5.2 North Fork Subbasin

5.2.1 INTRODUCTION

The North Fork Subbasin (Calwater 2.2a 113.81, North Fork SPWS) encompasses 47.9 square miles of private land in the northern end of the Gualala River Watershed. The main channel has a zig-zag pattern in response to faulting. There are 127 miles of “blue line” streams, and five major tributaries: Little North Fork, Robinson Creek, Dry Creek, Stewart Creek, and Billings Creek (Figure 5.2-1). Predominant land uses include timber production, grazing, small vineyards, and some 40-acre and larger subdivisions.

A stream gage was installed in the fall of 2000 near the confluence of the North Fork with the South Fork (Station NFG, North Fork Gualala River Near Gualala). It is maintained by the California Department of Water Resources (DWR) and has been in operation since installation. Stream flow and water temperature data are available by accessing the California Data Exchange website at http://www.cdec.water.ca.gov.

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 5.2-2.

5.2.2 GEOLOGY

Mélange of the Franciscan Complex underlies oak savanna woodland in the eastern headwaters. Large areas of active earthflows and other forms of landsliding are abundant and contribute sediment to the streams (Figure 5.2-3). Figure 5.2-4 presents the relative landslide potential map for the North Fork Subbasin. The complete maps and explanations for both maps are on Plates 1 and 2. The steep tributaries in the upper reaches can be characterized as source (>12 percent slope) and transport (4-12 percent slope) reaches.

5.2.3 VEGETATION

The North Fork Subbasin has the highest timber site quality in the watershed. With over 70 inches of rainfall per year within the coastal fog influence, the lower and middle reaches of the North Fork Subbasin contain prime timber growing ground for Redwood and Douglas fir (Figure 5.2-5). In the upper third of the North Fork Subbasin, there is an abrupt vegetational transition to the mélange clay soil type. At the base of the Billings Creek Planning Watershed (PWS) along the Tombs Creek fault, dense conifer stands give way to prairie grasslands and oak woodland. Mixed conifer hardwood stands dominant north slopes. Conifers dominate stream floors. Approximately 17 percent of the North Fork Subbasin consists of prairie grasslands/oak woodland.

5.2.4 LAND USE

The North Fork Subbasin has the longest span of past land use practices in the watershed. The subbasin has been subject to three eras of intensive land use: (1) old growth redwood harvesting in the lower to central reaches 1868 to 1911, (2) tractor harvesting between 1942 to 1968, and (3) cable/tractor harvesting throughout the lower to central reaches in excess of 50 percent of the Doty, Robinson, and Stewart Creek PWS between 1990 to present.

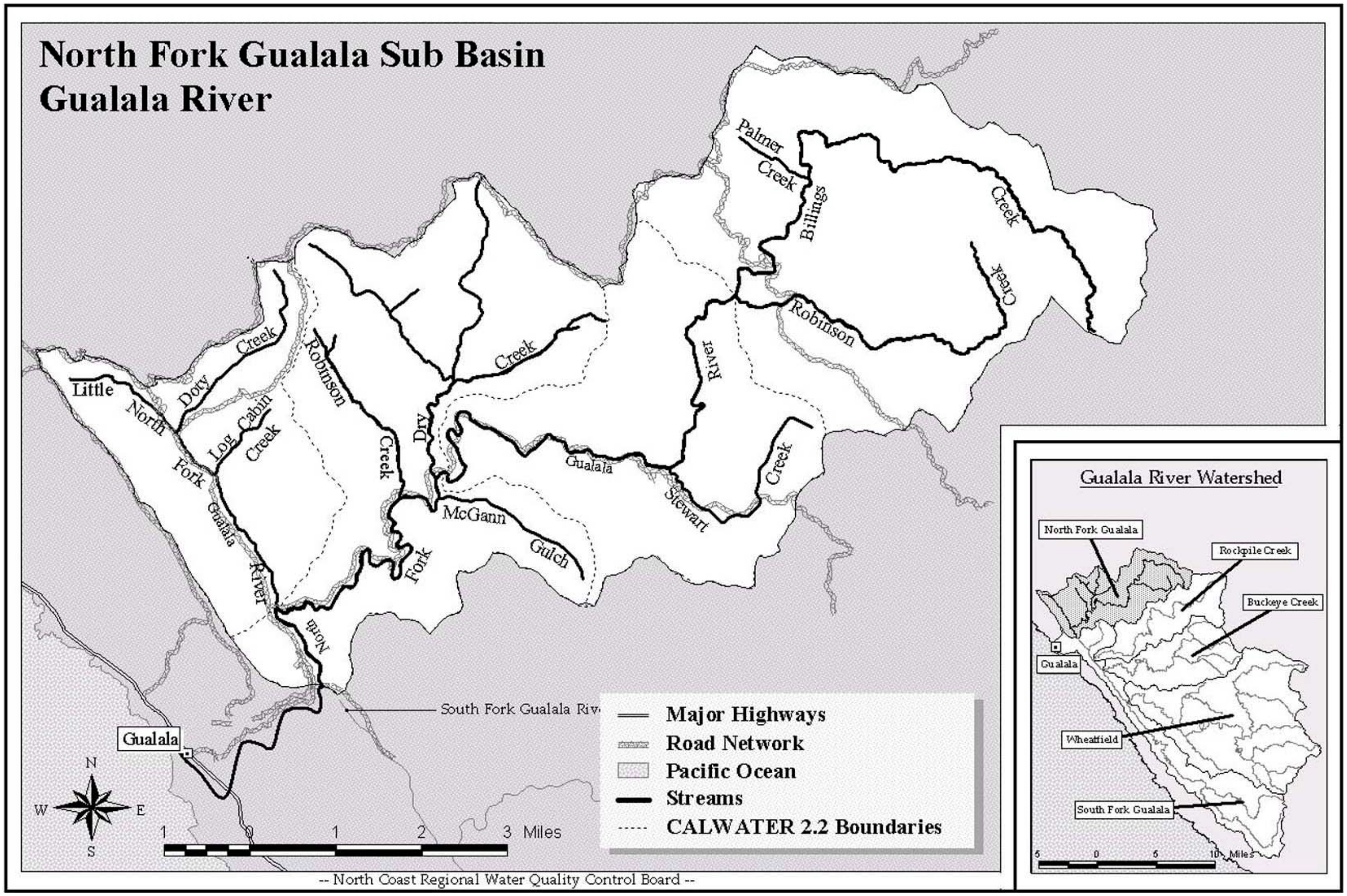

Figure 5.2-1
North Fork Gualala River Subbasin

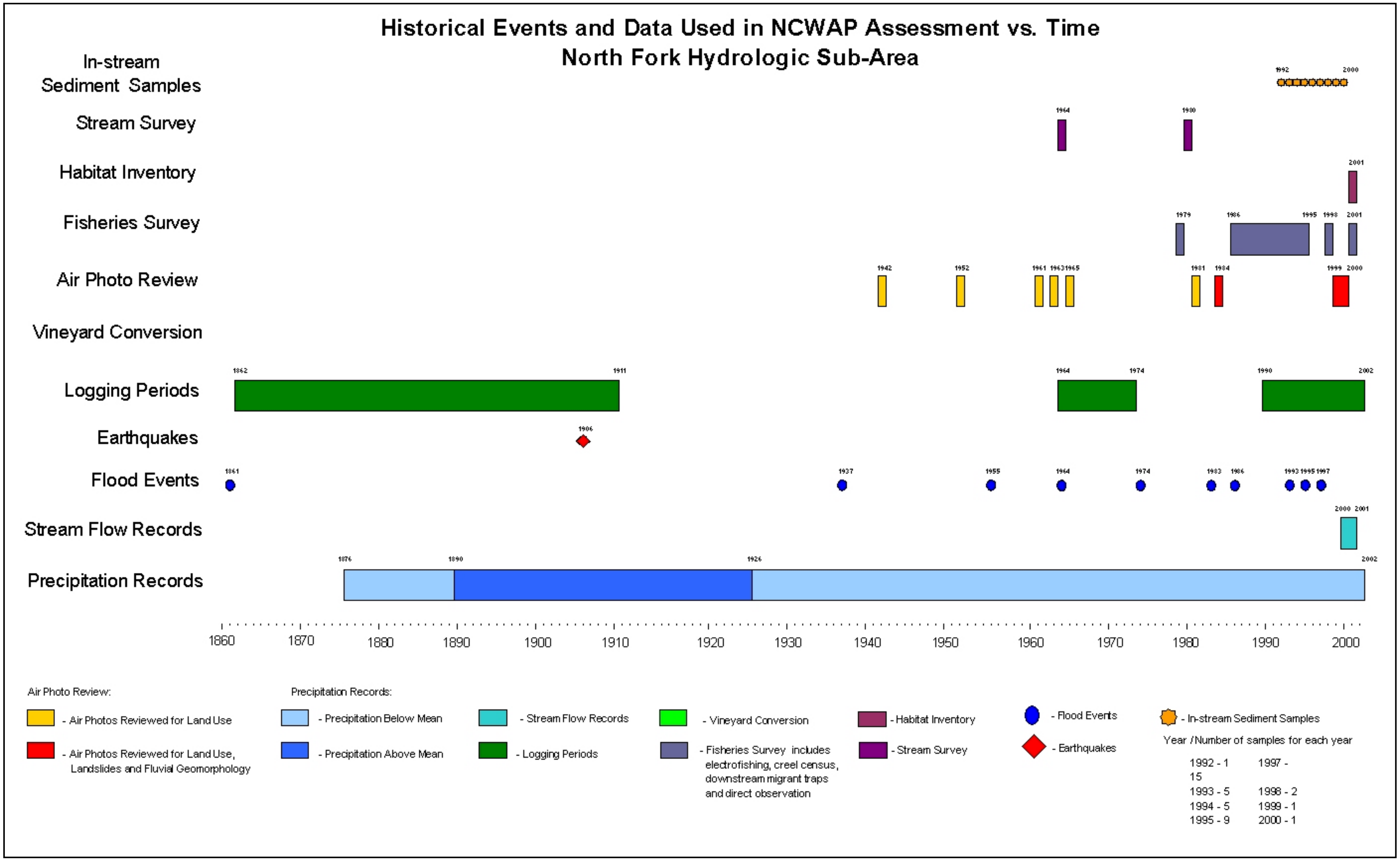

Figure 5.2-2
Historic Events and Data Used in the NCWAP Assessment for the North Fork Gualala River Subbasin

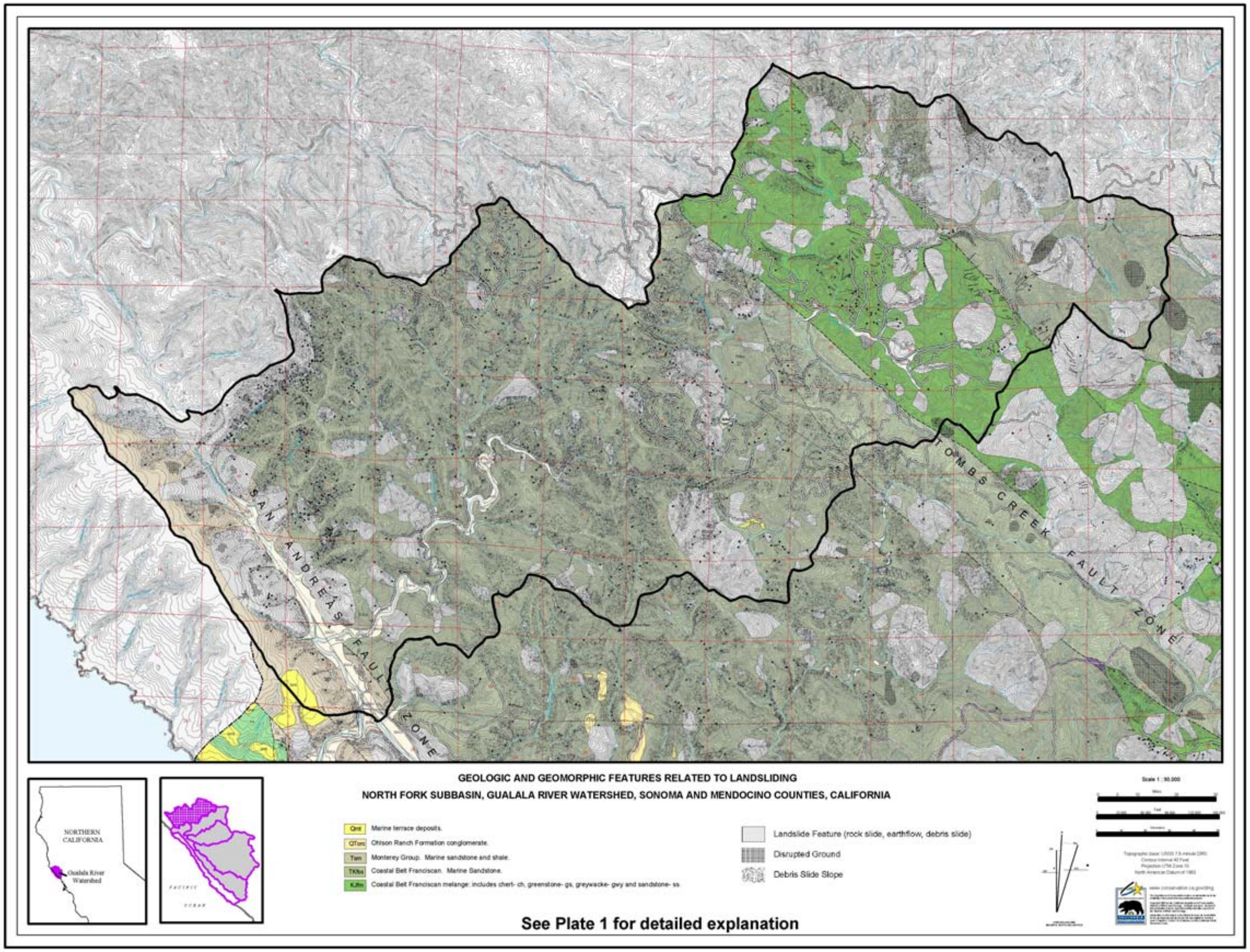

Figure 5.2-3
Geologic and Geomorphic Features Related to Landsliding - North Fork Gualala River Subbasin

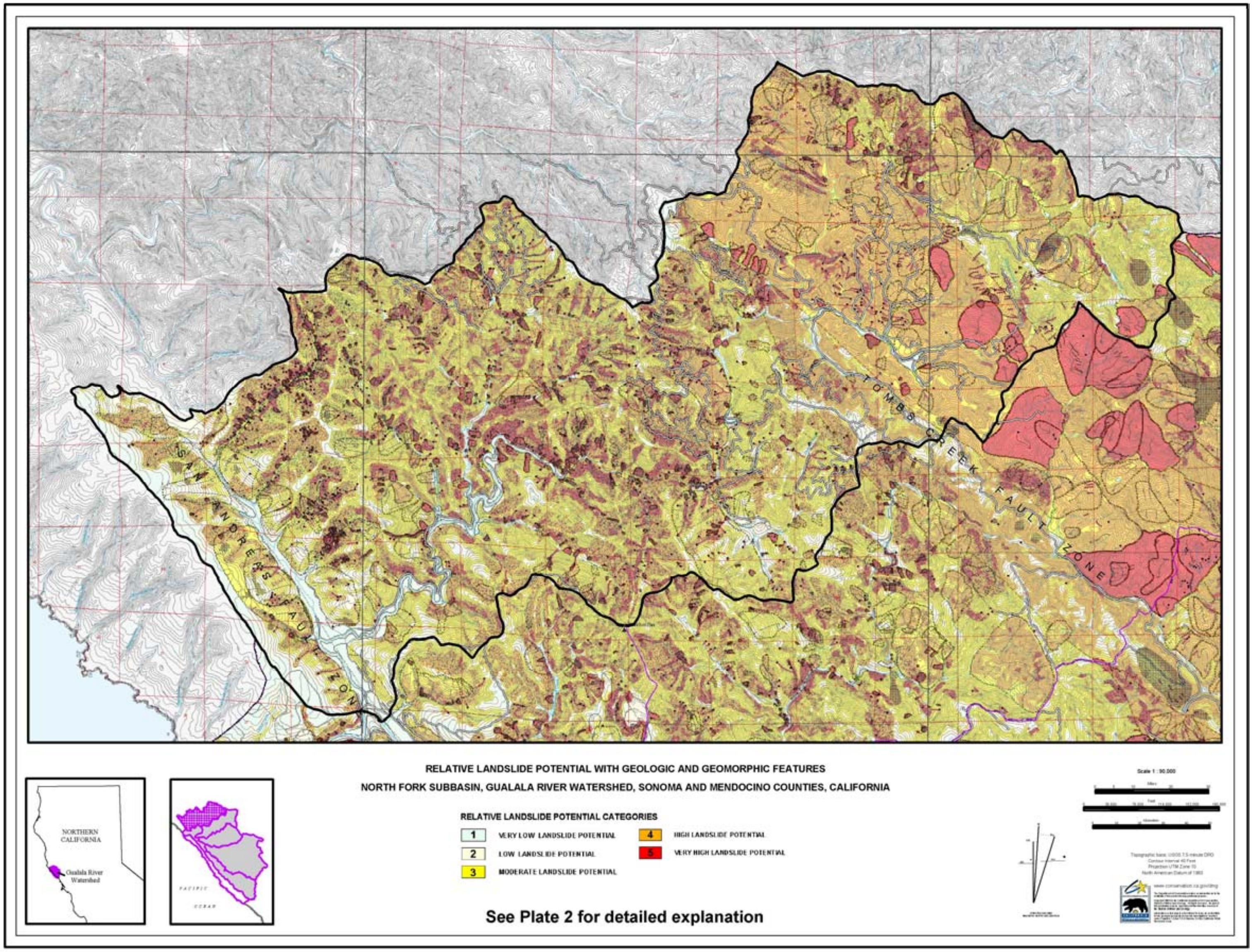

Figure 5.2-4
Relative Landslide Potential with Geologic and Geomorphic Features - North Fork Gualala River Subbasin

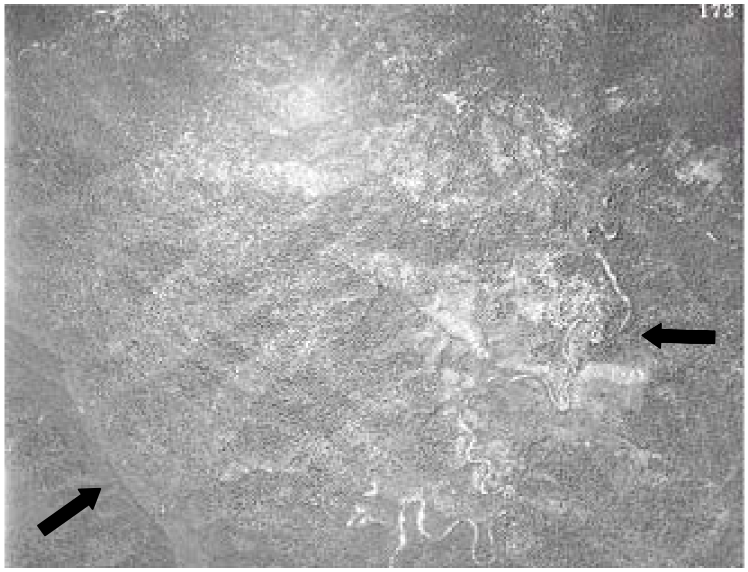

Figure 5.2-5
Lower to Middle Reaches of the North Fork Subbasin in 1936,
Showing Mid-Sized Second Growth Redwood Stands
(Note absence of any road network at this time)

The redwood dominated alluvial flats were clear-cut by the turn of the century. During the logging of the 1950s and 1960s, these areas were considered pre-merchantable young growth. In the purchase discussions for GRI in 1948, the second growth redwood was given zero value. These stands have mostly been selectively cut two times since the original turn-of-the-century clear-cut. Aerial photos from 1936 show predominantly mid-sized second growth redwood with no active road network (Figure 5.2-6).

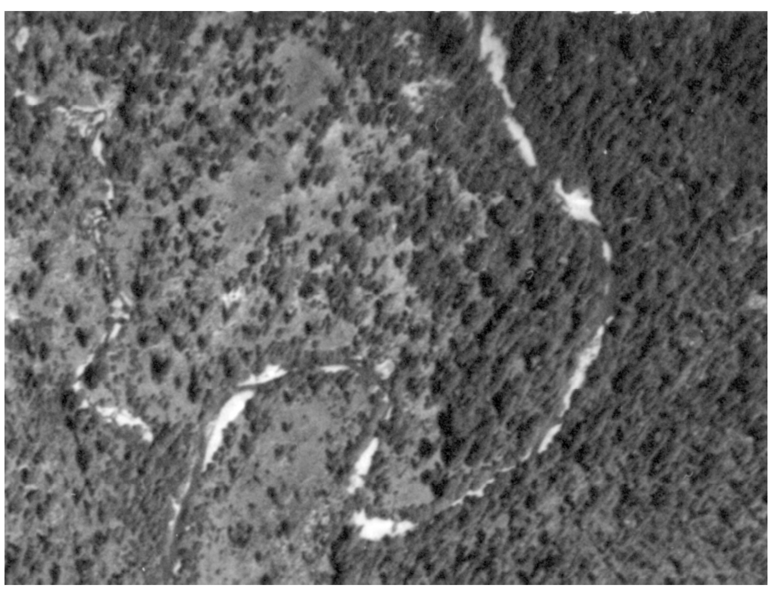

Figure 5.2-6
Confluence with Dry Creek, 1936
(The old growth Redwood had been cleared, and the area burned to create grazing land (left))

The 1936 shade canopy cover map (Figure 5.2-7) shows bank-to-bank exposure limited to the lower subbasins' alluvial floodplains. At this time, the channel was aggraded and wide, preventing dense wooded conifer growth adjacent to the stream channel. Upstream of the confluence with Dry Creek, topography was narrowly incised with conifer canopy entirely covering the mainstem North Fork until one reaches the mélange, which is largely non-coniferous and lacking in canopy. There was entire bank-to-bank cover over all tributary watercourses in the middle and lower North Fork Subbasin, including Stewart, Dry, Robinson, and Doty creeks in 1936.

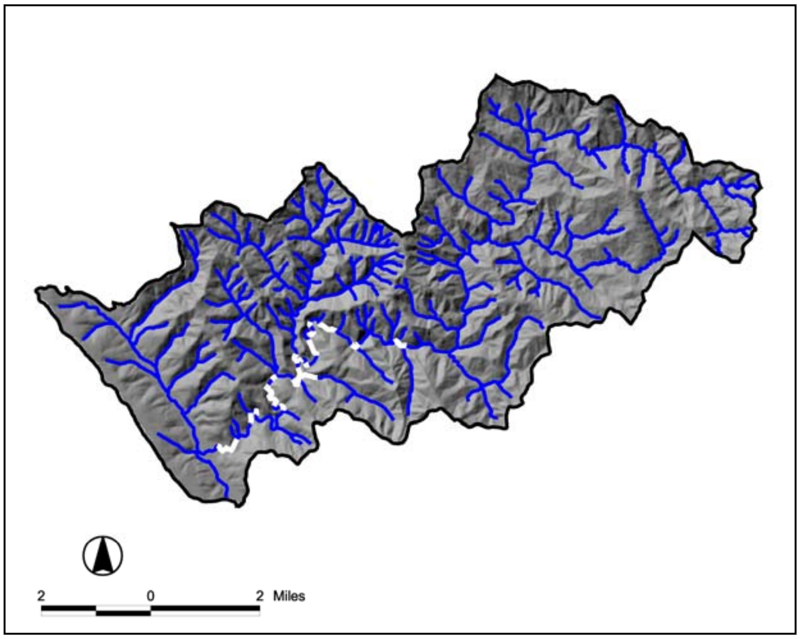

Figure 5.2-7
1936 Bank-to-Bank Stream Exposure (White)
(Dark blue shows partial to entire canopy cover over blue line streams)

Table 5.2-1
North Fork Subbasin Stand Replacement Operations 1932 - 1973 - Total Area = 30,636 acres

Time Period	Acres Under Operation	Type of Operation	Cumulative Percent of Subbasin Under Operation Since 1932	Mean Annual Increment (acres/percent by year)
1932– 1942	60	Stand Replacement	.2	10 (.02)
1942 – 1952	1,100	Stand Replacement	3.7	110 (0.3)
1952 – 1960	8,800	Stand Replacement	32.5	1,100 (3.6)
1960 – 1964	4,550	Stand Replacement	47.4	1.137 (3.7)
1964 – 1973	3,750	Stand Replacement	59.7	375 (1.2)

Tractor logging operations accelerated during the mid-1950s in the middle reaches flanked by Dry Creek to the south. These operations removed old growth redwood and Douglas fir. Roads were built adjacent to the stream channel of all primary tributary watercourses (Figure 5.2-8). The most active logging period occurred between 1952 and 1960. Thirty-three percent of the entire 30,600-acre North Fork Subbasin was logged. In a four-year period between 1960 and 1964 an additional 16 percent of the subbasin was tractor logged. By 1968, 12 percent more area was harvested, totaling 56 percent of the subbasin from 1952.

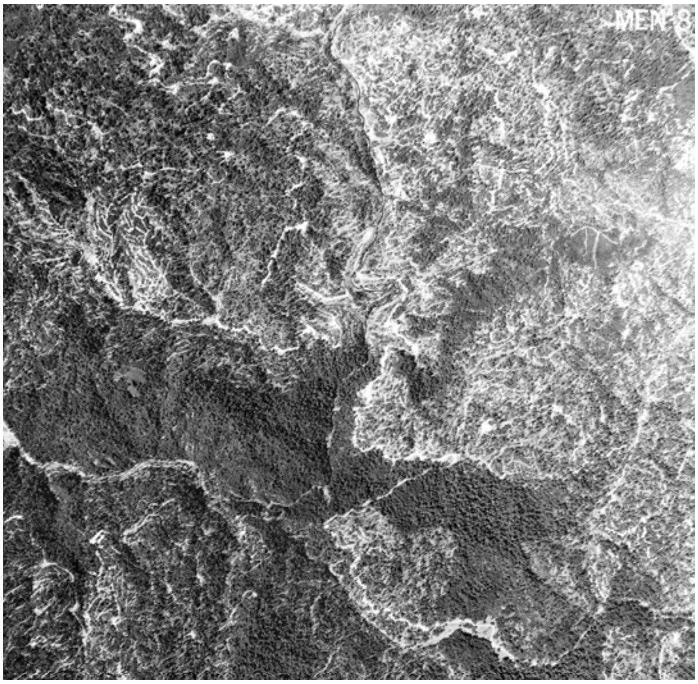

Figure 5.2-8
Old Growth Tractor Logging by 1963 in the Central Reaches of the North Fork Subbasin, at the Confluence with Stewart Creek (bottom center)

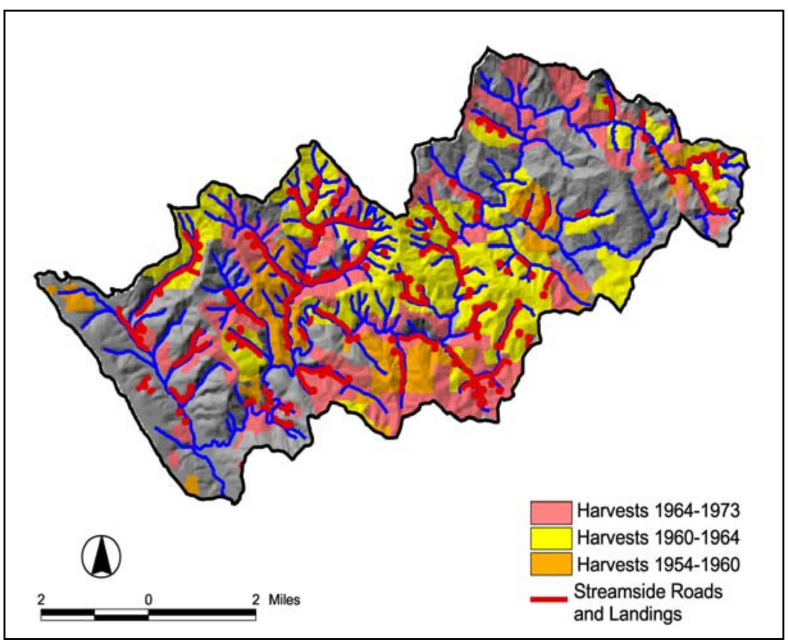

Figure 5.2-9
Mid-20th-Century Tractor Operations and Streamside/Instream Roads and Landings.
Red lines (roads) and circles (landings) show where sidecast fill has been pushed into the creek burying the streambank.

Roadfill sidecast to the stream channel was undermined during peak flows creating numerous debris slides and road fill failures thatdischarged into watercourses. Many of these relict road debris slides have been mapped by the California Geologic Survey (Plate 3 and Figure 5.2-10).

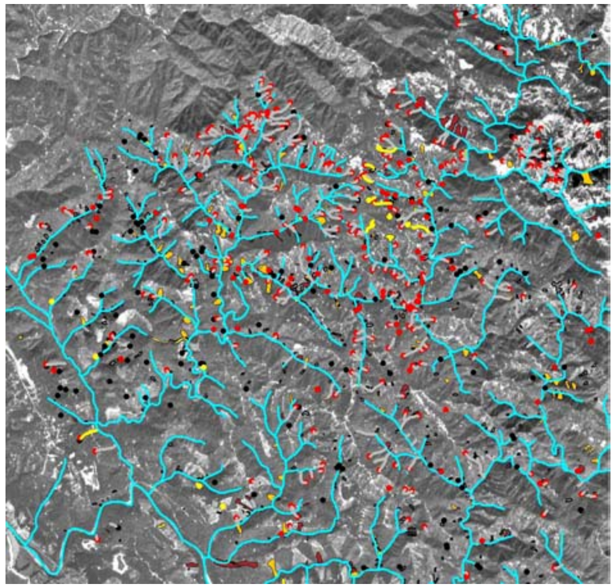

Figure 5.2-10
Smaller Debris Slides and Debris Flows
(red: 2000, black: 1984). Mapped by CGS

Peak storm events occurred in the 1962, 1964, 1966, and 1971 water years. In addition, streamside/ instream road and landing construction and timber clearing left bank-to-bank watercourse exposure throughout the central and upper reaches of the mainstem of the North Fork, and all major tributary watercourses including Stewart Creek, Dry Creek, Robinson Creek, and Doty Creek (Figure 5.2-11).

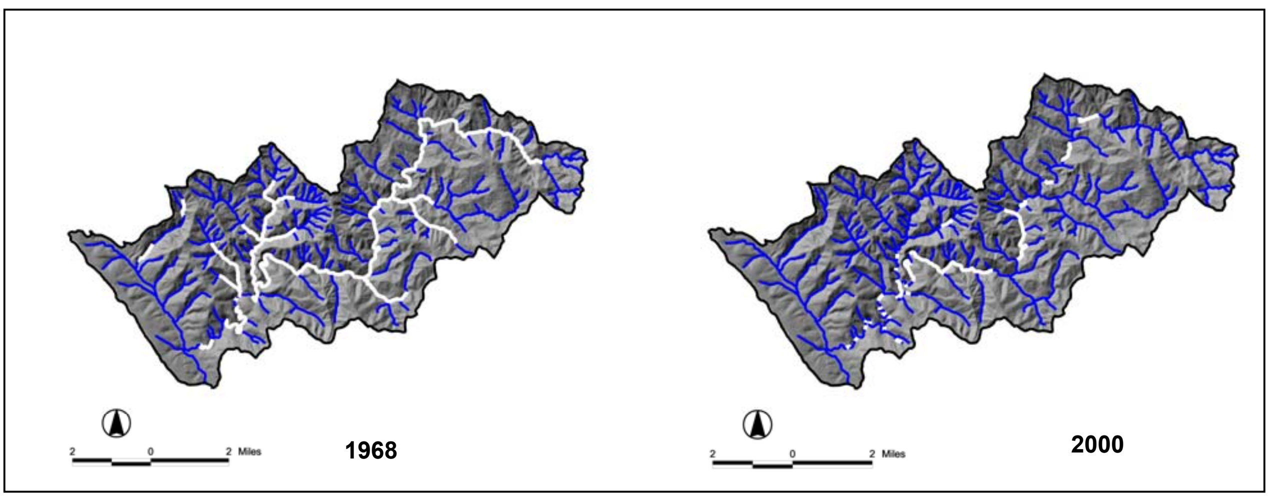

Figure 5.2-11
Bank-to-Bank Shade Canopy Exposure (White) from 1968 (left) and 2000 (right)
Dark blue shows partial to entire shade canopy cover.

Most of the lower reaches and alluvial flats of the North Fork Subbasin, including the Little North Fork, were logged between 1965 and 1968. Because of the younger age of these stands at the time, selective removal of higher quality trees continued to leave a vegetated appearance after logging. This practice tended to leave partial canopy cover over streams. Road construction continued to follow the streambank channel to one side, typically clearing riparian canopy within the right-of-way.

Overstory shade canopy cover for 2001 shows improvement compared to 1968, reflecting vegetational ingrowth over 34 years. In 1936, 5 percent of the blue line streams were exposed bank-to-bank (Figure 5.2-7), limited to alluvial openings in the lower subbasin reaches throughout generally wooded conditions (Figure 5.2-5). In 1968, approximately 65 percent of the blue line streams were entirely exposed bank-to-bank by the end of the tractor harvesting era in the middle and upper subbasin reaches. By 2000, this improved to approximately 25 percent of blue line streams exposed bank-to-bank. Streamside canopy in the middle subbasin reaches now consists primarily of 40-year-old pole to mid-sized conifers. Ground surveys support these findings. The California Department of Fish and Game (CDFG) habitat typing data for 2001 shows average canopy density improving with 77 percent density for the North Fork mainstem and 84 percent for the North Fork Subbasin tributaries. The habitat typing results are consistent with canopy measurements surveyed by the cooperative monitoring program between the Gualala River Watershed Council (GRWC) and GRI. The canopy condition is also consistent with the results of the Hillslope Monitoring Group Study (1998). This study found that the various riparian retention regulatory standards developed in varying and incremental degrees over the last 25 years have allowed recovery of riparian canopy over post WWII logging conditions, when all canopy was removed.

The time period 1968 to 1990 was inactive compared to previous eras, with an additional 4 percent of the subbasin subject to stand replacement harvests. Logging operations were slow during the recessions of 1970 and 1973. During the later 1970s and throughout the 1980s, stand thinnings were the dominant treatment. These operations extended throughout the lower reaches and alluvial basins in second growth redwood dominated areas. Habitat conditions began to recover. Overall streamside canopy cover continued to improve (see 2000 stream cover in Figure 5.2-11). There was improvement in dispersal of sediment discharges by implementation of the Forest Practice regulations, compared to nothing prior to 1973. However, substandard road networks continued to be vulnerable to large storm events, particularly during the 1986 and 1996 water years.

Table 5.2-2
North Fork Subbasin Timber Harvest Operations 1974 – 2001 - Total Area = 30,636 Acres

Time Period	Acres Under Operation	Type of Operation	Cumulative Percent of Subbasin Under Operation Since 1974 Some Overlap with Mid-20th-Century Areas	Mean Annual Increment (acres/ percent by year)
1974 – 1990	550	Stand Replacement	1.8	34.4 (0.1)
1991 – 2001	11,220	THPs	38.4 (43% cable, 57% tractor)	1,020 (3.5)

Active harvest operations resumed from 1990 to the present (Figure 5.2-12), with the clearcut method predominant. Areas that had once been understocked, and therefore avoided during the 1950s, had become mature and were subject to harvest. Since 1973, a total of 38.4 percent of the subbasin have been subject to Timber Harvest Plans (THPs). This acreage includes minimal entry Watercourse and Lake Protection Zone (WLPZ) riparian buffer corridors, and some selection removal areas. The

Hillslope Monitoring Project (California State Board of Forestry 1998) found roads as the dominant land use sediment source of modern harvest operations. Discharge problems from waterbars expressed as a function of acreage were not found to be as substantial a source.

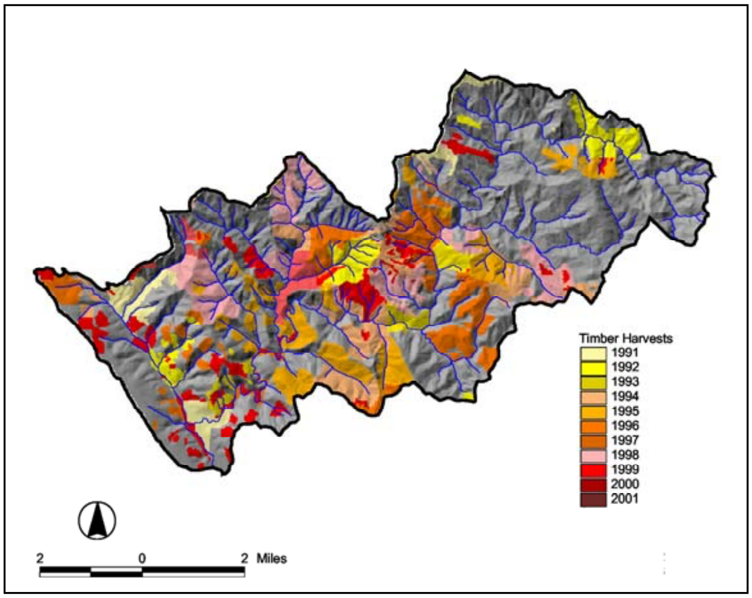

Figure 5.2-12
Timber Harvest Plans from 1991 to 2001

5.2.5 Roads

Historic Roads (1952 to 1968)

Built during the late 1950s thru 1968, streamside/instream road and landing networks spanned most of the natural fluvial drainage system of the central North Fork Subbasin. These roads dominated stream channel structure throughout Stewart, Dry, Robinson, and Doty creeks. The mid-20th-century road networks followed streams up the narrow valleys and inner gorger canyons of the central North Fork. Heavy tractors cut into the steep sidebanks at the base of the streams, making the near vertical cut banks along the roads prone to failure during winter storms. Tractors graded the streambank flat to one side, simplifying channel complexity and structure. These operations pushed large volumes of dirt debris into the streams as road fill sidecast. In addition, CGS mapping found that the mid-20th-century road networks crossed a high density of debris slides and debris flows.

The deeply incised channel topography tended to concentrate flows during storm events. The steep topography and high stream density probably caused intense, flashy runoff, that (1) challenged and often removed the primitive log/dirt road stream crossings and instream landings, and (2) undermined the streamside roads collapsing road segments into the streams. CGS mapping found a high density of mid-20th-century road debris slide failures in the central subbasin reaches (Figure 5.2-10). 1963 and 1981 aerial photos showed a high frequency of road and landing failures along streamside roads particularly concentrated in the central subbasin reaches throughout the steep terrain.

A total of approximately 18 miles of roads were built at near or equal elevation to the streambank transition line with sidecast covering the streambank leading to the creek. More roads were located slightly upslope, but still near the creek (not mapped with this study). On a watershed-wide basis, about 80 percent of the aggraded reaches and about 70 percent that were braided occurred in areas of historic instream/streamside roads and landings in 1984. Some 145 instream landings and 174 km of instream/streamside roads were spatially associated with stream braiding and aggradation. The dense network of historic instream/streamside roads and landings that lined Robinson, Dry, and Stewart creeks showed a similar high correlation with stream braiding and aggradation (excess of 75 percent) in 1984.

Modern Roads

Successive aerial photo overlays show a shift in current road locations to ridgelines and mid-slope benches. This coincides with general field observations that the older streamside roads are now mostly vegetated and wooded. The current road network now consists of 291 miles. The U.C. Davis Information Center for the Environment ("ICE") developed a contemporary road map for the total maximum daily load (TMDL), which shows most of the current roads located distant from watercourses. We clipped all "ICE" roads within 50 feet of a watercourse to find about 2.5 miles of current roads within 50 feet of blue line streams in the subbasin. Of these roads, about one mile are located in areas that may be affected by historically active landsliding and stream bank erosion. These are concentrated in the steep central subbasin reaches throughout the Robinson Creek and Stewart Creek PWSs.

Although the current road network has less overall coincidence of debris slides and stream crossing failures compared to historic times, most of the contemporary road failures are in close proximity to streams and steep slopes. There are approximately 3 miles of roads crossing steep slopes (excess of 60 percent), mostly located throughout the deeply incised central subbasin reaches. Combining roads segments with streams and steep slopes shows that active point slides are found within 60 meters of a road and predominantly along blue line streams in steep areas. These areas occur primarily throughout the central subbasin reaches, in the Robinson Creek and Stewart Creek PWSs. The Ecological Management Decision Support (EMDS) model shows the North Fork Subbasin with a high road density for the Gualala River Watershed overall at 6.1 miles per square mile, reflecting active timber harvesting during the 1990s. This can indicate a need to evaluate and potentially upgrade road drainage facilities to current sizing standards, and to actively monitor the road network during the winter period to assure functional dispersal of drainage.

Landowners within the North Fork Subbasin have implemented some road-upgrading programs. Many programs are developed in conjunction with the GRWC, government agencies and/or Resource Conservation Districts. For example, GRI, in partnership with the Watershed Council and the Sotoyome Resource Conservation District (Sonoma County) has assessed and produced an implementation plan for the entire Little North Fork watershed. When the work is completed approximately 45 miles will be upgraded and an estimated 57,993 cubic yards of sediment will be prevented from entering the watercourses. As part of GRI road management program, an additional 32 miles of roads (26 percent) has been upgraded in the North Fork Subbasin in the last three years reducing sediment delivery to streams by an estimated 8,606 cubic yards.

The 1986 and 1996 storms produced the dominant sediment pulses in the subbasin in recent times, causing blowouts of substandard road watercourse crossings (log, etc) and undersized culverts. There are 2.7 road crossings per mile of stream in the North Fork Subbasin. Recent upgrade measures completed after these storms have reduced overall failures. More recent surveys of the GRI road network to detail additional upgrade specifications have occurred, and some of the recommended road upgrade work has been completed. The NCWAP potential restoration map (Plate 3, Figures 5.2-23a and 5.2-23b) identifies high probability sediment source areas, combining the analysis for both historic and current roads. This map shows the central subbasin reaches of the North Fork Subbasin with the highest priority for future restoration work for sediment abatement.

5.2.6 FLUVIAL GEOMORPHOLOGY

In the lower reaches of the subbasin, streams generally meander through alluviated valleys that range from a couple of hundred feet to almost a thousand feet across within steep valleys. The mainstem North Fork channel is sinuous and low gradient with a well-developed floodplain and stable point bars.

About 56 percent of the Subbasin has a high to very high potential for landsliding and represents a major source area for stream sediment (Figure 5.2-4). Instream sediment levels, indicative of disturbance, occur along 29 of 127 miles of the blue lines streams in the subbasin. This is a 40 percent reduction compared to levels in 1984. Most of the reduction occurred in the tributaries, while the lower reaches showed less change. Table 5.2-3 lists the lengths of sediment storage mapped and relative change between 1984 to 1999/2000 for the North Fork Subbasin.

Table 5.2-3
North 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
Billings Creek	10.4	26.7	15.5	40.0	-33.1	38.8
Stewart Creek	9.4	34.6	15.9	58.5	-40.9	27.1
Robinson Creek	9.2	20.2	14.5	31.6	-36.2	45.9
Doty Creek	0.2	1.4	2.4	16.2	-91.5	14.9
Total	**29.2**	**23.0**	**48.3**	**38.1**	**-39.5**	**126.7**

5.2.7 WATER QUALITY

Instream Sediment

Streambed substrate cores can be quite variable across a riffle area, however, the percent fines <0.85 mm from McNeil cores of riffles at four sites in the mainstem Little North Fork, one site in Doty Creek, and one site in McGann Gulch (sites dot 256, mcg 209, lnf 255, lnf 201, lnf 202, lnf 203), often exceeded the Gualala proposed TMDL target of 14 percent. Dry Creek site 211 was closer to the target, but was exceeded three out of the four years.

According to THP records and California Department of Forestry and Fire Protection (CDF) aerial photo analysis, historic sediment sources still exist in this subbasin. For example, in McGann Gulch, a large instream landing complex built in the late 1960s more recently failed in the 1990s. The upper reaches have scoured out leaving the sediment to settle out in the lower reaches. Due to the loading, McGann Gulch now flows underneath the gravel at the base of the Gulch during low flows, upstream of the North Fork, or dries up, stranding young-of-the-year steelhead trout. Instream landings and streamside roads from the 1960s are densely concentrated in Dry and Robinson creeks, some of which continue to discharge during high stream flows. Pebble count data are available from GRI for a total of

12 sites for the period of 1997-2001. Data from the Coastal Forest Lands (CFL) are available for three sites for the period of 1995-1997 (Figure 5.2-13). Those data are presented in Appendix 4.

Water Temperature

Water temperature data from continuous recorders were available for 29 sites in the North Fork Subbasin (Figure 5.2-14). The period of record from 1994 to 2001 yielded 81 observations for maximum weekly average temperature (MWAT) and seasonal maximum temperature.

MWATs in the tributary sites were moderately to fully suitable. The mainstem sites varied from moderately suitable to moderately unsuitable for summertime rearing (Table 5.2-4, Figure 5.2-15). There was a trend from higher water temperatures upstream in the North Fork to lower temperatures as the stream flowed towards the ocean (Figure 5.2-16). Air temperatures are generally higher and canopy density lower in the upper, northeastern oak woodland and grassland, probably contributing to higher water temperatures. As the North Fork flowed west into the coastal influence and better canopy coverage, it also received flows from cooler tributaries, combining to reduce the mainstem water temperatures.

Seasonal maximum temperatures were below the lethal limit of 75 F except for the three upper-most stations in the northeastern area (sites NF214, NF272, NF216). Seasonal maxima at those stations ranged from 75-80 F for values from 1994-2001 (nine observations at the three sites).

Table 5.2-4
EMDS Ratings for Maximum Weekly Average Temperatures (MWATs) in the North Fork Subbasin

Stream	No. of Sites	No. of Observations	Period of Record	EMDS Suitability Ratings						
				+++	++	+	0	-	--	---
North Fork Mainstem	10	25	1994-2001							
Lost Creek	1	3	1995-1998							
Dry Creek	4	14	1994-2001							
McGann Gulch	2	4	1995-1997							
Robinson Creek	5	16	1994-2001							
Doty Creek	2	2	1994, 1998							
Little North Fork	5	17	1994-2001							

EMDS ratings:
+++ = fully suitable (50-60F)
++ = 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)

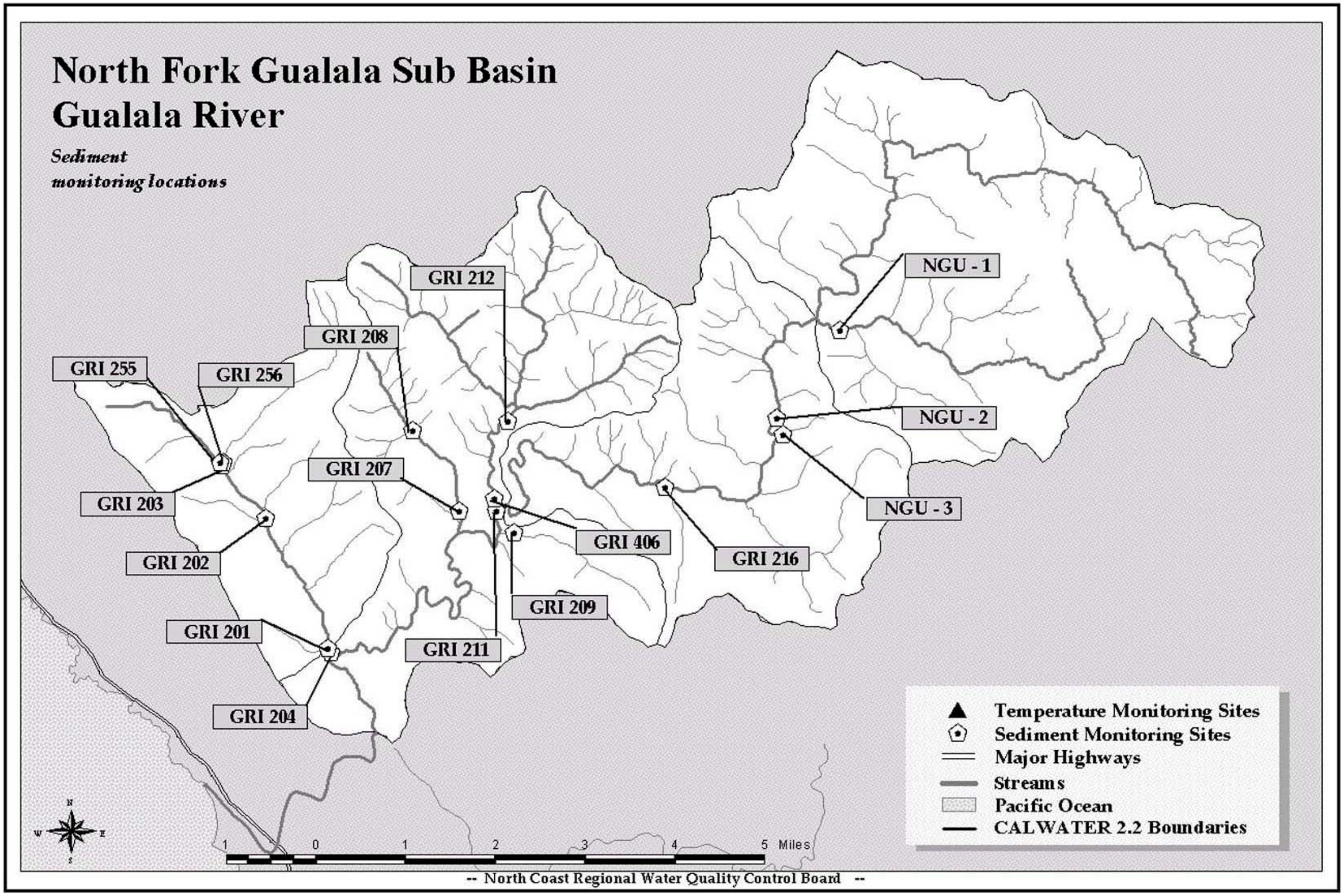

Figure 5.2-13
Instream Sediment Sampling Sites, North Fork Subbasin

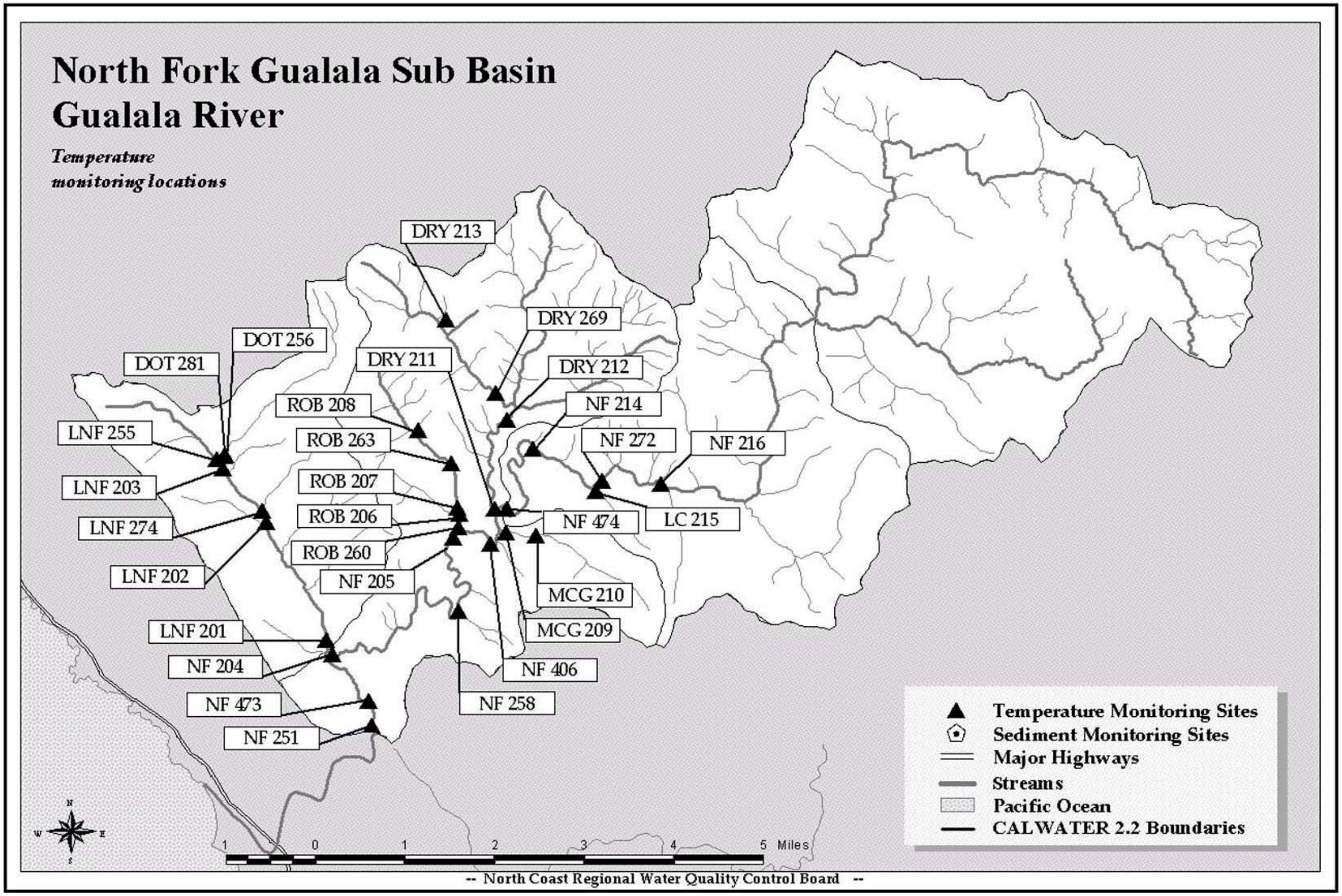

Figure 5.2-14
Instream Temperature Sampling Sites, North Fork Subbasin

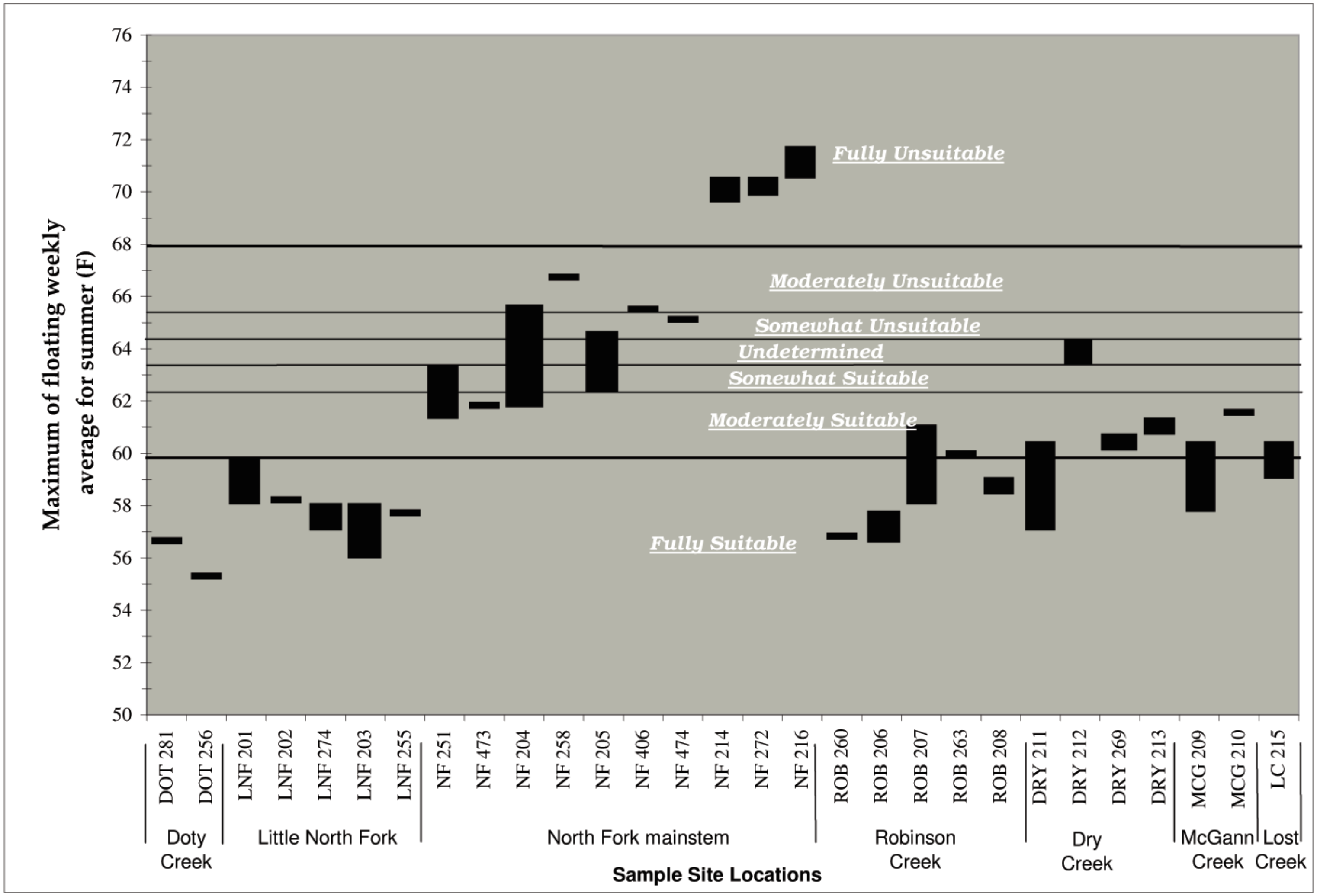

Figure 5.2-15
Maximum Weekly Average Temperature (MWAT) Ranges for the North Fork Subbasin from 1994-2001
(Data from GRI and GRWC continuous monitoring devices. See Figure SF1 for locations)

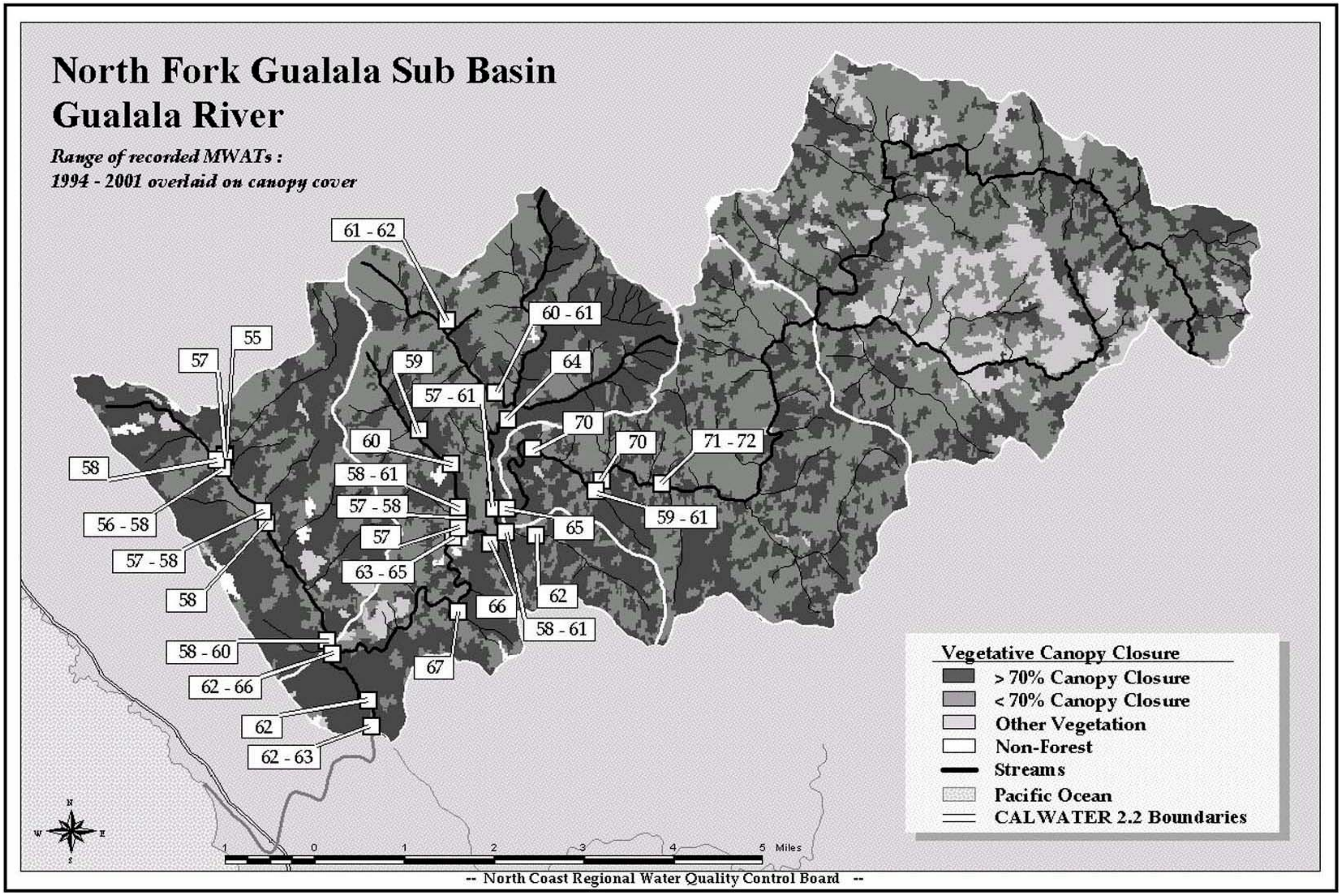

Figure 5.2-16
MWAT Temperature Ranges in the North Fork Subbasin for the Period of Record, 1994-2001
Overlaid on the LanSat Vegetation Layer for 2000

5.2.8 FISH HABITAT RELATIONSHIP

Historic Habitat Conditions

In 1964, CDFG stream surveys were conducted on the mainstem North Fork and the Little North Fork in the North Fork Subbasin. These surveys were made by direct observation and were not accompanied by quantitative data (Table 5.2-5).

Table 5.2-5
Summary of Historic (1964) Stream Surveys Conducted in the North Fork Subbasin, Gualala River Watershed, California

Tributary	Date Surveyed	Habitat Comments	Barrier Comments	Management Recommendations
North Fork Subbasin				
North Fork	9/17 and 18/1964	Excellent steelhead trout, coho salmon spawning and nursery stream. Spawning areas poor in the upper ½ of the stream and excellent in the lower ½ of the stream; Pool: Riffle ratio 50:50; Good shelter provided by logs, boulders, algae, and roots.	None	Should be managed as a steelhead trout, coho salmon stream. The future planting of coho salmon is recommended to increase the population. The removal of log jams is not recommended.
Little North Fork	9/10/1964	Fair spawning area with loose gravel available, approximately 60 percent of the stream available for spawning, spawning area suitable for steelhead trout and coho salmon. Pool: Riffle ratio 80:20. Good shelter available as undercut banks, overhanging vegetation, logs, and rocks	30 partial barriers	Continue to manage as a steelhead trout, coho salmon spawning and nursery stream. Habitat improvement, consisting of removal of slash and debris and log jams to improve fish passage and stream condition is suggested. Possible planting of coho salmon to establish a better run is recommended.

Current (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 were given for each of the individual habitat elements measured in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998) (Table 5.2-6). When habitat conditions fall below the target values, restoration projects may be recommended to meet critical habitat needs for salmonids.

Table 5.2-6
Habitat Inventory Target Values taken 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 more 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 2001 on eight streams in the North Fork Subbasin. Most of the tributaries surveyed were close to the target value for canopy cover with the exception of Dry Creek and Robinson Creek. Canopy cover target values were reached on Log Cabin Creek. North Fork, Log Cabin Creek, Robinson Creek and Little North Fork met the target values for pool tail embeddedness. Doty Creek and McGann Gulch did not meet the target value for embeddedness. The target values for pool frequency/depth were not met on any of the streams surveyed. The target values for pool shelter/cover were not met on any of the streams surveyed (Table 5.2-7). Robinson Creek had the highest shelter/cover rating, reflecting the addition of large wood by the Gualala River Watershed Council's Cooperative Monitoring Program.

Table 5.2-7
Summary of Current (1995, 1997, and 2001) Conditions Based Upon Habitat Inventory Surveys from the North Fork Subbasin, Gualala River Watershed, California

Condensed Tributary Reports are located in Appendix 5, Attachment E

Habitat Element Stream Name	Surveyed Length (feet)	Canopy Cover	Embeddedness	Primary Pool Depth/ Frequency	Shelter Cover Ratings
North Fork Subbasin*					
Doty Creek	6,237	74%	25%	4%	36
Dry Creek	11,161	58%	70%	6%	32
Dry Creek Tributary #1	2,695	59%	51%	22%	30
Little North Fork	20,806	76%	83%	16%	54
Log Cabin Creek	1,698	83%	90%	1%	43
McGann Gulch	1,980	76%	0%	3%	5
North Fork	59,362	78%	82%	29%	28
Robinson Creek	7,819	66%	65%	3%	70

Log Cabin Creek had a canopy cover over 80 percent not a habitat deficiency. Canopy cover on the North Fork, Little North Fork, McGann, Robinson, Dry and Doty Creeks showed a habitat deficiency related to canopy cover (Figure 5.2-17).

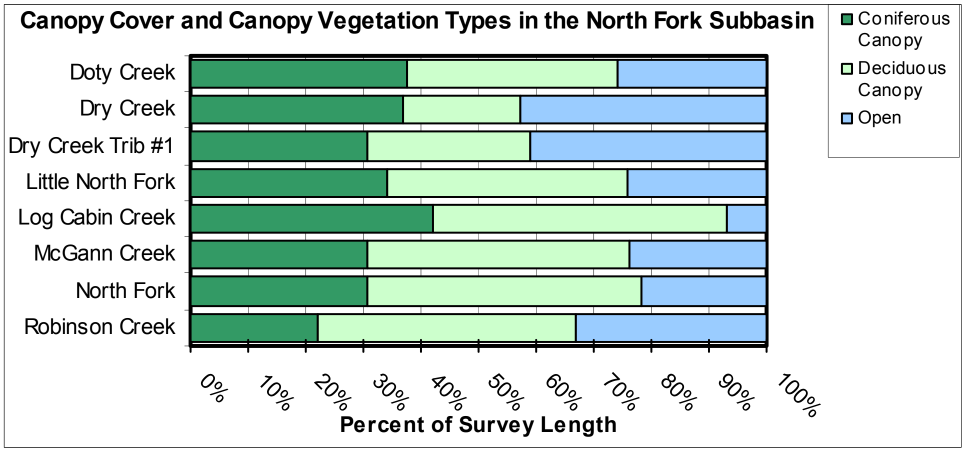

Figure 5.2-17
Canopy Cover and Canopy Vegetation Types in the North Fork Subbasin 2001, Gualala River Watershed, California

The GRWC measured canopy cover independent of CDFG's surveys (Figure 5.2-18). Their method differed in that they measured in the middle of the habitat unit, whereas CDFG measured at the head (upstream end) of the unit. Canopy composition was also measured differently. GRWC calculated composition type by identifying and counting tree species in riparian plots that extended from bank full to 100 feet inland on both sides of the channel. CDFG calculated the percent vegetative composition by estimating the percent of shade each vegetation type represented in the densiometer.

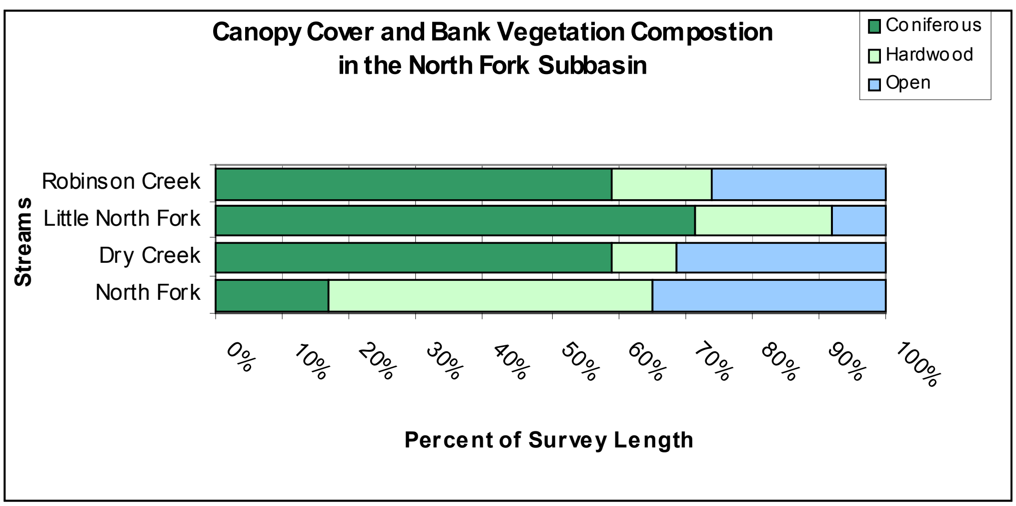

Figure 5.2-18
Canopy Cover and Canopy Vegetation Types in the North Fork Subbasin measured by the Gualala River Watershed Council, Gualala River Watershed, California

Categories 1 and 2 embeddedness (<50 percent embedded) are considered the most suitable for spawning. Category 5 is unsuitable spawning substrate, which includes clay, bedrock, and logs. Embeddedness was not a habitat deficiency on Dry Creek, Dry Creek Tributary #1, Little North Fork, Log Cabin Creek, the North Fork, and Robinson Creek. Embeddedness values on both Doty Creek and McGann Gulch showed habitat deficiency (Figure 5.2-19).

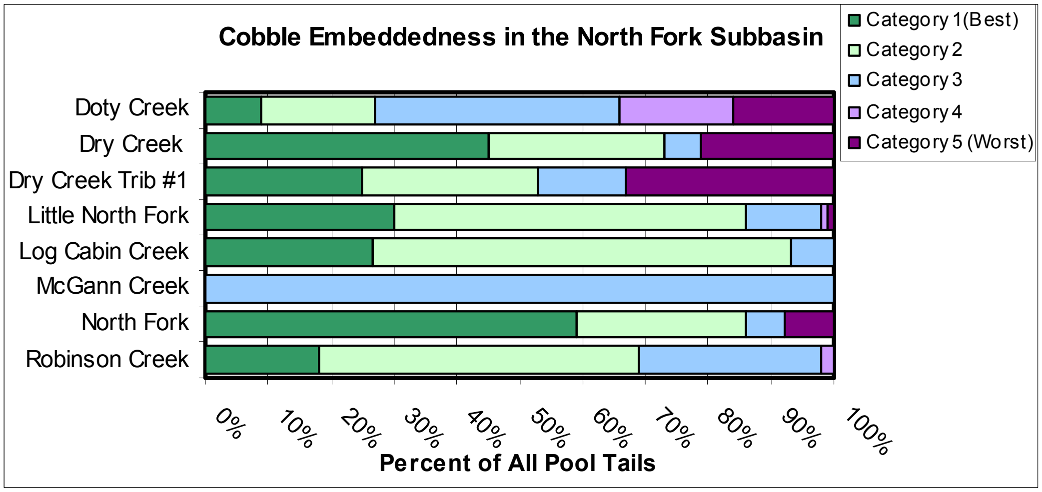

Figure 5.2-19
Cobble Embeddedness in the North Fork Subbasin 2001, Gualala River Watershed, California

All of the streams surveyed in the North Fork Subbasin showed habitat deficiencies in pool depth/frequency (Figure 5.2-20). Both the Little North Fork and North Fork had a pool frequency over 40 percent pools, meeting the frequency target value. However, neither met the depth target value based on the stream order. The Little North Fork is a second order stream with a target of 40 percent of the pools 2 feet or over. The North Fork mainstem is a third order stream with a target of 40 percent of the pools 3 feet or over.

Shelter/cover ratings were below target values for all of the streams surveyed in the North Fork Subbasin (Figure 5.2-21). The top three types of shelter/cover provided were mostly small woody debris, large woody debris and boulders (Figure 5.2-22). Small woody debris, large woody debris, and boulders provided most of the shelter on Doty and. Dry Creeks. Small woody debris, large woody debris, and root masses provided most of the shelter on the Little North Fork. Small woody debris, undercut banks, and root masses provided most of the shelter on Log Cabin Creek. Most of the shelter was provided by undercut banks, root masses and aquatic vegetation on McGann Gulch. Small woody debris, terrestrial vegetation, and boulders provided most of the shelter on the mainstem North Fork. Small woody debris, large woody debris, and undercut banks provided most of the shelter on Robinson Creek.

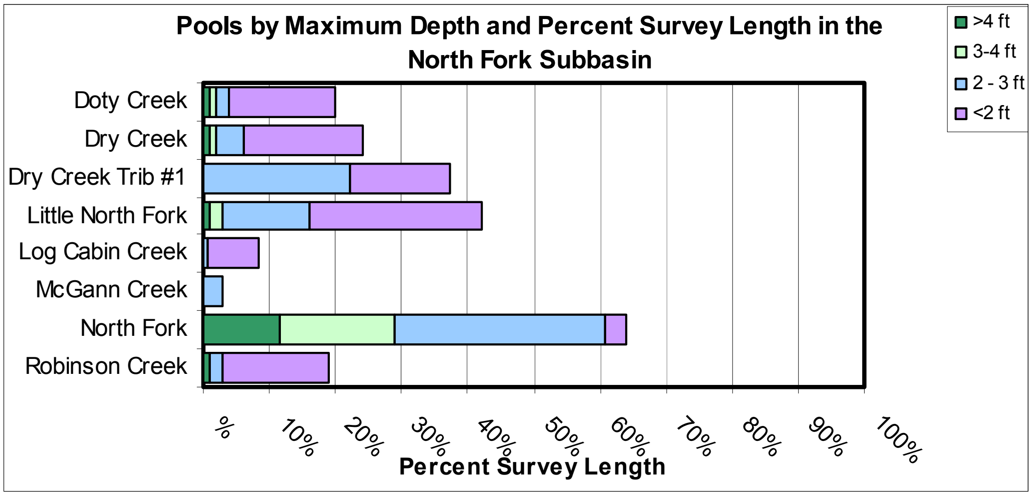

Figure 5.2-20
Pools by Maximum Depth and Percent Survey Length in the North Fork Subbasin 2001, Gualala River Watershed, California

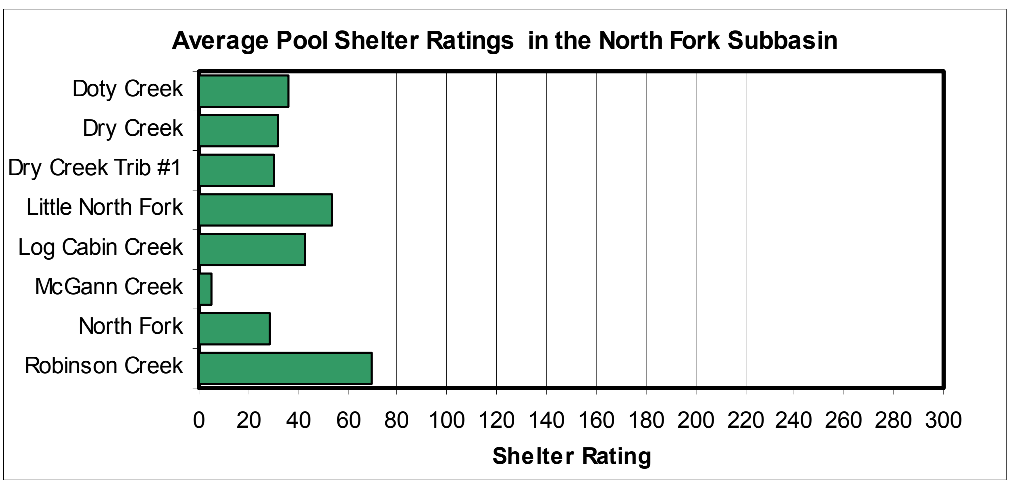

Figure 5.2-21
Average Pool Shelter Ratings in the North Fork Subbasin 2001, Gualala River Watershed, California

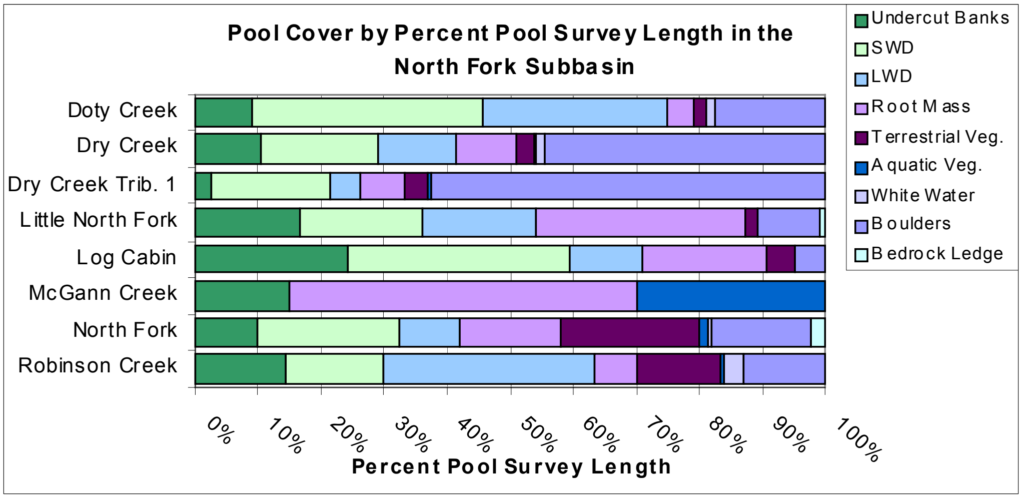

Figure 5.2-22
Type of Pool Shelter/Cover by Percent of Pool Survey Length in the North Fork Subbasin 2001, Gualala River Watershed, California

Large Woody Debris Data

Large woody debris data were provided by the GRWC's Cooperative Monitoring Program. Most large wood was cleared from the streams during the 1950s, 1960s and 1970s. The literature suggests a target value of 130 pieces of large wood >8 inches per 1,000 feet (Beechie and Sibley 1997, Martin 1999).

Large wood surveys were conducted on Robinson Creek, Dry Creek, the Little North Fork, and the lower section of the North Fork mainstem. Both Dry Creek and the Little North Fork have the highest wood volume and most pieces per 1,000 feet of stream reach for the subbasin. The high pool ratios in both tributaries could be a reflection of the higher large wood volumes.

A large wood placement project placed 9,100 cubic feet of large woody debris in the Little North Fork and Robinson Creek tributaries. Approximately 64 pieces of large woody debris with an average diameter of 32 inches were added to the Little North Fork at eight sites along the stream reach. The placement of wood is not included in Table 5.2-8.

Table 5.2-8
Summary of Watershed Cooperative Monitoring Program large woody debris data, North Fork Subbasin (1998 - 2000) Watershed size is calculated as the area above the monitoring site.

Tributary	Site Number	Watershed Size (acres)	Volume Cubic Feet/1,000	Quantity Pieces/1,000
North Fork	473	30,600	1,567	33
North Fork	204	25,433	1,958	35
Little North Fork	404	4,217	5,099	50
Little North Fork	203	1,963	3,843	77
Robinson	207	1,068	1,592	39
Dry Creek	211	4,104	5,168	69
Dry Creek	212	3,756	2,470	27

Changes In Habitat Conditions From 1964 to 2001

Changes between historic and current instream conditions were compared on the streams surveyed in 1964 and subsequently habitat inventoried from 2001. Data from the 1964 stream surveys provide only a qualitative snapshot of the conditions at the time of the survey, and 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.

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

In the North Fork Subbasin, both the Little North Fork and the North Fork were surveyed in 1964 and 2001. The canopy cover increased indicating improved conditions over those observed in the 1960s aerial photographs. The spawning substrate conditions appear to have improved or remained the same between 1964 and 2001. The 2001 pool frequency/depth and shelter cover appear to have decreased since 1964 (Table 5.2-9).

Table 5.2-9

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

Habitat Element Stream Name	1964 Canopy Cover Photos	2001 Canopy Cover	1964 Spawning Substrate	2001 Spawning Substrate	1964 Pool Depth/ Frequency	2001 Pool Depth/ Frequency	1964 Shelter Cover	2001 Shelter Cover Value	Change in Conditions from 1964 to 2001
North Fork Subbasin				>50%		>40%		>80	
Little North Fork	Low or Absent	76%	Good	83%	50%	16%	Good	54	Recovered canopy; Improved spawning conditions; Decreased pool habitat and shelter/cover.
North Fork	Low or Absent	78%	Excellent	82%	80%	29%	Good	28	Recovered canopy; No change or return of spawning conditions; Decreased pool habitat and shelter/cover.

Ecological Management Decision Support (EMDS) Reach Model

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 judgment, 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. The reference curve breakpoints for these habitat parameters are presented in Table 4.1-1, Chapter 4.

EMDS scores for the subbasin overall were not calculated because only 81 percent of the blue line streams were habitat inventoried, and water temperature data was recorded in 2001 on only four of the eight streams surveyed. The MWAT on the Little North Fork was fully suitable at both of the sites sampled. The MWAT on Dry Creek was fully suitable at the only site sampled. The five MWATs on the mainstem North Fork in 2001 ranged from moderately suitable to fully unsuitable. The MWAT's increased as the sample sites moved upstream in an easterly direction away from the coast. The average of the five MWAT's was 64 F, an undetermined EMDS score for the mainstem (Table 5.2-10).

Table 5.2-10
Ecological Management Decision Support (EMDS) Reach Model Scores on Salmonid Heath and
Productivity Suitability for the North Fork Subbasin, Gualala River Watershed, California , Based Upon
Habitat Inventory Surveys Conducted in 2001

Subbasin Stream Name	Canopy Cover Score	Embeddedness Score	Pool Depth Score	Pool Shelter Score	Pool Quality Score	2001 MWAT Water Temperature Score
North Fork Subbasin	n/a	n/a	n/a	n/a	n/a	n/a
Doty Creek	+++	-	- - -	- -	-	
Dry Creek	-	++	- - -	- - -	- - -	+++
Dry Creek Tributary #1	-	+	- - -	- -	- -	
Little North Fork	+++	++	- - -	- -	- -	+++
Little North Fork Tributary #1	+++	+	- -	- -	- -	
Log Cabin Creek	+++	+	- - -	- -	- -	
McGann Gulch	++	- - -	- - -	- - -	- - -	
North Fork	++	++	+++	- - -	U	U
Robinson Creek	-	-	- - -	+	-	+++

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 were incorporated into both the identification of LFAs and their ranking.

Pool shelter/cover was the predominant limiting factor in the North Fork Subbasin, followed by pool depth, and canopy cover. Pool depth was the predominant limiting factor on most of the streams surveyed with the lack of pool shelter/cover being a close second. Embeddedness was limiting on both Doty Creek and McGann Gulch. Canopy cover was a limiting factor on Robinson and Dry Creeks (Table 5.2-11).

Table 5.2-11
Limiting Factors in the North Fork Subbasin Affecting Salmonid Health and Production Based Upon Habitat Inventory Surveys Conducted in 2001 and EMDS Scores in the North Fork Subbasin (*Rank 1 is the most limiting factor*)

Subbasin Stream Name	Canopy Cover Related to Shade over the stream	Embeddedness Related to Spawning Suitability	Pool Depth Related to Summer Conditions	Pool Shelter Related to Escape and Cover
North Fork Subbasin Score				
Doty Creek		3	1	2
Dry Creek	3		1	2
Little North Fork			1	2
Little North Fork Tributary #1			1	2
Log Cabin Creek			1	2
McGann Gulch		3	2	1
North Fork				1
Robinson Creek	2		1	

Restoration Recommendations

The proposed restoration recommendations were based upon the habitat inventory surveys, limiting factors analysis, landowner and local expertise, and the biologist's professional judgment.

Restoration recommendations for the North Fork Subbasin are listed by priority, "1" being the highest priority (Table 5.2-12). The highest priority for restoration is instream structure enhancement. The next four recommendations, in order of decreasing priority, are: road repair or removal, bank stabilization, barrier removal, and riparian/canopy development. Livestock/ feral pig exclusion was not identified as a problem in the sections of the subbasin surveyed.

Table 5.2-12
Priorities for Restoration for the North Fork Subbasin
Rank 1 is the highest priority

Stream Name	Bank Stabilization	Roads Repair or Removal	Riparian Canopy Development	Instream Structure Enhancement	Livestock or Feral Pig Exclusion	Barrier Removal
North Fork Subbasin	3	2	5	1		4
Doty Creek		2	4	1		3
Dry Creek			2	1		
Little North Fork		2		1		
Little North Fork Tributary #1		2		1		
Log Cabin Creek	3	2		1		
McGann Gulch	2			1		
North Fork		2		1		
Robinson Creek		2	3	1		

Figure 5.2-23a illustrates the limiting factors as determined by CDFG and various sediment sites identified by CGS as potential restoration targets. Figure 5.2-23b 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].).

Potential Refugia

The NCWAP interdisciplinary team identified and categorized refugia habitat by using professional judgment and criteria developed for north coast watersheds. The criteria considered different values of watershed and stream ecosystem processes, the presence and status of fishery resources, forestry and other land uses, land ownership, potential risk from sediment delivery, water quality, and other factors that may affect refugia productivity. Information from CDFG's habitat inventory surveys, EMDS reach model, professional judgment, and local Gualala River Watershed expertise were used to assess streams as potential refugia. Five NCWAP Refugia Categories and Criteria were described: (1) High Quality Refugia; (2) High Potential Refugia; (3) Medium Potential Refugia; (4) Low Quality Habitat; and (5) Critical Contributing Areas (Section 2.2.5, Chapter 2).

Medium Potential Refugia was identified in the Little North Fork and North Fork. The potential refugia identified on the Little North Fork were related to shade canopy and water temperature. The potential refugia identified on the North Fork were related to shade canopy and pool depth (Table 5.2-13).

Table 5.2-13
Refugia Categories for Surveyed Tributaries in the North Fork Subbasin, Gualala River Watershed, California

Stream	Refugia Categories				Other Categories		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area	Data Limited
North Fork Subbasin							
North Fork Gualala River			X			X	X
Little North Fork			X			X	
Robinson Creek				X		X	
McGann Gulch				X		X	X
Dry Creek				X		X	
Doty Creek				X		X	
Log Cabin Creek				X			X

5.2.9 FISH HISTORY AND STATUS

Salmonid population data is very limited in the North Fork Subbasin.

- **1950s**- No data available.
- **1960s**- In 1964, stream surveys were done on the North Fork and Little North Fork. Both the Little North Fork and North Fork showed steelhead trout and coho salmon present.
- **1970s**- No data available.
- **1980s**- Steelhead trout density in 1983 was 0.85 fish per meter at one station on Robinson Creek (three-pass electrofishing method). Three-pass electrofishing data were collected on a lower and upper site in the Little North Fork in 1988 and 1989, with an average steelhead trout density of 0.45 fish per meter.
- **1990s**- During the 1990s, 45,280 coho salmon were planted on the Little North Fork. GRI observed coho salmon young-of-the-year during snorkel surveys on the Little North Fork, Robinson, and Dry Creeks in 1998. One-year and older steelhead trout were observed on the Little North Fork, Robinson, North Fork, and Dry Creek in 1999 during snorkel surveys. Three pass electrofishing data were collected on a lower and upper site in the Little North Fork in 1990-1993, 1995, 1998, 1999, and 2000. No effort was recorded in 1990-1992. Both sites showed small fluctuations in young-of-the-year populations and a slight increase in one-year-old fish from 1995-2000. Two-year and older steelhead trout numbers were identical at the lower site and slightly increased at the upper site from 1998-2000. Between July 1, 1999 and June 30, 2000, spawner and electrofishing surveys were conducted on the Little North Fork. These surveys were conducted to determine whether the planting of coho salmon during the three-year period of 1995/1996-1997/1998 was effective. These coho salmon were from Noyo River stocks, hatched and reared at the Mad River hatchery. No coho salmon were found on the Little North Fork.
- **2000s**- During the 2000s, 13,050 steelhead trout were planted between Elk Prairie and Dry creeks. Young-of-the-year and one-year-old steelhead trout were observed (no coho salmon) on the North Fork using the Modified Ten Pool Protocol. During snorkel surveys, GRI observed one-year and

older steelhead trout on the Little North Fork, North Fork, Robinson and Dry Creeks in 2000 and 2001. In September 2002, coho salmon young-of-the year were observed in Dry Creek, a tributary of the North Fork during a snorkel survey, and at two sites on the Little North Fork and Doty Creek during electrofishing. Coho young-of-the-year were present on McGann Gulch (pers. comm. R. Dingman).

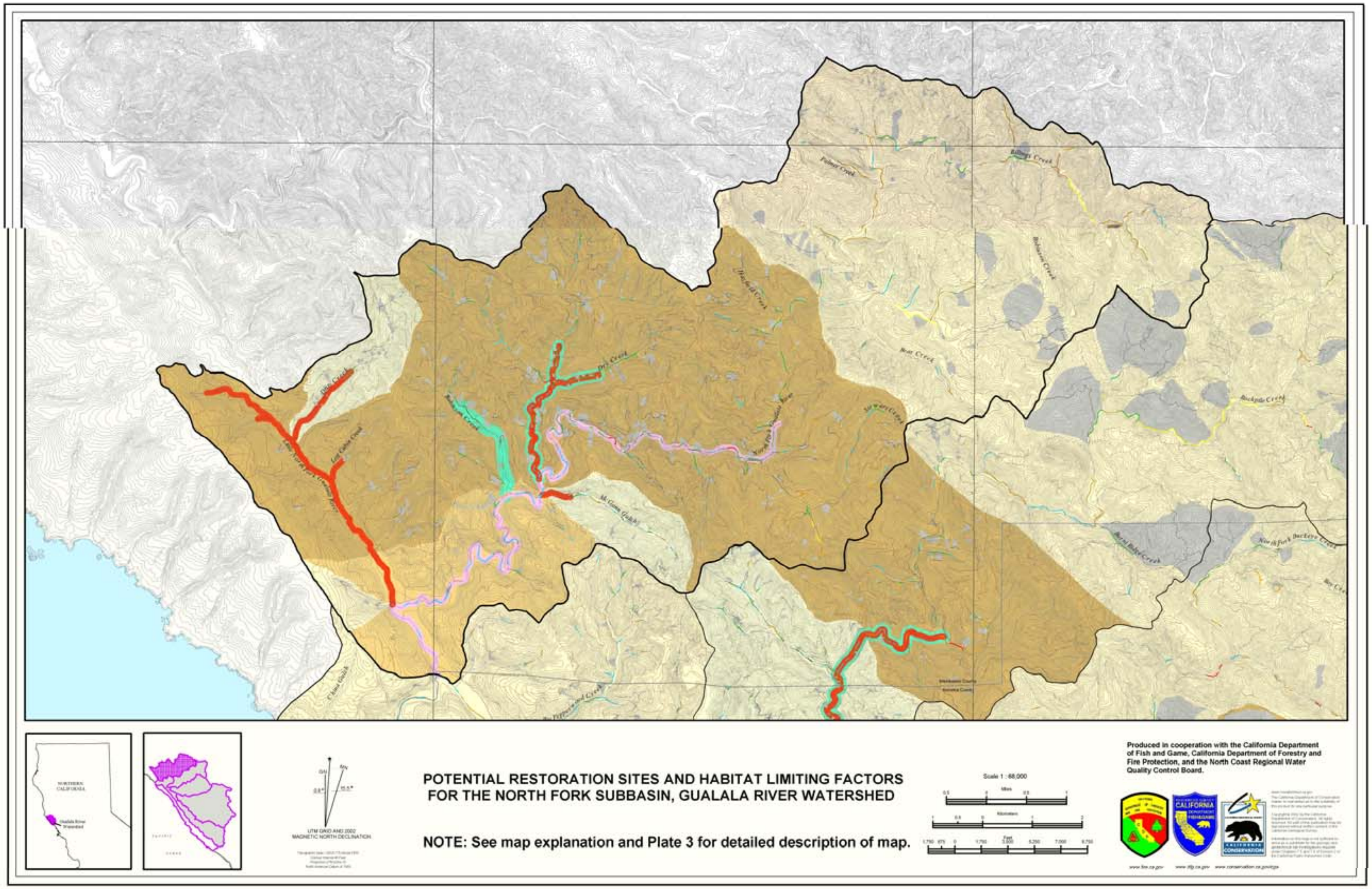

Figure 5.2-23a
Potential Restoration Sites and Habitat Limiting Factors for the North Fork Subbasin, Gualala River Watershed

Explanation

Roads
Streams
Watershed boundary
Sub-basin boundary
Historically Active Landslides (mapped as a point if too small to delineate at the scale of this map)

I SPATIALLY ASSOCIATED FACTORS DERIVED FROM AERIAL PHOTO INTERPRETATION OF LANDSLIDING AND SEDIMENT CONDITIONS

A *HISTORIC IN-STREAM ROADS POSSIBLY RELATED TO FLUVIAL SEDIMENT*

Stream reaches with persistent aggrading or braiding in both 1984 and 2000 photos that may be associated with historic in-stream roads or landings. See recommendation #5.

B *ROADS POSSIBLY RELATED TO LANDSLIDES AND/OR ERODING BANKS*

Road segments that may be affected by historically active landsliding and bank erosion. See recommendation #6.

Road segments that may be affected by historically active landsliding. See recommendation #7.

C *FLUVIAL SEDIMENT CONDITIONS POSSIBLY RELATED TO LANDSLIDES*

Stream reaches with potentially adverse sediment accumulations that may be affected by historically active landslides and lack any apparent association with the modern road network or the historic in-stream roads or landings. See recommendation #8.

Stream reaches with potentially adverse sediment accumulations that may be affected by erosion from adjacent dormant landslide terrain that lack any apparent association with historically active landsliding, the modern road network, and historic in-stream roads or landings. See recommendation #9.

D *POTENTIALLY UNRELATED FLUVIAL SEDIMENT CONDITIONS*

Stream reaches with potentially adverse sediment accumulations that lack any of the above associations. See recommendation #9.

II LIMITING FACTORS DERIVED FROM GROUND BASED HABITAT SURVEYS (SEE DFG APPENDIX)

A *CANOPY AND POOLS AS LIMITING FACTORS* (All stream reaches surveyed by DFG in 2001 are highlighted as follows. Reaches that were not surveyed in 2001 are not highlighted on the map.)

Stream reaches with inadaquate canopy cover as the limiting factor. See recommendation #2.
Stream reaches with inadequate pool depths as the limiting factor. See recommendation #4.
Stream reaches with inadequate pool shelter as the limiting factor. See recommendation #3.
Stream reaches with both inadaquate pool depths and shelter as limiting factors. See recommendations #3 and #4.

B *EMBEDDEDNESS AS A LIMITING FACTOR*

Areas draining into where embededdness conditions are unknown.
Areas draining into reaches where embeddedness is not limiting.
Areas draining into reaches where embeddedness is marginal but not limiting.
Areas draining into reaches where embeddedness is somewhat limiting. See recommendation #1.
Areas draining into reaches where embeddedness is significantly limiting. See recommendation #1.

RECOMMENDATIONS BASED ON LIMITING FACTORS

(1) Reduce production of fine sediment throughout the contributing area. Evaluate contribution from roads and upgrade roads as appropriate. Evaluate contribution from soil disturbance and control erosion as appropriate (see recommendations 5-10). Evaluate contribution from soil disturbance and control erosion as appropriate. Consider the additive effect of the short-term increases in erosion due to mitigation activities. Distribute individual activities both spatially and temporally as appropriate to avoid additive sediment impacts. Institute best management practices in erodible areas; such as, areas shown on the CGS Relative Landslide Potential Map (Plate Two), and National Resources Conservation Service soil maps.

(2) Enhance current riparian vegetation by planting additional trees, and stabilize stream banks as needed. Also, consider both downstream and upstream effects.

(3) Enhance pool shelter by adding submerged or partially submerged structures. Consider both upstream and downstream effects due to operation and possible failure.

(4) Install in-stream structures to produce hydraulic variability and to scour pools. Consider both downstream and upstream effects due to operations and possible failure.

RECOMMENDATIONS BASED ON SPATIAL ASSOCIATIONS

(5) Evaluate relationship on-site. Consider channel restoration and drainage improvements for the road and landing. Consider engineered abandonment.

(6) Evaluate relationship on-site. Consider road drainage improvements to prevent saturation of slide area. Consider abandonment or realignment where feasible. Consider stream bank stabilization where feasible.

(7) Evaluate relationship on-site. Consider road drainage improvements to prevent saturation of slide area. Consider abandonment or realignment where feasible.

(8) Evaluate on-site whether these represent natural background conditions. If mitigation is desired, road construction may be needed for equipment access.

(9) No recommendation because potentially associated active sediment sources have not been identified.

EXPLANATION FOR POTENTIAL RESTORATION SITES AND HABITAT LIMITING FACTORS FOR THE GUALALA RIVER WATERSHED MAP

NOTE: See Plate 3 for complete description of map.

Produced in cooperation with the California Department of Fish and Game, California Department of Forestry and Fire Protection, and the North Coast Regional Water Quality Control Board.

www.fire.ca.gov www.dfg.ca.gov www.conservation.ca.gov/cgs

Figure 5.2-23b
Explanation for Potential Restoration Sites and Habitiat Limiting Factors for the Gualala River Watershed Map

5.2.10 NORTH 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 North Fork Subbasin and its fisheries, but do not necessarily reflect the findings of the assessment. Some have been disproved by the assessment findings.

- Abandoned roads, new road construction, and road maintenance issues related to landsliding and sediment input.
- High-water temperatures and low shade canopy density, as well as the density and diversity of the riparian zone.
- Location and conduct of timber harvest operations.
- Current logging practices on steep unstable slopes and near streams, especially regarding sediment contributions.
- Best management practices required by current forest practice rules are reducing forestry impacts to insignificance.
- Sediment as a limiting factor for salmonids due to pool filling, aggradation, and small-sized spawning substrate.
- Absence of salmonid information, low fish densities, or absences of fish.
- Invasive and exotic plants and wildlife may have affected the subbasin conditions to varying degrees in various locations. Pampas grass was mentioned as one of the prominent problem species.

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.

The hypotheses are presented by subbasin because of differences in geology, climate, and land use. However, they follow the same basic format. The three working hypotheses are:

1. Stream conditions in the North Fork Subbasin provide suitable habitat for salmonids.
2. Depleted overstory shade canopy cover along the upper North Fork mainstem and tributaries from legacy harvests and other factors continues to contribute to elevated water temperatures.

3. A lack of in stream large woody debris contributes to a simplified habitat structure (e.g., lack of large, deep pools).

4. Instream conditions are improving in the North Fork Subbasin.

Working Hypothesis 1

Stream conditions in the North Fork Subbasin provide suitable habitat for salmonids.

Supporting Findings

- Young-of-the-year coho salmon were observed in tributaries of both the Little North Fork and North Fork.
- Young-of-the-year, year-old and older steelhead trout were observed in all surveys throughout the subbasin in 2002.
- MWATs from 2001 were fully suitable on Dry Creek, the Little North Fork and Robinson Creek.
- Water temperatures for the period of record (1994-2001) were suitable in the tributaries and the mainstem North Fork downstream of the Little North Fork confluence.
- Canopy cover target values (from Flosi et al 1998) were met on Log Cabin Creek. The North Fork, McGann Gulch, Little North Fork, and Doty Creek nearly met the target values. Canopy cover has improved since the aerial photos of the 1960s. Embeddedness target values were met on Dry Creek, Little North Fork, Log Cabin, North Fork, and Robinson Creek (Section 5.2.8).
- Canopy cover EMDS scores were fully suitable on Doty Creek, the Little North Fork, and Log Cabin Creek. McGann Gulch and the North Fork were moderately suitable. Embeddedness was moderately suitable on Dry Creek, the Little North Fork, and the North Fork. Log Cabin was somewhat suitable. Pool depth was suitable on the North Fork. Shelter was somewhat suitable on Robinson Creek (Table 5.2-10).
- Areas of potential refugia were identified on the Little North Fork and North Fork.

Contrary Findings

- Water temperatures for the period of record (1994-2001) ranged from undetermined to fully unsuitable in the mainstem North Fork upstream of the confluence with the Little North Fork. MWATs and seasonal maxima were higher in the upstream areas, decreasing as the North Fork mainstem flowed off the oak woodland into the coastal areas (Figure 5.2-16).
- Seasonal maximum water temperatures were above the 75 F lethal level at the three upstream-most mainstem sites (nf216, nf272, nf214) for the period of record (Section 5.2.7).
- Canopy cover target values (from Flosi et al 1998) were not met on Dry and Robinson Creek. Embeddedness target values were not met on Doty Creek or McGann Gulch. Primary pool depth and frequency were not met on any of the streams surveyed. Pool shelter target values were not met on any of the streams surveyed (Section 5.2.8).
- Canopy cover EMDS scores were unsuitable on Dry Creek and Robinson Creek. Embeddedness was unsuitable on Dry Creek, McGann Gulch, and Robinson Creek. Pool depth was unsuitable fully unsuitable on Doty Creek, the Little North Fork, Log Cabin, McGann

Gulch, and Robinson Creek. Pool shelter was unsuitable on all inventoried streams except Robinson Creek (Table 5.2-10).

- Canopy cover as interpreted from aerial photos has not recovered to 1942 levels (Section 5.2.4).

- A high proportion of road crossings, and roads are located low on the sideslope (EMDS Watershed model). The EMDS model indicates a higher level of concern for overall subbasin conditions with more than 50 percent of the middle subbasin reaches harvested during the most recent 10 year period as a land use index.

Limitations

- Only 81 percent of the subbasin was habitat inventory surveyed.

- Available temperature data did not span all sites in all years from 1994-2001, however three or more years' data were available for five of the ten mainstem sites. Only one year's data were available for four of the ten mainstem North Fork sites (nf474, nf406, nf258, nf473). No temporal trends were apparent for the mainstem North Fork.

- Temperature data were limited to the lower half of the watershed (9 miles). No stream temperature data were available in the upper reaches of the main stem (Figure 5.2-16).

Conclusions

- The hypothesis is supported.

- Physical habitat conditions are suitable for salmonids in the North Fork Subbasin.

- Water temperatures are suitable for salmonids in the tributaries and in the mainstem North Fork below its confluence with the Little North Fork. Water temperatures were high in the upper mainstem North Fork.

Working Hypothesis 2

Depleted overstory shade canopy cover along the upper North Fork mainstem and tributaries from legacy harvests and other factors continues to contribute to elevated water temperatures.

Supporting Findings

- Canopy cover target values (from Flosi et al 1998) were not met on Dry and Robinson Creek as measured by habitat inventory surveys in 2001 (Section 5.2.8).

- Canopy cover EMDS scores were unsuitable on Dry Creek and Robinson Creek (Table 5.2-10).

- Three points emerged from the comparison of water temperature MWATs for the period of record to the LandSat vegetation layers: (1) water temperatures were higher in the upstream areas draining the northeastern portion of the subbasin, (2) vegetation in the area upstream of those high temperatures (Franciscan Complex mélange) is open oak grasslands with poor canopy, and 3)water temperatures in the mainstem North Fork decreased from upstream of Dry Creek to downstream of Robinson Creek (Figure 5.2-16).

- Timber harvesting prior to 1968 removed riparian canopy throughout the middle and upper mainstem North Fork (upstream from the confluence with Dry Creek) and higher tributaries in the subbasin (Section 5.2.4).

- Current riparian canopy in the middle subbasin reaches consists of mid sized 40 year old second growth coniferous stands. Riparian canopy stocking has not fully recovered to 1936 density and old growth conditions upstream from Dry Creek (Section 5.2.4)

- Linear regression of channel canopy measurements and MWATs for 11 sites in the Gualala River Watershed showed a significant relationship of water temperature to channel canopy (page 3-18).

Contrary Findings

- Canopy coverage as measured by bank-to-bank exposure has improved since 1968 aerial photos.

Limitations

- Only 81 percent of the subbasin was habitat inventory surveyed.

- A hydrothermal area is documented on the North Fork, one mile above the confluence of Stewart Creek approximately in line with two well-documented hydrothermal areas on the Tombs Creek Fault. The extent to which such areas may influence stream temperatures is unknown.

- The linear regression of canopy and MWAT did not account for the factors of stream flow, stream aspect, thermal reach length, air temperature, relative location in the watershed, contributions from tributaries and groundwater inflow, and differences among years.

Conclusion

- The hypothesis is supported.

Working Hypothesis 3

A lack of in stream large woody debris contributes to a simplified habitat structure (e.g., lack of large, deep pools).

Supporting Findings

- Shelter/cover did not meet Flosi, et al (1998) target values on any of the streams surveyed. (Table 5.2-6).

- Pool shelter EMDS scores were somewhat to fully unsuitable for the streams surveyed (Table 5.2-10).

- Pool depth and pool shelter are rank 1 and 2 limiting factors throughout the subbasin (Table 5.2-7).

- LWD is low due to streamside road construction, timber harvesting, and salmonid migration barrier removal. (Sections 5.2.4 and 5.2.8).

- Roads, landings, and skid trails built in or adjacent to streams between 1952 and 1968 buried, removed, and dispersed large woody debris. The reduction of LWD likely reduces pool formation and sediment storage in the tributaries (Section 5.2.4).

- Timber harvest up to the mid-1990s in the lower and middle reaches frequently selectively cut large conifer vegetation down to the stream bank, reducing the available recruitment supply of large woody debris (Section 5.2.4).

- Stream clearance projects in the 1970s and 1980s to clear log jam barriers to salmonid migration removed large amounts of woody debris throughout the North Fork Subbasin, except on the North Fork (Section 5.2.4).
- Stream buffers are regenerating since the mid-1990s under current land management practices and Forest Practice Rules, and large trees are present in the riparian zone in the alluvial flats. However, the dense stands of riparian zone conifers have not reestablished to levels seen before mid-20th-century logging (Section 5.2.4).
- The Watershed Cooperative Monitoring Program identified deficient large woody debris on the North Fork, Little North Fork, Robinson Creek, and Dry Creek (Table 5.2-8).
- Pool depth and pool shelter are rank 1 and 2 limiting factors throughout the subbasin (Table 5.2-7).
- Enhancement of instream structure is a priority 1 restoration priority (Table 5.2-12).

<u>Contrary Findings</u>

- Shelter was somewhat suitable on Robinson Creek.
- In the lower watershed woody debris large enough to function in the channels is abundant adjacent to Little North Fork, lower Doty Creek and lower Robinson Creek.

<u>Limitations</u>

- Only 81 percent of the subbasin was habitat inventory survey.

<u>Conclusion</u>

- The hypothesis is supported.

Working Hypothesis 4

Instream conditions are improving in the North Fork Subbasin.

<u>Supporting Findings</u>

- Overall levels of channel disturbance in the Robinson Creek PWS decreased from 1984 to 1999/2000, based on aerial photo interpretation. Approximately 75 percent of the main channel appeared disturbed with enlarged and numerous bars and lack of riparian vegetation in 1984. By 1999/2000 the main channel appeared to have improved with disturbance between 50 and 75 percent (Section 5.2.6).
- The Dry Creek channel was at least 80 percent disturbed in 1984 images. In the 1999/2000 images, the upper reach of Dry Creek improved to approximately 50 percent of the channel showing disturbance (Section 5.2.6).
- Overall conditions of the channels in the Doty Creek PWS improved from 1984 to 1999/2000, based on aerial photo interpretation (Section 5.2.6).
- At least 80 percent of the North Fork channel within the Stewart Creek PWS appeared disturbed from 1984 aerial photos. By 1999/2000, the channel appears to have improved to 50 to 70 percent disturbance (Section 5.2.6).

- Thalweg profiles from 1998 to 2001 at three sites (nf 204, lnf 203, dry 211) in the subbasin showed no significant changes in bed elevation in these response reaches (Appendix 4).

- Canopy coverage has increased since 1968 aerial photos as measured by bank-to-bank exposure (Section 5.2.4).

<u>*Contrary Findings*</u>

- Canopy coverage as measured by bank-to-bank exposure has not recovered to the extent observed in 1936 aerial photos (Section 5.2.4).

<u>*Limitations*</u>

- Canopy coverage (bank-to-bank exposure) and fluvial characteristics came from aerial photo interpretation. The direct linkage to fish habitat conditions has not been made.

<u>*Conclusions*</u>

- The hypothesis is supported.

- Overall levels of channel disturbance have improved since 1984.

- Canopy coverage as measured by bank-to-bank exposure has improved since 1968, but not to 1936 levels. More information on the improvement with regard to riparian composition over the period of photo records is needed to discuss improvement in the riparian zone beyond canopy coverage.

Subbasin Recommendations

1. Maintain and enhance riparian zones to achieve target canopy density and diversity including large conifers for LWD recruitment.

    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 North Fork and its tributaries.

    b, Maintain or enhance existing riparian cover. Where current canopy density and diversity are inadequate and site conditions are appropriate, initiate tree planting, thinning, and other vegetation management to hasten the development of a denser, more extensive and diverse riparian canopy. Dry Creek, Robinson Creek, the central and higher reaches of the mainstem, and the lower reaches of Bear and Stewart Creeks are high priority areas for riparian improvements. Areas with persistent bank exposure include: (1) the central and higher reaches of the mainstem, (2) the lower reaches of Bear and Stewart Creeks, and (3) the upper reaches of Dry Creek.

    c. Land managers in this subbasin should be encouraged to add more large organic debris and shelter structures in order to meter sediment inputs, improve channel structure, channel function, habitat complexity, and habitat diversity for salmonids. Pool shelter has the lowest suitability for salmonids in the whole subbasin. 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 enhancement is the top tributary recommendation.

2. Address existing and potential sediment sources. Refer to Plate 3, *Potential Restoration Sites and Habitat Limiting Factors for the Gualala River Watershed* for more specifics.

   a. Continue efforts such as road erosion proofing, improvements, and decommissioning throughout the subbasin to reduce sediment delivery to the North Fork and its tributaries. Road sediment inventory and control is second of the top three tributary recommendations. Activities to reduce road-related sediment inputs are suggested for the Little North Fork and tributaries (Doty Creek, Log Cabin Creek, Tributary #1), Robinson Creek, Stewart Creek, McGann Gulch, and the mainstem North Fork.

   b. At stream bank erosion sites, encourage cooperative efforts to reduce sediment yield to streams. Bank stabilization is the third priority of tributary recommendations. Bank stabilization is a restoration priority 2 for McGann Gulch, and priority 3 for Log Cabin Creek.

   c. Decommission and revegetate streamside roads:

      i) Focus on the instream and near-stream roads where channel braiding and/or aggradation are still persistent today, as noted in Stewart and Dry Creeks, upper Billings Creek, and upper Robinson Creek tributary to Billings Creek.

      ii) Concentrate on those tributaries in the lower and central subbasin reaches containing the best historical anadromous habitats where mid-20th-century operations caused the worst damage: Doty, Log Cabin, Dry, Robinson, and Stewart Creeks, and McGann Gulch. A waterfall upstream of the confluence of Stewart Creek and the mainstem blocks anadromous fish passage.

   d. Concentrate modern road upgrade/ repairs starting with those associated with historically active landsliding and/ or eroding streambanks on:

      i) The main timber haul route following the North Fork between Dry Creek and Stewart Creek, and 2 upslope roads crossing unnamed tributaries in this area

      ii) Dry and Stewart Creeks, and the upper reaches of Robinson Creek tributary to Billings Creek.

   e. In the timber dominant lower and central subbasin reaches:

      i) Incorporate mitigation elements into Timber Harvest Plans and pursue cost sharing grants to decommission legacy streamside roads and upgrade existing road drainage facilities.

      ii) Encourage the use of cable or helicopter yarding on steep and unstable slopes to reduce soil compaction, surface disturbance, surface flow interference, and the resultant sediment yield.

      iii) Evaluate the possibility of spreading timber harvesting operations over time and space to avoid concentrated road use by heavy equipment and resultant mobilization of road surface fines into watercourses.

   f. Consider careful planning of land uses that could exacerbate mass wasting, since the relative potential of landsliding is high to very high in 56 percent of the subbasin.

   g. Pursue cost sharing grants such as those organized by the Sotoyome RCD to upgrade roads in upland areas underlain by the mélange.

h. Evaluate the fish rescue activities and fish holding facilities on Doty Creek to determine if it is causing a migration barrier and/or habitat degradation due to water diversion.

3. Encourage the continuation and expansion of stream monitoring using the protocols developed by the GRWC.

4. Encourage more habitat inventory surveys and biological surveys of tributaries, as only 81 percent has been completed.