

## EXECUTIVE SUMMARY

### Watershed Analysis for Mendocino Redwood Company's Ownership in the Hollow Tree Creek Watershed

This report presents the results of a watershed analysis performed by Mendocino Redwood Company (MRC) on their ownership<sup>1</sup> in the Hollow Tree Creek watershed. The MRC ownership in the Hollow Tree Creek watershed is considered the Hollow Tree watershed analysis unit (WAU). This section presents a brief overview of the watershed and the watershed analysis process followed by MRC. More specific information is found in the individual modules of this report.

The Hollow Tree Creek is a tributary to the South Fork Eel River that is on the 303(d) list as sediment and temperature impaired and a total maximum daily load (TMDL) has been developed for sediment and temperature reduction in the river (EPA, 1999). The Hollow Tree Creek and its tributaries support populations of coho salmon, chinook salmon and steelhead trout, fisheries of concern in northern California. For this reason MRC conducted a watershed analysis to assist in their efforts to reduce non-point source pollution, evaluate current and past land management practices and establish a baseline for monitoring of watershed conditions over time. The watershed analysis will also be used to identify needs for site-specific management planning and restoration in the watershed to reduce impacts to aquatic resources and potentially to improve fish and aquatic habitat conditions.

MRC's approach to the Hollow Tree Creek watershed analysis was to perform resource assessments of mass wasting, surface and point source erosion (roads/skid trails), hydrology, fish habitat, riparian condition and stream channel condition. Mass wasting, riparian condition and surface and point source erosion modules address the hillslope hazards. The fish habitat and stream channel condition modules address the vulnerability of aquatic resources. Prescriptions are developed to address the issues and processes identified in the watershed analysis. Finally, monitoring is suggested to determine the efficacy of the prescriptions to protect sensitive aquatic resources. The monitoring will provide the feedback for MRC's adaptive management approach to resource conservation.

## RESULTS

### *Mass Wasting*

A total of 367 shallow-seated landslides (debris slides or torrents) were identified and characterized in the Hollow Tree WAU. A total of 34 deep-seated landslides (rockslides or earth flows) were mapped in the Hollow Tree WAU. The majority of landslides observed in the Hollow Tree WAU are debris slides and debris torrents. Of the 367 shallow-seated landslides in the Hollow Tree WAU, 26% are determined to be road-associated.

A total of approximately 774,000 tons of mass wasting sediment delivery was estimated for the time period 1969-2000 in the Hollow Tree WAU, resulting in a mean sediment delivery rate of 775 tons/sq. mi./yr. Of the total estimated amount, 500,000 tons (66% of total) occurred from 1969-1978 and 274,000 tons (35% of total) occurred in the 1979-2000 time period (Table A-5).

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<sup>1</sup> It must be emphasized that only the Mendocino Redwood Company ownership is analyzed in the watershed.

The landscape was partitioned into six Mass Wasting Map Units (MWMU) representing general areas of similar geomorphology, landslide processes, and sediment delivery potential for shallow-seated landslides (Map A-2). The mass wasting map unit with the highest sediment delivery is MWMU 1, which is estimated to deliver 46% of the total sediment input for the Hollow Tree WAU. This is due to the steep slopes of the inner gorge along Hollow Tree Creek. Combining all streamside units (MWMU 1, 2, 3) would yield 69% of the total sediment input. MWMU 5 is estimated to have delivered less than 0.5% of the total sediment input. MWMU 4 delivered 30% of the total estimated sediment inputs, primarily due to the high number of road-related slides occurring in this unit. The percent of sediment delivery from road related slides in MWMU 4 was 52%. The total sediment delivered from non-road related slides in MWMU 1, 2, and 3 was 83%, while MWMU 4 delivered 17% of the total non-road related delivery.

#### ***Surface and Point Erosion (Roads/Skid Trails)***

It was determined that there are 178.8 miles of truck roads in the Hollow Tree WAU (skid trails not included). This represented an average road density of 5.4 miles of road per square mile.

Approximately 34.6 miles of road contributes surface erosion to watercourses (defined as contributing road length). This represents approximately 19% of the total road length in the Hollow Tree WAU.

Roads in the Hollow Tree WAU are estimated to generate, on average, 420 tons/mi<sup>2</sup>/yr of sediment from road-associated surface and point source erosion (Table ES-1).

Table ES-1.Road Associated Surface and Point Source Erosion Estimates by Planning Watershed for the Hollow Tree WAU.

<b>Planning Watershed</b>	<b>MRC Owned (sq mi)</b>	<b>Surface Erosion (tons/sq mi/yr)</b>	<b>Point Source Erosion (tons/sq mi/yr)</b>	<b>Total (surface +point source) (tons/sq mi/yr)</b>
Lower Hollow Tree Creek	2.8	160	310	460
Middle Hollow Tree Creek	16.2	160	210	370
Upper Hollow Tree Creek	10.5	210	220	430
Mill Creek	1.1	250	420	680
Low Gap Creek	1.2	100	440	540
Jack of Hearts	1.1	220	330	550
<b><i>Hollow Tree WAU Total</i></b>	<b><i>32.9</i></b>	<b><i>180</i></b>	<b><i>240</i></b>	<b><i>420</i></b>

The future potential for point source erosion was evaluated in the Hollow Tree WAU. This potential erosion or controllable erosion was identified during the road inventory during 2001-2003 then adjusted by road erosion control work performed in 2003. A total of 108,167 cubic yards of controllable erosion was identified in the Hollow Tree WAU in the initial road inventory. In 2003 13,167 yards of controllable erosion was treated through road erosion control work. As of the end of 2003 there are 95,000 cubic yards of controllable erosion to be treated in the Hollow Tree WAU (Table ES-2).

Table ES-2. Controllable Erosion by Treatment Immediacy for the Hollow Tree WAU.

Location	Controllable Erosion Treatment Immediacy (yd <sup>3</sup> )		
	High	Moderate	Low
Culverts	17817	3973	10760
Crossings	2827	8024	17491
Landings	2300	1578	6503
Erosion Features	1995	1033	3174
Road slides	11010	2917	3598
<b>Total</b>	<b>35949</b>	<b>17525</b>	<b>41526</b>

In the Hollow Tree WAU the majority of the forested portion of what is now the MRC ownership was harvested using tractor based yarding during the 1970s, 1980s, and 1990s. This high level of skid trail construction and use is estimated to contribute a high level of sediment delivery. In general, skid trail sediment delivery rates were highest during the 1970s lowering in subsequent decades (prior to 1970s was not evaluated).

### ***Hydrology***

Using the peak flow record from the South Fork Eel River at Leggett for 1965-2000, the flood of record is December, 1964 (Water Year 1965) at 78,700 cubic feet per second calculated to be greater than an 80 year event for the South Fork Eel and thus assumed the same for Hollow Tree Creek. Each decade there has been at least one peak greater than or equal to a 10 year event with the exception of the 1990s. In this last decade there have been 2 storms greater than a 2 year recurrence (1993 and 1995), 5 storms greater than a 1.5 year storm. The occurrence of these storms suggests that the Hollow Tree Creek WAU has been subjected to stressful hydrologic conditions, particularly in the 1960-1980's time period possibly creating a greater incidence of landslides, road failures or surface erosion than the 1990's decade. However, the 1990's still received large storms.

Throughout the last 40-50 years in the Hollow Tree Creek WAU, based on South Fork Eel River flow data, there have been 3 flood events >20 year recurrence (Figure C-1). These flood events occurred in 1965, 1966 and the 1974 water years. There has been one additional 10-year event, this occurred in 1986. Large events have the capacity to re-shape river or stream channels and transport large sediment loads. The meteorological events that created these large floods also can be assumed to be a major contributor to the erosion and mass wasting delivered to the watercourses in the WAU.

### ***Riparian Function***

The riparian function assessment is divided into two groups: 1) the potential of the riparian stand to recruit large woody debris (LWD) to the stream channel along with the level of concern about current LWD conditions in the stream, and 2) a canopy closure and stream temperature assessment. Our analysis showed a need for large woody debris in most of the channel segments of the Hollow Tree WAU due to past stream clearing, historic harvest and low riparian recruitment potentials. Channel segments with LWD levels that are well below targets will need to be a priority for future recruitment and restoration work. Riparian LWD recruitment potential in the Hollow Tree WAU is moderate to low. Currently, the streams range primarily between marginal and deficient LWD quality ratings, with no streams on target.

Canopy closure over watercourses is generally very good throughout the Hollow Tree Creek WAU. Stream temperatures are generally in favorable ranges for rearing salmonids in the Hollow Tree WAU. The exception to this is along lower portions of Hollow Tree Creek where the channel widens and

receives less shade. Stream canopy shade ratings in Hollow Tree WAU show mainly on target ratings, a few streams exhibiting marginal ratings and lower Hollow Tree Creek with a deficient rating.

### ***Stream Channel Condition***

Baseline information on the stream channels of the Hollow Tree WAU was collected and reported (see Stream Channel Condition module). Individual channel segments were categorized into geomorphic units using the baseline stream channel information, topography the channel segments are found in, position in the drainage network, and gradient/confinement classes. Five stream geomorphic units were established to represent the range of channel conditions and sensitivities to input factors of coarse and fine sediment and LWD (Table ES-3). Long term channel monitoring observations have been collected on 4 streams in the Hollow Tree WAU for 1999, 2001 and 2003 the results for these observations are presented in the Stream Channel Condition module.

Table ES-3. Stream Geomorphic Units and Sensitivities for the Hollow Tree WAU.

<b>Stream Geomorphic Unit</b>	<b>Channel Sensitivity</b>		
	<b>Coarse Sediment</b>	<b>Fine Sediment</b>	<b>LWD</b>
Geomorphic Unit I. Highly Confined Low Gradient Channels within Inner Gorge Topography.	Moderate	Moderate	Moderate
Geomorphic Unit II. Confined to Moderately Confined Moderate Gradient Channel Segments.	High	Moderate	High
Geomorphic Unit III. Unconfined to Moderately Confined Channel Migration Zones.	Moderate	Low	High
Geomorphic Unit IV. Moderate Gradient Confined Transport Segments.	Moderate	Low	Moderate
Geomorphic Unit V. High Gradient Transport Segments.	Low	Low	Low

### ***Fish Habitat Assessment***

The anadromous fish species inhabiting the Hollow Tree WAU are steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*), fall run chinook salmon (*O. tshawytscha*) and Pacific lamprey (*Lampetra tridentata*). Other fish species include Sacramento sucker (*Castomus occidentalis*), California roach (*Lavinia symmetricus*), and three-spine stickleback (*Gasterosteus aculeatus*).

Habitat typing data indicated that spawning habitat was generally fair to good throughout most of the Hollow Tree WAU. However, permeability data indicated gravels with low permeability. Reduction of erosion rates should increase the quality of spawning gravel in the Hollow Tree WAU. Throughout most of the Hollow Tree WAU, summer rearing and over-wintering habitat is limited by a lack of large woody debris, these life stages were generally rated as fair. Land management activities that promote woody debris recruitment should directly increase the quality of rearing habitat in the Hollow Tree WAU.

### ***Sediment Input Summary***

The average estimated sediment input for the time period 1969-2000 for the Hollow Tree WAU is 1260 tons/square mile/year. The inputs in the Hollow Tree WAU over this time frame have come from mass wasting (61%) and surface and point source erosion (39%). Road associated sediment delivery is the major contributor in the Hollow Tree WAU. By adding the contribution of road surface, point source and mass wasting sediment delivery, roads represented 57% of the sediment inputs from 1969-2000 in the Hollow Tree WAU. When skid trials are included the proportion of sediment inputs increases to 63%. In

almost all of the Hollow Tree WAU sediment inputs were significantly higher in the past (as represented by 1969-1979 time period). Forest harvest practices have improved over time and it should be expected that sediment inputs will decrease as well.

### ***Land Management Prescriptions***

The following prescriptions were specifically prepared for use in the Hollow Tree WAU. These prescriptions are meant to help address issues to aid in the stewardship of aquatic resources of the Mendocino Redwood Company ownership in the Hollow Tree WAU. The prescriptions are meant to be used in addition to the current California Forest Practice Rules and company policies. At the time of the publication of this watershed analysis MRC's forest management policies are governed by interim guidelines prior to the issuance of a Habitat Conservation Plan and Natural Community Conservation Plan (HCP/NCCP). Once the HCP/NCCP is approved, the conservation strategies set forth in these documents will become the company policies. A prescription is only presented if it deviates from or adds clarification to these policies.

### **Mass Wasting**

#### *Mass wasting map unit 1 – Inner gorge or steep streamside slopes adjacent to low gradient watercourses*

Where there is inner gorge within MWMU 1 protections will extend from the edge of the watercourse transition line up to the break in slope of the inner gorge and 25 feet of additional slope distance after the break in slope of the inner gorge.

#### MWMU 1 Road construction:

- No new road or landing construction unless field reviewed and approved by a California Registered Geologist.

#### MWMU 1 Existing Roads:

- Roads or landings shall be maintained at the design standards that lower risk of mass wasting sediment delivery. Existing roads and landings within MWMU 1 should be considered for abandonment if no longer needed.

#### MWMU 1 Tractor Yarding:

- Equipment exclusion zones on inner gorge slopes. Equipment exclusion zones on steep streamside slopes (non-inner gorge) except for existing roads or where alternative yarding method creates potential for greater sediment delivery.

#### MWMU 1 Skid Trail Construction or Reconstruction:

- No new tractor trail construction unless field reviewed and approved by a California Registered Geologist.

#### MWMU 1 Timber Harvest:

- MWMU 1 will receive no harvest on inner gorge slopes unless approved by a California Registered Geologist. On steep streamside slopes within MWMU 1, in addition to the riparian protections set as company policy, timber harvest must retain a minimum of 50% canopy<sup>2</sup> dispersed evenly across the slopes.

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<sup>2</sup> Only trees greater than 30 feet in height count towards canopy measurement.

*Mass wasting map unit 2 – Inner gorge or steep streamside slopes adjacent to moderate to high gradient watercourses*

Where there is inner gorge within MWMU 2 protections will extend from the edge of the watercourse transition line up to the break in slope of the inner gorge and 25 feet of additional slope distance after the break in slope of the inner gorge.

MWMU 2 Road construction:

- If inner gorge topography, no new road or landing construction unless field reviewed and approved by a California Registered Geologist. If steep streamside slope topography, road construction shall be minimized. If road construction must occur, the road must utilize the highest design standards to lower risk of mass wasting sediment delivery.

MWMU 2 Existing Roads:

- Roads or landings shall be maintained at the design standards that lower risk of mass wasting sediment delivery. Existing roads and landings within MWMU 2 should be considered for abandonment if no longer needed.

MWMU 2 Tractor Yarding:

- Equipment exclusion zones on inner gorge slopes. Equipment exclusion zones on steep streamside slopes except for existing roads or where alternative yarding method creates potential for greater sediment delivery.

MWMU 2 Skid Trail Construction or Reconstruction:

- No new tractor trail construction unless field reviewed and approved by a California Registered Geologist.

MWMU 2 Timber Harvest:

- No harvest on inner gorge slopes unless approved by a California Registered Geologist. On steep streamside slopes within MWMU 2, in addition to the riparian protections set as company policy, timber harvest must retain a minimum of 50% canopy (see footnote 2) dispersed evenly across the slopes.

*Mass wasting map unit 3 – Steep dissected terrain*

MWMU 3 Road construction:

- No new road construction across MWMU 3 unless field reviewed and approved by a California Registered Geologist unless it is the best road alternative<sup>3</sup>.

MWMU 3 Existing Roads:

- Roads or landings shall be maintained at the design standards that lower risk of mass wasting sediment delivery. Existing roads and landings within MWMU 3 should be considered for abandonment if no longer needed.

MWMU 3 Tractor Yarding:

- Equipment limited to existing roads or stable trails<sup>4</sup>.

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<sup>3</sup> Best road alternative – the placement has a lower potential for sediment production and greater cost effectiveness.

<sup>4</sup> Stable trail – skid trail that has >85% of trail's tread intact, fill cracks or settling can have occurred provided the trail is still 85% intact and can have corrective action such that the trail presents little risk of future sediment

**MWMU 3 Skid Trail Construction or Reconstruction:**

- No new tractor trail construction or reconstruction unless field reviewed and approved by a California Registered Geologist.

**MWMU 3 Timber Harvest:**

- Retain 50% canopy (see footnote 2, page v) with trees dispersed evenly across slope. Tree retention shall be emphasized in the axis of headwall swales. Deviations from this default must be field reviewed and approved by a California Registered Geologist.

*Rockslides*

No harvest or new road construction will occur on active portions of rockslides with a risk for sediment delivery unless approved by a California Registered Geologist.

Roads

Mendocino Redwood Company, Trout Unlimited, California Department of Fish and Game, United States Fish and Wildlife Service have teamed to do a comprehensive restoration program in the Hollow Tree Creek watershed. This program involves the upgrade of all roads within the watershed and installation of stream enhancement structures. Roads that are no longer needed are being decommissioned in the watershed. This program is to be conducted in three phases beginning in 2003 and extending likely through 2008. Mendocino Redwood Company is committed to this program.

A small portion of roads within the Hollow Tree WAU will not be treated during this cooperative restoration effort, notably the areas in the Hollow Tree WAU outside of the Hollow Tree Creek watershed (Mill Creek, Jack of Hearts Creek, and Low Gap Creek). For all roads the following prescriptions apply.

*High and Moderate Erosion Hazard Roads*

The roads with a high erosion hazard rating should be given special attention for maintenance or erosion control. These roads should be considered high priority roads for rock surface, improved and increased road drainage relief, design upgrades or decommissioning.

The moderate erosion hazard roads should be given similar attention, but not as high a priority as the high erosion hazard roads.

*High and moderate treatment immediacy sites for roads in the Hollow Tree WAU*

The high treatment immediacy controllable erosion sites will be the highest priority for erosion control, upgrade, or modifications to existing design. These sites will be scheduled for repair based on operational considerations of harvest scheduling, proximity and availability of equipment, magnitude of the problem, and accessibility to the site.

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delivery after use. Cut bank slumps can occur on stable trails, however, the slump cannot be removed if it buttresses failure of upslope soils.

The moderate treatment immediacy controllable erosion sites will be the next highest priority (relative to the high treatment immediacy sites) for erosion control, upgrade, or modifications to existing design. The moderate treatment immediacy sites will typically be addressed when in close proximity to high treatment immediacy sites.

#### *Fish passage barriers from culverts in the Hollow Tree WAU*

There are 2 known culverts that are partial fish passage barriers in the Hollow Tree WAU; located on road crossings in Walters Creek and South Fork Redwood Creek. These crossings will be removed and crossings that will pass all life stages of salmonids will be installed.

Other fish migration barriers likely exist and need to be investigated over time.

#### Riparian

##### *Large woody debris recruitment*

The company policies for streamside stand retention are considered to be appropriate at this time for LWD recruitment. Monitoring of LWD recruitment will be done to determine if this is correct.

In the interim MRC will promote attempts to place LWD in stream channels to provide habitat structure. The stream locations with high instream LWD demand should be considered the highest priority for LWD placement. The moderate instream LWD demand segments would be next.

##### *Stream Shade*

The company policies for promoting streamside canopy and riparian management are considered to be appropriate at this time to improve stream canopy. Monitoring of stream temperatures and canopy will be done to determine if this is correct.

Areas with low canopy in the Hollow Tree WAU will have the following considerations:

- Restoration harvest within the AMZ will not remove trees providing effective shade.
- Stream temperatures will be monitored to determine if temperatures fluctuate over time.

#### ***Monitoring***

Aquatic resources monitoring will be conducted in the Hollow Tree WAU. This monitoring is to assist Mendocino Redwood Company to assess impacts to aquatic resources associated with past or future timber harvest and related forest management activities in the Hollow Tree WAU. The monitoring suggested in this plan is monitoring that MRC does across all its lands including the Hollow Tree WAU. However, other monitoring efforts not mentioned here may be conducted by MRC in the Hollow Tree WAU. Currently a comprehensive monitoring plan is being developed for the MRC lands. Once that plan is finalized it will supercede the monitoring presented here.

#### *Monitoring Plan Goals:*

- Test the efficacy of the Hollow Tree WAU prescriptions to address impacts to aquatic resources from timber harvest and related forest management activities.



- To assess long term channel conditions. Are current and future forest management practices inhibiting, neutralizing or promoting stream channel conditions for aquatic habitat?

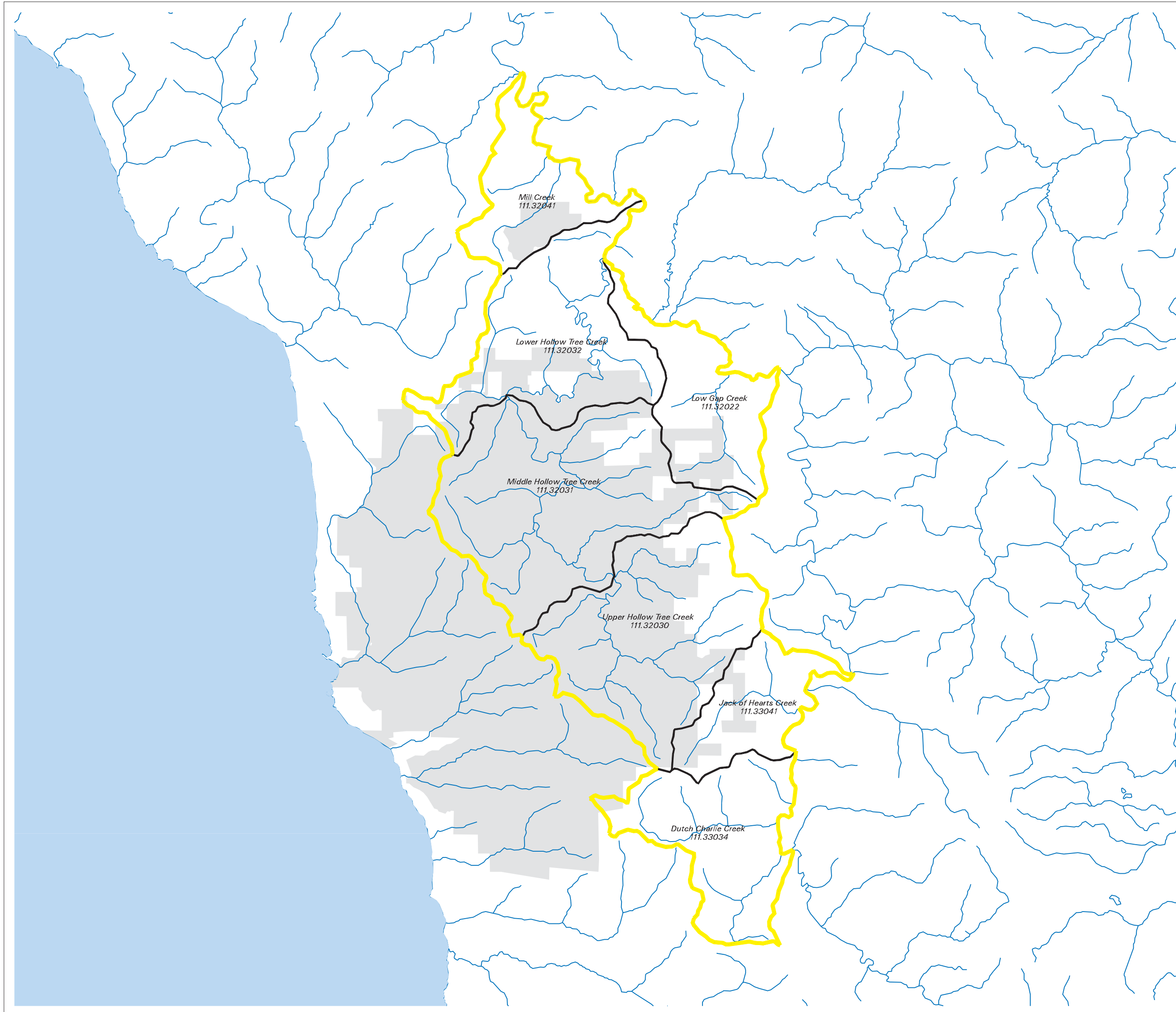
A monitoring report will be produced each year that monitoring is conducted in the Hollow Tree WAU. The report will cover the monitoring and analysis that has occurred up to that year; if no monitoring is conducted in a given year than no report will be produced. The goal will be to have a report completed by February of the year following the monitoring. Table ES-4 summarizes some of the monitoring to be conducted in the Hollow Tree WAU over time.

Table ES-4. Monitoring Matrix for Mendocino Redwood Company Lands Including the Hollow Tree Watershed Analysis Unit.

Monitoring Objectives	Reasoning, Comments	Technique
1. Determine effectiveness of measures to reduce management created mass wasting.	Management created mass wasting is significant contributor of sediment delivery.	Evaluation of mass wasting following a large storm event or after approximately 20 years.
2. Determine effectiveness of erosion control practices on high and moderate surface erosion hazard roads and landings.	Roads provide sediment delivery in the Hollow Tree WAU.	Evaluation of watercourse crossings, landings, and road lengths for erosion evaluation.
3. Determine in-stream large woody debris amounts over time.	Large woody debris is needed for stream channel and aquatic habitat improvement in the Hollow Tree WAU.	Stream LWD inventories and mapping of LWD designation areas in select stream reaches and long term channel monitoring sites.
4. Determine if stream temperatures are staying within properly functioning range for salmonids.	Stream temperature can be a limiting factor for salmonid growth and survival.	Stream temperature probes and assessment conducted in strategic locations.
5. Determine if fine sediment in stream channels is creating effects deleterious to salmonid reproduction.	Many forest practices can produce high fine sediment amounts. Need to ensure fine sediments are not impacting salmonid reproduction.	Permeability measurements on select stream reaches (bulk gravel samples if necessary).
6. Determine long-term channel morphology changes from coarse sediments.	Channel morphology can be altered from sediment increases, possibly affecting aquatic habitat.	Thalweg profiles and cross section surveys on select stream reaches.
7. Determine presence and absence of fish species in Class I watercourses.	Management practices and resource protections can affect distribution of aquatic organisms.	Electro-fishing and snorkeling observations at select locations to determine species composition and presence.

# Hollow Tree Creek Watershed Analysis Unit

## Hollow Tree Creek Watershed Overview



- Major Streams
- Planning Watershed
- Hollow Tree Creek Watershed Analysis Unit Boundary
- Ocean, Lake, Pond
- MRC Ownership

