

## 5.6 Gualala Mainstem/South Fork Subbasin

### 5.6.1 INTRODUCTION

The Gualala Mainstem/South Fork Subbasin (Gualala Hydrologic Subarea, Calwater 2.2a 113.85) contains 134 miles of “blue line” stream in its 63.7-square-mile watershed. The subbasin is composed of two Calwater 2.2a Super Planning Watersheds (SPWSs): Marshall Creek (113.8501, 45.2 square miles) and Lower South Fork Gualala River (113.8502, 18.5 square miles). The river system originates in the far southern end of the Gualala River Watershed and flows north along the San Andreas Fault to meet the North Fork Gualala. From that point to the ocean, the stream is considered the Gualala River mainstem (Figure 5.6-1). The Gualala River estuary is within that part of the subbasin, however it was parsed out as its own section (Section 5.1).

Nearly the entire subbasin is privately owned, with 15 acres of federal land and 38 acres of state land. Predominant land uses are timber production, grazing, and small vineyards.

A stream flow gage was installed in 2001 near the confluence with the Wheatfield Fork Gualala South Fork Gualala River above Wheatfield Fork near Annapolis. It is maintained by the California Department of Water Resources (DWR) and has been in operation since installation.

Historic events and the period of record on the various data sets used in the NCWAP assessment are presented in a graphic format in Figure 5.6-2.

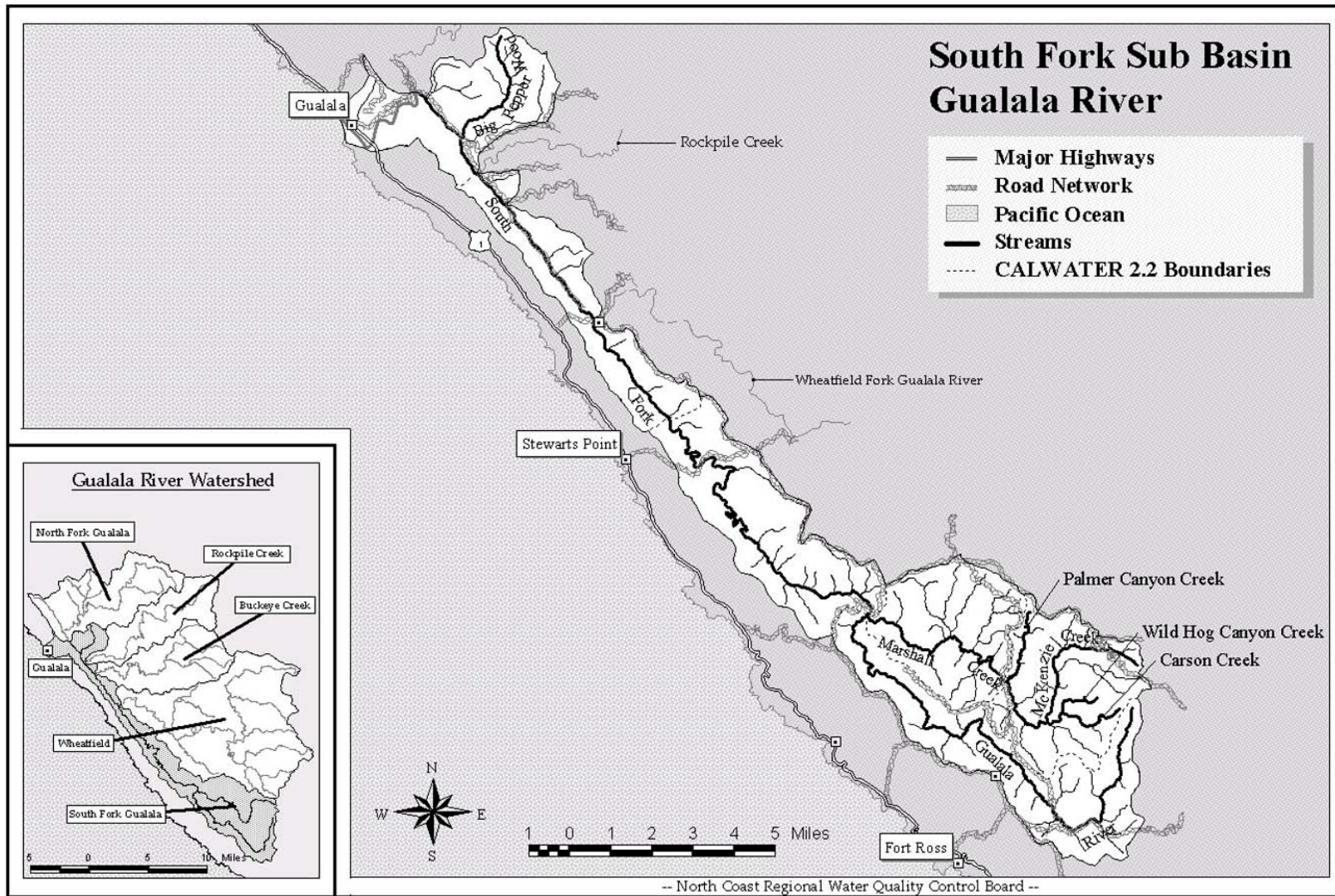
### 5.6.2 GEOLOGY

The majority of the length of the South Fork is confined in the narrow linear valley presumably formed by the San Andreas Fault. The stream is low gradient and is slightly sinuous in the narrow valley where it flows across a narrow 12-mile-long floodplain. The upper reaches flow from steeper terrain outside of the San Andreas Fault zone (Figures 5.6-3 and 5.6-5). Figures 5.6-4 and 5.6-6 show the relative landslide potential map for the Gualala Mainstem and South Fork Subbasin. The complete maps and explanations for both maps are on Plates 1 and 2.

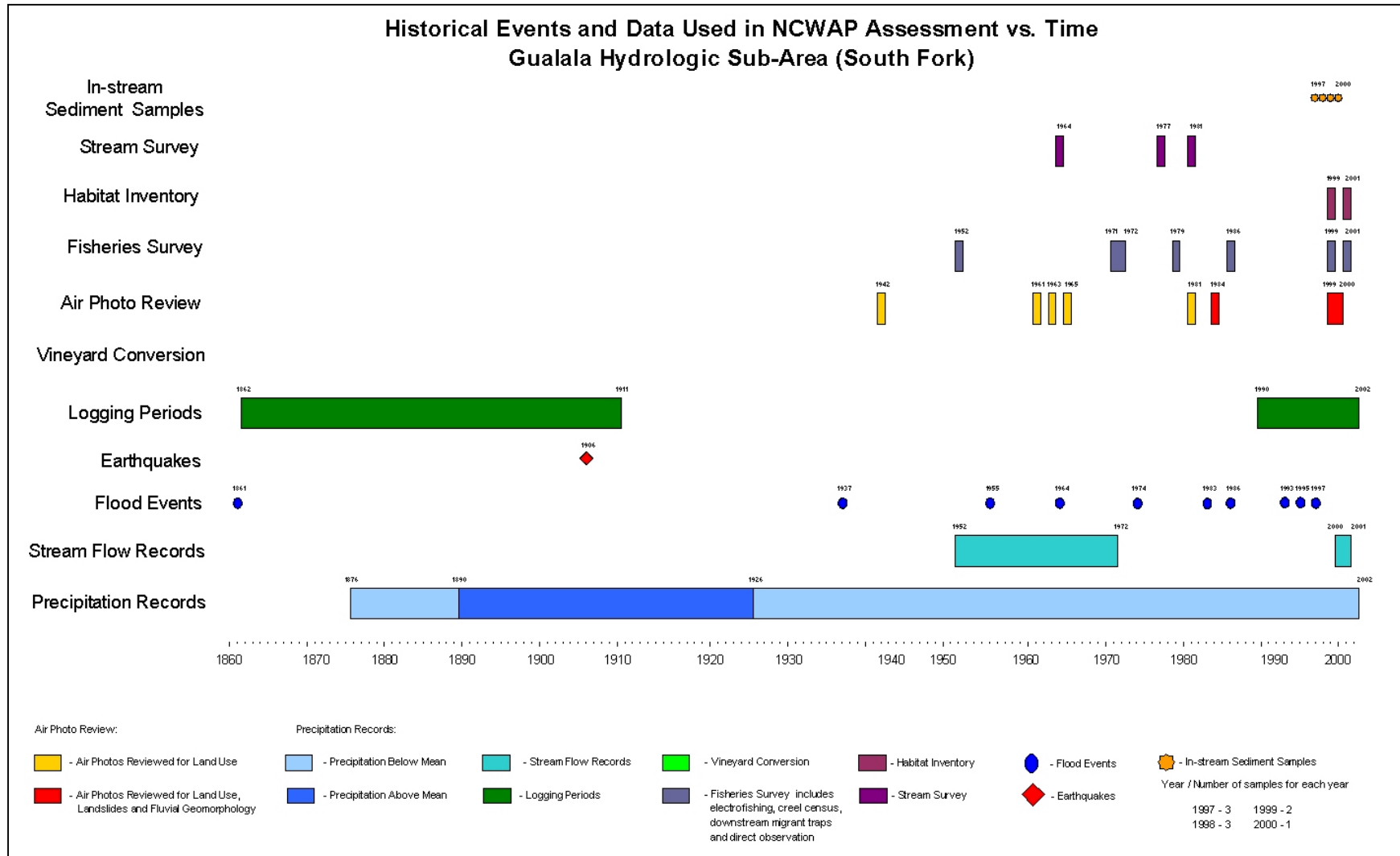
About 50 percent of the subbasin has a high to very high potential for landsliding and represents the major source area for stream sediment (Figures 5.6-4 and 5.6-6).

### 5.6.3 VEGETATION

The 1942 aerial photos show the South Fork upstream of the Wheatfield bordered by a variety of timber types as a result of an area-wide fire in the early 1900s. There was partial to entire canopy cover throughout most reaches along the mainstem Upper South Fork, Marshall Creek, and tributaries in 1942 (Figure 5.6-7). McKenzie Creek had dense mature redwood and Douglas fir cover. There was consistent oak woodland cover along upland riparian channels in the dense mélange soil type. This prairie grassland/oak woodland is the dominant vegetative cover in upslope areas. Dense old growth redwood forests lined the lower South Fork. This area today is occupied by advanced second growth redwood and Douglas fir timberlands. Appendix 3 provides a more detailed description.

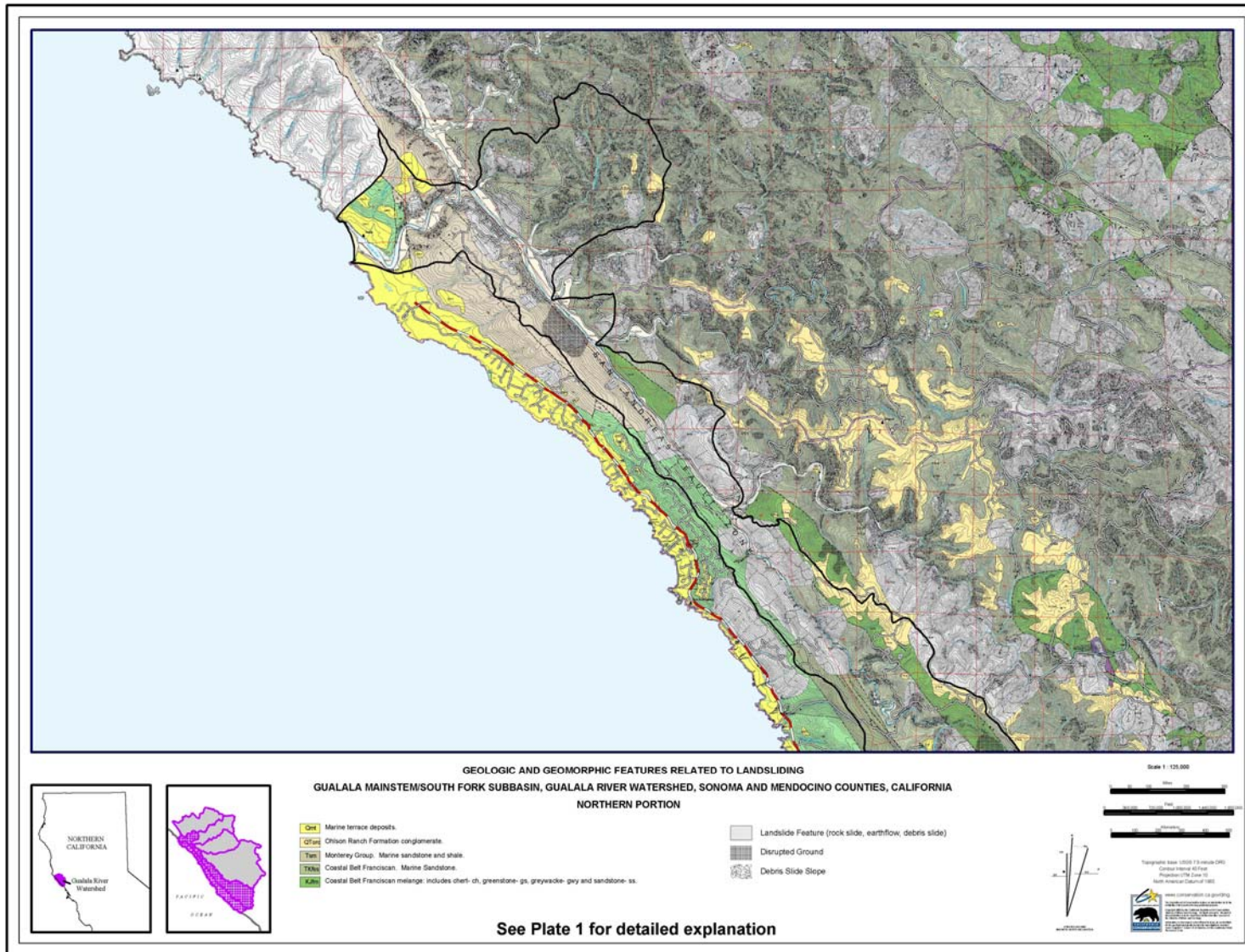


**Figure 5.6-1**  
Gualala Mainstem/South Fork Subbasin

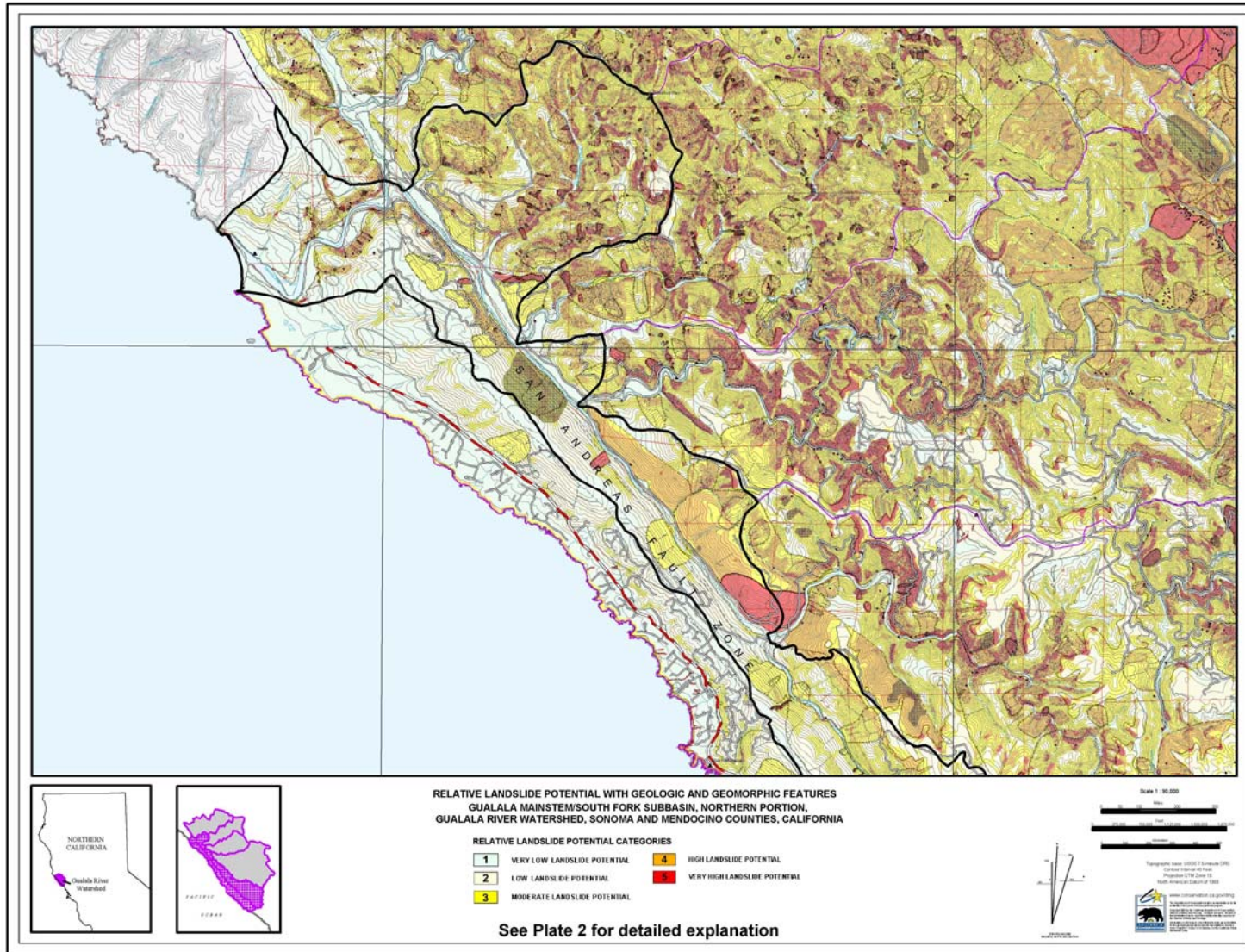


**Figure 5.6-2**  
 Historic Events and Data Used in the NCWAP Assessment for the Gualala Mainstem/South Fork Subbasin

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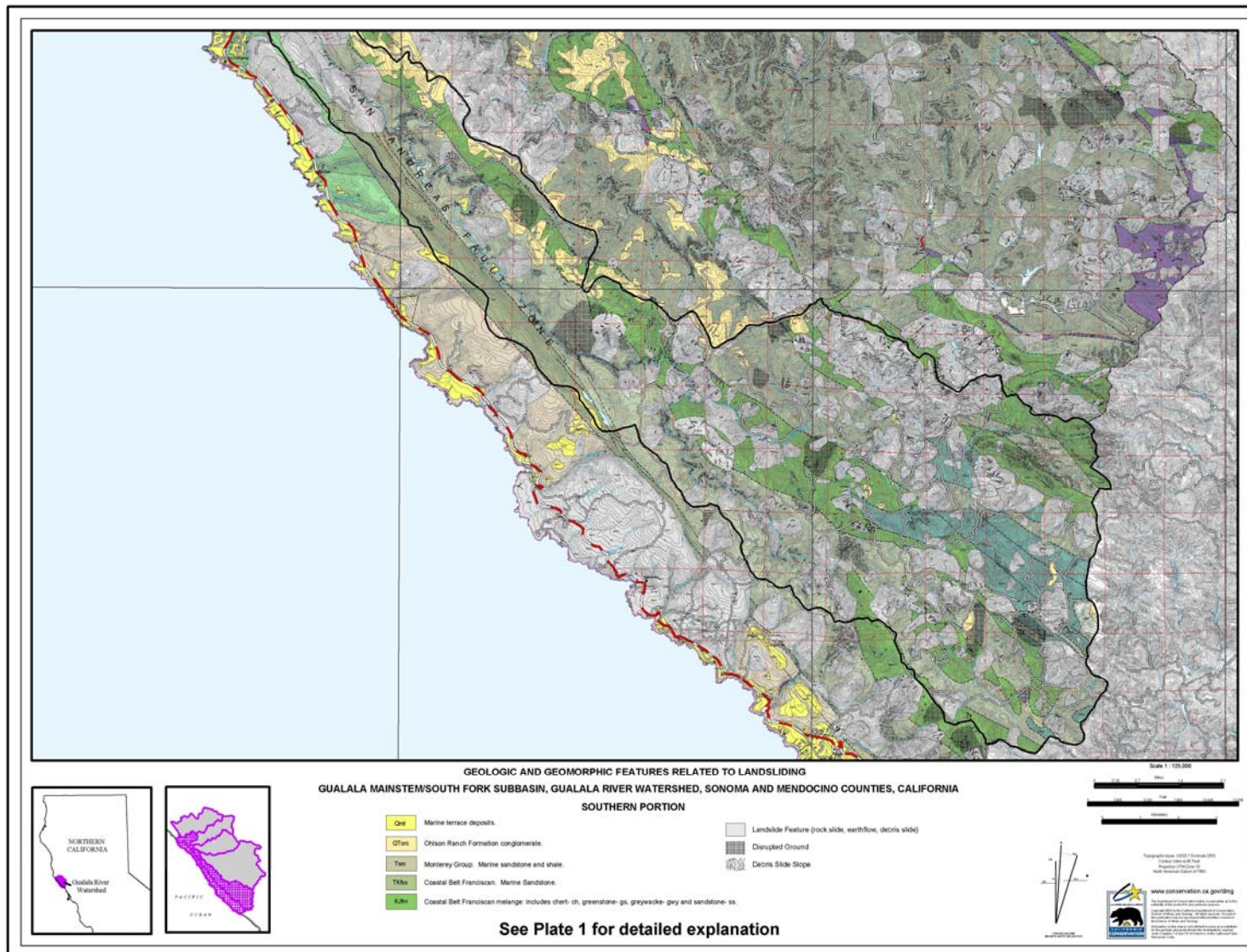


**Figure 5.6-3**  
 Geologic and Geomorphic Features Related to Landsliding - Gualala Mainstem/South Fork Subbasin, Northern Portion

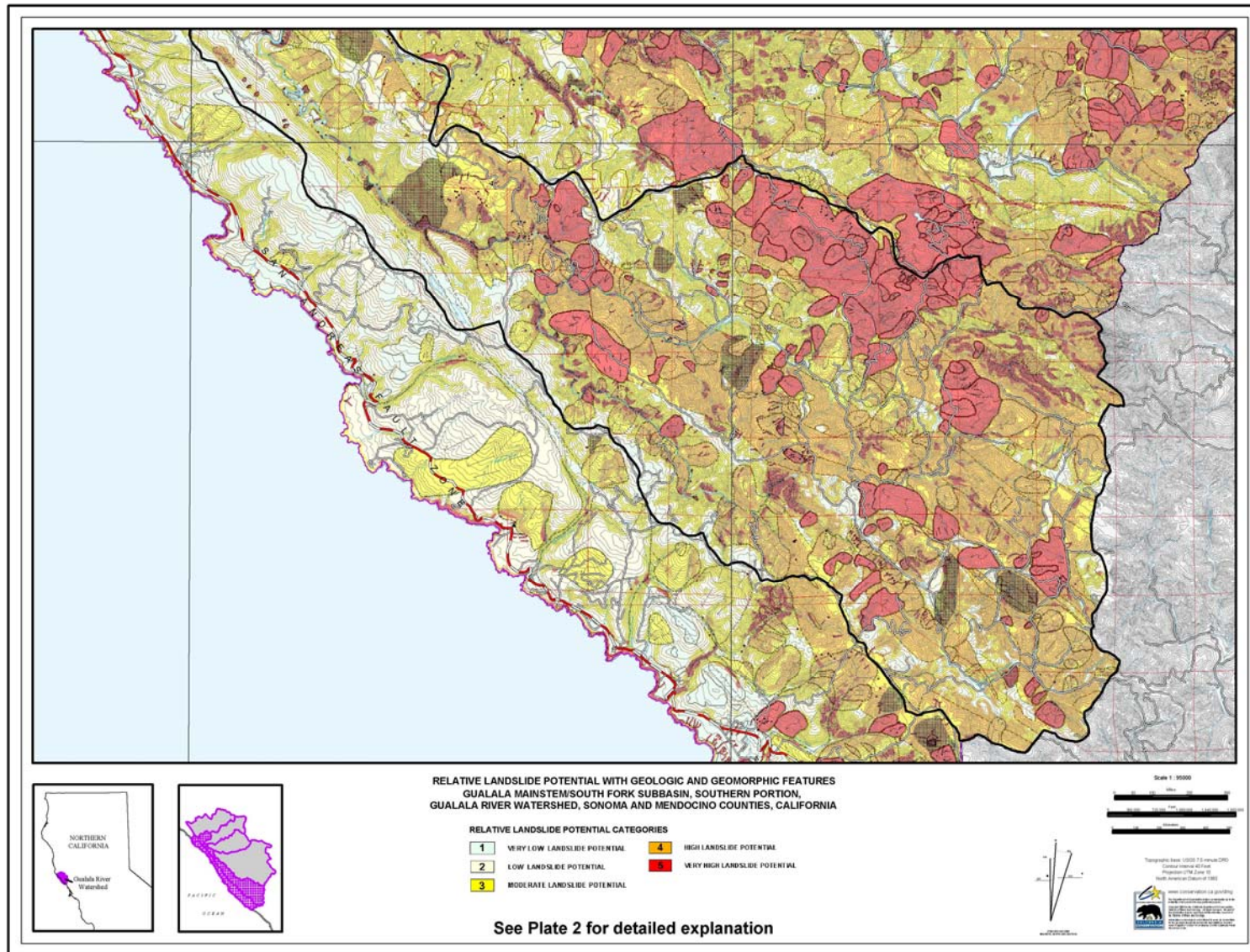


**Figure 5.6-4**  
 Relative Landslide Potential with Geologic and Geomorphic Features - Gualala Mainstem/South Fork Subbasin, Northern Portion

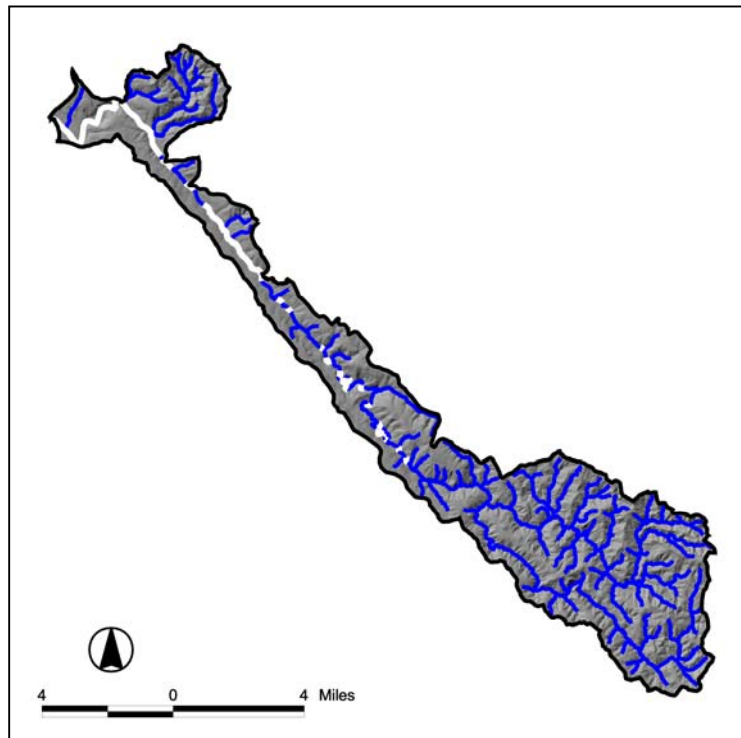
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**Figure 5.6-5**  
 Geologic and Geomorphic Features Related to Landsliding - Gualala Mainstem/South Fork Subbasin, Southern Portion



**Figure 5.6-6**  
 Relative Landslide Potential with Geologic and Geomorphic Features - Gualala Mainstem/South Fork Subbasin, Southern Portion



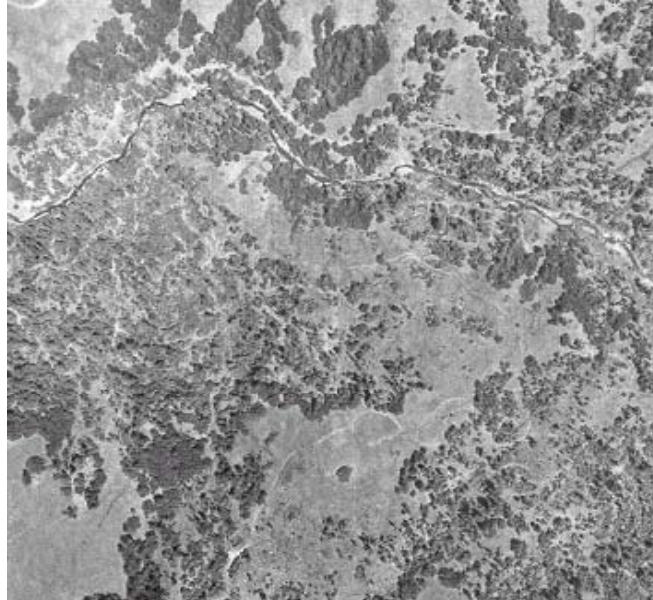
**Figure 5.6-7**  
1942 Bank-to-Bank Exposure (White) and Partial to Entire Cover Over Blue Line Streams (Dark Blue)

#### 5.6.4 LAND USE

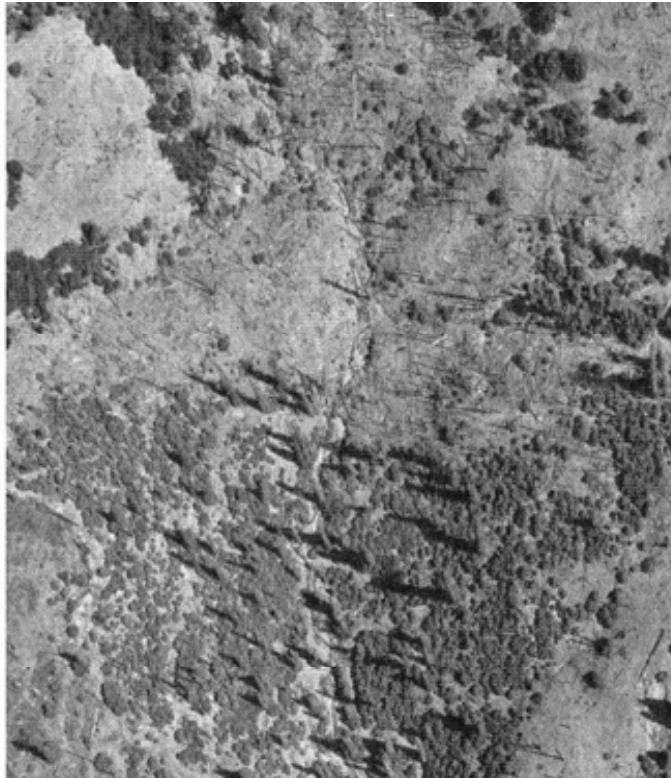
Timber use and ranching have been the dominant land use activities. At the turn of the century, the railroad was built along the South Fork Gualala to transport old growth logs to the Clipper Mill. The long narrow lower South Fork valley was initially harvested during the turn of the century. Remnants of these logging systems are still evident in portions of the watercourse channel. Old growth redwood cutover areas were then used as grazing land. The current second growth stand in the South Fork is the result of regeneration following a severe fire in the early 1900s. The area was reentered during the 1950s for removal of scattered larger sized timber.

Post World War II tractor logging operations began early in the middle to upper reaches of the subbasin due to the proximity of the coast and available road networks. Timbered areas along the lower to central reaches of the mainstem Marshall Creek were logged during the mid 1950s. This removed overstory shade canopy from north facing slopes where conifered areas were confined (Figure 5.6-8). During the mid to late 1950s, downslope conifered areas throughout Wild Cattle and Palmer canyons were removed during an area-wide conversion (Figure 5.6-9). Logging operations used stream channels for skid trails, truck roads, and landing sites (Figure 5.6-10). Harvest operations removed overstory canopy cover with intent to maintain permanent conversion for grazing use. Two large fires burned through the area: one in 1955, and the Creighton Ridge Fire in the early 1980s.





**Figure 5.6-8**  
Overstory Shade Canopy Elimination, Upper South Fork, June 1965



**Figure 5.6-9**  
Conversion Project Removing Conifers Over the Creek in an Upper McKenzie Creek Tributary,  
Leaving Hardwoods Upslope

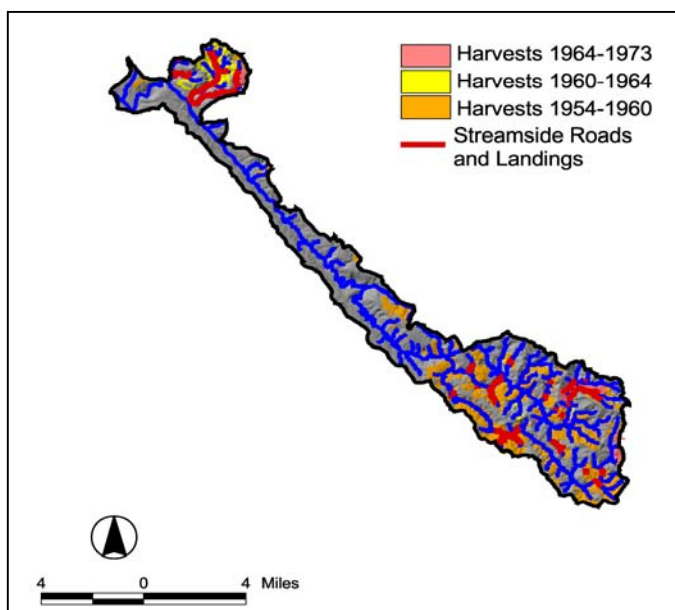
**Table 5.6-1**

Gualala Mainstem/South Fork Subbasin Stand Replacement Operations 1932 – 1973 - Total Area = 40, 756 acres

Time Period	Acres Under Operation	Type of Operation	Cumulative Percent of Subbasin Under Operation Since 1942	Mean Annual Increment (acres/percent by year)
1932– 1942	200	Stand Replacement	.05	20 (.05)
1942 – 1952	500	Stand Replacement	1.7	50 (.12)
1952 – 1960	9,800	Stand Replacement	25.7	1,187 (3.0)
1960 – 1964	600	Stand Replacement	27.0	150 (0.3)
1964 – 1973	950	Stand Replacement	29.7	95 (0.2)

Turn of the century old growth redwood logging extended along the lower South Fork, clearing the riparian zone along the river (Table 5.6-1). Stand type analysis of 1936 and 1942 photos showed mid-sized second growth redwood stands lining the lower South Fork. This even-aged stand structure indicates that the entire original old growth stand was removed bordering each side of the river, leaving bank-to-bank exposure along the Gualala River at the turn of the century.

The mid-20th-century tractor era largely avoided this area. Mapping of 1968 bank-to-bank exposure conditions showed some reaches with partial to entire canopy cover downstream of the confluence with Wheatfield Fork (Figure 5.6-11), reflecting in-growth of second growth conifer stands lining the aggraded substrate of the Lower South Fork by 1968. The 1964 fisheries surveys report coho salmon presence in conjunction with comparatively favorable habitat conditions along the lower South Fork including mid sized riparian structure lining the river. However, further inland, the 1965 aerial photos show the middle reaches of the North Fork, Rockpile, Buckeye, and Wheatfield subbasins largely removed of the old growth conifer stands by tractors, leaving bank-to-bank exposure over the major tributary streams. Only the Lower South Fork and Mainstem Gualala River maintained a larger sized stand component lining both sides of the streambank in 1965.

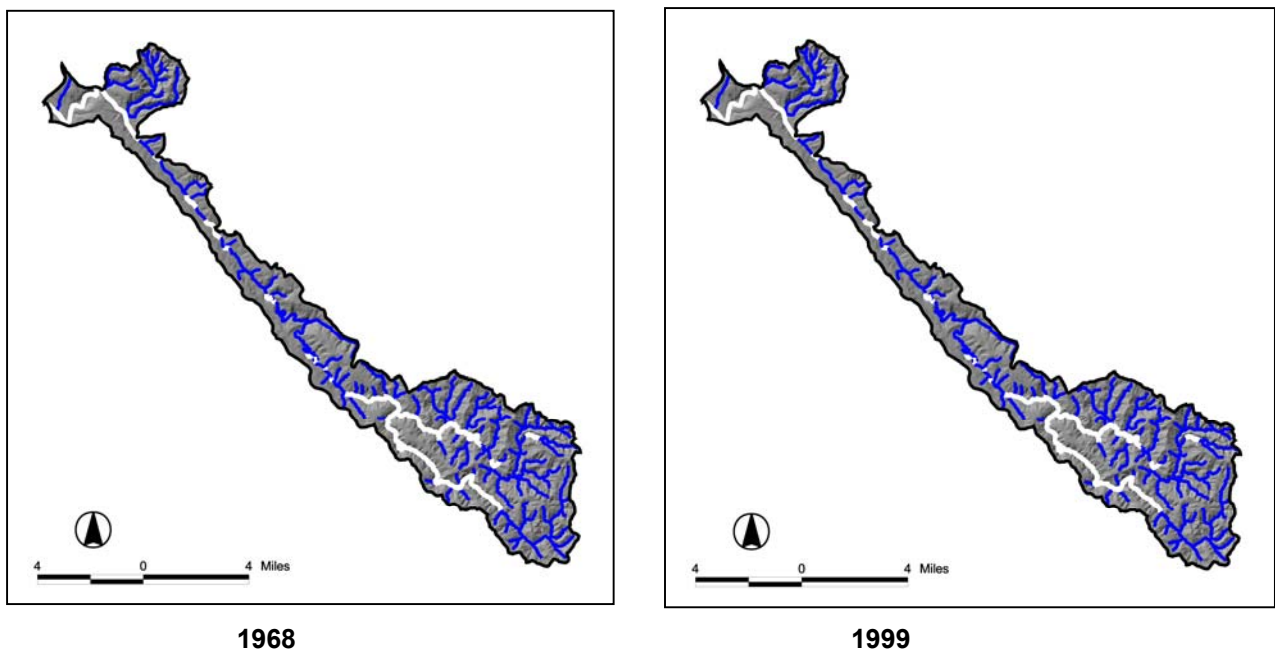


**Figure 5.6-10**

Mid-20th-Century Stand Replacement Operations, Streamside Roads and Landings (Red)

Mid-20th-century tractor operations were concentrated in the upper reaches of the South Fork Subbasin, eliminating riparian canopy cover along Marshall and McKenzie creeks, and the mainstem South Fork upstream from the confluence with Marshall Creek (Figure 5.6-11). In 1942, approximately 15 percent of the blue line streams were exposed bank-to-bank (Figure 5.6-7). The lower South Fork by 1942 was naturally aggraded and wide, creating bank-to-bank exposure throughout long sections of the river despite the mid-sized timber stand lining the streambank. In 1968, approximately 35 percent of the blue line streams were exposed bank-to-bank by the end of the tractor harvesting era. Bank-to-bank overstory shade canopy cover for 1999 shows improvement compared to 1968 in the upper subbasin reaches, reflecting riparian ingrowth since the late 1960s. By 1999, canopy cover improved to approximately 25 percent of blue line streams exposed bank-to-bank (Figure 5.6-11 above). Streamside canopy in the upper subbasin reaches now consists primarily of mid-sized mixed hardwood/conifer stands. Extended grazing use and conversions to rangeland have delayed vegetational ingrowth in many riparian areas of the upper subbasin.

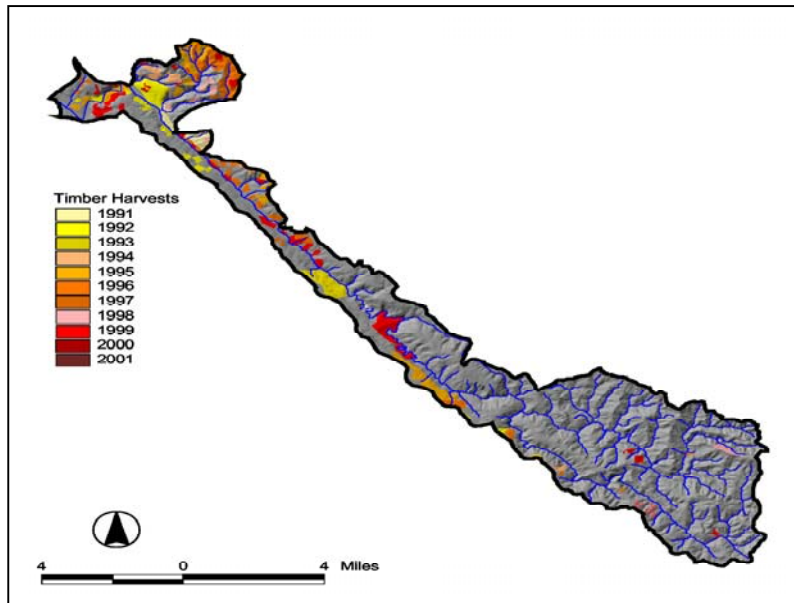
After the early 1960s, timber harvesting slowed. No more than approximately 1,500 acres was harvested by stand replacement between 1960 and 1973 (Table 5.6-2). Ranching became the more dominant land use activity.



**Figure 5.6-11**  
1968 Bank-to-Bank Stream Exposure and 1999 Bank-to-Bank Stream Exposure

After 1990, timber harvesting accelerated in the lowest reaches throughout now-mature second-growth redwood tracts (Figure 5.6-12). Rotating clear cut block units offset uncut areas of equal size by the three-year adjacency requirement. Recently, vineyard development has appeared along the uppermost ridgelines with a decline in rangeland uses. However, 1999 air photos show that vineyards consist of small patch clearances diffusely scattered throughout the east portions of the subbasin separated by wider areas of existing vegetation (Appendix 3). Grazing lands have been vegetationally typed at 2,450 acres (6.1 percent).

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**Figure 5.6-12**  
1991 to 2001 Timber Harvest Plans

**Table 5.6-2**

Gualala Mainstem/South Fork Subbasin Timber Harvest Operations – 1974 – 2001 - Total Area = 40, 756 acres

Time Period	Acres Under Operation	Type of Operation	Cumulative Percent of Subbasin Under Operation Since 1974	Mean Annual Increment (acres/percent by year)
1974 - 1990	2,400	Stand Replacement	5.8%	150 (0.4)
1991 - 2001	7,350	THPs	21.5 (tractor 58% cable 32%)	735 (1.6)

**5.6.5 ROADS**

Mid-20th-century streamside roads and landings lined McKenzie and Palmer Canyon creeks, and tributaries to Marshall Creek. Approximately 15 miles of streamside roads were bulldozed along watercourses in the subbasin. Most of these were in the upper subbasin reaches. Multiple debris slide failures have been documented with these roads with the 1965 photos. Instream/streamside roads and landings in 1984 showed a high correlation with stream braiding and aggradation in these areas.

There have been few areas in the upper subbasin that have been under THPs with which to upgrade existing roads and decommission abandoned roads. Mid-20th-century streamside roads in the upper subbasin reaches are recommended as the highest priority for proper abandonment or upgrade procedures.

The current road network in the subbasin consists of approximately 116 miles, at a density of 6.8 miles/square mile. There are approximately 1.5 miles of modern roads located within 50 feet of blue line streams. Of these, less than one-half mile are located in areas that may be affected by historically active landsliding and stream bank erosion.

## Documentation of Land Use Impacts

### *Marshall Creek*

- Conversions to rangeland have been the dominant form of historical use with major portions of riparian areas converted to rangeland. A loop conversion project removed all downslope conifered areas eliminating the riparian zone throughout Wild Cattle Canyon, extending east in an arc connecting Palmer Canyon, during the later 1950s. Sheep were noted grazing in the riparian zone in Palmer Canyon Creek during a 1981 survey.

### *McKenzie Creek*

- A continuous wide belt of mature Douglas-fir occupied the lower and central reaches of McKenzie Creek extending from the confluence with Marshall Creek to Devils Rib Ridge. The Upper McKenzie was then logged after the 1964 fisheries survey. The main haul road followed the stream channel. Numerous instream landings are located throughout the subbasin. The riparian zone was cleared of all overstory vegetation.
- Substantial historic logging damage noted. The McKenzie Creek Subbasin is a Gualala River Watershed Council high priority area, with numerous restoration projects already completed.

### *Wild Hog Canyon Creek and Carson Creek*

Both creeks were logged during the late 1950s. The haul road and landing sites lined the main channel. Overstory riparian canopy was largely removed.

## 5.6.6 FLUVIAL GEOMORPHOLOGY

About 50 percent of the subbasin has a high to very high potential for landsliding and represents the major source area for stream sediment (Figures 5.6-4 and 5.6-6). Instream sediment accumulations, indicative of disturbance, occur along 33 of 140 miles of the blue lines streams in the subbasin. This is a 42 percent reduction compared to levels in 1984, mostly in the tributaries. The lower South Fork in the vicinity of Valley Crossing showed channel lowering over the past several decades. Table 5.6-3 lists the lengths of sediment storage mapped and relative change between 1984 to 1999/2000 for the Gualala Mainstem/South Fork Subbasin.

**Table 5.6-3**  
 Gualala Mainstem/South Fork Subbasin Stream Characteristics Representing Sediment Sources or Storage

Planning Watershed	Year 2000		Year 1984		1984 to 2000	1:24K Streams
	Length Miles	Percent Total Stream for Subbasin	Length Miles	Percent Total Stream for Subbasin	Length Miles	Total Length Miles
<b><i>Marshall Creek</i></b>						
Upper Marshall Creek	3.6	13.6	6.9	26.1	-47.8	26.3
Lower Marshall Creek	4.1	18.5	9.9	44.0	-58.1	22.4
Upper South Fork Gualala River	6.3	23.9	10.4	39.2	-39.0	26.5
Middle South Fork Gualala River	6.6	27.2	7.6	31.5	-13.6	24.2
<b>Total</b>	<b>20.6</b>	<b>20.8</b>	<b>34.7</b>	<b>34.9</b>	<b>-40.6</b>	<b>99.5</b>
<b><i>Lower South Fork Gualala River</i></b>						
Mouth of Gualala River	4.6	34.5	8.2	61.9	-44.2	13.2
Big Pepperwood Creek	5.4	25.0	10.0	46.1	-45.8	21.6
<b>Total</b>	<b>12.6</b>	<b>31.0</b>	<b>22.3</b>	<b>55.0</b>	<b>-43.6</b>	<b>40.5</b>
<b>Total Watershed</b>	<b>33.2</b>	<b>23.7</b>	<b>57.0</b>	<b>40.8</b>	<b>-41.8</b>	<b>140.0</b>

## 5.6.7 WATER QUALITY

### Water Chemistry

Basic water chemistry data were available from USEPA's StoRet system and NCRWQCB sampling for three sites in the Gualala Mainstem/South Fork Subbasin:

- the mainstem near Gualala (15 times between September 14, 1975 and October 14, 1977, February 13, 1975, April 4, 1985 and February, May, and June, 2001),
- the South Fork near Valley Crossing (April and September from 1974 to 1988 and February, May, and June, 2001), and
- the South Fork at Hauser Bridge (February, May, and June, 2001).

All parameters met water quality objectives in the NCWQCB's *Basin Plan*. The data indicated a moderately hard water oligotrophic stream with pH slightly above neutral, high dissolved oxygen, low dissolved solids, and low nutrients (nitrogen and phosphorus), consistent with measurements in other north coastal streams. Appendix 4 contains the raw data and graphs for these stations.

### Water Temperature

Water temperature data from continuous recorders were available for 17 sites in the Gualala Main/South Fork Subbasin (Figure 5.6-13). The period of record from 1994 to 2001 yielded 46 observations for maximum weekly average temperature (MWAT) and seasonal maximum temperature.

MWATs in the upper tributary sites (McKenzie and Palmer Canyon creeks) ranged from moderately unsuitable to fully suitable. MWATs in the lower tributaries (Pepperwood creeks, Groshong Gulch) ranged from moderately to fully suitable. (Table 5.6-4, Figures 5.6-14 and 5.6-15)

The mainstem sites varied from somewhat to fully unsuitable (Table 5.6-4, Figures 5.6-14 and 5.6-15).

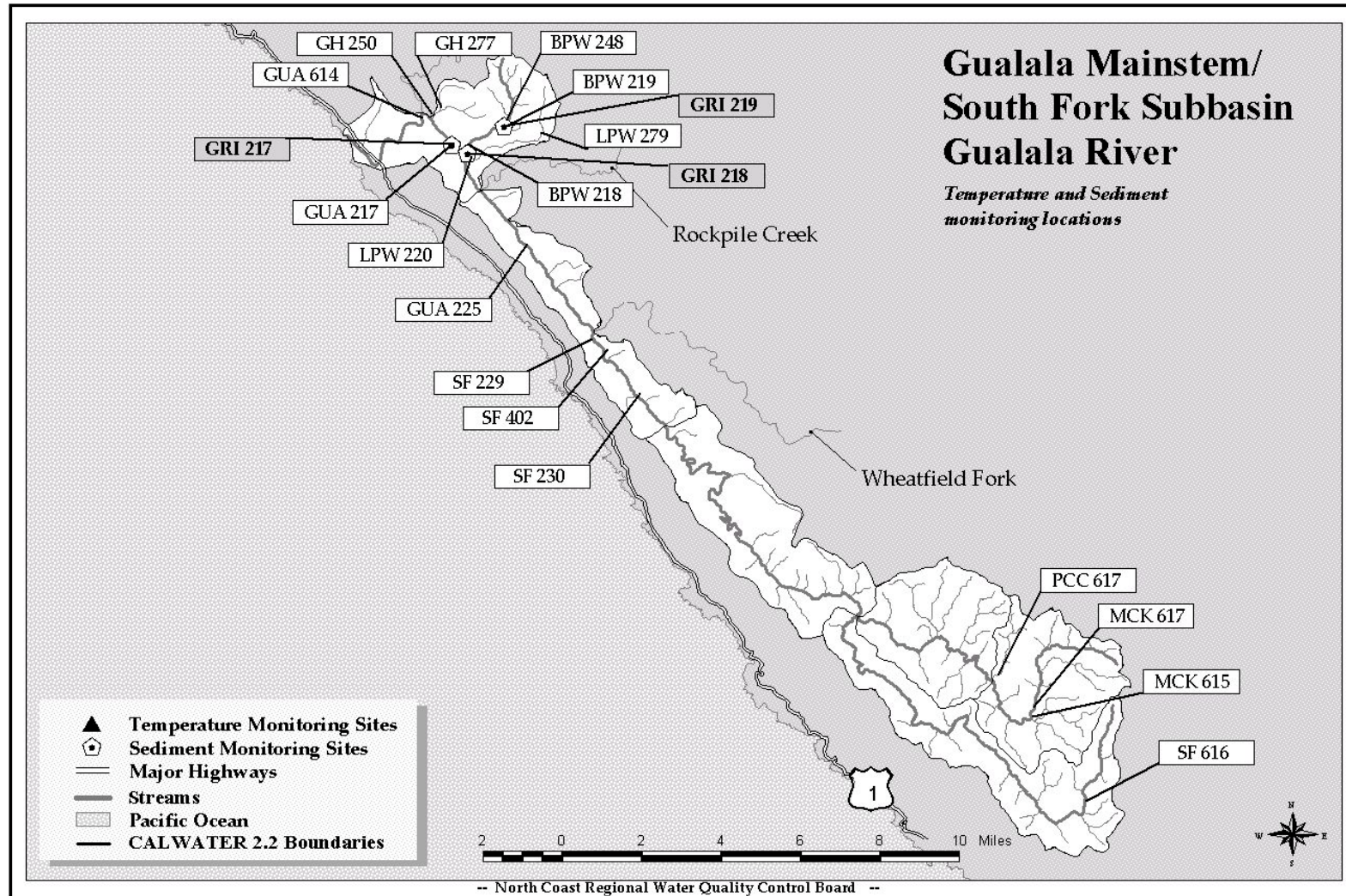
**Table 5.6-4**

Ecological Management Decision Support (EMDS) Ratings for Maximum Weekly Average Temperatures (MWATS) in the Gualala Mainstem/South Fork Subbasin

Stream	No. of Sites	No. of Observations	Period of Record	EMDS Suitability Ratings						
				+++	++	+	0	-	--	---
South Fork Mainstem	7	20	1994-2001							
Palmer Canyon Creek	1	1	2000							
McKenzie Creek	2	4	2000, 2001							
Little Pepperwood Creek	2	6	1994-1998							
Big Pepperwood Creek	3	12	1994-2000							
Groshong Gulch	2	3	1996-2000							

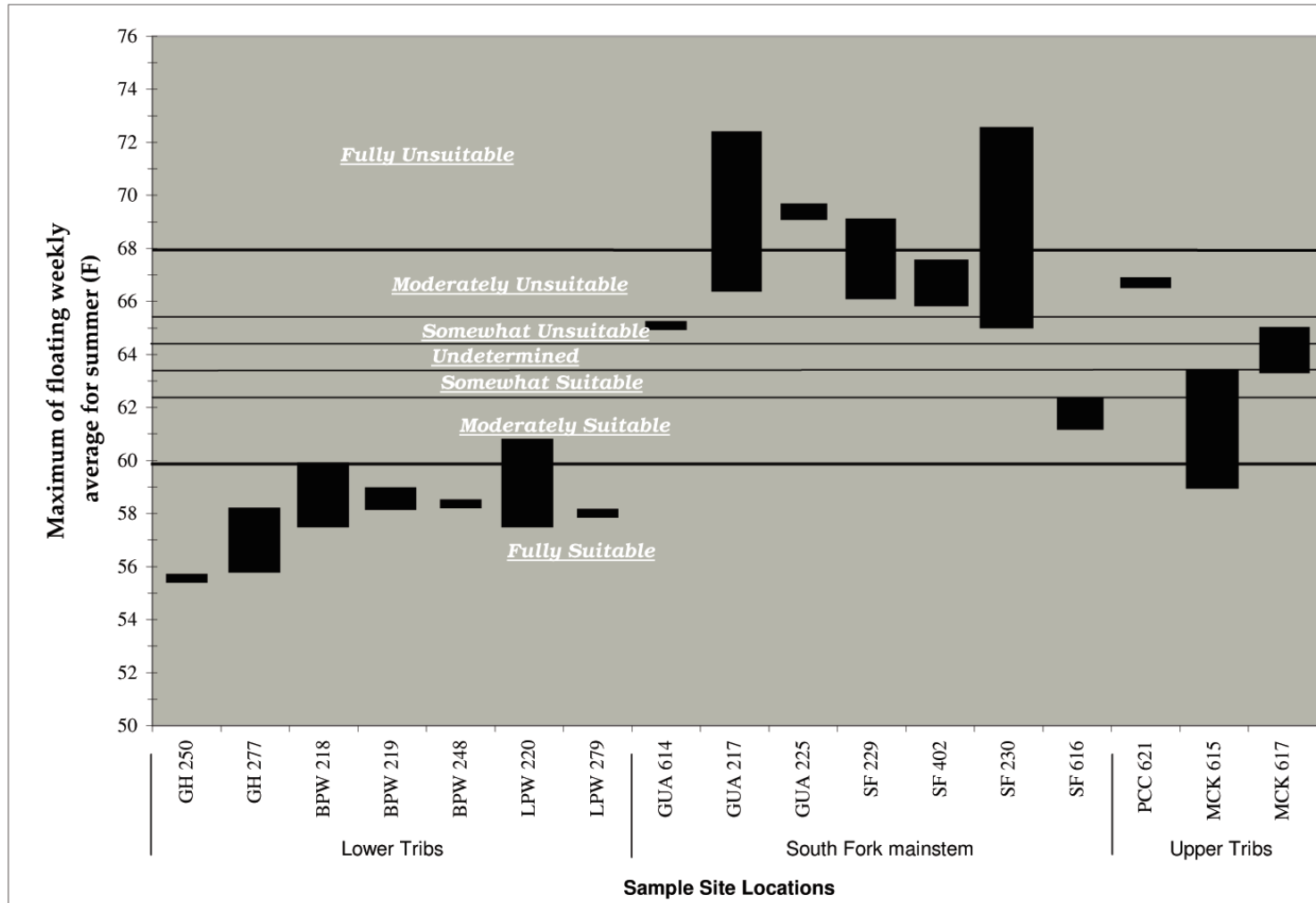
EMDS ratings:

- +++ = fully suitable (50-60 F)
- ++ = moderately suitable (61-62 F)
- + = somewhat suitable (63 F)
- 0 = undetermined (between somewhat suitable and somewhat unsuitable) (64 F)
- = somewhat unsuitable (65-66 F)
- = moderately unsuitable (67 F)
- = unsuitable (> 68 F)



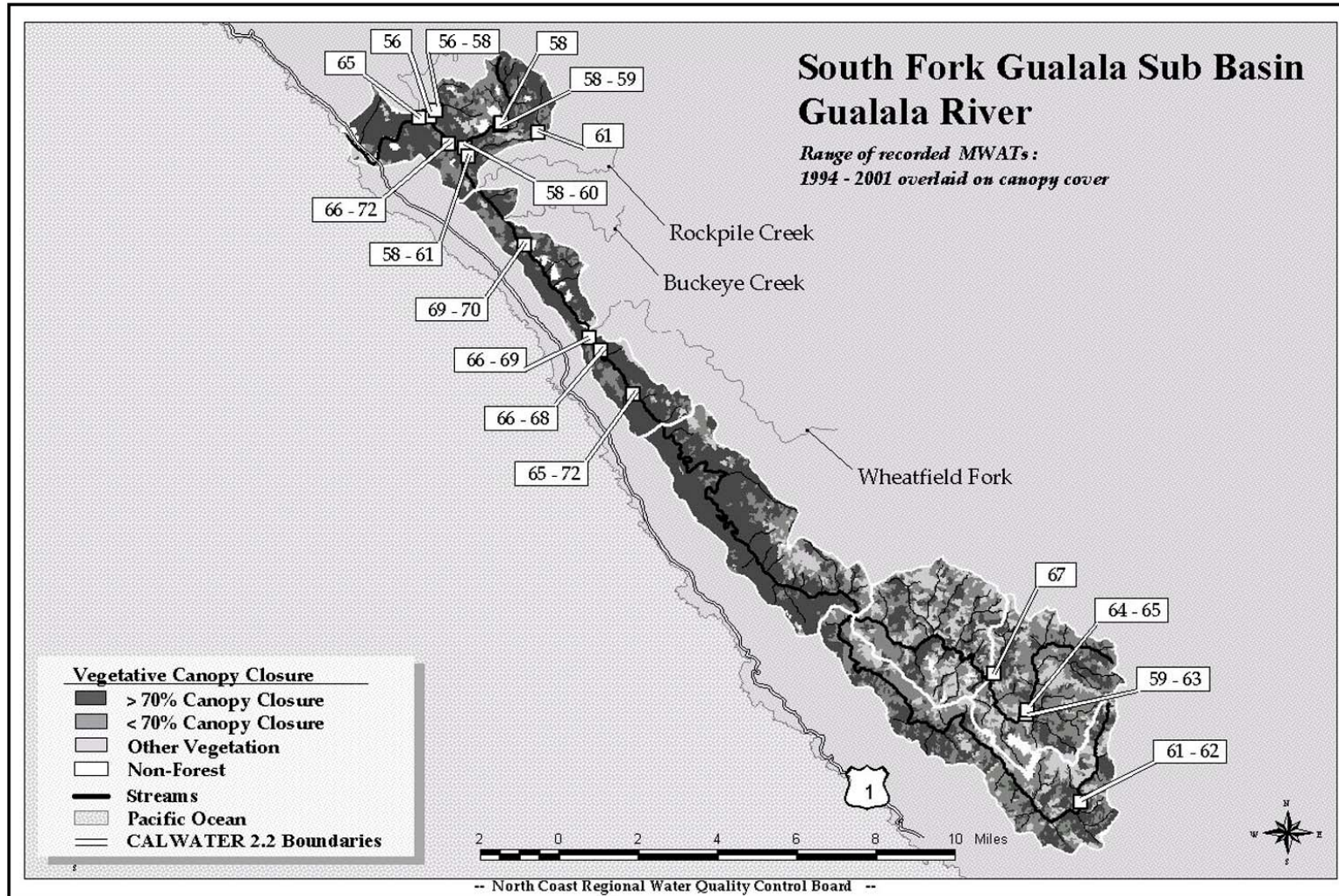
**Figure 5.6-13**  
In-Stream Sediment and Temperature Sampling Sites, Gualala Mainstem/South Fork Subbasin

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**Figure 5.6-14**  
 Maximum Weekly Average Temperatures for the Gualala Mainstem/South Fork Subbasin, 1994-2001,  
 From Continuous Temperature Monitors Maintained by GRI and GRWC





**Figure 5.6-15**  
 MWAT Temperature Ranges in the Gualala Mainstem/South Fork Subbasin for the Period of Record, 1994-2001 Overlaid on the LanSat Vegetation Layer for 2000

Seasonal maximum temperatures were above the lethal limit of 75 F at three of the seven mainstem sites (six of 20 observations). Tributary sites were below the limit, with the single observation in Palmer Canyon Creek at 74 F.

### 5.6.8 FISH HABITAT RELATIONSHIP

#### Historic Habitat Conditions

CDFG stream surveys were conducted in 1964, 1977, and 1981 on seven tributaries in the South Fork Subbasin, South Fork, Marshall Creek, Marshall Creek Tributary #3, Marshall Creek Tributary #5, McKenzie Creek, McKenzie Creek Tributary #6, and Palmer Canyon Creek. These surveys were made by direct observation and were not backed by quantitative data (Table 5.6-5).

**Table 5.6-5**

Summary of Historic (1964-1981) Stream Surveys Conducted in the Gualala Mainstem/South Fork Subbasin

South Fork Mainstem Subbasin	Date Surveyed	Habitat Comments	Barrier Comments	Management Recommendations
South Fork	9/23 and 9/24 1964  5/17 and 18/1977	Plentiful spawning areas throughout the stream. Pool: Riffle 95:5. Generally poor shelter consisting of overhanging banks, boulders, logs, aquatic plants and overhanging aquatic plants.  Summer flows are limited. Pool: Riffle ratio 7:3. The majority of pools had little to no shelter. Shelter consisted of boulders, aquatic plants, logs, undercut banks, and overhead canopy	Old Log Jams. None Complete. No barriers observed. Each summer a dam is constructed approximately ½ mile below the Wheatfield Fork.	Continue to manage for production of juvenile steelhead trout and coho salmon.
Marshall Creek	9/28/1964	Deposits of good spawning gravel exist throughout the stream from the mouth to the upper fisheries value. Pool: Riffle ratio 50:50. Good shelter provided by logs, boulders, undercut banks, roots, and trees.	No complete barriers.	Should be managed as a steelhead trout and coho salmon spawning and nursery stream.
Marshall Creek Tributary #3	9/28/1964	Very limited fisheries value. Watershed severely burned 10 years ago. Lower half mile has spawning gravel available, but summer flow is very low.	Total barrier to fish a half mile above the mouth.	None
Marshall Creek Tributary #5	9/29/1964	Summer flows are limited. Some suitable spawning gravel directly above large log jams.	Over 40 log jams in a 1 mile stretch of stream. A number form complete fish passage barriers.	Remove log jams.
McKenzie Creek	9/23 and 24/1964	Spawning areas fair to good in the lower 1/3 of stream, excellent in the middle section of stream, and fair in the upper 1/3 of stream; Pool: Riffle ratio 60:40; Good shelter provided by rocks and undercut banks.	7 partial barriers; Large 7 feet high 40 feet dam present 1/6 mile upstream from mouth; Large bedrock falls 1-1/4 miles upstream	Continue to manage as a coho salmon, steelhead trout spawning and nursery area. After removal of falls, possible planting of coho salmon to re-establish a self-

**Table 5.6-5**  
Summary of Historic (1964-1981) Stream Surveys Conducted in the Gualala Mainstem/South Fork Subbasin

South Fork Mainstem Subbasin	Date Surveyed	Habitat Comments	Barrier Comments	Management Recommendations
				supporting run.
McKenzie Creek Tributary #6	10/1/1964	Streambed unsuitable for spawning except for the lower ½ mile of stream which is dry in the summer.	Impassable 10 ft falls ½ mile upstream from the mouth.	None
Palmer Canyon Creek	7/31/1981	Could become a good spawning area and nursery habitat for rainbow trout/steelhead trout if improved. Occasional small isolated spawning areas separated by areas of boulders or heavily silted areas. Adequate vegetative cover, undercut banks and logs are present in the lower and mid sections of stream.	9 partial fish passage barriers; 2 complete fish passage barriers.	Needs removal of log jams, healing of eroded areas and stream bank cover in upper sections.

### Current 1999 and 2001 Conditions

#### Target Values from the Habitat Inventory Surveys (Flosi et al 1998)

Beginning in 1991, habitat inventory surveys were used as a standard method to determine the quality of the stream environment in relation to conditions necessary for salmonid health and production. Target values for each of the individual habitat elements measured are provided in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998) (Table 5.6-6). When habitat conditions fall below the target values, restoration projects may be recommended to meet critical habitat needs for salmonids.

**Table 5.6-6**  
Habitat Inventory Target Values from the  
*California Salmonid Stream Habitat Restoration Manual* (Flosi et al 1998).

Habitat Element	Canopy Cover	Embeddedness	Primary Pool Depth/Frequency	Shelter/Cover
Range of Values	0-100%	0-100%	0-40%	Ratings range from 0-300
Target Values	>80%	>50% or greater of the stream length is <50% embedded	Depth-1st and 2nd order streams >2 feet 3rd and 4th order streams >3 feet. Frequency->40% of stream	>80

Habitat inventory surveys were conducted in 1999 and 2001 on seven streams in the Gualala Mainstem/South Fork Subbasin. The target values for canopy cover were met on Camper Creek, Carson Creek, Palmer Canyon Creek, and upper South Fork. Cobble embeddedness target values were met on Camper Creek, Marshall Creek, McKenzie Creek, Palmer Canyon Creek, upper South Fork, and

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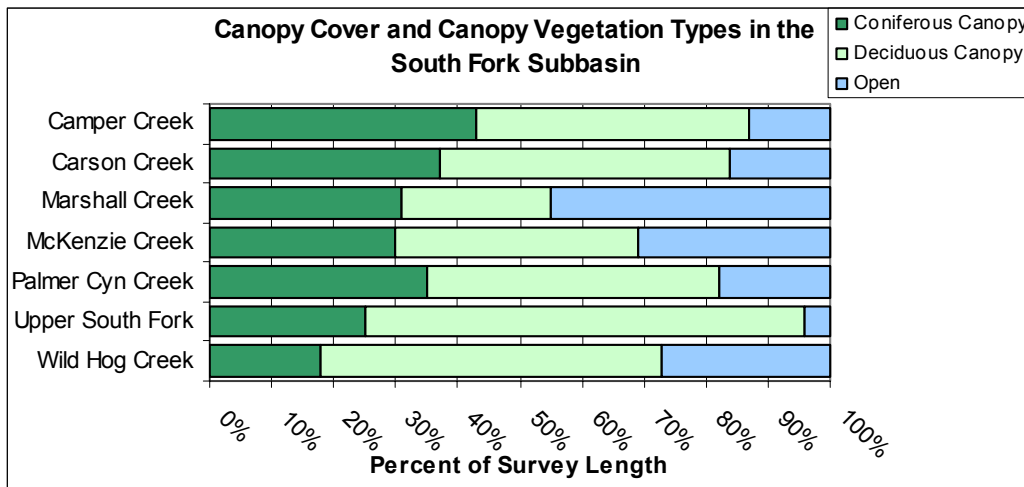
Wild Hog Creek. None of the streams in the subbasin met the target values for primary pool depth/frequency or shelter/cover (Table 5.6-7).

**Table 5.6-7**

Summary of Current (1999 and 2001) Conditions Based Upon Habitat Inventory Surveys From the Gualala Mainstem/South Fork Subbasin, Gualala River Watershed, California  
Condensed Tributary Reports are located in Appendix 5

Habitat Element Stream Name	Surveyed Length (feet)	Canopy Density	Embeddedness	Primary Pool Depth/Frequency	Shelter Cover Ratings
Main stem /South Fork Subbasin	57,218				
Camper Creek (1999)	3,546	86%	70%	3%	25
Carson Creek (1999)	6,834	83%	50%	14%	19
Marshall Creek ( <i>partial survey</i> )	21,698	55%	90%	13%	13
McKenzie Creek (1999)	3,801	69%	60%	18%	23
Palmer Canyon Creek	95	82%	65%	3%	12
Upper South Fork ( <i>partial survey</i> )	8,451	96%	73%	5%	22

Canopy coverage was a habitat deficiency on Marshall, McKenzie, and Wild Hog Creeks. The canopy was dominated by deciduous tree species (Figure 5.6-16).



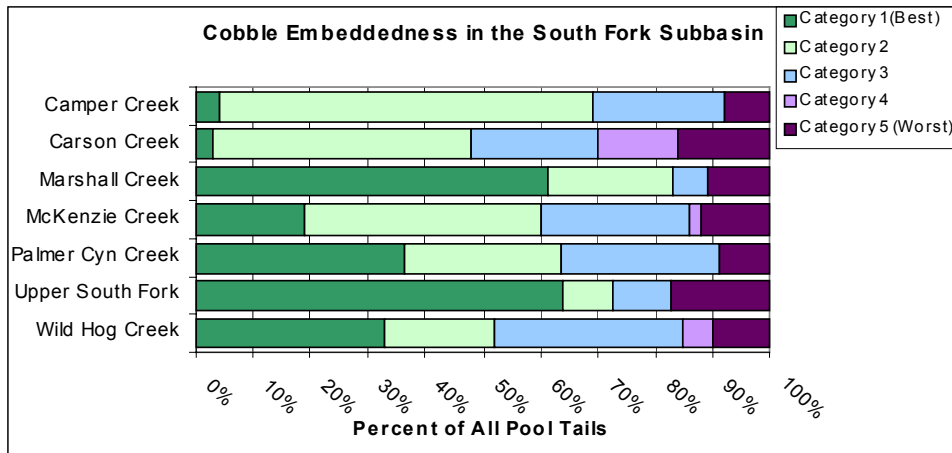
**Figure 5.6-16**

Canopy Cover and Canopy Vegetation Types in the Seven Tributaries Surveyed, Gualala Mainstem/South Fork Subbasin 1999 and 2001, Gualala River Watershed, California

Categories 1 and 2 embeddedness (<50 percent embedded) are considered the most productive for spawning. Category 5 is unsuitable substrate, which includes clay, bedrock, and logs. Data collected during 1999 and 2001 habitat inventory surveys showed that all streams, except Carson Creek, had greater than 50 percent of the pool tails surveyed were categories 1 and 2. Slightly less than 50 percent of the pool tails surveyed on Carson Creek were categories 1 and 2 (Figure 5.6-17).

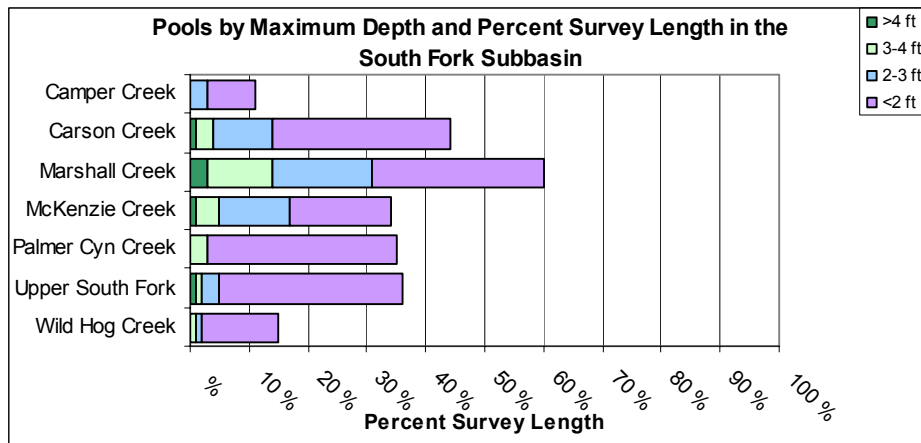
All streams surveyed in the South Fork Subbasin had habitat deficiencies in pool depth. Camper, McKenzie, Palmer Canyon, Wild Hog creeks and the Upper South Fork did not meet pool frequency

target values (Figure 5.6-18). Carson and Marshall creeks met the pool frequency target values, however, neither met the depth target value.



**Figure 5.6-17**

Cobble Embeddedness in the Gualala Mainstem/South Fork Subbasin 1999-2001, Gualala River Watershed, California



**Figure 5.6-18**

Pools by Maximum Depth and Percent Survey Length in the Gualala Mainstem/South Fork Subbasin 1999 and 2001, Gualala River Watershed, California

Shelter/cover ratings were below target values for all of the streams surveyed in the South Fork Subbasin (Figure 5.6-19). The top three types of shelter/cover were mostly bedrock ledges, small woody debris, and large woody debris. Small woody debris, boulders, and bedrock ledges provided the most shelter on Camper Creek. The primary cover types were undercut banks, root masses, and white water on Carson Creek. The primary cover types were small woody debris, root masses, and bedrock ledges on Marshall Creek. The primary cover types were boulders, large woody debris, and root masses on McKenzie Creek. On Palmer Canyon Creek, boulders, small woody debris, and aquatic vegetation provided the most shelter. The primary cover types were small woody debris, boulders, and bedrock

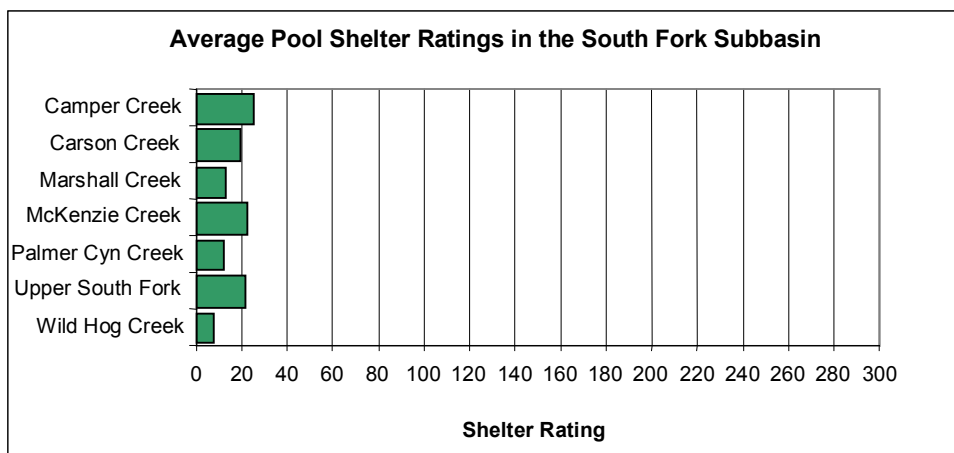
5.6 Gualala Mainstem/South Fork Subbasin

ledges on Upper South Fork. Large woody debris and bedrock ledges provided the most shelter on Wild Hog Creek (Figure 5.6-20).

**Large Woody Debris Data**

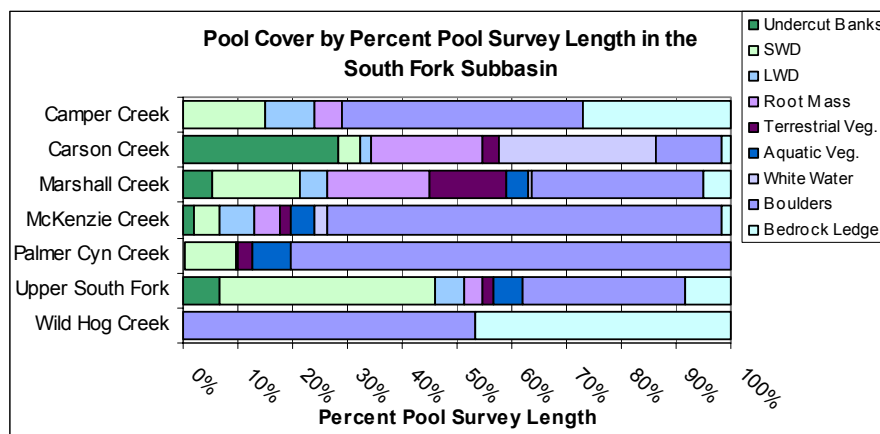
Most large wood was cleared from the streams during the 1950s, 1960s and 1970s. A target value of 130 pieces of large wood >8 inches per 1,000 feet of stream is recommended in the literature (Beechie and Sibley 1997, Martin 1999).

Large wood surveys were conducted in 1998-2001 at one site on Pepperwood Creek (a tributary to the lower South Fork) and two sites in the lower South Fork as part of the Watershed Cooperative Monitoring Program. The surveys showed the lower South Fork and Pepperwood Creek lack volume and pieces of large woody debris (Table 5.6-8).



**Figure 5.6-19**

Average Pool Shelter Ratings in the Gualala Mainstem/South Fork Subbasin 1999 and 2001



**Figure 5.6-20**

Types of Pool Cover by Percent of Pool Survey Length in the Gualala Mainstem/South Fork Subbasin, 1999 and 2001

**Table 5.6-8**

Summary of Watershed Cooperative Monitoring Program Large Woody Debris Surveys,  
Gualala Mainstem and Lower South Fork Subbasin (1998 - 2001)

Tributary	Site Number	Watershed* Size (acres)	Volume Cubic Feet/1,000'	Quantity Pieces/1,000'
Pepperwood Creek	218	1,825	2,275	61
Gualala South Fork	217	157,415	1,207	23
Gualala South Fork	402	31,081	1,390	23

\*Watershed size is calculated as the area above the monitoring site.

### Changes in Habitat Conditions From 1964 to 2001

Changes between historic and current instream conditions were compared between the streams surveyed in 1964, 1977, and 1981 and subsequently habitat inventoried in 1999 or 2001. Data from the earlier stream surveys only provide a qualitative snapshot of the conditions at the time of the survey and the terms such as excellent, good, fair and poor were based on the judgment of the biologist or scientific aid conducting the survey. The results of the historic stream surveys cannot be used in comparative analyses with the quantitative data provided by the habitat inventory surveys with any degree of accuracy. However, the two data sets may be used to show general trends (Table 5.6-9).

**Table 5.6-9**

Comparison Between Historic Habitat Conditions Observed in 1964 with Current Habitat Inventory Surveys Based Upon Quantitative Measurements in 2001 from the Gualala Mainstem/South Fork Subbasin, Gualala River Watershed, California

Habitat Element Stream Name	1960s Canopy Cover Photos	2001 Canopy Cover	1964 Spawning Conditions	2001 Spawning Conditions	1964 Pool Depth/Frequency	2001 Pool Depth/Frequency	1964 Shelter Cover	2001 Shelter Cover Values	Change in conditions from 1964 to 2001
<b>Mainstem/South Fork Subbasin</b>									
Marshall Creek (partial survey)	Low or Absent	55%	Good	90%	50%	13%	Good	13	Some canopy recovery: Improved spawning conditions. Decreased pool habitat and shelter/cover.
McKenzie Creek (1999)	Low or Absent	69%	Good	60%	60%	18%	Good	23	Some canopy recovery: Improved spawning conditions: Decreased pool habitat and shelter/cover.
Upper South Fork	Low or Absent	96%	Good	73%	95%	5%	Poor	22	Recovered canopy: Improved spawning conditions. Decreased pool habitat and shelter/cover.

## 5.6 Gualala Mainstem/South Fork Subbasin

According to aerial photographs, the canopy density of the 1960s was reduced substantially from the conditions observed in the 1940s, when canopy appeared to be low or absent throughout the subbasin.

In the South Fork/Mainstem Subbasin, South Fork, Marshall Creek, McKenzie Creek and Palmer Canyon Creek were surveyed in 1964, 1977, and 1981 and partial surveys were conducted in 1999 and 2001. The canopy cover increased in the headwaters area of the South Fork, indicating improved conditions over those observed in the 1960s aerial photographs. On Marshall and McKenzie Creeks, the canopy cover appears to have increased somewhat, indicating some improvement, but still does not meet target values. The 2001 pool frequency/depth and shelter cover appear to have decreased since 1964 on Marshall and McKenzie Creeks. The headwaters area of the South Fork appears to have had a decrease in pool frequency/depth since 1964, while the pool shelter/cover conditions have remained the same.

### Ecological Management Decision Support

Although the EMDS Reach Model scores are based upon the habitat inventory survey data, the analysis differed. The habitat inventory data were divided into reaches based upon Rosgen Channel type and then converted to a weighted average. Each weighted average reach was compared to a set of habitat reference conditions which were determined from empirical studies of naturally functioning channels, expert opinion, and peer reviewed literature. EMDS rated each habitat component with a suitability score between -1 and +1, where suitability is a function of salmonid health and productivity. EMDS scores were not calculated for the South Fork Subbasin because only 31 percent of the streams were habitat inventoried (Table 5.6-10).

**Table 5.6-10**

Ecological Management Decision Support (EMDS) Reach Model Scores on Salmonid Health and Productivity Suitability for the Gualala Mainstem/South Fork Subbasin, California, Based Upon Habitat Inventory Surveys Conducted in 1999 and 2001

Subbasin Stream Name	Canopy Cover Score	Embeddedness Score	Pool Depth Score	Pool Shelter Score	Pool Quality Score	2001 MWAT Water Temperature Score
South Fork Subbasin Score	+	+	-	---	--	
Camper Creek (1999)	++	--	---	--	-	
Carson Creek (1999)	+++	--	-	---	--	
Marshall Creek ( <i>partial survey</i> )	--	+	-	---	--	
McKenzie Creek (1999)	+	-	-	--	-	+
Palmer Canyon Creek	++	+	---	---	---	
Upper South Fork Headwaters	+++	++	---	---	---	+++
Wild Hog Creek (1999)	+	-	---	---	---	

The 2001 water temperature data was provided by GRI and the GRWC.

- +++ = Fully Suitable
- ++ = Moderately Suitable
- + = Somewhat Suitable
- U = Undetermined
- = Somewhat Unsuitable
- = Moderately Unsuitable
- = Fully Unsuitable



### Limiting Factors Analysis

The Gualala River Watershed LFA was developed for assessing coarse scale stream habitat components. Habitat inventory data, EMDS reach model scores, and the biologist's professional judgment was incorporated into both the identification of LFAs and their ranking. Pool depth was the predominant limiting factor on Camper Creek. Pool shelter/cover was the most limiting factor on Carson, Marshall, McKenzie, Palmer Canyon Creeks and the Upper South Fork (Table 5.6-11).

**Table 5.6-11**

Limiting Factors for the Gualala Mainstem/South Fork Subbasin Affecting Salmonid Health and Production Based Upon Habitat Inventory Surveys Conducted in 1999 and 2001 and EMDS Scores in the Gualala River Watershed ( *Rank 1 is the most limiting factor* )

Subbasin Stream Name	Canopy Cover Related to Water Temperature	Embeddedness Related to Spawning Suitability	Pool Depth Related to Summer Conditions	Pool Shelter Related to Escape and Cover
South Fork Subbasin	4	3	2	1
Camper Creek (1999)			1	2
Carson Creek (1999)		3	2	1
Marshall Creek ( <i>partial survey</i> )	2	4	3	1
McKenzie Creek (1999)	3	4	2	1
Palmer Canyon Creek		3	2	1
Upper South Fork ( <i>partial survey</i> )		3	2	1
Wild Hog Creek (1999)	3	4	2	1

Figure 5.6-21a illustrates the limiting factors as determined by CDFG and various sediment sites identified by CGS as potential restoration targets. Figure 5.6-21b is the map explanation. General recommendations are made for each limiting factor and type of sediment site. The map is a reduced image of Plate 3, *Potential Restoration Sites and Habitat Limiting Factors for the Gualala River Watershed*. (See Plate 3 to view details at a higher scale [1:48,000])

### Restoration Recommendations

**Table 5.6-12**

Priorities for Restoration for the Gualala Mainstem/South Fork Subbasin Based Upon 1999 and 2001 Data (*Rank of 1 indicates highest priority*)

Stream Name	Bank Stabilization	Roads Repair or Removal	Riparian Canopy Development	Instream Structure Enhancement	Livestock or Feral Pig Exclusion	Barrier Removal
South Fork Subbasin	5	2	3	1	6	4
Camper Creek (1999)		2		1		
Carson Creek (1999)		2		1		
Marshall Creek ( <i>partial survey</i> )	3	4	1	2	5	
McKenzie Creek (1999)		2		1		3
Palmer Canyon Creek		3	2			1
Upper South Fork ( <i>partial survey</i> )		3	2	1		
Wild Hog Creek (1999)			2	1		

## Potential Refugia

No potential refugia were identified based upon 2001 data.

### 5.6.9 FISH HISTORY AND STATUS

Salmonid population data is limited for the Gualala Mainstem/South Fork Subbasin.

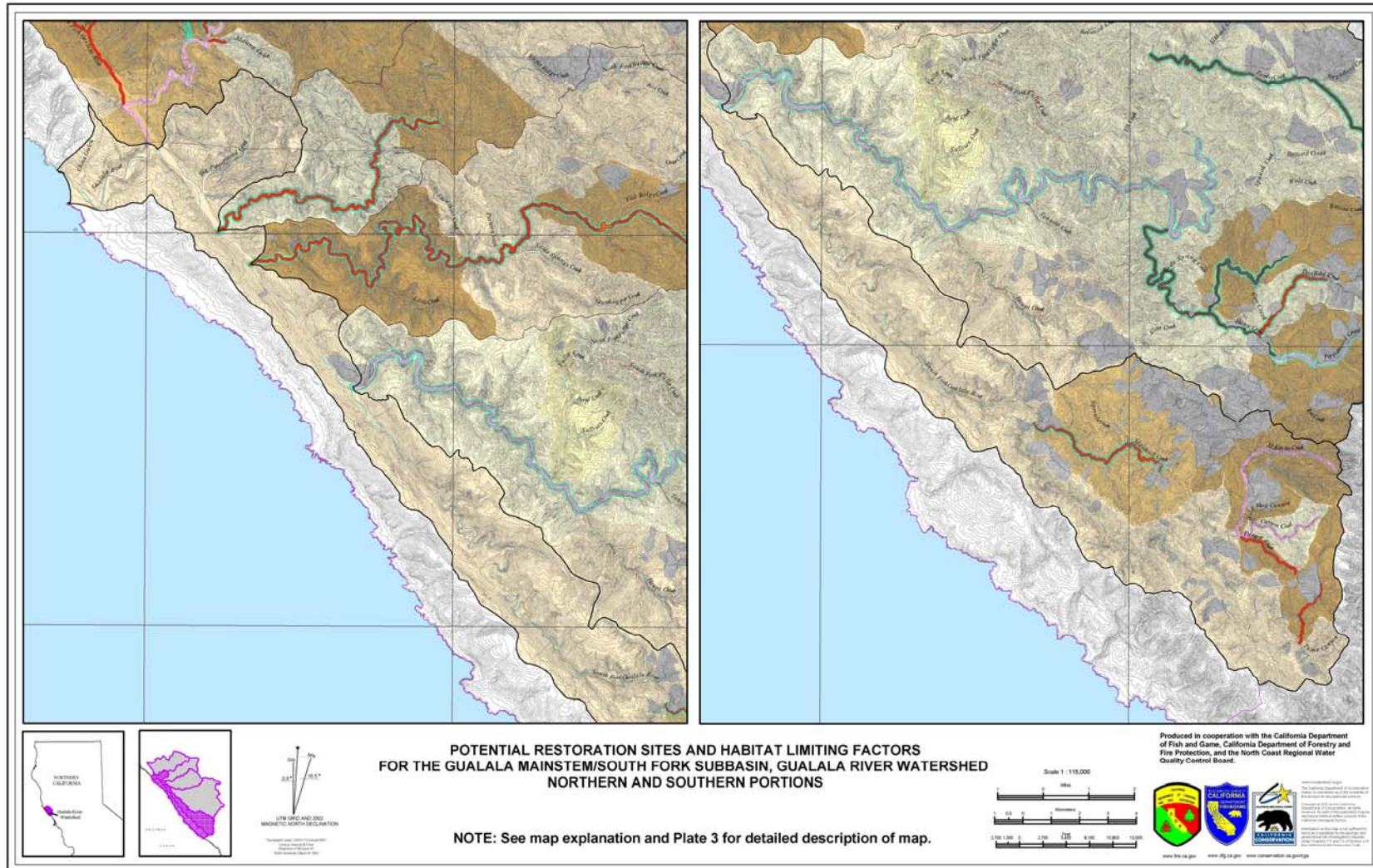
- **1950s-** On August 15, 1952, one station was electrofished on the mainstem of the Gualala River 20 yards below the confluence with the North Fork. The purpose of the survey was to determine whether a resident trout population existed, that would warrant the opening of a summer fishery. The criteria used to determine a harvestable resident population was sufficient numbers of fish over the 8.0-8.5 inch size. The report concluded that the opening of a summer trout fishery was not warranted. There were no coho salmon captured during this survey. During December 1954 and January and February of 1955, creel surveys were conducted to determine the quality of the fishery. Some 507 fish were checked. A total catch estimate of 1,352 fish for the season was extrapolated with data from a use count. No distinction was made as to whether the fish were steelhead trout or coho salmon.
- **1960s-** Steelhead trout were present during stream surveys conducted on the lower and upper South Fork, Marshall, McKenzie, and Sproule creeks in 1964.
- **1970s-** During the 1970s, 105,000 coho salmon were planted. Creel censuses conducted in November (1972-73) recorded coho salmon.

During the 1970s, 105,000 coho salmon, 83,320 steelhead trout were planted at the confluence of Valley Crossing, Pepperwood, North Fork and Clark's Crossing. In the mid 1970s, a five-year study using creel censuses, use counts, adult tagging, and downstream migrant trapping was conducted in conjunction with the planting of steelhead trout (from Mad River and San Lorenzo River stocks). The goal of the program was to estimate winter adult steelhead trout population, estimate angler harvest rate, and to evaluate the contribution of hatchery steelhead trout to the sport fishery. This program was essentially focused on enhancing the Gualala River as a sport fishing stream. Though there was a considerable body of data collected in these years, an effort to standardize results was lacking. In some year's population estimates were backed by data with 95 percent confidence intervals, 7,608 in 1975-1976 and 4,323 in 1976-1977 and the 1974 population estimates are not accompanied by supporting data.

Harvest estimates were made at the end of the fishing seasons for each of the five years studied. Most of these surveys began in December and recorded steelhead trout.

- **1980s-**No data available.
- **1990s-**GRI observed one-year and older steelhead trout on the South Fork in 1997 and 1998.
- **2000s-**During snorkel surveys, GRI observed one-year and older steelhead trout on the South Fork in 2000 and 2001. The Modified Ten Pool Protocol on Marshall Creek and the Upper South Fork headwaters showed young-of-the-year and one year old steelhead trout, but no coho salmon were observed.

Volunteer spawning surveys were conducted in the Subbasin February through April, 2001. Because of the period, all of the redds found were considered to be steelhead trout. The South Fork (14.5 miles) survey recorded 12 redds and five live fish.



**Figure 5.6-21a**  
 Potential Restoration Sites and Habitat Limiting Factors for the Gualala Mainstem/South Fork Subbasin, Gualala River Watershed

5.6 Gualala Mainstem/South Fork Subbasin

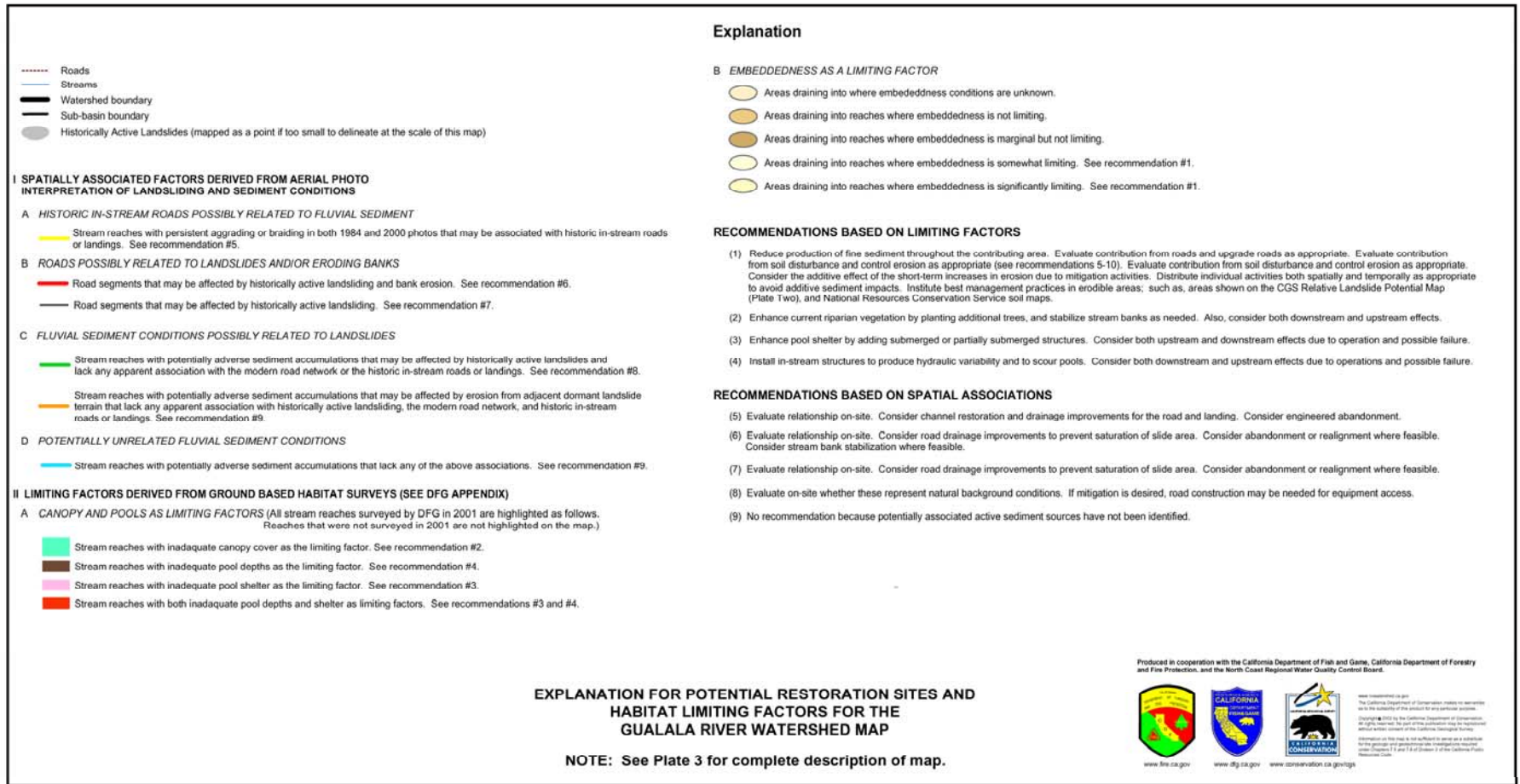


Figure 5.6-21a  
Explanation for Potential Restoration Sites and Habitat Limiting Factors for the Gualala River Watershed Map

#### 5.4.10 GUALALA MAINSTEM/SOUTH FORK SUBBASIN PUBLIC ISSUES, SYNTHESIS, AND RECOMMENDATIONS

After conducting public scoping meetings and workshops, the NCWAP team compiled a preliminary list of general issues based upon public input and initial analyses of the available data. Some issues were suggested by watershed analysis experts, and some by Gualala River Watershed residents and constituents. The following general concerns were expressed as potential factors affecting the Gualala River Watershed and its fisheries, but do not necessarily reflect the findings of the assessment. Some have been disproved by the assessment findings.

- Large Woody Debris (LWD) recruitment potential is a concern.
- There is concern over abandoned roads, new road construction, and road maintenance issues related to landsliding and sediment input. Subdivision construction is not an issue at this time.
- Best management practices required by current forest practice rules are reducing forestry impacts to insignificance.
- Timber harvest, grazing and vineyards are land use concerns from the standpoint of sediment generation and potential for pesticide/herbicide use.
- Summertime water temperatures are a concern in the lower sections of the mainstem.
- There is concern and desire expressed to assess status and trends of exotic flora and fauna, including invasive species. Pampas grass is of particular concern.

#### Working Hypotheses

The primary purpose of these hypotheses is to elucidate in a succinct format the judgment of the Team regarding watershed conditions relative to anadromous salmonids. As such, they are responsive to the assessment questions presented on pages 1-1 and 1-2. The findings supporting the hypothesis are presented, along with recommendations for watershed improvements, and to further investigate the hypotheses. As such, they are not intended to be the final word, but are the best judgment based on the information at hand.

Recommendations for watershed improvements and further study are presented at the end of the section, as single recommendations apply in many cases to more than one hypothesis.

Hypotheses are presented for the South Fork and tributaries upstream of the confluence with the Wheatfield Fork (Marshall Creek SPWS and the portion of the Lower South Fork SPWS upstream of Wheatfield). No hypotheses are presented for the lower section of the subbasin where data are sparse and inconclusive (see Section 5.1, Estuary).

The hypotheses pertaining to the upper South Fork and tributaries upstream of the confluence with the Wheatfield Fork are:

1. Instream conditions are suitable for salmonids in the South Fork and tributaries upstream of the confluence with the Wheatfield Fork.
2. Historically logged areas have contributed sediment to the streams.
3. Instream and near stream conditions are improving.

### **Working Hypothesis 1**

*Instream conditions are suitable for salmonids in the South Fork and tributaries upstream of the confluence with the Wheatfield Fork.*

#### Supporting Findings

- Steelhead trout (young-of-the-year, one year and older) were detected on South Fork during electrofishing surveys in October of 2001.
- Water temperatures were fully suitable for salmonids the headwaters of the South Fork in 2001 and somewhat suitable in McKenzie Creek (Table 5.6-4)
- CDFG habitat inventory survey results met target values for canopy cover in Camper Creek, Carson Creek, Palmer Canyon Creek, and in the headwaters of the South Fork. Embeddedness target values were met on all seven of the streams surveyed (Table 5.6-7).
- The EMDS scores from Carson Creek and in the headwaters of the South Fork were fully suitable for canopy cover. Camper and Palmer Canyon Creeks were moderately suitable for canopy cover. McKenzie and Wild Hog Creeks were somewhat suitable for canopy cover (Table 5.6-10).
- Embeddedness was moderately suitable in the headwaters of the South Fork, and somewhat suitable on Marshall and Palmer Canyon Creeks (Figure 5.6-17).

#### Contrary Findings

- Coho salmon were not detected on the South Fork during electrofishing surveys in October of 2001.
- Water temperatures (MWAT) in 2001 were unsuitable for salmonids at one of two sites in the lower mainstem South Fork and undetermined at one of two sites in McKenzie Creek (Table 5.6-4).
- Water temperatures (MWAT) in 1995-98 and 2000-2001 were unsuitable for salmonids at five of seven sites in the mainstem, both sites in McKenzie Creek in 2000-2001, and the site in Palmer Canyon Creek in 2000 (Table 5.6-4).
- CDFG habitat inventory target values for canopy cover were not met on Marshall and McKenzie Creeks. The Marshall Creek EMDS score for canopy cover was moderately unsuitable (Table 5.6-7).
- Target values were not met on any of the seven streams surveyed for primary pool depth/frequency or shelter/cover. The EMDS scores ranged from somewhat to fully unsuitable on all of the seven streams surveyed for pool depth, pool shelter and pool quality (Table 5.6-10).

#### Limitations

- Only 31 percent (1.6 miles) of the SPWS was habitat inventory surveyed.
- The modified ten pool protocol electrofishing methodology was used as designed to indicate coho salmon presence/not detected only. It cannot be used to for species composition, species density or population estimates.
- Water temperature data for the SPWS were restricted to eight sites for the period of 1995-1998 and 2000-2001. Water temperature data were available for only four sites in 2001.

### Conclusions

- The Hypothesis is supported within the limitations of the length of streams habitat inventory surveyed.

### **Working Hypothesis 2**

*Historically logged areas have contributed sediment to the streams.*

### Supporting Findings

- Most of the higher and east reaches of the South Fork were clear-cut between 1952 and 1961 building roads in or along the major tributaries streams (Figure 5.6-10). This left large areas of disturbed ground.
- Approximately 15 miles of historic logging roads built in or along the streambed simplified pool structure and complexity throughout the Marshall and McKenzie Creeks, and the upper mainstem tributaries (Section 5.6.4).
- Numerous debris flows and debris slides involved roads, and numerous failures occurred along instream and near-stream roads and landings during large storm events as observed in 1961 and 1965 aerial photos. This increased sedimentation in the streams (Section 5.6.4).
- Many undersized culverts and substandard road drainage facilities failed during the 1986 and 1996 storms, representing a portion of contemporary sediment pulses in the subbasin. These failures were generally more numerous where roads (mostly ranchland roads) cross high or very high potential landslide areas (105 miles) (Section 5.6.4).
- LWD recruitment has been limited due to streamside road construction, timber harvesting, and salmonid migration barrier removal. The reduction of LWD likely reduces pool formation and sediment storage in the tributaries

### Marshall Creek

- Streamside roads lined Wild Hog and Palmer Canyon creeks by 1959. Lack of erosion control facilities along streamside roads and landings created gully erosion observed in 1965 photos (Figure 5.6-10).
- Modern road segments within 60 meters of historically active landslides are numerous in the upper tributary stream reaches of Marshall Creek and may be contributing excess sediment to streams.

### McKenzie Creek

- Streamside/instream roads and landings were densely concentrated in the central and higher reaches of McKenzie Creek (1961, 1965, and 1981 photos) (Figure 5.6-10).

### Contrary Findings

- Embeddedness target values were met on all seven of the streams surveyed.
- Approximately 1.5 miles of modern roads (out of 116 miles total) are located within 50 feet of blue line streams in the subbasin.
- The northeast portion of the Upper South Fork watershed is underlain primarily by Central Belt Franciscan mélangé. This may contribute relatively large amounts of fine grained sediment to streams.

Limitations

- Only 31 percent (1.6 miles) of the SPWS was habitat inventory surveyed.
- Observations of landuse and associated impacts are from aerial photo interpretations.

Conclusions

- The hypothesis is supported by the limited data available.

**Working Hypothesis 3**

*Instream and near stream conditions are improving.*

Supporting Findings

- Overstory shade canopy as observed from aerial photos has recovered in the middle to upper reaches as indicated by (1) comparison of 1981 bank-to-bank exposure with 2001 habitat inventory survey, and (2) canopy density ranged between approximately 50 to 75 percent between the years 1999, 2000, and 2001 in McKenzie, Carson, Camper, and Wild Hog creeks (Section 5.6.4).
- The McKenzie Creek channel in the Upper Marshall Creek PWS was more than 50 percent disturbed based on 1984 aerial photo interpretation, and improved to less than 25 percent disturbed per 1999/2000 photos (Table 5.6-3).
- Channel disturbance observed from aerial photos for the Upper South Fork PWS decreased from 39.2 percent disturbance in 1984 to 23.9 percent in 1999/2000 photos (Table 5.6-3).

Contrary Findings

- The levels of channel disturbance observed from aerial photos in the South Fork Gualala in the Middle South Fork PWS are similar between 1984 and 1999/2000 (31.5 percent and 27.2 percent, respectively) (Table 5.6-3).
- Channel disturbance was 50 to 75 percent in the lower reach of Marshall Creek downstream of McKenzie Creek (Lower Marshall Creek PWS) in 1984 and nearly the same in 1999/2000 observations with approximately 50 percent of the channel disturbed (Table 5.6-3).
- Riparian canopy has not recovered to 1942 levels observed from aerial photos (Figures 5.6-7 and 5.6-10).

Limitations

- Only 31 percent (1.6 miles) of the SPWS was habitat inventory surveyed. Analysis is limited by a comparable lack of historical stream surveys in this SPW with which to indicate comparative trends.

Conclusions

- The hypothesis is supported by the limited data available.
- Current riparian shade canopy cover has improved from 1968 when long portions of riparian zones had been cleared of all vegetation, but not to the 1942 levels.
- Improvements in the levels of channel disturbances from 1984 to 1999/2000 are generally positive, but mixed, with some areas improving and others staying the same.



### **Subbasin Recommendations**

Target restoration and land use activities to the four highest priorities for restoration in the Gualala Mainstem/South Fork Subbasin: (1) large wood placement, (2) road repair or removal, (3) riparian canopy development, (4) barrier removal, (5) bank stabilization, and (6) livestock or feral pig exclusion.

1. Install fish habitat improvement structures including large woody debris placement.
  - a. Land managers in the subbasin should be encouraged to add more large organic debris and shelter structures in order to improve sediment metering, channel structure, channel function, habitat complexity, and habitat diversity for salmonids. The natural large woody debris recruitment process should be enhanced by developing large riparian conifers with tree protection, planting, thinning from below, and other vegetation management techniques. Instream structure enhancement is a restoration priority 1 in McKenzie and Wild Hog creeks, and the South Fork, priority 2 in Marshall Creek.
  - b. At stream bank erosion sites, encourage cooperative efforts to reduce sediment yield to streams. Grazing is an issue in the subbasin. Bank stabilization is the third of the top three recommendations.
  - c. Reduce livestock and feral pig access to the riparian zone to encourage stabilization of stream banks and revegetation of the riparian zone.
2. Address road issues.
  - a. Decommission and revegetate streamside roads, focusing on those where channel braiding and/or aggradation are persistent today, such as the central and upper reaches of McKenzie Creek, and the lower reaches of Marshall Creek including Palmer Canyon and Wild Hog Creeks. Road repair and removal is a restoration priority 2. (from CGS restoration map)
  - b. Upgrade and maintain existing road systems to eliminate sediment sources to pools and spawning gravels. Carefully engineer new roads or repairs to reduce adverse sediment impacts. Use the CGS Restoration map to locate where ranch roads cross historically active landslides to target further field evaluation. These areas have been mapped in dense concentrations in the east subbasin reaches.
  - c. Target road upgrade/repair starting with instream sediment indicators where fish habitat is less than suitable, priority 1 in McKenzie, Wild Hog, and the South Fork, and priority 2 in Marshall Creek.
  - d. Incorporate mitigation elements into Timber Harvest Plans and pursue cost sharing grants for decommissioning legacy streamside roads and upgrading road drainage facilities in the timber-dominant lower subbasin, including Little and Big Pepperwood Creeks.
  - e. Pursue cost sharing grants organized by the Sotoyome RCD to upgrade ranchland roads in the ranchland upland areas.
  - f. Develop erosion control plans for decommissioning old roads, maintaining existing roads, and constructing new roads. Consider careful planning of land uses that could exacerbate mass wasting, since the relative potential of landsliding is high to very high in 50 percent of the subbasin.

3. Address riparian zone issues.
  - a. Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures in order to reduce heat inputs to the Upper South Fork and its tributaries.
  - b. In the east subbasin reaches, retain, plant, and protect trees to achieve denser riparian canopy to enhance current canopy recovery from mid-20th-century block clearance logging and ranchland conversions. The following areas continue to show gaps on riparian shade cover compared to 1942:
    - i. The central to upper reaches of the Upper South Fork, McKenzie Creek, and Wild Hog and Palmer Canyon creeks .
    - ii. Riparian canopy development is a restoration priority 1 for Marshall Creek and a priority 2 for the South Fork and Palmer Canyon and Wild Hog creeks.
  - c. Reduce livestock and feral pig access to the riparian zone to encourage stabilization of stream banks and revegetation of the riparian zone.
4. Expand monitoring efforts in the subbasin.
  - a. Conduct both instream and hillslope monitoring to determine whether current land use practices are allowing for recovery and protection of the salmonid habitat in the subbasin. Use GRWC protocols for instream measurements. Improve baseline information on habitat conditions by conducting inventory surveys in the South Fork and major tributaries upstream of the confluence with the Wheatfield Fork.
  - b. Expand continuous temperature monitoring efforts into the upper subbasin and tributaries. Consider looking at canopy composition and monitoring air temperatures to examine canopy, temperature, and other microclimate effects on water temperatures.
  - c. Investigate the availability and quality of other temperature and canopy data for the eastern area, and reevaluate the relationship of canopy to actual stream temperatures. Spot temperature and canopy measurements from habitat inventory data may be useful in providing information from areas in the subbasin for which we have no other data.
  - d. Conduct habitat inventory surveys in the remainder of the SPWS to provide information for restoration priorities and as a baseline for future comparisons.
5. Remove fish migration barriers in Palmer Canyon Creek and McKenzie Creek.