EXECUTIVE SUMMARY

Watershed Analysis for Mendocino Redwood Company's Ownership in the Big River Watershed

This report presents the results of a watershed analysis performed by Mendocino Redwood Company (MRC) on their ownership in the Big River watershed. The MRC ownership in the Big River watershed is considered the Big River watershed analysis unit[1] (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 Big River is on the 303(d) list as sediment impaired and a total maximum daily load (TMDL) has been developed for sediment reduction in the river (EPA, 2001). The Big River and its tributaries support populations of coho salmon, chinook salmon and steelhead trout, three 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 in the watershed to reduce impacts to aquatic resources and potentially to improve fish and stream habitat conditions.

MRC's approach to the Big River 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.

The Big River watershed encompasses approximately 75,300 acres. The MRC ownership is within 10 different planning watersheds in the Big River watershed as delineated by the California Water Agency. MRC owns approximately 45 percent of the land in the Big River watershed, approximately 34,060 acres.

RESULTS

Mass Wasting

A total of 1547 landslides were identified in the Big River WAU from 1970-2000. Of that total 1101 were shallow-seated landslides (debris slides, torrents, or flows) and 446 deep-seated landslides (rockslides or earth flows). Of the 1101 shallow-seated landslides in the Big River WAU, 671 are determined to be road-associated.

[1] The WAU is only MRC lands in the watershed.

Mass wasting is estimated to contribute 783,000 tons or 490 tons/mi^2/yr over the 30 years analyzed. The majority of these inputs occurred in the 1970s and the 1990s. The highest estimated sediment input rate from mass wasting occurred in the Two Log planning watershed, with the majority of that occurring in the 1970's. Mettick Creek was the next highest sediment input rate with the higher rate occurring in the 1970's as well. The other planning watersheds had varied rates of inputs, with the 1970's or 1990's being highest.

Approximately 61% of the shallow-seated landslides in the Big River WAU are road associated. Of the road associated landslides, 41% are from truck roads, 4% from landings and 16% from skid trails. Road associated mass wasting was found to have contributed approximately 509,000 tons (320 tons/sq. mi./yr) of sediment over the 30 years analyzed (1970-2000) in the Big River WAU (Table A-6). This represents approximately 65% of the total mass wasting sediment inputs for the Big River WAU for 1970-2000. In the Mettick Creek, Russell Brook, Two Log and South Daugherty Creek planning watersheds, road associated landslide sediment delivery was a major sediment source, approximately 2/3 of the mass wasting sediment inputs. Roads are a significant factor in the cause of shallow-seated mass wasting events in the Big River WAU.

The landscape was partitioned into five Mass Wasting Map Units (MWMU) representing general areas of similar geomorphology, landslide processes, and sediment delivery potential for shallow-seated landslides (see Map A-2, Section A). The steep streamside and inner gorge areas of MWMU 1 and 2 contribute the highest amount of the sediment in the watershed, 54%. In the mid-slope areas of MWMU 3 and 4 a large amount of road associated landslides are occurring. No sediment delivery was observed in the low slope areas of MWMU 5.

Surface and Point Source Erosion (Roads/Skid Trails)

It was determined that there are 381.5 miles of truck roads in the Big River WAU (skid trails not included) this represented an average road density of 7.3 miles of road per square mile (Table ES-1).

Table ES-1. Road Surface Areas, Contributing Road Surface Areas, Road Lengths and Road Densities for the Big River WAU.

Planning Watershed	Road Surface Area (ac)	Road Contributing Area (ac)	Road Length (miles)	Road Density (mi/sq mi)
East Branch North Fork	54.4	8.3	28.1	7.1
Lower North Fork	59.5	8.4	30.7	9.0
Mettick Creek	202.0	20.2	104.2	6.5
Rice Creek	30.6	2.7	15.8	10.9
Russell Brook	138.3	11.6	71.3	7.7
South Daugherty	156.5	18.1	80.7	7.1
Two Log	98.6	12.6	50.7	7.6
Big River WAU Total	***734.0***	***81.9***	***381.5***	***7.3***

Roads within MRC's ownership of the Big River WAU are estimated to generate 320 tons/mi^2/yr of sediment from road-associated surface and point source erosion (Table B-1). South Daugherty Creek and Mettick Creek planning watersheds are estimated to yield 4390 and 4050 tons/year of sediment, respectively; the highest amounts of sediment delivery in the Big River WAU. However, when normalized by area Russell Brook, East Branch North Fork Big River and South Daugherty contribute the highest rates of sediment delivery, 440, 400 and 390 tons/mi^2/yr respectively. This is due to a high density of high use roads within a relatively small area of MRC ownership in these planning watersheds.

Table ES-2. Road Associated Surface and Point Source Erosion Estimates by Planning Watershed for the Big River WAU.

Planning Watershed	Total Road Assoc. Erosion (tons/yr)	MRC Owned Acres	Road Assoc. Erosion Rate (tons/mi^2/yr)	Surface Erosion Rate (tons/mi^2/yr)	Point Source Erosion Rate (tons/mi^2/yr)
East Branch North Fork	1580	2527	400	165	235
Lower North Fork	930	2170	270	235	35
Mettick Creek	3140	10294	200	130	70
Rice Creek	440	924	300	290	20
Russell Brook	4050	5926	440	170	270
South Daugherty	4390	7242	390	160	230
Two Log	2000	4275	300	220	80
Big River WAU totals	***16530***	***33,358 ****	***320***	***190***	***130***

* No road data for Dark Gulch presented, MRC ownership in Big River WAU is 34,060 acres.

A few high treatment immediacy point source erosion sites were identified in the Big River WAU. The sites are mapped and described in Section B.

In the Big River WAU the portion that was harvested using tractor based yarding during the 1940s, 1950s and 1960s produced a high level of sediment delivery. This high impact skid trail construction and usage brought high sediment delivery rates on those particular acres. However, the widespread geographic extent of skid trails during the 1970s and 1980s produced the greatest amounts of total skid trail area and sediment delivered in the Big River WAU. The 1970s brought skid trail use area and sediment delivery peaks on Two Log Creek, Lower North Fork Big River and Rice Creek planning watersheds. The 1980s brought skid trail use area and sediment delivery peaks on the East Branch North Fork Big River, Russell Brook, Mettick Creek and South Daugherty Creek planning watersheds.

Hydrology

Throughout the last 50 years in the Big River WAU (based on Navarro and Noyo data) there have been numerous large flood events. Using the streamflow data from the Navarro and Noyo Rivers for the last 50 years, there have been 4 events >20 year recurrence (1955, 1965, 1974, and 1993 water years) and an additional 4 events > 10 year recurrence (1970, 1982, 1986, and 1996 water years). These flood 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 Big River WAU due to past splash dam activity, 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 Big River WAU is primarily low. Currently, the streams in the Big River WAU have a deficient or marginal LWD quality rating. None of the major streams in the Big River WAU received an on target LWD quality rating.

Canopy closure over watercourses in the Big River WAU ranges from poor to good. Big River, North Fork Big River and South Fork Big River have less than ideal canopy cover values but this is to be expected from larger river channels. East Branch North Fork Big River and Two Log Creek are two areas that have good canopy cover. Daugherty Creek is an area which has low canopy cover.

Stream temperatures in the Big River WAU are commonly above levels that are stressful to salmonids. At times, maximum daily temperatures at many sites in the Big River WAU exceed the maximum lethal temperatures of coho salmon (23 C^o). Temperatures for all sites exceeded the MWAT threshold maximums for coho salmon (17-18 C^o) (Brett, 1952 and Becker and Genoway, 1979). The high temperature levels are of concern for rearing habitat quality in the Big River WAU but are not entirely related to canopy cover issues.

Stream Channel Condition

Baseline information on the stream channels of the Big River 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).

Table ES-3. Stream Geomorphic Units and Response Potential for the Big River WAU.

	Channel Response Potential		
Stream Geomorphic Unit	**Coarse Sediment**	**Fine Sediment**	**LWD**
I. Confined low gradient channels of the Big River watershed.	Moderate	Moderate	Moderate
II. Confined to moderately confined depositional channels of tributaries of the Big River watershed.	Moderate	Moderate	High
III. Highly confined depositional channels of tributaries of the Big River watershed.	Moderate	Moderate	High
IV. Moderate gradient confined transport channels of the Big River watershed.	Moderate	Low	Moderate
V. High gradient transport channels of the Big River watershed.	Low	Low	Low

Fish Habitat Assessment

The anadromous fish species inhabiting the Big River WAU are steelhead trout (*Oncorhynchus mykiss*), coho salmon (*O. kisutch*), chinook salmon (*O. tshawytscha*), and pacific lamprey (*Lampetra tridentata).* Other non-salmonid species include sculpin (*Cottus* spp.), threespine stickleback (*Gasterosteus aculeatus),* California Roach (*Lavina symmeticus),* and Sacramento Sucker (*Castomus occidentalis).*

Habitat typing data indicated that salmonid spawning habitat was fair to good in the Big River WAU. Salmonid rearing and over-wintering habitat was fair to poor in the Big River WAU. Throughout most of the Big River WAU, habitat is limited by a lack of large woody debris. Management activities that promote woody debris recruitment should directly increase the quality of habitat in the Big River WAU.

Sediment Input Summary

The average estimated sediment input for the past thirty years for the Big River WAU is 880 tons/square mile/year. The inputs in the Big River WAU over the last 30 years have come from mass wasting (48%) and surface and point source erosion (52%). Road associated erosion is the dominant sediment contributing process in the Big River WAU. The road associated mass wasting, surface and point source erosion combined accounts for 66% of the estimated sediment inputs in the Big River WAU. When skid trail erosion is included with the road sediment inputs the amount totals 81% of the sediment inputs of the Big River WAU.

Land Management Prescriptions

The following prescriptions were specifically prepared for use in the Big River 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 Big River 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

MWMU 1 Road construction:

- If inner gorge topography, no new road or landing construction unless field reviewed and approved by a California Registered Geologist. If not inner gorge 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 1 Existing Roads:

- Existing roads and landings shall be abandoned when no longer needed. If abandoning is not feasible, then roads or landings shall be maintained at the design standards that lower risk of mass wasting sediment delivery.

MWMU 1 Tractor Yarding:

- Equipment exclusion zones on inner gorge slopes. Equipment exclusion zones on non-inner gorge slopes 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 on inner gorge slopes, no new tractor trail construction or reconstruction on non-inner gorge slopes 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 other areas (non-inner gorge slopes) within MWMU 1, in addition to the riparian

protections set as company policy, timber harvest must retain a minimum of 50% overstory canopy dispersed evenly across the slopes.

- The 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.
- For those areas that do not have well defined inner gorge topography in MWMU 1 timber harvest must retain 50% canopy[2].

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

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 not inner gorge 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:

- Existing roads and landings shall be abandoned when no longer needed. If abandoning is not feasible, then roads or landings shall be maintained at the design standards that lower risk of mass wasting sediment delivery.

MWMU 2 Tractor Yarding:

- Equipment exclusion zones on inner gorge slopes. Equipment exclusion zones on non-inner gorge 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 on inner gorge slopes, no new tractor trail construction or reconstruction on non-inner gorge slopes 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 other areas (non-inner gorge 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 1, page vi) dispersed evenly across the slopes.
    - The 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.
    - For those areas that do not have well defined inner gorge topography in MWMU 2 timber harvest must retain 50% canopy (see footnote 2).

Mass wasting map unit 3 – Steep dissected terrain

MWMU 3 Road construction:

[2] Only trees greater than 30 feet in height count towards canopy measurement.

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

MWMU 3 Existing Roads:
- Existing roads and landings shall be abandoned when no longer needed. If abandoning is not feasible, then roads or landings shall be maintained at the design standards that lower risk of mass wasting sediment delivery.

MWMU 3 Tractor Yarding:
- Equipment limited to existing roads or stable trails[4].

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 vi) 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

High and Moderate Erosion Hazard Rating Roads in the Big River WAU

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.

The roads in close proximity to watercourses in the Big River WAU will be assessed, where possible, for decommissioning based on road network connectivity and harvesting needs. Assessment or scheduling of road decommissioning will consider operational considerations of harvest scheduling, proximity and availability of equipment, magnitude of the problem, and accessibility to the site.

[3] Best road alternative – the placement has a lower potential for sediment production and greater cost effectiveness.
[4] 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 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 following roads can have been identified, to date, for decommissioning:

- Road DC-023 from DC0023-05 to SC-018
- Road M-150
- Road DC-23-07
- Road SC-037
- Road SC-016-07
- Road SC-012
- Road GC-018

Known high treatment immediacy sites for roads in the Big River WAU

The known 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.

Known Fish Passage Barriers

There are 5 known culverts that are barriers to upstream fish migration. These are on road crossings on Frykman Gulch, Bull Team Gulch, Boardman Gulch and 2 culverts on Donkey House Gulch. The 5 known culverts shall be removed or replaced with a drainage facility that will pass both juvenile and adult salmonids. All of these crossings should be a high priority for fish passage improvement. 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 unnaturally low canopy in the Big River WAU will have the following considerations for canopy improvement:

- Tree planting along the river for restoration of riparian vegetation should be emphasized.
- Restoration harvest within the AMZ will not remove trees providing effective shade.
- Stream temperatures will be monitored to determine if temperatures are lowering as canopy grows in over time.

Monitoring

Aquatic resources monitoring will be conducted in the Big River 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 Big River WAU. The monitoring suggested in this plan is monitoring that MRC conducts across all its lands including the Big River WAU. However, other monitoring efforts not mentioned here may be conducted by MRC in the Big River 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 Big River 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?

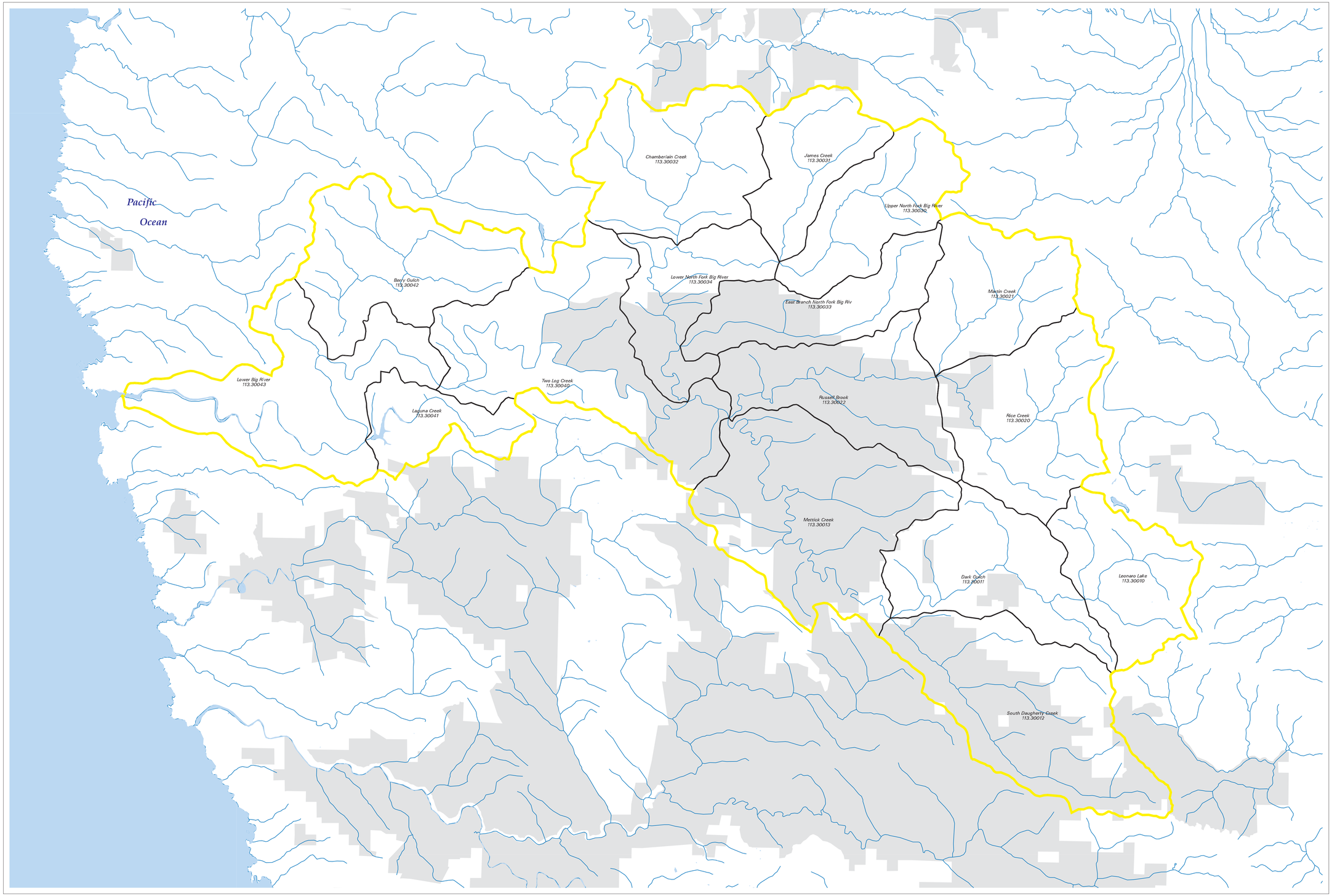
A monitoring report will be produced each year that monitoring is conducted in the Big River WAU. The report will cover the monitoring and analysis that has occurred up to that year; if no monitoring is conducted in a given year than no report will be produced. The goal will be to have a report completed by February of the year following the monitoring. Table ES-5 summarizes some of the monitoring to be conducted in the Big River WAU over time.

Table ES-5. Monitoring Matrix for Mendocino Redwood Company Lands Including the Big River 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 Big River 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 Big River 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 salmonids in Class I watercourses.	Management practices and resource protections can affect distribution of salmonids.	Electro-fishing and snorkeling observations at select locations to determine species composition and presence.

Big River Watershed Analysis Unit

Big River Watershed Overview



Major Streams
Planning Watershed
Big River Watershed Boundary
Ocean, Lake, Pond
MRC Ownership

0 1 2 Mile

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