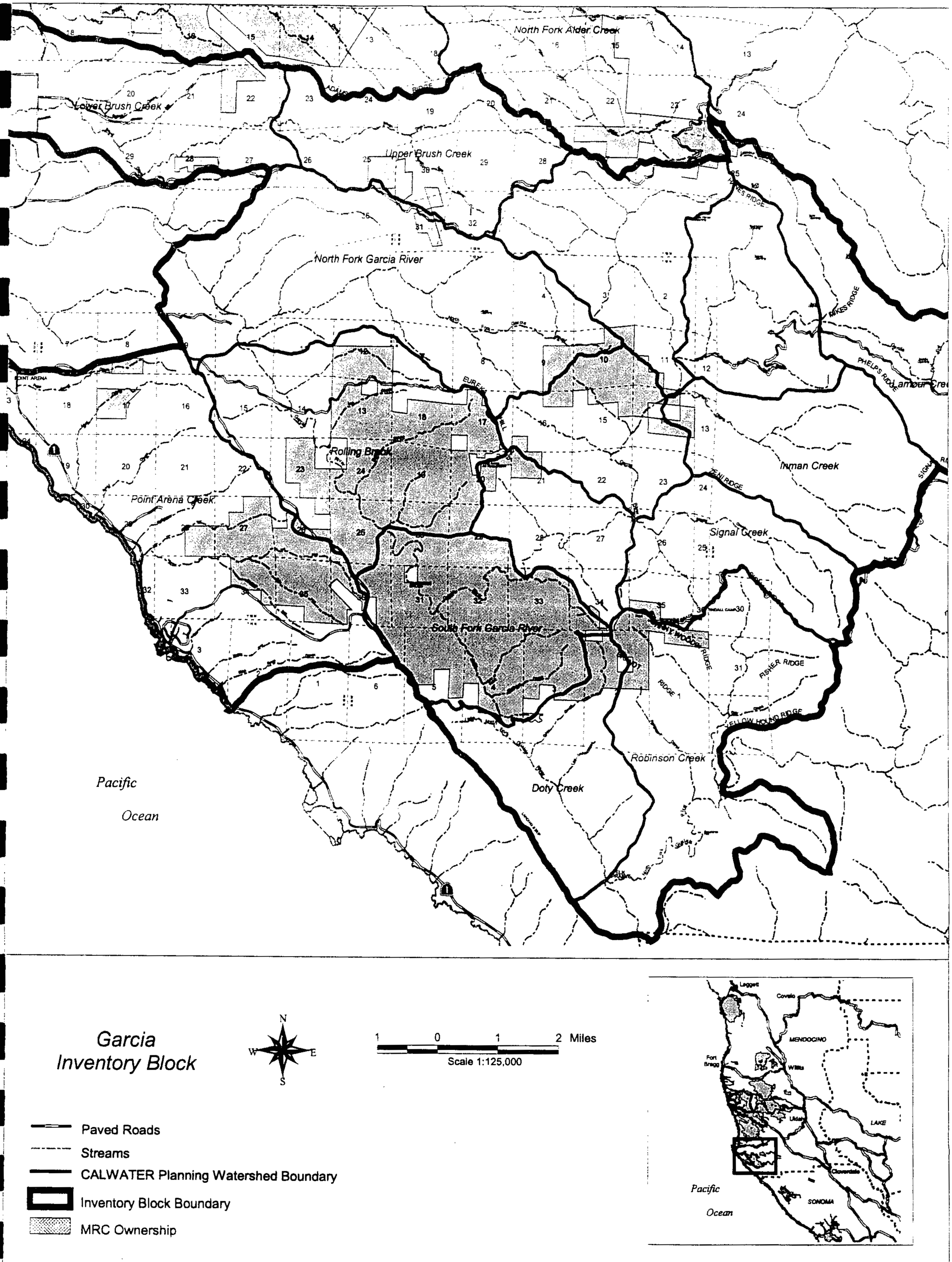
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Lower Brush Creek
Upper Brush Creek
North Fork Garcia River
Rolling Brook
Point Arena Creek
South Fork Garcia River
Inman Creek
Signal Creek
Robinson Creek
Doty Creek
Lamour Creek
PHELPS RIDGE
MIKES RIDGE
FISHER RIDGE
YELLOW HOUND RIDGE
POINT ARENA
Pacific
Ocean
Garcia
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Paved Roads
Streams
CALWATER Planning Watershed Boundary
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MRC Ownership
Leggett
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MENDOCINO
Fort Bragg
Willits
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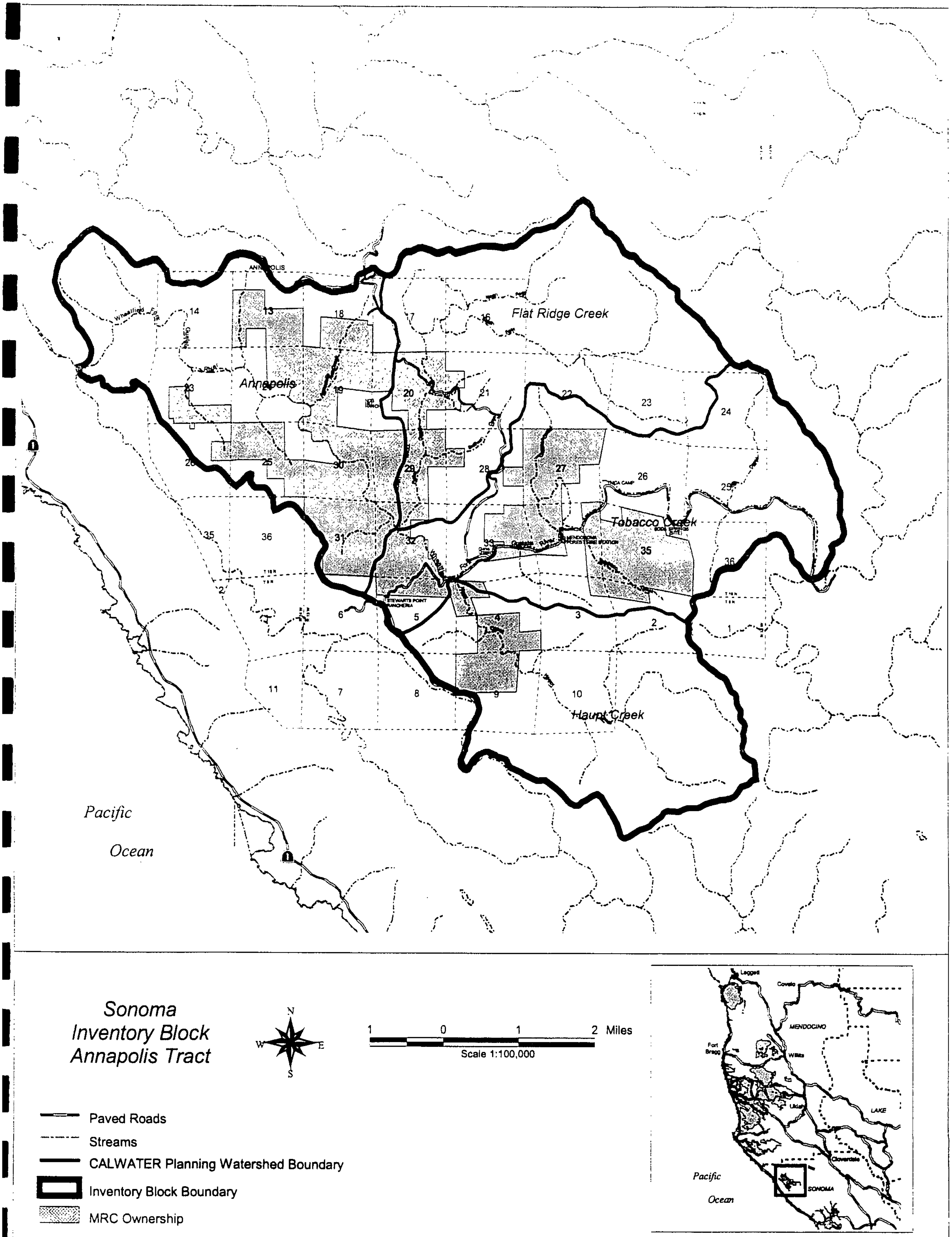
LAKE
Cloverdale
SONOMA



Flat Ridge Creek
Annapolis
Tobacco Creek
Haupt Creek
Pacific
Ocean
Sonoma
Inventory Block
Annapolis Tract
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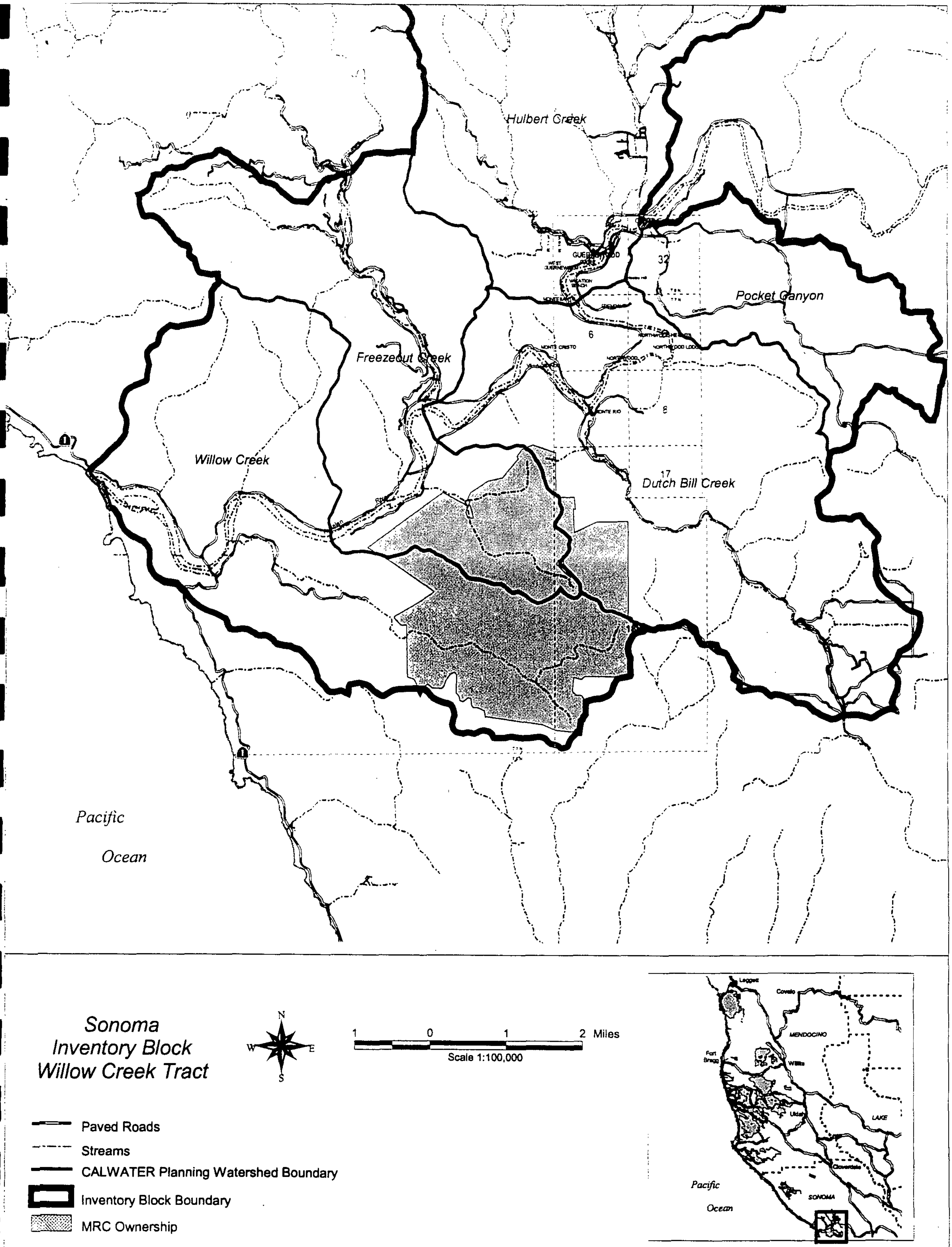
1 0 1 2 Miles
Scale 1:100,000
Paved Roads
Streams
CALWATER Planning Watershed Boundary
Inventory Block Boundary
MRC Ownership
MENDOCINO
LAKE
SONOMA
Pacific
Ocean



Hulbert Creek
Pocket Canyon
Freezeout Creek
Willow Creek
Dutch Bill Creek
MONTE RIO
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Ocean
Sonoma
Inventory Block
Willow Creek Tract
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SONOMA
Pacific
Ocean

APPENDIX B:

VEGETATION CLASSIFICATION EXPLANATIONS

Classifying Vegetation

Classification Rules and Symbology

Vegetation on MRC's property is classified according to a stand's species composition, the dominant size of the trees in the stand, and the canopy closure, or density, of the stand.

Species Classification

Vegetation polygons that have 5 percent or more of their area covered by tree crowns are classified as forest and will be labeled with a three-part labeling system that includes species, size, and density. Definitions and symbols for each are as follows. A stand is labeled with an appropriate conifer or hardwood species symbol when 75 percent or more of the basal area in the stand can be attributed to that species. If no one species represents 75 percent or more of the basal area, a mixed-species symbol will be used.

Dominant-Conifer Species Symbols

At least 75 percent of the basal area is in the species classified.

RW	Coast redwood
DF	Douglas-fir
KP	Knobcone pine
WH	Western hemlock
GF	Grand fir

Dominant-Hardwood Species Symbols

At least 75 percent of the basal area is in the species classified.

AL	Alder
TO	Tanoak
LO	Live oak
BO	Black oak
MO	Madrone

Two-Species Symbols (Conifer)

No one conifer species has 75 percent of the stand's basal area, but two conifer species combined do have at least 75 percent of the basal area. At least 75 percent of the basal area is in the species mix classified.

RD	Redwood/Douglas-fir

Mixed-Species Symbols (Hardwoods)

Conifer species do not comprise 75 percent or more of the stand's basal areaThe stand is comprised of a mixture of species that make up 75% of the basal area.

CH	Conifer/Hardwood mix
MH	Mixed Hardwood

Non-Forest Symbols

Vegetation polygons that have less than 5 percent of their area covered by tree crowns should be classified as non-forest and will be labeled with one of the following symbols, depending on the predominant cover.

BR	Brush
GR	Grass and meadows
BG	Bare ground, including rocks and watercourse beds
WA	Water

Size Classification

A diameter size class label is assigned to each of MRC's forested stands. The division of size classes assists management in predictions of wildlife habitat and silvicultural activity. MRC's vegetation is classified into five Diameter at Breast Height (DBH) size classes. The size classes are as follows:

DBH Class

1	0-8 inches
2	8-16 inches
3	16-24 inches
4	24-32 inches
5	>32 inches

Tree diameter is measured at breast height. Rules for assigning a size class label have been developed, since MRC's stands often contain many diameter classes resulting from uneven-aged management. Figure 1 describes the process for determining size class.

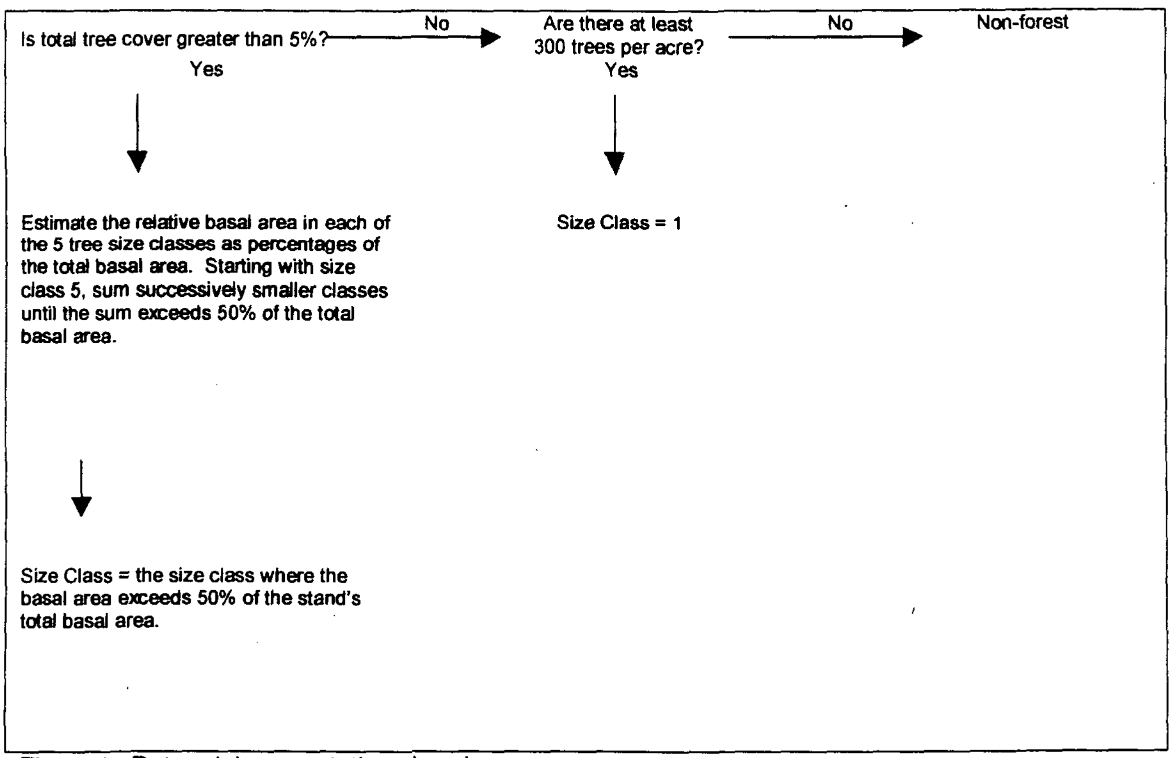


Figure 1. Determining vegetation size classes.

Density Classification

There are five density classes in this vegetation classification scheme, ranked by canopy-closure gradations of 20-percent intervals. Figure 2 demonstrates the rules for defining density classes.

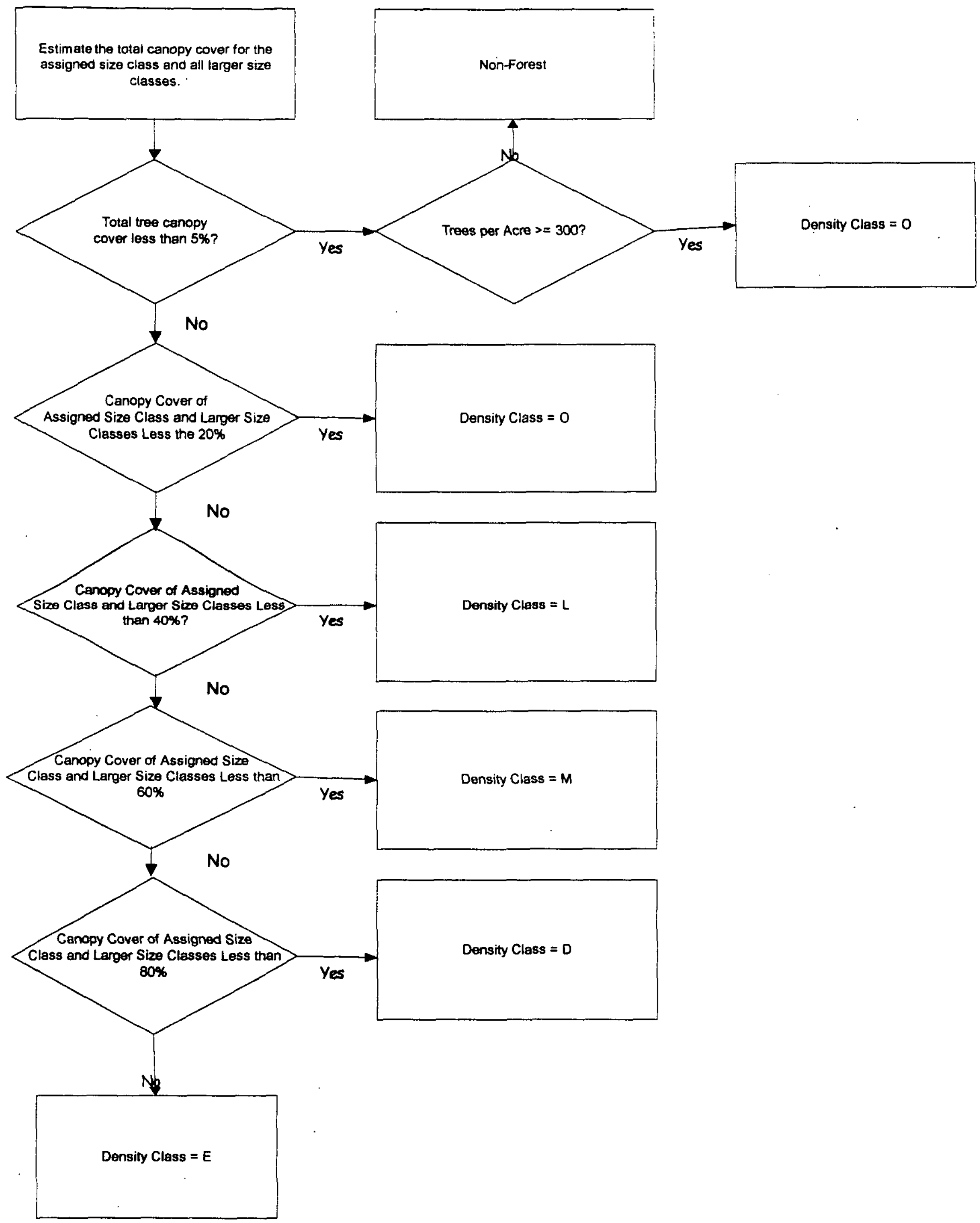


Figure 2. Rules for determining vegetation density classes.

Option A

Mendocino Redwood Company, L.L.C.

Revised February 29, 2000

Option A

Mendocino Redwood Company, L.L.C.

Revised February 29, 2000

Table of Contents

Summary

The following document is a report addressing the requirement of the California Forest Practice Rules (14 CCR 913.11) for a forest landowner to achieve "Maximum Sustained Production of High Quality Timber Products" (MSP) through what is know as an "Option A." Guidelines for completing an Option A document are included in the rules (14 CCR 913.11(a)). Key issues covered are harvest levels, harvest compared to growth, silviculture, and consideration of non-timber forest values.

The Option A document addresses harvest levels over a 100-year period. This time frame is set by the need to calculate a "Long Term Sustained Yield" (LTSY) as a maximum limit for harvest levels. Long Term Sustained Yield (LTSY) is defined in the California Forest Practice Rules (14 CCR 895.1) as "the average growth sustainable by the inventory predicted at the end of a 100-year planning horizon." Mendocino Redwood Company (MRC) calculated the Long Term Sustained Yield (LTSY) for the conifer portion of its forestlands as 136 MMbf per year, or 590 bf per acre per year. This calculation was done with the use of computer models described in detail in later sections and appendices of this Option A.

Mendocino Redwood Company's (MRC's) proposed conifer harvest levels do not exceed the calculation of Long Term Sustained Yield (LTSY) in any decade. Conifer harvest levels average 64% of growth in the first two decades and 54% in the next three decades. Total inventory of conifers is expected to double by the end of the fifth decade. Growth estimates continue to be tested by comparison to other forestlands in the region, and by measuring the permanent growth plots on the ownership. In the preparation of this Option A plan, site indices were adjusted downward from previous growth calculations to ensure the company's growth projections represented the best data available. More detailed descriptions of these calculations are included in later sections and appendices of this Option A.

Mendocino Redwood Company Option A

Conifer* Harvest, Growth and Inventory Levels by Decade

Planning Decade	Beginning Conifer Inventory Mbf**	Conifer Growth Mbf	Conifer Harvest Mbf	Harvest as % of Growth	Harvest as % of Inventory
1	2,264,700	655,300	418,100	64%	1.85%
2	2,501,900	800,300	511,000	64%	2.04%
3	2,791,200	1,029,800	599,900	58%	2.15%
4	3,221,100	1,217,800	630,600	52%	1.96%
5	3,808,300	1,306,200	680,200	52%	1.79%
6	4,434,300	1,358,300	794,600	58%	1.79%
7	4,998,000	1,385,700	885,500	64%	1.77%
8	5,498,200	1,379,900	958,100	69%	1.74%
9	5,920,000	1,380,300	999,200	72%	1.69%
10	6,301,100	1,365,300	998,200	73%	1.58%

* Conifer species on MRC's lands include redwood, Douglas-fir, grand fir, western hemlock and a few pines.

** "Mbf" is a thousand board feet. A board foot is aproximately 1 foot by 1 foot by 1 inch of wood, a common term used to determine the volume of wood in the trunk of a tree.

Mendocino Redwood Company's (MRC's) stated purpose (see the company Web Site at www.mendocinoredwoodco.com) is to be a company that utilizes high standards of environmental stewardship and operates as a successful business. Since the company began 18 months ago, employees have been testing and implementing policies for the protection of non-timber forest resources particularly improved fisheries and upslope wildlife habitat.

These policies are reflected in the determination of Option A harvest levels in three ways. Available acres for harvest and total harvest are limited by the company's silvicultural policies. The trigger and retention requirements of these policies are incorporated in the calculation of Maximum Sustained Production (MSP). Acres available for harvest are also limited by constraining specific acres related to management goals such as protection of old growth, unique ecosystems, Marbled Murrelet habitat, Water and Lake Protection Zone (WLPZ) buffers, and scenic buffers. A third way policies are reflected in the Option A are with the limitations imposed by achieving targeted stand conditions. Harvest levels are set so increases in conifer stocking per acre, improvements in Wildlife Habitat Relationship (WHR) size classes, and increases in the number of trees > 32" diameter breast height (dbh) are met by the end of the fifth decade.

The Option A shows a transition on Mendocino Redwood Company (MRC) lands away from even-age silviculture. The company is targeting an increase in uneven-age silviculture (mostly individual tree and group selection) to 90% by the fifth decade. This goal is driven by the belief that uneven-age management is a better way to achieve a balance in the company's economic and stewardship objectives. The move to selection silviculture results in higher retention of trees per acre, less harvest disturbance and greater structural diversity within a forested stand. Uneven-age silviculture also results in less time between harvests in a given stand, and higher numbers of total acres harvested for a given volume of production. Consequently, Mendocino Redwood Company (MRC) is moving to lighter-impact logging practices as a part of this transition to uneven-age management. During 1998 Mendocino Redwood Company (MRC) harvested approximately 80% of its conifer volume for the year with the use of a cable yarder and the balance with tractor and helicopter. Compared to tractor, cable yarding techniques result in less soil disruption, less erosion potential, and less road and skid trail construction. The company will continue to use cable yarding to minimize soil and site disturbance, and expects the percentage of cable yarding to remain at or close to these levels over time.

The last section of this report details how Mendocino Redwood Company (MRC) will work with the California Department of Forestry (CDF) and other agencies to monitor the assumptions and projections contained in the Option A. The objective of this monitoring activity will be to determine if the ownership wide calculation of Maximum Sustained Production (MSP) is still valid given growth, inventory and non-timber forest value considerations. Each Timber Harvest Plan (THP) will link constraints in the Option A with actual on the ground conditions and silviculture used in the Timber Harvest Plan (THP). Any harvest activities that represent a variance from this Option A plan will be addressed in detail as to why the variance has occurred and any impacts to Long Term Sustained Yield (LTSY). Cumulative effects, unstable soils analysis, sediment capture, and other site-specific operational analyses will be addressed in individual Timber Harvest Plans (THPs).

California Forest Practice Rule 913.11(a)

913.11, 933.11, 953.11 Maximum Sustained Production of High Quality Timber Products

The goal of this section is the achieve Maximum Sustained Production of High Quality Timber Products (MSP). MSP is achieved by meeting the requirements of either (a) or (b) or (c) in a THP, SYP or NTMP, or as otherwise provided in Article 6.8, Subchapter 7.

(a) Where a Sustained Yield Plan (14 CCR 1091.1) or Nonindustrial Timber Management Plan (NTMP) has not been approved for an ownership, MSP will be achieved by:

(1) Producing the yield of timber products specified by the landowner, taking into account biologic and economic factors, while accounting for limits on productivity due to constraints imposed from consideration of other forest values, including but not limited to, recreation, watershed, wildlife, range and forage, fisheries, regional economic vitality, employment and aesthetic enjoyment.

(2) Balancing growth and harvest over time, as explained in the THP for an ownership, within an assessment area set by the timber owner or timberland owner and agreed to by the Director. For purposes of this subsection the sufficiency of information necessary to demonstrate the balance of growth and harvest over time for the assessment area shall be guided by the principles of practicality and reasonableness in light of the size of the ownership and the time since adoption of this section using the best information available. The projected inventory resulting from harvesting over time shall be capable of sustaining the average annual yield achieved during the last decade of the planning horizon. The average annual projected yield over any rolling 10-year period, or over appropriately longer time periods for ownerships which project harvesting at intervals less frequently than once every ten years, shall not exceed the projected long-term sustained yield.

(3) Realizing growth potential as measured by adequate site occupancy by species to be managed and maintained given silvicultural methods selected by the landowner.

(4) Maintaining good stand vigor.

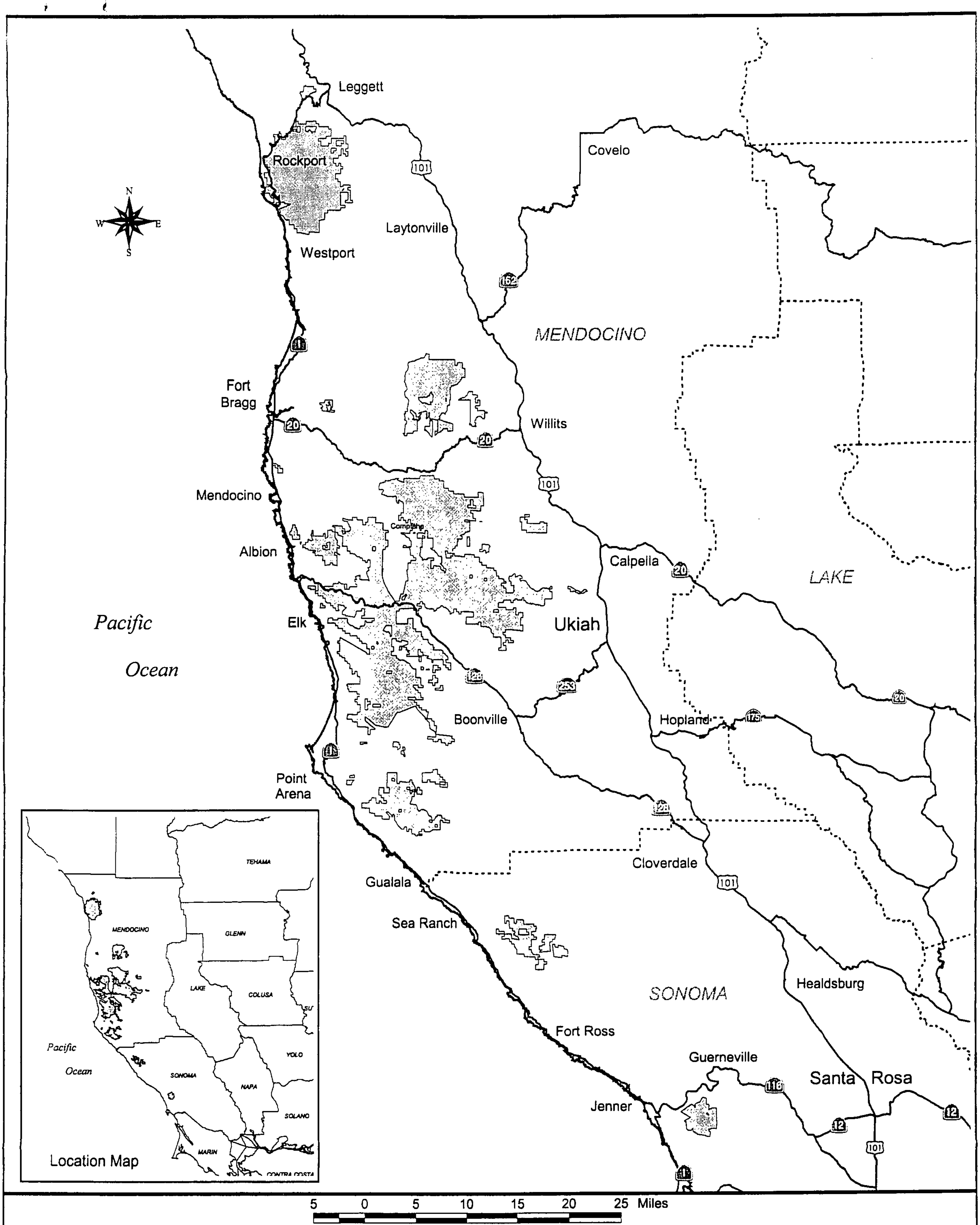
(5) Making provisions for adequate regeneration.

Assessment Area

This Option A covers all the forestlands owned by the Mendocino Redwood Company (MRC). The forestlands are comprised of approximately 232,000 acres situated in the western portion of Mendocino County and the northwestern portion of Sonoma County in the redwood ecoregion of northwestern California. MRC began operations with the purchase of these lands on June 30, 1998.
MRC's forestlands are situated south of the Humboldt County line, west of highway 101, north of the Willow Creek Road that runs from the town of Occidental to the mouth of the Russian River in Sonoma County, and east of the Pacific Ocean. The forestlands are located in three distinct areas: the Rockport Tract (39,188 acres) just south of the Humboldt County line; the major ownership block (179,839 acres) south of the headwaters of the Noyo River, north of the ridge separating the Garcia from the Gualala River in southern Mendocino County, east of the Pacific Ocean, and west of highway 101; and the Sonoma County forestlands (12,573 acres) in the Willow Creek and Wheatfield Fork watersheds just east of the Pacific Ocean. The forestlands are in the watersheds of the following significant rivers: South Fork of the Eel, Noyo, Big River, Albion, Navarro, Greenwood Creek, Garcia, and Russian.

Most of the MRC forestlands would be classified as second growth stands of redwood and Douglas-fir, mixed conifers and hardwoods, or mixed hardwoods. Elevations within the MRC forestlands range from sea level to 3,400 feet. Average daily temperatures range from a high of 66.5 degrees (Fahrenheit) during July to a low of 43.6 degrees (Fahrenheit) in December. Annual precipitation ranges from 50 to 80 inches. MRC's forestlands lie within the rugged Coast Range province that is underlain by marine sandstones of the Franciscan Formation.

Companies such as the Union Lumber Co., Albion Lumber Co., Mendocino Lumber Co., Rockport Redwood Co., L.E. White L.C., Holms Lumber Co., and Southern Pacific Land Company were some of the early owners of what now comprise MRC forestlands. Harvesting started at the mouths of watersheds and progressed up-stream and up-slope to the ridgelines. Initial logging activities generally consisted of burn, clearcut, and burn again. Logs were transported to mills via the river systems. Later entries into these forests, and forests further inland were commonly accomplished with steam donkeys and railroads. During the 1940s, crawler tractors and trucks replaced the railroads. Clearcutting continued to be a common harvest method. In response to tax laws in the 1940s and 1950s, many stands were managed to remove 70% of the stocking, typically the larger, healthier trees. Subsequent owners managed their lands to maximize fiber output and the success of their mill investments. As a result of this ownership history, a significant portion of the MRC acreage is at reduced levels of conifer stocking with trees in young age classes.



MENDOCINO REDWOOD COMPANY, LLC
OWNERSHIP

Balancing Growth and Harvest over Time

Balancing growth and harvest over time, as explained in the THP for an ownership, within an assessment area set by the timber owner or timberland owner and agreed to by the Director. For purposes of this subsection the sufficiency of information necessary to demonstrate the balance of growth and harvest over time for the assessment area shall be guided by the principles of practicality and reasonableness in light of the size of the ownership and the time since adoption of this section using the best information available. The projected inventory resulting from harvesting over time shall be capable of sustaining the average annual yield achieved during the last decade of the planning horizon. The average annual projected yield over any rolling 10-year period, or over appropriately longer time periods for ownerships which project harvesting at intervals less frequently than once every ten years shall not exceed the projected ***long-term sustained yield****. FPA 913.11(a)(2)*

The California Forest Practice Rules define Long Term Sustained Yield (LTSY) as "the average growth sustainable by the inventory predicted at the end of a 100-year planning horizon" (14 CCR 895.1). Mendocino Redwood Company (MRC) determined Long Term Sustained Yield (LTSY) by averaging the growth of the last decade. Only growth associated with forested land types (on sites 1 through 5) were included for LTSY analysis. Approximately 5,400 acres of "non-forested" land (sites 6 and 7), and 1,700 acres of "no harvest" set-asides in the assessment area were excluded in the calculation. Conifer LTSY has been calculated at 590 board feet per acre per year or 136 MMbf per year across the entire acreage. Harvest levels throughout the planning period do not exceed LTSY.

MRC's inventory data and projections of growth are important components in the calculation of LTSY. MRC's timber inventory data is derived from two levels of forest stratification. First, the ownership is divided into inventory blocks that are organized geographically as groups of watershed areas. MRC is currently divided into 10 such units. Second, forest vegetation is categorized within each inventory block based on species composition, tree size, and stand density. These categories form the vegetation strata. Sample plots are installed in the vegetation strata to obtain estimates of forest conditions. Plots are allocated to each stratum in order to meet inventory block confidence targets. MRC's inventory estimates are currently based on over 6,700 sample plots.

The data from inventory field plots is input into a Microsoft Access database where basal area and timber volumes are computed and maintained for each tree. MRC is constantly improving its inventory estimates through post-harvest inventory updates, developing a stand-level inventory from a stratified inventory, and improving the resolution of inventory estimates. The statistical reliability of MRC's inventory meets a precision target of +/- 10% with 95% confidence for total board foot volume for each of the inventory blocks. For a complete description of the inventory classification, data capture and ongoing data updating efforts, please refer to Appendix A of this document.

Growth estimates of the forest include the regeneration of new trees after harvest, as well as the diameter and height growth on existing trees. Growth estimates take into account tree species, individual tree conditions, and competition. Projections of forest strata are based on species composition, tree size, stand density, and the site-specific ability of a given site to grow trees (site quality). Growth is computed using simulation models. Growth models are calibrated for the ownership using permanently marked growth plots.

The models used to estimate growth are called CRYPTOS (Cooperative Redwood Yield Research Project) and FREIGHTS (Forest Resource Inventory, Growth and Harvest

Tracking System). CRYPTOS predicts stand development from a tree list given a variety of data describing the stand site. FREIGHTS uses CRYPTOS as a part of a multi-period analysis to look at successive layers of harvest, growth, and silviculture to determine growth and inventory over time. A more detailed description of CRYPTOS and FREIGHTS is included in the next section and Appendix B of this Option A.

Estimates of growth for the ownership are weighted averages (by acres) of individual stands. Growth varies widely by stand. Young stands with small trees may not have any measurable volume and, although they may be growing rapidly, show zero volume growth. Stands that are 25 – 50 years old may be growing in excess of 10%. Growth rates slow down as stands approach maturity.

Growth estimates for MRC forests from these models show MRC forests growing at an average annual rate of 2.9% per year or an average of 66 MMbf/year over the next decade. Growth increases to 3.8% at the fourth decade, then declines to 2.2% by the tenth decade. The initial gains in growth are largely a function of a significant influx of young trees to measurable size (greater than 6" d.b.h.). The leveling off of growth rates in later periods is related to MRC's transition to uneven-aged stands and increased average tree size and age.

Mendocino Redwood Company Option A

Growth as % of Inventory

Planning Decade	Beginning Conifer Inventory Mbf	Conifer Growth Mbf	Growth as % of Inventory (avg. annual)
1	2,264,700	655,300	2.9%
2	2,501,900	800,300	3.2%
3	2,791,200	1,029,800	3.7%
4	3,221,100	1,217,800	3.8%
5	3,808,300	1,306,200	3.4%
6	4,434,300	1,358,300	3.1%
7	4,998,000	1,385,700	2.8%
8	5,498,200	1,379,900	2.5%
9	5,920,000	1,380,300	2.3%
10	6,301,100	1,365,300	2.2%

Currently, MRC is in the process of completing a re-inventory of the permanent growth plots put in place during 1994 to cross check the calculated growth estimates. Since growth is such a key parameter to be measured on our lands, MRC will also be adding growth plots for future calibrations of growth simulation models.

Methodology to Determine Maximum Sustained Production (MSP)

The methodology to determine Maximum Sustained Production (MSP) is to calculate growth for the next 100 years with constraints that reflect operating policies to protect non-timber resources. This is accomplished in three steps performed in a series of iterations to test for targeted outcomes such as availability of adequate types of wildlife habitat acreage. The first step is to categorize all the Mendocino Redwood Company (MRC) acreage into land types, the second is to run the FREIGHTS model with MRC silvicultural regimes, and the third is to run the linear program with additional policy constraints. The flow chart at the end of this section diagrams the process of these steps.

MRC acreage is categorized into land types to allocate available silviculture and impacts of different management activities on overall growth. Land types have the following basic components:

- Strata type - the combination of vegetation strata, and site class.
- Yarding method - tractors, cable, or helicopter.
- Planning watersheds - from the Calwater data set.
- Special constrained harvest areas - such as watercourse buffers, Coastal Zone buffers, road buffers, and viewshed buffers (other constraints are discussed in a later section of this report).

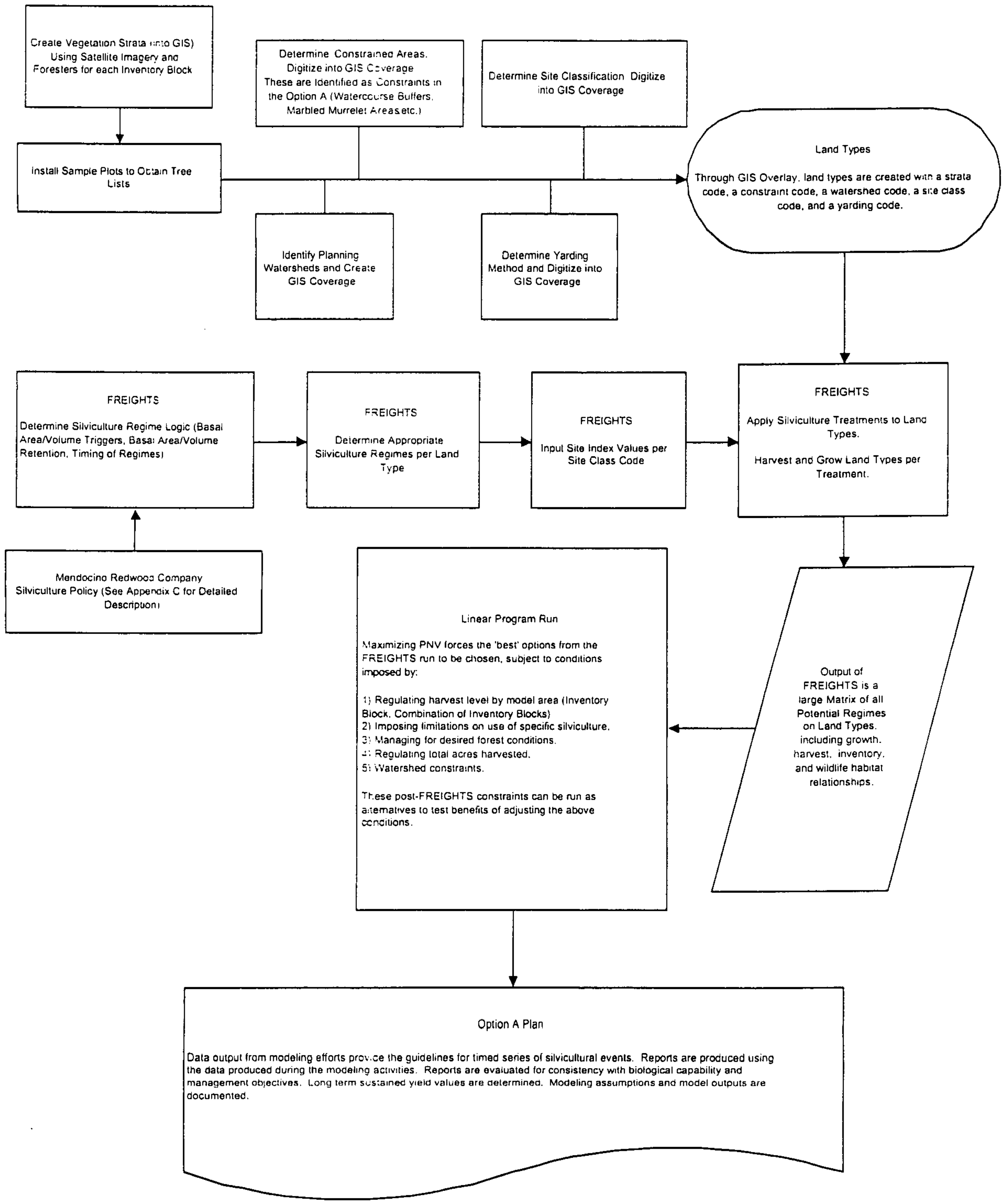
The FREIGHTS (Forest Resource Inventory, Growth, and Harvest Tracking System) model uses the land types, combined with inventory data, growth data and MRC silvicultural logic to simulate a matrix of all possible futures for all the company acreage. The output produced by FREIGHTS is a series of data tables which represent the projected tree lists, harvest volumes, and growth resulting from the silviculture and growth assumptions applied to the initial inventory estimates. FREIGHTS is programmed for this modeling effort to retain tree lists from the original sampling data for the entire planning period. This allows a number of reports to be computed using tree data. FREIGHTS operates by growing each plot in a land type inventory individually from one decade to the next. All plots are aggregated to arrive at periodic stand statistics. Default calibrations, determined from a robust data set acquired throughout the redwood region, are used for this modeling effort. Harvests are accomplished by database commands within FREIGHTS that allow specific silvicultural prescriptions to be applied to each plot individually. The prescriptions are based on desired residual plot characteristics. Appendix C provides detail on MRC's silvicultural policies and how these policies were modeled in FREIGHTS.

The linear program selects the solution from the FREIGHTS matrix that makes the most sense for the company based on additional constraints, which are:

- Transition to uneven-aged silviculture over time
- Targeted growth in inventory levels over time
- Targeted WHR forest conditions over time

The transition to uneven-aged silviculture is accomplished by limiting the availability of even-aged silviculture after the fourth decade. Targeted stand conditions constraints are accomplished by setting a maximum harvest level and running the model to see if the solution results in targeted stand and inventory conditions. By running the model in a series of iterations, the level of harvest with targeted conditions could be determined. The targeted conditions are discussed in more detail in subsequent sections of this report.

Flow Chart of Modeling Process



Option A Tables and Charts

The following 11 tables and charts display the calculation of Maximum Sustained Production (MSP) on Mendocino Redwood Company (MRC) forestlands. All data displayed is the result of the growth and yield simulation and linear programming modeling.

Table 1: Modeled Inventory, Growth and Harvest by Decade
Tabular results of FREIGHTS and linear program, these numbers reflect expected harvest plans and resulting inventory and growth. The growth models used for these projections were developed with an emphasis on conifers. The growth coefficients for hardwoods are still under development.

Chart 1: Modeled Conifer Inventory, Growth, and Harvest by Decade

Chart 2: Modeled Hardwood Inventory, Growth and Harvest by Decade

Table 2: Modeled Harvest Volume by Silvicultural Group by Decade
The overall percentages of volume harvested by even-age and uneven-age silviculture are expected to match planned operations. Within these silvicultural types, the proportions of volume harvested by specific silvicultural group may fluctuate by as much as 20 percent.

Chart 3: Modeled Conifer Harvest Volume by Silivculture Type by Decade
Even-age silviculture includes seed tree removal and variable retention. Uneven-age silviculture includes high retention selection, selection, selection (high hardwood competition), and transition.

Chart 4: Modeled Hardwood Harvest Volume by Silviculture Type by Decade
Even-age silviculture includes seed tree removal and variable retention. Uneven-age silviculture includes high retention selection, selection, selection (high hardwood competition), and transition.

Chart 5: Modeled Harvest Acres by Silvicultural Type by Decade
Modeled harvest acres show approximately 55,400, or 5,500 acres annually in the 1st decade. Actual harvest acres will likely be near 6,500 acres annually for the 1st decade. The discrepancy is due to the economically driven model choosing the most well-stocked acres first, whereas MRC foresters will prioritize hardwood-dominated acres for conifer recapture in the early years of the plan. An increase in harvest acres in the 1st decade is likely followed by decreases in the 2nd and 3rd decades. The overall trend toward increasing harvest acres by decade is directly related to MRC's transition to uneven-age management. MRC recognizes that the increased number of acres covered by decade may result in risk for increased sedimentation. Consequently, MRC is taking steps to minimize road usage, improve drainage, and improve road surfaces.

Chart 6: Modeled Standing Conifer Basal Area per Acre by DBH Range by Decade
Chart shows trend of improved distribution of conifer basal area per acre by size ranges over time as an expected result of harvest levels and silviculture logic discussed in this Option A plan.

Chart 7: Modeled Standing Conifer Volume by DBH Range by Decade
Chart shows trend of increased conifer volume in larger size ranges over time as an expected result of harvest levels and silviculture logic discussed in this Option A plan.

Chart 8: Modeled Acres by Forest Condition by Decade
The decline of acres in stands over 25 MBF/acre at the end of the 1st decade is the result of the model choosing high volume stands for harvest that have not been constrained within the model design. MRC will not choose harvest acres in this way, but rather will direct harvest locations with other unmodeled factors such as minimization of roads used, watershed effects, conifer recapture of hardwood-dominated acres, and logical harvest unit sizing.

Chart 9: Modeled Acres by WHR size class by Decade
WHR size classes are calculated by using an average of all trees greater than 5" DBH (15 years old +). Decades 1 through 3 show the results of young trees entering the WHR size class calculation. MRC's efforts to retain and recruit larger trees is evidenced by the reduction of size classes 2, 3, and 4"A". Size class 4'B' becomes the dominant size class in the final decades. Size classes 4"C", 5 and 6 are difficult to achieve as the majority of stands toward final decades will be in uneven-aged management. Uneven-aged stands nearly always contain an element of younger trees which, even amidst a large tree component, reduce the stand's average quadratic mean diameter.

Table 1. Modeled Inventory, Growth and Harvest by Decade

Option A

Mendocino Redwood Company Ownership

Species Group	Decade	Beginning Inventory (MBF)	Growth During Decade (MBF)	Harvest During Decade (MBF)
All Species				
	1	2,770,200	912,600	515,500
	2	3,167,300	1,136,900	696,100
	3	3,608,100	1,405,200	818,900
	4	4,194,400	1,592,000	924,800
	5	4,861,600	1,642,500	951,800
	6	5,552,300	1,658,100	1,029,800
	7	6,180,600	1,649,600	1,067,100
	8	6,763,100	1,622,300	1,098,100
	9	7,287,300	1,613,300	1,101,500
	10	7,799,100	1,586,800	1,096,700
Conifer				
	1	2,264,700	655,300	418,100
	2	2,501,900	800,300	511,000
	3	2,791,200	1,029,800	599,900
	4	3,221,100	1,217,800	630,600
	5	3,808,300	1,306,200	680,200
	6	4,434,300	1,358,300	794,600
	7	4,998,000	1,385,700	885,500
	8	5,498,200	1,379,900	958,100
	9	5,920,000	1,380,300	999,200
	10	6,301,100	1,365,300	998,200
Hardwood				
	1	505,500	257,300	97,400
	2	665,400	336,600	185,100
	3	816,900	375,400	219,000
	4	973,300	374,200	294,200
	5	1,053,300	336,300	271,600
	6	1,118,000	299,800	235,200
	7	1,182,600	263,900	181,600
	8	1,264,900	242,400	140,000
	9	1,367,300	233,000	102,300
	10	1,498,000	221,500	98,500

**Note: Tabular results of FREIGHTS and linear program, these numbers reflect the expected harvest plans and resulting inventory and growth.

Chart 1. Modeled Conifer Inventory, Growth, and Harvest by Decade

Option A

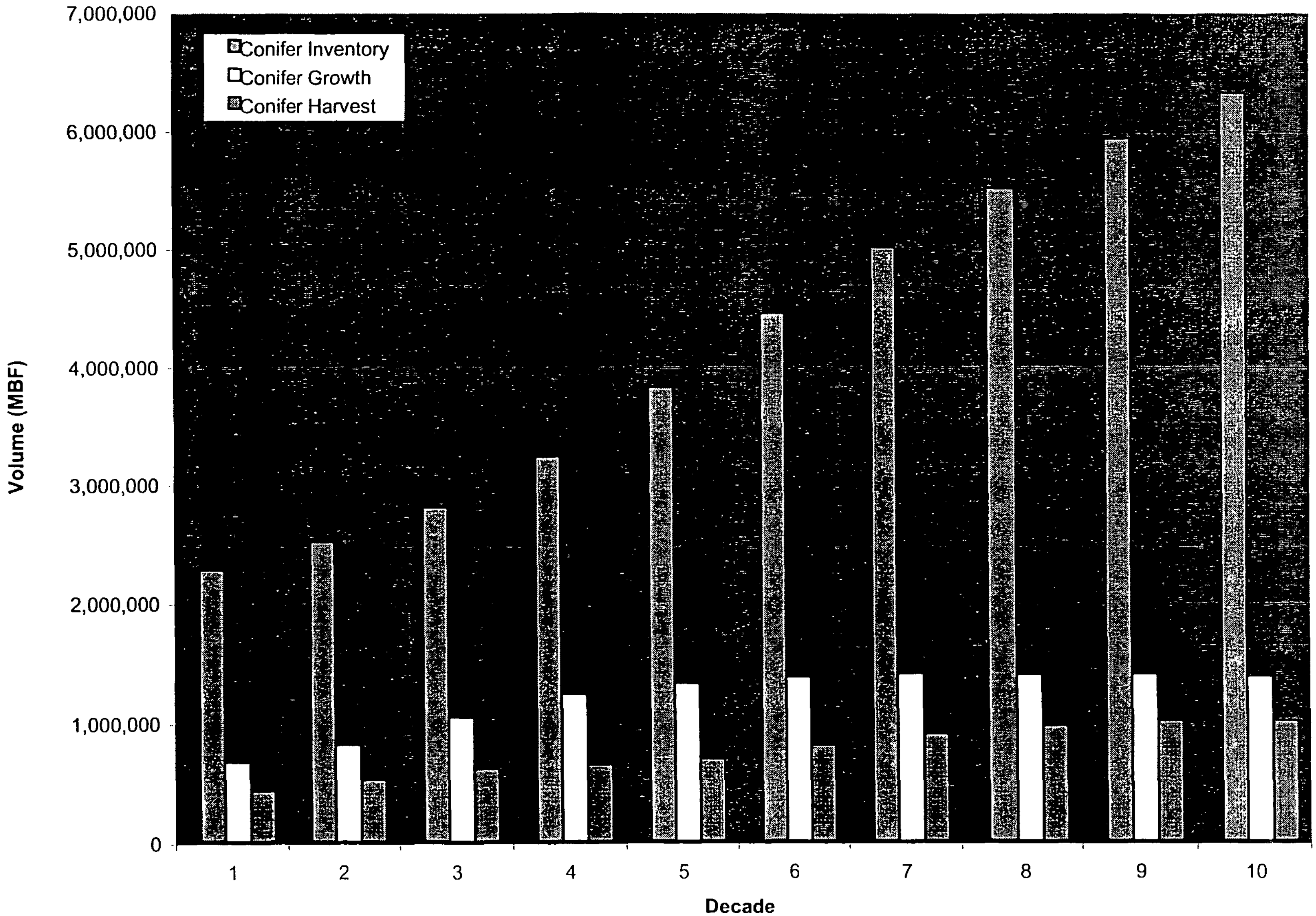


Chart 2. Modeled Hardwood Inventory, Growth, and Harvest by Decade

Option A

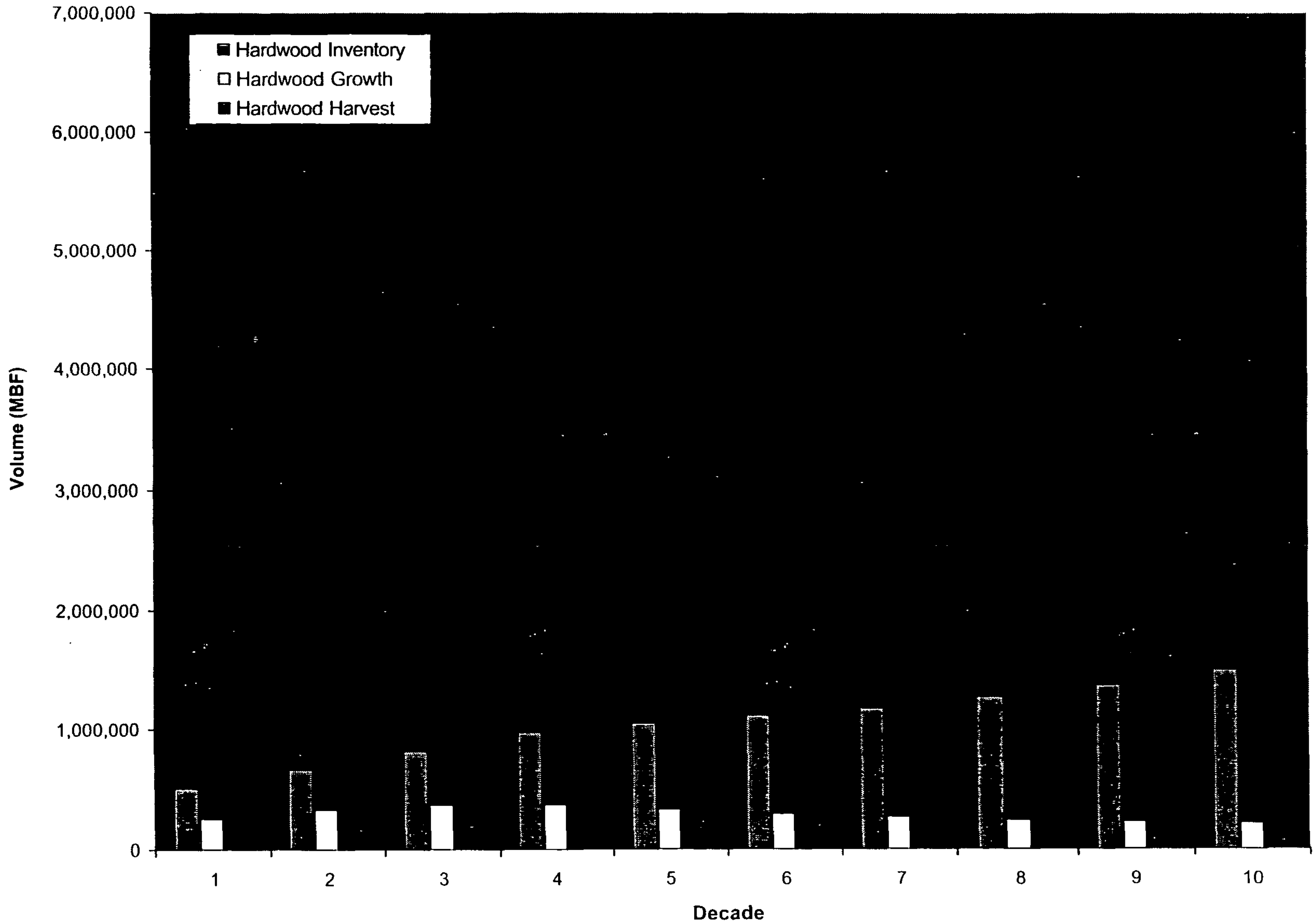


Table 2. Modeled Harvest Volume by Silvicultural Group by Decade

Option A

Mendocino Redwood Company Ownership

Species Group	Silvicultural Group	Decade 1	2	3	4	5	6	7	8	9	10
Conifer											
	High Retention Selection	7,700	11,200	18,500	27,300	31,800	29,700	39,600	44,600	45,900	45,900
	No Harvest	0	0	0	0	0	0	0	0	0	0
	Seed Tree/Shelterwood Removal	20,700	5,900	1,400	7,100	0	0	0	0	0	0
	Selection/Commercial Thinning	248,600	312,800	489,900	547,800	633,800	748,400	834,500	901,000	941,900	939,300
	Transition	5,000	8,300	5,400	6,900	11,500	10,000	11,400	12,500	11,400	13,000
	Variable Retention	136,100	172,800	84,700	41,300	3,100	6,500	0	0	0	0
	Volume (MBF) from Even-age Silviculture =	156,800	178,700	86,100	48,400	3,100	6,500	0	0	0	0
	Volume (MBF) from Uneven-age Silviculture =	261,300	332,300	513,800	582,000	677,100	788,100	885,500	958,100	999,200	998,200
	Total Conifer Harvest Volume (MBF) =	418,100	511,000	599,900	630,400	680,200	794,600	885,500	958,100	999,200	998,200
Hardwood											
	High Retention Selection	400	700	3,900	9,000	12,600	6,400	5,000	2,900	2,600	3,300
	No Harvest	0	0	0	0	0	0	0	0	0	0
	Seed Tree/Shelterwood Removal	17,900	3,500	3,700	10,300	0	0	0	0	0	0
	Selection/Commercial Thinning	22,700	94,900	169,800	250,500	255,200	223,500	175,500	135,100	98,900	93,500
	Transition	1,000	600	1,700	2,300	2,700	2,000	1,100	2,000	800	1,800
	Variable Retention	55,300	85,400	39,900	22,100	1,100	3,300	0	0	0	0
	Volume (MBF) from Even-age Silviculture =	73,200	88,900	43,600	32,400	1,100	3,300	0	0	0	0
	Volume (MBF) from Uneven-age Silviculture =	24,100	96,200	175,400	261,800	270,500	231,900	181,600	140,000	102,300	98,600
	Total Hardwood Harvest Volume (MBF) =	97,300	185,100	219,000	294,200	271,600	235,200	181,600	140,000	102,300	98,600

**Note: The overall percentages of volume harvested by even-age and uneven-age silviculture are expected to match planned operations. Within these silvicultural types, the proportions of volume harvested by specific silvicultural group may fluctuate by as much as 20 percent.

Chart 3. Modeled Conifer Harvest Volume by Silvicultural Type by Decade Option A

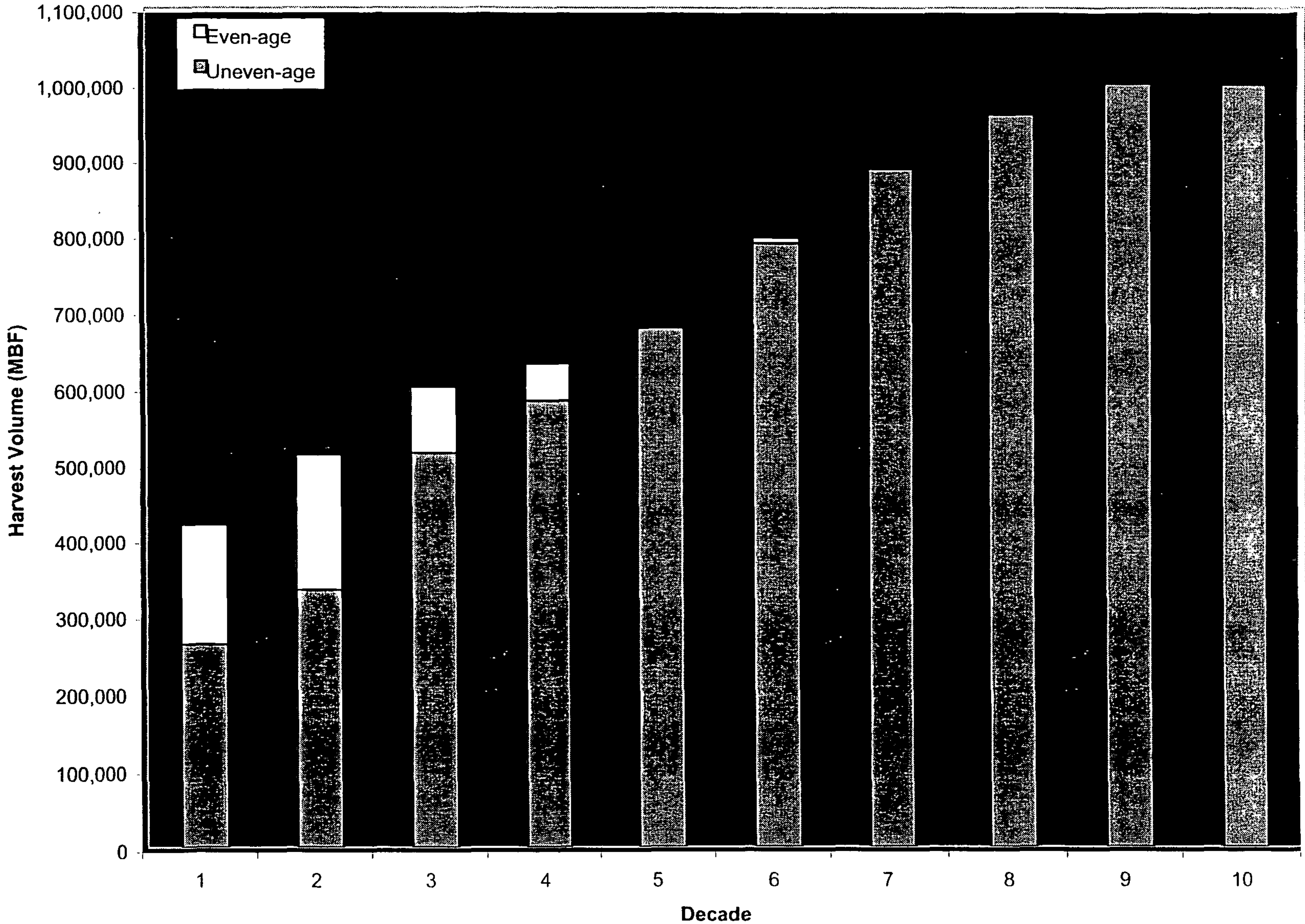


Chart 4. Modeled Hardwood Harvest Volume by Silvicultural Type by Decade

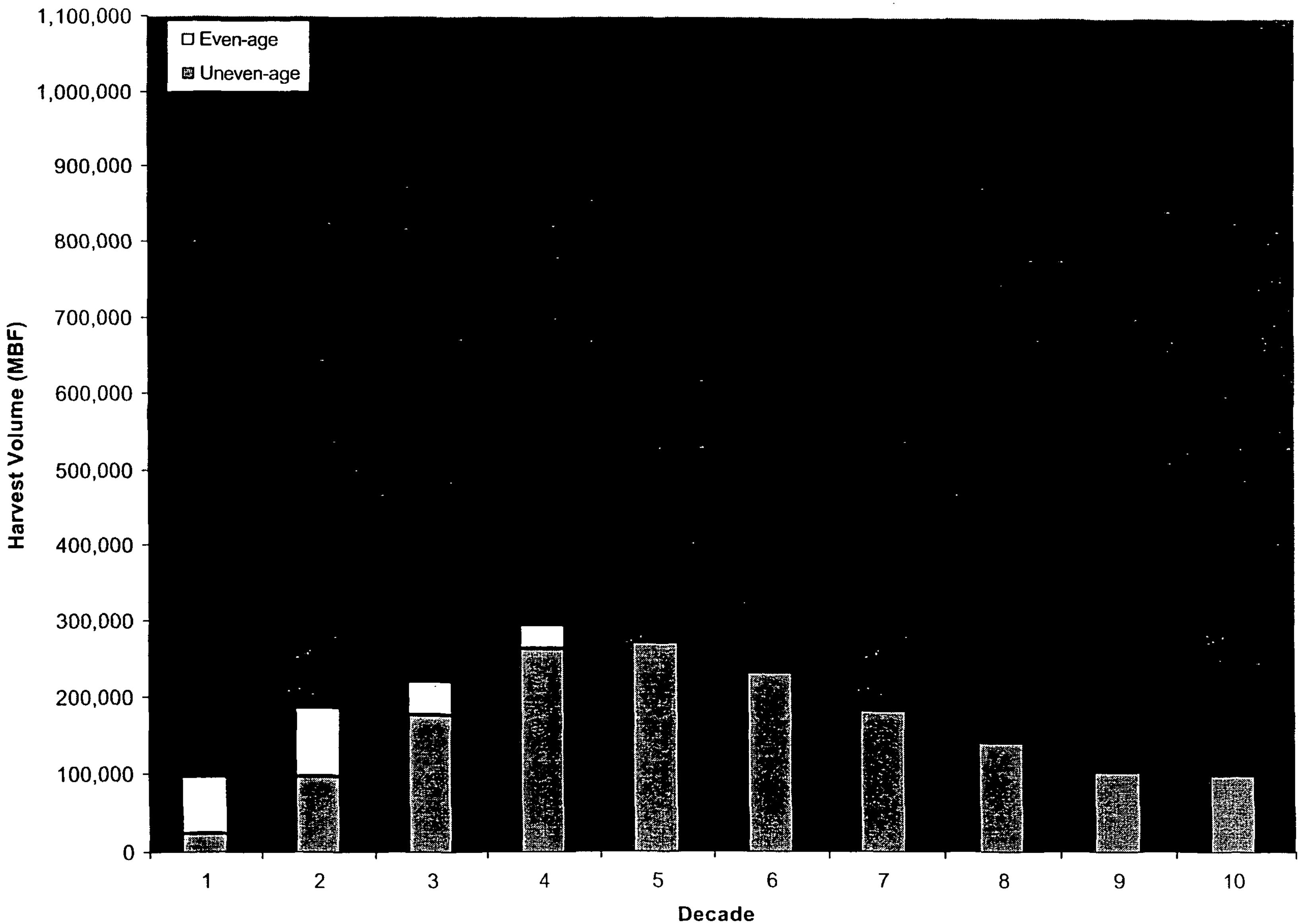
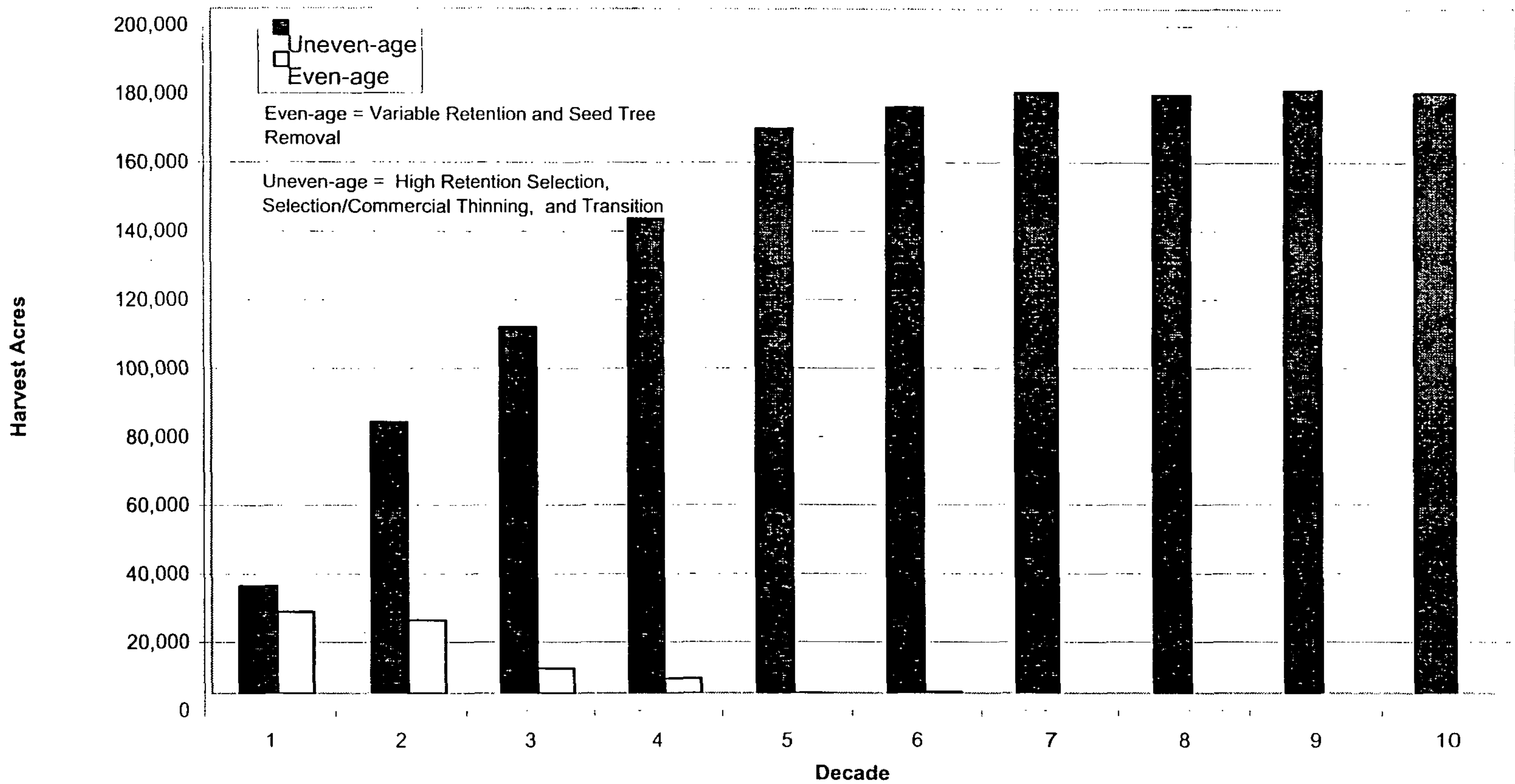


Chart 5. Modeled Harvest Acres by Silvicultural Type by Decade Option A

	Decade									
Silviculture Type	1	2	3	4	5	6	7	8	9	10
Even-age	23,800	21,300	7,400	4,400	100	500	0	0	0	0
Uneven-age	31,600	79,400	107,200	138,800	165,100	171,200	175,700	175,000	176,300	175,500
Total Harvest Acres =	55,400	100,700	114,600	143,200	165,200	171,700	175,700	175,000	176,300	175,500



**Note: Modeled harvest acres show approximately 55,400, or 5,540 acres annually in the 1st decade. Actual harvest acres will likely be near 6,500 acres annually for the 1st decade. The discrepancy is due to the economically driven model choosing the most well-stocked acres first, whereas MRC foresters will prioritize hardwood-dominated acres for conifer recapture in the early years of the plan. An increase in harvest acres in the 1st decade is likely followed by decreases in the 2nd and 3rd decades. The overall trend toward increasing harvest acres by decade is directly related to MRC's transition to uneven-age management. MRC recognizes that the increased number of acres covered by decade may result in risk for increased sedimentation. Consequently, MRC is taking steps to minimize road usage, improve drainage, and improve road surfaces.

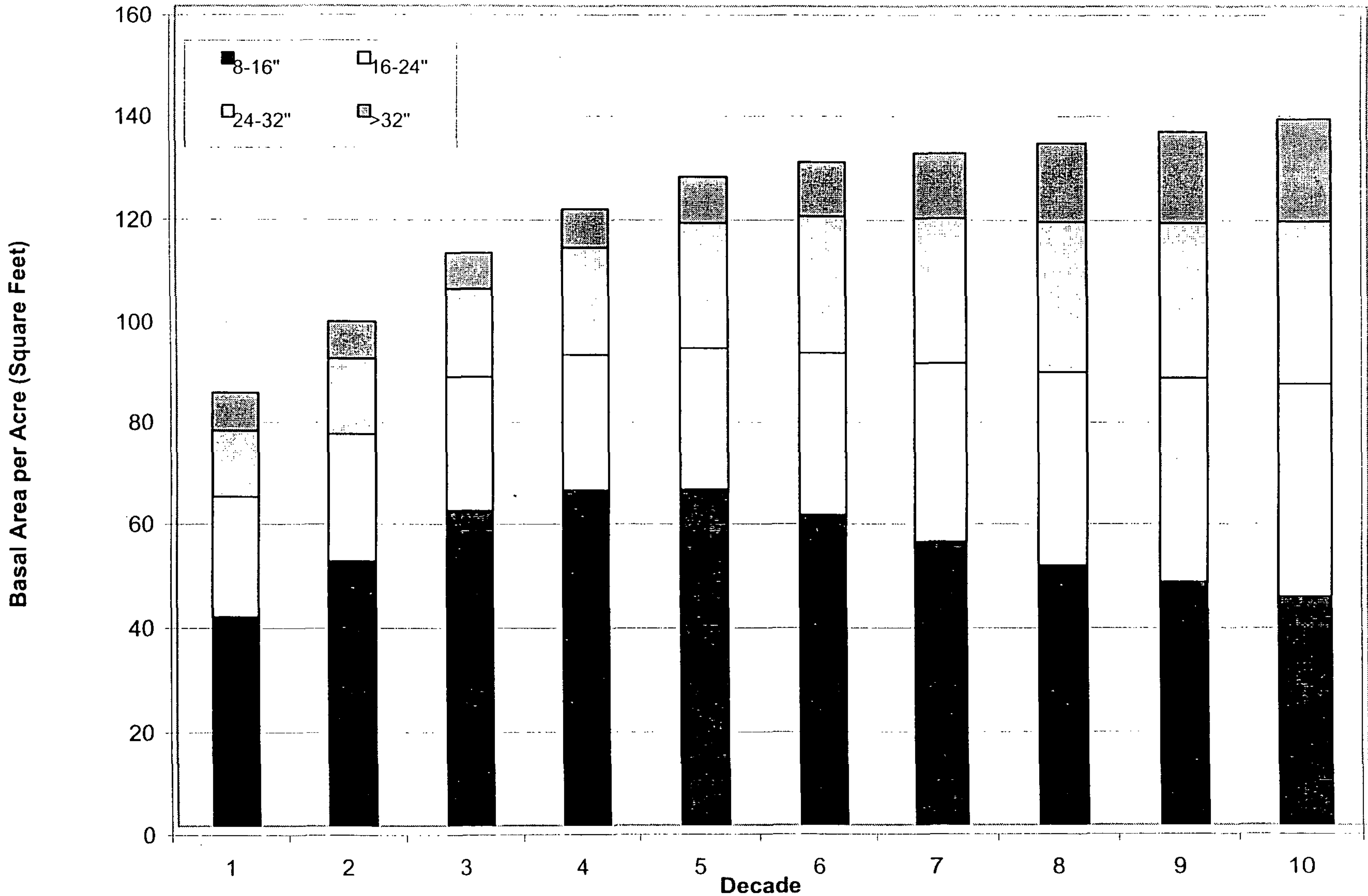

8-16"
16-24"
24-32"
>32"
160
140
120
100
80
60
40
20
0
Basal Area per Acre (Square Feet)
1
2
3
4
5
6
7
8
9
10
Decade

Chart 7. Modeled Total Standing Conifer Volume (MBF) by DBH Class by Decade

Option A

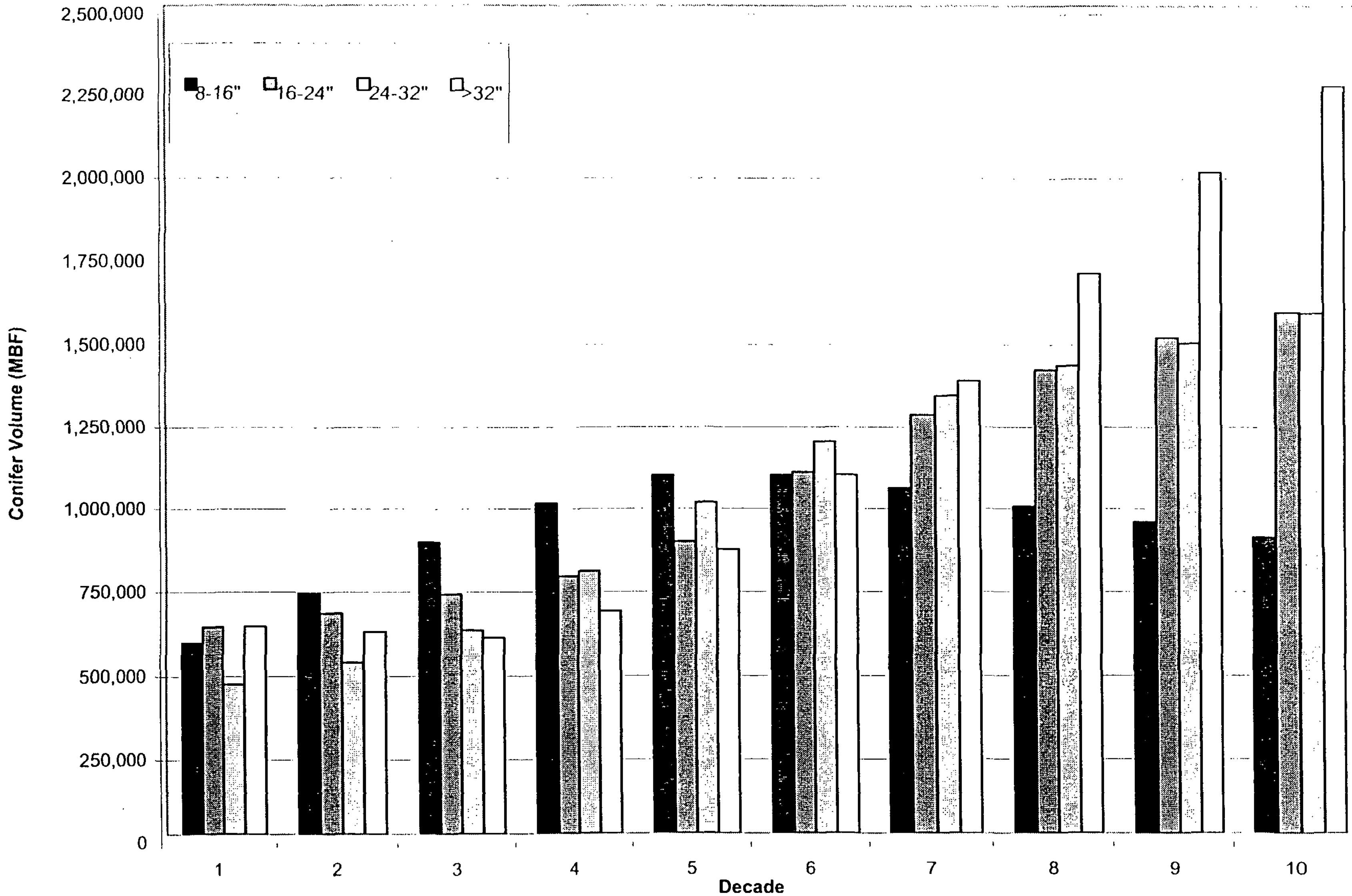
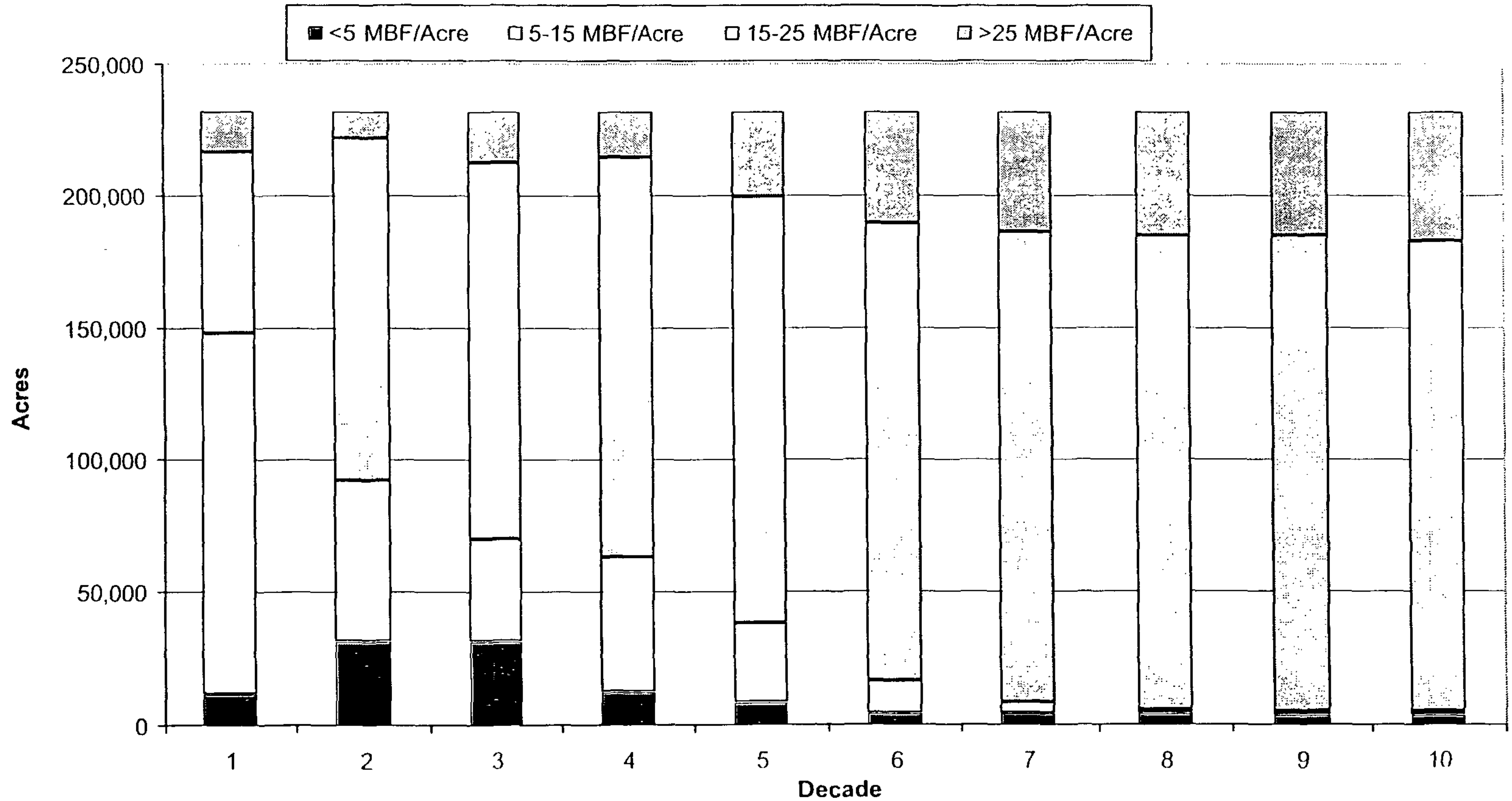


Chart 8. Modeled Acres by Forest Condition by Decade

Option A

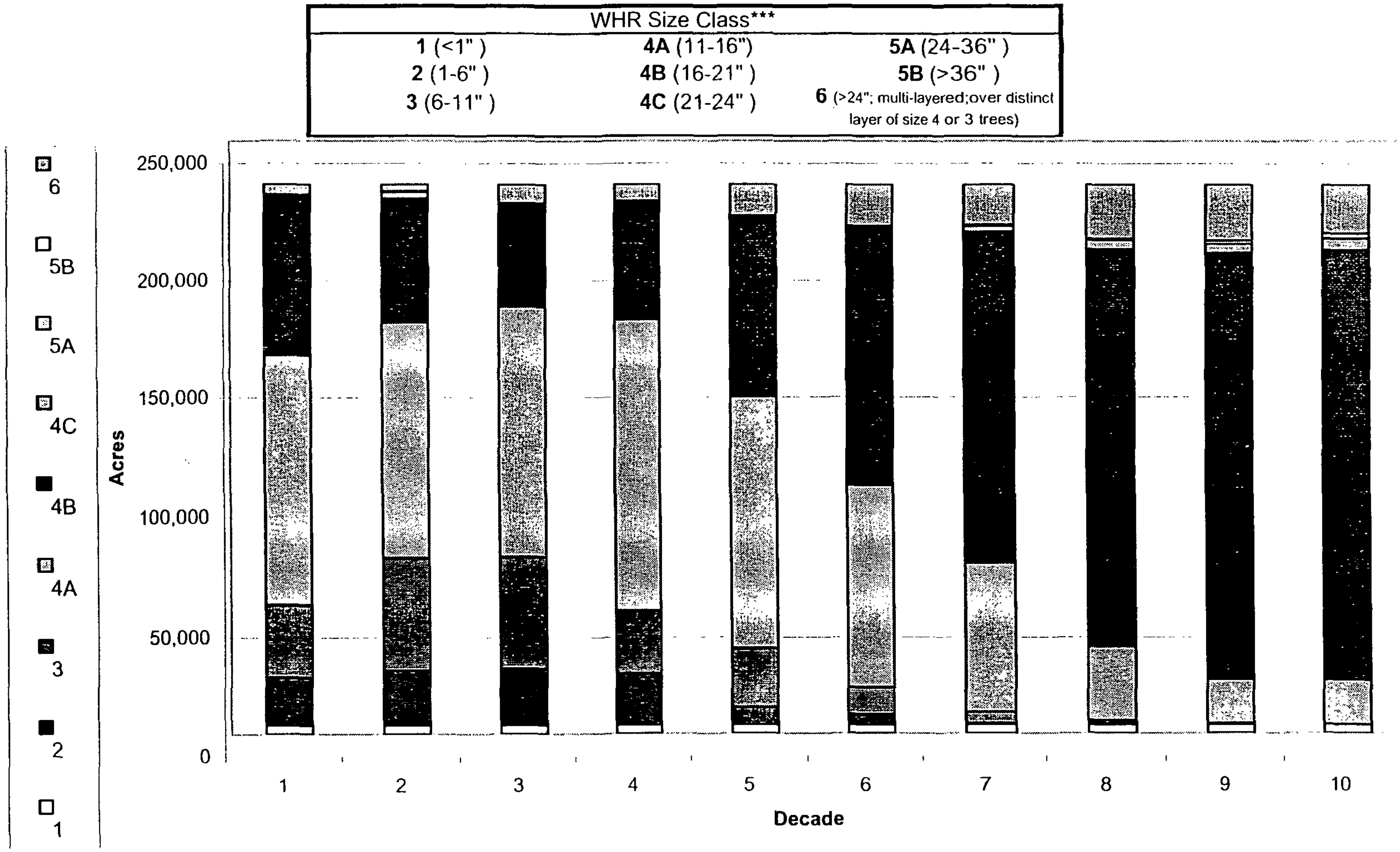
Decade

Conifer Volume	1	2	3	4	5	6	7	8	9	10
>25 MBF/Acre	15,500	9,700	19,300	17,200	32,700	42,600	46,100	47,300	47,600	49,600
15-25 MBF/Acre	68,200	129,800	142,500	151,500	160,900	172,400	177,100	178,600	179,000	177,400
5-15 MBF/Acre	136,400	60,900	38,600	51,000	30,000	12,800	4,400	1,800	1,500	1,100
<5 MBF/Acre	11,500	31,200	31,200	11,900	8,000	3,800	4,000	3,900	3,500	3,500
Total Acres =	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600	231,600



**Note: The decline of acres in stands over 25 MBF/acre at the end of the 1st decade is the result of the model choosing high volume stands for harvest that have not been constrained within the model design. MRC will not choose harvest acres this way, but rather will direct harvest locations with other ummodeled factors such as minimization of roads used, watershed effects, conifer recapture of hardwood-dominated acres, and logical harvest unit sizing.

Chart 9. Modeled Acres by WHR Size Class by Decade Option A



**Note: WHR size class 4 is 11 - 24" and WHR size class 5 is > 24". We have further divided the size classes to 4A, 4B, and 4C, as well as 5A and 5B, to add further definition to our stand conditions. due to the broadness of these categories. WHR size classes are calculated by using a quadratic mean diameter of all trees greater than 5" DBH (15 years old +). Decades 1 through 3 show the results of young trees entering the WHR calculation. Since MRC is shifting toward uneven-age management, all stands will maintain a component of small trees that results in a higher percentage of acres in WHR size class 4B.

Site Occupancy, Stand Vigor, Regeneration

...MSP will be achieved by:
(3) Realizing growth potential as measured by ***adequate site occupancy*** *by species to be managed and maintained given silvicultural methods selected by the landowner.*
(4) Maintaining ***good stand vigor****.*
(5) Making ***provisions for adequate regeneration****.*
FPA 913.11(a)(3-5)

These three provisions for ensuring Maximum Sustained Production (MSP) are related to the conditions found in the forest after a harvest operation is complete. MRC's tree retention and restocking guidelines are designed to create future healthy stands for continued timber production and improved wildlife habitat features. The details of these policies by silviculture type are included in Appendix C.

Regeneration activities on MRC lands include tree planting, site preparation work, vegetative management work, and pre-commercial thinning. Regeneration work is designed to improve conditions for the growth of new trees on a site that has been harvested and where openings are left in the forest canopy. All modeled silviculture assumes stocking levels at or above state regulations (FPA 913,933,953). Modeled partial cuts assume conifer basal area retention levels well above minimum retention levels in the state regulations. For silvicultural prescriptions where the retained conifer basal area is below 50 square feet of basal area, such as rehabilitation and variable retention, an initial conifer stocking of 300 stems per acre is assumed.

All modeled silviculture regimes assume that the retained trees are the most vigorous trees in the stand for each of the size classes being retained. No silviculture regimes were designed to model the effects of harvesting only the dominant and co-dominant trees in a stand. Furthermore, it is MRC policy that the selection of trees for harvest on partial cuts prioritizes diseased and suppressed trees prior to removing co-dominant and dominant trees. The on-going effort to recruit and retain older structural elements, such as snags and large woody debris represent exceptions to this priority.

Hardwoods are modeled for harvest within each of the silviculture regimes. The targeted hardwood basal area retention level averages 15% of the conifer basal area across the property, the specific retention level depending on site-specific attributes. Approximately 50% of MRC's lands have a much higher component of hardwood than existed prior to commercial logging activities. In these stands hardwoods typically make up the dominant overstory species. One of MRC's objectives is to return a portion of this ground for redwood and Douglas-fir stand growth in closer proportion to the mix that originally existed on the ownership where hardwoods are more typically the understory species.

Limits on MSP by Consideration of Other Forest Resources

...MSP will be achieved by:
producing the yield of timber products specified by the landowner, taking into account biologic and economic factors, while accounting for limits on productivity due to constraints imposed from consideration of other forest values, including but not limited to, ***recreation, watershed, wildlife****, range and forage,* ***fisheries****, regional economic vitality, employment and* ***aesthetic enjoyment****. FPA 913.11(a)(1)*

Non-timber forest values considered in the calculation of Maximum Sustained Production (MSP) include improvements to terrestrial wildlife habitat, improvements to aquatic habitat, and increased attention to community issues such as viewshed, recreational opportunities, and economic vitality. These considerations impact the determination of MSP through silvicultural logic constraints, land typing constraints, targeted forest conditions (Wildlife Habitat Relationships, or WHR), and harvest level constraints. The models used to determine MSP incorporate all of these constraints. It is difficult, therefore, to isolate the impact of any one constraint or policy on Long Term Sustained Yield (LTSY). The total set of constraints can be determined by comparing the Option A to a model run with constraints reflecting only the current California Forest Practice Rules in Option C. The comparison of these two model runs demonstrates that the non-timber forest value considerations in MRC's Option A have an approximate 24% impact on LTSY.

Mendocino Redwood Company Option A Impact of Constraints on LTSY		
	Proposed Option A with MRC policy constraints	**Option C Rules only**
Annual Harvest Level Mbf		
average first 50 years	56,600	84,300
average second 50 years	92,700	138,600
average for 100 years	74,700	111,000
Calculation of Long Term Sustained Yield (LTSY) bf/acre/year	590	780

Mendocino Redwood Company's (MRC) silvicultural logic has been designed to minimize the impact of timber harvest on other non-timber forest values. MRC's trigger and retention requirements will promote greater vertical diversity, improve distribution of large woody debris, provide sufficient canopy to improve stream temperature, promote development of larger trees, and rehabilitate poorly stocked conifer stands experiencing excessive hardwood competition as the result of past harvesting practices. Detailed descriptions, trigger conditions, stocking, retention and re-entry specifications for MRC silviculture prescriptions are found in Appendix C of this document. Appendix C also details how these policies were modeled to limit LTSY.

Geographic constraints applied to land types included 6,480 acres of no-harvest, 21,780 acres of High Retention Selection, and 16,260 acres of Selection silviculture in all decades of the plan. These acres were constrained to reflect geographically referenced and marked sensitivities to old growth habitat, unique habitats such as oak woodlands, restoration of riparian and stream ecosystems, and protection of community viewsheds. The 44,500 non-overlapping acres are designated and mapped in MRC's Geographic Information System (GIS).

Acres Constrained for Non-Timber Forest Values

Forest Value	Acres Impacted	Origin of Data	Modeled Constraint
Old Growth Stands and Groves	50	Identified by Area Foresters	No Harvest
Oak Woodlands	4,800	Identified by Area Foresters and Vegetation Classification as Unique Vegetation	No Harvest
Marbled Murrelet Management Areas	1,400	Identified by Area Foresters. Future management is the focus of on-going discussions between MRC biologists and agency personnel.	No Harvest
Navarro Strip	230	Described in Conservation Easement	No Harvest
WLPZ Buffer Zones	21,400	Watercourses are Buffered for Horizontal Distances of 100' (Class I) and 75' (Class II). Modeling Horizontal Distance Represents a Field Buffer of 100' - 150' for Class I Watercourses and a Field Buffer of 75' - 110' for Class II Watercourses, Depending on Slope.	High Retention Selection Silviculture Only
Selected State Park and other Buffers	380	Polygons Identified Adjacent to Navarro Redwoods and Hendy Woods State Parks. Visual Corridors Identified near Armstrong Redwoods State Park in Sonoma County.	High Retention Selection Silviculture Only
Coastal Commission Coastal Zone	5,200	Selected polygons Interpreted from Coastal Commission Maps.	Selection Silviculture Only*
Coastal Zone Special Treatment Areas	3,100	Selected Areas interpreted from Coastal Commission maps.	Selection Silviculture Only*
Neighboring Landowners	3,800	Polygons identified for Neighbors who are not Industrial Forestland Owners.	Selection Silviculture Only
County Road and Scenic Buffers	3,900	Corridor Centered on Selected County Roads Adjacent to Property.	Selection Silviculture Only*
Skunk Railroad Buffer	260	Corridor Centered on Skunk Railroad.	Selection Silviculture Only
Total Impacted Acres	**44,520**		

* These acres are constrained for the calculation of LTSY with the most likely silviculture although site specific conditions may warrant different initial prescriptions in some cases.

Achievement of targeted forest conditions is used to limit harvest levels and Long Term Sustained Yield (LTSY) to account for implementation of MRC's internal policies to restore and protect terrestrial and aquatic wildlife habitat, public access and domestic water sources. Targeted forest conditions are also used to account for the management of Northern Spotted Owl nesting, roosting, and foraging habitat. Model results are captured by decade to reflect changes in average tree diameter and per acre stocking to determine if targeted forest conditions are met. Results are shown graphically on Charts 8 and 9 in a previous section of this Option A and summarized below.

Mendocino Redwood Company Option A Targeted Forest Condiitons			
	Percent of Acres		Total Volume Mbf
	>25 mbf/acre	>=WHR Size Class 4B (>=16" QMD)	Trees >32" DBH
Current	7%	32%	622,000
After 50 years	20%	55%	1,076,700

MRC operating policies to protect terrestrial wildlife habitat, aquatic wildlife habitat, public access, and domestic water supplies are listed on the following four pages. These are baseline or minimum requirements for MRC ground operations. Each THP area will be evaluated for site specific conditions. Where poor stream or up-slope conditions exist, more restrictive operating policies may be used as the standard.

Following the six pages of MRC operating policies are three pages of silvicultural descriptions, trigger and retention requirements. These are also included in Appendix C with an explanation of how they were modeled for the calcualtion of LTSY. These silvicultural requirements are policies for foresters to follow when preparing a timber harvest plan. When exceptions to these silvicultural requirements are sought due to site specific conditions, a full explanation will be provided in the THP.

MRC Policies Protecting Non-Timber Forest Values		
Forest Value	**Target Feature**	**MRC Policy**
Wildlife Habitat Terrestrial	Snags	All snags will be retained except in cases where they pose safety or excessive fuel loading hazards.
		Permanent conifer and hardwood snag retention and recruitment, of size and distribution to be biologically meaningful, will be a part of every timber harvest plan.
		On a THP by THP basis, either prior or post harvest activities, MRC will capture and map snag locations and record tree morphology as part of a long-term monitoring project.
		If snag density is deficient, live cull trees or deformed green trees will be recruited.
		In WLPZs and other wildlife emphasis areas (Northern Spotted Owl sites, unique areas) recruit a minimum of 2-3 snags/acre (min 16"d.b.h., 10' length) averaged on 40 acre increments.
		In general forested areas, recruit a minimum of 1-2 snags/acre (min 16"d.b.h., 10' length) on 40 acre increments.
Wildlife Habitat Terrestrial	Breeding Raptors	To protect breeding raptors in proposed operating areas:
		-The RPF, or designee, will look for nests, white wash, and other sign during on-the-ground inspections of the THP areas during THP design and layout
		-The RPF, or designee, will look for the potential retention of trees that have the characteristics attractive for raptor nesting
		-If raptor sign is detected during preparation or operation of a THP, the company biologist will be called for internal consultation
		-During pre-operative meetings with the Licensed Timber Operators (LTOs) MRC will alert the LTO to protective measures and concerns for breeding raptors
		-Fallers will be advised to look up in the tree prior to falling and check for raptor nests. If a nest, or other sign, is observed the faller will advise the MRC representative supervising the THP oeprations and leave the tree standing
Wildlife Habitat Terrestrial	Old Growth	MRC will not harvest old growth as defined below:
		– Un-entered stands of more than 20 acres.
		– Stands of 5 acres or more with an average of 6 old growth trees per acre or more (old growth trees defined as trees over 250 years old and 48 inches d.b.h. or larger) .
		– Individual residual old growth trees with significant wildlife value (eg. large limbs, cavities, nesting platforms, limited available structures).

MRC Policies Protecting Non-Timber Forest Values		
Forest Value	**Target Feature**	**MRC Policy**
Wildlife Habitat Terrestrial	Large Woody Debris	All large woody debris (LWD) in WLPZs will be retained with the exception of removal due to road obstruction or moved for riparian and stream restoration work.
		In WLPZs recruit a minimum of 7 downed logs/acre (min 16"avg. diameter, 10' length) averaged over 40 acres.
		In general forested areas, recruit and retain a minimum average of 5 downed logs/acre (min 16"avg. diameter, 10' length) averaged over 40 acres.
		All unmerchantable logs generated from current operations will be returned to the forest floor prior to removal of equipment. Unmerchantable logs, left from past operations, will be returned to the forest floor or watercourse enhancement projects when equipment is available in the area.
Wildlife Habitat Terrestrial	Hardwoods	Every timber harvest plan will be reviewed for the retention of any hardwood trees that enhance wildlife habitat.
		Every THP will retain all of the trees of the true oak species (> 18" dbh) present prior to harvest with the exception of incidental removal for safety, road right of way, or yarding corridors
		The objective across the forestlands is to restore the natural balance between conifer and hardwood, which will vary depending on site. Hardwood retention will be 15% of the total post harvest basal area, provided that hardwoods comprised at least 15% of the basal area prior to harvest.
Wildlife Habitat Terrestrial	Rare and Endangered Plants	For each THP, MRC will determine the likelihood of impact on plants of concern. Initially this will involve working with the Native Plant database and/or a consulting botanist to identify likely habitats and develop survey protocols where appropriate.

MRC Policies Protecting Non-Timber Forest Values

Forest Value	Target Feature	MRC Policy
Wildlife Habitat Aquatic	Unstable Areas	Foresters will first use Division of Mines and Geology landslide maps, past Timber Harvest Plans and the SHALSTAB model as tools to potentially identify unstable areas. SHALSTAB maps will be included in the THP.
		No harvest activity will occur, with the exception of cable or helicopter harvesting that retains over 50% of the pre-harvest basal area, or any construction of roads and landings in areas identified in the field as having a significant likelihood of sediment delivery from mass wasting unless a site-specific assessment is conducted and operations approved by a registered geologist.
Wildlife Habitat Aquatic	Exposed Soil	In WLPZs, 100 square feet of exposed mineral soil will require mulching, cover with slash, and/or seeding.
		In WLPZs, roads assessed and identified with capacity for significant discharge of sediment will require mulching, cover with slash, and/or seeding.
Wildlife Habitat Aquatic	Equipment Exclusion Zones (EEZs)	Equipment excluded from WLPZs for all Class I, II and ELZs for all Class III streams with exception of existing trails with no sign of instability.
		When equipment used in WLPZs or ELZs, trails and landings will be packed with slash and debris following completion of operations.
Wildlife Habitat Aquatic	Water Drafting	Water drafting for timber operations from within a channel zone of a Class I watercourse will meet the following standards: -Speed of water entering intake pipe will be less than .33 feet per second -All approaches to drafting locations will be rocked -Intakes used will be screened with mesh, perforated plate or pipe with openings of 3/32" or smaller -Water usage will be restricted in such a way so as to keep flows above critical levels -Modifications to drafting locations will minimize removal/disturbance to the streambank, streambed, and existing vegetation

MRC Policies Protecting Non-Timber Forest Values		
Forest Value	**Target Feature**	**MRC Policy**
Wildlife Habitat Aquatic	Roads	Construction/reconstruction of roads will follow guidelines in the 1994 handbook by Weaver and Hagans. A short supplement with specifics for MRC roads may be developed by end of year 2000.
		All construction/reconstruction of roads will meet water quality standards developed in MRC's watershed analysis work to control sediment delivery, protect stream bank stability, and provide passage for fish in all life stages in Class I streams.
		Rocked fords, rolling dips and out-sloping will be used where possible; watercourse crossing will be sized to pass the 100 year flood.
		The condition of culverts, bridges, and all other erosion control structures will be monitored on an annual basis. Additional monitoring will occur during the wintertime and major storm events for identified projects or trouble spots.
		A long-term road management plan will be developed to cover ongoing monitoring and maintenance for temporary, seasonal, and permanent roads.
Wildlife Habitat Aquatic	Watershed Analysis Objective	Intensive field watershed analysis (also know as "Level II") will be completed on all 303d listed watersheds (70% of MRC forestlands) by the end of 2001.
		This analysis will include assessments of:
		Mass wasting inventory and map untis.
		Analysis of road erosion and road erosion hazard.
		Stream channel condition.
		Riparian function and condition for shade and large woody debris recruitment potential.
		Fish habitat conditions.
		Potential salmonid distribution and habitat.

MRC Policies: Protecting Non-Timber Forest Values		
Forest Value	**Target Feature**	**MRC Policy**
Wildlife Habitat Aquatic	Streamside	At least 70% absolute canopy cover within the WLPZs will be retained or recruited. (ref. High Retention Selection retention specifications)
		Where watershed analysis indicates there is high or moderate in-stream large woody debris (LWD) demand, any harvest activity in the watercourse and lake protection zones (WLPZ) will recruit and permanently retain 20 trees per 330 feet of lineal Class I watercourse (10 each side) and 10 trees per 330 feet of lineal Class II watercourse (5 each side) that have the greatest potential for LWD input. Greatest potential for LWD input is defined by: disposition (likelihood to fall in the watercourse), distance to the stream, size, and species. Priority will be given to the largest 20% diameter trees within 60' of the watercourse. These retention standards will be held constant so long as scientific research indicates that the policy is necessary. (ref. High Retention Selection retention specifications)
		Sanitation salvage logging will not be conducted in WLPZ or ELZ buffer areas.
		All large woody debris (LWD) in the watercourse and WLPZ will be retained. No salvage logging of LWD.
		Foresters are encouraged to look, with guidance from biologists, for ways to put more LWD into the stream channel.
		Foresters are encouraged to develop increased filter capacity in these zones including thinning, pruning, lopping, and revegetating slides.
		Any current or future livestock leases will include mitigation measures to protect streamsides and avoid riparian damage.
Wildlife Habitat Aquatic	Road Survey Objective	All MRC roads will be inventoried, mapped, associated sediment sources assessed, and mitigation work identified and prioritized by December 2003.
		Site-specific upgrade projects for road stabilization, road removal, and other prescriptions to address sediment sources will be developed, implemented, and monitored.

MRC Policies Protecting Non-Timber Forest Values		
Forest Value	**Target Feature**	**MRC Policy**
Wildlife Habitat Aquatic	Winter Harvesting (November 15 to April 15)	Cable yarding on rocked landings may be conducted if sediment movement can be avoided. Loading and hauling on rocked roads and landings will not be conducted during periods of rainfall or when roadside ditches are flowing with surface runoff, or when roads are saturated and cannot support the heavy loads. At first sign of measurable rain, trucks in the woods will make their final trip out, and trucks not yet in the woods will be asked to return home for the day Operations during extended periods of dry weather, defined as prior to two inches of rainfall after November 15, might include tractor logging and hauling on non rocked roads.
Education and Recreation	Public Access	MRC encourages cooperative education and research projects on its ownership.
		MRC properties are open at designated times and locations for the following additional activities:
		Hiking, camping, picnicking, firewood cutting, bicycling, horseback riding, cross-country running, hunting, fishing, and collection of burls, mushrooms, greens, and basket making materials
		Written permits and/or leasing arrangements (obtained by calling the Calpella office 707-485-8731 or Fort Bragg office 707-962-2800) are required for all of the above in order to shelter wildlife, prevent road damage or sedimentation, shield watercourses, educate individuals about safety issues, and to allow the company protection from personal liability claims.
Domestic Water Source	Potable Water	Foresters will protect sources of domestic water by providing a no-harvest and/or a High Retention Selection Harvest buffer.

Descriptions of Different Silvicultural Harvest Prescriptions Used by MRC

Prescription	Description	California Forest Practices Rules Ref. and Label
Uneven-Aged Management		
Single Tree Selection	To establish and maintain multi-storied, uneven-aged stands of redwoods and Douglas-fir by harvesting individual trees more or less uniformly throughout the stand. Provides space for growth of remaining trees and space for growth of new trees.	913.2(a)(2)(A) "Selection System"
Group Selection (Conifer & Mixed)	To establish and maintain multi-storied, uneven-aged stands of redwoods and Douglas-fir by harvesting trees in small (< 2.5 acre) groups. Width of groups is commonly twice tree height of surrounding mature trees to maintain forest influence.	913.2(a)(2)(B) "Group Selection"
High Retention Selection	To accelerate stand development of large trees and closed canopy by harvesting individual trees targeted to result in the growth of larger trees and to create and maintain special habitat elements such as decadent trees, snags, and downed logs.	913.2(a)(2)(A) "Selection System"
Commercial Thinning	To promote timber growth, increase average stand diameter, and improve forest health by the removal of trees in a manner that results in a stand with two or three distinct canopy layers.	913.3(a) "Commercial thinning"
Transition	To develop an uneven-aged stand from an even-aged stand or a stand with unbalanced or irregular stocking. Involves removal of trees individually or in small groups to create a balance of different stand structure and natural reproduction.	913.2(b) "Transition"
Even-Aged Management		
Variable Retention	To rotate stands with poorly stocked conifer volume and relatively high volumes of hardwood, dispersed and/or aggregated retention of 10% to 40% or more of the existing stand to provide for vigorous growth of remaining stand combined with pockets of undisturbed trees to provide for ecological functionality, habitat structure, and forest complexity.	913.6 "Alternative Prescription" "AP/Clearcut"
Seed Tree Removal Step	This step harvests a portion of the seed trees left in an earlier entry and after a fully stocked stand of regenerated trees has become established.	913.1(c)(2) "Seed Tree Removal Step"
Shelterwood Removal Step	This step harvests a portion of the overstory of trees left in an earlier entry for wind and soil stability and after a fully stocked stand of regenerated trees has become established.	913.1(d)(3) "Shelterwood Removal Step"
Rehabilitation	To rehabilitate poorly stocked conifer stands experiencing excessive hardwood competition and allow for site prep and conifer regeneration and transition into well-stocked stand of conifers.	913.4(b) "Rehabilitation"

Targeted Pre-Harvest Conditions on MRC Forestlands				
Prescription	Species	Pre-Harvest Conifer Basal Area (Feet Squared per Acre)		Other Key Pre-Harvest Factors
Uneven-Aged Management		Lower Limit	Upper Limit	
Single Tree Selection	Conifer/Mixed	120	None	
Group Selection	Conifer	120	None	20% of the Stands' Area May Meet Stocking Standards Using the Point Count Method. The Remaining 80% Must Meet the Pre Harvest Basal Area Trigger (120 sf per acre).
Group Selection	Mixed	90	None	Hardwood basal area greater than 50 sf/acre. 20% of the Stands' Area May Meet Stocking Standards Using the Point Count Method. The Remaining 80% Must Meet the Pre-Harvest Basal Area Trigger (120 sf per acre).
High Retention Selection	Conifer/Mixed	260	None	Basal Area Present for 70% Absolute Canopy Cover
Commercial Thinning	Conifer	120	None	Will Not Be Applied to a Stand That Has Been Selectively Harvested Within 10 Years
Transition	Conifer/Mixed, Mixed/Hardwood	60	100	
Even-Aged Management*				
Variable Retention	Mixed	25	135	Greater Than 60 sf ba/acre Hardwoods**
Seed Tree Removal	Conifer/Mixed	15	50***	Regeneration @ 300 Point Count
Shelterwood Removal	Conifer/Mixed	25	100***	Regeneration @ 300 Point Count
Rehabilitation	Mixed/Hardwood	None	50	Less than 300 point count. Greater Than 50 sf ba/acre Hardwoods

Note: These recommended silvicultural harvest prescriptions are expected to result over time in an increase in more mature forest types, which is the goal of MRC. If a forester determines that a different silvicultural prescription would better achieve the goals of MRC, then that prescription can be used after consultation with the Chief Forester, Forestlands Manager, or Stewardship Director.

* The majority of even-aged management is used in hardwood dominated stands to rotate the stands back to planted conifers.

** Due to the variability of hardwood inventory across MRC's forest lands, the pre-harvest hardwood basal area may vary as much as 30% for this prescription.

*** Pre-dominant conifer basal area.

MRC Targets For Stocking, Retention and Re-entry Specifications

Silviculture	Post Harvest Stocking Levels	Retention Conifer Basal Area (Square Feet of Basal Area per Acre)	Time before next harvesting activities
Uneven-Aged Management			
Single Tree Selection	All Age, evenly distributed	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years
Group Selection (Conifer)	Less Than 20% of Pre-Harvest Stand in Clearings	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years
Group Selection (Mixed)	Less Than 20% of Pre-Harvest Stand in Clearings	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years
High Retention Selection	Greater Than 70% Absolute Canopy Closure, Six Trees At Least 32" dbh or Greater Per Acre, If LWD Deficient, then Permanent Retention per Operating Policy	Greater Than 200 sf ba and Greater Than 75% sf ba of Pre-Harvest Stand	At Least 15 Years
Commercial Thinning	Equal to or Greater Average Tree Diameter Than in Pre-Harvest Stand	> 110 sf ba	Transition to Selection 10-20 Years
Transition	Less Than 20% of Pre-Harvest Stand in Clearings	> 50 sf ba	Transition to Selection 20-30 Years
Even-Aged Management			
Variable Retention	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	Approximately 10% to 40% Depending on the Acreage Retention	Transition to Selection 30-60 Years
Seed Tree Removal Step	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	Greater Than 10 sf ba, if Pre-Harvest Stocking is Less Than 75 sf ba; Greater Than 50 sf ba if Pre-Harvest Stocking is Greater Than 75 sf ba	Transition to Selection 30-60 Years
Shelterwood Removal Step	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	Greater Than 10 sf ba, if Pre-Harvest Stocking is Less Than 75 sf ba; Greater Than 50 sf ba if Pre-Harvest Stocking is Greater Than 75 sf ba	Transition to Selection 30-60 Years
Rehabilitation	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	> 10 sf ba Where Conifer > 10 sf ba Pre-Harvest	Transition to Selection 30-60 Years

Consideration of Regional Economic Vitality and Employment

...MSP will be achieved by:
producing the yield of timber products specified by the landowner, taking into account biologic and economic factors, while accounting for limits on productivity due to constraints imposed from consideration of other forest values, including but not limited to, recreation, watershed, wildlife, range and forage, fisheries, ***regional economic vitality, employment*** *and aesthetic enjoyment. FPA 913.11(a)(1)*

MRC currently employs 54 full-time and 16 part-time and seasonal workers. This group represents a set of individuals with wide variety of scientific backgrounds and expertise. MRC's associated mills, treating and distribution businesses employ an additional 450 full-time and 20 to 30 part-time and seasonal workers.

In addition to the employment of MRC and its two associated companies, MRC purchases products and engages in contracts with over 150 suppliers, most of which are located in Mendocino County. The value of MRC's contracts with these suppliers is over $ 20 million per year, and these contracts involve over 300 additional contractor employees. The majority of these contracts are involved in the logging and hauling operations. MRC will be partnering more closely with these contractors to ensure that forest management objectives are carried out in all aspects of operations on the ground. Partnering activities include joint training programs and greater involvement of contractors with timber harvest planning and layout.

As MRC improves the forest inventories and wildlife habitat on its land base, these successes will contribute to the stability and diversity of employment in our communities. Employment opportunities will be related directly to the forest products industry and the continual addition of value-added products. The impacts will also be indirect with the benefits of restored fisheries, recreation and tourism.

The economic effects of MRC's harvest production activities on local economies can be analyzed by looking at direct and indirect employment and payrolls, local sales taxes, property taxes, and timber yield taxes. Multipliers are determined per million board feet of timber harvest to arrive at projected economic contributions.

Direct employment and payroll covers employees of MRC and their wages or salaries. It also covers employees of logging, trucking, and other contractors employed by MRC in the course of normal operations. Data collected from MRC manufacturing operations indicate that the direct employment per million board feet is 12.15 jobs. The jobs considered in this multiplier include foresters, biologists, watershed specialists, logging contractors, managers, and mill workers. It did not include other contractors engaged in trucking, road construction, and vegetation management. It also did not include consultants, inspectors, and vendors associated with timber harvest. It also did not include all employees associated with the Calpella Distribution Center and the Ukiah wood treatment plant, which amount to 7.32 jobs per million board feet log scale. These jobs were considered in the regional employment multiplier considered below.

McKillop (1995) estimated a timber industry employment multiplier of 2 and an income multiplier of 1.6, per million board feet of timber harvested. McKillop and Spriggs (1993) estimated that $257 per year is collected in local sales tax for each job created directly and indirectly by timber harvesting in California, Oregon, and Washington. This amounts to $6,246 in sales tax revenue per million board feet harvested. The average yield tax per million board feet of conifer harvest in Mendocino County is estimated to be $13,630.

Property taxes are not subject to fluctuations due to timber harvest. MRC pays property taxes for the land value of its timberlands as well as for the sawmills and other facilities. The analysis below only includes the property taxes paid as the result of a viable timber harvesting operation, such as those associated with the facilities. It does not include those taxes associated with the land since those taxes would be paid in the absence of a timber harvesting program. The following table shows the effect of timber harvest on the local economy per million board feet of conifers harvested.

Multipliers per Million Board Feet of Timber Harvested					
Timber Jobs	Regional Jobs	Timber Payrolls	Regional Payrolls	Yield Tax	Sales Tax
12.2	24.3	$274,300	$438,600	$13,630	$6,246
Estimated Contribution by 1999 Harvest (40 mmbf)					
488	972	$`10,972,000	$17,544,000	$545,200	$249,840

This analysis does not include the jobs and tax revenues created as the result of hardwood harvest. A successful program utilizing the hardwood resource could bring in additional jobs and revenues. Hardwood harvest accounts for 23% of the total harvest in the first two decades. The projections provided below use the multipliers discussed above and the projected conifer harvest for the 100-year period. The projections are in real dollars and do not account for inflation.

Annual Contribution to Regional Economic Vitality and Employment Based on Timber Harvest

Decade	Conifer Harvest (MMBF/year)	Timber Jobs	Regional Jobs	Timber Payrolls ($1000s)	Regional Payrolls ($1000s)	Yield Tax ($1000s)	Sales Tax ($1000s)	Property Tax (Fixed) ($1000)	Total Taxes ($1000)
1	42	510	1,020	11,514	18,400	570	260	5,418	6,248
2	51	620	1,240	14,000	22,400	700	320	5,418	6,438
3	60	730	1,460	16,500	26,300	820	370	5,418	6,608
4	63	770	1,540	17,300	27,600	860	390	5,418	6,618
5	68	830	1,660	17,300	29,800	930	420	5,418	6,768
6	80	970	1,940	21,900	35,100	1,100	500	5,418	7,018
7	89	1,080	2,160	24,400	39,000	1,200	560	5,418	7,178
8	96	1,170	2,340	26,300	42,100	1,300	600	5,418	7,318
9	99	1,200	2,400	27,200	43,400	1,300	620	5,418	7,338
10	99	1,200	2,400	27,200	43,400	1,300	620	5,418	7,338

Consideration of Range and Forage

...MSP will be achieved by:
*producing the yield of timber products specified by the landowner, taking into account biologic and economic factors, while accounting for limits on productivity due to constraints imposed from consideration of other forest values, including but not limited to, recreation, watershed, wildlife, **range and forage**, fisheries, regional economic vitality, employment and aesthetic enjoyment. FPA 913.11(a)(1)*

The structure and composition of the vegetation on MRC's ownership is diverse. The dominant vegetation type is forest (primarily composed of redwood, Douglas-fir, and tanoak.) Forest structure and composition is dynamic, due to harvesting activities and forest succession. A portion of the forested landscape will consist of forage species as the result of harvest. The actual acreage of forage may decrease as the result of increased use of uneven-aged silviculture. Grasslands on MRC property currently represent approximately 4% of the acreage. Many of these lands were forested prior to conversion attempts earlier in the century. Native American fire management may have contributed to the current existing vegetation. Some of these grasslands are gradually returning to forest cover as the result of fire exclusion and reforestation. There are no specific model constraints or policies to manage range and forage.

Option A Monitoring

Mendocino Redwood Company is in a continual process of improving its knowledge about the forest resource. The projections described in the Option A serve as a set of hypotheses under which the company will operate until better information becomes available that challenge the hypotheses. The improved information may alter either the baseline data, used for modeling future forest harvests and forest conditions, or the models themselves, used for projecting the baseline data through a set of management activities. The efforts employed to increase our knowledge serve as a monitoring tool and a feedback loop to the hypotheses presented in this Option A. Efforts aimed at increasing our understanding of the forestlands include:

- Increasing the resolution of inventory estimates by shifting toward individual stand estimates
- Re-measurement of permanent growth plots
- Installation of new permanent growth plots
- Sampling of post-harvest stands
- Experiments with different vegetation management alternatives
- Watershed analysis work
- Wildlife survey work
- Ecosystem relationships studies

Tracking of the hypotheses related to silviculture activities and harvested acres will be accomplished using Mendocino Redwood Company's Geographical Information System (GIS). Silviculture events are input into the Geographical Information System (GIS) concurrently with harvesting activities, providing up-to-date reports for comparison with Option A guidelines. The following reports will be provided to the California Department of Forestry on an annual basis:

- Harvest volume by silviculture prescription
- Harvest acres by silviculture prescription
- Results of growth calibrations from measurement of permanent growth plots
- Number and location of trees permanently retained for snag recruitment (reported by species group and diameter)

In addition, Mendocino Redwood Company will work with agencies such as California Department of Forestry (CDF), California Department of Fish and Game, California Department of Mines and Geology, and Water Quality Resources to develop a meaningful environmental monitoring report for determining progress on policy objectives and tracking protection of the non-timber forest resources.

Since the acquisition of inventory and growth data is an ongoing management activity, it is anticipated that the underlying assumptions of the baseline inventory and rate of growth will improve over time. While the impact of these adjustments is not expected to change the projections of harvest in this plan, certain circumstances would require a review by the California Department of Forestry and may trigger a revision of the document. They are:

- A deviation from the average conifer harvesting volume projections in any 10 year period which exceeds 10 percent. To the extent that hardwood markets fluctuate, a harvest variation greater than 10 percent may occur without triggering a revision of the Option A.

- A change of ownership which results in either an increase or a decrease to Mendocino Redwood Company's ownership by more than 10 percent (23,000 acres).
- A change of forest conditions from catastrophic events that results in a net change of more than 10 percent of Mendocino Redwood Company's forest conditions.
- Any deviation from the plan that could result in a significant change in timber operations and could result in significant adverse effects to watershed, fish, or wildlife values.
- A deviation greater than 10 percent from the baseline inventory estimates, or modeled projections, as the result of ongoing inventory and growth monitoring.

Mendocino Redwood Company will notify CDF should any of the conditions stated above become fact.

Appendix A

Forest Resources Inventory

December 2, 1999

Table of Contents

Classifying Vegetation

Introduction

The Mendocino Redwood Company (MRC) forestland is divided into ten inventory blocks. The vegetation in these inventory blocks was originally classified in 1993, using satellite imagery, aerial photos, and ground verification by area foresters. Refinements and updates to the vegetation classification are ongoing processes. MRC has reclassified four of its ten inventory blocks in the past two years, in order to improve the resolution of the vegetation data.

Classification Rules and Symbology

A stand on MRC's property is an area of land, usually greater than 5 acres, that contains similar vegetation. Vegetation on MRC's property is classified according to a stand's species composition, the dominant size of the trees in the stand, and the canopy closure, or density, of the stand. Since much of MRC's ownership has a history of uneven age silviculture, vegetation does not fit neatly into discrete age classes and do not usually have one dominant diameter class. Rules for classification have been created to reduce ambiguity in labeling stands.

Species Classification

Vegetation polygons that have 5 percent or more of their area covered by tree crowns are classified as forest and will be labeled with a three-part labeling system that includes species, size, and density. Definitions and symbols for each are as follows.

Non-Forest Symbols

Vegetation polygons that have less than 5 percent of their area covered by tree crowns should be classified as non-forest and will be labeled with one of the following symbols, depending on the predominant cover.

BR	Brush
GR	Grass and meadows
BG	Bare ground, including rocks and watercourse beds
WA	Water

A forested polygon is labeled with an appropriate conifer or hardwood species symbol when 75 percent or more of the basal area in the stand can be attributed to that species. If no one species represents 75 percent or more of the basal area, a mixed-species symbol will be used.

Dominant-Conifer Species Symbols

At least 75 percent of the basal area is in the species classified.

RW	Coast redwood
DF	Douglas-fir
KP	Knobcone pine
WH	Western hemlock
GF	Grand fir

Dominant-Hardwood Species Symbols

At least 75 percent of the basal area is in the species classified.

AL	Alder
TO	Tanoak
LO	Live oak
BO	Black oak
MO	Madrone

Two-Species Symbols (*Conifer*)

No one conifer species has 75 percent of the stand's basal area, but two conifer species combined do have at least 75 percent of the basal area. At least 75 percent of the basal area is in the species mix classified.

RD	Redwood/Douglas-fir

Mixed-Species Symbols (Hardwoods)

Conifer species do not comprise 75 percent or more of the stand's basal areaThe stand is comprised of a mixture of species that make up 75% of the basal area.

CH	Conifer/Hardwood mix
MH	Mixed Hardwood

Size Classification

A diameter size class label is assigned to each of MRC's forested stands. The division of size classes assists management in predictions of wildlife habitat and silvicultural activity. MRC's vegetation is classified into five Diameter at Breast Height (DBH) size classes. The size classes are as follows:

DBH Class

1	0- 8 inches
2	8-16 inches
3	16-24 inches
4	24-32 inches
5	>32 inches

Tree diameter is measured at breast height. Rules for assigning a size class label have been developed, since MRC's stands often contain many diameter classes resulting from uneven-aged management. Figure 1 describes the process for determining size class.

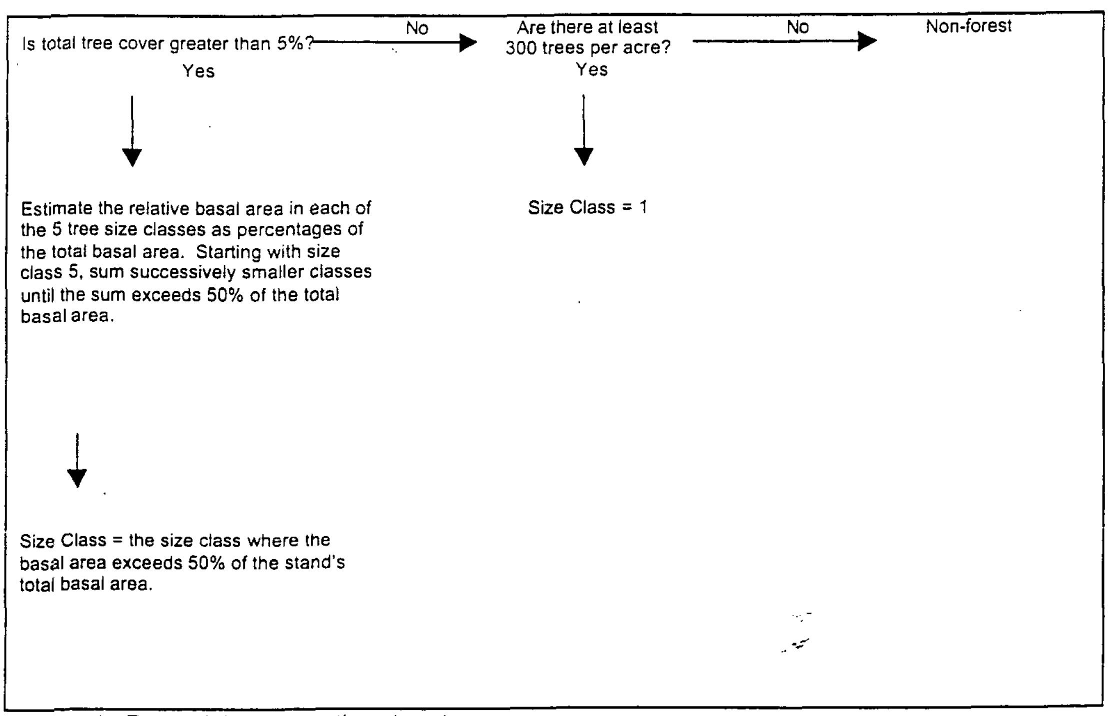


Figure 1. Determining vegetation size classes.

Density Classification

There are five density classes in this vegetation classification scheme, ranked by canopy-closure gradations of 20-percent intervals. Figure 2 demonstrates the rules for defining density classes.

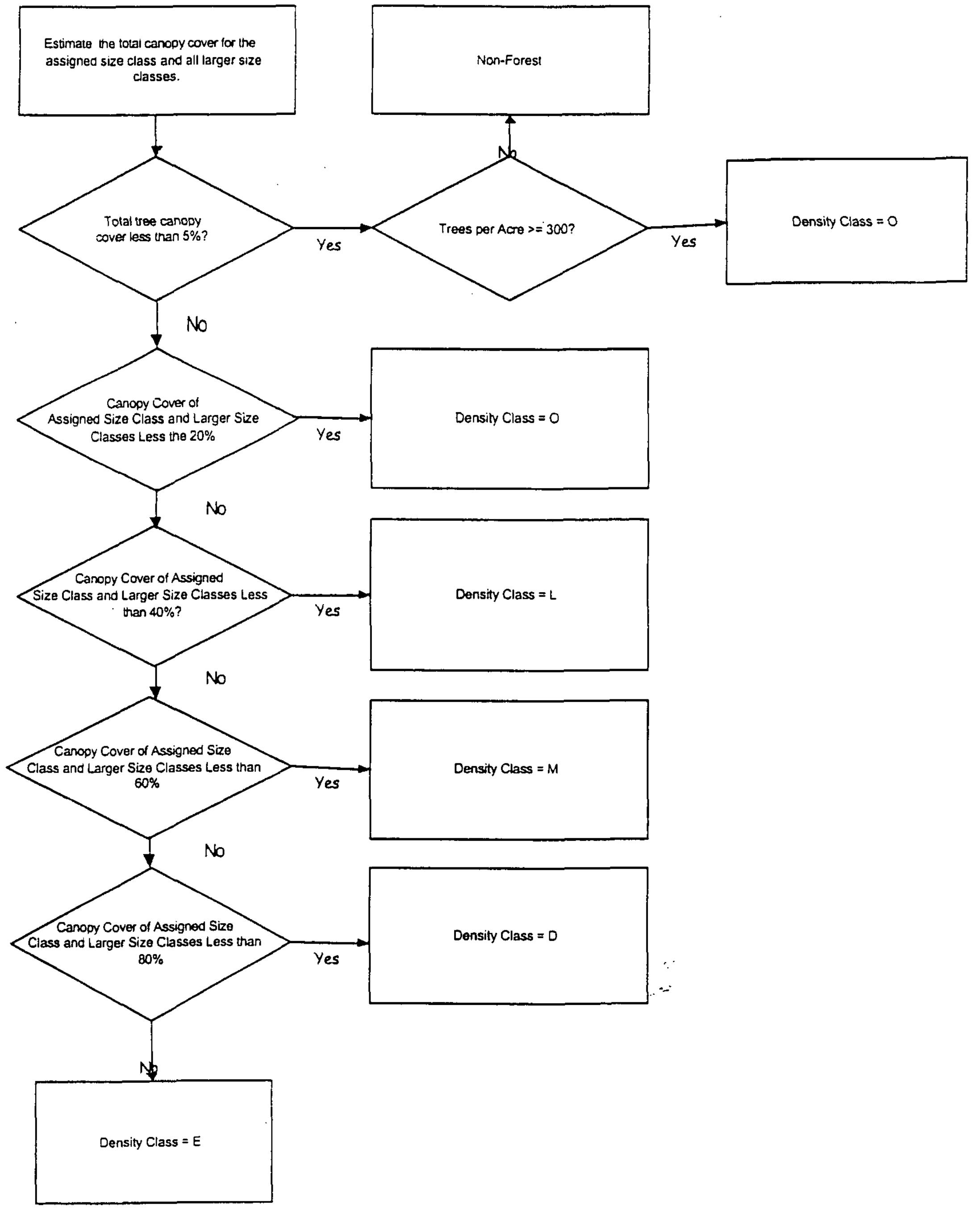


Figure 2. Rules for determining vegetation density classes.

Sampling Merchantable Stands

Introduction

The objective of the timber sampling system is to obtain an unbiased data set across all site and age classes of various forest vegetation characteristics used to provide estimates of timber volume and habitat features to support strategic planning and operational needs. Inventory sampling began in 1994 and is an ongoing effort. Ongoing inventory strategies include:

- Re-measurement of growth plots
- Updating inventory estimates in post-harvest stands
- Increasing sampling resolution (conversion to a stand level inventory)
- Continual inventory improvements of timber estimates and habitat components
- Installation of new permanent growth plots

A strategy to monitor growth estimates and habitat features, verify inventory estimates, update inventories as the result of harvest and growth, and increase vegetation resolution emerged shortly thereafter. The section titled "Original Data Capture" describes the procedures used to obtain the original inventory data. A description of the procedures used in updating the inventory, as the result of timber harvest, or through efforts of increasing vegetation resolution, begins with the section titled "Ongoing Inventory Efforts".

Original Data Capture

The following section describes procedures used in 1994 when the original inventory process was implemented.

<u>Training Sample Selection</u>

Objective
To identify vegetation polygons that will be photo sampled and/or field sampled to use as training sites for supervised image classification.

Procedures

1. Using the vegetation polygons that have been delineated and digitized, generate summary statistics describing the number of stands and acreage in each strata.

2. Randomly select a representative sample of approximately 60% of the vegetation polygons within each vegetation class to be photo sampled.
3. From the list of vegetation polygons that have been selected for photo sampling, randomly select 50% of the vegetation polygons within each vegetation class to be field sampled.

This represents approximately 30% of the vegetation polygons that have been derived through the phototyping process.
4. After the data collected using these procedures have been analyzed and summarized, select the most appropriate set of vegetation polygons from each vegetation class.

<u>Preliminary Field Sample</u>

Objective
To install field plots designed to verify the vegetation classification, to establish crown cover and basal area relationships to be used in relating photo and satellite cover estimates with actual ground conditions, and to determine strata variability for sample-size calculations.

Procedures
Procedures for establishing plots for a preliminary field sample are:

1. Locate two L-shaped strip plots, each leg 4 chains long, on the aerial photo for each vegetation polygon to be visited. The two plots should be oriented in cardinal directions (N/S and E/W) and should begin at a point that can be located on the ground.

Two types of measurements will be made in each plot:

- Strip cover–A 4-chain transect along which crown cover by species and size class is estimated using the line intercept method.
- Strip measurement–A 4-chain by 1/2-chain strip plot that generally crosses major drainages will be established for taking specific tree measurements listed below. For "Dense" vegetation classes, a 4-chain by 20-ft-wide strip plot will be established.

2. Complete and record the following general plot information:

- Inventory block
- Section
- Township
- Range
- Map sheet number
- Stand number
- Vegetation class
- Type of cruise
- Cruiser initials
- Date
- Cluster number
- Cluster letter (A = N-S orientation, B = E-W orientation)
- Percent slope (10%)
- Aspect (NN, NW, WW, SW, SS, SE, EE, NE)
- Comments

Establishing Strip Measurement Plots

The procedure for establishing strip measurement plots is:

1. Travel to the reference point for the selected plot identified by MRC staff on the aerial photograph. Monument the reference point with yellow flagging that is annotated with the appropriate plot number, date, and cruiser initials.

2. Intervisibly flag from the reference point to the plot center (i.e., the vertex of the "L") and monument with yellow flagging that is annotated with the appropriate plot number, date, and cruiser initials.

3. Accurately measure the 4-chain strip using a loggers tape, a 100-ft tape, or a chain. Hang flagging frequently to help identify the plot centerline.

4. For all trees of 9.6 inches dbh or greater, the following measurements will be completed and recorded.

Measurement	Degree of Precision	Allowable Error
Tree number	-	-
Species	-	No error
Diameter at breast height	1 inch	±1 inch
Total tree height	1 ft	±10
or number of 16.5 ft logs	5 inches dib	No error
Height to base of crown	1 ft	±15 ft
or live crown ratio	10%	-
Defect by log position	10%	±10

Condition class	-	-

For trees of 3.6 to 9.5 inches dbh within 5 ft of the strip-plot centerline, measurements to be completed and recorded are:

Measurement	Degree of Precision	Allowable Error
Species	-	No error
Diameter at breast height	1 inch	±1 inch

Establishing Strip Cover Plots

The procedure for establishing strip cover plots is:

1. After establishing the plot center and laying out the plot centerline, the cover transect will be completed on both legs of the L-shaped plot.

2. From either end of the transect, begin by determining the species and size class of the overstory cover (to be interpreted as seen from an aerial photo).

3. Continue along the plot centerline, counting the number of steps of the species/size class overstory cover until the species/size class changes.

4. Record the number of steps of the species/size class on the field form.

5. Continue determining the number of steps occupied by each species/size class encountered along the transect.

Field Plot Sample Selection

Objective

To select a set of stands within each vegetation class to be field sampled, and to allocate plots to those stands such that the desired level of statistical precision will be achieved.

Procedures

1. Based on desired confidence in and variability of board foot volume, estimate the number of plots to sample within each strata.

Put at least three clusters in each vegetation class.

2. Use the following procedure to determine which stands of a vegetation class should be sampled. Only those stands allocated three or more clusters will be sampled.

Larger stands have a greater chance of being sampled. All stands within the vegetation class must be included in the list.

a. List the individual stands (in any order) by stand number, acreage, and acreage accumulation for one vegetation class, making sure the final acreage accumulation equals the acreage list total.

b. Select random numbers ranging from zero to the acreage list total and keep a tally of which stands these random numbers indicate. A random number indicates a stand when it is equal to or less than the acreage accumulation of a stand and more than the acreage accumulation of the previous stand. The tally represents the number of clusters allocated to the stand.

c. Continue to select random numbers and tally clusters until any one stand has exactly three clusters tallied. When this occurs, add three to the cluster count for this vegetation class, then continue to select random numbers and tally clusters. When a stand tally has more than three clusters tallied, then add one to the cluster count.

d. Continue to select random numbers and tally clusters until the cluster count equals or just exceeds the total number of clusters allocated to this vegetation class. When this occurs, total the tallies, ignoring the stand tallies less than three. This total and the cluster count should be nearly equal. (Note that this procedure may devote two more clusters to the vegetation class than were allocated.)

3. Use the following cluster location procedure to locate clusters in stands of a given section:

a. Place a Mylar 1:12,000-scale, 5-chain spacer guide (with numbered lines) between the ortho map sheet and a light table. Place the guide under the section such that it is oriented north/south or east/west- whichever orientation crosses contour lines. Note this orientation near the southwest corner of the section with a large "N"

or "E", under the phrase "Cruise Line Direction." Make sure the guide covers the entire section and will not shift from this proper placement.
b. Determine in which stand clusters are to be located and the numbers of the lines that intersect this stand. Randomly select one of the lines and locate clusters along this line, as described in step c.
c. Clusters are spaced from each other by 5 chains and from stand boundaries by 3 chains. Clusters should not be established unless the location is clearly within the stand or unless subsequent field establishment can clearly be made within the stand. Make sure the entire "L" shape of the cluster fits within the stand, and be sure to allow for the radius of plot (37.2 feet).
d. If all intersecting lines become filled with clusters before all clusters within the stand have been established, randomly select two lines to continue to locate clusters between. Offset these intermediate clusters such that adjacent plot areas do not overlap.
e. Once all the clusters are located within the stand, consecutively number each cluster. The numbering sequence should begin with the lowest numbered cruise line and progress along the cruise line direction from south to north or from east to west.

Field Sampling Procedures

Objective

To install field plots designed to collect appropriate vegetation measurements for calculating volume and growth statistics, as well as habitat features, for each merchantable vegetation class within each inventory block.

Procedures

Stands that are cruised will have three or more clusters in which measurements will be taken. Each cluster consists of three temporary, 1/10-acre fixed-radius plots oriented in an "L" shape.
Measurements will be taken on:

- Merchantable trees (any standing live or dead tree taller than 4.5 ft and greater than 9.6 inches dbh).
- Regeneration (any tree less than or equal to 9.6 inches dbh).
- Crown cover.
- Down woody debris.

Every merchantable tree within the 1/10-acre plots will be measured. Regeneration will be measured within 1/100-acre plots around each plot center. Cover will be measured on a transect between the "A" and "B" plots of each cluster. Fuel load/downed logs will be recorded on the "B" plot of each cluster.

Establishing Cluster and Plot Locations

Use the following procedure to establish clusters:

1. Clusters are to be established by using bearings and distances either from a point easily identifiable on the ortho map sheet or from a previously established plot.

Once a cluster location has been established, this point becomes the center of Plot B that should be established on the ground within 100 ft of the location on the ortho map sheet.

2. From Plot B, Plot A is to be accurately established at a distance of 2 chains directly north.

3. From Plot B, Plot C is to be established at a distance of 2 chains directly west.

4. The B plot for an adjacent cluster is located 5 chains from the current B plot-as shown on the ortho map sheet. Adjust bearing and distances whenever crossing a feature easily identifiable on the ortho map sheet.

5. If any B plot is established with more than half of its area within an adjacent stand, reestablish that plot in its proper place as shown on the ortho map sheet.

If any A or C plot is established with more than half of its area within an adjacent stand, that plot should be re-established.

Plots are not to be reestablished because of rock outcrops, roads, skid trails, or other features within the stand boundary. However, when plots are established in these features or the completed plot card has no trees measured, indicate the feature encountered in the plot card comment spaces.

Filling Out Inventory Plot Cards

1. Enter the following information on the inventory plot card for each plot:

- Inventory block
- Section
- Township
- Range
- Map sheet number
- Stand number
- Vegetation class
- Type of cruise
- Cruiser initials
- Date
- Cluster number
- Cluster letter
- Plot type
- Plot size
- Minimum top diameter
- Percent slope
- Aspect
- Brush cover percent
- Comments

2. For all trees of 9.6 inches dbh or greater on each 1/10-acre plot (37.2-ft radius), tree measurements to be completed and recorded are as follows:

- Tree number
- Species
- Diameter at breast height
- Total tree height
- Height to base of crown
- Defect by log position
- Condition class
- Damage

For hardwoods, record tree number, species, dbh, and total height only. In addition, measure the breast height age (bh age) of at least two, and ideally three, vigorous conifer trees within the size class of the stand. This measurement indicates the site index for the stand.

3. Within a 1/100-acre sub-plot around the plot center (11.8-ft radius), fill out the following fields for trees less than 9.6 inches dbh only:

- Plot size
- Minimum top

- Tally of trees by species and size class
- Number of logs to the minimum top, if appropriate

4. Between plots A and B of each cluster record nine "point samples" of cover.

The nine points will consist of the A and B plot centers and 1/4-chain intervals on the line between those points; at each point, fill out the species and size class of the highest canopy over that point.

5. In each 1/10-acre B plot, record:

- Tons/acre of fuel (estimated from USDA fuels book)
- Tally of downed logs by species group, size class, decay class, and origin

Selecting Trees for Measuring Breast Height Age

To be considered eligible for bh age measurement, a tree must have the following qualities:

- be a conifer located within the plot,
- have a dbh in the size class of the stand,
- have a dominant or codominant crown class, and
- be nearly free of defect so that it is of good vigor.

Final selection should be made on the basis of determining which of the eligible trees is the most vigorous. Relative vigor should be assessed by evaluating the crown condition, foliage complement, and bole condition of the trees present on the plot. Trees with full, healthy crowns, good diameter growth and no disease or damage should be considered more vigorous than trees lacking these qualities. In many stands it may be difficult to find trees meeting these criteria; thus, it is important to look for such trees at each plot (until three have been identified and measured within a given stand). If there is only one tree on the plot that is eligible, then that tree should be bored. If there are no eligible trees, then the bh age measurement should be taken at a subsequent plot.

Measuring Trees

1. Measure diameters at a point 4.5-ft above ground level or root collar on the uphill side of the tree to the nearest inch. In the case of irregularities in dbh, such as swelling, bumps, depressions, and branches, measure the diameter immediately above the irregularity at the place where it ceases to affect the normal stem.

All height measurements shall be taken by clinometer or abney level.

2. In no event should the angle from level to the point of measurement exceed 45 degrees (i.e., 100% or 66 topo).
3. Visually balance or compress the lowest live branches of the conifer and record this height above ground as crown height in either feet or as a percentage of total height.
4. Breast height (bh) age shall not include the present year's growth. Use an increment borer at least 16 inches long when obtaining bh age. No hardwood species are to be bored. Cores should be re-inserted into the bole after measurements have been performed. When a tree has a radius greater then the length of the borer, use the following procedures to estimate bh age:

a. Bore into the tree at breast height as far as possible, then extract the core and count the rings. Measure the bark thickness at breast height.

Divide dbh in half, then subtract the bark thickness. This difference is the radius of the wood part of the tree.

$$(dbh)/2 - bt = r$$

where:
dbh = diameter at breast height
bt = bark thickness
r = radius

Measure the length of the core. Subtract this length from the radius of the wood. This determines how much longer the core would have to be to reach the pith,

$$r - l = dp$$

where:
r = radius
l = length
dp = depth to pith

5. Count the number of rings on the innermost inch, extrapolate to the calculated center, and add to the total core ring count. Record sum as breast height age:

$$(nxdp) + rc = bhage$$

where:
n = number of rings on the innermost inch
dp = depth to pith
rc = total core ring count
bhage = breast height age
If bhage is more than 250, record 250.

Tolerance Standards

Listed below are the tolerance standards that will be used to evaluate the accuracy of field measurements.

Measurement	**Tolerance**
Plot location	
• B plot	±100 ft of location on ortho map sheet
• A and C plots	±10% of the true horizontal distance between plots
Percent slope	±10%
Percent brush cover	±20%
Species identification	±1% of the total trees recorded
Diameter at breast height	±1.0 in.
Total tree height	±5 ft
Number of 16.5-ft logs	±2% of total logs recorded
Crown height	±10 ft
Live crown ratio	±10%
Defect by 16.5-ft logs	±20% by log
Breast height age	±10 yr
Net volume:	
Individual plots by:	
• Total	±10% of the check-cruised total net volume
• Species	±15% of the check-cruised net volume by species
Summary of plots by:	
Total	± 5% of the check-cruised total net volume
Species	±8% of the check-cruised net volume by species
Tree count	
• Summary of plots	±1% of check-cruised total

Ongoing Inventory Efforts

Updating Vegetation Polygons

Objective

To identify unique vegetation polygons and install field plots designed to collect appropriate vegetation measurements for calculating timber volume and growth statistics, and determine habitat quality.

Procedure A

1. Solicit maps from foresters responsible for each inventory block which show the locations of recent silvicultural interventions.
2. Visit polygon and make ocular estimate of current vegetation classification using vegetation rules to classify stands.
3. Update vegetation database in the GIS to reflect its present condition. The stand then assumes the tree list for the vegetation stratum to which it is assigned. The timber inventory reflects the changed vegetation.

Procedure B

1. Solicit maps from foresters responsible for each inventory block which show the locations of recent silvicultural interventions.
2. Visit each polygon and install field plots.
3. Vegetation sampling is conducted using the same procedures described in the "Field Plot Sample Selection."
4. Update vegetation database in the GIS to reflect its present condition. The stand has its own unique set of data to derive inventory estimates.

Increase Inventory Block Resolution

Objective

To reduce the variation of vegetation features within vegetation classes. Increasing the resolution of the inventory block to forest stands that have a similar management history will improve the estimates of forest structure and habitat quality.

Procedures

1. Identify inventory block boundaries to one or more watershed boundaries that share similar vegetation composition. The desired size of the inventory blocks is approximately 30,000 acres.
2. Clip the GIS vegetation coverage to the new inventory block boundaries.

Classifying Vegetation Within New Inventory Blocks

Objective

To reduce the variation within vegetation classes in order to improve estimates of timber volume and habitat quality.

Procedures

1. Obtain Landsat TM satellite image that cover the desired inventory block(s).
2. Identify training sites which represent the variation of vegetation classes within the 'new' inventory blocks. These training sites are used to 'educate' the satellite image classification process to identify vegetation classes across the spatially defined area.
3. Create maps which display the successive masks of homogeneous classes and heterogeneous classes until quality is assured by managers knowledgable of local vegetation characteristics and history.
4. Post classify the resulting GIS vegetation coverage with previous GIS vegetation coverage that contains stands that have been independently surveyed. The previous coverage is merged with the new coverage where stands have been uniquely identified.

Field Plot Sample Selection

Objective

To select a set of stands within each vegetation class to be field sampled, and to allocate plots to those stands such that the desired level of statistical precision will be achieved.

Procedures

1. Based on the desired confidence in and variability of board foot volume, estimate the number of plots to sample within each strata. The equation used to estimate the number of plots need in each stratum is:

nj = t^2*s^2j/Ej^2

where:

n= the number of required sample plots for stratum j

t= t value for x degrees of freedom and confidence level

s^2= variance of the sample mean

E= specified error

Stand Selection and Plot Allocation

Objective

To select a set of stands within each vegetation class to be field sampled, and to allocate plots to those stands such that the desired level of statistical precision will be achieved.

Procedure

1. Plots are distributed throughout the geographical distribution of the stratum. Larger stratum are preferred over smaller stratum, to ensure that sample plots are installed in the correct stratum. Three plots are generally installed in a line, with two chains separating plot centers. Plots are added to each stratum until the desired number of plots is met. The plot locations are put into a GIS coverage which can be mapped along with the vegetation coverage.

Field Sampling Procedures of Re-classified Vegetation

Objective

To collect appropriate vegetation measurements for calculating timber volume and growth statistics, as well as determining habitat quality.

Procedures

1. Plots are located from maps made from GIS plot coverages and vegetation coverages. Plots are installed regardless of skid trails, slides, or other features that might effect vegetation composition.
2. Data recorded at each plot include:

- Cruiser
- Date
- Stand Number
- Inventory Block
- Plot Number
- Strata
- Plot Type (fixed or variable plots)
- Plot Size (for fixed radius plots)
- Basal Area Factor (for variable plots)
- Aspect
- Slope
- Brush Species and Density
- Skid Trail Presence
- Presence of Wildlife Features

3. Tree measurements obtained and data recorded at each plot for trees larger than six inches include:

- Tree Number
- Species
- Diameter at Breast Height
- Total Tree Height
- Height to Base of Crown
- Condition Class (Healthy, Live Snag, Dead Snag)

4. Breast height age on at least two vigorous conifer trees which represent the age of the stand. This measurement indicates the site index of the stand.
5. Down logs meeting the following criteria are measured for average diameter and length (within plot):

- an average diameter of at least six inches,
- a length of at least ten feet, for average diameters less than 16 inches, or

- a length of at least six feet, for average diameters greater than 15.9".

6. Regeneration (any tree less than six inches) is measured on a 1/100-acre sub-plot. Thrifty trees are tallied by species and size class (less than 3 inches and trees 3 inches to 5.9 inches).

Sampling Submerchantable Stands

Introduction

The collection of field data in submerchantable stands leads to an estimate of growth, stocking, and competition in submerchantable stands, as well as volume estimates of merchantable "residual" trees in submerchantable stands by strata and inventory block.

For this inventory, submerchantable stands are equivalent to Size 1 stands in MRC's forest inventory vegetation classification scheme. Size 1 stands are dominated (in terms of basal area and/or crown closure) by trees less than 9.6 inches dbh. Usually Size 1 stands will have been created by a regeneration harvest. They may contain residual merchantable trees.

The procedures described in this section will yield area-wide estimates of stocking and growth in submerchantable stands suitable for forest-wide planning and scheduling projections. More intensive use (i.e., a greater sample size) of these procedures will yield information concerning the condition of individual stands--suitable for identifying treatment options that might be considered.

The sampling design employed in this inventory consists of a grid of 1/50 or 1/100-acre circular plots. A third of the plots in each stand are measure plots, in which detailed information about individual submerchantable trees is measured and recorded. All other plots are count plots, in which trees are tallied by species and diameter class. Merchantable trees are sampled using a variable-radius cruise around each plot center (basal area factor [BAF] equals 20 or 25).

Field Plot Sample Selection

Objective

To select a set of stands within various species/density types and age of submerchantable stands to be sampled.

The procedures described here were tested on a small sample of stands--228 submerchantable stands in MRC's ownership-and will not result in a significant number of stand-specific summaries. These procedures may be used to select additional stands for a heavier sample, or may be used to sample all submerchantable stands in an area.

Procedures

1. Summarize acres of submerchantable stands in each inventory block with regard to the (1) type of silvicultural operation that created the stands, (2) year of the timber harvesting plan (THP) that created the stands, (3) species type, and (4) density class.

2. Distribute the number of sampled stands allocated to each inventory block proportionately to categories of the above stands that have significant acreage.

Field Sampling Procedures

Objective

To install field plots designed to collect appropriate vegetation measurements for assessing submerchantable stand growth, stocking, competition, and volume.

Procedures

1. Lay Out Plots

Determine sample point locations by laying a grid of plot-center locations across each stand selected for sampling.

The objective is to establish between 15 and 30 plots in each stand to be sampled; the plots should be distributed across the stand. Because the area of a stand may vary over a wide range (typically between 10 and 40 acres), it is necessary to vary the spacing between plot-center locations in order to achieve the goal of establishing 15 to 30 plot centers.

Guidelines for Plot Spacing

Size of Stand (acres)	Suggested Plot Spacing (chains)
Less than 25	2 x 5
25 to 40	3 x 5
Greater than 40	4 x 5

When the spacing of the grid has been determined, lay an appropriate grid over a map of the stand (this may be done using the GIS or with a mylar grid over a hardcopy map). The grid should be oriented in a north/south, east/west direction. All potential plot centers that fall within the stand should be numbered, and reference points may then be established from appropriate nearby roads.

When verifying the mapped boundaries of a submerchantable stand, should the field crew find that the boundaries do not correspond to what they find on the ground, they may make appropriate adjustments to the map. When a plot center location (which was established on a map) actually falls outside of the submerchantable stand, the plot should be deleted from the list to be cruised. An effort should be made to maintain the ratio and distribution of measure plots to count plots.

It is desirable to have some plots near the edge of the submerchantable stand so that the data set will reflect the range of conditions in the sampled stand. However, it is not intended that submerchantable or merchantable trees in this data set actually be trees that are growing in the neighboring merchantable stand. Thus, for plots near the edge of the stand, the following procedures should be considered:

a. If the intended submerchantable circular plot around the plot center will include area outside of the sampled stand, move the plot center just far enough away to keep the circular plot entirely within the sampled stand.

b. Do not record data for any "in" merchantable tree that occurs in the neighboring stand.

2. Take plot measurements.

As outlined above, the submerchantable stand inventory will be carried out using a fixed-area measure- and-count design for submerchantable trees and a variable-plot radius design for residual merchantable trees.

The plot size for measuring or counting submerchantable trees is usually 1/50 acre (16.7-ft radius). However, in order to avoid the time required to measure densely stocked measure plots, the plot size may be reduced to 1/100, 1/300, or 1/1,000 acre. The plot size should be chosen so that approximately 5 to 10 trees are measured per plot. Measure-plot sizes include:

Size of Plot (acres)	Radius (ft)
1/50	16.7
1/100	11.8
1/300	6.8
1/1,000	3.7

Plot header information to be recorded at every plot includes:

- plot location information
- vegetation type
- cruise type
- cruiser
- cruise date

- plot number
- plot type
- plot size
- slope
- aspect
- percent of plot unstocked because of an unstockable ground feature
- competition type
- cover percentage
- average height.

Every third plot, beginning with the second plot measured in a stand, is a measure plot. Measure trees on this plot for height, diameter, crown ratio, and height growth. Species, tree origin, damage, and "free-to-grow" status will also be recorded.

The remaining plots are count plots on which trees will be tallied by species and diameter class. Use four diameter: (1) less than 0.1 inches dbh (including trees shorter than 4.5 ft), (2) 0.1 to 2.9 inches dbh, (3) 3.0 to 5.9 inches dbh, and (4) 6.0 to 9.5 inches dbh.

On every plot, use a 20- or 25-BAF prism. Measure all merchantable (9.6 inches dbh and larger) "in" trees for dbh, total height (or number of logs), height-to-crown base (or percent crown ratio), defect, and condition. Measurements are identical to those taken in the merchantable stand inventory.

Validating Site Quality

Introduction

This section describes the methods used in a study conducted in the fall of 1994 designed to validate MRC's site quality data. Two types of data were collected and used in site/growth analyses:

- Diameter and height growth information for the past 5 and 10 years on 1/10-acre plots. This growth information was compared with growth modeled using CRYPTOS. Results of this analysis yielded site-quality estimates that could be compared to other data.
- Locations and measurements of site trees. Site estimates from measured trees were calculated and compared with site predictions based on soil types and on the growth estimates derived from measured volume growth.

Plot Layout Design

Growth measurements will be taken on one hundred 1/10-acre plots. These 100 plots are distributed across the range of soil types and vegetation types that are found in the Ukiah Inventory Block in order to obtain a reasonably robust data set for analysis. Vegetation types in merchantable size classes were divided into nine groups:

CH2D	(CH2D strata)
CH2M	(CH2M strata)
CH2LO	(CH2L and CH2O strata)
RD2MD	(RD2M, DF2M, and DF2D strata)
RD2L	(RD2L, RW2L, and RT2L strata)
RD2O	(RD2O, RW2O, and RT2O strata)
RD3MD	(RD3M and RD3D strata)
RD3	(RD3L and RW3L strata)
RD3O	(RD3O and RW3O strata)

Soil types are divided into four groups, based on the site quality that was estimated for each soil type in the soil survey documentation. The groups roughly corresponded to Site Class 2, Site Class 3, Site Class 4, and "suitable (primarily) for oak woodlands." Growth measurement plots are assigned within each group to cover the range of soil types composing that group. Growth plots were not assigned to areas in which harvesting has taken place since 1987.
Plot locations are not exactly located. Rather, each plot is assigned a 5-acre plot area that has the desired vegetation/soil characteristics. The field crew will choose an appropriate 1/10- acre plot within each plot area. This procedure allows the field crew to avoid measuring trees in areas that would be relatively meaningless for this study (i.e., plots in which most or all trees are hardwoods). In addition, the field crews will search for site trees within and adjacent to these plot areas.

Field Sampling Procedures

Objective
To locate appropriate growth-plot locations and site trees, take appropriate measurements at these locations, and record the locations of the growth plot and site trees.
General procedures are listed below, with more detailed procedures in subsequent sections.

Procedures

1. Locate on the ground the 5-acre plot area shown on the 1:12,000-scale field mapsheet.
2. Briefly survey the 5-acre area, looking for site trees and potential locations for a growth plot.
3. Choose a growth-plot location. Establish a plot center and measure all merchantable trees inside a 1/10-acre fixed-radius plot around the plot center.
4. Choose up to 3 site trees within or adjacent to the 5-acre plot area. Take appropriate site-tree measurements.
5. As accurately as can be determined from the features shown, mark the locations of the growth-plot center and the site trees on the field mapsheet.
6. Later, in the office, transfer the growth-plot center and site-tree locations to a clean mapsheet.

Establishing Growth Plot Locations

Growth measurements will be taken on all merchantable trees within the 1/10-acre fixed-area circular growth plot (37.2 ft diameter). Use the following procedures to establish plot locations:

1. Using the provided 1:12,000 field mapsheet, identify the approximately 5-acre area in which the 1/10-acre measurement plot is to be located.

Generally, the 5-acre areas are circular, with the radius of the circle measuring approximately 4 chains.

2. Choose a plot center within the 5-acre area using the following criteria:

- Trees in the 1/10-acre plot should be primarily conifers.
- The 1/10-acre plot should be representative of the range of site conditions on the 5-acre area.
- The 1/10-acre plot should represent the "expected" vegetation characteristics (i.e., RD2L = Redwood/Douglas-fir type, size 2, low density). However, this is optional.

3. If a 1/10-acre growth plot cannot be found that meets the first two criteria in step 2, then:
a. Use an appropriate location off the 5-acre plot area that might have been observed while surveying the plot area. However, the location must be within the larger stand containing the plot area (lines shown in purple on the field mapsheet).
b. Otherwise, take no measurements, move on the next plot area, and report the lack of a suitable growth plot to the appropriate supervisor.

Monumenting Growth Plot Locations

Procedures

1. Indicate plot-center locations with a 6-foot metal fence post and yellow plastic flagging.
2. Hang the flagging as close as possible to eye level at the plot center and so that it is clearly visible.
3. Using a black marker with permanent ink, record directly on the flagging at each plot center the growth plot number, the cruise date, and the cruiser initials.
4. Paint the tree number of each measured merchantable tree on the bole of the tree, facing the plot center.
5. Establish a reference point on the nearest road by attaching a bright orange flasher to a tree in a visible location and affixing an aluminum tag with distance and directions to the plot center.

Filling Out Inventory Plot Cards

Plot header information to be completed on each card is as follows:

- Inventory block
- Section
- Township
- Range
- Map sheet number
- Growth plot number
- Type of cruise
- Cruiser initials
- Date
- Plot type
- Plot size
- Minimum top
- Percent slope
- Aspect
- Brush cover percent

For all trees of 9.6 inches dbh or greater on each 1/10-acre (37.2 ft radius, horizontal distance) tree measurements to be completed and recorded are as follows:

- Tree number
- Species
- Diameter at breast height
- Total tree height
- Height to base of crown
- Defect by log position
- Condition class
- Damage
- 5-year radial increment
- 10-year radial increment

- 5-year height growth
- 10-year height growth

Height growth measurements will be taken only on a sub-sample of trees. MRC staff foresters will coordinate this effort.

For hardwoods, record tree number, species, diameter at breast height, total height, and condition class only. Trees will be numbered in the following order: Tree 1 is the first tree on the plot in a clockwise direction from a line running north from the plot center. Tree 2 is the next tree clockwise from north, and so on. As noted previously, the number of each tree will be painted on its bole on the side facing the plot center.

Measuring Trees

1. Measure diameters at a point 4.5 ft above the ground level or root collar on the uphill side of the tree to the nearest 0.1 inch.

In the case of irregularities in dbh, such as swelling, bumps, depressions, branches, etc., measure the diameter immediately above the irregularity at the place where it ceases to affect the normal stem form.

2. Measure the height of a tree using a clinometer or abney level.

3. In no event should the angle from level to the point of measurement exceed 45 degrees (i.e., 100% or 66 topo).

4. Visually balance or compress the lowest live branches of the conifer and record this height above ground as crown height in feet.

Take 5- and 10-year radial growth measurements.

Do not include the present year's growth in the measurement. On plots of less than 20% slope, bore all conifer trees at the point that lies between the long and short axes and faces plot center as close to breast height as possible. On plots of more than 20% slope, bore trees at a point that lies between the long and short axes as close to breast height as possible on the uphill side of the tree.

- Do not bore hardwood trees.
- Re-insert cores with about 1/2 inch of core protruding from the bole.

Tolerance Standards

Listed below are the tolerance standards that will be used to evaluate the accuracy of field measurements.

Measurement	Tolerance
Percent slope	±10%
Percent brush cover	±20%
Species identification	±1% of the total trees recorded
Diameter at breast height	±0.3 inch
Total height	±5 ft
Crown height	±10 ft
Defect by 16.5-ft logs	±20% by log
Five- and ten-year growth increments	±0.05 inch
Five- and ten-year height increments	±2 inches

Selecting and Measuring Site Trees

Ideally, 4 site trees will be found and measured on each 5-acre plot area. In most cases, fewer trees will have to suffice. To be considered eligible for site-tree measurement, a tree must:

- be a conifer,
- be at least 25 years old (breast height age),
- have a dominant or codominant crown class, and
- be more or less defect-free so that it can be effectively bored.

Final selection should be made on the basis of determining which of the eligible trees is the most vigorous. Relative vigor should be assessed by evaluating the crown condition, foliage complement, and bole condition of the trees present on the plot. Trees with full, healthy crowns, good diameter growth, and no disease or damage should be considered vigorous. A "true" site tree, of course, is one that has grown relatively free of growth-restricting competition throughout its life. It is recognized that very few such trees exist. The goal of the selection process is to find trees that come as close to this ideal as possible.
An attempt should be made to select breast height age measurement trees from all major conifer species existing within the stand. Breast height (bh) age shall be recorded in years, but should not include the present year's growth. Use an increment borer at least 16 inches long when obtaining bh age. Cores should be re-inserted into the bole after measurements have been taken. When a tree has a radius greater then the length of the borer, use the following procedures to estimate bh age:

1. Bore into the tree at breast height as far as possible, extract the core, and count the rings.

Measure the bark thickness at breast height. The bark thickness should be measured at a point where it is relatively thick, (i.e., a place that is representative of where the diameter tape will lie when pulled tight against the tree bole).

2. Divide the measured dbh in half, then subtract the bark thickness.

This difference is the radius of the wood part of the tree:

$$(dbh)/2 - bt = r$$

where:
dbh = diameter at breast height
bt = bark thickness
r = radius

3. Measure the length of the core. Subtract this length from the radius of the wood. This determines how much longer the core would have to be to reach the pith:

$$r - l = dp$$

where:
r = radius
l = length
dp = depth to pith

4. and add to the total core ring count. Record sum as breast height age:

$$(nxdp) + rc = bhage$$

where:
n = number of rings on the innermost inch
dp = depth to pith
rc = total core ring count
bhage = breast height age

If bhage is more than 250, record 250.

Orders Called Ready For more than 2 weeks					
Customer	**Cust #**	**MFP #**	**Product**	**Date Ready**	**Date Ordered**
Westside Timber	2-11554	206315	2x4x6 Std & Btr	10-Jul-00	10-Jul-00
Fred C Holmes	4454b	206823	2x4x104-1/4 Std & Btr	14-Jul-00	14-Jul-00
Fred C Holmes	9457a	207164	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
Fred C Holmes	9457b	207165	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
Fred C Holmes	9457c	207166	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
Fred C Holmes	9457d	207167	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
Fred C Holmes	9457e	207168	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
Riverside	po22011	207176	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
Riverside	po22013	207177	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
Riverside	po22014	207178	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
Riverside	po22015	207179	2x4x104-1/4 Std & Btr	31-Jul-00	31-Jul-00
North Star	6823	207208	2x4x92-1/4 Economy	3-Aug-00	1-Aug-00
North Star	6824	207209	2x4x92-1/4 Economy	8-Aug-00	2-Aug-00
Continental	19002	207382	1x4x5 Dunnage	9-Aug-00	9-Aug-00
Westside Timber	4-11949	207517	2x4x92-1/4 Sel Str	14-Aug-00	14-Aug-00
California Forest	919	207555	2x4x8 Utility HF	15-Aug-00	15-Aug-00
Continental	19008	207504	2x4x92-1/4 Economy	17-Aug-00	11-Aug-00
Continental	19009	207505	2x4x92-1/4 Economy	18-Aug-00	11-Aug-00
Continental	18984	207239	1x4x92-1/4 Millrun	17-Aug-00	2-Aug-00

Stock Available For Sale			Range Of Production	
Product	**Availability**	**Condition Of Stock**	**Start Date**	**Last Date**
2x4x92-1/4 Utility	248,376	Starting to Mold	5-Jul-00	26-Aug-00
2x4x104-1/4 Std & Btr	194,780	Starting to Check	3-Aug-00	31-Aug-00
2x2x6&7 Millrun	149,049	Starting to Mold & Turn Black	13-Jun-00	31-Aug-00
2x2x92&104 Millrun	138,235	Starting to Mold & Turn Black	24-May-00	26-Aug-00
2x4x6 Std & Btr	134,224	Starting to Check	4-Aug-00	31-Aug-00
3x4x92-1/4 Std & Btr	69,312	Starting to Check	21-Jul-00	21-Jul-00
2x4x8 Std & Btr Contr Grade HF	35,243	Starting to Mold & Turn Black	15-May-00	29-Jul-00
2x2x6&7 Millrun HF	36,631	Turned Black	15-Nov-99	29-Jul-00
1x4x6 Millrun	65,170	Starting to Mold	3-Aug-00	31-Aug-00
3x4x8&9 Millrun	98,192	Starting to shrink	24-Jul-00	11-Aug-00

Appendix B
Growth and Yield Modeling
December 2, 1999

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Appendix A described the methodology used for acquiring inventory estimates on the ownership. The estimates of inventory are the basis for projecting future forest conditions amidst management alternatives. This appendix describes the quality of the baseline information and the methodology used for assessing management alternatives using computer-modeling techniques.

Forest Inventory

Data Processing Procedures

The methodology for acquiring inventory information is described in Appendix A (Forest Resources Inventory). The data from inventory field plots is input in a Microsoft Access database. The database warehouses the data and allows the data to be processed for a wide variety of inventory related reports. Data are maintained for each tree. Basal area and timber volumes are computed for each tree. Equations for board foot timber volume (merchantability to a six-inch top) are calculated using equations from the Co-op Redwood Yield Research Project (CRYPTOS) reports (Krumland and Wensel, 1978). Summary reports can be processed at the plot level, the stand level, the inventory block level, and at the ownership level. Data tables from the GIS vegetation coverage are linked to the Microsoft Access database for spatial elements needed to sum inventories.

Estimate of Precision of Inventory Estimates

The statistical reliability of MRC's inventory meets or exceeds the design specification of 95% confidence, plus or minus 10% of the mean for total board foot volume within each of the inventory blocks.MRC's inventory estimates are currently based on over 6,700 sample plots. Plots are added regularly to sample post harvest stands and to obtain data at increased vegetative resolution.

Strata Types

Strata types are the biological units for which growth and yield predictions are made. Overlaying the vegetation coverage and the site productivity coverage creates a strata type GIS layer. Forest inventory data is linked to each strata type. These data include a tree list (species, dbh, height, live crown ratio, and tree weight—number of trees per acre), a site index for all tree species found in the strata, and strata acreage.

Site Quality

Determining Site Quality on MRC Ownership

Site quality is determined for an area by determining the rate at which tree height increases on the area. Site quality is a key variable in growth and yield modeling. The quality of yield predictions is linked to the accuracy of the site data. MRC has developed and maintains a GIS coverage for site productivity on a landscape level. Site quality was determined using a combination of government soil survey data and field sampling.

Gathering Site Tree Data

Data for predicting site quality were collected along with inventory variables in 1993 and 1994. Growth sampling occurred to supplement this data on the Rockport and Ukiah inventory blocks.

Trees selected for site quality predictions must meet the following conditions:

- be at least 25 years old.
- have a dominant or codominant crown class (with a full, healthy crown).
- be defect free (no visible damage or disease).

The data set for predicting site quality included:

- 260 site trees from the Navarro Inventory Block.

- 166 site trees from the Rockport Inventory Block.
- 60 site trees from the Sonoma Inventory Block.
- 228 site trees from the Ukiah Inventory Block.

A site index was calculated for each Douglas-fir site tree using King (1966) at a breast-height age of 50 years. Site indices for redwood were computed for a 50-year index using Wensel and Krumland (1986).

Determining Site Quality from Soil Surveys

Site indices were derived from soil surveys for MRC's ownership. In addition to the soil survey site classes (1 to 5), additional categories were necessary to distinguish poor site quality lands. The categories *marginal timberland* and *non timberland* (brush, grass, rock, etc.) were added. These categories were delineated using vegetation maps and input from MRC foresters.

The soil data used for MRC's ownership is based upon *Soil Survey of Mendocino County, Eastern Part, Soil Survey of Mendocino County, Western Part, California* (SCS 1987), and *Soil Survey of Sonoma County, California* (SCS 1972). Site indices for these surveys are based on *Yield of Douglas-fir in the Pacific Northwest* (McArdle and Meyer 1961).

Site Indices

Both sampled trees and soil survey data were used to create a coverage of site class. Each site class reflects the potential productivity of MRC's forestland. Species were assigned values representing potential height at age 50 in each site class for MRC's ownership (see Table 2). The site index values are used in MRC's growth equations.

Table 2. Fifty-year site index values by species.

Species	Site Class 1	Site Class 2	Site Class 3	Site Class 4	Site Class 5
Douglas-fir	146	125	103	82	61
Grand fir	146	125	103	82	61
Coast redwood	135	118	96	78	56
Sugar pine	133	114	93	75	54
Sitka spruce	141	120	99	72	46
Western hemlock	125	103	82	61	42
Other conifer	117	100	82	66	48
Alder	130	111	91	73	53
Madrone	65	56	46	36	26
Tanoak	100	86	71	56	41
Other hardwood	65	56	46	36	26

Species	Site Class 1	Site Class 2	Site Class 3	Site Class 4	Site Class 5
Residual redwood	117	100	82	66	48

Landtype Analysis

Landtypes

Land types are spatially explicit landscape units for which alternative management activities are evaluated and allocated over time. The objective of land type analysis is to develop GIS data sets that contain logical and reasonable aggregations of land conditions that exist across MRC's ownership. A full range of management activities, which specify the intensity and timing of harvesting and associated costs, are applied to the land type. The expected future conditions that result from a temporal series of management activities are determined for each land type.

Creating Land Types

Land types are the basic land units to which management activities are allocated and scheduled over time. Land types have the following basic components:

Strata type—The combination of vegetation strata, and site class.

Yarding method—Tractor, cable, or helicopter (based primarily on slope, access, and sensitivity).
Planning watershed—From the state CalWater data set.

Special concern areas—Geographically distinct areas where the full range of silviculture treatments may not be appropriate. These typically include streamside and roadside buffers, areas near domestic water supplies, parks, county roads, coastal zones, and others that receive special silviculture assignments. A full list of the geographic constraints afforded special treatment in this Option A can be found in the main body of the Option A.

Land types are created using GIS overlay analysis. Because of the various independent data layers used to create land types, many very small polygons can result. Small polygons (less than 0.5 acres) are first aggregated into neighboring polygons. These polygons are then generalized to produce a minimum polygon size of 6 acres using the following rules:

1. Yarding method and site class boundaries will not split vegetation polygons.
2. Yarding method and site class boundaries will not split THP boundaries.
3. Features such as special concern areas that are inherently small and features such as ownership and planning watersheds whose boundaries must remain constant are processed in such a way that the GIS will not eliminate their borders. This processing logic may preserve polygons as small as 0.5 acres in cases where the modeling or analysis requires they be preserved.

It is also possible for land type polygons to be quite large. The processing procedures allow large polygons to be subdivided by logical breaks such as slope, aspect, and road crossings to produce polygons that are no larger than 40 acres. This helps ensure that individual land units do not exceed legal size limitations and will more likely conform to operational units to be included in future THPs.

Data Sources

Data used to create land types come from many sources, including interpreted data sources and modeled data sources. A GIS layer created from an interpreted data source means the data was digitized or scanned. A modeled data type is a theoretical representation of the data, derived from a series of processes or analyses. Data layers and their origins are summarized in Table 3.

Table 3. Land type data sources.

Land Type Data Sources	
Forest Value	**Origin of Data**
Planning Watersheds	Interpreted from California Department of Forestry and Fire Protection (CDF) CalWater Database
Vegetation Strata	Interpreted from Satellite Imagery, Aerial Photos, and Area Foresters
Site Productivity	Interpreted from USGS Soil Maps
Ownership Boundary	Interpreted from Ownership Data
Yarding Method	Interpreted
Watercourses	Modeled and Interpreted
Old Growth Stands and Groves	Identified by Area Foresters
Oak Woodlands	Identified by Area Foresters and Vegetation Classification as Unique Vegetation
Marbled Murrelet Management Areas	Identified by Area Foresters. Future management is the focus of on-going discussions between MRC biologists and agency personnel.
Navarro Strip	Described in Conservation Easement
WLPZ Buffer Zones	Watercourses are Buffered for Horizontal Distances of 100' (Class I) and 75' (Class II). Modeling Horizontal Distance Represents a Field Buffer of 100' - 150' for Class I Watercourses and a Field Buffer of 75' - 110' for Class II Watercourses, Depending on Slope.
Selected State Park and other Buffers	Polygons Identified Adjacent to Navarro Redwoods and Hendy Woods State Parks. Visual Corridors Identified near Armstrong Redwoods State Park in Sonoma County.
Coastal Commission Coastal Zone	Polygons Interpreted from Coastal Commission Maps.
Coastal Zone Special Treatment Areas	Special Treatment Areas interpreted from Coastal Commission maps.
Neighboring Landowners	Polygons identified for Neighbors who are not Industrial Forestland Owners.
County Road and Scenic Buffers	Corridor Centered on County Roads Adjacent to Property.
Skunk Railroad Buffer	Corridor Centered on Skunk Railroad.

Resource Capability Model

After land types have been created, an ASCII file referred to as the LMX (Land type Model eXchange) file is produced. The LMX contains pertinent information about each land type that is needed to link strata type yields to land type polygons for the linear programming decision analysis and other reporting and analyses. This file is imported into the **resource capability model** (RCM) database.

The RCM tests the thousands of land types with a wide range of possible management activities and produces summaries of important management inputs and resource outputs. The RCM defines the range of biologically feasible activities that can be considered as management options throughout the planning process. The wide range of management options in the RCM offers a realistic range of activities that can be considered and evaluated in the planning process.

Policy Alternative Models

Alternative sets of management goals and desired resource conditions can be formulated by creating **policy alternative models** (PAMs). Each PAM contains a subset of the RCM that filters the biologically possible actions by applying policy constraints in specific geographic locations (land types). For example, the RCM may include variable retention areas adjacent to fish-bearing streams (as a biologically feasible silviculture regime), but a PAM restricts the range of silviculture in these areas to regimes that never reduce the canopy closure below 70%. Linking the PAM and the RCM into a virtual table and filtering the data allow only those alternatives that are acceptable to management policy and meet biological thresholds to be considered.

PAMs behave as further constraints to the constraints used in the formation of the land types. Constraints applied to the model in the preparation of this Option A included:

- Geographic Constraints: Harvest levels were controlled at the watershed level and the landscape level.
- Land Type Constraints: Land type constraints force the linear program to assign one or more management prescriptions to the acres found in each land type. Each acre must be allocated and no acre can be allocated more than once. Silvicultural treatments are limited to those that are acceptable for the land type.
- Non-declining Inventory. Total inventory (conifers and hardwoods) must not decline from decade to decade until some "maximum sustainable production" level is achieved.
- Harvest per Decade Less than LTSY. LTSY is defined as the average annual growth on Site Class 1 to 5 stands (that are not constrained for No Harvest) in decade 10.
- Minimum/Maximum Percent of Harvest to be in Hardwoods.
- Non declining yield greater than 10%.
- Achieving more stands with larger trees.

The desired future conditions are modeled by the constraints applied to linear programming. Constraints are applied to both the ownership and watershed levels. The mathematical programming provides the optimal arrangement of temporal management activities for each land type.

Yield Generation

The growth, harvest, and yield models have been integrated into a single computer simulator that makes it feasible to examine large numbers of complex management scenarios. This simulator is referred to as FREIGHTS (Forest REsource Inventory, Growth, and Harvest Tracking System).

Growth, harvest, yield, and wildlife habitat relationships (WHR) projections are derived for each silvicultural regime on each land type under consideration. The regimes specify the range of silvicultural activities that may occur for a land type.

The CRYPTOS (Cooperative Redwood Yield Research Project) model used within FREIGHTS to project forest growth and yield for MRC's ownership was developed in 1982 by Dr. Bruce Krumland of Landring Inc.. Evaluation by Krumland (1982) and a consensus of CRYPTOS model users over the last 20 years indicates the model provides a reasonable prediction of stand development over a wide variety of stand conditions.

Accuracy of Growth Estimates

Accuracy, in a conventional statistical sense, is an estimate of how close a predictor is to actual conditions. This estimate combines measures of both bias and variability. For growth estimates used in an Option A, accuracy measurements involve assessments of predictions of growth by stand and treatment type over all time periods in the plan as well as by aggregate estimates for the ownership. FREIGHTS was compared to commonly used forest growth and yield simulators for California forests (CRYPTOS, CACTOS, and Forest Vegetation Simulator [FVS]), to establish its relative ability to predict growth.

The growth engine nested in the FREIGHTS program is CRYPTOS. The CRYPTOS model was calibrated for tree basal area and height growth using all growth data available to the Redwood Research Cooperative in 1982 (Krumland 1982). The growth data consisted of all trees on over 1,500 growth plot measurements collected between 1930 and 1980. This guarantees that overall, the main components of the model are centered at their long-term historical levels.

CRYPTOS provides a reasonable prediction of stand development over a wide variety of stand conditions. The models used in MRC's Option A are as accurate as possible given the available methods and data. More precise resolute measures of accuracy must be deferred until sufficient long-term forest growth plot series are available for analysis.

Plot-based Modeling

FREIGHTS "grows" each plot in a land type inventory individually from midpoint to midpoint of successive growth periods (for MRC's Option A, a period is one decade). All plots are then aggregated to arrive at periodic stand statistics. All harvests and regeneration are assumed to take place at the midpoints of projection periods.

Harvesting is simulated in the model by commands that allow cutting to be applied to each plot individually. The prescription is based on desired residual plot characteristics. This feature is designed to mimic as closely as possible the actual on-the-ground operation of marking and felling crews. In instances where harvests fail to meet a desired criterion, additional commands are available to reinstate the pre-harvest state.

Regeneration is simulated in the model by commands that allow stocking to be brought up to certain standards on each inventory plot. These plots are used as proxies for stocking standard plots and provide the mechanism necessary to ensure that post-harvest stocking is in compliance with stocking regulations.

Reporting Land Allocation

Land use is allocated over the 100-year planning horizon using linear programming. The long-term implications and trends of forest, fish, wildlife, and watershed resources from the selected mix of management prescriptions are reviewed for each watershed. If product outputs are too low or impacts are too great, the resource sensitivities can be reevaluated, policies altered, and the decision analysis can be re-run with modified constraints. Through this iterative process. amounts and locations of silvicultural activities that potentially result in adverse impacts are identified and mitigated. When a balanced land use allocation is found, detailed assessments describing both short- term and long-term resource trends are prepared. This Option A plan is the result of many iterations of policy adjustments.

Appendix C
Modeled Silviculture Regimes
December 2, 1999

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Introduction

Specific goals of Mendocino Redwood Company (MRC) include increasing the size and age of the inventory, improving the conifer stocking ratios with respect to hardwoods, and promoting larger trees and dense canopy closure in watercourse buffers. The following descriptions of Mendocino Redwood Company silviculture policies and modeling logic used to simulate Mendocino Redwood Company policy provide the rationale for applying a specific regime to a stand, as well as the logic used to trigger a silvicultural event and provide for retention. The logic included in the following regime descriptions was used in the modeling methodology to calculate Maximum Sustained Production (MSP).

The development of the logic used in the modeling scenarios considered the California Forest Practice Rules and Mendocino Redwood Company policies. Mendocino Redwood Company policies for silviculture retention meet, and usually exceed, silviculture retention standards stated in the California Forest Practice Rules. A description of Mendocino Redwood Company's silvicultural prescriptions, policies for silviculture triggers, and silviculture retention standards are included in Tables 1, 2, and 3 respectively. MRC foresters are expected to follow the company policies. When exceptions to these policies are sought due to site-specific conditions, a full explanation will be provided in the Timber Harvest Plan (THP).

Following the MRC silvicultural policy tables are the descriptions of how these policies were modeled. Modeled conifer basal area retention standards exceed minimum standards in the California Forest Practice Rules for every modeled regime. The model logic is intended to be unambiguous and fit as closely as possible the silvicultural policies of Mendocino Redwood Company.

A stand is considered for inventory and modeling purposes as a unit of vegetation with similar vegetation features. A quantitative representation of the stand is produced by measuring forest stand variables through field sampling (described in Appendix A). The data obtained from field sampling varies, sometimes widely, between plots. Forest stand conditions, such as trees per acre, timber volume, and basal area are usually defined in terms of the average conditions of the stand. The logic used for assigning silviculture regimes to stands evaluates the quantified representation of the stand in terms of the stand's averages.

The implementation of the silviculture logic developed for modeling, including retention and vegetation management assumptions, is expected to vary among stands in timber harvest plans. Existing field conditions may warrant variance from the standards applied in the modeling activities, in order to meet the overall objectives of Mendocino Redwood Company's silviculture policies. The retention standards identified for the regimes should be considered as an average applied to stands. Some stands will have higher retention values than those specified in the silviculture logic, some will have lower retention values. The average will be at, or above the retention standards specified in the silviculture regimes. Since both pre-harvest and post-harvest stands can be quantified, updating post-harvest stands is expected to be an important monitoring tool for testing compliance with Mendocino Redwood Company silviculture policies.

Table 1. Silviculture descriptions and cross reference to the California Forest Practice Rule silviculture descriptions.

Prescription	Description	California Forest Practices Rules Ref. and Label
Descriptions of Different Silvicultural Harvest Prescriptions Used by MRC		
Uneven-Aged Management		
Single Tree Selection	To establish and maintain multi-storied, uneven-aged stands of redwoods and Douglas-fir by harvesting individual trees more or less uniformly throughout the stand. Provides space for growth of remaining trees and space for growth of new trees.	913.2(a)(2)(A) "Selection System"
Group Selection (Conifer & Mixed)	To establish and maintain multi-storied, uneven-aged stands of redwoods and Douglas-fir by harvesting trees in small (< 2.5 acre) groups. Width of groups is commonly twice tree height of surrounding mature trees to maintain forest influence.	913.2(a)(2)(B) "Group Selection"
High Retention Selection	To accelerate stand development of large trees and closed canopy by harvesting individual trees targeted to result in the growth of larger trees and to create and maintain special habitat elements such as decadent trees, snags, and downed logs.	913.2(a)(2)(A) "Selection System"
Commercial Thinning	To promote timber growth, increase average stand diameter, and improve forest health by the removal of trees in a manner that results in a stand with two or three distinct canopy layers.	913.3(a) "Commercial thinning"
Transition	To develop an uneven-aged stand from an even-aged stand or a stand with unbalanced or irregular stocking. Involves removal of trees individually or in small groups to create a balance of different stand structure and natural reproduction.	913.2(b) "Transition"
Even-Aged Management		
Variable Retention	To rotate stands with poorly stocked conifer volume and relatively high volumes of hardwood, dispersed and/or aggregated retention of 10% to 40% or more of the existing stand to provide for vigorous growth of remaining stand combined with pockets of undisturbed trees to provide for ecological functionality, habitat structure, and forest complexity.	913.6 "Alternative Prescription" "AP/Clearcut"
Seed Tree Removal Step	This step harvests a portion of the seed trees left in an earlier entry and after a fully stocked stand of regenerated trees has become established.	913.1(c)(2) "Seed Tree Removal Step"
Shelterwood Removal Step	This step harvests a portion of the overstory of trees left in an earlier entry for wind and soil stability and after a fully stocked stand of regenerated trees has become established.	913.1(d)(3) "Shelterwood Removal Step"
Rehabilitation	To rehabilitate poorly stocked conifer stands experiencing excessive hardwood competition and allow for site prep and conifer regeneration and transition into well-stocked stand of conifers.	913.4(b) "Rehabilitation"

Table 2. Mendocino Redwood Company Trigger Condition **Policies** for Silviculture Regimes.

Targeted Pre-Harvest Conditions on MRC Forestlands				
Prescription	Species	Pre-Harvest Conifer Basal Area (Feet Squared per Acre)		Other Key Pre-Harvest Factors
Uneven-Aged Management		Lower Limit	Upper Limit	
Single Tree Selection	Conifer/Mixed	120	None	
Group Selection	Conifer	120	None	20% of the Stands' Area May Meet Stocking Standards Using the Point Count Method. The Remaining 80% Must Meet the Pre Harvest Basal Area Trigger (120 sf per acre).
Group Selection	Mixed	90	None	Hardwood basal area greater than 50 sf/acre. 20% of the Stands' Area May Meet Stocking Standards Using the Point Count Method. The Remaining 80% Must Meet the Pre-Harvest Basal Area Trigger (120 sf per acre).
High Retention Selection	Conifer/Mixed	260	None	Basal Area Present for 70% Absolute Canopy Cover
Commercial Thinning	Conifer	120	None	Will Not Be Applied to a Stand That Has Been Selectively Harvested Within 10 Years
Transition	Conifer/Mixed, Mixed/Hardwood	60	100	
Even-Aged Management*				
Variable Retention	Mixed	25	135	Greater Than 60 sf ba/acre Hardwoods**
Seed Tree Removal	Conifer/Mixed	15	50***	Regeneration @ 300 Point Count
Shelterwood Removal	Conifer/Mixed	25	100***	Regeneration @ 300 Point Count
Rehabilitation	Mixed/Hardwood	None	50	Less than 300 point count. Greater Than 50 sf ba/acre Hardwoods

Note: These recommended silvicultural harvest prescriptions are expected to result over time in an increase in more mature forest types, which is the goal of MRC. If a forester determines that a different silvicultural prescription would better achieve the goals of MRC, then that prescription can be used after consultation with the Chief Forester, Forestlands Manager, or Stewardship Director.

* The majority of even-aged management is used in hardwood dominated stands to rotate the stands back to planted conifers.

** Due to the variability of hardwood inventory across MRC's forest lands, the pre-harvest hardwood basal area may vary as much as 30% for this prescription.

*** Pre-dominant conifer basal area.

Table 3. Mendocino Redwood Company Stocking, Retention, and Re-entry **Policies**

MRC Targets For Stocking, Retention and Re-entry Specifications			
Silviculture	**Post Harvest Stocking Levels**	**Retention Conifer Basal Area (Square Feet of Basal Area per Acre)**	**Time before next harvesting activities**
Uneven-Aged Management			
Single Tree Selection	All Age, evenly distributed	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years
Group Selection (Conifer)	Less Than 20% of Pre-Harvest Stand in Clearings	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years
Group Selection (Mixed)	Less Than 20% of Pre-Harvest Stand in Clearings	Greater Than 90 sf ba if Pre-Harvest Stocking is Less Than 220 sf ba; Greater Than 140 sf ba if Pre-Harvest Stocking is Greater Than 220 sf ba	At Least 10 Years
High Retention Selection	Greater Than 70% Absolute Canopy Closure, Six Trees At Least 32" dbh or Greater Per Acre, If LWD Deficient, then Permanent Retention per Operating Policy	Greater Than 200 sf ba and Greater Than 75% sf ba of Pre-Harvest Stand	At Least 15 Years
Commercial Thinning	Equal to or Greater Average Tree Diameter Than in Pre-Harvest Stand	> 110 sf ba	Transition to Selection 10-20 Years
Transition	Less Than 20% of Pre-Harvest Stand in Clearings	> 50 sf ba	Transition to Selection 20-30 Years
Even-Aged Management			
Variable Retention	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	Approximately 10% to 40% Depending on the Acreage Retention	Transition to Selection 30-60 Years
Seed Tree Removal Step	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	Greater Than 10 sf ba, if Pre-Harvest Stocking is Less Than 75 sf ba; Greater Than 50 sf ba if Pre-Harvest Stocking is Greater Than 75 sf ba	Transition to Selection 30-60 Years
Shelterwood Removal Step	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	Greater Than 10 sf ba, if Pre-Harvest Stocking is Less Than 75 sf ba; Greater Than 50 sf ba if Pre-Harvest Stocking is Greater Than 75 sf ba	Transition to Selection 30-60 Years
Rehabilitation	10% to 40% or More Pre-Harvest Acreage in Permanent or Rolling Retention in Representative Forest	> 10 sf ba Where Conifer > 10 sf ba Pre-Harvest	Transition to Selection 30-60 Years

HIGH RETENTION SELECTION
MODEL LOGIC

Description

The goal of this regime is to create and maintain dense, multistoried, uneven-aged stands with a variety of diameter classes. The regime is considered for stands with 50% or more of the stand's overall basal area in trees greater than 16". The regime is applied to sensitive areas, such as watercourse buffers.

Timing Options

The regime is available for harvest throughout the planning horizon. The minimum re-entry period is 20 years.

Trigger Conditions

Stands must have a minimum of 260 square feet of conifer basal area per acre to be selected for harvest. The regime is considered for conifer-dominated stands and mixed conifer and hardwood stands. This simulates a canopy closure of at least 70% and a presence of large trees (6 trees 32" DBH or greater). No harvest can occur within a size class unless the following minimum conifer basal area is present in the stand:

First Condition for Harvest	Minimum Total Conifer Basal Area for Harvest Within Stand	
	260 square feet per acre	
Size Class	Stand Size	Minimum Conifer Basal Area for Harvest Within Size Class
2	8 – 16"	51 square feet per acre
3	16 – 24"	51 square feet per acre
4	24 – 32"	51 square feet per acre
5	>32"	51 square feet per acre

Hardwood harvest is triggered if hardwood basal area exceeds 30 square feet of basal area per acre.

Residual Stand Conditions

Minimum retention of conifer basal area for this regime is 200 square feet per acre. The minimum retention of conifer basal area is, by size class:

Size Class	Stand Size	Minimum Conifer Basal Area Retention by Size Class
2	8 – 16"	50 square feet per acre
3	16 – 24"	50 square feet per acre
4	24 – 32"	50 square feet per acre
5	>32"	50 square feet per acre

The retention basal area for any size class may be less than desired if the pre-harvest stand did not have the minimum retention. If hardwoods are harvested, retention is 15% of the conifer retention, or 30 square feet of basal area per acre.

Regeneration Assumptions

Natural regeneration and planted seedlings are assumed for this regime. The growth model assumes that post-harvest stands are regenerated with 40 seedlings per acre. The assumed regeneration mimics the species composition of the pre-harvest stand by determining the proportion of redwood trees and Douglas-fir trees present in the pre-harvest stand and assigning the same proportion to the seedlings. The small trees 'grow' in the model with a small tree modeling routine which adds 1 foot height growth per year until the tree achieves 10 feet in height, upon which the trees are assumed to have a DBH of 4". These trees are then grown in the FREIGHTS growth model where the trees are subject to competition and mortality.

Vegetation Control Assumptions

No vegetation control is modeled with this regime.

SELECTION (Low Hardwood Competition) MODEL LOGIC

Description

The goal of this regime is to create and maintain continuous cover of multistoried, uneven-aged forested vegetation on the ownership. The regime is applied to stands that are not experiencing a high level of hardwood competition. The regime is designed to develop and maintain a variety of diameter classes.

Timing Options

The regime is available for harvest throughout the planning horizon. The minimum re-entry period is 10 years.

Trigger Conditions

Stands must have a minimum of 120 square feet of conifer basal area per acre to be selected for harvest. The regime is considered for both conifer-dominated stands and mixed conifer and hardwood stands. No harvest can occur within a size class unless the following minimum conifer basal area is present within the stand:

First Condition for Harvest	Minimum Total Conifer Basal Area for Harvest Within Stand	
	120 square feet per acre	
Size Class	Stand Size	Minimum Conifer Basal Area for Harvest Within Size Class
2	8 – 16"	31 square feet per acre
3	16 – 24"	31 square feet per acre
4	24 – 32"	31 square feet per acre
5	>32"	31 square feet per acre

Hardwood harvest is triggered if hardwood basal area exceeds 15 square feet of basal area per acre.

Residual Stand Conditions

Minimum conifer retention for this regime is, by size class:

Size Class	Stand Size	Minimum Conifer Basal Area Retention by Size Class
2	8 – 16"	30 square feet per acre
3	16 – 24"	30 square feet per acre
4	24 – 32"	30 square feet per acre
5	>32"	30 square feet per acre

If hardwoods are harvested, retention is 15% of the conifer retention, or 18 square feet of basal area per acre.

Regeneration Assumptions

Natural regeneration and planted seedlings are assumed for this regime. The growth model assumes that post-harvest stands are regenerated with 50 seedlings per acre. The assumed regeneration mimics the species composition of the pre-harvest stand by determining the proportion of redwood trees and Douglas-fir trees present in the pre-harvest stand and assigning the same proportion to the seedlings. The small trees 'grow' in the model with a small tree modeling routine which adds 1 foot height growth per year until the tree achieves 10 feet in height, upon which the trees are assumed to have a DBH of 4". These trees are then grown in the FREIGHTS growth model where the trees are subject to competition and mortality.

Vegetation Control Assumptions

No vegetation control is associated with this regime.

SELECTION (High Hardwood Competition) MODEL LOGIC

Description

The goal of this regime is to create and maintain continuous cover of multistoried, uneven-aged forested vegetation on the ownership. The regime is applied to stands experiencing a high level of hardwood competition. The conifer basal area trigger is lower than for the other silviculture regimes in order to enter stands for the purpose of reducing hardwood competition. The regime is designed to develop and maintain a variety of diameter classes.

Timing Options

The regime is available for harvest throughout the planning horizon. The minimum re-entry period is 10 years.

Trigger Conditions

Stands must have a minimum of 90 square feet of conifer basal area per acre and a maximum of 120 square feet of conifer basal area per acre. Also, stands must have between 50 and 80 square feet of hardwood basal area per acre to be selected for harvest. The regime is considered for mixed conifer and hardwood stands. No harvest can occur within a size class unless the following minimum conifer basal area is present within the stand:

First Condition for Harvest	Minimum Total Conifer Basal Area for Harvest Within Stand	
	90 square feet per acre	
Size Class	Stand Size	Minimum Conifer Basal Area for Harvest Within Size Class
2	8 – 16"	23 square feet per acre
3	16 – 24"	23 square feet per acre
4	24 – 32"	23 square feet per acre
5	>32"	23 square feet per acre

Hardwood harvest is triggered if hardwood basal area exceeds 15 square feet of basal area per acre.

Residual Stand Conditions

Minimum conifer retention for this regime is, by size class:

Size Class	Stand Size	Minimum Conifer Basal Area Retention by Size Class
2	8 – 16"	22.5 square feet per acre
3	16 – 24"	22.5 square feet per acre
4	24 – 32"	22.5 square feet per acre
5	>32"	22.5 square feet per acre

Hardwood retention is 15 square feet of hardwood basal area per acre.

Regeneration Assumptions

Natural regeneration and planted seedlings are assumed for this regime. The growth model assumes that post-harvest stands are regenerated with 60 seedlings per acre. The assumed regeneration mimics the species composition of the pre-harvest stand by determining the proportion of redwood trees and Douglas-fir trees present in the pre-harvest stand and assigning the same proportion to the seedlings. The small trees 'grow' in the model with a small tree modeling routine which adds 1 foot height growth per year until the tree achieves 10 feet in height, upon which the trees are assumed to have a DBH of 4". These trees are then grown in the FREIGHTS growth model where the trees are subject to competition and mortality.

Vegetation Control Assumptions

No vegetation control is associated with this regime.

VARIABLE RETENTION MODEL LOGIC

Description

The goal of this regime is to rotate stands with low conifer basal area and relatively high hardwood basal area. The regime is considered an even-aged regime. Pockets of the pre-harvest stand are retained to provide habitat structure and forest complexity. The stand will be managed using uneven-age silviculture in successive entries.

Timing Options

The regime is available for harvest for the first six decades. The re-entry period is 30 years.

Trigger Conditions

Stands must have between 50 square feet and 120 square feet of conifer basal area per acre. The stand must also have at least 80 square feet of hardwood basal area per acre. The regime is considered for mixed conifer and hardwood stands and mixed hardwood stands. The stand must have 50% or more of its overall basal area in trees greater than 16" to be considered for harvest.

Residual Stand Conditions

The modeled retention is 20% of both the conifer and hardwood pre- harvest basal area, representing both the species and size distribution found in the pre-harvest stand.

Regeneration Assumptions

Natural regeneration and planted seedlings are assumed for this regime. The growth model assumes that post-harvest stands are regenerated with 300 seedlings per acre. The assumed regeneration mimics the species composition of the pre-harvest stand by determining the proportion of redwood trees and Douglas-fir trees present in the pre-harvest stand and assigning the same proportion to the seedlings. The small trees 'grow' in the model with a small tree modeling routine which adds 1 foot height growth per year until the tree achieves 10 feet in height, upon which the trees are assumed to have a DBH of 4". These trees are then grown in the FREIGHTS growth model where the trees are subject to competition and mortality.

Vegetation Control Assumptions

Vegetation control will reduce approximately 75% of the hardwoods that sprout after each harvest. This is achieved in the model by allowing only 25% of the stumps to sprout. This is determined by analyzing the number of hardwood trees per acre prior to harvest.

SEED TREE REMOVAL
MODEL LOGIC

Description

The seed tree removal regime is the final step in rotating the stand that preceded it. Seed trees are removed when the younger stand established in part by the seed trees fully occupies the stand. While considered an even-aged regime, the developing stand will be treated in subsequent treatments with uneven-age silviculture.

Timing Options

The regime is available for harvest for the first four decades.

Trigger Conditions

Stands must have between 15 and 60 square feet of conifer basal area per acre. The regime is considered for conifer-dominated stands and mixed conifer and hardwood stands. The stand must have 50% or more of its overall basal area in trees larger than 16" DBH, with a vigourous and well-stocked understory stand of smaller trees. Hardwood harvest is triggered if the hardwood basal area exceeds 15 square feet per acre.

Residual Stand Conditions

Minimum conifer basal area retention is 10 square feet of conifer basal area per acre. If hardwoods are harvested, retention is 15 square feet of hardwoods per acre.

Regeneration Assumptions

Natural regeneration and planted seedlings are assumed for this regime. The growth model assumes that post-harvest stands have 300 trees per acre, mimicking the species composition present prior to harvest. The assumed stand has trees which are 4" DBH and 10 feet and height. These trees are then grown in the FREIGHTS growth model where the trees are subject to competition and mortality.

Vegetation Control Assumptions

Vegetation control will reduce approximately 75% of the hardwoods that sprout after each harvest. This is achieved in the model by allowing only 25% of the stumps to sprout. This is determined by analyzing the number of hardwood trees per acre prior to harvest.

REHABILITATION MODEL LOGIC

Description	The rehabilitation regime is reserved for those stands experiencing excessive hardwood competition. This regime is considered as an even-aged regime. Rehabilitation removes the hardwood competition and allows conifer regeneration to take place. Successive harvests will incorporate uneven-aged silviculture.
Timing Options	The regime is available throughout the planning horizon. Subsequent harvest will be treated with uneven-age silviculture. The minimum re-entry period is 30 years.
Trigger Conditions	Stands must have less than 50 square feet of conifer basal area per acre and more than 50 square feet of hardwood basal area per acre. The regime is considered for mixed conifer and hardwood stands and mixed hardwood stands. The stand must have 50% or more of its overall basal area in trees larger than 8" DBH.
Residual Stand Conditions	Minimum conifer basal area retention is 10 square feet of conifer basal area per acre. Minimum hardwood retention is 15 square feet of hardwood basal area per acre.
Regeneration Assumptions	Natural regeneration and planted seedlings are assumed for this regime. The growth model assumes that post-harvest stands are regenerated with 300 seedlings per acre. The assumed regeneration mimics the species composition of the pre-harvest stand by determining the proportion of redwood trees and Douglas-fir trees present in the pre-harvest stand and assigning the same proportion to the seedlings. The small trees 'grow' in the model with a small tree modeling routine which adds 1 foot height growth per year until the tree achieves 10 feet in height, upon which the trees are assumed to have a DBH of 4". These trees are then grown in the FREIGHTS growth model where the trees are subject to competition and mortality.
Vegetation Control Assumptions	Vegetation control will reduce approximately 75% of the hardwoods that sprout after each harvest. This is achieved in the model by allowing only 25% of the stumps to sprout. This is determined by analyzing the number of hardwood trees per acre prior to harvest.

TRANSITION
MODEL LOGIC

Description

The goal of the transition regime is to develop uneven-aged stands from even-aged stands and/or to improve stocking levels in understocked stands.

Timing Options

The regime is available throughout the planning horizon. Subsequent harvest will be treated with selection silviculture. The minimum re-entry period is 20 years.

Trigger Conditions

Stands must have between 60 and 90 square feet of conifer basal area per acre to be selected for transition. Stands must also have less than 80 square feet of hardwood basal area to be considered for transition. The regime is considered for conifer-dominated stands, mixed conifer and hardwood stands and mixed hardwood stands. Stands must have 50% or more of its overall basal area in trees larger than 16" DBH. Hardwood harvest is triggered if hardwood basal area exceeds 15 square feet of hardwood basal area per acre.

Residual Stand Conditions

Minimum conifer basal area retention is 50 square feet of conifer basal area per acre. If hardwoods are harvested, retention is 15 square feet of hardwood basal area per acre.

Regeneration Assumptions

The stand is assumed to have 200 seedlings per acre, representing the pre-harvest conifer species mix. The height growth is at the rate of one foot a year. The trees begin growth in the CRYPTOS model at year 10, when the trees are approximately 4" in diameter and 10 feet in height. They are subject to competition and mortality when they enter the CRYPTOS model.

Vegetation Control Assumptions

Vegetation control will reduce approximately 50% of the hardwoods that sprout after each harvest. This is achieved in the model by allowing only 50% of the stumps to sprout.