North Coast Watershed Assessment Program

Gualala River Watershed Assessment Report

March, 2003

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California Environmental Protection Agency
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Accessing NCWAP Products

The North Coast Watershed Assessment Program produces a number of reports and other information products. This page provides a guide to what we produce and how to gain access to those products.

NCWAP Reports

NCWAP's main products are basin level assessment reports for each subject watershed. These reports consist of an integrative synthesis report and a number of discipline oriented appendices. A limited number of these synthesis reports and appendices were produced in printed media for program cooperators, stakeholder groups, and program partners. Printed reports were also distributed to most major libraries. Printed documents are not currently available to the public; however the entire synthesis report document, including appendices and maps, is available on a compact disk (CD) in PDF format or via the NCWAP website www.ncwatershed.ca.gov. The NCWAP watershed assessment reports are currently available for the Gualala River, Mattole River, and Redwood Creek watersheds. Other reports will become available over time. CDs containing the reports, appendices, and maps may be requested from:

California Department of Fish and Game
Wildlife and Habitat Data Analysis Branch
1807 13th Street, Suite 202
Sacramento, CA 95814
(916) 324-9265

Klamath Resource Information System CDs and Website

The Institute for Fisheries Resources (IFR) has produced Klamath Resource Information System (KRIS) projects for six North Coast watersheds. KRIS is a custom software program capable of managing watershed datasets, tables, charts, photos and maps. There are currently KRIS products for the Noyo, Big, Ten Mile, Gualala, and Mattole rivers, and Redwood Creek; they are available via the IFR website (www.krisweb.com). These products may also be requested on Compact Disc from:

Department of Forestry and Fire Protection
Fire and Resource Assessment Program
1920 20th Street
Sacramento, CA 95815
(916) 227-2651
frap@fire.ca.gov

Maps of Landslides and Relative Landslide Potential

The California Geological Survey has produced maps and GIS coverage of landslides and relative landslide potential. To order additional maps contact one of the California Geological Survey offices:

Publications Sales-Sacramento
(916) 445-6199   fax: (916)324-5644

Publications and Information Office-Sacramento
(916) 445-5716

Southern California Regional Office-Los Angeles
(213) 239-0878

Bay Area Regional Office-San Francisco
(415) 904-7707

You may also download the order form from the web site:
www.consrv.ca.gov/cgs/information/publications/ordering.htm

Datasets and GIS Products

NCWAP has produced a number of datasets and GIS products as a part of its work. These are available at the NCWAP website, www.ncwatershed.ca.gov

Executive Summary

Gualala River Watershed Assessment

North Coast Watershed Assessment Program

The North Coast Watershed Assessment Program (NCWAP) is an interagency effort between the California Resources Agency and the California Environmental Protection Agency (CalEPA), established to provide a consistent body of information on North Coast watersheds for use by landowners, stakeholders, and collaborative watershed groups. The program's work is intended to provide answers to the following assessment questions at the basin and subbasin scales in California's North Coast watersheds:

- What are the history and trends of the size, distribution, and relative health and diversity of salmonid populations?
- What are the current salmonid habitat conditions? How do these conditions compare to desired conditions?
- What are the past and present relationships of geologic, vegetative, and fluvial processes to stream habitat conditions?
- How has land use affected these natural processes?
- Based upon these conditions, trends, and relationships, are there elements that could be considered to be limiting factors for salmon and steelhead trout production?
- What watershed and habitat improvement activities would most likely lead toward more desirable conditions in a timely, cost effective manner?

To help answer these questions, the watershed assessments met these strategic program goals:

- Organize and provide existing information and develop limited baseline data to help evaluate the effectiveness of various resource protection programs over time;
- Provide assessment information to help focus watershed improvement programs, and assist landowners, local watershed groups, and individuals to develop successful projects. This will help guide support programs, like CDFG's Fishery Restoration Grants Program, toward those watersheds and project types that can efficiently and effectively improve freshwater habitat and lead to improved salmonid populations;
- Provide assessment information to help focus cooperative interagency, nonprofit and private sector approaches to "protect the best" watersheds and streams through watershed stewardship, conservation easements, and other incentive programs;
- Provide assessment information to help landowners and agencies better implement laws that require specific assessments such as the State Forest Practice Act, Clean Water Act, and State Lake and Streambed Alteration Agreements.

The program was established by the California Resources Agency and the California Environmental Protection Agency, and developed by the Departments of Fish and Game (CDFG), Forestry and Fire Protection (CDF), Conservation/California Geological Survey (CGS), Water Resources (DWR), and by the North Coast Regional Water Quality Control Board (NCRWQCB) and State Water Resources Control Board. The Institute for Fisheries Resources (IFR) is also a partner and participant in this program.

Salmonids, Habitat, and Land Use Relationships

There are several factors necessary for the successful completion of an anadromous salmonid's life history. In the freshwater phase of the life history, stream connectivity, stream condition, and riparian function are essential for survival. Stream connectivity describes the absence of barriers to the free instream movement of adult and juvenile salmonids. Stream condition includes several factors: adequate stream flow, suitable water quality, suitable steam temperature, and complex habitat. Adequate instream flow during low flow periods is essential for good summer time stream connectivity, and is necessary to provide juvenile salmonids free forage range, cover from predation, and utilization of localized temperature refugia from seeps, springs, and cool tributaries. Three important aspects of water quality for anadromous salmonids are water temperature, turbidity, and sediment load. Habitat complexity for salmonids is created by a combination of deep pools, riffles, and flatwater habitat types.

Geology, climate, watershed hydrologic responses, and erosion events interact to shape freshwater salmonid habitats in the Gualala River Watershed. "In the absence of major disturbance, these processes produce small, but virtually continuous changes in variability and diversity against which the manager must judge the modifications produced by nature and human activity. Major disruption of these interactions can drastically alter habitat conditions" (Swanston, 1991). Major watershed disruptions can be caused by catastrophic events, such as the 1955 and 1964 floods. They can also be created over time by multiple small natural and / or human disturbances.

Naiman and others (1992) offer the perspective that "Several aspects of disturbance regimes are important to the functioning of biological communities in mountain watersheds. Unfortunately, knowledge of natural disturbance regimes is limited because of the length of time required for the processes to operate (100-1,000 years) and therefore to be observed by humans, and because recent use has altered the disturbance regimes in ways not fully understood." They go on to conclude, "Therefore, the type, intensity, and frequency of erosional events and their spatial distribution across the landscape are important considerations to understanding the relationships between geomorphic process, form, and ecological functioning of watersheds. The temporal and spatial scales at which these processes occur, however, complicate their study. Our minimal knowledge of natural disturbance regimes limits our understanding of the functioning of ecologically healthy watersheds over long periods and large spatial scales, thus precluding accurate environmental assessments of the long-term effects of land use in watersheds in the coastal ecoregion."

A functional riparian zone helps to control the amount of sunlight reaching the stream, and provides vegetative litter and invertebrate fall. These contribute to the production of food for the aquatic community, including salmonids. Tree roots and other vegetative cover provide stream bank cohesion and buffer impacts from adjacent uplands. Near stream vegetation eventually provides large woody debris and complexity to the stream (Flosi et al. 1998).

A main component of the North Coast Watershed Assessment Program (NCWAP) is the analysis of these stream and watershed factors in order to identify whether any of them are at a level that limits production of anadromous salmonids in North Coast watersheds. A limiting factor can be anything that constrains, impedes, or limits the growth and survival of a population. This limiting factors analysis (LFA) provides a means to evaluate the status of key environmental factors that affect anadromous salmonid life history. This information will be useful to identify the underlying causes of stream habitat deficiencies and help reveal if there is a linkage to watershed processes and land use activities.

The Gualala River Watershed

WATERSHED DESCRIPTION

The Gualala River drains 298 square miles along the coast of southern Mendocino and northern Sonoma counties (Figure ES-1). The river enters the Pacific Ocean near the town of Gualala, 114 miles north of San Francisco and 17 miles south of Point Arena. The Gualala River Watershed is elongated, running over 32 miles long in a north/south direction, with an average width of 14 miles. Elevations vary from sea level to 2,602 feet at Gube Mountain and terrain is most mountainous in the northern and eastern parts of the watershed. A long history of movement along the San Andreas Fault and the Tombs Creek Fault has been a dominant force in shaping of the watershed.

The climate is influenced by fog near the coast with seasonal temperatures ranging from 40 to 60 degrees Fahrenheit (F), and the interior areas of the watershed ranging from below freezing to over 90 F.

A rainfall/runoff hydrology predominates in the Gualala River Watershed, with minimal snow accumulation. Detention time and time of concentration of rainfall are reduced by steep slopes and high rainfall amounts, causing stream levels to rise quickly in response to rainfall. Alterations of the landscape can change the hydrologic curves, flood frequencies and peaks within the subbasins of the Gualala River Watershed. However, affects on unit discharge hydrographs due to changes in land use or geomorphology within the watershed can not be directly assessed with existing data. Precipitation in the watershed is highly seasonal, most precipitation occurring October through April. Average annual precipitation ranges from 33 inches at the lower elevations near the Pacific Ocean to 63 inches at the higher elevations in the southeastern upper watershed. Coastal conifer forests of redwood and Douglas fir occupy the northwestern, southwestern and central portions of the watershed, while oak-woodland and grassland cover many slopes in the interior. Coho salmon naturally inhabited the streams flowing from coniferous forest, but were likely sub-dominant to steelhead trout in interior areas due to the more open nature of the channels, less suitable habitat, and naturally warmer stream temperatures. The interior is largely grassland with scattered oaks. Surface waters in this area generally lack shade and are warmed with abundant sunshine and warmer air temperatures.

Current fish species include coho (silver) salmon (H. Alden, pers. comm. 2002, CDFG unpub. 2002), steelhead trout, pacific lamprey, roach, coastrange sculpin, prickly sculpin, riffle sculpin (R. Kaye, pers. comm. 2002) and three-spine stickleback. Above impassable barriers, resident populations of rainbow trout exist (Cox 1989). Species inhabiting the coastal lagoon/estuary include starry flounder, staghorn sculpin (Brown 1986) and Pacific herring (R. Kaye, pers. comm. 2002).

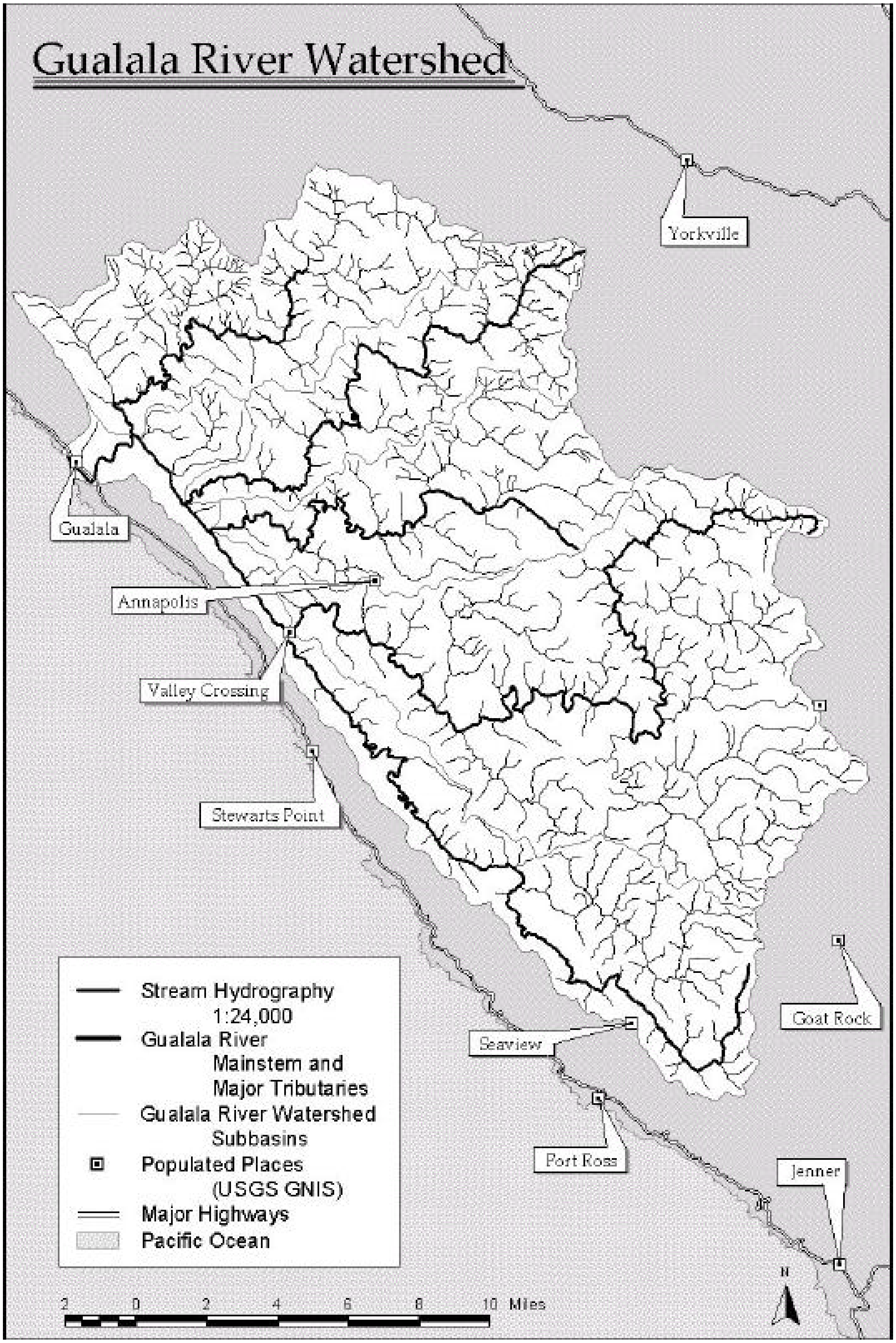

Figure ES-1
Gualala River Watershed Streams and Towns

Historic anecdotal accounts cite eulachon in the estuary and Sacramento sucker in the mainstems of both Buckeye Creek and the Wheatfield Fork (Higgins 1997). Snyder (1907) did not observe Sacramento suckers on the Wheatfield Fork. Juvenile Chinook (king) salmon specimens were caught prior to 1945, indicating that they were present at that time (D. Fong pers. comm.). It is unknown if eulachon, Sacramento sucker or Chinook salmon inhabit the watershed today.

Salmonid population data is limited for the watershed. Limited fish surveys combined with anecdotal evidence suggests that coho salmon and steelhead trout populations were large and experienced a decline prior to the 1960s. After World War II ended in 1945, the Gualala River became a popular place to fish for coho salmon, steelhead trout, and possibly chinook salmon, based on the 200-300 percent increase in fishing pressure (Taft 1946). The increased fishing pressure indicated that the coho salmon and steelhead trout populations were large in the 1940s. Length frequencies of fish captured in 1952 electrofishing in the North Fork showed a healthy condition (Kimsey 1952). Bruer (1953) wrote that there were millions of young steelhead trout and coho salmon in the Gualala River Watershed.

Fish stocking began in 1969, and over the next 30 years 347,780 hatchery coho salmon were stocked throughout the Gualala River Watershed. Even with the extensive planting, coho salmon had not been consistently observed, except in the North Fork Subbasin. Electrofishing data from 2001 indicated that coho salmon were not detected and possibly may be extirpated from the watershed (Coho Salmon Status Review 2001). In September of 2002, young-of-the-year coho salmon were observed in the North Fork Subbasin during snorkel surveys on Dry Creek, a tributary to the North Fork, and in two sites on the Little North Fork and Doty Creek during electrofishing surveys.

Although accurate coho salmon population estimates were never conducted, stream surveys indicated that the coho salmon population began to decline prior to the 1960s. Stream surveys from 1964 recommended stocking coho salmon to reestablish a viable self-supporting run in streams with pre-existing populations. This stocking indicated a shift from the large, fishable population of the 1940s toward the need to reestablish a viable population in the 1960s, further establishing that the coho salmon population declined during the 1950s. By 1956, adverse logging conditions and past improper practices had done considerable damage to the headwaters (Fisher 1957).

The distribution of coho salmon has changed substantially over the past 32 years in the watershed. Coho salmon were known to inhabit four of the five subbasins, some 10-15 tributaries. Currently, coho young-of-the-year are observed in the North Fork Subbasin only.

Starting in the 1940s and continuing today, steelhead trout have been actively fished on the Gualala River. In 1945, a summer juvenile steelhead trout closure was ordered to protect juvenile salmonids. This closure remained in effect until 1982. Bruer (1953) stated that the Gualala River was a prime steelhead trout and coho salmon stream and should be used to provide recreation for hundreds of anglers. By 1956, the Gualala River continued to sustain a good steelhead trout population despite the damage to the headwaters. Fishing pressure continued to increase through the early 1970s. In spite of the increased pressure, the steelhead trout catch was less than in the 1950s, probably due to smaller steelhead trout populations. During the 1970s, CDFG efforts focused on a program to enhance sport fishing, and began planting steelhead trout in 1970. By 1990, 426,290 had been planted.

Steelhead trout young-of-the-year and older were observed in all ten of the tributaries electrofished in September 2001. During the 2001 fishing season, local angler and long time Gualala CDFG Warden Ken Hofer reported that the steelhead trout run was the largest seen in over seven years.

The steelhead trout distribution does not appear to have changed over the past 37 years. This conclusion is based on comparison between stream surveys from 1964 and 1970, and the habitat inventory and electrofishing surveys of 2001. No data exist to confirm the steelhead trout distribution prior to the mid 1950s-60s logging era. Slash and log jams located in both tributaries and headwater areas were well documented in the 1964 and 1970 stream surveys. This logging debris caused barriers to fish passage and may have reduced steelhead trout distribution from its potential pre-logging range.

The Gualala River Watershed Council (GRWC), in collaboration with local landowners, has obtained funding to conduct stream surveys, road assessment and restoration, revegetation, instream habitat improvement, public education, and monitoring. Data on water temperatures, large woody debris, and other characteristics from the GRWC and other cooperators were helpful in this assessment.

GENERAL GUALALA RIVER WATERSHED ISSUES

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 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.**

- Filling of the estuary since the turn of the century due to sediment from logging
- The extent to which the estuary functions in sustaining salmonids, and what factors may be limiting its functions
- Excessive extraction of water during low flow periods, including the recent proposal to extract large volumes of wintertime flows and transport the water to Southern California
- 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
- Herbicides used on industrial timberlands and agricultural operations
- Location and conduct of timber harvest operations
- Best management practices required by current forest practice rules are reducing forestry impacts to insignificance
- Sub-division construction, grazing, feral pigs, and land use conversions
- Current logging practices on steep unstable slopes and near streams, especially regarding contributions of sediment to an already impaired system
- Sediment as a limiting factor for salmonids due to pool filling, aggradation, and small-sized spawning substrate
- Reduced instream large wood and limited large woody debris recruitment potential from past stream clearance projects and tree removal
- Absence of salmonid information, low fish densities, or absences of fish

- Impacts of invasive and exotic plants and wildlife on the watershed conditions; Pampas grass was mentioned as one of the prominent problem species.

General Assessment Methods

The NCWAP assessment is a science and history based assessment of watershed conditions. The assembled data were used to document current conditions and to infer trends and relationships between processes and conditions where possible. Establishing scientific certainty or proof of cause and effect was more limited due to fragmentary background data. While this limited our comparisons with recent data, collected under new methods and standards, this report provides a substantial body of pertinent information and conclusions. Current conditions were assessed to the extent possible with the resources available, using current standards of sampling, interpretation, and quality control. The synthesis of information resulted in the interpretation of current conditions and trends derived from aerial photos, satellite images, and field data. An Ecological Management Decision Support (EMDS) knowledge base was developed to identify relationships and to map the distribution of conditions suitable for salmonids. A logical outcome of the synthesis was the identification of limiting factors and subsequent management and instream recommendations for watershed protection and improvement.

METHODS

Each of NCWAP's participating departments developed data collection and analysis methods used in the assessments. They also developed a number of tools for interdisciplinary synthesis of the collected information. These include models, maps, and matrices for integrating information on basin, subbasin, and stream reach scales to explore linkages among watershed processes, conditions and use. These tools provided a framework for identifying watershed refugia areas and factors limiting salmonid productivity, as well as understanding the potential for cumulative impacts from natural and man caused impacts. This information provided the basis for developing restoration, management and conservation recommendations.

The Gualala NCWAP Team considered concerns and questions raised in scoping sessions with watershed residents, landowners, interested stakeholder groups, agencies, and other scientists. They then compiled existing information and data, and identified data gaps to focus additional data collection. This report describes data collection and analysis methods used by each of NCWAP's participating departments, and for identifying limiting factors for salmonids.

The CDFG identified the need for habitat inventories for the Gualala River Watershed. CDFG biologists used the standard channel, stream, and biological sampling methods contained within the CDFG's California Salmonid Stream Habitat Restoration Manual (Floss, et al. 1998) to survey over 100 miles of streams in the watershed in 2001. Prior to the NCWAP effort only 15 miles of habitat inventory survey existed. Electrofishing surveys occurred in conjunction with the habitat inventories. This data lead to the development of the limiting factor analysis, refugia identification, and EMDS Model stream Reach Model. CDFG, CDF and CGS co-developed a map of potential restoration sites.

While descriptive narratives about the land use history of the watershed existed, little of that was both site specific and quantitative in nature. CDF mapping included: 1) historical road networks (1945 – 1968) to compare with maps of current roads, 2) riparian canopy cover changes over time, and 3) timberstand and rangeland change detections as a function of area.

Evaluating the geology, relative slope stability and fluvial geomorphic characteristics within the Gualala River Watershed was a critical element in the assessment of current watershed conditions, the relative impact of past land-use practices (turn of the 20th century, mid-20th-century, and recent past of 1991-2001), and development of recommendations for further work to improve aquatic habitat conditions. The Department of Conservation/ California Geological Survey (CGS) updated existing landslide maps, provided new landslide maps where they did not currently exist, and provided stream channel geomorphic maps for the watershed. That effort was geared toward providing essential baseline geologic data to aid in the development of watershed restoration projects, watershed management strategies, and watershed plans. CGS produced a map of potential restoration sites with the data and recommendations from CDF and DFG.

The Regional Water Board assessment included comparison of recently collected and past available water quality information comprised predominately of a water temperature data set, some limited water chemistry data, and some limited sediment data. Those data were compared to the Water Quality Control Plan water quality objectives, and thresholds from the literature. Stream substrate core sample results were compared to targets from the Gualala River Watershed Technical Support Document for the Board's Total Maximum Daily Load program (TMDL).

Data and metrics from permanent stream monitoring reaches collected over the last five years by Gualala Redwoods, Inc and the GRWC were evaluated. This included results from continuous temperature measurements, thalweg surveys, pebble counts, canopy cover measurements, large woody debris inventories, macroinvertebrate sampling, riparian condition, stream cross sections, snorkel surveys and photo records.

The California Department of Water Resources conducted a hydrologic assessment of the Gualala River Watershed, which included climate and precipitation, stream flow, and stream flow diversion information. In addition, three stream flow gages were installed in the major branches of the river network.

The results of the assessments conducted by the various department personnel on the Gualala Team were brought together in an integrated synthesis process. This process attempts to describe the spatial and temporal relationships between the watershed and stream conditions and the dynamic watershed processes that have been at work to form them. To assist in this process, the team used GIS based watershed data coverages and an Ecological Management Decision Support (EMDS) model to help evaluate watershed conditions and processes.

SCALE OF INFORMATION

NCWAP's Gualala Team sub-divided the Gualala River Watershed into five subbasins for assessment purposes: North Fork, Rockpile, Buckeye, Wheatfield Fork, and the Gualala Mainstem/South Fork (Figure ES-2). Each subbasin has somewhat unique attributes that are generally common to the several CalWater 2.2a Planning Watersheds (PWS) contained within each subbasin. These PWS are approximately 3,000-10,000 acres and are used as planning and evaluation units for projects such as Timber Harvesting Plans submitted to CDF. These common subbasin attributes pertain to its geology, vegetation, climate, land use, streams, fisheries, towns and communities, access corridors, etc. The reader will encounter the term "blue line streams," which refers to those streams identified on standard U.S. Geologic Survey (USGS) topographic maps as solid blue lines.

Figure ES-2
The Gualala River Watershed with NCWAP subbasins and Calwater 2.2a Planning Watersheds.

Subbasins and their planning watersheds are used as the basis of the format of the assessment report. They also are used as the basis for display of the Ecological Management Decision Support system GIS images, geologic and landslide maps, landslide potential maps, potential restoration sites maps, and tabular data.

Assessment Products

The assessment is intended to be useful to landowners, residents, watershed groups, agencies, and individuals to help guide restoration, land use, and management decisions, and to direct further studies. The report includes descriptions of historical and current vegetation cover and change, land use, geology and geomorphology, water quality, water temperature, stream flow, water use, and instream habitat conditions. The compilation of existing data, collection of new data, and synthesis of those data provided the following products:

- New California Geological Survey (CGS) maps of landslides, relative landslide potential, and instream sediment features at a 1:24,000 scale for the entire Gualala River Watershed. Mapping was conducted from 1984 and 1999/200 aerial photo sets.
- New California Department of Fish and Game (CDFG) habitat inventory surveys and fish presence data for large portions of the major tributaries in the watershed (101.1 miles).
- New CDFG electrofishing presence/not detected status of coho salmon and steelhead trout.
- Historical fisheries data for some areas in the Gualala River Watershed.
- New CDFG table of Limiting Factors Affecting Salmonid Health and Production Based Upon Habitat Inventory Surveys Conducted in 1999 and 2001, and EMDS Stream Reach Scores in the Gualala River Watershed, California.
- New CDFG table of Potential Salmonid Refugia Based Upon Habitat Inventory Surveys, EMDS Stream Reach, professional judgment, and local expertise in the Gualala River Watershed, California.
- New California Department of Forestry and Fire Protection (CDF) mapping of historical and current land use patterns across the Gualala River Watershed.
- New CDF description of historical land use in the Gualala River Watershed.
- Data excerpted from the North Coast Regional Water Quality Control Board (NCRWQCB) TMDL study and other water quality studies of the Gualala River.
- Various data provided by cooperative landowners and the Gualala River Watershed Council in the Gualala River Watershed.
- A hydrologic report for the Gualala River Watershed prepared by the Department of Water Resources.
- New CGS, CDF, and CDFG map of Potential Restoration Sites and Habitat Limiting Factors for the Gualala River Watershed (Plate 3).
- New CDFG table of Priorities for Restoration for the Gualala River tributaries.
- Recommendations for management and restoration.
- Recommendations for additional monitoring.

- Ecological Management Decision Support system (EMDS) models to help analyze data.
- Databases of information used and collected.
- A data catalogue and bibliography.
- Web based access to the Program's products: http://ncwatershed.ca.gov.
- A CD under development through the Institute for Fisheries Resources (IFR) which uses the Klamath Resource Information System (KRIS) to present and describe selected assessment information.

General Assessment Questions, Conclusions, and Recommendations

The NCWAP Gualala Team utilized the six NCWAP assessment questions presented in the program description at the beginning of this summary to organize conclusions and recommendations. Discussion of this Team's findings and recommendations for improvement activities specific to subbasins, streams, stream reaches, and in some cases potential project sites are included in each subbasin section of this report. The Appendices to this report contain even more specific assessment methods, findings, conclusions, and recommendations for stream and watershed improvements.

Summary information is presented below, first for the Gualala River Watershed as a whole, then by individual subbasin. A summary table of conditions and recommended actions is provided as Table ES-1 at the end of this Executive Summary.

Watershed-Wide Findings, Conclusions, and Recommendations

What are the history and trends of the sizes, distribution, and relative health and diversity of salmonid populations in the Gualala River Watershed?

Salmonid population data are limited for the Gualala River Watershed. Limited fish surveys combined with anecdotal evidence suggest that coho salmon and steelhead trout populations on the Gualala River were large and experienced a decline prior to the 1960s. Thirty years of extensive planting of coho salmon occurred in an attempt to reestablish a viable population. In 2001, the Coho Salmon Status Report did not find coho salmon in their historical streams, and possibly extirpated from the watershed. In September 2002, a few coho salmon young-of-the–year were observed in tributaries of the Little North Fork and North Fork. Insufficient data exist to assess the current steelhead trout population, although it is likely that it also decreased in the 1960s. The steelhead trout distribution does not appear to have changed over the past 37 years.

What are the current salmonid habitat conditions in the Gualala River Watershed? How do these conditions compare to desired conditions?

[Erosion/Sediment] Instream sediment conditions in regards to salmonid habitat in some stream reaches in the watershed are considered unsuitable for salmonids. For example, in the inventoried section of Rockpile Creek pool depth was unsuitable and embeddedness was somewhat unsuitable, and extensive timber harvest between 1952 and 1960 (42 percent of the subbasin) created many streamside roads and landings that contributed sediment to the streams. Most of the Gualala River Watershed has improved from 1984 to 1999/2000, based on aerial photo interpretation of accumulations of sediment that were interpreted as indicative of channel disturbance.

[Instream Habitat] Pool habitat, escape and ambush shelter/cover, and water depth are unsuitable for salmonids in some mainstem and tributary stream reaches in the Gualala River Watershed. Large woody debris function in the channel is low throughout the watershed. Increasing the instream habitat complexity is the top recommendation category for all of the subbasins. The Gualala Mainstem/South Fork Subbasin has roads as a co-recommendation;

[Riparian/Water Temp] Water temperatures are suitable in the smaller tributaries for which we had data. In contrast, mainstem temperatures were in the unsuitable range in most of the subbasins. Canopy density also is limited in some areas of the watershed. Riparian/Water Temperature is a top recommendation category in the Wheatfield Subbasin;

[Gravel/Substrate] Available data from sampled streams suggests that suitable spawning gravel for salmonids is limited in some streams, and abundant in others;

[Other] Salmonid habitat conditions are the best in the North Fork Subbasin. Macroinvertebrate surveys indicate generally good conditions.

What are the relationships of geologic, vegetative, and fluvial processes to natural events and land use history?

The Coast Ranges in general and the Gualala River Watershed in particular are areas of naturally high background levels of landslide activity due to climate, steep slopes, weak rock, high rainfall, seismic shaking, and uplift. Natural disturbances such as large storms, earthquakes, and fires are triggers for episodes of widespread landsliding. Stream sedimentation trends fluctuate with the episodic recurrence of natural disturbances.

The large portions of the river flow along the San Andreas Fault Zone. Damage from the 1906 San Francisco earthquake was reported to include landslides from heavily timbered slopes that entered the river from both sides of the valley.

Certain land use activities have accelerated erosion into the river. Between 1950 and 1970, many timbered areas of the watershed were clearcut. Tractors were operated on steep, erosion prone slopes. Erosion and landsliding during the winters of those years appeared excessive compared to that of similar winters as seen in earlier photos. Widespread erosion of logging roads and landings was noted in aerial photos taken in 1965. CDF reports from that period described logging related erosion. More recent reports show that some of the roads in the watershed are still eroding periodically.

The intensity and the extent of timber harvest are lower in recent decades as compared to the 1950-1970 period. The degree of related erosion also has decreased. Further analysis is needed to determine to what extent recent land use related erosion is either retarding recovery or is detrimental to salmon habitat conditions. Regrowth of the timber stands and riparian areas indicates some degree of recovery throughout the watershed. Between 1984 and 1999/2000, sediment loads as evident from aerial photos have declined substantially, indicating some level of recovery. Specifically this indicates that since 1984, total erosion from upslope areas has not resulted in a net increase of sedimentation within the majority of the tributaries to a degree discernable in 1999/2000 aerial photos.

Future disturbances can variably aid or impede stream channel recovery. This natural variability and uncertainty makes prediction of the effects of current land use speculative. However modified practices and erosion control (such as those recommended in this report) in those areas identified and mapped as geologically unstable can reduce the degree to which land use related erosion may impact stream sedimentation and recovery.

How has land use affected these natural processes?

The Gualala River Watershed has been subject to three eras of intensive land use: 1) old growth redwood harvesting in the lower watershed reaches between 1868 to 1911, 2) tractor harvesting of remaining old growth areas between 1942 to 1968, and 3) cable/tractor harvesting of second growth in the lower watershed coastal reaches between 1991 and 2001. These activities were separated in time and space and have been affected by variable recovery functions.

Major rainstorm events have interacted with natural geologic instabilities and other natural conditions and processes to establish stream conditions. Anadromous salmonids have developed adaptive strategies to cope with this natural variability to a substantial extent. However, land use activities have accelerated natural erosion to varying degrees. Approximately 95 miles of instream/streamside roads simplified the stream channel complexity and structure throughout the watershed between 1952 and 1968. Timber operations and ranchland conversions removed riparian canopy cover, changing streambank exposure from about five percent in 1942 to a range of 40 to 70 percent bank exposure in the Gualala River Watershed by 1968. Most large woody debris was removed during mid-20th-century streamside road construction and stream clearance projects during the 1970s and 1980s.

Heavy rainfall and high river flows during mid-20th-century storm events activated many road debris slides and washed out large sections of streamside roads. Road failures were more pronounced in steep terrain and along streams and historically active landslides. Sediment generated by the mid-20th-century tractor era disturbances would be routed through the river network over a period of decades to centuries. Lower gradient stream reaches have longer residency time of this material. Higher embeddedness and a shallow pool structure can be long-term impacts in lower gradient reaches.

The early logging activities left a legacy of impacts, some of which persist to the present. The mid-20th-century tractor era caused the heaviest impacts. The use of crawler tractors was characterized by large-scale sideslope excavations and skid trail networks. Streamside road building pushed sidecast over the streambank, frequently burying the stream channel. Heavy winter storms during the mid-20th-century period caused channel aggradation, evidenced by temporary channel adjustments such as flow deflection around multiple road debris slides in logged areas.

The mid-20th-century harvests basically defined canopy conditions today. Current riparian canopy generally consists of mid sized 40-year-old second growth coniferous/mixed conifer hardwood stands in the middle to upper reaches. In the oak savanna that overlies the melange of the Franciscan Complex, riparian vegetation has not re-established since logging, probably due to continued grazing, slope instability, and higher air temperatures than in the coastal areas. Overall, watershed-wide riparian shade canopy has improved since the 1960s, but still falls short of the 1942 levels of canopy density and coverage. Large woody debris has not recovered from mid-20th-century removals. However, riparian zones in the western portion have largely recovered from the first round of logging. There are many large trees adjacent to the streams, in most cases providing recruitable large wood for the smaller tributaries.

Channel braiding and/or aggradation patterns spatially associated with the historical instream road network may persist in some of the middle reaches. The current road network shows less overall coincidence of debris slides and stream crossing failures compared to historical times. However, most of the contemporary road failures are in close proximity to streams and steep slopes. Timber Harvest Plan records generally indicate that road failures triggered by storm events represent a portion of contemporary management related sediment pulses in the watershed. The degree to which recent sediment inputs may delay, or possibly reverse channel recovery is not known.

Interpretation of aerial photos points out that stream channel characteristics associated with disturbance from sediment have improved from 1984 to 1999/2000. This period includes recent timber harvesting in the northern portion of the watershed that included new road building. Harvest of coastal redwood and Douglas fir actively occurs today, but with substantially improved practices. While some areas of the watershed experienced more improvement than others during this period, an overall trend towards improvement in the transport reaches was observed. Response reaches were varied. With continued reductions in the amounts of in-channel sediment accumulations, fish habitat values should also improve.

Based upon these conditions, trends, and relationships, are there elements that could be considered to be limiting factors for salmon and steelhead trout production?

Based on the information available for the Gualala River Watershed, salmonid populations are currently being limited by:

- General watershed-wide lack of instream habitat complexity;
- Instream sediment conditions in some areas;
- High summer water temperatures in the mainstems;
- Reduced watershed-wide coho salmon and steelhead trout populations over those observed in the 1960s.

What habitat improvement activities would most likely lead to more desirable conditions in a timely and cost effective manner?

A restoration action plan that targets the general areas identified below, and the specific locations identified in the subbasin sections that follow would help create a systematic viable approach. Watershed groups that work with the landowners, such as the Gualala River Watershed Council, may be well suited for this.

Flow and Water Quality Improvement Activities

- Continue stream flow gage maintenance for long-term flow studies.
- Reductions in sediment delivery and deposition, as well as improved riparian canopy density and diversity as presented in recommendations below, should improve water quality conditions for salmonids.

Erosion and Sediment Delivery Reduction Activities

- Continue efforts such as road assessments, storm proofing, improvements, and decommissioning throughout the watershed to reduce sediment delivery to the Gualala River and its tributaries.
- Evaluate and address sediment sources such as bank erosion, road erosion, gullies, road-stream crossing failures, skid trails, and erosion features associated with timber harvest through efforts such as road assessments, storm proofing, improvement, and road decommissioning, etc. Some historically active sediment sites are identified on Plate 3, Potential Restoration Sites and Habitat Limiting Factors for the Gualala River Watershed.

Riparian and Instream Habitat Improvement Activities

- Maintain and enhance existing riparian density and diversity. Where current canopy is inadequate and site conditions are appropriate, initiate tree planting and other vegetation management to hasten the development of denser, more extensive and diverse riparian canopy. 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. Artificial regeneration and vegetation management efforts should be targeted in the eastern reaches of the watershed, since riparian canopy has improved during the last 40 years in the lower and middle watershed reaches;

- Land managers should work to add more large organic debris and shelter structures to streams in order to improve sediment metering, channel structure, channel function, habitat complexity, and habitat diversity for salmonids. Pool depth and shelter consistently were limiting;
- Ensure that stream reaches with high quality habitat are protected from degradation. The best stream conditions as evaluated by the stream reach EMDS and identified as potential refugia were found in the North Fork and Little North Fork;
- Reduce livestock and feral pig entry into the riparian zone to encourage stabilization of stream banks and revegetation of the riparian zone.

Supplemental Fish Rescue and Rearing Activities

- Evaluate fish rescue activities and continue if deemed appropriate.

Education, Research and Monitoring Activities

- Encourage continuation and expansion of the in-channel monitoring using the protocols developed by GRWC.
- Expand the aerial photo interpretation of channel characteristics to include pre-1984 conditions. This will provide a better idea of the trajectory of improving conditions. Ground-truth the aerial photo interpretation of channel characteristics to compare to actual habitat conditions and fine-tune the analytical techniques for trend comparisons.
- Expand continuous temperature monitoring (water and air) into locations in the eastern portion of the watershed to help explain warmer water temperatures in those areas. Conduct canopy density and diversity sampling to enhance the water temperature data and facilitate modeling.

Subbasin Findings, Conclusions, and Recommendations

North Fork Subbasin

The most northerly of the five subbasins, the North Fork Subbasin has the steepest topography and broadest tributary valleys. Although the formation of this region created steep slopes, the area is relatively more stable and coherent compared to the rest of the watershed. About 56 percent of the Subbasin has a high to very high potential for landsliding. Major tributaries include the Little North Fork and Robinson, Dry, Stewart and Billings creeks. The land is primarily used for timber production, grazing, small vineyards and rural 40 acre and larger subdivisions. The Subbasin supports populations of steelhead trout, with coho salmon only occasionally observed.

Key Findings:

- Historically the Subbasin supported populations of coho salmon and steelhead trout. Steelhead trout and coho salmon were observed in the Little North Fork and North Fork in 1964. During the 1990s, 45,280 coho salmon were planted on the Little North Fork. The North Fork Subbasin supports populations of steelhead trout and shows some presence of coho salmon. Though information is limited, coho salmon and steelhead trout studies indicate that numbers are depressed compared to pre-1960s populations. Potential refugia have been identified in the North Fork and Little North Fork.

- Habitat elements in the North Fork Subbasin downstream of Stewart Creek are suitable and salmonids are present.
- Tributary water temperatures were mostly in the suitable ranges, with many deemed as "fully suitable." Water temperatures over the period of record (1994-2001) were in the unsuitable ranges in the mainstem of the North Fork upstream of the confluence with the Little North Fork. It appears that water temperatures in the mainstem are warmer upstream, due in part to higher air temperatures and low canopy density in the grassland/oak woodland areas. As the mainstem flows toward the ocean, water temperatures decrease in response to cooler air temperatures, better canopy density, and tributary inflows.
- The North Fork Subbasin has the highest road density in the watershed. Mid-20th-century roads and landings built in or near the main channel of the North Fork may still be contributing excess sediment. Streamside roads and landings were densely concentrated along Stewart, Dry, Robinson, and Doty Creeks. According to THP records and CDF aerial photo analysis, historical 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. However, recent upgrade measures completed after the 1986 and 1996 storms have reduced overall failures.
- 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. Shade canopy has improved based on 1999/2000 aerial photos, but has not recovered to 1936 levels. Canopy density was fully to moderately suitable on six out of the eight streams that were habitat inventoried. The exceptions were Dry and Robinson, which were both somewhat unsuitable.
- Pool depth and shelter are the most limiting factors (rank 1 and 2) for the Subbasin as a whole. Large woody debris is important in pool formation and shelter. Large wood was removed from the streams during the 1950s, 1960s and 1970s in association with timber harvest activities and stream clearance projects to improve fish migration access. Large wood surveys conducted in 1998-2000 in Robinson Creek, Dry Creek, the Little North Fork, and the lower section of the North Fork mainstem as part of the Watershed Cooperative Monitoring Program demonstrated that large wood is deficient in most areas of the Subbasin.
- Thalweg surveys indicate the channels have been stable over the last several years.
- Macroinvertebrate surveys indicate generally good conditions.
- Instream channel characteristics indicative of disturbance (sediment depositions, eroding banks, etc.) decreased by forty percent between the 1984 and 1999/2000 aerial photos, with 29 of 127 miles of blue line stream impacted in 1999/2000.

Key Recommendations:

- 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. 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.

- 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.
- 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.
- 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.
- Maintain and 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.
- 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.
- 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.
- 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.
- Encourage continuation and expansion of the in-channel monitoring using the protocols developed by GRWC.
- Encourage more habitat inventory surveys and biological surveys of tributaries, as only 81 percent of the Subbasin has been completed.

ROCKPILE SUBBASIN

The Rockpile Subbasin is bounded to the north by the North Fork Subbasin and to the south by the Buckeye Subbasin. It encompasses 35 square miles of private land primarily used for timber production and grazing. This Subbasin is not as steep as the North Fork Subbasin, but with the same zigzag pattern to the main channel. About 60 percent of the Subbasin is in the high and very high landslide potential categories. There are 88 miles of “blue line” streams, and two major tributaries: Red Rock Creek and Horsethief Canyon.

Key Findings:

- No historical fish data were available. Young-of-the-year, one year, and older steelhead trout were observed during habitat inventory surveys in 2001. Gradient is suitable for coho salmon in the mainstem of lower Rockpile up through the Middle Rockpile PWS, although tributaries to lower Rockpile mainly are too steep for the species. High water temperatures and restricted pool depth are likely limiting steelhead trout production.
- Conditions for salmonids generally were unsuitable in the mainstem of Rockpile Creek. The lower 8.5 miles of the 21.8 miles of the mainstem Rockpile Creek were habitat inventoried. Pool

depth, pool shelter, and canopy density were the three most limiting factors. Embeddedness of spawning gravel was rated somewhat suitable.

- A small tributary near the mouth had suitable water temperatures as measured in 1997-1998. Water temperatures were in the unsuitable ranges for summertime rearing of salmonids for the period of record (1994-2001) in the lower 11 miles of the mainstem and in Horsethief Canyon.
- The Rockpile Subbasin has yet to recover from logging practices from the 1950s and 1960s. Those practices resulted in a legacy of poorly sited roads and landings and sediment influxes to the system still observed today. A high density of road debris slides was observed in 1963 and 1981 aerial photos. Many sources may still be contributing excess sediment, especially where channel braiding and/or aggradation are persistent as noted in the mainstem, Red Rock Creek, and Horsethief Canyon.
- The canopy conditions seen today were essentially defined by mid-20th-century logging, and have not recovered to pre-1942 conditions. Current riparian canopy consists of mid-size 40 year old second growth coniferous and mixed conifer/hardwood stands in the middle to upper reaches.
- Large wood, important in metering sediment as well as creating pools and pool complexity, was deficient in the stream, based on data from the Watershed Cooperative Monitoring program and biologist’s observations during the habitat inventory survey in 2001.
- Overall levels of channel disturbance as interpreted from aerial photos were less in the Subbasin in 1999/2000 than in 1984. Instream sediment depositions indicative of disturbance occur along 20 of 88 miles of blue line streams, representing a 38 percent reduction from 1984 observations. Most of the reduction occurred in the tributaries, while the lower reaches showed less improvement.

Key Recommendations:

- Land managers in this 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. Pool shelter is the most limiting factor in Rockpile Creek, the stream surveyed in the 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 structure enhancement is the first of the top three recommendations.
- Maintain and enhance existing riparian cover. Where current canopy is inadequate and site conditions are appropriate, initiate tree planting and other vegetation management to hasten the development of denser and more extensive riparian canopy. Riparian canopy development is the second priority recommendation. The mainstem, Red Rock Creek and Horsethief Canyon are the primary areas needing attention.
- At stream bank erosion sites, encourage cooperative efforts to reduce sediment yield to streams. Grazing is an issue in the upper Subbasin. Bank stabilization is the third of the top three recommendations.
- Continue efforts such as road erosion proofing, improvements, and decommissioning throughout the Subbasin to reduce sediment delivery to central Rockpile Creek and Rockpile Creek tributaries. Focus efforts on areas adjacent to the streams, abandoning and vegetating historical streamside roads were feasible. Channel characteristics improved the least in the Middle and Upper Rockpile Creek PWSs.

- Encourage the use of cable or helicopter yarding on steep and unstable slopes to reduce soil compaction, surface disturbance, and resultant sediment yield.
- Consider careful planning of land uses that could exacerbate mass wasting, since the relative potential of landsliding is high to very high in 60 percent of the Subbasin.
- Encourage more stream inventories and biological surveys of tributaries, as only 39 percent of the Subbasin has been completed.
- Encourage continuation and expansion of the in-channel monitoring using the protocols developed by GRWC.

BUCKEYE SUBBASIN

The Buckeye Subbasin is bounded to the north by the Rockpile Subbasin and to the south by the Wheatfield Subbasin. It encompasses 40.3 square miles of private land used primarily for timber production, grazing, and small vineyards. It contains more moderate terrain compared to the North Fork and Rockpile. About 53 percent of the Subbasin falls into the high and very high categories for landslide potential. There are 90 miles of "blue line" streams, and three major tributaries: Flat Ridge, Grasshopper, and Osser creeks.

Key Findings:

- No current salmonid or other fish population data exist, and historical data are very limited. Though data are limited, historically the Subbasin probably supported populations of coho salmon and steelhead trout.
- Conditions for salmonids generally were unsuitable in the mainstem of Buckeye Creek. The lower 9.6 miles of the mainstem were habitat inventoried, and pool depth, shelter, and canopy density were the three most limiting factors. Embeddedness of spawning gravel was rated somewhat suitable.
- Water temperatures for the period of record (1994-2001) in the lower 13.5 miles of the mainstem and in Flat Ridge, Franchini, Grasshopper, and Soda Springs creeks were in the unsuitable ranges for summertime rearing of salmonids. A small tributary near the mouth had suitable temperatures as measured in 1998.
- Most of the middle reaches of the Buckeye Subbasin were clear-cut between 1952 and 1968 and included roads in or along the major tributaries, streams and the mainstem Buckeye. Timber harvesting activities today are much reduced in comparison. Debris flows and debris slides involved roads, and numerous failures occurred along instream and near-stream roads and landings as observed from historical aerial photos. These probably resulted in increased sedimentation in the streams. The Little Creek, Grasshopper, and Flat Ridge Creek PWSs have a high density of streamside roads and landings, a potential for large sediment inputs during storm events.
- Post World War II construction of roads, landings, and skid trails in riparian zones by crawler tractors eliminated overstory shade canopy cover on long sections of Buckeye Creek and tributaries. There was near entire canopy elimination in the Subbasin, with operations concentrated in the late 1950s to 1964. Some shade canopy in the highest tributary reaches was observed in 1999-2000 aerial photos. Several decades will be needed for shade canopy to recover to the 1942 conditions of mostly old growth coniferous cover.

- Review of 1961 and 1963 aerial photos showed riparian areas entirely cleared of vegetation and remnant downed logs. Construction of roads, landings, and skid trails in or adjacent to streams between 1952 and 1968 buried, removed, or dispersed large woody debris in the Subbasin. Field observations confirm low amounts of large woody debris. Although riparian areas are regrowing under current land management practices, dense buffers of conifers large enough to serve as large wood recruitment have not reestablished, except on the alluvial flats in the lower Subbasin.
- Overall levels of channel disturbance as interpreted from aerial photos were less in the Subbasin in 1999/2000 than in 1984. Instream sediment depositions indicative of disturbance occur along 18 of 90 miles of blue line streams, representing a 57 percent reduction from 1984 observations. Most of the reduction occurred in the tributaries, while the response (lower) reaches showed less change.

Key Recommendations:

- Land managers in this 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. Pool shelter is the most limiting factor in the Buckeye Creek, the stream surveyed in the Subbasin. Instream structure enhancement is the first of the top three recommendations.
- Enhance large woody debris through short and long-term efforts through 1) ongoing large wood placement efforts, and 2) enhancement of the natural large woody debris recruitment process by developing large riparian conifers with tree protection, planting, thinning from below, and other vegetation management techniques.
- Landowners should develop erosion control plans for decommissioning old roads, maintaining existing roads, and constructing new roads. Decommission and revegetate streamside roads where feasible, focusing on those associated with unsuitable fish habitat conditions such as Little, Franchini, Grasshopper, and Osser creeks.
- Maintain and enhance existing riparian cover. Ensure that adequate streamside protection zones are used on Buckeye Creek to reduce solar radiation and moderate air temperatures, particularly on mainstem and upper tributaries. Retain, plant, and protect trees to achieve denser riparian canopy where current canopy is inadequate, particularly on the mainstem and Francini, Grasshopper and Soda creeks.
- 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.
- Consider careful planning of land uses that could exacerbate mass wasting, since the relative potential of landsliding is high to very high in 53 percent of the Subbasin.
- Conduct both instream and hillslope monitoring to determine whether current timber harvest practices are allowing for recovery and protection of the salmonid habitat in the Subbasin. Use GRWC protocols for instream monitoring. Improve baseline information on habitat conditions by conducting inventory surveys in Buckeye Creek major tributaries.
- 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.
- Encourage more habitat inventory surveys and biological surveys of tributaries as only 37 percent of the Buckeye Subbasin has been completed.

WHEATFIELD FORK SUBBASIN

The Wheatfield Fork Subbasin has 246 miles of "blue line" stream in a watershed area of 111.6 square miles in the middle and eastern portion of the Gualala River Watershed. The mélange of the Franciscan Complex predominates in the eastern portion of the Subbasin. About 60 percent of the Subbasin is categorized as high to very high landslide potential. Most of the Subbasin is privately owned (166 acres of federal land), with land uses in timber production, grazing, vineyards, and some rural subdivisions.

Key Findings

- Historically the Subbasin supported populations of coho salmon and steelhead trout. Currently the Subbasin supports populations of steelhead trout. Though information is limited, coho salmon and steelhead trout studies indicate that populations are depressed compared to pre-1960s populations.
- Conditions for salmonids were generally unsuitable in the Wheatfield Fork Subbasin. The lower 22 miles of the mainstem were habitat inventoried, and pool shelter, depth, embeddedness and canopy density were the limiting factors. Embeddedness of spawning gravel varied, ranging from moderately unsuitable to moderately suitable.
- Water temperatures for the period of record (1995-2001) in the lower mainstem Wheatfield Fork and Fuller Creek were in the unsuitable ranges for summertime rearing of salmonids. Moderately to fully suitable temperatures were observed in the tributaries: Annapolis Falls Creek, Crocker Creek, and a small tributary near the mouth for the period 1995-1999. Some evidence of cooling of the mainstem by tributaries was observed in 2001.
- Most of the lower and middle reaches of the Wheatfield Fork Subbasin were clear-cut between 1952 and 1961, with roads in or along the major tributary streams. This left large areas of disturbed ground prone to erosion. Both mid-20th-century and modern aerial photos show numerous debris flows and debris slides involving roads and numerous failures along instream and near-stream roads and landings. Streamside roads and landings were prominent in Tobacco Creek, lower House Creek, central North Fork Wheatfield, and central to higher Tombs Creek. Still-active sediment sources occur in the lower reaches of Haupt Creek and Tobacco Creek. More landslides were observed in Fuller Creek in the 1965 and 1984 aerial photos compared to the 1942 photos, which represented an undisturbed old growth condition.
- Post World War II construction of roads, landings, and skid trails in riparian zones by crawler tractors eliminated overstory shade canopy cover in long sections of the Wheatfield Fork and tributaries. There was near entire canopy elimination along the lower mainstem and main tributaries, especially pronounced during the mid to late 1950s. There is measured improvement in canopy cover since 1968, but it has not recovered to 1942 levels.
- Large wood is lacking in streams in this Subbasin, as reflected in some of the habitat values. Construction of roads, landings, and skid trails in or adjacent to streams between 1952 and 1968 buried, removed, or dispersed LWD. Aerial photos from 1961 and 1965 show riparian areas entirely cleared of vegetation and remnant downed logs in the Fuller Creek, Tobacco, and Annapolis PWSs. The lower Wheatfield lacks volume and pieces of large woody debris (Watershed Cooperative Monitoring Program).
- Overall levels of channel disturbance as interpreted from aerial photos were less in the Subbasin in 1999/2000 than in 1984. Instream sediment depositions indicative of disturbance occur along 56 of 300 miles of blue line streams, representing a 52 percent reduction from 1984 observations. Most of the reduction occurred in the tributaries.

Key Recommendations:

- Maintain and enhance existing riparian cover. Improvement of riparian canopy is a priority 1 restoration recommendation. Ensure that adequate streamside protection zones are used on the Wheatfield Fork and tributaries to reduce solar radiation and moderate air temperatures, particularly on the mainstem and upper tributaries. Retain, plant, and protect trees to achieve denser riparian canopy where current canopy is inadequate, particularly in the Lower Wheatfield SPWS: Fuller, Tobacco, and Haupt Creeks.
- 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 2.
- 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.
- Reduce livestock and feral pig entry into the riparian zone to encourage stabilization of stream banks and revegetation of the riparian zone. Improvement of riparian canopy is a priority 1 restoration recommendation, and bank stabilization is a priority 3.
- Decommission and revegetate streamside roads, focusing on those where channel braiding and/ or aggradation are persistent today, such as:
  - the lower reaches of Haupt and Tobacco Creeks,
  - the Lower to middle reaches of Tombs, Wolf, and Elk Creeks, and unnamed tributaries to the mainstem Wheatfield Fork upstream from Tombs Creek,
  - the larger tributary watercourses in the lower reaches of House Creek, and
  - the middle to higher reaches of House, Pepperwood, Danfield and Cedar Creeks.
- Landowners should develop erosion control plans for decommissioning old roads, maintaining existing roads, and constructing new roads. Target road upgrade and repair in the areas identified above.
- Incorporate mitigation elements into Timber Harvest Plans in the timber dominant Lower Wheatfield SPWS to decommission historical streamside roads and upgrade road drainage facilities.
- Consider careful planning of land uses that could exacerbate mass wasting, since the relative potential of landsliding is high to very high in 60 percent of the Subbasin.
- Pursue cost sharing grants organized by the Sotoyome RCD to upgrade roads in the ranching-dominated Walters Ridge and Hedgepeth Lake SPWSs.
- 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 monitoring. Improve baseline information on habitat conditions by conducting inventory surveys in more Wheatfield Fork tributaries.

- 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.
- Encourage more habitat inventory surveys and biological surveys of tributaries, as only 45 percent of the Subbasin has been completed.

GUALALA MAINSTEM/SOUTH FORK SUBBASIN

The Gualala Mainstem/South Fork Subbasin contains 134 miles of "blue line" stream in its 63.7 square mile watershed. The river system originates in the far southern end of the Gualala River Watershed and flows north as an alluvial stream 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. The upper reaches flow from steeper terrain outside the San Andreas Fault zone. About 50 percent of the Subbasin is categorized as high to very high landslide potential. Nearly all of the 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.

Key Findings:

- The Subbasin historically supported populations of coho salmon and steelhead trout. During the 1970s, 105,000 coho salmon and 83,320 steelhead trout were planted in the Subbasin. The Subbasin supports populations of steelhead trout, but coho salmon have not been observed recently where very limited electrofishing was conducted. Information is limited, but coho salmon and steelhead trout studies indicate that populations are depressed compared to pre-1960s populations.
- Habitat inventories were difficult to obtain on the South Fork due to access problems. Camper, Carson, McKenzie and Wild Hog creeks were inventoried in 1999, and Palmer Canyon Creek and parts of Marshall Creek and the upper South Fork were inventoried in 2001. Pool shelter and depth were unsuitable in the areas inventoried. Pool shelter, depth, and embeddedness were the three most limiting factors in the Subbasin.
- Moderately to fully suitable water temperatures for the period of record (1994-2001) were observed in McKenzie Creek in the upper Subbasin, and Little and Big Pepperwood Creeks and Groshong Gulch in the lower Subbasin. Water temperatures were in the unsuitable ranges for summertime rearing of salmonids in Palmer Canyon Creek and the South Fork.
- Most of the higher and eastern reaches of the South Fork Subbasin were clear-cut and roaded between 1952 and 1961 in or along the major tributary streams. This left large areas of disturbed ground prone to erosion and mass wasting. 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. Most of those roads and landings are concentrated in the McKenzie, Palmer Canyon, and Marshall Creek watersheds.
- Timber harvest operations and road building in riparian zones shortly after WW II eliminated overstory shade canopy in large areas of the headwaters: the mainstem South Fork upstream of the Marshall Creek confluence, Wild Hog and Palmer Canyon creeks, and the central and upper reaches of the McKenzie Creek watershed. Prolonged ranchland operations prevented timely reestablishment of vegetative cover over streams. Overstory shade canopy has improved since 1968 on approximately 25 percent of the stream areas, most notably in the upper Subbasin. The mainstem South Fork down stream of the Marshall Creek confluence was clearcut around 1900,

and has had two or three selection harvests in the 1980s and 1990s. The riparian zone is dominated by large second growth, some of suitable size to function as LWD.

- Large wood recruitment was limited by streamside road construction, timber harvesting, and salmonid migration barrier removal programs. The reduction of LWD likely reduces pool formation, pool complexity, and sediment storage in the tributaries. Approximately 15 miles of historical logging roads that were built in or along the streambed simplified pool structure and complexity throughout the Marshall and McKenzie Creeks, and the upper mainstem tributaries. Large wood surveys 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 identified the lack of large woody debris.
- Overall levels of channel disturbance as interpreted from aerial photos were less in the Subbasin in 1999/2000 than in 1984. Instream sediment depositions indicative of disturbance occur along 33 of 140 miles of blue line streams, representing a 42 percent reduction from 1984 observations. Most of the reduction occurred in the tributaries. Similar degrees of streambed aggradation were observed in aerial photos from1942 and 1999/2000. Gravel mining records indicate that the lower South Fork may have down cut between 1921 to 1993, suggesting sediment transport exceeding supply in the lower reaches.

Key Recommendations:

- 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.
- 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 3.
- Incorporate mitigation elements into Timber Harvest Plans for decommissioning legacy streamside roads and upgrading road drainage facilities in the timber-dominant lower Subbasin, including Little and Big Pepperwood Creeks.
- 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.
- Maintain and enhance existing riparian cover. Improvement of riparian canopy is a priority 3 restoration recommendation. Ensure that adequate streamside protection zones are used to reduce solar radiation and moderate air temperatures. Retain, plant, and protect trees to achieve denser riparian canopy where current canopy is inadequate, particularly in the Upper South Fork and its tributaries, McKenzie, Wild Hog, and Palmer Canyon creeks.
- Reduce livestock and feral pig entry into the riparian zone to encourage stabilization of stream banks and revegetation of the riparian zone.
- Consider migration barrier removal in Palmer Canyon and McKenzie Creeks.
- 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.

- 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 monitoring. 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.
- 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.
- Encourage more habitat inventory surveys and biological surveys of tributaries as only 31 percent of the Subbasin has been completed.

Table ES-1

Summary of Gualala River Watershed Conditions and Recommended Actions by Subbasins Based Largely on Habitat Inventory Surveys

Note that the following designations are based largely on habitat inventory data, which does not include entire subbasin stream systems. Consequently, the designations below are applicable only to the sections of stream that were inventoried. Refer to the subbasin information for more detail, pages 12-19.

	North Fork Subbasin	Rockpile Subbasin	Buckeye Subbasin	Wheatfield Fork Subbasin	Main/South Fork Subbasin
Identified Conditions					
Flow	~	~	~	~	~
Fish Passage Barriers	~ (+/-) [a]	+	+	+	–
Water Temperature	~ (+/-)[a]	–	–	–	~ (+/-) [a]
Canopy Cover	r	r	r		
Instream Sediment	~/R	~/R	~/R	~/R	R
Natural Sediment Sources	~	–	–	~	~
Management-Related Sediment Sources	~	–	–	~	~
Pools	–	–	–	–	–
Escape Cover	–	–	–	–	–
Recommendations					
Flow	#	#	#	#	#
Erosion/Sediment	X	X	X	X	X
Riparian/Water Temperature	X	X	X	X	X
Instream Habitat	X	X	X	X	X
Gravel/Substrate					
Other	†			*	*/†

+ condition is favorable for anadromous salmonids
- condition is not favorable for anadromous salmonids
~ condition is mixed or indeterminate for anadromous salmonids
R trend indicates improved conditions 1984-2000
r trend indicates improved condition 1964-2001
X recommendation applies
recommendation may apply, but needs more study
* there is evidence that stock and/or feral pigs are impacting the stream or riparian area, and exclusion should be considered
† there are barriers to fish migration in the stream
a ~ (+/-) both suitable and unsuitable areas were identified.