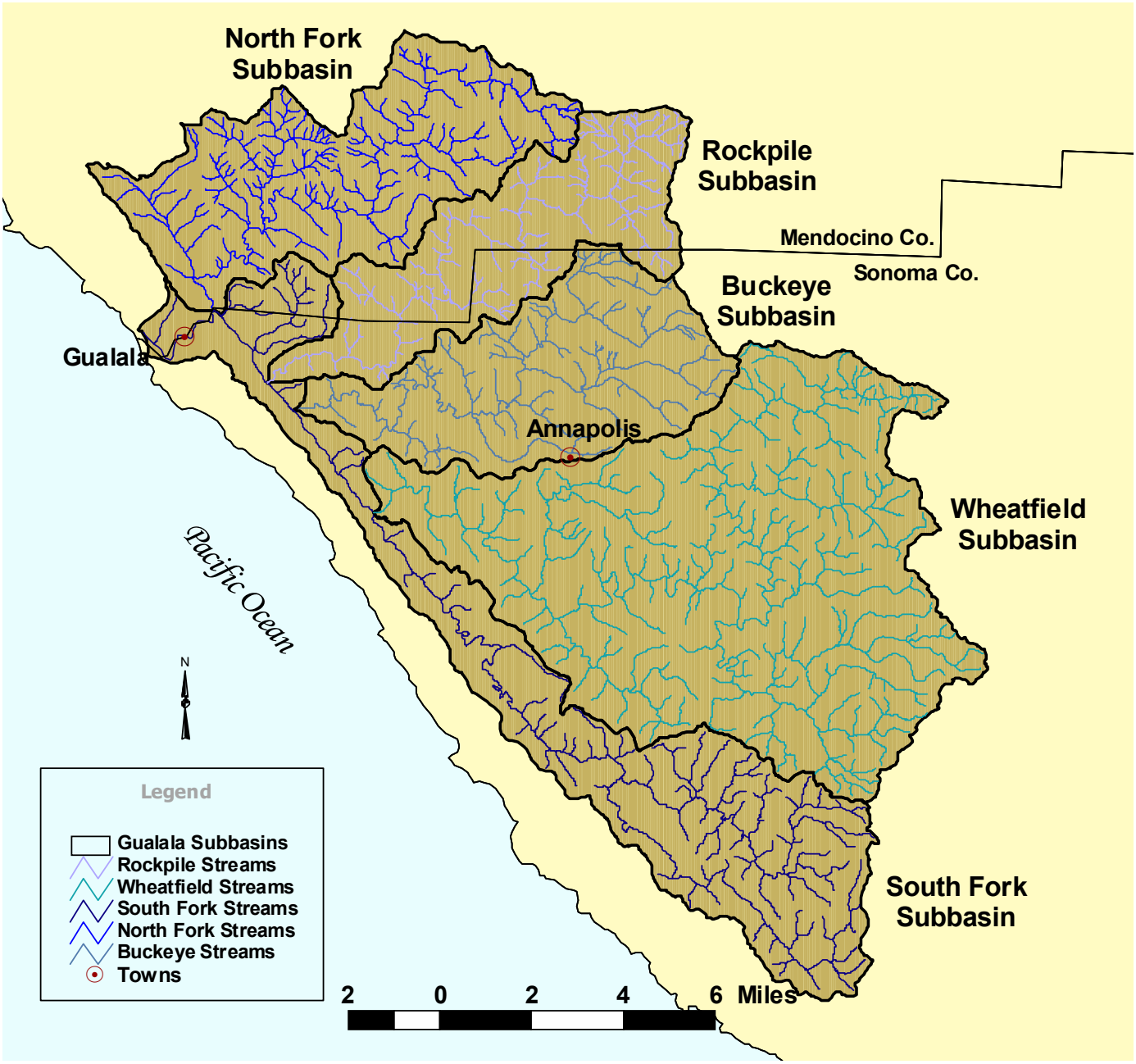
Gualala Basin Assessment Implementation Summary



California Department of Fish and Game

Coastal Watershed Planning and Assessment Program

NCWAP Gualala Assessment and Support Team

Fisheries:	
Cynthia LeDoux-Bloom	California Department of Fish and Game
John Richardson	Pacific States Marine Fisheries Commission
Scott Downie	California Department of Fish and Game
Forestry and Land Use:	
Donald Morse	California Department of Forestry and Fire Protection
Russell Henly, PhD.	California Department of Forestry and Fire Protection
Water Quality:	
Robert Klamt, Team Lead	North Coast Regional Water Quality Control Board
Ranjit Gill	North Coast Regional Water Quality Control Board
Bryan McFadin	North Coast Regional Water Quality Control Board
Hydrology:	
John Clements	Department of Water Resources
Andy Corry	Department of Water Resources
Geology:	
Michael Fuller, RG,CEG	Department of Conservation/California Geological Survey
Mary Scruggs, RG,CEG	Department of Conservation/California Geological Survey
Michael Purcell, RG	Department of Conservation/California Geological Survey
Wayne Haydon, RG, CEG	Department of Conservation/California Geological Survey
Stephen Sterling, CEG, CHG, RGp	Department of Conservation/California Geological Survey
Fluvial Geomorphology:	
Kit Custis, RG, CEG and GHG	Department of Conservation/California Geological Survey
Geographic Information System, Data Management, EMDS, and KRIS:	
Steve Cannata	California Department of Fish and Game
John Carotta	Department of Conservation/California Geological
Richard Fadness	North Coast Regional Water Quality Control Board
Chris Fischer	California Department of Forestry and Fire Protection
Patrick Higgins	Institute for Fishery Resources
Kevin Hunting	California Department of Fish and Game
Chris Keithley	California Department of Forestry and Fire Protection
Lisa Ohara	Department of Conservation/California Geological Survey
Peter Roffers	Department of Conservation/California Geological Survey
Sandra Summers	Department of Conservation/California Geological Survey
Jennifer Terwilliger	California Department of Fish and Game
Richard Walker, PhD.	California Department of Forestry and Fire Protection
Research and Documents Production:	
Colette Schantz	North State Resources, Inc.
Dolores Padilla	Department of Conservation/California Geological Survey

Suggested Citation:
Downie, Scott T., C.M. LeDoux-Bloom, J. Richardson. 2003. Gualala Basin Assessment Implementation Summary. CDFG Coastal Watershed Planning and Assessment Program, P. 55. California Department of Fish and Game, Sacramento, California

Implementation Summary Contents

List of Figures

List of Tables

Gualala Basin Assessment Implementation Summary

Preface to this Summary

This summary builds upon the Gualala River Watershed Assessment Report's findings and recommendations in as concise a manner as possible (Klampt et al. 2003). Therefore, that assessment's goals, methods, and analytic tools and systems are only briefly discussed. Likewise, the basin's contextual background, history, and the conditions of its geology, hydrology, vegetation, stream systems, water quality, and land uses are also briefly summarized. The complete Assessment Report and its Appendices should be consulted for more details of its assessment and the development of its findings and recommendations. Those findings and recommendations have been expanded upon by subsequent and additional analysis by the California Department of Fish and Game (CDFG) for this implementation summary. In this summary, the products of the CDFG efforts are indicated as such. We have also taken the liberty of adopting the term "basin" as a substitute for the original report's "river watershed" reference term for the Gualala Basin (Gualala River Watershed). Feedback from readers has indicated this reduces confusion with the various scales of watersheds referred to in the text of the report.

Gualala Basin Assessment Report Structure and Usage Guide

The Gualala Assessment Report has eight main sections:

- Executive Summary;
- Program Introduction and Overview:
    - Six guiding assessment questions (see page 2);
    - Four strategic program goals (see page 3).
- Assessment Strategy and General Methods;
- Gualala Basin Profile;
- Interdisciplinary Synthesis and Findings;
- Subbasin Profiles and Syntheses;
    - Estuary
    - North Fork Subbasin
    - Rockpile Subbasin
    - Buckeye Subbasin
    - Wheatfield Subbasin
    - Gualala Mainstem/South Fork Subbasin
- Four small sections presenting the Limitations, References, Glossary, and a List of Abbreviations;
- Appendices.

The elements of the five subbasin profile sections are all the same:

- Disciplinary findings and analyses;
- Listing of issues raised during the assessment;
- Ecological Management Decision Support (EMDS) calculations (limiting factors analysis);
- Restoration recommendations;
- Refugia rating analysis and results;
- Listing of issues raised by the assessment;
- Tributary recommendations analysis and results;
- Synthesis of information presented as working hypotheses;
- Recommendations for the subbasin.

There are seven appendices to the Gualala Assessment Report:

- Appendix 1: Hydrology;
- Appendix 2: Geology;
- Appendix 3: Land use;

- Appendix 4: Water Quality;
- Appendix 5: Anadromous Salmonids and Stream Conditions;
- Appendix 6: Interdisciplinary Synthesis;
- Appendix 7: Public Responsiveness Summary.

Of interest to many readers are the recommendations associated with specific locations in the basin with which they are familiar or in which they have ownership. In the report, basin and subbasin maps are provided at the beginning of each of the five profile sections to help them locate points of interest. By referring to the general tributary refugia rating system results, surveyed streams can be easily determined and their refugia ratings observed. Discussion concerning the development of the refugia rating system is in the Methods Section of the Gualala Report, and also in Appendix 5 of that report.

Watershed improvement recommendations are summarized at the end of each subbasin section in the report. As specific to stream and reaches as possible. Following the tributary recommendation tables and discussion, the six guiding assessment questions are answered. The assessment questions and their responses at the Gualala Basin scale are presented on pages ES-11 through ES-15, in the report's Executive Summary. Responses to question six list the tributary improvement recommendations and general watershed improvement activities. Responses to question six highlight key improvement recommendations in five general categories:

- Flow and water quality improvement activities;
- Erosion and sediment delivery reduction activities;
- Riparian and habitat improvement activities;
- Supplemental fish rescue and rearing activities;
- Education, research, and monitoring activities.

In addition to the listing of recommendations in the Executive Summary, with more detail in the subbasin sections, the Assessment Report provides a map of potential restoration sites and habitat limiting factors as guidance in prioritizing restoration activities (see pages 4-39-4-41 in the Assessment Report). Supplementing the map are tables of restoration priorities on pages 4-41 through 4-47 of the Assessment Report.

The organization of the Assessment Report's findings, conclusions, and recommendations sections are intended to allow the reader to compare EMDS results, refugia ratings, limiting factors, and the resultant improvement recommendations for logic and appropriateness. Investigators are encouraged to read back through the IA Analysis, disciplinary findings, etc., and to the detail contained in the appendices. This should provide a clear understanding of the assessment results and help validate the assessment.

California's Large Scale Watershed Assessment Program

In 2000, the California Legislature established its first large scale watershed assessment program, the North Coast Watershed Assessment Program (NCWAP), composed of a multi-disciplinary team from the Resources Agency and the departments of Fish and Game (CDFG), Forestry and Fire Protection (CDF), Conservation/California Geologic Survey (DOC/CGS), and Water Resources (DWR), in conjunction with the North Coast Regional Water Quality Control Board (NCRWQCB) and State Water Resources Control Board. The program's intent was to provide a consistent body of information on North Coast watersheds for use by landowners, agencies, stakeholders, and collaborative watershed groups. Due to California's General Fund reductions in 2003, that program was eliminated as a multi-agency effort, but CDFG has continued their large scale watershed assessment activities with the Coastal Watershed Planning and Assessment Program (CWPAP). Regardless, the resultant assessment products should facilitate actions to create positive change in watershed conditions in the North Coast.

The assessments are guided by six logical assessment questions at basin, subbasin, and tributary scales:

- 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 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 basin assessment has been designed to meet 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 CDFGs Fishery Restoration Grants Program and the State Water Board's Consolidated 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.

General Assessment Approach

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

The general steps in a large-scale assessment included:

- Form multi-disciplinary team. In order to assess watershed conditions and processes, several specialists were needed and included: geologists, fluvial geo-morphologists, foresters, hydrologists, water quality analysts, fisheries biologists, habitat specialists, planners, and most importantly, the landowners and residents of the assessment area;
- Conduct scoping and outreach workshops. A series of meetings from Spring 2001 through Spring 2003 were held during the course of the Gualala assessment;
- Determine logical assessment scales. The Gualala assessment team used the California Watershed Map (CalWater version 2.2a) to delineate the Gualala Basin into six subbasins for assessment and analyses purposes (Figure 1). These study areas include the Estuary, North Fork, Rockpile, Buckeye, Wheatfield, and Mainstem-South Fork subbasins. In general, the CalWater 2.2a Planning Watersheds (PWs) contained within each of these assessment subbasins have common physical, biological, and/or cultural attributes. However, there is enough variance between the six areas' attributes that they were delineated as separate subbasins. Demarcation in this logical manner provides a large, yet common scale for conducting assessments. It also allows for reporting findings, and making recommendations for watershed improvement activities that are generally applicable across a subbasin area;
- Discover and organize existing data and information according to discipline. This information was used to form the basis of the disciplinary appendices to the assessment report;
- Identify data gaps needed to develop the assessment. Working with limited time and resources constrained the amount of field work that was performed. Limited data existed prior to this effort in the Gualala Basin;
- Collect field data. Over 100 miles of new stream data and numerous fishery surveys were performed for this assessment. Foresters and geologists were able to check air photo analyses with field verification at several locations. Some new water quality samples were taken, other water temperature data were provided by

landowners and a watershed council. New stream flow gages were installed on the North Fork, the Wheatfield Fork, and the South Fork above the Wheatfield Fork;

- Amass and analyze information. Each agency assembled data to create the various specific reports. The reports were then interpreted and entered into the Assessment Report as disciplinary findings in each chapter specific to the basin and subbasins. The full reports were also made available in the Gualala Basin's appendices;
- Conduct Integrated Analysis (IA). Through the use of a series of IA Tables the disciplinary information were related to one another. These tables begin with geologic conditions and processes operating on them. These processes include natural disturbances like precipitation, earthquakes, fires, floods, droughts, landslides, and vegetation history, as well as human caused impacts to processes associated with land use. These disturbance factors cause responses in riparian and stream channel conditions, water quality, which in turn affects fish and other biota. The IA Tables follow these processes (drivers) through the delivery process and help explain the conditions (responses) they cause. The IA process also helps identify watershed condition trends;
- Conduct limiting factors analysis (LFA). The Ecological Management Decision Support system (EMDS) was used, along with expert analysis and local input, to evaluate factors at the tributary scale. These factors were rated to be either beneficial or restrictive to the well being of fisheries. The CDFG Restoration Manual (Flosi, et al. 1998), and other literature, provided habitat condition values to help set EMDS reference curves. Additionally, findings and recommendations from over 26 Gualala tributary surveys were used to verify the EMDS results;
- Conduct refugia rating analysis. The CDFG NCWAP assessment team created a worksheet for rating refugia quality at the tributary scale (see Page 51). The worksheet has 21 condition factors rated on a sliding scale from high to low quality. The 21 factors are grouped into five categories: 1) stream condition; 2) riparian condition; 3) native salmonid status; 4) present salmonid abundance; and 5) management impacts (disturbance impacts to terrain, vegetation, and the biologic community). The tributary ratings are determined by combining the results of air photo analyses, EMDS, and data in the CDFG tributary reports by a multi-disciplinary, team of expert analysts. Ratings of various factors are combined to determine an overall refugia rating on a scale from high to low quality. The tributary ratings are subsequently aggregated at the subbasin scale and expressed as a general estimate of subbasin refugia conditions. Factors with limited or missing data are noted and discussed in the comments section as needed. In most cases, there are data limitations on one to three factors. A discussion of the rating system is at the end of this summary. The Gualala NCWAP team did not have the refugia rating sheet at the time of their assessment; the CWPAP team used it in their analysis for this Gualala Implementation Summary document;
- Develop conclusions and recommendations. Recommendation tables for watershed and stream improvement activities were developed at the tributary scale based upon stream inventory information, air photo analysis, field verification samples, workshop inputs, and other information. The recommendation tables are presented at the end of each Profile chapter as answers to the sixth assessment guiding question;
- Facilitate monitoring of conditions. CDFG is developing a monitoring program and will facilitate adopting it in the Gualala and other assessed watersheds.

Figure 1. Gualala subbasins and CalWater 2.2a Planning Watersheds.

Gualala Basin Profile

The Gualala Basin drains an area of 298 square miles along the coast of southern Mendocino and northern Sonoma counties. The river enters the Pacific Ocean near the town of Gualala, approximately 115 miles north of San Francisco and seventeen miles south of Point Arena. The Gualala Basin is about thirty-two miles long on a northwest – southeast orientation, and extends inland about fourteen miles. Elevations vary from sea level to 2,602 feet at Gube Mountain; the most mountainous terrain is in the northern and eastern parts of the watershed.

The name Gualala comes from the Kashia Pomo Indian phrase, "ah kha wa la lee", which means "where the water flows down". The southern, central and northern Pomo Indians inhabited the Mendocino Sonoma coast when trappers and settlers from Mexico and Russia arrived to this area. There were three tribes of Pomo Indians; Kashia, Yokiya and Bokeya. An early Mexican land grant held by Rafael Garcia used the Gualala River as a boundary line to separate the Bokeya and Yokiya Pomo tribes.

That land grant was cancelled by Rancho de Herman, and since March 11, 1859, the mainstem Gualala downstream of the North Fork has delineated the border between Sonoma and Mendocino counties. A white settler named Charlie Haupt married a Kashia Pomo woman and invited her people to live with them. The tribe lived on the Haupt ranch until 1919, when they moved to the 40 acres reservation purchased for them by the federal government. This reservation is still located near the headwaters of Haupt Creek (www.gualala.com/history/pomo.htm).

The Gualala Basin has a Mediterranean climate and is influenced by fog near the coast with seasonal temperatures ranging from 40 to 60° F, with the interior areas of the watershed ranging from below freezing to over 90° F seasonally. Rainfall also varies by location within the watershed with an average of 33 inches falling near the town of Gualala, and totals reaching over 63 inches in some areas of the interior.

A long history of movement along the San Andreas and Tombs Creek faults has been a dominant force in shaping the Gualala Basin. These faults transect the basin along northwest-southeast oriented lines. The Tombs Creek Fault separates highly unstable mélange on the east from relatively stable terrain on the west. The South Fork Gualala and the Little North Fork of the Gualala River flow within a linear valley formed by the San Andreas Fault. Bedrock underlying much of the basin has been tectonically broken and sheared making it relatively weak, easily weathered, and inherently susceptible to landsliding and erosion.

Prior to European settlement, coniferous forest occupied approximately two thirds of the Gualala Basin. Dense old growth redwood forests dominated the northwestern portion of the basin, particularly the alluvial North Fork Subbasin. Old growth redwood forest also lined the long and narrow South Fork Gualala valley. Douglas fir predominated in central and mid-slope locations more distant from the coast. In the inland, eastern portion of the Gualala Basin, the natural distribution of Douglas fir becomes increasingly fragmented. Here, the long summer drought limits Douglas fir to north facing slopes. Oak-woodland predominates on higher, inland terrain that is beyond the foggy coastal marine influence. Additionally, large areas of prairie grassland occupy the driest sites along the higher slopes and ridges. These grasslands occupy larger continuous areas on the highest and most eastern areas of the basin.

The total Gualala Basin resident population for the year 2000 census was estimated to be about 2,700 people with the majority residing in or near the town of Gualala and less in and around the town of Annapolis. Over 99 percent of the basin is held as private property. Compared to other north coast watersheds, the basin has one of the longest records of timber harvest as a primary land use.

Logging of the virgin old growth redwood forest began during the mid 1800s in lower portions of the watershed near coastal ramp and port facilities. There was concentrated demand for the resource after the 1906 earthquake and subsequent rebuilding of San Francisco. Fire was used extensively to reduce slash during logging and to convert redwood forest to grazing land after the logging. Gasoline powered crawler tractors made their appearance in the North Coast in the late 1920s, but logging in the Gualala was inactive during the Great Depression. Increased demand for lumber products during the 1950s coincided with the widespread deployment of heavy tractors that were greatly improved by technology advanced during World War II. By 1964, tractor harvesting had continued at an active pace to comprise a majority of the timbered areas in the west and central parts of the watershed.

The current fishery resources of the Gualala Basin include coho salmon, steelhead trout, pacific lamprey, California roach, coast range sculpin, prickly sculpin, riffle sculpin, and threespine stickleback. Above barriers to anadromous fish, resident populations of rainbow trout may exist. Species inhabiting the coastal lagoon/estuary include starry

flounder, staghorn sculpin, and Pacific herring. Historic anecdotal accounts cite Sacramento sucker in the system, and eulachon were alleged to be in the estuary. Additionally, Chinook salmon juveniles were caught prior to 1945.

Salmonid population data are very limited and only two credible population estimates have been made for the Gualala Basin, although anecdotal evidence suggests that the coho salmon and steelhead trout populations were larger historically than today. No population estimates were conducted using actual data for coho salmon. The population estimates commonly referenced were generated by comparing the Gualala's size, geographical location, and precipitation with better studied watersheds. However, two credible adult steelhead trout population estimates were made in 1975-76 and 1976-77. The populations were estimated by a CDFG study to be 7,608 in 1975-76 and 4,324 in 1976-77 with .95 confidence intervals.

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. There was an estimated threefold increase in fishing pressure at that time. The increased fishing pressure indicated that the coho salmon and steelhead trout populations were plentiful in the 1940s. By the 1960s, the salmonid populations began to decrease and the CDFG stream surveys recommended stocking coho salmon to reestablish viable self-supporting runs in streams with histories of pre-existing populations. Over the next 30 years, 347,780 hatchery coho salmon were stocked. CDFG began planting steelhead trout in 1970, and by 1989, 310,092 had been planted. By 1992 stocking of coho and steelhead had ceased except for some very small releases associated with CDFG research projects.

Gualala Basin Profile Stream Reach Condition EMDS

The anadromous reach condition EMDS system calculates stream reach conditions for salmonids based upon water temperature, riparian vegetation, stream flow, and in-channel characteristics. Data used by the EMDS system come from CDFG stream inventories. Currently, adequate data do not exist for all stream reaches in the Gualala Basin to evaluate canopy, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids, thus the percent of each subbasin surveyed must be considered. More details of how the EMDS model functions are in Appendix 5 of the Gualala Assessment Report.

EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of the individual survey. EMDS stream reach scores were weighted by stream length to obtain overall scores for the surveyed tributaries and their subbasins within the basin context. The EMDS describes the overall weighted average reach conditions in the Gualala Basin as "somewhat unsuitable" for salmonids (Table 1). Obviously, there is a great deal of variation among streams, subbasins, and among the several parameters evaluated. Suitable conditions exist for canopy in the North Fork and South Fork subbasins, both of which are heavily influenced by summer coastal fog; somewhat suitable conditions exist for embeddedness in the North Fork while the other four subbasins were somewhat unsuitable or undecided. Pool quality, pool depth and pool shelter were found to be unsuitable where surveys were conducted. These results are based upon surveys of fifty percent of the Gualala Basin's streams and may change as more data are collected and analyzed.

Table 1. EMDS anadromous reach condition model results for the Gualala Basin.

Subbasin	Percent Surveyed	Canopy	Embeddedness	Pool Quality	Pool Depth	Pool Shelter
North Fork	81	++	+	- -	- - -	- -
Rockpile	39%	- -	-	- -	- - -	- -
Buckeye	37%	-	U	-	- -	-
Wheatfield Fork	62%	- -	-	- -	- - -	- -
Mainstem/South Fork	31%	+ +	-	- -	- -	- - -
Gualala Basin	50%	+	-	- -	- - -	- -

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - Somewhat Unsuitable; - - Moderately Unsuitable; - - - Fully Unsuitable

Gualala Basin Profile Summary of Tributary Recommendations

The Estuary Subbasin was not included in the NCWAP report's tributary recommendations due to a lack of data. The Gualala River Watershed Council recently conducted an assessment of estuary conditions and their findings have helped CWPAP analysts formulate subsequent recommendations for the estuary. Future estuary work by the Council will lead to better focused recommendations in the future. The NCWAP team did develop recommendations for the

other four subbasins. Each tributary was originally assigned from zero to ten applicable recommendations, which were ranked in order of importance (Table 2). To compare the occurrence of recommendations between the five inland subbasins in the Gualala Basin, the three top ranking recommendations for each tributary were compiled (e.g., Table 7). Complete tributary recommendations can be found in each of the subbasin sections of this report, except for the estuary. Methods to determine recommendations can be found beginning on page 44 of this document.

In terms of the most frequently given recommendations in each subbasin, the North Fork Subbasin had pool, cover, and roads recommendations for four out of nine tributaries surveyed. The Rockpile and Buckeye subbasins shared the same recommendations for the two streams surveyed. The Wheatfield Fork Subbasin had a canopy recommendation for eight out of nine tributaries surveyed, and the Mainstem/South Fork Subbasin had one road recommendation for all seven of the tributaries surveyed.

Table 2. Occurrence of improvement recommendations in first three ranks in surveyed streams, Gualala Basin.

Subbasin	# of Surveyed Tributaries	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Live-stock Feral Pigs	Fish Passage
North Fork	9	22.8	3	5	3	3	8	8	2	3	0	1
Rockpile	1	8.4	1	1	1	1	1	1	0	0	0	0
Buckeye	1	9.7	0	1	1	1	1	1	0	0	0	0
Wheatfield Fork	9	56.7	6	3	8	4	7	7	6	0	5	0
Mainstem/ South Fork	7	10.4	1	7	2	2	5	6	0	0	1	1
Gualala Basin	27	108	11	17	15	11	22	23	8	3	6	2

Gualala Basin Profile Summary of Refugia Areas

The CWPAP assessment team identified and characterized refugia habitat in the Gualala Basin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures 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. Details of the refugia rating system can be found beginning on page 45 of this document. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales. This analysis was conducted subsequent to the NCWAP report release. Thus, some of this information is newly reported here and may slightly vary from the original assessment report due to consideration of additional data or parameters.

The most complete data available in the Gualala Basin were for twenty-seven tributaries surveyed by CDFG. However, several Gualala Basin tributaries, mostly small, were lacking data for some factors considered by the assessment team. Salmonid tributary habitat conditions in the Gualala Basin are generally best in the North Fork Subbasin, and mixed in the Rockpile, Buckeye, Wheatfield Fork, and South Fork subbasins (Table 3). The Estuary could not be evaluated due to the lack of data.

Table 3. Subbasin salmonid refugia area ratings in the Gualala Basin.

Subbasin	Refugia Categories:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
North Fork			**X** (N=10)				X
Rockpile				(N=1) **X**			X
Buckeye			(N=1) **X**				X
Wheatfield Fork			(N=10) **X**			X	X
South Fork			(N=7) **X**				X

*Ratings are done on a sliding scale from best to worst. Subbasin refugia ratings are aggregated from their tributary ratings. Relative rating is indicated by an **X**; N = number of streams surveyed in the subbasin. Distances surveyed weight ratings; refer to the subbasin sections for surveyed distances.

Gualala River Tributaries by Refugia Category:

Tributaries with High Quality Habitat, High Quality Refugia:
None

Tributaries with High Potential Refugia:

North Fork Subbasin:
North Fork Gualala
Little North Fork Gualala

Wheatfield Subbasin:
Fuller Creek
North Fork Fuller Creek
South Fork Fuller Creek
Sullivan Creek

Tributaries with Medium Potential Refugia:

North Fork Subbasin:
Doty Creek
Log Cabin Creek
Robinson Creek
Dry Creek
McGann Creek
Unnamed Trib., Dry Creek
Unnamed # 1, LNF Gualala
Unnamed # 2, LNF Gualala

Buckeye Subbasin:
Buckeye Creek

Wheatfield Fork Subbasin:
House Creek

South Fork Subbasin:
Camper Creek
Carson Creek
Upper South Fork Gualala
Marshall Creek
McKenzie Creek
Palmer Canyon Creek
Wild Hog Canyon Creek

Tributaries with Low Quality Habitat, Low Potential Refugia:

Rockpile Subbasin:
Rockpile Creek

Wheatfield Fork Subbasin:
Wheatfield Fork
Haupt Creek
Tombs Creek
Pepperwood Creek
Danfield Creek

<u>Other Related Refugia Component Categories:</u>

Potential Future Refugia (Non-anadromous)
None Identified

Tributaries with Critical Contributing Areas/Functions:

Wheatfield Fork Subbasin:
Wheatfield Fork

Data Limited Tributaries:
All streams were missing some data components that would have provided a better data set for use in the refugia analysis. In all streams rated, this usually involved one or two of the factors used in the rating process and did not prevent refugia determination from being estimated.

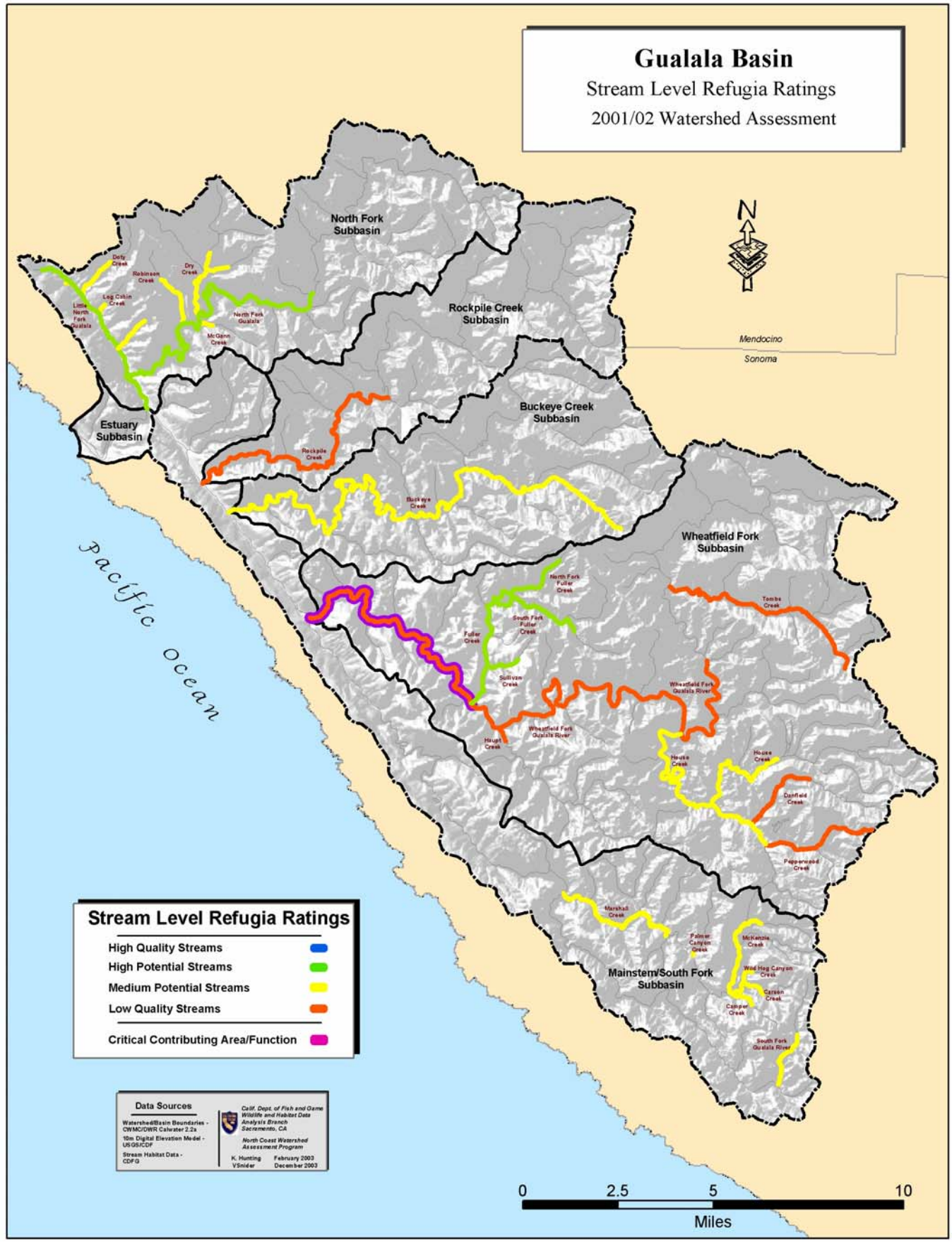


Figure 2. Refugia categories for the Gualala Basin surveyed tributaries.

Gualala Basin: Responses to Assessment Question Six:

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

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;
- CDFG stream surveys encountered extended dry reaches in some streams during summer surveys. These areas should be further investigated to determine if water conservation measures would lead to improvements in flow during dry periods.

Erosion and Sediment Delivery Reduction Activities:

- Continue efforts such as road assessments and subsequent improvements like storm proofing 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 and other land use. Some historically active sediment sites are identified on Plate 3, "Potential Restoration Sites, and Habitat Limiting Factors for the Gualala Basin," found in the Gualala Basin Geologic Report, Appendix 2.

Riparian and Habitat Improvement Activities:

- Maintain and enhance existing riparian density and diversity. Where 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 basin, since riparian canopy has improved during the last 40 years in the middle and lower stream reaches of the basin;
- Land managers should add more large organic debris and shelter structure to streams in order to improve sediment metering, channel structure, channel function, habitat complexity, and diversity for salmonids. Pool depth and shelter consistently need help;
- 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 access and related disturbance impacts in riparian zones to encourage stabilization of stream banks and accelerate re-vegetation.

Supplemental Fish Rescue and Rearing Activities:

- Evaluate fish rescue activities, for example the operation on Doty Creek, and continue if deemed appropriate.

Education, Research, and Monitoring Activities:

- Encourage continuation and expansion of the in-channel monitoring using the protocols developed by CDFG and 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 air and water temperature monitoring into locations in the eastern portion of the watershed to assess warm summer water temperatures in those areas;
- Conduct canopy density and diversity sampling to enhance the water temperature data and facilitate modeling.

Gualala Estuary

Gualala Estuary/lagoon, Gualala Basin, Mendocino County, California
© P.T. Nunn 2002

Introduction

Estuaries are critical habitats for all anadromous salmonids. Estuaries provide the connection between freshwater and marine environments through which salmonids pass as juveniles during seaward migrations and as adults during spawning migrations. Estuaries are also recognized as valuable salmonid nursery areas because their ocean connection helps provide abundant food supplies, diverse habitat, and relative security from predators. Fish that utilize estuaries for an important part of their life cycle, such as salmonids, are referred to as estuarine-dependent.

During seaward migrations, all juvenile coho salmon and steelhead utilize at least a brief estuarine residence while they undergo physiological adaptations to salt water and imprint on their natal stream. Juvenile salmonids may also extend their estuarine residency to utilize the sheltered, food rich environment for several months or a year before entering the ocean. Studies have revealed that juvenile salmonids utilizing estuaries for three months or more return to their natal stream at a higher rate than non-estuarine reared members of their cohort (Reimers 1973; Nicholas and Hankin 1989). Estuarine reared salmonids may be at an advantage because they enter the ocean at a larger size or during more favorable conditions. A larger size may be advantageous by allowing juvenile salmonids to avoid predation or increase their prey items.

Estuarine rearing is a strategy that adds diversity to juvenile salmonid life history patterns and increases the odds for survival of a species encountering a wide range of environmental conditions in both the freshwater and marine environments. Additionally, an extended estuarine residency may be especially beneficial for salmonids from rivers where low summer flows or warm water temperatures severely limit summer rearing habitat. Benefits are dependent upon the estuary retaining its connection with cool, nutrient laden seawater.

The Gualala River Estuary/lagoon is within the Big Pepperwood Creek Planning Watershed, and extends upstream from the Pacific Ocean to the North Fork Gualala River confluence at river mile 3.4 (RM 3.4), which is about four feet above sea level. The town of Gualala lies alongside the lower 0.8 miles of the estuary. The subbasin assessment area is approximately 2.5 square miles. China Gulch is the only USGS designated blue line stream in the estuary. During

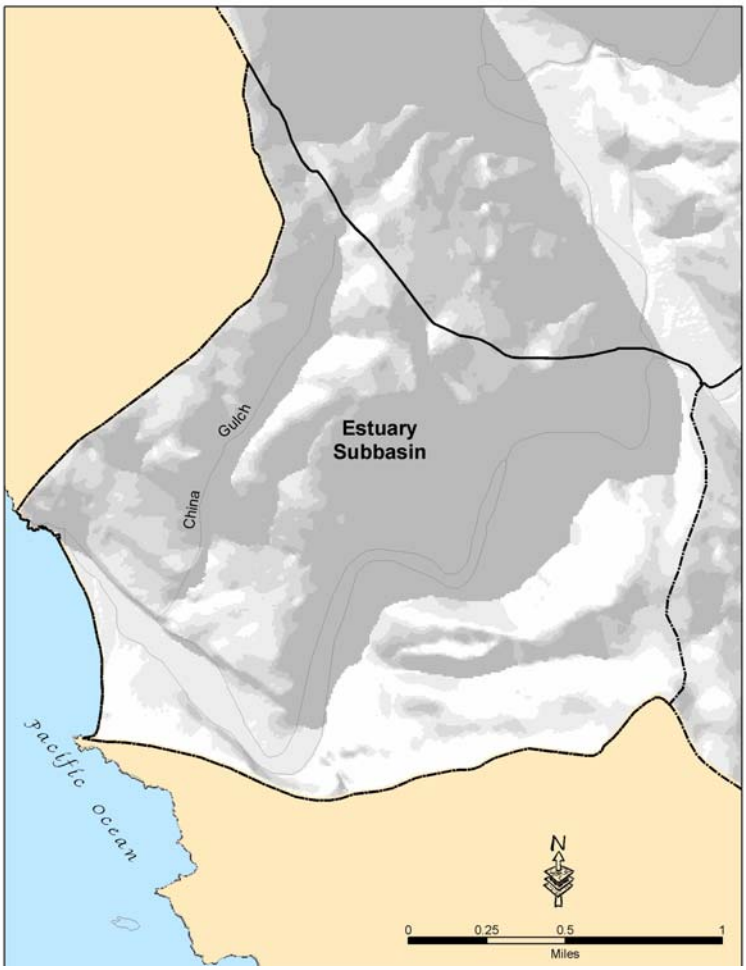


Figure 3. Estuary Subbasin, Gualala River, Sonoma County, California

summer months, a sand bar typically forms across the mouth of the estuary which blocks the exchange of tidewater, creating a coastal lagoon. The lagoon typically extends upstream from the ocean beach about three miles.

The Sotoyome Resource Conservation District (SRCD), in partnership with the Gualala River Watershed Council, was recently awarded a $150,000 grant by the California Coastal Conservancy to perform an estuary assessment and to develop an enhancement plan. They in turn contracted with ECORP Inc. for some components of the research. This project will assess the physical and biological conditions of the estuary from the confluence with the North Fork downstream, ascertain the estuary's affects on the life history strategies of Gualala salmonids, and determine how existing conditions may be affecting general estuarine aquatic productivity. Improvement recommendations based on the findings will be a final product.

Preliminary Estuary Study Findings and Observations:

The following findings and inferences were made from estuarine data collected by ECORP Inc. in 2002, and Regional Water Board staff in 2003. Additional 2003 ECORP Inc. data were not available when this summary was in preparation. None of these data were available to the NCWAP assessment team in 2002.

In 2002 and 2003 the lagoon's summer/fall sandbar was observed to breech for the winter/spring period on December 13 and 4 respectively. In mid-June 2003, large swells broke through the sandbar, virtually draining the estuary until the bar closed and reformed the lagoon later in the month.

Water temperatures over 68°F are considered stressful and potentially lethal to salmonids, and oxygen levels below 6mg/L are considered to impair production. In the Gualala estuary, most samples taken at depths greater than six feet, recorded the highest temperatures, greatest salinity, and lowest dissolved oxygen levels. Based on these limited data, it appears that water temperature and oxygen content at some sites may not be optimal for salmonids (Table 4).

Table 4. Oxygen and Water Temperature ranges collected in 2002 and 2003, Estuary Subbasin, Gualala Basin

Year and Source	Oxygen (mg/L)				Water Temperature (F)			
	Fall	Winter	Spring	Summer	Fall	Winter	Spring	Summer
2002 ECORP, Inc.	0.5-8.0	ND	ND	5.0-8.0	57-59	ND	ND	61-66
2003 RWQCB	3.3-21.0	2.1-16.4	9.9-12.7	0.6-8.7	65-69	47-53	49-71	65-72

In June – November 2002, the estuary researchers used a beach seine to collect fisheries data at nine sample sites. Steelhead was the most frequently counted species in the samples. Their size classes were dominated by 1+ and 2+ juveniles. Counts increased through the summer and were highest during September. By October counts began to drop, and only incidental observations occurred in November. Some fish may have been prey for birds, snakes, etc., missed during sampling due to net avoidance, or may have moved back upstream (Figure 4).

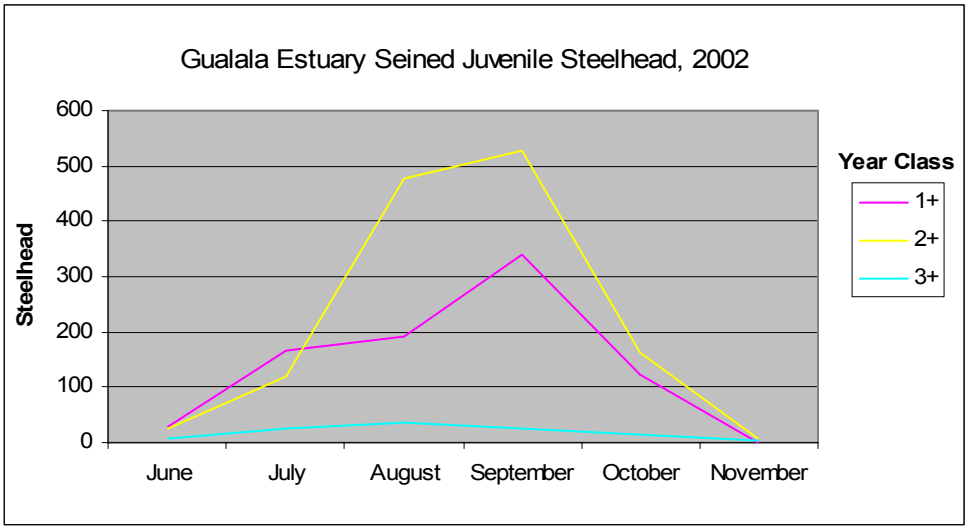


Figure 4. 2002Gualala estuary seined juvenile steelhead.

In July 2002, macroinvertebrate sampling was conducted in the lower Gualala River. Samples collected in the reach from the North Fork Gualala confluence (RM3.4) to the campground (RM2.4) indicated that the benthic macroinvertebrate biotic condition was rated "Good" with a score of 20. Samples from the campground downstream to the Highway 1 Bridge (RM0.9) rated "Poor" with a score of 10. Little research has been conducted on the normal ranges of macroinvertebrate abundance and distribution in transition zones between riverine and estuarine conditions.

Stream Reach Condition EMDS

The stream reach EMDS was not used to evaluate the estuary or its most significant tributary, China Gulch.

Analysis of Tributary Recommendations

According to the USGS 7.5 minute topographical map, China Gulch has 1.3 miles designated with a blue line indicating perennial or intermittent flow. It is the only such blue line stream in the subbasin. China Gulch flows through the town of Gualala; it was not surveyed during the assessment and no tributary recommendations were developed.

Refugia Areas

There were inadequate data to conduct refugia analysis at the time of the assessment. At the conclusion of current SRCD assessment, refugia status will be estimated.

Gualala Estuary Profile: Responses to Assessment Question Six:

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

There are currently only preliminary data with which to consider this question. This question should be addressed in more detail after the SRCD Estuary Assessment and Enhancement Plan are completed. However, based upon their preliminary findings the following prudent measures should be considered:

- Encourage cooperative efforts to reduce the amount of sediment transported from streams throughout the Basin;
- Maintain and enhance existing riparian canopy cover and near stream forest areas;
- Deep pools with cooler water and adequate levels of cover for salmonids appear to be uncommon in the estuary. Develop potential projects to add large wood or other structures to increase depth and habitat complexity at suitable sights within the estuary;
- Support local efforts to monitor summer water and air temperatures on a 24-hour basis to establish a base line of information to help detect long-range trends and short-term effects on the aquatic/riparian community.

Subbasin Conclusions

The Gualala estuary in summer is more correctly termed a coastal lagoon. The mouth is usually closed to sea water intrusion from June through October. Only occasionally during this period, ocean swells wash over the lagoon's sandbar. Consequently, there is little exchange of sea water and fresh water, and virtually no access for fish to move between the two environments.

No hypotheses or conclusions were developed during the original NCWAP assessment because the estuary study was in progress and there were no results at the time of the Assessment Report's printing. Since then some preliminary findings have enabled further analysis by the CDFG Coastal Watershed Planning and Assessment Program.

Aquatic and instream conditions in estuaries, at the most downstream section of a river system, are a response to watershed processes and products from upstream. Sediment and warm water are two watershed products most deleterious to any estuary's fisheries. This appears to be the case with the Gualala Estuary, thus long term improvements in this subbasin must be produced by careful watershed stewardship throughout the Gualala Basin.

Based on only two years of data, current summer/fall lagoon conditions appear to be less than hospitable for salmonids. Elevated summer water temperature, some areas with low dissolved oxygen, simplified stream habitat with poor escape cover and shallow depths are factors that contribute to the present habitat conditions.

General Recommendations:

The Gualala Basin is naturally composed of very unstable and erosive terrain. It is unknown if historic estuarine conditions were more or less favorable for salmonid populations. However, opportunities for improvements currently include:

- Land use project planning throughout the Gualala must include appropriate Best Management Practices (BMPs) to reduce erosion as close to natural rates as possible;
- During land use projects, prescribed BMPs must followed during the course of any project to minimize erosion and sediment delivery and to prevent vegetation removal near streams;
- Develop streamside canopy, especially with appropriate native conifers;
- Add large woody debris to improve instream structure, create pools, and improve channel complexity;
- Water temperature, turbidity, and suspended sediment monitoring will provide better information with which to understand trends and plan improvements;
- Monitoring of salmonid usage of the estuary/lagoon should continue to provide guidance for improvements.

Many landowners and managers are interested and motivated to eliminate watershed and stream impacts to salmonids related to land use, and wish to accelerate a return to beneficial conditions. They are encouraged to do so, enlisting the aid and support of private sector and public agency technology, experience, and funding opportunities.

North Fork Gualala Subbasin

North Fork Gualala, North Fork Subbasin, Gualala Basin, Mendocino County, California
Photo courtesy of the Gualala Redwoods Inc.

Introduction

The North Fork Subbasin encompasses 47.9 square miles of private land in the northern end of the Gualala Basin. There are four Planning Watershed Areas. The main channel has a zigzag pattern in response to faulting. There are 157 streams, and ten USGS blue line streams which provide up to 127 miles of habitat. The five major tributaries are the Little North Fork, Robinson, Dry, Stewart, and Billings creeks (Figure 5). Predominant land uses include timber production, grazing, small vineyards, and some forty-acre and larger subdivisions. Nine tributaries were inventoried by CDFG in 2001. There were seventeen reaches, totaling 22.1 miles in the inventory surveys (Table 5). The inventories included channel and habitat typing, and biological sampling.

Table 5. North Fork Subbasin with estimated anadromy.

Stream	CDFG Survey (Y/N)	Survey Length (miles)	Estimated Anadromous Habitat Length (miles)	Reach	Channel Types
Little North Fork	Y	3.9	3.9	3	F4, B4, B3
Little North Fork Unnamed Tributary	Y	1.0	1.0	2	F4, A4
Doty Creek	Y	1.2	1.2	2	F4, A3
Log Cabin	Y	0.3	0.3	1	B4
North Fork	Y	11.2	13.6	1	F4
Robinson Creek (lower)	Y	1.5	1.5	1	B4
Dry Creek	Y	2.1	2.9	1	F4
Dry Creek Tributary #1	Y	0.5	0.5	2	F4, B1
McGann Gulch	Y	0.4	2.0	1	
Stewart Creek	N		2.3		
Lost Creek	N		0.3		
Robinson Creek (upper)	N		4.1		
Bear Creek	N		1.6		
Billings Creek	N		5.9		
Palmer Creek	N		0.8		

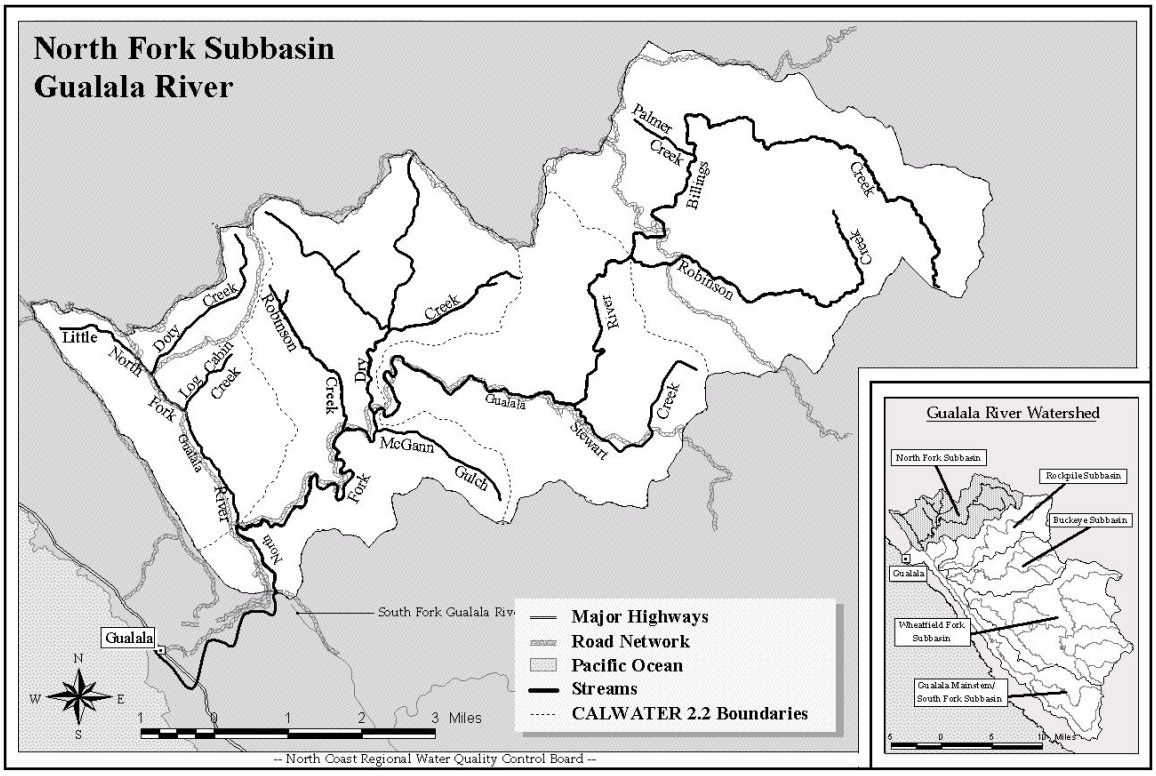


Figure 5. North Fork Subbasin, Gualala Basin, Mendocino County, California

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used by the EMDS system come from CDFG stream inventories. Currently, data exist in the Gualala Basin to evaluate the overall canopy, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of individual survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for tributaries and the entire North Fork Subbasin. Weighted average reach conditions on surveyed streams in the North Fork Subbasin were evaluated by the EMDS as somewhat unsuitable for salmonids (Table 6). Most of the streams surveyed had suitable canopy cover and embeddedness conditions.

Table 6. EMDS anadromous reach condition model results for the North Fork Subbasin..

Stream	Canopy	Embeddedness	Pool Depth	Pool Shelter	Pool Quality	Water Temperature
North Fork Subbasin	++	+	--	---	--	
Doty Creek	+++	-	---	--	-	
Dry Creek	-	++	---	---	---	+++
Dry Creek Trib #1	-	+	---	--	--	
Little North Fork	+++	++	---	--	--	+++
Little NF Trib #1	+++	+	---	--	--	
Log Cabin Creek	+++	+	---	--	--	
McGann Creek	++	---	---	---	---	
North Fork	++	++	+++	---	U	U
Robinson Creek	-	-	---	+	-	+++

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - Somewhat Unsuitable; - - Moderately Unsuitable; - - - Fully Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 28.1 miles on ten tributaries in the North Fork Subbasin. A CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat

inventories (Table 7). More details about the tributary recommendation process are given in the Gualala Synthesis Section of the Watershed Profile.

Table 7. Ranked tributary recommendations summary in the North Fork Subbasin based on CDFG stream inventories.

Stream	# of Surveyed Stream Miles	Banks	Roads	Canopy	Temp.	Pool	Cover	Spawning Gravel	LDA	Livestock and/or Feral Pigs	Fish Passage
Doty Creek	1.2		5			1	2	3	6		4
Dry Creek	2.1			3	4	1	2				
Dry Creek Trib #1	0.5			3		1	2				
Little North Fork	3.9		3			1	2				
Little NF Trib #1	1.0					1	2				
Log Cabin Creek	0.3	4	3			2	1		5		
McGann Creek	0.4	4				2	1	3			
North Fork	11.2	2	3		4		1				
Robinson Creek	1.5		4	2	3	1			5		

Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

In order to further examine North Fork Subbasin issues through the tributary recommendations given in CDFG stream surveys, the top three ranking recommendations for each tributary were collapsed into five different recommendation categories: Instream Habitat, Erosion/Sediment, Riparian/Water Temperature, Gravel/Substrate, and Other (Table 8). When examining recommendation categories by number of tributaries, the most important recommendation category in the North Fork Subbasin is Instream Habitat.

Table 8. Top ranking recommendation categories by number of tributaries in the North Fork Subbasin.

North Fork Subbasin Target Issue	Related Table Categories	Count
Instream Habitat	Pool / Cover	16
Erosion / Sediment	Bank / Roads	8
Riparian / Water Temp	Canopy / Temp	6
Gravel / Substrate	Spawning Gravel / LDA	5
Other	Livestock / Barrier	1

However, comparing recommendation categories in the North Fork Subbasin by number of tributaries could be confounded by the differences in the number of stream miles surveyed on each tributary. Therefore, the number of stream miles in each subbasin assigned to various recommendation categories was calculated (Figure 6). When examining recommendation categories by number of stream miles, the most important recommendation categories in the North Fork Subbasin are Instream Habitat, Erosion/Sediment and Riparian/Water Temperature. These comprise the recommended improvement activity focus areas.

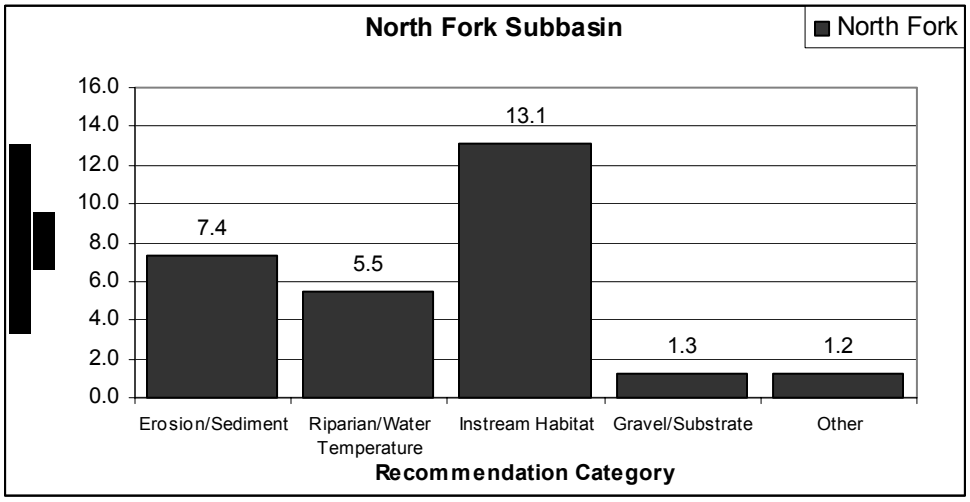


Figure 6. Recommendation categories by stream miles in the North Fork Subbasin.

The high number of Instream Habitat Recommendations across the North Fork Subbasin indicates that high priority should be given to restoration projects emphasizing pools and shelter/cover.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the North Fork Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures 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. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales. The most complete data available in the North Fork Subbasin were for tributaries surveyed by CDFG. However, some tributaries were still lacking data for some factors considered.

Salmonid habitat conditions in the North Fork Subbasin on surveyed streams are generally rated as medium potential refugia. However, North Fork and Little North Fork provide high potential refugia (Table 9).

Table 9. Tributary salmonid refugia area ratings in the North Fork Subbasin.

Stream	Refugia Categories:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area	Data Limited
North Fork		X					X
Little North Fork		X					X
Unnamed #1, LNF Gualala			X				X
Unnamed #2, LNF Gualala			X				X
Robinson Creek			X				X
McGann Creek			X				X
Dry Creek			X				X
Unnamed Trib., Dry Creek			X				X
Doty Creek			X				X
Log Cabin Creek			X				X

**Ratings in this table are done on a sliding scale from best to worst.*

North Fork Subbasin: Responses to Assessment Question Six:

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

- 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;

- Continue efforts such as road erosion proofing and decommissioning throughout the subbasin to reduce sediment delivery to the North Fork and its tributaries;
- Encourage cooperative efforts to reduce sediment yield to streams at stream bank erosion sites;
- 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;
- 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;
- 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 addition of 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;
- 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;
- Encourage more habitat inventory surveys and biological surveys of tributaries, as only 81 percent of the subbasin has been completed;
- Encourage continuation and expansion of the in-channel monitoring.

Subbasin Conclusions

Based upon this assessment, the North Fork Subbasin appears to have the least impacted habitat for salmonids in the Gualala Basin. Historical accounts indicate that this subbasin supported populations of coho salmon and steelhead trout. Current surveys indicate that it continues to have the highest fish productivity in the Gualala Basin, and is the only subbasin where coho salmon were observed during the assessment. However, the salmonid populations are currently being limited by depleted canopy cover and elevated water temperatures along the upper reaches of the North Fork mainstem and its tributaries. Reduced habitat complexity is also present in some reaches. These stream impacts are at least somewhat related to elevated levels of sediment yield. In general, roads, especially near-stream, unpaved roads, are major sources of erosion.

The North Fork Subbasin has 125 miles of identified roads. Recently, through the on-going cooperative watershed improvement efforts by CDFG and Gualala Redwoods Inc., 65 miles of road improvements have occurred resulting in reduced sediment delivery to subbasin streams. In particular, the Doty Creek Planning Watershed was identified to contain the highest density of roads proximate to streams in the subbasin. Eighty-three percent of the Doty Creek roads have been improved to date.

These cooperative improvement efforts should be continued. Additionally, residents and landowners located in the headwaters areas of the subbasin have an opportunity to help maintain and improve stream habitat by becoming better educated in methods of planting riparian vegetation and near-stream forest areas to reduce water temperatures. They can also help reduce road related sedimentation to improve water quality and habitat complexity. They are also encouraged to enlist the aid and support of the Gualala Basin improvement groups and agency technology, experience, and funding to accomplish these goals.

Rockpile Subbasin

Rockpile Creek, Rockpile Subbasin, Gualala Basin, MendocinoCounty, California
Photo courtesy of the Gualala Redwoods Inc.

Introduction

The Rockpile Subbasin is bounded to the north by the North Fork Subbasin and to the south by the Buckeye Subbasin. It encompasses thirty-five square miles of private land primarily used for timber production and grazing. This subbasin has steeper hillslopes than the North Fork Subbasin, but has the same zigzag pattern in the main Buckeye Creek channel. There are four Planning Watersheds, 114 streams, and five USGS blue line streams which provide up to 88 miles of habitat. There are two major tributaries: Red Rock Creek and Horsethief Canyon (Figure 7). CDFG conducted one inventory that provided data for a single reach that was 5.1 miles long (Table 10).

Table 10. Streams with estimated anadromy in the Rockpile Subbasin.

Stream	CDFG Survey (Y/N)	Survey Length (miles)	Estimated Anadromous Habitat Length (miles)	Reach	Channel Type
Rockpile Creek	Y	5.1	21.3	1	F4
Burnt Ridge Creek	N		2.2		
Horsethief Canyon Creek	N		1.1		

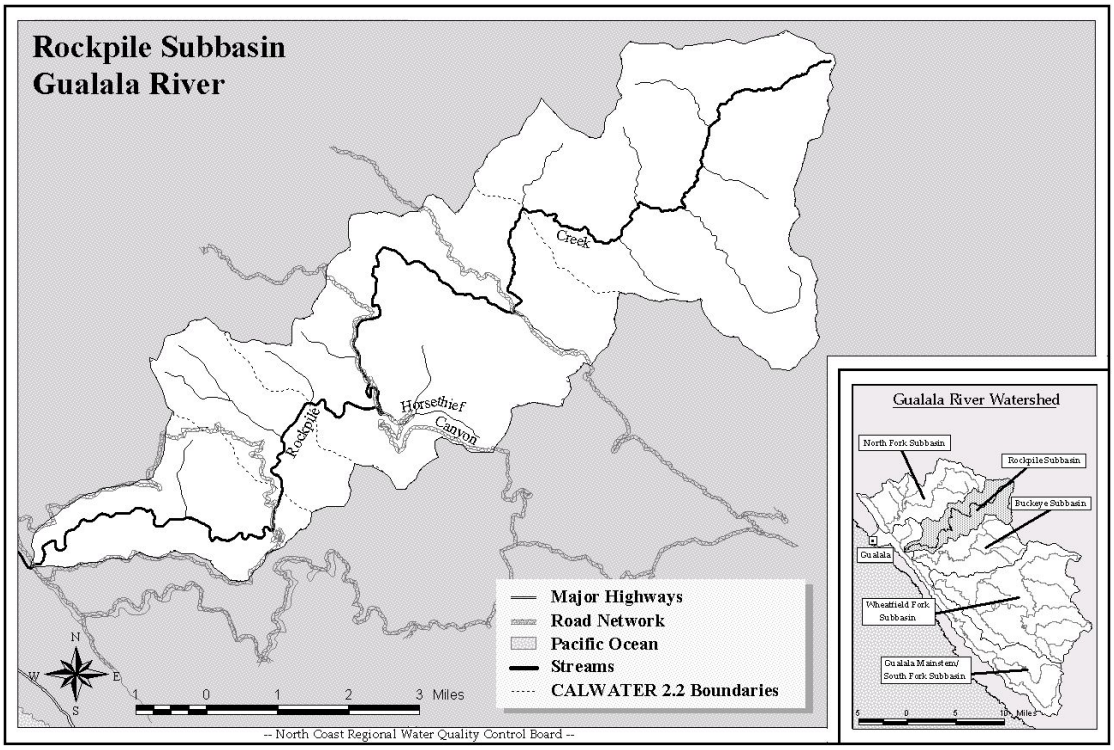


Figure 7. Rockpile Subbasin, Gualala Basin, Mendocino County, California.

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used by the EMDS system come from CDFG stream inventories. Currently, data exist in the Gualala Basin to evaluate the overall canopy, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of individual survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for tributaries and the entire Rockpile Subbasin. One partial survey on one stream may not be representative of the entire subbasin even though data were collected on the mainstem of Rockpile Creek. Weighted average reach conditions on surveyed streams in the Rockpile Subbasin as evaluated by the EMDS are moderately unsuitable for salmonids (Table 11).

Table 11. EMDS anadromous reach condition model results for the Rockpile Subbasin.

Stream	Canopy	Pool Quality	Pool Depth	Pool Shelter	Embeddedness	Water Temperature
Rockpile	**--**	**--**	**---**	**--**	**--**	**U**
Rockpile Creek	--	--	---	--	-	U

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - Somewhat Unsuitable; - - Moderately Unsuitable; - - -Fully Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 5.1 miles on one tributary in the Rockpile Subbasin. A CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories. More details about the tributary recommendation process are given in the Gualala Synthesis Section of the Watershed Profile.

Table 12: Ranked tributary recommendations summary in the Rockpile Subbasin based on CDFG stream inventories.

Stream	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Rockpile Creek	5.1	5	6	3	4	1	2				

Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

Further analysis of the Rockpile Subbasin was limited because only one tributary was surveyed. However, the top three ranking recommendations were collapsed into five different recommendation categories: Erosion/Sediment, Riparian/Water Temp, and Instream Habitat (Table 13).

Table 13. Top three ranking recommendation categories by number of tributaries in the Rockpile Subbasin.

Rockpile Subbasin Target Issue:	Related Table Categories:	Count:
Erosion / Sediment	Bank / Roads	1
Riparian / Water Temp	Canopy / Temp	1
Instream Habitat	Pool / Cover	1
Gravel / Substrate	Spawning Gravel / LDA	0
Other	Livestock / Barrier	0

The high number of Erosion/Sediment, Riparian/Water Temperature, and Instream Habitat Recommendations across the Rockpile Subbasin indicates that high priority should be given to restoration projects emphasizing sediment reduction, re-vegetation of banks, pools, and cover (Figure 8).

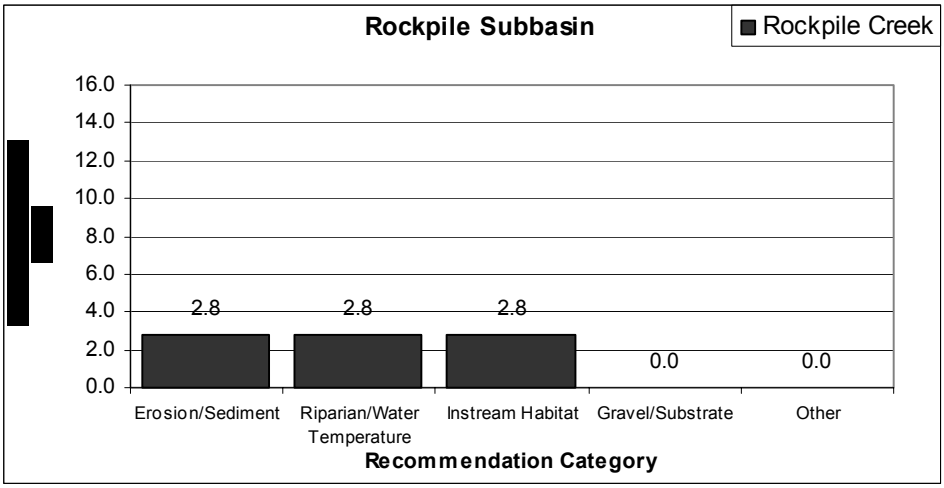


Figure 8. Recommendation categories by stream miles in the Rockpile Subbasin.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Rockpile Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures 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. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The only data available in the Rockpile Subbasin were for the tributary surveyed by CDFG. Salmonid habitat conditions in the Rockpile Subbasin on the only surveyed stream are generally rated as low potential refugia (Table 14).

Table 14. Tributary salmonid refugia area ratings in the Rockpile Subbasin.

Stream	Refugia Categories*:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
Rockpile Creek				X			X

*Ratings in this table are done on a sliding scale from best to worst.

Rockpile Subbasin Profile: Responses to Assessment Question Six:

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

- 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;
- Continue efforts such as road erosion proofing and decommissioning throughout the subbasin to reduce sediment delivery to Rockpile Creek and its tributaries. Focus efforts on roads and areas adjacent to the streams;
- Encourage cooperative efforts to reduce sediment yield to streams. Grazing is an issue in the upper part of the subbasin. Bank stabilization is the third of the top three recommendations;
- Encourage the use of cable or helicopter yarding on steep and unstable slopes to reduce soil compaction, surface disturbance, and resultant sediment yield;
- Maintain and enhance existing riparian cover. Where current canopy is inadequate and site condition 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;
- Encourage the addition of 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. Channel characteristics have improved the least in the Middle and Upper Rockpile Creek PWSs;
- 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.

Subbasin Conclusions

The Rockpile Subbasin has some of the steepest hill slopes in the Gualala Basin. The subbasin also appears to be one of the most impacted due to naturally occurring geologic processes and land use. Historic and current accounts show that steelhead trout inhabit subbasin streams, while no records document the presence of coho salmon. High instream sediment levels, high summer water temperatures, low canopy cover, simplified salmonid habitat, and limited amount of appropriately sized spawning substrate indicate that present conditions in mainstem Rockpile Creek are unsuitable for salmonids.

Accordingly, there are abundant opportunities for improvements in watershed stream and habitat conditions. These opportunities include reduction in sediment yield to streams, riparian canopy restoration, improvements to instream habitat complexity, such as large woody debris placement, and monitoring stream and fishery responses to these treatments. During project planning and design phases, careful consideration must be made concerning a proposed project's watershed context, and proximity to unstable and erosive terrain. Additionally, best management practices must be followed to minimize erosion and sediment delivery to streams during project implementation.

Current landowners and managers interested and motivated to improve land use and accelerate a return to suitable watershed conditions and benefit salmonids are encouraged to do so. They are encouraged to enlist the aid and support of Gualala Basin improvement groups and agency technology, experience, and funding to accomplish these goals.

Buckeye Subbasin

Buckeye Creek, Buckeye Subbasin, Gualala Basin, Sonoma County, California

Introduction

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 than the North Fork and Rockpile subbasins. There are five Planning Watershed Areas, 81 streams, ten blue line streams which provide up to ninety miles of habitat. There are three major tributaries in the subbasin; Flat Ridge, Grasshopper, and Osser creeks (Figure 9). In 2001, CDFG inventoried 9.7 miles of Buckeye Creek, providing data for three reaches (Table 15).

Table 15. Buckeye Subbasin with estimated anadromy.

Stream	CDFG Survey (Y/N)	Survey Length (miles)	Estimated Anadromous Habitat Length (miles)	Reach	Channel Types
Buckeye Creek	Y	9.7	16.0	3	F4, F1
Flat Ridge Creek	N		2.5		
Franchini Creek	N		1.8		
Grasshopper Creek	N		4.1		
Little Creek	N		0.3		
North Fork Buckeye Creek	N		0.6		
Osser Creek	N		5.2		
Porter Creek	N		2.4		
Roy Creek	N		3.9		
Soda Springs Creek	N		1.1		

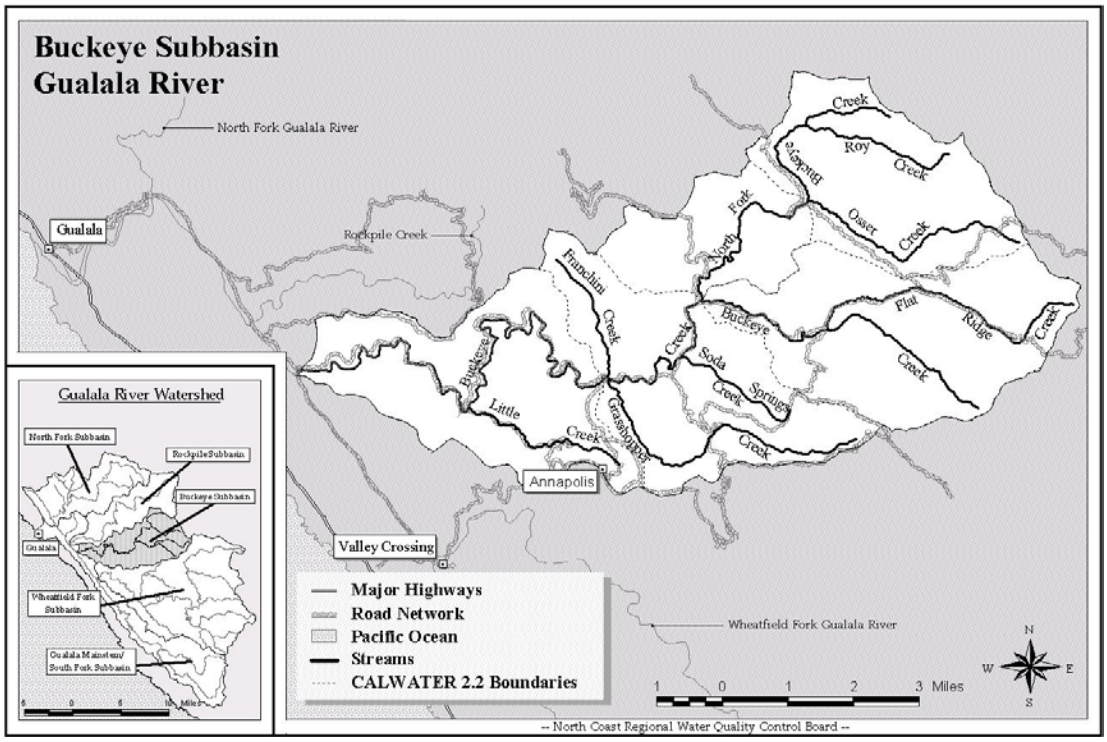


Figure 9. Buckeye Subbasin, Gualala Basin, Sonoma County, California.

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used by the EMDS system come from CDFG stream inventories. Currently, data exist in the Gualala Basin to evaluate the overall canopy, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. EMDS calculations and conclusions are pertinent only to the surveyed stream and are based on conditions present at the time of individual survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for the tributary surveyed and the entire Buckeye Subbasin. One partial survey on one stream may not be representative of the entire subbasin even though data were collected on the mainstem of Buckeye Creek. Weighted average reach conditions on the surveyed stream in the Buckeye Subbasin as evaluated by the EMDS are somewhat unsuitable for salmonids (Table 15).

Table 16. EMDS anadromous reach condition model results for the Buckeye Subbasin.

Stream	Canopy	Pool Quality	Pool Depth	Pool Shelter	Embeddedness	Water Temperature
Buckeye	-	-	--	-	**U**	--
Buckeye Creek	-	-	--	-	U	--

Key:					
+++	Fully Suitable	U	Undetermined	-	Somewhat Unsuitable
++	Moderately Suitable			- -	Moderately Unsuitable
+	Somewhat Suitable			- - -	Fully Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 9.7 miles on one tributary in the Buckeye Subbasin. A CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories. More details about the tributary recommendation process are given in the Gualala Synthesis Section of the Watershed Profile (Table 17).

Table 17. Ranked tributary recommendations summary in the Buckeye Subbasin based on CDFG stream inventories.

Stream	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock	Fish Passage
Buckeye Creek	9.7		3	4	5	1	2				

Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

Further analysis of the Buckeye Subbasin was limited because only one tributary was surveyed; however, the top three ranking recommendations for the tributary were collapsed into five different recommendation categories: Erosion/Sediment, Riparian/Water Temp, and Instream Habitat (Table 18).

Table 18. Top three ranking recommendation categories by number of tributaries in the Buckeye Subbasin.

Buckeye Subbasin Target Issue:	Related Table Categories:	Count:
Erosion / Sediment	Bank / Roads	1
Riparian / Water Temp	Canopy / Temp	1
Instream Habitat	Pool / Cover	1
Gravel / Substrate	Spawning Gravel / LDA	0
Other	Livestock / Barrier	0

The equal number of Erosion/Sediment, Riparian/Water Temperature and Instream Habitat Recommendations across the Buckeye Subbasin indicates that priority should be given to restoration projects emphasizing sediment reduction, re-vegetation of banks, pools, and cover (Figure 10).

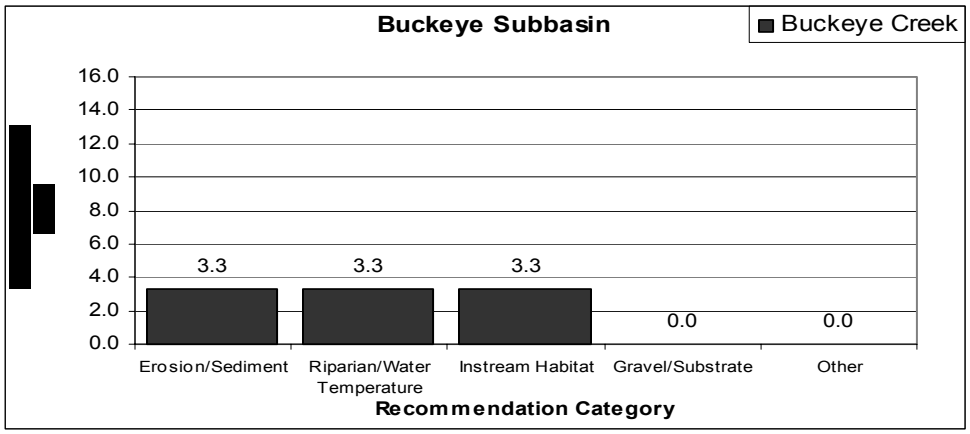


Figure 10. Recommendation Categories by stream miles in the Buckeye Subbasin.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Buckeye Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures 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. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The only complete dataset available in the Buckeye Subbasin was for the one tributary surveyed by CDFG in 2001. Salmonid habitat conditions in the Buckeye Subbasin on the one surveyed stream are generally rated as medium potential refugia (Table 19).

Table 19. Tributary salmonid refugia area ratings in the Buckeye Subbasin.

Stream	Refugia Categories*:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
Buckeye Creek			X				X

*Ratings in this table are done on a sliding scale from best to worst.

Buckeye Subbasin Profile: Responses to Assessment Question Six:

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

- 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;
- 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;
- 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;
- 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 Franchini, Grasshopper and Soda creeks;
- Encourage the addition of large organic debris and shelter structures in order to improve sediment metering, channel structure, channel function, habitat complexity, and habitat diversity for salmonids. The CDFG survey found pool shelter to be the most limiting factor in Buckeye Creek. Instream structure enhancement is the first of the top three recommendations;
- Enhance large woody debris through short and long-term efforts through ongoing large wood placement efforts and 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;
- Encourage more habitat inventory surveys and biological surveys of tributaries as only 37 percent of the Buckeye Subbasin has been completed;
- 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. Improve baseline information on habitat conditions by conducting inventory surveys in 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.

Subbasin Conclusions

The Buckeye Subbasin is characterized by steep gradient tributaries flowing into the mainstem Buckeye Creek, which is dominated by bedrock and a relatively narrow floodplain. The lower subbasin is influenced by the summer coastal fog and remains cool; the interior areas beyond the influence of the marine layer become hot and dry during summer.

Historic and current accounts show that steelhead trout are common in the subbasin, while only one record described coho salmon on Franchini Creek in the 1960s. High instream sediment levels, simplified instream salmonid habitat, relatively open canopy cover, and a lack of appropriately sized spawning substrate indicate that present conditions on the mainstem of Buckeye Creek are unsuitable for salmonids. However, air photos indicate instream and near stream conditions have improved since 1984 and the trend can be accelerated.

There are abundant opportunities for improvements in subbasin stream conditions. Improvements to instream complexity, such as additional large woody debris, riparian canopy restoration, and water temperature monitoring, are examples of opportunities. The unstable and erosive terrain should be considered prior to project planning and implementation and appropriate best management practices should be followed to minimize erosion and sediment delivery to streams. Current landowners and managers interested and motivated to eliminate impacts related to land use and accelerate a return to suitable conditions for salmonids are encouraged to do so, enlisting the aid and support of Gualala Basin restoration groups, and agency technology, experience, and funding opportunities.

Wheatfield Fork Subbasin

Wheatfield Fork near the Boy Scout Camp Gualala Basin, Sonoma County, California

Introduction

The Wheatfield Fork Subbasin has 198 streams, twenty blue line streams which provide up to 246 miles of habitat. There are ten Planning Watershed Areas which include three CalWater 2.2a SPWSs: Walters Ridge, Hedgepeth Lake, and Lower Wheatfield Fork (Figure 11). Most of the subbasin is privately owned (166 acres of federal land), with land uses in timber production, grazing, vineyard, and some rural subdivisions. CDFG conducted habitat inventories on ten streams for a total of 57.7 miles providing data on 28 reaches (Table 20).

Table 20. Streams with estimated anadromy in the Wheatfield Fork Subbasin.

Stream	CDFG Survey (Y/N)	Survey Length (miles)	Estimated Anadromous Habitat Length (miles)	Reach	Channel Types
Allen Creek	N		1.0		
Cedar Creek	N		2.3		
Danfield Creek	Y	2.3	4.3	1	F4
Fuller Creek	Y	3.9	3.9	4	E4, F4,
Grasshopper Creek	N		0.6		
Haupt Creek	Y	0.4	4.8	1	F4
House Creek	Y	10.4	11.8	1	F4
Jim Creek	N		0.9		
NF Fuller Creek	Y	2.7	2.6	7	F1, B4, A4, E3, E4
Pepperwood Creek	Y	3.4	3.7	1	F4
SF Fuller Creek	Y	4.4	4.0	6	F4, B1, B3, B4,
Soda Spring Creek	N		0.6		
Spanish Creek	N		1.0		
Sullivan Creek	Y	0.9	1.2	3	E4, E5, B4
Tombs Creek	Y	7.1	8.5	1	B4
Wheatfield Fork	Y	22.2	28.8	3	F4
Wolf Creek	N		3.6		

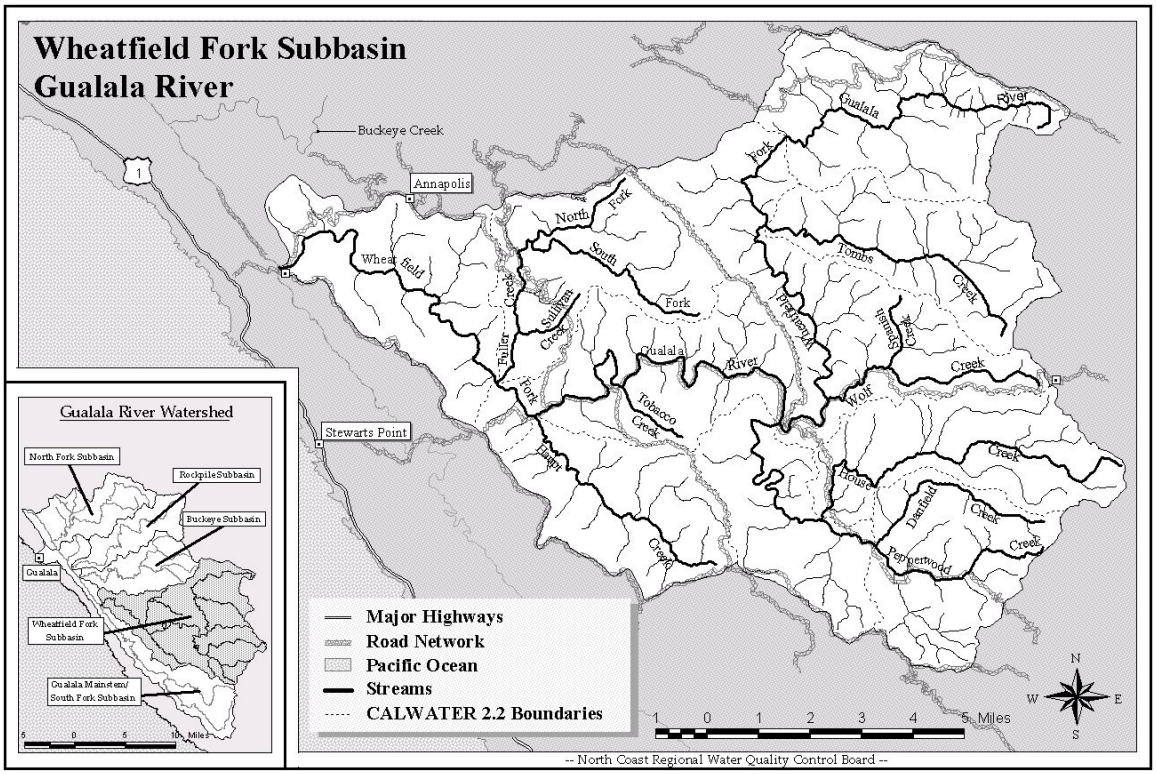


Figure 11. Wheatfield Fork Subbasin, Gualala Basin, Sonoma County, California.

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used by the EMDS system come from CDFG stream inventories. Currently, data exist in the Gualala Basin to evaluate canopy, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of individual survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for tributaries and the entire Wheatfield Fork Subbasin. Weighted average reach conditions on surveyed streams in the Wheatfield Fork Subbasin as evaluated by the EMDS are somewhat unsuitable for salmonids (Table 21).

Table 21. EMDS anadromous reach condition model results for the Wheatfield Fork Subbasin.

Stream	Canopy	Pool Quality	Pool Depth	Pool Shelter	Embeddedness	Water Temperature
Wheatfield Subbasin	**--**	**--**	**-**	**---**	**U**	**U**
Danfield Creek	---	---	---	---	--	
House Creek	---	--	---	U	++	
Pepperwood Creek	---	---	---	---	+	
Tombs Creek	-	--	---	-	-	
Wheatfield Fork	--	-	+	---	-	---

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - Somewhat Unsuitable; - - Moderately Unsuitable; - - - Fully Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 57.7 miles on ten tributaries in the Wheatfield Fork Subbasin. In Table 22, a CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories. More details about the tributary recommendation process are given in the Gualala Synthesis Section of the Watershed Profile.

Table 22. Ranked Tributary Recommendations Summary in the Wheatfield Fork Subbasin based on CDFG Stream Inventories.

Stream	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock Feral Pigs	Fish Passage
Danfield Creek	2.3	2		3			4			1	
Fuller Creek	3.4	2	3	1			4				
NF Fuller Creek	2.7			1			2				
SF Fuller Creek	4.4			1			2				
House Creek	10.4	3	2	4			5			1	
Pepperwood Creek	3.4	4		2			3			1	
Sullivan Creek	0.9						1				
Tombs Creek	7.1	2		3			4			1	
Wheatfield Fork	22.1	2	3	4			1				

Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

In order to further examine Wheatfield Fork Subbasin issues through the tributary recommendations given in CDFG stream surveys, the top three ranking recommendations for each tributary were collapsed into five different recommendation categories: Instream Habitat, Riparian/Water Temp, Erosion/Sediment, Gravel/Substrate, and Other (Table 23). When examining recommendation categories by number of tributaries, the most important recommendation category in the Wheatfield Fork Subbasin is Instream Habitat.

Table 23: Three ranking recommendation categories by number of tributaries in the Wheatfield Fork Subbasin.

Wheatfield Fork Subbasin Target Issue:	Related Table Categories:	Count:
Instream Habitat	Pool / Cover	14
Riparian / Water Temp	Canopy / Temp	12
Erosion / Sediment	Bank / Roads	9
Gravel / Substrate	Spawning Gravel / LDA	7
Other	Livestock / Barrier	6

However, comparing recommendation categories in the Wheatfield Fork Subbasin by number of tributaries could be confounded by the differences in the number of stream miles surveyed on each tributary. Therefore, the number of stream miles in each subbasin assigned to the various recommendation categories was calculated (Figure 12). When examining recommendation categories by number of stream miles, the most important recommendation categories in the Wheatfield Fork Subbasin are Instream Habitat, Erosion/Sediment, and Riparian/Water Temperature.

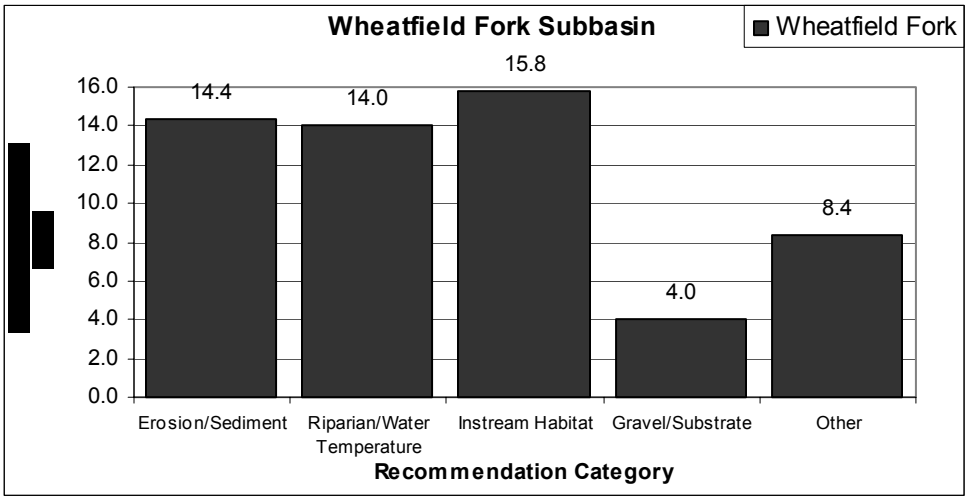


Figure 12. Recommendation categories by stream miles in the Wheatfield Fork Subbasin.

The high number of Instream Habitat, Erosion/Sediment Riparian/Water Temp Recommendations and Other (feral pigs and livestock) across the Wheatfield Fork Subbasin indicates that high priority should be given to restoration projects emphasizing pools, shelter cover, sediment reduction, riparian re-planting, and control of stock access to streams.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Wheatfield Fork Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures 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. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales. The most complete data available in the Wheatfield Fork Subbasin were for tributaries surveyed by CDFG. However, many of these tributaries were still lacking data for some factors considered by the team. Salmonid habitat conditions in the Wheatfield Fork Subbasin on surveyed streams are mixed (Table 24). Four tributaries are rated as high potential, House Creek is rated as medium potential, and five tributaries are rated as low quality. Additionally, the Wheatfield Fork serves as a critical contributing area.

Table 24. Tributary salmonid refugia area ratings in the Wheatfield Fork Subbasin.

Stream	Refugia Categories*:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
Danfield Creek				X			X
Fuller Creek		X					X
NF Fuller Creek		X					X
SF Fuller Creek		X					X
House Creek			X				X
Pepperwood Creek				X			X
Sullivan Creek		X					X
Tombs Creek				X			X
Haupt Creek				X			X
Wheatfield Fork				X		X	X

*Ratings in this table are done on a sliding scale from best to worst.

Wheatfield Fork Subbasin Profile: Responses to Assessment Question Six:

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

- 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;
- Decommission and revegetate streamside roads, focusing on those where channel braiding and/or aggradation are present;
- Pursue cost sharing grants to upgrade appurtenant ranch roads in the Walters Ridge and Hedgepeth Lake SPWSs;
- Reduce livestock and feral pig entry and subsequent impacts to the riparian zone to encourage stabilization of stream banks and re-vegetation of the riparian zone. These impacts are most common in Danfield, House, Pepperwood and Tombs creeks;
- Retain, plant, and protect trees to achieve denser riparian canopy cover where current canopy is inadequate. 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;

- Encourage the addition of large organic debris and shelter structures in order to improve sediment metering, channel structure, channel function, habitat complexity, and habitat diversity for salmonids;
- Encourage more habitat inventory surveys and biological surveys of tributaries, as only 45 percent of the subbasin has been completed;
- Evaluate canopy composition and monitor air temperatures to examine canopy, temperature, and other microclimate effects on water temperatures;
- 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;
- Expand continuous temperature monitoring efforts into the upper subbasin and tributaries.

Subbasin Conclusions

The Wheatfield Fork Subbasin is characterized by steep tributaries flowing into the mainstem Wheatfield Fork, which is dominated by bedrock and a relatively narrow floodplain. Large areas of active earthflows and other forms of landsliding are abundant and contribute sediment directly into subbasin streams. These relatively high sediment levels can be attributed to both natural and human land use disturbances. For example, road building adjacent to stream channels or across debris slide slopes and/or steep terrain has also contributed sediment to streams.

Historic and current accounts show that steelhead trout inhabit the subbasin, while only one record described coho salmon on Haupt Creek in the 1960s. Relatively high instream sediment levels, simplified salmonid habitat, low levels of instream woody debris, open canopy cover, and a lack of appropriately sized spawning substrate indicate that present conditions are unsuitable for salmonids. Nonetheless, air photos indicate instream and near stream conditions have improved since 1984.

There are abundant opportunities for improvements in watershed stream conditions. Control measures for access to streams by livestock and feral pigs, improvements to instream complexity, such as additional large woody debris, increased riparian canopy density, and monitoring physical and biological responses to these treatments, are examples of appropriate treatments. During project planning and design, careful consideration of the watershed context and the proposed site's proximity to unstable and erosive terrain must be made. During project implementation, appropriate best management practices should be followed to minimize soil disturbance and potential sediment delivery to streams.

Current landowners and managers interested and motivated to eliminate impacts related to land use and accelerate a return to suitable conditions for salmonids are encouraged to do so, enlisting the aid and support of Gualala restoration groups and agency technology, experience, and funding opportunities.

Mainstem-South Fork Subbasin

Marshall Creek, inland Mainstem-South Fork, Gualala Basin, Sonoma County, California

Introduction

The Gualala Mainstem/South Fork Subbasin is a 63.7 square mile watershed. There are six planning Watershed Areas, 94 streams, and nineteen USGS blue line streams which provide up to 134 miles of habitat (Figure 13). The river system originates in the southern end of the Gualala Basin 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 the entire subbasin is privately owned, with only15 federally owned acres and 38 state owned acres. Predominant land uses are timber production, grazing, and small vineyards. CDFG conducted habitat inventory surveys on seven streams and collected data for 8.4 survey miles (Table 25).

Table 25. Streams with estimated anadromy in the Mainstem-South Fork Subbasin.

Stream	CDFG Survey (Y/N)	Survey Length (miles)	Estimated Anadromous Habitat Length (miles)	Reach	Channel Type
Camper Creek	Y	0.7	0.7	1	G4
Carson Creek	Y	1.3	1.3	1	B4
Marshall Creek	Y	1.6	35.7	1	F4
McKenzie Creek	Y	2.6	2.6	1	B3
Palmer Canyon Creek	Y	0.1	0.5	1	B4
South Fork	Y	1.6	35.7	1	F4
Sproule Creek	N		1.3		
Wild Cattle Canyon Creek	N		1.4		
Wild Hog Canyon Creek	Y	0.5	0.8	1	

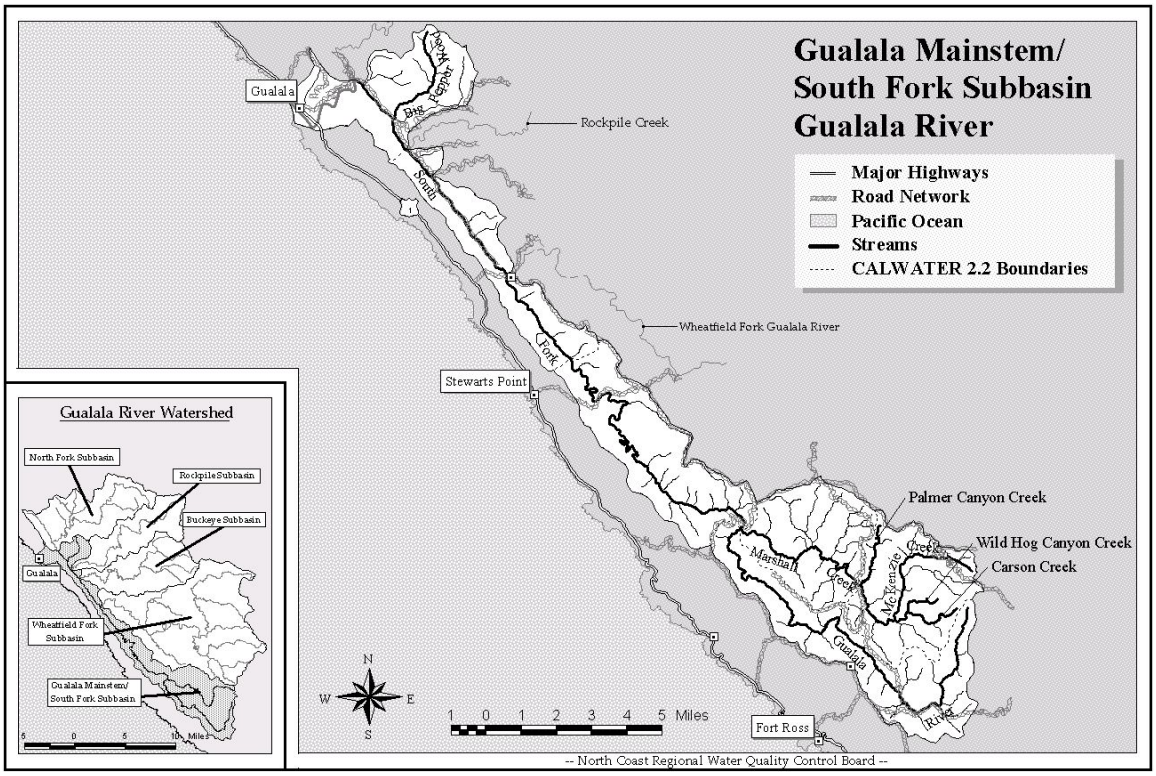


Figure 13. Mainstem-South Fork Subbasin, Gualala Basin, Sonoma County, California.

Stream Reach Condition EMDS

The anadromous reach condition EMDS evaluates the conditions for salmonids in a stream reach based upon water temperature, riparian vegetation, stream flow, and in channel characteristics. Data used by the EMDS system come from CDFG stream inventories. Currently, data exist in the Gualala Basin to evaluate the overall reach, canopy, in channel, pool quality, pool depth, pool shelter, and embeddedness conditions for salmonids. EMDS calculations and conclusions are pertinent only to surveyed streams and are based on conditions present at the time of survey.

EMDS stream reach scores were weighted by stream length to obtain overall scores for subbasin tributaries. Weighted average reach conditions on surveyed streams in the subbasin as evaluated by the EMDS are somewhat unsuitable for salmonids (Table 26).

Table 26: EMDS anadromous reach condition model results for the Mainstem-South Fork Subbasin

Stream	Canopy	Pool Quality	Pool Depth	Pool Shelter	Embeddedness	Water Temperature
Mainstem-South Fork Subbasin	+	--	-	---	+	
Camper Creek	++	-	---	--	--	
Carson Creek	+++	--	-	---	--	
Marshall Creek	--	--	-	---	+	
McKenzie Creek	+	-	-	--	-	+
Palmer Canyon	++	---	---	---	+	---
Upper South Fork	+++	---	---	---	++	+++
Wild Hog Creek	+	---	---	---	-	

Key: +++ Fully Suitable; ++ Moderately Suitable; + Somewhat Suitable; U Undetermined; - Somewhat Unsuitable; - - Moderately Unsuitable; - - -Fully Unsuitable

Analysis of Tributary Recommendations

CDFG inventoried 8.4 miles on seven tributaries in the Mainstem-South Fork Subbasin (Table 27). A CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories. More details about the tributary recommendation process are given in the Gualala Synthesis Section of the Watershed Profile.

Table 27: Ranked Tributary Recommendations Summary in the Mainstem-South Fork Subbasin based on CDFG Stream Inventories.

Stream	# of Surveyed Stream Miles	Bank	Roads	Canopy	Temp	Pool	Cover	Spawning Gravel	LDA	Livestock Feral Pigs	Fish Passage
Camper Creek	0.7		2				1				
Carson Creek	1.3		2			3	1	4			
Marshall Creek	1.6	3	4	1			2			5	
McKenzie Creek	2.6		2				1				3
Palmer Canyon	0.1		3	2							1
Upper South Fork	1.6		3	2			1				
Wild Hog Creek	0.5			2			1				

Temp = summer water temperatures seem to be above optimum for salmon and steelhead; Pool = pools are below target values in quantity and/or quality; Cover = escape cover is below target values; Bank = stream banks are failing and yielding fine sediment into the stream; Roads = fine sediment is entering the stream from the road system; Canopy = shade canopy is below target values; Spawning Gravel = spawning gravel is deficient in quality and/or quantity; LDA = large debris accumulations are retaining large amounts of gravel and could need modification; Livestock = there is evidence that stock is impacting the stream or riparian area and exclusion should be considered; Fish Passage = there are barriers to fish migration in the stream.

In order to further examine Mainstem-South Fork Subbasin issues through the tributary recommendations given in CDFG stream surveys, the top three ranking recommendations for each tributary were collapsed into five different recommendation categories: Instream Habitat, Riparian/Water Temp, Erosion/Sediment, Other, and Gravel/Substrate (Table 28). When examining recommendation categories by number of tributaries, the most important recommendation category in the Mainstem-South Fork Subbasin is Instream Habitat.

Table 28: Three ranking recommendation categories by number of tributaries in the Mainstem-South Fork Subbasin.

Mainstem-South Fork Subbasin Target Issue:	Related Table Categories:	Count:
Instream Habitat	Pool / Cover	11
Riparian / Water Temp	Canopy / Temp	9
Erosion / Sediment	Bank / Roads	8
Other	Livestock / Barrier	2
Gravel / Substrate	Spawning Gravel / LDA	1

However, comparing recommendation categories in the Mainstem-South Fork Subbasin by number of tributaries could be confounded by the differences in the number of stream miles surveyed on each tributary. Therefore, the number of stream miles in each subbasin assigned to the various recommendation categories was calculated (Figure 14). When examining recommendation categories by number of stream miles, the most important recommendation categories in the Mainstem-South Fork Subbasin are Erosion/Sediment Instream Habitat, and Riparian/Water Temperature.

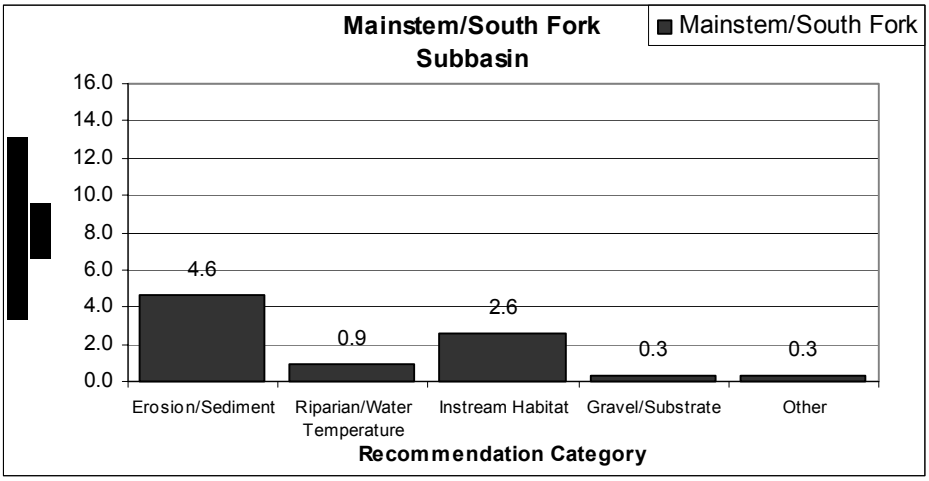


Figure 14. Recommendation categories by stream miles in the Mainstem-South Fork Subbasin.

The high number of Erosion/Sediment and Instream Habitat Recommendations across the Mainstem-South Fork Subbasin indicates that high priority should be given to restoration projects emphasizing sediment reduction, pools, and cover.

Refugia Areas

The interdisciplinary team identified and characterized refugia habitat in the Mainstem-South Fork Subbasin by using expert professional judgment and criteria developed for north coast watersheds. The criteria included measures 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. The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales.

The most complete data available in the Mainstem-South Fork Subbasin were for tributaries surveyed by CDFG. However, many of these tributaries were still lacking data for some factors considered by the team. Salmonid habitat conditions in the Mainstem-South Fork Subbasin on surveyed streams are generally rated as medium quality potential refugia (Table 29).

Table 29. Tributary salmonid refugia area ratings in the Mainstem-South Fork Subbasin.

Stream	Refugia Categories*:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
Camper Creek			X				X
Carson Creek			X				X
Upper South Fork			X				X
Marshall Creek			X				X
McKenzie Creek			X				X
Palmer Canyon Creek			X				X
Wild Hog Canyon Creek			X				X

*Ratings in this table are done on a sliding scale from best to worst.

Mainstem-South Fork Subbasin Profile: Responses to Assessment Question Six:

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

- Consider migration barrier removal in Palmer Canyon and McKenzie 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;
- 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, Palmer Canyon, and Wild Hog creeks;
- Continue to incorporate mitigation elements into Timber Harvest Plans for decommissioning legacy streamside roads and upgrading road drainage facilities in the lower subbasin, including Little and Big Pepperwood creeks;
- At stream bank erosion sites, encourage cooperative efforts to reduce sediment yield to streams;
- Reduce livestock and feral pig access and subsequent impacts to the riparian zone to encourage stabilization of stream banks and re-vegetation. This problem is most common on Marshall Creek;
- Improvement of riparian canopy is the third priority 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 cover where current canopy is inadequate, particularly in the Upper South Fork and its tributaries, McKenzie, Wild Hog, and Palmer Canyon creeks;
- Encourage the addition of large organic debris and shelter structures in order to improve sediment metering, channel structure, channel function, habitat complexity, and habitat diversity for salmonids;

- 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. 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;
- Encourage more habitat inventory surveys and biological surveys of tributaries as only 31 percent of the subbasin has been completed;
- Expand continuous temperature monitoring efforts into the upper subbasin and tributaries. Consider canopy composition, air and water temperature monitoring to examine canopy, temperature, and other microclimate effects on water temperatures.

Subbasin Conclusions

The Mainstem-South Fork Subbasin is characterized by a confined narrow valley thought to have been formed by the San Andreas Fault. This valley contains the twelve-mile long flood plain of the South Fork Gualala River. The entire subbasin is near the coast and influenced by summer fog. About half of the subbasin has high to very high potential for landsliding, and landslides represent a major source for stream sediment. The limited data available also show that historically logged areas have contributed sediment to the streams.

Historic and current accounts show that coho salmon and steelhead trout inhabit the subbasin. Although relatively high instream sediment levels, simplified salmonid habitat, and a lack of appropriately sized spawning substrate are observed in the subbasin, available data and air photos indicate that present conditions are suitable for salmonids and instream and near stream conditions have improved since 1984.

The salmonid populations are thought to be currently constrained by a lack of instream complexity, such as that formed by in-channel large woody debris. Elevated water temperatures found along the South Fork mainstem are exacerbated by low canopy cover in some locations. Elevated levels of sediment yield are thought to contribute to some negative stream impacts. The unstable and erosive terrain should be considered during project planning and design. Caution and appropriate best management practices should be followed during implementation to minimize erosion and sediment delivery to streams.

Current landowners and managers interested and motivated to improve watershed conditions and re-establish suitable conditions for salmonids are encouraged to do so through improved land use practices. They are encouraged to enlist the aid and support of Gualala Basin restoration groups and agency technology, experience, and funding opportunities.

Gualala Basin in the Regional Context

Introduction

Within the context of the North Coast, the Gualala River Basin is unique in many ways. Over the past 5-20 million years, much of the region was uplifted. A long history of movement along the San Andreas and Tombs Creek faults has been a dominant force in shaping the watershed. The Gualala system concurrently evolved as the bedrock was uplifted, crushed, and redistributed along active faults. A rainfall/runoff hydrology predominates with minimal snow accumulation. Detention time and time of concentration of rainfall are reduced by steep slopes and high rainfall accumulations, causing stream levels to rise quickly in response to rainfall. The unstable bedrock and soil conditions combined with concentrated rainfall, high regional uplift rates, and very active seismicity produce widespread, naturally occurring landsliding with associated large volumes of sediment delivered to streams. Sediment can be transported by high gradient reaches but settles in the very low gradient flood plains of the North, Little North, Wheatfield, and South forks.

The total Gualala Basin resident population for the year 2000 census was approximately 2,700 people. The population increases seasonally increase due to tourism on weekends and in the summer months. Both Gualala and Annapolis are about an hour drive time to Santa Rosa, the closest urbanized area. Historic economics were based upon fishing, forestry and ranching. The current economy has been more reliant on tourism and viticulture with forestry and ranching providing less employment opportunities than in the past.

Fishery resources of the Gualala Basin include winter-run steelhead trout. The coho salmon and steelhead trout have been traditionally important as food and recreation resources to local residents and visitors.

Summary of Subbasin Conditions and Recommendations

Based on six assessment questions, salmonid habitat in the Gualala Basin was found to have low, medium and high potential to serve as refugia for coho salmon and steelhead trout (Table 30).

Table 30: Subbasin salmonid refugia area ratings in the Gualala Basin.

Subbasin	Refugia Categories:				Other Categories:		
	High Quality	High Potential	Medium Potential	Low Quality	Non-Anadromous	Critical Contributing Area/Function	Data Limited
North Fork			**X** (N=10)				X
Rockpile				(N=1) **X**			X
Buckeye			(N=1) **X**				X
Wheatfield Fork			(N=10) **X**			X	X
South Fork			(N=7) **X**				X

*Ratings are done on a sliding scale from best to worst. Subbasin refugia ratings are aggregated from their tributary ratings. Relative rating is indicated by an **X**; N = number of streams surveyed in the subbasin. Distances surveyed weight ratings; refer to the subbasin sections for surveyed distances.

Salmonid Populations

The assessment of salmonid populations found that:

- The Gualala Basin historically supported relatively robust populations of coho salmon and steelhead trout;
- Recent biological stream surveys indicate the presence of steelhead trout in all five Gualala subbasins and the presence of a few young-of-the-year coho salmon in the North Fork subbasin;
- There are no credible estimates of subbasin or tributary specific population abundance levels of coho salmon, and two years of population data from the mid 1970s exist for steelhead trout;
- Gualala basin-wide salmonid population estimates indicate possible extirpation of coho salmon and probably depressed metapopulations of steelhead trout;
- Instream sedimentation in several stream reaches throughout the basin may be approaching or exceeding levels considered suitable for salmonid populations;
- High summer water temperatures in some surveyed tributaries are deleterious to summer rearing salmonid populations in inland areas of the North Fork, Rockpile, Buckeye Wheatfield and South Fork subbasins;

- In general, pool habitat, escape and ambush cover, and water depth are unsuitable for salmonids in most mainstem and tributary stream reaches in the Gualala Basin. Large woody debris recruitment potential is poor in the all of the subbasins. Instream habitat improvement is the top recommendation category in all subbasins;
- Available data from sampled streams suggest that all subbasins have limited suitable, high quality spawning gravel for salmonids;
- Salmonid habitat conditions in the Gualala Basin are generally best in the North Fork Subbasin and the headwaters of the Mainstem-South Fork, mixed in the Wheatfield Fork and Buckeye subbasins, and most impacted in the Rockpile Subbasin.

Tables 31 and 32 were based largely on Habitat Inventory Surveys and do not include entire subbasin stream systems. Consequently, the designations below are applicable only to the sections of stream that were inventoried.

Table 31. Summary of Gualala subbasins stream and basin conditions.

Identified Conditions	North Fork Subbasin	Rockpile Subbasin	Buckeye Subbasin	Wheatfield Fork Subbasin	Mainstem-South Fork Subbasin
In-Stream Sediment	~/R	~/R	~/R	-/R	R
Water Temperature	~	-	-	-	~
Pools	-	-	-	-	-
Flow	~	~	~	~	~
Escape Cover	-	-	-	-	-
Fish Passage Barriers	~	~	~	~	~
Natural Sediment Sources	~	-	~	+	+
Management-Related Sediment Sources	~	-	+	~	~

\+ 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

Table 32. Summary of recommended actions.

Recommended Improvement Activity Focus Areas	North Fork Subbasin	Rockpile Subbasin	Buckeye Subbasin	Wheatfield Fork Subbasin	Mainstem-South Fork Subbasin
Flow		ND	ND	ND	X
Erosion/Sediment		X	X	X	X
Riparian/Water Temperature	X	X	X		X
Instream Habitat	X	X	X	X	X
Gravel/Substrate			X	X	X
Fish Passage Barriers				X	X

X Recommended improvement activity focus areas
ND Data Limited

Geology

- The Coast Ranges in general and the Gualala Basin 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 trigger for episodes of widespread landsliding. Stream sedimentation trends fluctuate with the episodic recurrence of these 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 were clear-cut. 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 basin are still eroding periodically;
- The intensity and the extent of timber harvest are lower in recent decades as compared to the 1950-1970 periods. 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. Re-growth of the timber stands and riparian areas indicates some degree of recovery throughout the basin. Between 1984 and 1999/2000, sediment loads have declined substantially, indicating some recovery. Since 1984, the total erosion from upslope areas has not resulted in a net increase of sedimentation within the majority of the tributaries to a degree discernable from the 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 summary) 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.

Vegetation

The assessment of vegetation found that:

- Historic timber harvesting and streamside road construction reduced riparian canopy and increased direct sediment inputs and water temperature. Overall, the current landscape is comprised of smaller diameter forest stands than in pre-European times;
- Large woody debris recruitment potential is currently limited by the low percentage of near-stream forest stands containing trees in large diameter classes, but the situation should improve with the current forest management scenario.

Land Use Impacts

The assessment of land use found that:

- Land use, including road construction and use, timber harvesting, and grazing, has added excess sediment to the fluvial system. Many of the effects from these activities are spatially and temporally removed from their upland sources;
- Currently, roads are a major land use contributor of sediment. Large storms or other catastrophic events combined with poor road location and construction practices have the potential to deliver large and adverse amounts of sediment into stream systems;
- Vineyard conversions are becoming common;
- Grazing is an issue in some areas throughout the basin. Feral pig and stock impacts to streams are common in the Wheatfield Fork and Mainstem-South Fork. Watercourse exclusionary fencing is limited.

Limiting Factors Analysis General Conclusions

Based on available information for the Gualala Basin, salmonid populations in general are currently being affected in various locations by:

- General basin-wide lack of instream habitat complexity;
- Instream sediment conditions in some areas;
- High summer water temperatures in the mainstem and larger, major tributaries;
- Reduced basin-wide coho salmon and steelhead trout populations relative to those observed in the 1960s.

Summarized Recommendations (from page nine above):

***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
- CDFG stream surveys encountered extended dry reaches in some streams during summer surveys. These areas should be further investigated to determine if water conservation measures would lead to improvements in flow during dry periods.

***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 and road decommissioning, etc. Some historically active sediment sites are identified on Plate 3, "Potential Restoration Sites and Habitat Limiting Factors for the Gualala Basin" in the CGS Appendix 2.

***Riparian and 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 access and subsequent impacts to the riparian zone to encourage stabilization of stream banks and re-vegetation of the riparian zone.

Supplemental Fish Rescue and Rearing Activities:

- Evaluate fish rescue activities on Doty Creek and continue only if deemed appropriate.

Education, Research, and Monitoring Activities:

- Encourage continuation and expansion of in-channel monitoring;
- 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 air and water temperature monitoring 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.

Advantages

The Gualala Basin has several advantages for planning and implementing successful salmonid habitat improvement activities that include:

- An active restoration community made up of skilled and experienced individuals. This community is composed of several natural resources agencies, Gualala landowners, and watershed groups. This broad base provides a common forum for different points of view and interests concerning the watershed and fisheries within the basin;
- An expanding group of cooperative landowners from all subbasins in the Gualala. The effect of this growing cooperative land-base is the ability to choose locations for projects where the best result can be achieved in the shortest period of time. This accelerates the overall effectiveness of the watershed improvement program;
- Several watersheds and streams are now well into recovery and should respond well to continued stewardship and improvement treatments;
- This Gualala Basin Assessment Implementation Summary and its related Synthesis Report containing findings, conclusions, and recommendations for improvement opportunities. These reports provide focus from the basin scale, through the subbasin scale and down to the level of specific tributary assessments. With this tool to focus project design efforts, local landowners and restoration groups can pursue the mutual development of site specific improvement projects and larger long-term programs on an adaptive basis;
- A population of steelhead. Although depressed from historic levels there remain local stocks that can take advantage of improved conditions. Over time, barring overwhelming outside impacts, the stocks should grow in response to watershed efforts;
- The Gualala River Watershed Council, through funding from Clean Water Act grants, is well into developing a GIS system and monitoring program that facilitate restoration planning and the documentation of projects and their success. Its USEPA-approved Quality Assurance Project Plan is exemplary and forms the basis for collection of meaningful and significant information;
- The North Coast Regional Water Quality Control Board's sediment TMDL for the Gualala River watershed corroborates the need for erosion control, and its implementation includes grant funding opportunities and collaborative activities with the Regional Water Board.

Challenges

The Gualala Basin also has some challenges confronting efforts to improve watershed and fish habitat conditions, and increase anadromous fish populations:

- Not all landowners are interested in salmonid habitat improvement efforts. Without a watershed wide cooperative land-base, treatment options are limited. In some cases, this can remove some key areas from consideration of project development;
- Movement along the San Andreas Fault coupled with high natural erosion rates will always be a part of the Gualala landscape. These high background erosion thresholds makes the need to reduce human induced erosion to as close to zero as possible an imperative;
- Summer and early fall water resources are limited in some parts of the inland subbasins. The instream habitat conditions in that subbasin are of no use to fish without water in the streams. As human water use intensifies, the loss of critical fish stocks will continue and compromise other fishery improvement efforts.

Conclusion

The degree to which a river system reacts in a responsive manner to management improvements and restoration efforts is a function of existing watershed conditions, trends, and watershed processes. In addition, the status of processes influencing watershed conditions will affect the success of watershed improvement activities. A good knowledge base of these current watershed conditions and processes is essential in planning successful watershed improvement. Acquiring this knowledge requires property access. Access is also needed to design, implement, monitor, and evaluate suitable improvement projects. This systematic and iterative process is dependent upon the cooperative attitude of resource agencies, watershed groups and individuals, and landowners and managers.

The Gualala assessment has considered a great deal of available information regarding watershed conditions and processes in the Gualala Basin. This long and detailed assessment and analysis process has identified problems and made recommendations to address these problems while considering the advantages and challenges of conducting watershed improvement programs in the Gualala Basin.

After considering these problems, recommendations, advantages and challenges, the Gualala Basin appears to be a candidate for a successful long-term programmatic watershed improvement effort. According to the current refugia analysis, the Gualala Basin has low to medium potential refugia in the basin. Reaching improvement goals is dependent upon the formation of a well-organized and thoughtful program founded on a broad based community commitment to active watershed stewardship. The energy and opportunity appears to be present and underway in many parts of the basin. If these efforts are pursued vigorously and patiently, one day the Gualala could once again be known as "where the waters flow down" and be home to both a healthy fishery resource and a healthy watershed-based community in a uniquely diverse and beautiful area.

Recommendation and Refugia Determination Methods

Tributary Recommendations Analysis

The California Department of Fish and Game (CDFG) inventoried 28 tributaries to the Gualala River and the headwaters of the Gualala from 1995 to 2001 using protocols in the *California Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998). The tributaries and the headwaters of the Gualala River surveyed were composed of 51 stream reaches, defined as Rosgen channel types. The stream inventories are a combination of several stream reach surveys: habitat typing, channel typing, biological assessments, and in some reaches LWD and riparian zone recruitment assessments. An experienced biologist and/or habitat specialist conducted QA/QC on field crews and collected data, performed data analysis, and determined general areas of habitat deficiency based upon the analysis and synthesis of information.

The CDFG biologist selected and ranked recommendations for each of the inventoried streams, based upon the results of these standard CDFG habitat inventories, and updated the recommendations with the results of the stream reach condition EMDS and the refugia analysis (Table 33). It is important to understand that these selections are made from stream reach conditions that were observed at the times of the surveys and do not include upslope watershed observations other than those that could be made from the streambed. They also reflect a single point in time and do not anticipate future conditions. However, these general recommendation categories have proven to be useful as the basis for specific project development, and provide focus for on-the-ground project design and implementation. Bear in mind that stream and watershed conditions change over time and periodic survey updates and field verification are necessary if watershed improvement projects are being considered.

Table 33. List of tributary recommendations in stream tributary reports.

Recommendation	Explanation
Temp	Summer Water Temperatures Were Measured To Be Above Optimum For Salmon And Steelhead
Pool	Pools Are Below Target Values In Quantity And/Or Quality
Cover	Escape Cover Is Below Target Values
Bank	Stream Banks Are Failing And Yielding Fine Sediment Into The Stream
Roads	Fine Sediment Is Entering The Stream From The Road System
Canopy	Shade Canopy Is Below Target Values
Spawning Gravel	Spawning Gravel Is Deficient In Quality And/Or Quantity
LDA	Large Debris Accumulations Are Retaining Large Amounts Of Gravel And Could Need Modification
Livestock	There Is Evidence That Stock Is Impacting The Stream Or Riparian Area And Exclusion Should Be Considered
Fish Passage	There Are Barriers To Fish Migration In The Stream

In general, the recommendations that involve erosion and sediment reduction by treating roads and failing stream banks, and riparian and near stream vegetation improvements precede the instream recommendations in reaches that demonstrate disturbance levels associated with watersheds in current stress. Instream improvement recommendations are usually a high priority in streams that reflect watersheds in recovery or good health. Various project treatment recommendations can be made concurrently if watershed and stream conditions warrant.

Fish passage problems, especially in situations where favorable stream habitat reaches are being separated by a man-caused feature (e.g., culvert), are usually a treatment priority. In these regards, more general watershed scale upslope assessments can go a long way in helping determine the suitability of conducting instream improvements based upon watershed health. As such, there is an important relationship between the instream and upslope assessments.

Additional considerations must enter into the decision process before these general recommendations are further developed into improvement activities. In addition to watershed condition considerations as a context for these

recommendations, there are certain logistic considerations that enter into a recommendation's subsequent ranking for project development. These can include work party access limitations based upon lack of private party trespass permission and/or physically difficult or impossible locations of the candidate work sites. Biological considerations are made based upon the propensity for benefit to multiple or single fishery stocks or species. Cost benefit and project feasibility are also factors in project selection for design and development.

Potential Salmonid Refugia

Establishment and maintenance of salmonid refugia areas containing high quality habitat and sustaining fish populations are activities vital to the conservation of our anadromous salmonid resources (Moyle and Yoshiyama 1992; Li et al. 1995; Reeves et al. 1995). Protecting these areas will prevent the loss of the remaining high quality salmon habitat and salmonid populations. Therefore, a refugia investigation project should focus on identifying areas found to have high salmonid productivity and diversity. Identified areas should then be carefully managed for the following benefits:

- Protection of refugia areas to avoid loss of the last best salmon habitat and populations. The focus should be on protection for areas with high productivity and diversity;
- Refugia area populations which may provide a source for re-colonization of salmonids in nearby watersheds that have experienced local extinctions, or are at risk of local extinction due to small populations;
- Refugia areas provide a hedge against the difficulty in restoring extensive, degraded habitat and recovering imperiled populations in a timely manner (Kaufmann et al. 1997).

The concept of refugia is based on the premise that patches of aquatic habitat provide habitat that still retain the natural capacity and ecologic functions that support wild anadromous salmonids in such vital activities as spawning and rearing. Anadromous salmonids exhibit typical features of patchy populations; they exist in dynamic environments and have developed various dispersal strategies including juvenile movements, adult straying, and relative high fecundity for an animal that exhibits some degree of parental care through nest building (Reeves et al. 1995). Conservation of patchy populations requires conservation of several suitable habitat patches and maintaining passage corridors between them.

Potential refugia may exist in areas where the surrounding landscape is marginally suitable for salmonid production or altered to a point that stocks have shown dramatic population declines in traditional salmonid streams. If altered streams or watersheds recover their historic natural productivity, through either restoration efforts or natural processes, the abundant source populations from nearby refugia can potentially re-colonize these areas or help sustain existing salmonid populations in marginal habitat. Protection of refugia areas is noted as an essential component of conservation efforts to ensure long-term survival of viable stocks, and a critical element towards recovery of depressed populations (Sedell 1990; Moyle and Yoshiyama 1992; Frissell 1993; Frissell et al. 2000).

Refugia habitat elements include the following:

- Areas that provide shelter or protection during times of danger or distress;
- Locations and areas of high quality habitat that support populations limited to fragments of their former geographic range;
- A center from which dispersion may take place to re-colonize areas after a watershed and/or sub-watershed level disturbance event and readjustment.

Spatial and Temporal Scales of Refugia

These refugia concepts become more complex in the context of the wide range of spatial and temporal habitat required for viable salmonid populations. Habitat can provide refuge at many scales from a single fish to groups of them, and finally to breeding populations. For example, refugia habitat may range from a piece of wood that provides instream shelter for a single fish, or individual pools that provide cool water for several rearing juveniles during hot summer months, to watersheds where conditions support sustaining populations of salmonid species. Refugia also include areas where critical life stage functions such as migrations and spawning occur. Although fragmented areas of suitable habitat are important, their connectivity is necessary to sustain the fisheries. Today, watershed scale refugia are needed to recover and sustain aquatic species (Moyle and Sato 1991). For the purpose of this discussion, refugia are considered at the fish bearing tributary and subbasin scales. These scales of refugia are generally more resilient than the smaller, habitat unit level scale to the deleterious effects of landscape and riverine disturbances such as large floods, persistent droughts, and human activities (Sedell et al. 1990).

Standards for refugia conditions are based on reference curves from the literature and CDFG data collection at the regional scale. The assessment team uses these values in its EMDS models and stream inventory, improvement recommendation process. Li et al. (1995) suggested three prioritized steps to use the refugia concept to conserve salmonid resources:

- Identify salmonid refugia and ensure they are protected;
- Identify potential habitats that can be rehabilitated quickly;
- Determine how to connect dispersal corridors to patches of adequate habitat.

Refugia and Metapopulation Concept

The concept of anadromous salmonid metapopulations is important when discussing refugia. The classic metapopulation model proposed by Levins (1969) assumes the environment is divided into discrete patches of suitable habitat. These patches include streams or stream reaches that are inhabited by different breeding populations or sub-populations (Barnhart 1994; McElhany et al. 2000). A metapopulation consists of a group of sub-populations which are geographically located such that over time, there is likely genetic exchange between the sub-populations (Barnhart 1994). Metapopulations are characterized by 1) relatively isolated, segregated breeding populations in a patchy environment that are connected to some degree by migration between them, and 2) a dynamic relationship between extinction and re-colonization of habitat patches.

Anadromous salmonids fit nicely into the sub-population and metapopulation concept because they exhibit a strong homing behavior to natal streams forming sub-populations, and also have a tendency to stray into new areas. The straying or movement into nearby areas results in genetic exchange between sub-populations or seeding of other areas where populations are at low levels. This seeding comes from abundant or source populations supported by high quality habitat patches which may be considered as refugia.

Habitat patches differ in suitability and population strength. In addition to the classic metapopulation model, other theoretical types of spatially structured populations have been proposed (Li et al. 1995; McElhany et al. 2000). For example, the core and satellite (Li et al. 1995) or island-mainland population (McElhany et al. 2000) model depicts a core or mainland population from which dispersal to satellites or islands results in smaller surrounding populations. Most straying occurs from the core or mainland to the satellites or islands. Satellite or island populations are more prone to extinction than the core or mainland populations (Li et al. 1995; McElhany et al. 2000). Another model termed source-sink populations is similar to the core-satellite or mainland-island models, but straying is one way, only from the highly productive source towards the sink subpopulations. Sink populations are not self-sustaining and are highly dependant on migrants from the source population to survive (McElhany et al. 2000). Sink populations may inhabit typically marginal or unsuitable habitat, but when environmental conditions strongly favor salmonid production, sink population areas may serve as important sites to buffer populations from disturbance events (Li et al. 1995) and increase basin population strength. In addition to testing new areas for potential suitable habitat, the source-sink strategy adds to the diversity of behavior patterns salmonids have adapted to maintain or expand into a dynamic aquatic environment.

The metapopulation and other spatially structured population models are important to consider when identifying refugia because in dynamic habitats, the location of suitable habitat changes (McElhany et al. 2000) over the long term from natural disturbance regimes (Reeves et al. 1995) and over the short term by human activities. Satellite, island, and sink populations need to be considered in the refugia selection process because they are an integral component of the metapopulation concept. They also may become the source population or refugia areas of the future.

Methods to Identify Refugia

Currently there is no established methodology to designate refugia habitat for California's anadromous salmonids. This is mainly due to a lack of sufficient data describing fish populations, metapopulations and habitat conditions and productivity across large areas. This lack of information holds true for basins especially in terms of metapopulation dynamics. Studies are needed to determine population growth rates and straying rates of salmonid populations and sub-populations to better utilize spatial population structure to identify refugia habitat.

Classification systems, sets of criteria and rating systems have been proposed to help identify refugia type habitat in north coast streams, particularly in Oregon and Washington (Moyle and Yoshiyama 1992; FEMAT 1993; Li et al. 1995; Frissell et al. 2000; Kisup County, 2000). Upon review of these works, several common themes emerge. A main theme is that refugia are not limited to areas of pristine habitat. While ecologically intact areas serve as dispersal centers for stock maintenance and potential recovery of depressed sub-populations, lower quality habitat areas also play important roles in long-term salmonid metapopulation maintenance. These areas may be considered the islands,

satellites, or sinks in the metapopulation concept. With implementation of ecosystem management strategies aimed at maintaining or restoring natural processes, some of these areas may improve in habitat quality, show an increase in fish numbers, and add to the metapopulation strength.

A second common theme is that over time within the landscape mosaic of habitat patches, good habitat areas will suffer impacts and become less productive, and wink out and other areas will recover and wink in. These processes can occur through either human caused or natural disturbances or succession to new ecological states. Regardless, it is important that a balance be maintained in this alternating, patchwork dynamic to ensure that adequate good quality habitat is available for viable anadromous salmonid populations (Reeves et al. 1995.)

Assessment Team Approach to Identifying Refugia

The interdisciplinary team identified and characterized refugia habitat by using expert professional judgment and criteria developed for North Coast watersheds. The criteria used 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. The expert refugia team encouraged other specialists with local knowledge to participate in the refugia identification and categorization process.

The team also used results from information processed by EMDS at the stream reach and planning watershed/subbasin scales. Stream reach and watershed parameter evaluation scores were used to rank stream and watershed conditions based on collected field data and air photo analysis. Stream reach scale parameters included pool shelter rating, pool depth, embeddedness, and canopy cover. Water temperature data were also used when available. The individual parameter scores identified which habitat factors currently support or limit fish production (see EMDS and limiting factors sections).

Planning watershed scale parameters used are road density, number of stream crossings, road proximity to streams, riparian cover, and LWD loading potential. The refugia team used the potential sediment production and other planning watershed scale EMDS evaluations in a similar manner as they became available.

When identifying anadromous salmonid refugia, the team took into account that anadromous salmon have several non-substitutable habitat needs for their life cycle. A NOAA Technical Memorandum listed five of these requirements (McElhany 2000):

- Adult migration pathways;
- Spawning and incubation habitat;
- Stream rearing habitat;
- Forage and migration pathways;
- Estuarine habitat.

The best refugia areas are large and meet all of these life history needs and therefore provide complete functionality to salmonid populations. These large, intact systems are scarce today and smaller refugia areas that provide for only some of the requirements have become very important areas, but cannot sustain large numbers of fish. These must operate in concert with other fragmented habitat areas for life history support and refugia connectivity becomes very important for success. Therefore, the refugia team considers relatively small, tributary areas in terms of their ability to provide at least partial refuge values, yet contribute to the aggregated refugia of larger scale areas. Therefore, the team's analyses use the tributary scale as the fundamental refugia unit.

The CDFG NCWAP assessment team created a tributary scale refugia-rating worksheet (CDFG Appendix 5). The worksheet was first used by the multi-disciplinary NCWAP Mattole Basin assessment team, but was not used by the NCWAP Gualala team. The worksheet has 21 condition factors that were rated on a sliding scale from high quality to low quality. The 21 factors were grouped into five categories:

- Stream condition;
- Riparian condition;
- Native salmonid status;
- Present salmonid abundance;
- Management impacts (disturbance impacts to terrain, vegetation, and the biologic community).

Tributary ratings were determined by combining the results of air photo analyses results, EMDS results, and data in the CDFG tributary reports by a multi-disciplinary, expert team of analysts. The various factors' ratings were combined to

determine an overall tributary rating on a scale from high to low quality refugia. Tributary ratings were subsequently aggregated at the subbasin scale and expressed a general estimate of subbasin refugia conditions. Factors with limited or missing data were noted. In most cases, there were data limitations on 1 – 3 factors. These were identified for further investigation and inclusion in future analysis.

The assessment team has created a hierarchy of refugia categories that contain several general habitat conditions. This descriptive system is used to rank areas by applying results of the analyses of stream and watershed conditions described above and are used to determine the ecological integrity of the study area. A basic definition of biotic integrity is "the ability [of an ecosystem] to support and maintain a balanced, integrated, and functional organization comparable to that of the natural habitat of the region" (Karr and Dudley 1981).

The Report of the Panel on the Ecological Integrity of Canada's National Parks submitted this definition:

> The Panel proposes the following definition of ecological integrity: "An ecosystem has integrity when it is deemed characteristic for its natural region, including the composition and abundance of native species and biological communities, rates of change and supporting processes. In plain language, ecosystems have integrity when they have their native components (plants, animals and other organisms) and processes (such as growth and reproduction) intact."

Assessment Team Salmonid Refugia Categories and Criteria:

High Quality Habitat, High Quality Refugia

- Maintains a high level of watershed ecological integrity (Frissell 2000);
- Contains the range and variability of environmental conditions necessary to maintain community and species diversity and supports natural salmonid production (Moyle and Yoshiyama 1992; Frissell 2000);
- Relatively undisturbed and intact riparian corridor;
- All age classes of historically native salmonids present in good numbers, and a viable population of an ESA listed salmonid species is supported (Li et al. 1995);
- Provides population seed sources for dispersion, gene flow and re-colonization of nearby habitats from straying local salmonids;
- Contains a high degree of protection from degradation of its native components.

High Potential Refugia

- Watershed ecological integrity is diminished but remains good (Frissell 2000);
- Instream habitat quality remains suitable for salmonid production and is in the early stages of recovery from past disturbance;
- Riparian corridor is disturbed, but remains in fair to good condition;
- All age classes of historically native salmonids are present including ESA listed species, although in diminished numbers;
- Salmonid populations are reduced from historic levels, but still are likely to provide straying individuals to neighboring streams;
- Currently is managed to protect natural resources and has resilience to degradation, which demonstrates a strong potential to become high quality refugia (Moyle and Yoshiyama 1992; Frissell 2000).

Medium Potential Refugia

- Watershed ecological integrity is degraded or fragmented (Frissell 2000);
- Components of instream habitat are degraded, but support some salmonid production;
- Riparian corridor components are somewhat disturbed and in degraded condition;

- Native anadromous salmonids are present, but in low densities; some life stages or year classes are missing or only occasionally represented;
- Relative low numbers of salmonids make significant straying unlikely;
- Current management or recent natural events have caused impacts, but if positive change in either or both occurs, responsive habitat improvements should occur.

Low Quality Habitat, Low Potential Refugia

- Watershed ecological integrity is impaired (Frissell 2000);
- Most components of instream habitat are highly impaired;
- Riparian corridor components are degraded;
- Salmonids are poorly represented at all life stages and year classes, but especially in older year classes;
- Low numbers of salmonids make significant straying very unlikely;
- Current management and / or natural events have significantly altered the naturally functioning ecosystem and major changes in either of both are needed to improve conditions.

Other Related Refugia Component Categories:

Potential Future Refugia (Non-Anadromous)

- Areas where habitat quality remains high but does not currently support anadromous salmonid populations;
- An area of high habitat quality, but anadromous fish passage is blocked by man made obstructions such as dams or poorly designed culverts at stream crossings etc.

Critical Contributing Areas

- Area contributes a critical ecological function needed by salmonids such as providing a migration corridor, conveying spawning gravels, or supplying high quality water (Li et al. 1995);
- Riparian areas, floodplains, and wetlands that are directly linked to streams (Huntington and Frissell 1997).

Data Limited

- Areas with insufficient data describing fish populations, habitat condition watershed conditions, or management practices.

General Steps to Identifying Refugia:

An interdisciplinary team identifies and characterizes refugia habitat by using expert professional judgment and criteria developed for North Coast watersheds. The criteria include the status of extant fishery populations and stream and watershed conditions affecting them. The team also considers the status and trends in processes delivering watershed products including the transport and routing of water, sediment, wood, nutrients, and heat through the system. Thus, the level of natural and land use disturbances – past, present, and future – are considered as well. This process provides insights concerning current watershed conditions, processes, and trends. It also projects likely outcomes for refugia status in the future. This process as presented here was not established or used by the Gualala NCWAP assessment team. They rather had a more informal expert session to make their determinations. Subsequent refugia determination work was done by CWPAP teams for this Implementation Summary.

Step One: A refugia rating team is established. The team includes the interdisciplinary assessment team plus local landowners or other experts.

Step Two: The team meets in an expert session to consider:

Ecological Management Decision Support system outputs and LFA conclusions based on stream reach scale. EMDS parameters include pool shelter rating, pool depth, embeddedness, and canopy cover. LFA parameters include these and others like flow, water quality, fish passage, etc.

EMDS Planning Watershed scale parameters for road density, number of stream crossings, road proximity to streams, riparian cover, and LWD loading potential. These parameters are used to estimate watershed process disturbance levels and risk to streams. The Basin Assessment Report's Integrated Analysis process is applied to each subbasin in the assessment area. These analyses consider the status and linkages between geology, vegetation history, land use,

water quality, fluvial geo-morphology, stream habitat, and fishery status at the subbasin scale. Systematic, stratified, random samples of streams are also used within the subbasin units. These samples have only been used in one subbasin to date, but they provide the information to estimate the conditions on several stream parameters. Local information provided by landowners and others well acquainted with the subject area.

Step Three: The refugia rating team uses the foregoing information to rate several fish, stream, and watershed components on a rating worksheet. Initially, team members complete the sections of the worksheet independently in the area of their expertise.

Step Four: The team collectively reviews the several independent ratings to validate the overall collective rating. The results of the tributary rating sheets are then collapsed into a rating for the Planning Watershed and subbasin scales within the basin context. Regional inter-basin comparisons can be made when the collection of large-scale basin assessments is more complete.

CDFG Refugia Rating Worksheet

The assessment team created a worksheet for rating refugia at the tributary scale (Table 34). The worksheet has 21 condition factors rated on a sliding scale from high to low quality. The 21 factors are grouped into five categories: 1) stream condition; 2) riparian condition; 3) native salmonid status; 4) present salmonid abundance; and 5) management impacts (disturbance impacts to terrain, vegetation, and the biologic community). The tributary ratings are determined by combining the results of aerial photo analyses, EMDS, and data in the CDFG tributary reports by a multi-disciplinary, team of expert analysts. Ratings of various factors are combined to determine an overall refugia rating on a scale from high to low quality. The tributary ratings are subsequently aggregated at the subbasin scale and expressed as a general estimate of subbasin refugia conditions. Factors with limited or missing data are noted and discussed in the comments section as needed. In most cases, there are data limitations on one to three factors. These are identified for further investigation and analysis.

The rating sheet is used by placing an "X" on a sliding scale extending from High Quality to Low Quality in each row of the rating sheet. The comments section can be used to explain items like missing data, or special situations like diversions or dams, etc.

After the sheets are completed, the ratings in each section are averaged as are the five sections' mean ratings to produce an overall summary rating for the sub-watershed (stream). These stream ratings are then normalized by stream distance and/or sub-watershed area and once more combined to produce a mean refugia rating useful for comparison between subbasins.

Although the range of variance within these layers is somewhat blurred through this lumping procedure, particulars and detail can be regained by focusing back down through the layers from subbasin to sub-watershed, stream, and finally to the individual parameters. In this manner guidance can be given to an analyst investigating opportunities for watershed improvements through restoration or management activities.

Table 34. CDFG Refugia Rating Worksheet.

Stream Name:			**Date:**
Raters:			
Ecological Integrity - Overall Refugia Summary Ratings:	High Quality; High Potential; Medium Potential; Low Quality (Other: *Non-Anadromous; Contributing Functions; Data Limited*)		
Stream Condition:	**High Quality**	**Medium Quality**	**Low Quality**
Stream Flow			
Water Temperature			
Free Passage			
Gravel			
Pools			
Shelter			
In-Channel Large Wood			
Canopy			
Nutrients			
Stream Summary Rating:			
Riparian Condition:	**High Quality**	**Medium Quality**	**Low Quality**
Forest Corridor Seral Stage			
Fluvial Dis-equilibrium			
Aquatic/Riparian Community			
Riparian Summary Rating:			
Native Salmonids Status: (Native Species and Age Classes)	**Present**	**Diminished**	**Absent**
Chinook			
Coho			
Steelhead			
Species Summary Rating:			
Salmonid Abundance:	**High**	**Medium**	**Low**
Chinook			
Coho			
Steelhead			
Abundance Summary Rating:			
Management Impacts:	**Low Impacts**	**Medium Impacts**	**High Impacts**
Disturbed Terrain			
Displaced Vegetation			
Native Biologic Integrity			
Impacts Summary Rating:			
Comments:			

Limitations of this Assessment

This assessment was limited in duration, scope, detail, and analysis level due to constraints in budget, time, access, and overall resources. Where data are limited, working hypotheses are offered along with recommendations to test or improve the knowledge base. Specific limitations are presented below to put the assessment into context and to provide guidance to improve future data collections and analysis.

- The California Department of Fish and Game's habitat inventory surveys provided the data for instream conditions, the Ecological Management Decision Support Reach Model, the Limiting Factors Analysis, and the Restoration Recommendations and Priorities. None of the subbasins had all streams surveyed. The following lists the amount of the subbasin surveyed by length: North Fork, 81%; Rockpile, 39%; Buckeye, 37%; Wheatfield 45%; and the Mainstem/South Fork, 31%. These data should be used only within this qualified, limited context;
- The California Geological Survey's landslide and geomorphic analyses were limited to aerial photo interpretation primarily from two sets of photos: 1984 and 1999/2000, and limited field verification. A limited number of 1965 aerial photographs were reviewed briefly for only a few selected portions of the watershed. Limited aerial photo coverage does not bracket temporal distribution of important watershed events, which may not be evident in photos taken years after the fact. Field checking of interpretations was limited;
- At the analysis scale of 1:24,000, the detection of geologic features smaller than 100 feet in the largest dimension is poor;
- Detailed site level mapping of landslides and sediment delivery were conducted by outside parties in various portions of the watershed. However, time and staffing constraints prevented full evaluations of those data;
- Existing geologic mapping of the Rockpile Subbasin is limited to the Geologic Map of the Santa Rosa Quadrangle (Wagner and Bortugno 1999), which was mapped at a scale of 1:250,000 (2-degree sheet). The presence and locations of geologic features in this area were inferred from surrounding areas where more detailed mapping was available;
- California Department of Forestry and Fire Protection's land use analysis used aerial photos exclusively. Sediment sources found in earlier photo sets were not field reviewed to ascribe current comparative condition;
- Localized point source channel aggradations and meandering flows observed shortly after the winter rains during the late 1950s and early 1960s were not systematically compared sequentially through time to detail evolving stream channel morphology. Only spot point comparisons with 1984, 1988, and 1999 photos were done depending on where damage was observed from winter rains during the late 1950s and early 1960s;
- There was only time to compare the broadest contrasts between 1950s/1960 era impacts with declining habitat conditions. To properly characterize subtle habitat changes and land use activities requires a much larger and finer detailed dataset to make more significant conclusions;
- North Coast Regional Water Quality Control Board's water chemistry analysis was limited to available U.S. Environmental Protection Agency StoRet data for the period April of 1974 to June of 1988 at three locations, and three samples obtained by NCRWQCB at five locations in 2001. The sampling frequency and small number of locations did not allow for any detailed temporal analysis;
- NCRWQCB did not have turbidity or suspended solids data, though considers them critical to watershed analysis. The absence of those data and any analysis of suspended loads and turbidity are limitations in this assessment.
- Pesticide data were not available from StoRet, nor collected in the NCRWQCB sampling of 2001;
- NCRWQCB analyzed water temperature and in-channel data supplied by the Gualala River Watershed Council (GRWC), Gualala Redwoods, Inc. (GRI), and from NCRWQCB files containing Coastal Forest Lands, Ltd. data for the period from 1992 to 2001. Not all locations were sampled throughout that period, limiting the ability to compare across years and among sites;
- In-channel data and some temperature data were provided as summary statistics (medians, means, and maximums), limiting the ability to factor variability into the analysis, and not allowing for independent checks on the data quality;

- The temperature range of 50-60° F was adopted as a "fully suitable" average condition for the needs of several cold-water fish species, including coho salmon and steelhead trout. As such, the range does not specifically represent fully suitable conditions for the most sensitive cold-water species, usually considered to be coho salmon;
- Water temperature data analysis did not include probability of exceedance from cumulative distribution plots, or hours of exceedance of a threshold. This analysis was limited by not having raw data for all sample sites or from throughout the stream system. Some raw data was obtained late in the analysis period and data interface problems were also encountered. Analysis of temperature information is without knowledge of the extent of a thermal reach upstream or downstream of the continuous data-logger;
- The EMDS model used is preliminary; not all components of the model are currently in use due to data and modeling issues (e.g., stream temperature, fish passage, stream flow); not all data layers used in the model have been fully subjected to quality control since the review of the model by scientists and practitioners is not yet complete.

Literature Cited

Barnhart, R.A. 1994. Salmon and steelhead populations of the Klamath-Trinity Basin, California. Proceedings of the Klamath Basin Fisheries Symposium 1994:73-97. California Cooperative Fisheries Research Unit, Humboldt State University, Arcata, California.

Flosi, G., S. Downie, J. Hopelain, M. Bird, R. Coey, and B. Collins. 1998. California salmonid stream habitat restoration manual, California Department of Fish and Game. Sacramento, California.

Forest Ecosystem Management Assessment Team (FEMAT). 1993. Forest ecosystem management: an ecological, economic, and social assessment. U.S. Government Printing Office 1993-793-071 report to the U.S. Department of Agriculture, U.S. Department of Interior, U.S. Department of Commerce, and U.S. Environmental Protection Agency. Portland, Oregon.

Frissell, C.A. 1993. Topology of extinction and endangerment of native fishes in the Pacific Northwest and California (U.S.A.). Oregon State University, Corvallis, Washington.

Frissell, C., P. Morrison, S. Adams, L. Swope, and N. Hitt. 2000. Conservation priorities: an assessment of freshwater habitat for Puget Sound salmon. The Trust for Public Land, Seattle, Washington.

Huntington, C., and C. Frissell. 1997. Aquatic conservation and salmon recovery in the north coast basin of Oregon: a crucial role for the Tillamook and Clatsop State forests. Report to Oregon Trout, Portland, Oregon.

Karr, J. and D.Dudley. 1981. Ecological perspective on water quality goals. Environmental Management 5:55-68.

Kaufmann, M. R., R. Graham, D. Boyce, W. Moir, L. Perry, R. Reynolds, R. Bassett, P. Mehlhop, C. Edminster, W. Block, and P. Corn. 1994. An ecological basis for ecosystem management. U.S. Forest Service General Technical Report RM-GTR-246, Rocky Mountain Research Station, Fort Collins, Colorado.

Kitsap County, 2000. Kitsap Peninsula salmonid refugia study. Port Orchard, Washington.

Klampt, R., C. LeDoux-Bloom, J. Clements, M. Fuller, D. Morse, and M. Scruggs. 2002. Gualala River watershed assessment report. North Coast Watershed Assessment Program. California Resources Agency, and California Environmental Protection Agency, Sacramento California.

Levins, R. 1969: Some demographic and genetic consequences of environmental heterogeneity for biological control. Bulletin of the Entomological Society of America, 15, 237-240.

Li, H.W., K. Currens, D. Bottom, S. Clarke, J. Dambacher, C Frissell, P. Harris, R.M. Hughes, D. McCullough, A. McGie, K. Moore, R. Nawa, and S. Thiele. 1995. American Fisheries Society Symposium 17:371-380.

McElhany, P., M. Rucklelshaus, M. Ford, T. Wainwright, and E. Bjorkstedt. 2000. Viable salmonid populations and recovery of evolutionarily significant units. NOAA Technical Memorandum NMFS-NWFSC-42.

Moyle, P., and G. Sato. 1991. On the design of preserves to protect native fishes. Pages 155 -169 *in* W. L. Minkley and J. E. Deacon, editors. Battle against extinction: native fish management in the American West. University of Arizona Press, Tucson, Arizona.

Moyle, P, and R.Yoshiyama. 1992. Fishes, aquatic diversity management areas, and endangered species: a plan to protect California's native aquatic biota. The California Policy Seminar, University of California, Davis, California.

Nicholas, J., and D. Hankin. 1988. Chinook salmon populations in Oregon coastal river basins: description of life histories and assessment of recent trends in run strengths. Oregon Department of Fish and Wildlife Research and Development Section: 359. Corvallis, Oregon.

Panel on the Ecological Integrity of Canada's National Parks. 2000. Report of the Panel on the Ecological Integrity of Canada's National Parks. Vancouver, British Columbia, Canada.

Reeves, G., L. Benda, K. Burnett, P. Bisson, and J. Sedell. 1995. A disturbance-based ecosystem approach to maintaining and restoring freshwater habitats of evolutionarily significant units of anadromous salmonids in the Pacific Northwest. American Fisheries Society Symposium 17:334-349.

Reimers, P. 1973. The length of residence of juvenile Chinook salmon in the Sixes River, Oregon. Fish Commission of Oregon Research Reports 4(2): 1- 43.

Sedell, J., G. Reeves, F. Hauer, J. Stanford, and C. Hawkins. 1990. Role of refugia in recovery from disturbances: modern fragmented and disconnected river systems. Environmental Management. Vol. 14, No. 5, pp 711-724.

Wagner, D., and E. Bortugno. 1982. Geologic map of the Santa Rosa quadrangle, California, 1:250,000. California Division of Mines and Geology. Sacramento, California.

www.gualala.com/history/pomo.htm. Web reference for native American discussion on page six.