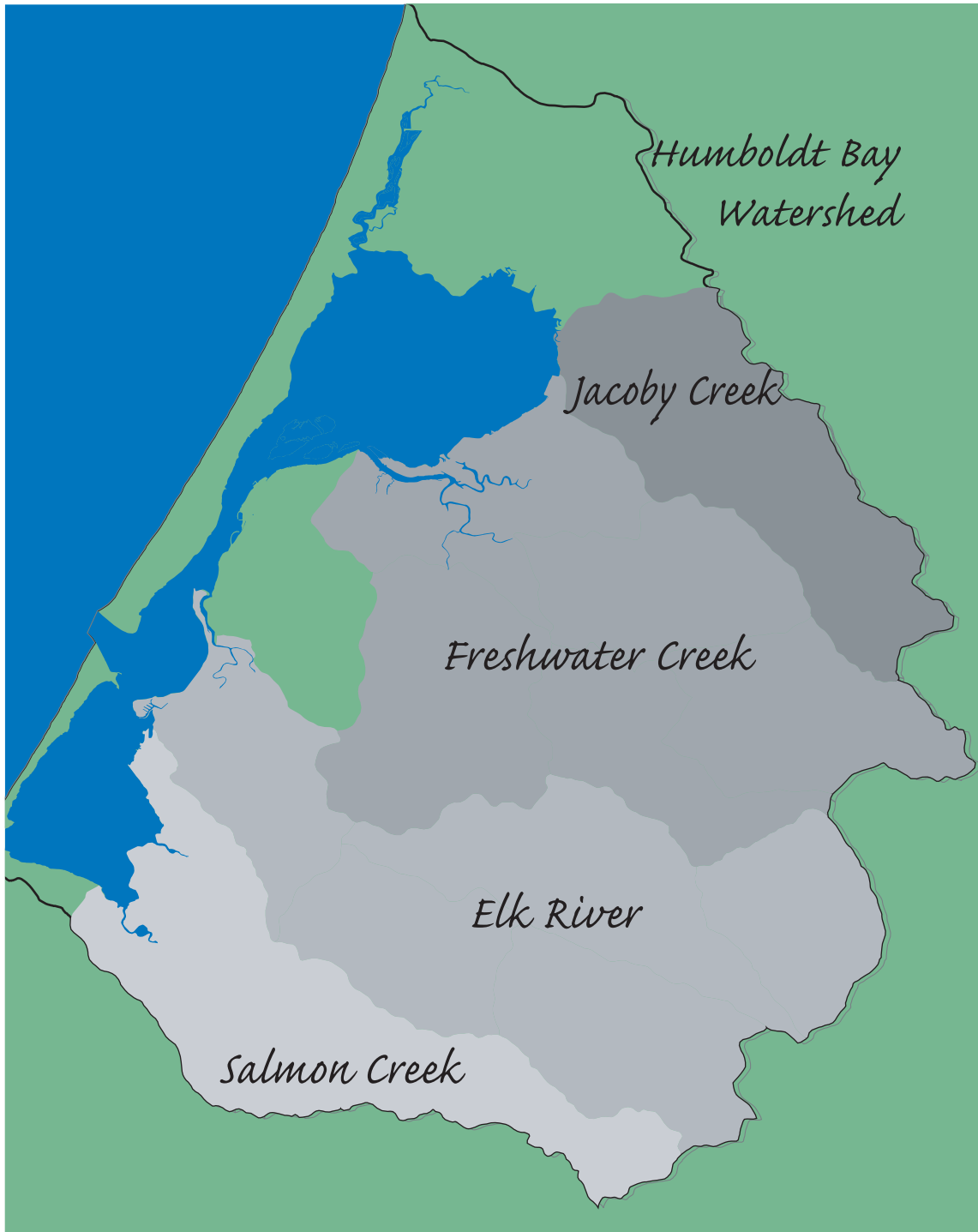


Humboldt Bay Watershed Salmon and Steelhead Conservation Plan



*Prepared for:
California Department of Fish & Game and the
California Coastal Conservancy*



*Prepared by:
The Humboldt Bay Watershed Advisory Committee and
The Natural Resources Services Division of
Redwood Community Action Agency*

Acknowledgements

This plan was compiled with the assistance of many people, too many to mention by name, including landowners, agencies, organizations and individuals. Special thanks to the following agencies and organizations for contributing time and resources:

California Department of Fish and Game, Eureka and Fortuna Offices
Pacific Lumber Company
Green Diamond Resource Company
Institute for River Ecosystems
NOAA National Marine Fisheries Services
Humboldt State University
Humboldt Fish Action Council
Salmon Forever
McBain and Trush



Thanks go to the members and supporters of the
Humboldt Bay Watershed Advisory Committee
for their dedication and patience to the writing process and for their guidance,
contributions, and reviews of this plan.

Funding granted through:
California Department of Fish and Game
California State Coastal Conservancy
National Marine Fisheries Service (NOAA)



The mission of the **Department of Fish and Game** is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public.



The **State Coastal Conservancy** acts with others to preserve, protect and restore the resources of the California Coast with a vision of a beautiful, restored, and accessible coastline.



The mission of the **National Marine Fisheries Service**, a branch of the **National Oceanic and Atmospheric Administration**, is to provide stewardship of living marine resources through science-based conservation and management and the promotion of healthy ecosystems.

The mission of the **Humboldt Bay Watershed Advisory Committee** is to improve the watershed's anadromous salmonid populations and related resources while considering regional ecological and socioeconomic needs.

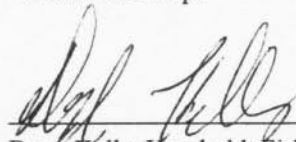


The **Natural Resources Services Division of Redwood Community Action Agency** would like to thank these organizations for their visionary assistance with this document; informational, financial, inspirational, and otherwise.

Endorsement for the Humboldt Bay Watershed Salmon and Steelhead Conservation Plan

We, the undersigned members of the Humboldt Bay Watershed Advisory Committee, have worked together to develop the goals and objectives contained in the Humboldt Bay Watershed Salmon and Steelhead Conservation Plan. The goals and objectives are intended to be used as a framework by agencies and community members either individually or collectively to improve the habitat and management of the Humboldt Bay watershed.

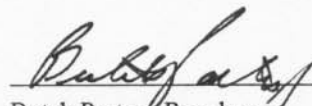
Joyce King, Salmon Forever
Watershed Groups



Doug Kelly, Humboldt Fish Action Council
Watershed Restoration



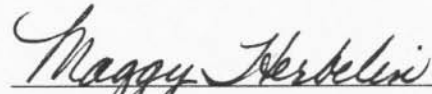
Cheri Sanville, Green Diamond Resource Company
Education/Outreach



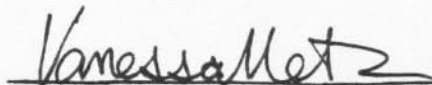
Butch Parton, Rancher
Landowners/Agriculture



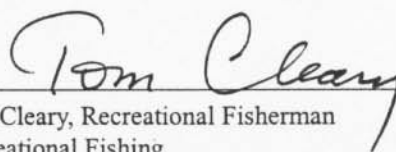
Jeff Barrett, Pacific Lumber Company
Industrial Timber



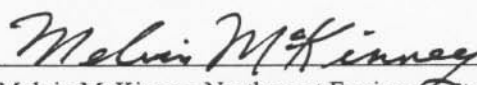
Maggy Herbolin, Chair
Community Representative



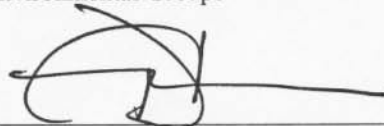
Vanessa Metz
Community Representative



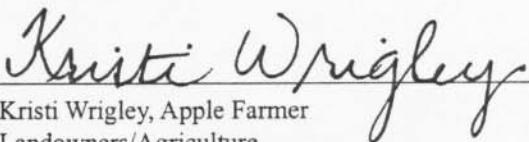
Tom Cleary, Recreational Fisherman
Recreational Fishing



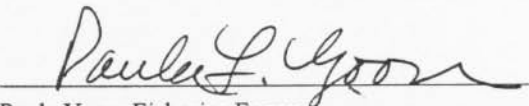
Melvin McKinney, Northcoast Environmental Center
Environmental Groups



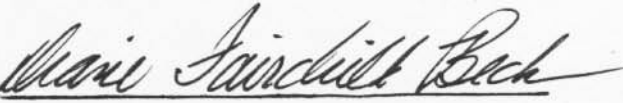
Darren Mierau, McBain and Trush
Science/Technical




Kristi Wrigley, Apple Farmer
Landowners/Agriculture



Paula Yoon, Fisheries Focus
Business



Diane Beck, Sierra Club
Environmental Groups (Alternate)



Mark Andre, City of Arcata
Local Government

Past and present HBWAC supporters, advisors, and NRS staff that have contributed to the completion of this document:

Christine Ambrose

Jeff Anderson

Jane Arnold

Ethan Bell

Ruth Blyther

Greg Bryant

Bernie Bush

Peter Bussman

Kevin Cunliffe

Robert Darby

Jan Duncan-Vaughn

Jud Ellinwood

Yvonne Everett

Mitch Farro

Clark Fenton

Dave Feral

Dave Fuller

Michelle Gilroy

Tom Hedt

Chris Heppe

Pat Higgins

Matt House

Curtis Ihle

Tami Jones

Matt Kiese

Randy Klein

Margaret Lang

Michael Lau

Frank Ligon

Mike Love

Susan McBride

Dana McCanne

Vanessa Metz

Brian Michaels

Mark Moore

Julie Neander

Larry Preston

Nancy Reichard

Leslie Reid

Seth Ricker

Gary Rynearson

John Schwabe

Trey Scott

Amanda Seely

Sheila Semans

Gene Senestrano

Shirley Shelburn

Maren Stidolph

Rick Store

Bill Thompson

Erica Upton

Susie Van Kirk

Mike Wallace

Mark Wheatley

Adona White

Sheli Wingo

John Woolley

Bob Wunner

Preface

The *Humboldt Bay Watershed Salmon and Steelhead Conservation Plan (SSCP)* is the result of a long and sometimes arduous process of research and data collection, meetings, lively and sometimes heated discussions, writing, review, revision, and back for more discussion. At times it felt like we, the members of the Humboldt Bay Watershed Advisory Committee (HBWAC), would never finish with this document. However, the process has been as important as completing the final product as we have developed respect for the each other; learned from our differences; developed a greater understanding of opposing view points; and come to agreement on goals and objectives for salmon conservation.

We know that this Plan is not the answer to the ultimate survival of salmon and steelhead in the Humboldt Bay watershed, but is a piece of the puzzle and offers a foundation to base future planning and implementation. Cooperative efforts will not always be the way to ensure that both the human and wildlife communities thrive. There are many other valuable tools available including legal and political avenues, regulations, incentives, personal action, and activism. Discourse, law suits, dissension, regulatory burdens, fear, and anger over how we manage the landscape will continue to be realities within our community. This Plan has evolved from an effort to communicate with people we do not agree with; a willingness to have difficult conversations; and a desire to get out into the watershed and work to protect what we value. This Plan provides some solutions to the threats faced by the salmon populations that the members of HBWAC have agreed upon; whether a timber manager or environmentalist, fisheries advocate or rancher, regulator or private landowner, scientist or farmer. The next step is to take this Plan and ensure that the recommendations it contains are implemented and that new data and information are added to future iterations. The members of HBWAC are eager to help make this happen, and depend upon continued support from past members, technical advisors, funding agencies, and those who have supported this effort to date.

Executive Summary

The *Humboldt Bay Watershed Salmon and Steelhead Conservation Plan (SSCP)* is a compilation of watershed information; a report on the evaluation of that information; and a list of high priority goals and objectives aimed at protecting and/or restoring watershed processes in order to preserve and enhance salmon and steelhead habitat. The *SSCP* was developed by the Humboldt Bay Watershed Advisory Committee (HBWAC), a diverse group of watershed stakeholders whose mission is “to improve the Humboldt Bay watershed’s anadromous salmonid populations and related resources while considering regional ecological and socioeconomic needs.” HBWAC members agreed to work together to find ways to maintain working timber and agricultural lands, accommodate population growth, support sustainable economic development, and protect and restore salmonid populations.

Humboldt Bay watershed contains a mosaic of environments under diverse ownership, jurisdictions, and land use, and no agency or governmental organization has overall responsibility for coordinating watershed protection and/or restoration efforts. It is evident that Humboldt Bay watershed fisheries are in need of recovery. HBWAC did not attempt to set recovery goals, conclusively determine the role of different management activities on cumulative watershed effects (CWE) or recommend specific management restrictions. Instead, the group worked to identify limiting factor trends and design goals and objectives that would assist in the recovery effort.

The *SSCP* was developed to encourage cooperative planning, education, implementation, and evaluation of watershed projects for protecting, maintaining and restoring salmonid habitat and natural watershed processes.

Approach

The *SSCP* focuses on the four main sub-watersheds of Humboldt Bay - from the ridge top to the estuary. From north to south these include Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek.

Over several years, Redwood Community Action Agency’s Natural Resources Services Division (NRS) staff and HBWAC compiled all available existing watershed information for the Humboldt Bay watershed and its tributary sub-watersheds. Sub-committees for each stream provided expert advice, and reviewed and edited draft sub-watershed chapters. Sub-committee products were then brought to the HBWAC for full committee review and approval.

The *SSCP* is comprised of:

- **A summary of information based upon available surveys and reports**
- **Determination of potential limiting factors for salmonids in each sub-watershed (Chapter V)**
- **Goals and objectives that stemmed from that existing information (Chapter VI)**

Historical and current conditions were summarized based on existing information including historical reports, observations, books, newspaper clippings, scientific and technical reports, monitoring data and analysis, fish habitat, sediment and flooding surveys, watershed analysis, letters, memos, and testimonials from landowners. Limiting factors that could potentially affect salmonids were determined for each watershed. Once gaps in research had been identified, priority goals and objectives were developed by the HBWAC.

Overall Conclusions

Because they represent some of the last significant native gene resources in Northern California, the salmonid populations (coho, chinook, steelhead, cutthroat) of Humboldt Bay watershed are critical to conservation and eventual recovery of the species.

Alteration of large-scale watershed processes that create and maintain habitat have impacted salmonid habitat in the Humboldt Bay watershed. HBWAC agreed upon potential and likely limiting factors for salmonids utilizing existing information and data collected from a wide variety of sources. The findings from this research include:

- Concentrations and durations of suspended sediment levels during wet months in Freshwater Creek, and Elk River, and to a lesser extent Jacoby Creek, frequently exceed accepted thresholds for salmonid growth and, at times, survival. Sediment is considered to be the most important limiting factor for salmonids in Freshwater Creek and Elk River.
- The floodplain capacity and function in the Humboldt Bay watershed has been substantially reduced over the past 150 years. Human activity has caused a loss of connectivity between streams and their floodplains reducing overall habitat complexity and availability of backwater and side channel habitat that is important rearing habitat for juvenile salmonids.
- Estuary habitat around Humboldt Bay has been significantly reduced by construction of levees and tidegates, and placement of fill. This habitat is necessary for salmon as it allows them to adapt to salt water and provides significant food resources for growth giving them the best possible chance for survival before they enter the ocean environment.
- The quality and complexity of instream habitat is degraded especially in low gradient reaches that are important for salmonids. There is an overall lack of large wood, deep pools, cover, and clean gravels in all of the watersheds tributary streams.
- Increased sediment inputs from legacy and current timber management activities in the upper watershed, have changed the channel morphology, and reduced channel capacity in the low gradient sections of Jacoby and Freshwater Creeks and Elk River (storage reaches).
- There is a lack of large wood in the middle and lower reaches of Humboldt Bay tributaries. Lack of large wood has reduced available rearing habitat.
- Diminished riparian habitat in Humboldt Bay tributaries has led to increased erosion, bank destabilization, lack of cover and complexity for fish habitat.

Specific Recommendations

HBWAC developed goals to address the above watershed issues concerning salmonids. The goals are very broad and to many may seem so straightforward that they do not even need to be stated. However, with a diverse stakeholder group such as HBWAC, it was critical to come to agreement on the most basic goals. Once agreement was reached the committee members were able to develop more detailed objectives for each goal. From the objectives, riparian projects and descriptions of needed technical studies were developed. This process will be continued. The goals will inform objectives, the objectives

will be refined and actions will be added to ensure implementation. The following is a list of the SSCP Goals for salmon and steelhead conservation in Humboldt Bay watershed:

- Maintain and restore floodplain processes that benefit salmonids.
- Maintain and restore estuary processes that benefit salmonids.
- Maintain and restore balance between delivery of sediment to the channel and sediment transport capacity.
- Establish access to suitable habitat for both adult and juvenile salmonids.
- Maintain and restore channel conditions that support spawning and rearing habitat.
- Protect and maintain instream LWD.
- Increase the amount of instream LWD where appropriate.
- Maintain and restore the long-term supply LWD
- Maintain existing functional riparian habitat.
- Identify and restore degraded riparian habitat where feasible.
- Assess and continue to monitor stream discharge, turbidity, and suspended sediment concentration (SSC).
- Reduce suspended sediment to levels that are suitable to salmonids during all life stages.
- Monitor temperature and dissolved oxygen in Humboldt Bay tributaries.
- Maintain or attain temperature and dissolved oxygen levels beneficial to salmonids during all life stages.
- Maintain and restore suitable high and low flow conditions (flow and velocity) to ensure juvenile summer and winter rearing habitat and adult salmonid migratory access.
- Maintain and restore natural flow regimes and water retention capacity.
- Improve evaluation methods for identifying cumulative watershed effects (CWE) and impacts on salmonids. Provide forums for sharing of information and a climate of mutual cooperation.
- Identify socioeconomic impacts of watershed management and future solutions.
- Work with local resource agencies to provide incentives for landowners who choose to protect and/or restore private lands for fisheries habitat values.

The HBWAC members consider all of the goals in the SSCP to be high priority. The overall prioritization is basic 1) protection of quality habitat; 2) restoration of watershed processes and reconnection of isolated habitat; 3) restoration of instream habitat; and 4) evaluation of restoration techniques and projects. Although there are many good arguments for focusing resources on the most significant limiting factors before working on other restoration opportunities this Plan takes a more holistic view. The entire watershed should be a focus of our stewardship and all of the various tools available should be utilized. Education, outreach, incentives, regulations, acquisition, research, assessment, monitoring, and restoration must all be used in creative ways if we are to protect and ultimately restore healthy runs of native salmon while supporting the local economic and social well being of the community. This document is intended to be updated periodically, dependent on funding availability, progress on project implementation, and need.

Table of Contents

Endorsement for the *Humboldt Bay Watershed SSCP* iii

Preface. □ v

Executive Summary vii

Table of Contents xi

Tables and Figures xv

I. Introduction 1

I. A. Scope..... □ 2

I. B. ESA Status of Salmonids in Humboldt Bay Watershed..... 3

I. C. Integration with Regional Planning Efforts and State and Federal Recovery Strategies 6

I. D. Goal Development Strategy and General Methods 7

 I. D. 1. The Humboldt Bay Watershed Advisory Committee 7

 I. D. 2. *Humboldt Bay Watershed Salmon and Steelhead Conservation Plan* Strategy/Guidelines 8

 I. D. 2.1 Ecological and Biological Goals Framework 8

 I. D. 2.2 Limiting Factor Determination 8

II. Setting 11

II. A. Natural History □ 14

 II. A. 1. Salmonid Presence..... 14

 II. A. 2. Geology □ 14

 II. A. 3. Soils □ 16

 II. A. 4. Climate and Rainfall..... 16

 II. A. 5. Hydrology □ 17

 II. A. 6. Vegetation □ 17

Historic Human Footprint in the Watershed 19

II. B. Recent Trends □ 24

III. Salmonid Habitat Requirements..... 31

III. A. Major Life Stages of Anadromous Salmonids 31

III. B. Anadromous Salmonid Habitat Requirements Related to Life History Stages.....	32
IV. Watershed Processes and Potential Risks to Anadromous Salmonid Habitat	35
V. A. Five Watershed Processes	35
IV. A. 1. Water.....□	35
IV. A. 2. Sediment.....□	38
IV. A. 3. Large Woody Debris.....	39
IV. A. 4. Heat.....□	39
IV. A. 5. Nutrients	40
IV. B. Potential Risks to Humboldt Bay Watershed Anadromous Salmonids	40
Selected Elements of Salmonid Habitat...In a Nutshell	41
IV. B. 1. Lower Reach.....□	43
IV. B. 2. Middle Reach.....□	44
IV. B. 3. Upper Reach	45
IV. C. Cumulative Watershed Effects in Humboldt Bay Watershed	46
V. Detailed Sub-watershed Information	49
V. A. Jacoby Creek Watershed Overview	49
V. A. 1. Geology.....□	50
V. A. 2. Land Use	50
V. A. 3. Salmonid Distribution (Summary of Existing Salmonid and Salmonid Habitat Data)	53
V. A. 3.1 Fish Surveys..□	53
V. A. 3.2 Habitat Surveys.....	54
Historic Human Footprint and Conditions in Jacoby Creek Watershed	57
V. A. 4. Restoration and Conservation Efforts.....	61
V. A. 5. Current Salmonid Habitat Conditions (By Lower, Middle, Upper Reaches)	61
V. A. 5.1 Estuary/ Lower Reach (Humboldt Bay to Old Arcata Road)	61
V. A. 5.2 Middle Reach (Old Arcata Road along the mainstem to the confluence of Morrison Gulch).....	64
V. A. 5.3 Upper Reach (The confluence of Morrison Gulch to the headwaters (including tributaries).....	67
V. A. 6. Opportunities and Challenges	69
V. B. Freshwater Creek Watershed Overview	81
V. B. 1. Geology.....□	81
V. B. 2. Land Use	82
V. B. 3. Salmonid Distribution.....	82
V. B. 3.1 Fish Surveys..□	84
Historic Human Footprint and Conditions Freshwater Creek Watershed.....	87
A Freshwater Creek Tributary Close-Up: Ryan Creek.....	91

V. B. 3.2 Habitat Surveys.....	96
V. B. 4. Opportunities and Challenges.....	97
V. B. 5. Restoration and Conservation Efforts.....	100
V. B. 6. Current Salmonid Habitat Conditions (By Lower Middle, Upper Reaches).....	101
V. B. 6.1 Estuary/Lower Reach (Humboldt Bay to Three Corners at Old Arcata Road).....	101
V. B. 6.2 Middle Reach (Three Corners to the confluence of Graham Gulch).....	104
V. B. 6.3 Upper Reach (Above Graham Gulch, Upper Freshwater, and South Fork Freshwater).....	107
V. C. Elk River Watershed Overview.....	119
V. C. 1. Geology.....□	119
V. C. 2. Land Use.....□	120
V. C. 3. Salmonid Distribution.....	122
V. C. 3.1 Fish Surveys□	122
V. C. 3.2 Fish Habitat Surveys.....	123
V. C. 4. Restoration and Conservation Efforts.....	124
Historic Human Footprint and Conditions in Elk River Watershed.....	125
V. C. 5. Opportunities and Challenges.....	128
V. C. 6. Current Salmonid Habitat Conditions (By Lower, Middle, Upper Reaches).....	132
V. C. 6.1 Estuary/Lower Reach.....	132
V. C. 6.2 Middle Reach.....	134
V. C. 6.3 Upper Reach South Fork Elk River.....	137
V. C. 6.4 Upper Reach North Fork Elk River.....	139
V. D. Salmon Creek.....□	151
V. D. 1. Geology.....□	151
V. D. 2. Land Use.....□	152
V. D. 3. Salmonid Distribution.....	152
V. D. 3.1 Fish Surveys□	154
V. D. 3.2 Fish Habitat Surveys.....	154
V. D. 4. Opportunities and Challenges.....	155
Historic Human Footprint and Conditions in the Salmon Creek Watershed.....	156
V. D. 5. Restoration and Conservation Efforts.....	159
V. D. 6. Current Salmonid Habitat Conditions.....	160
V. D. 6.1 Estuary/ Lower Reach.....	161
V. D. 6.2 Middle Reach.....	164
V. D. 6.3 Upper Reach.....	165

VI. Humboldt Bay Watershed Goals and Objectives173

References.....197

Appendices

- A. Humboldt Bay Plans
- B. Watershed Contacts
- C. Next Steps for the *SSCP*

Tables and Figures

List of Tables

I.1: ESA Status of Anadromous Salmonid Species in Humboldt Bay Watershed	3
I.2: Characteristics of Anadromous Salmonids in Humboldt Bay Watershed	4
I.3: Humboldt Bay Watershed Advisory Committee - Interests Represented.....	7
II.1: Salmonid Presence in Humboldt Bay Watershed.....	14
II.2: Dominant Geology in Humboldt Bay Sub-watersheds.....	15
III.1: General Habitat Requirements by Salmonid Life Stage.....	33
IV.1: Watershed Processes and Potential Impacts to Anadromous Salmonid Habitat Needs	36
IV.2: Length/Age Correlation for Juvenile Salmonids	43
V.1: Land Use Within Jacoby Creek Watershed	52
V.2: Jacoby Creek Habitat Types	55
V.3: Percent Cobble Embeddedness Ratings for Salmonid Spawning Habitat	55
V.4: Limiting Conditions for Salmonid Habitat in Lower Jacoby Creek	72
V.5: Limiting Conditions for Salmonid Habitat in Middle Jacoby Creek	73
V.6: Limiting Conditions for Salmonid Habitat in Upper Jacoby Creek.....	74
V.7: AFRAMP's 2003 Freshwater Downstream Migrant Trap (DSMT) Summary	85
V.8: HFAC/AFRAMP Downstream Migrant Trap Summary of the 1996-2000 Trapping Data	90
V.9: Existing Salmonid Habitat Conditions in Lower Freshwater Creek	110
V.10: Existing Salmonid Habitat Conditions in Middle Freshwater Creek	111
V.11: Existing Salmonid Habitat Conditions in Upper Freshwater Creek.....	112
V.12: Elk River Carcass and Live Adult Survey Summary	123
V.13: Existing Salmonid Habitat Conditions in Lower Elk River	142
V.14: Existing Salmonid Habitat Conditions in Middle Elk River.....	143
V.15: Existing Salmonid Habitat Conditions in North and South Fork Elk River	144
V.16: Humboldt Bay National Wildlife Refuge Migrant Trapping Data	152
V.17: Migrant Trapping Data in the Humboldt Bay National Wildlife Refuge.....	154

List of Figures

II.1: Land Use in Humboldt Bay Watershed.....	12
II.2: Humboldt Bay Watershed	13
II.3: Decrease in Humboldt Bay marshland distribution from 1897 to 1973 caused by diking	22
II.4: Humboldt Bay Watershed Land Use.....	26

II.5: Humboldt Bay Watershed Roads	27
II.6: Humboldt Bay Watershed Anadromous Salmonid Distribution	28
II.7: Humboldt Bay Watershed Stream Gradient	29
II.8: Humboldt Bay Watershed Geology.....	30
III.1: Salmonid Life Cycle	31
V.1: Jacoby Creek Watershed.....	51
V.2: Jacoby Creek Watershed Land Use	76
V.3: Jacoby Creek Watershed Roads.....	77
V.4: Jacoby Creek Watershed Anadromous Salmonid Distribution.....	78
V.5: Jacoby Creek Watershed Stream Gradient	79
V.6: Jacoby Creek Watershed Geology	80
V.7: Freshwater Creek Watershed.....	83
V.8: Adult salmonid captures at the HFAC weir during the 2003-04 season.....	85
V.9: Freshwater Creek Watershed Land Use.....	114
V.10: Freshwater Creek Watershed Roads.....	115
V.11: Freshwater Creek Watershed Anadromous Salmonid Distribution.....	116
V.12: Freshwater Creek Watershed Stream Gradient.....	117
V.13: Freshwater Creek Watershed Geology	118
V.14: Elk River Watershed.....	121
V.15: PALCO's findings on sediment delivery in the Elk River watershed.....	130
V.16: Elk River Watershed Land Use	146
V.17: Elk River Watershed Roads.....	147
V.18: Elk River Watershed Anadromous Salmonid Distribution.....	148
V.19: Elk River Watershed Stream Gradient.....	149
V.20: Elk River Watershed Geology	150
V.21: Salmon Creek Watershed.....	153
V.22: Salmon Creek Watershed Land Use	168
V.23: Salmon Creek Watershed Roads.....	169
V.24: Salmon Creek Watershed Anadromous Salmonid Distribution	170
V.25: Salmon Creek Watershed Stream Gradient	171
V.26: Salmon Creek Watershed Geology.....	172

I. Introduction

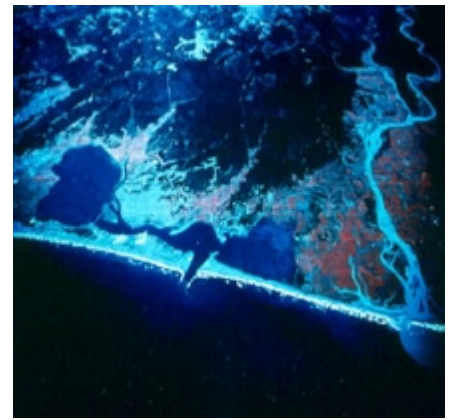
In Humboldt Bay watershed and elsewhere along the west coast of the United States, Pacific salmonids¹ (*Oncorhynchus* spp.) have experienced dramatic declines in abundance during the past several decades as a result of a multitude of human-induced and natural factors. Wild stocks of salmonids found today in the Humboldt Bay watershed represent remnants of once larger populations that historically thrived in the Bay and its tributaries.

Three species of salmonids present Humboldt Bay watershed are considered to be at high risk of extinction and are listed as threatened under the Federal Endangered Species Act. They are coho salmon (*Oncorhynchus kisutch*), chinook salmon (*O. tshawytscha*), and steelhead trout (*O. mykiss*). A fourth species found in the watershed, coastal cutthroat trout (*O. clarki clarki*) is not currently listed under the Endangered Species Act (ESA), but was considered for listing in 1999. These remaining salmonid populations in northern California that number in the hundreds are critical to conservation and restoration of the species because they represent the region's **last significant gene resources**. It is essential that existing populations do not deteriorate further, or there will be no basis for recovery. These populations may provide a source of colonists for currently damaged streams as they recover in the future (Higgins 2001).

In order for Pacific salmonid populations to be conserved and restored, a well dispersed network of habitats that retain a high degree of ecological integrity, referred to as **high-quality refugia** must be recovered and preserved to serve as centers for population expansion (Spence et al. 1996). Salmonid populations have historically strayed to avoid habitat degradation, and have re-colonized areas after habitat recovery (Rieman et al. 1993). The last healthy, functioning salmon streams, including those within the Humboldt Bay watershed, constitute refugia (Higgins 2001).

While federal and state recovery efforts are underway, this regional document, the *Humboldt Bay Watershed Salmon and Steelhead Conservation Plan (SSCP)*, was developed by the Humboldt

¹ The term salmonid refers to members of the family Salmonidae, which includes salmon and trout. Anadromous salmonids migrate between freshwater and the ocean, beginning and ending their lives in freshwater spawning grounds, and spending the majority of their adult lives at sea. Salmon make this migration only once, whereas trout will return to their spawning grounds several times before dying.



The 223 square mile Humboldt Bay watershed is important for the spawning, rearing, and migration of anadromous salmonids. The watershed supports four anadromous salmonid species, three of which are considered to be at high risk for extinction.



Currently in the Humboldt Bay watershed, coho salmon is the most prevalent of the four species discussed in this document.



Humboldt Bay supported commercial and sports fisheries in the early 1900s. The Humboldt Standard reported

in 1930:

Taking advantage of the large number of silverside salmon that are at present in the bay, local sportsmen are taking some record catches with their trolling tackle... Such a phenomenal run of the small size salmon has not been known on this coast for several years, and throngs of fishermen are trolling Humboldt Bay...

and in 1947:

Salmon fishing on Humboldt Bay is assuming the proportions of a boom, as the big fish keep coming in apparently without let-up... Our Humboldt bay salmon run has become statewide news with all the city papers getting excited about it. Seems little doubt but that the bay has stolen the show from the Klamath and Rogue river mouths.

(Historic articles compiled for HBWAC by watershed resident S. VanKirk)

Bay Watershed Advisory Committee (HBWAC), whose members include watershed stakeholders from a diversity of interest groups. The mission of HBWAC is to improve the Humboldt Bay watershed's anadromous salmonid populations and related resources while considering regional ecological and socioeconomic needs.

The Plan is an assimilation of watershed information, followed by goals and objectives aimed at protecting and/or restoring **watershed processes** in order to preserve and enhance salmon and steelhead habitat in the sub-watersheds of Humboldt Bay. The SSCP offers the foundation for a framework to systematically and cooperatively engage in salmonid habitat enhancement efforts in Humboldt Bay watershed. The long-term purpose of the SSCP is to encourage cooperative planning and implementation for salmonid conservation.

I. A. Scope

The Humboldt Bay watershed is located in the Eureka Plain Hydrologic Unit of the North Coast Hydrologic Region². This document discusses the sub-watersheds that drain into Humboldt Bay and estuarine aquatic habitats, but excludes the bay proper. The SSCP focuses on four main sub-watersheds of the Humboldt Bay watershed - from the headwaters to the estuaries. From north to south these include Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek. See Figure II.1 for location of Humboldt Bay and its major sub-watersheds.

The focus of the SSCP is on protection and restoration of watershed processes that benefit anadromous salmon and steelhead and their habitat. See Table I.2 for overview of anadromous salmonid species in Humboldt Bay watershed and their characteristics.

This document was developed for use by local, state, and federal governments as well as by landowners, consultants and watershed groups to help these agencies in their efforts to protect and improve watershed processes that support salmonid habitat. This document is intended to be updated periodically, dependent on funding availability, progress on project implementation, and need.

² CALWATER 2.2 watershed designations

I. B. ESA Status of Salmonids in Humboldt Bay Watershed

The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) is legally responsible for the conservation and recovery of threatened and endangered salmonid populations. The NMFS is responsible for evaluating and listing salmonid ESUs under the Federal ESA and the California Department of Fish and Game (CDFG) is responsible for listing salmonid ESUs under the State ESA.

For more information about ESA listings or to view maps of the ESUs visit the NOAA website

www.nwr.noaa.gov

Salmonid species function as reproductively isolated populations, or Evolutionarily Significant Units (ESUs), which evolve separately and behave like individual species. ESUs have the same protection as species under the Endangered Species Act (ESA).

Excessive water temperatures, high turbidity, sedimentation of habitats, loss of habitat complexity, sport and commercial harvest, pollution, poor hatchery practices, and migration barriers are some of the factors that have contributed to the decline in population abundance of wild salmonid stocks around the globe. Along the north coast surrounding the Humboldt Bay watershed, three species of salmonids are considered to be at high risk of extinction and have been listed as threatened under the Federal ESA. One of those species has been listed as threatened by the State of California. These species and dates of their listing are as follows:

- **Chinook (*Oncorhynchus tshawytscha*)**

Humboldt Bay watershed hosts fall chinook which belong to the California Coast ESU, which includes chinook in coastal streams from Redwood Creek in Humboldt County to the Russian River in Sonoma County. The California Coast ESU was listed as threatened under the ESA in September of 1999, based on loss of habitat and the fact that fall chinook appear to occur in relatively low numbers in northern streams.

- **Coho (*Oncorhynchus kisutch*)**

Humboldt Bay watershed hosts fall and spring coho which belong to the Southern Oregon and Northern California Coast (SONCC) ESU. This ESU includes coho from Cape Blanco in Curry County, Oregon to Punta Gorda in Humboldt County, California. NMFS (currently NOAA Fisheries) listed the SONCC coho ESU as threatened in May of 1997, and defined the ESU as all coho salmon naturally spawning in coastal streams between Cape Blanco and Punta Gorda. The SONCC

Anadromous Salmonid Species	Federally Listed	State Listed
Coho salmon	1997	2004
Chinook salmon	1999	na
Steelhead trout	2000	na
Coastal Cutthroat Trout	na	na

Table I.1: ESA Status of Anadromous Salmonid Species in Humboldt Bay Watershed

Table I.2: Characteristics of Anadromous Salmonids in Humboldt Bay Watershed

Species	Juveniles	Adult	Range	Spawning Time and Location	Spawning Behavior
Chinook <i>(Oncorhynchus tshawytscha)</i>	Dorsally blue-green to brown body silvery or light yellow; 6-12 parr marks; adipose fin edged with black.	Largest of the species, averaging 18 to 24 pounds; black lower gumline, olive brown to dark maroon with heavy black spotting on back.	Sacramento-San Joaquin Rivers north to Alaska. In Asia from Japan to Siberia.	Fall run chinook utilize the mainstems of larger river systems, with some utilization of smaller tributaries. Typically 1 to 2% gradient. Typically October to January.	Females lay up to 4,000 eggs; always die after spawning.
Coho <i>(Oncorhynchus kisutch)</i>	Adipose fin has dark edge, center is opaque; caudal, anal and adipose fins are pale orange. The leading fin ray of the anal fin is longer than the others and is sickle-shaped.	Black spots on their backs and tail fins; white gums, spawning males have bright red sides, females are paler.	Monterrey Bay to Alaska. In Asia from Northern Japan to Anadyr River in Russia.	Coho utilize all accessible reaches of streams, especially side channels, typically 1-3% gradient. Typically November to January.	Females lay 1000 to 5000 eggs; always die after spawning.
Steelhead <i>(Oncorhynchus mykiss)</i>	Dorsally blue or olive grey, silvery on sides and belly; 8 - 13 parr marks, oval almost round; back sides and dorsal fin covered with black spots.	Silvery sides and belly; black spots on back, head, sides, dorsal and caudal fins; mouth lining is white.	Originally found west of the Rockies from Baja to Alaska; introduced throughout the world. Resident forms are known as rainbow trout.	Steelhead typically utilize the tributary channels less than 8% (usually 3-5%) gradient; can use stable side channels to the mainstem. Typically late winter through spring (Dec.-April).	Females lay 200 - 12,000 eggs; some females are capable of spawning up to two or three times throughout their lifespan. If the fish survives spawning it will outmigrate to the ocean and return to spawn again.
Cutthroat <i>(Oncorhynchus clarki clarki)</i>	Body evenly spotted above and below lateral line; fins generally plain except for a dark leading edge on dorsal fin; tail usually spotted.	Dark olive green dorsally, sides and belly silvery white; spotting heavy over entire body and fins, especially on front half of body; red or yellow "cutthroat" mark at base of throat.	Humboldt County to Alaska; optionally anadromous	Cutthroat utilize small streams and headwaters, usually further up than steelhead; use off-channel habitats such as intermittent tributaries and sloughs. Typically late winter through spring.	Females lay 400 - 4000 eggs; some females may spawn up to five times throughout their lifespan.

ESU was listed as state threatened by the State of California in June 2004.

- **Steelhead (*Oncorhynchus mykiss*)**

Humboldt Bay watershed hosts winter and summer steelhead. Humboldt Bay watershed's steelhead belong to the Northern California ESU, which extends from Redwood Creek in Humboldt County to the Gualala River in Sonoma County. The ESU, which includes both winter and summer steelhead, was listed as threatened in June of 2000 based on habitat degradation and the genetic influence of hatchery steelhead on wild stocks.

Humboldt Bay watershed's **coastal cutthroat (*Oncorhynchus clarki*)** belong to the Southern Oregon/California Coast ESU. While some biologists familiar with the region believe, and anecdotal evidence suggests, that major declines in cutthroat populations have occurred since historic times, some populations appear to be stable or increasing (O. W. Johnson et al. 1999). NOAA Fisheries concluded in 1999 that a listing was not warranted at that time. Since then, NOAA Fisheries transferred jurisdiction under the ESA for this species to the U.S. Fish and Wildlife Service (USFWS).

Regulatory Implications of ESU Listings

Animals or plants listed under the ESA are protected from 'take', which is further defined as 'harm or harassment'. To protect listed fish, any activity that may have an effect on a listed species may be regulated or prohibited. This can include changes or closure of fishing seasons, or regulation of land use practices and development.

Part of NOAA Fisheries' regulatory jurisdiction is to designate critical habitat for each listed species. Any actions by the federal government or that has a federal nexus that may affect critical habitat may be regulated and overseen by NOAA Fisheries. Actions on non-federal lands that may have an effect on an ESU may require consultation with NOAA Fisheries. NOAA Fisheries has authority to issue incidental take permits for a listed species if the applicant provides a Habitat Conservation Plan (HCP). For example, Pacific Lumber Company has an HCP and an incidental take permit for coho, chinook, steelhead and coastal cutthroat trout in the Humboldt Bay watershed. Green Diamond Resource Company, the other large commercial timber company in Humboldt Bay watershed currently has an HCP for spotted owls, but is working on an Aquatic HCP that is likely to be approved in Summer 2005.



Chinook salmon



Coho salmon



Steelhead trout



Coastal cutthroat trout



Chum salmon (Oncorhynchus keta) were historically present in the Humboldt Bay watershed, but have not been found in recent years except occasionally in small numbers. Chum salmon Humboldt Bay watershed can be considered in the Pacific Coast Evolutionarily Significant Unit, which was petitioned for federal inclusion to the United States and deemed not warranted.

NOAA Fisheries is currently in the process of developing guidelines for avoiding “take”, creating ESU recovery plans, and monitoring recovery for local coho, chinook, and steelhead stocks, as mandated under the ESA. This procedure necessitates cooperation between local, state, and federal governments along with other watershed stakeholders.

I. C. Integration with Regional Planning Efforts and State and Federal Recovery Strategies

The development of the *SSCP* has coincided with both federal and state salmonid recovery planning efforts, and is intended to help synchronize the efforts of groups currently participating in salmonid conservation, not only making them more efficient, but also maximizing the ability of the region to draw state and federal watershed matching grants.

The goals and objectives developed by HBWAC for the *SSCP* were based upon guidelines that have been developed in other watersheds in the Pacific Northwest.

There are numerous water quality, land use, and habitat conservation related planning documents being created by agencies and organizations in Humboldt Bay and around the watershed (Appendix A). Information and goals from the *SSCP* have been incorporated in varying degrees, in to state and federal coho recovery planning and Total Maximum Daily Load (TMDL) process, including the CDFG *Recovery Strategy for California Coho Salmon*, and Elk River and Freshwater Creek’s TMDLs. Likewise, applicable information and goals from these documents and processes have been incorporated into the *SSCP*.

Project activities developed in order to achieve the goals and objectives in this document are intended to be cross referenced to protocols in the CDFG *California Salmonid Stream Habitat Restoration Manual*.

Goals and objectives in the *SSCP* are consistent with goals for the State Water Resources Control Board’s (SWRCB) *Watershed Management Initiative*, in that this Plan promotes cooperative and collaborative efforts and is designed to focus limited resources on key issues. Protecting and enhancing the anadromous salmonid resources is a broad goal stated by the SWRCB for the Humboldt Watershed Management Area.

Goals and objectives of the *SSCP* are being incorporated into the Humboldt Bay Management Plan (currently being developed by the Humboldt Bay Harbor, Conservation, and Recreation District) and the Humboldt County 2005 General Plan Update.

The mission of HBWAC is to improve the Humboldt Bay watershed's anadromous salmonid populations and related resources while considering regional ecological and socioeconomic needs.

I. D. Goal Development Strategy and General Methods

I. D. 1. The Humboldt Bay Watershed Advisory Committee

The Humboldt Bay Watershed Advisory Committee (HBWAC) was formed in the summer of 1997, primarily in response to the Federal ESA coho listing. The mission of HBWAC is to improve the watershed's anadromous salmonid populations and related resources while considering regional ecological and socioeconomic needs. HBWAC is a cooperative, voluntary association of timberland managers, ranchers, salmon restoration interests, state, federal and local government agencies, environmental groups, citizen groups, and business interests.

HBWAC meets on a monthly basis to conduct watershed planning, including developing outreach and education projects and writing the *Humboldt Bay Watershed Salmon and Steelhead Conservation Plan*. HBWAC provides a forum for communication and cooperation between multiple interest groups, stakeholders, and overlapping jurisdictions within Humboldt Bay watershed. HBWAC has 13 voting members, each with one alternate voting member, representing diverse interest groups (Table I.3). A two-thirds majority is required to pass any committee action. A quorum of seven is necessary to take action on agenda items. The HBWAC meetings are open to the public.

Redwood Community Action Agency's (RCAA) Natural Resources Services Division (NRS) staff and HBWAC have compiled existing information for background of this document which led to creating goals and objectives for each sub-watershed in the Humboldt Bay watershed. Sub-committees for the specific sub-watersheds provided technical and expert advice and reviewed drafts. Before any information was added to the plan, sub-committee work was brought to HBWAC for full committee review. A completed draft of the plan was approved by HBWAC before being released to the public.

Interest Represented	Member Affiliation
Local Government	City of Arcata
State Government	California Coastal Commission California Department of Fish and Game
Federal Government	NOAA - National Marine Fisheries Service
Recreational Fishing	Recreational Fisherman
Watershed Restoration	Fisheries Focus Humboldt Fish Action Council
Environmental Groups	Northcoast Environmental Center Sierra Club
Education/ Outreach	CampFire USA
Science/Technical	McBain and Trush
Landowners/ Agriculture	Rancher Apple Farmer
Industrial Timber	Pacific Lumber Company
Business	Vacant
Watershed Group	Salmon Forever
At Large	Citizen

Table I.3: Humboldt Bay Watershed Advisory Committee - Interests Represented

I. D. 2. Humboldt Bay Watershed Salmon and Steelhead Conservation Plan Strategy/Guidelines

I. D. 2.1 Ecological and Biological Goals Framework

An effective strategy to ensure the long-term persistence of salmonids must be grounded in principles of watershed dynamics, ecosystem function, and conservation biology (Spence et al. 1996; Frissel 1993).



Jacoby Creek Watershed gravel bar and representative riparian vegetation

As previously mentioned, considering that Humboldt Bay watershed serves as high quality refugia for Pacific Coast salmonids and that the existing salmonids represent the last significant gene resources, critical habitat needs to be protected and restored. Guidelines for developing the *SSCP* goals and objectives were based on the following ecological and biological goals for salmon and steelhead conservation that were developed by Spence et al. (1996).

- Maintain and restore natural **watershed processes** that create habitat characteristics favorable to salmonids. It is essential that whole, contiguous landscapes be managed to protect natural processes (i.e., the natural rates of delivery of water, sediment, heat, organic materials, nutrients and other dissolved materials), rather than specific states (Reeves et al. 1995). Ecosystems are dynamic, evolving entities that must be managed to retain their capacity to recover from natural disturbances (e.g. climate change, fire, disease, floods).
- Maintain **habitats required by salmonids during all life stages** - from embryos and alevins through adults - and functional corridors linking these habitats. The complex life histories of salmonids demand a wide array of habitat types. Different portions of a watershed may accommodate spawning and rearing, and these habitats vary with species.
- Maintain **connectivity between high-quality habitats** to allow for reinvasion and population expansion. The high degree of landscape fragmentation that has resulted from human activities has left many salmonid populations in relative isolation.

I. D. 2.2 Limiting Factor Determination

Alteration of large-scale watershed processes that create and maintain habitat have impacted salmonid habitat in the Humboldt

Bay watershed. Stream channels essentially act as transport systems for water, sediment, wood, nutrients and heat which are input into the watershed. In an undisturbed watershed, these products enter streams at natural rates. Land use activities alter the rate of supply of watershed products to the channels, resulting in environmental changes and, potentially, impacts to salmonid populations (Bryant 1996). HBWAC agreed upon *potential and likely* limiting factors utilizing existing information, personal communications, observations, and data collected for other assessments.

II. Setting

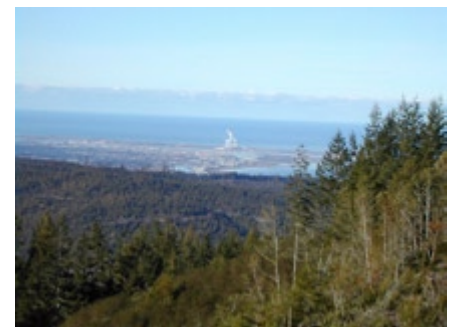
Humboldt Bay, a multi-watershed coastal lagoon, is the largest estuary in California north of San Francisco, located 275 miles south. Within the basin are the ancient redwoods of the Headwaters Forest, highly productive industrial timberlands, prime agricultural lands, and functioning streams and wetlands, all of which are connected to the bay and its eel grass beds and tidal marshlands. These natural features support some of the best remaining wild salmon runs in northern California, as well as hundreds of aquatic species, shorebirds, and waterfowl species, and dynamic urban and rural communities of well-informed and actively involved people.

Humboldt Bay is a major shipping center for the north coast and hosts an extensive oyster industry. The most heavily populated urban centers around Humboldt Bay include the City of Arcata (pop. 16,651) and the City of Eureka (pop. 26,128).

The Humboldt Bay watershed is 223 square miles in area. Elevation of the ridges forming the boundary of the watershed to the east is 1,500 feet on average. A narrow band of relatively flat land, consisting of both tidal marshes and stream floodplains, surrounds the bay. Over 90 percent of the bays former tidelands have been converted to agricultural, residential, commercial, or industrial uses. The largest regions of these flatlands include the Arcata bottoms at the north end of the bay and the lower reaches of major streams entering the bay. The remainder of the watershed, at least two-thirds of the total area, is relatively steep and predominately managed for timber production.

From north to south, the four major streams in the Humboldt Bay watershed are Jacoby Creek (draining 17 square miles), Freshwater Creek (draining 31 square miles), Elk River (draining 29 square miles), and Salmon Creek (draining 17 square miles). Jacoby and Freshwater Creeks drain into Arcata Bay to the north, Elk River into Entrance Bay (just south of Eureka), and Salmon Creek into South Bay. Smaller streams flow primarily into the North Bay. See text box on page 12 for more information on smaller urban streams in Arcata. Numerous sloughs exist around the bay that are part of the historic tidal bay ecosystem. Some of these sloughs have limited freshwater input and provide critical nursery habitat for marine species, but relatively little is known about salmonid use of these salt water sloughs.

Humboldt Bay watershed is in the forefront of the controversy about balancing extraction of timber resources and the need to maintain and restore water quality, fish habitat, and reduce hazards



Humboldt Bay and the Pacific Ocean - a view from the watershed



Watershed signage placed by the City of Arcata helps to bring awareness and educate citizens about watersheds in the urban area

to downstream inhabitants. The HBWAC was formed to provide a neutral forum for stakeholders to discuss and problem solve, hopefully leading to improvements within the watershed.

Population centers in the watershed are concentrated in two cities and five smaller communities near Humboldt Bay, with a total population of about 70,000. Scattered farms and residential homes are found upstream of the bay along the streams. Almost the entire upper portion of the watershed is owned by industrial timber companies, Pacific Lumber Company and Green Diamond Resource Company (formerly Simpson Resource Company and before that Simpson Timber Company). The lower reaches of all streams, and the majority of flatlands surrounding the bay, are dominated by agricultural use. Agriculture and residential uses mix in the middle reaches of watershed streams. There is more residential development in Jacoby and Freshwater Creeks than in Elk River or Salmon Creek.



Helicopter logging in Humboldt Bay Watershed

Outside of incorporated municipalities, there is little public ownership of land within the watershed. The few exceptions include: the City of Arcata owns and manages a demonstration forest in the Jacoby Creek watershed; the U. S. Fish and Wildlife Service (USFWS) manages the Humboldt Bay National Wildlife Refuge (HBNWR), with holdings in both the north and south bay areas; Humboldt County manages a small park in Freshwater Creek; and the Bureau of Land Management (BLM) owns Headwaters Forest in upper Elk River and Salmon Creek.

Current land use statistics for the Humboldt Bay (2002) indicate that the majority of existing land use is in timber production (Figures II.1 and II.4).

Land Use in the Humboldt Bay Watershed

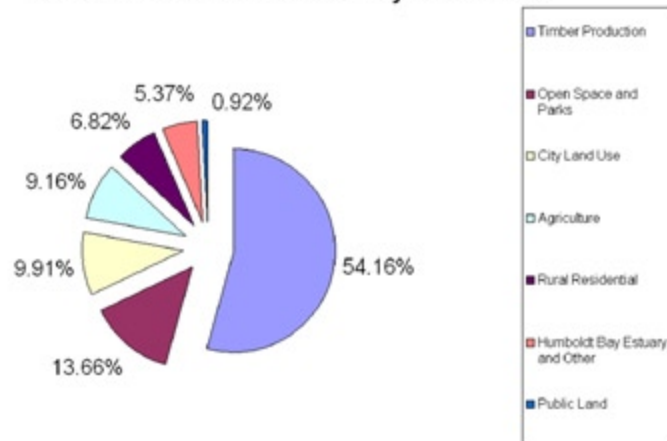
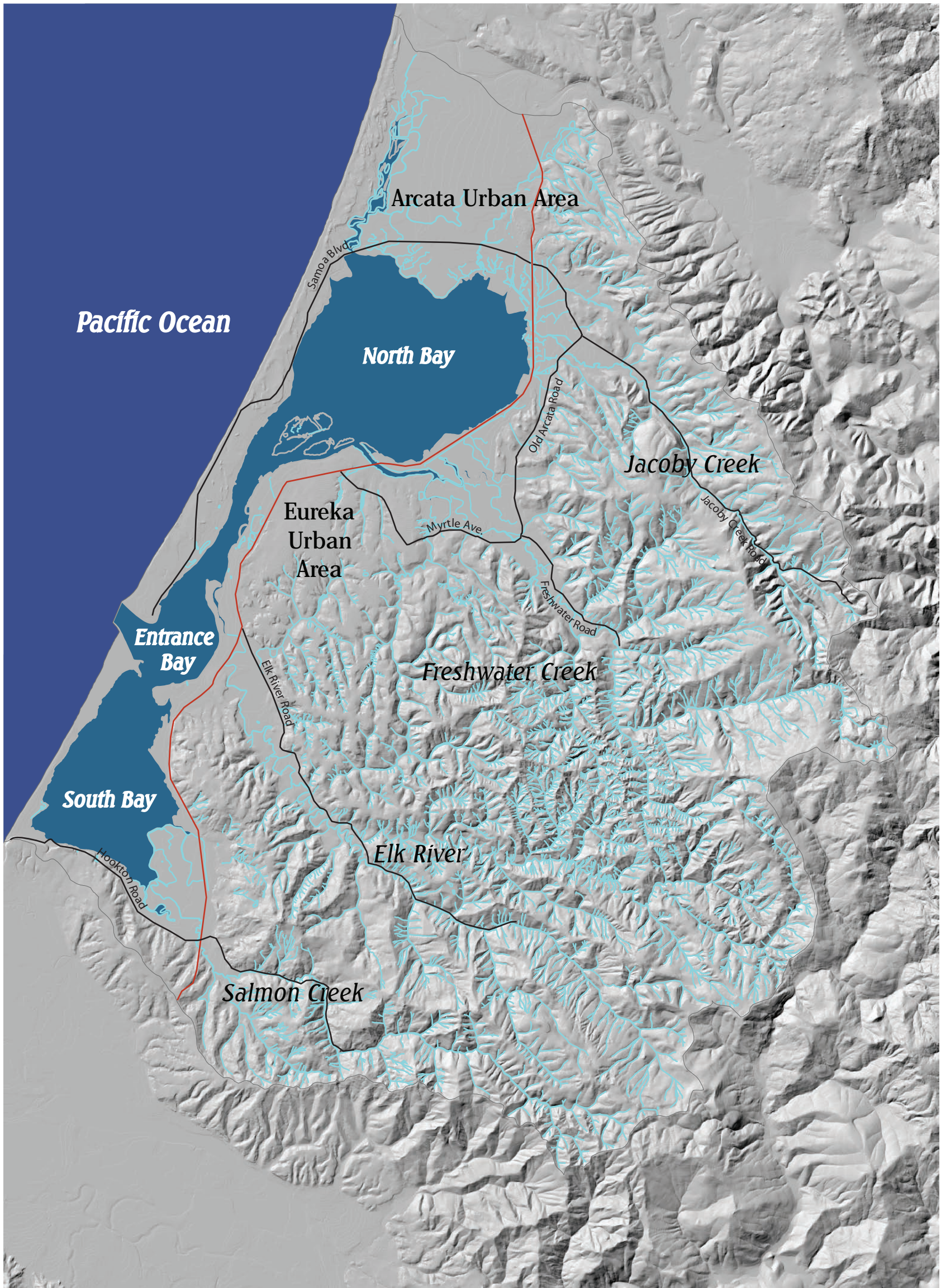


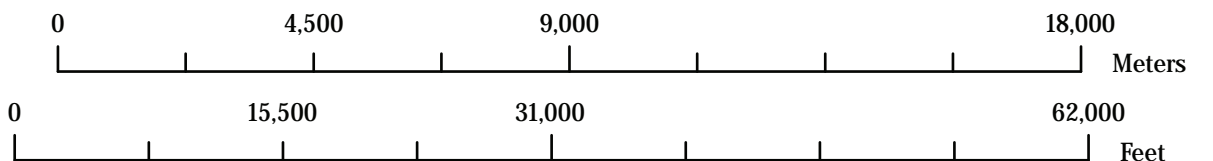
Figure II.1 Land Use in Humboldt Bay Watershed (Statistics from Humboldt County Planning Department 2002).

Figure 11.2: Humboldt Bay Watershed



- Humboldt Bay Watershed Boundary
- Humboldt Bay
- Humboldt Bay Streams
- Pacific Ocean
- Roads
- Highway 101

Map Design by
 Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Roads - CDE 1:24,000, 2000.
 Roads data does not account for timber roads, driveways or historic legacy roads.



II. A. Natural History

An understanding of the natural and cultural history of the Humboldt Bay watershed may increase our understanding of how human-caused and naturally occurring watershed processes interact and affect habitat conditions for salmonids as well as other species. Below is a brief description of where salmonid populations are currently found within Humboldt Bay watershed, followed by a short discussion of geology, soils, climate and rainfall, hydrology, and vegetation in the watershed. See Section V for more details on each subwatershed.

II. A. 1. Salmonid Presence

The four main sub-watersheds of Humboldt Bay watershed support native wild populations of salmon and steelhead (Figure II.6). The streams from north to south and the salmonid species each sub-watershed supports are listed in Table II.1 with watershed area and miles of perennial stream.

Tributary	Watershed Area (acres)	Miles of perennial stream	Salmonid Species Present
Jacoby Creek	13,017	26.5	coho, steelhead, cutthroat, resident rainbow trout, and chinook (rarely)
Freshwater Creek	37,100	58	coho, steelhead, resident rainbow trout, cutthroat, and chinook, chum (rarely)
Elk River	37,500	329	coho, chinook, steelhead, and cutthroat
Salmon Creek	16,400	14	coho, steelhead, cutthroat

Table II.1: Salmonid Presence in Humboldt Bay Watershed

II. A. 2. Geology

The Humboldt Bay watershed is located about 30 miles northeast of the junction of the Gorda, Pacific, and North American crustal plates. Tectonic activity in the area is extremely high. The Gorda Plate is undergoing subduction beneath the North American Plate.

Anadromous salmonids in Arcata's Urban Streams

Most of Arcata's urban streams headwaters are situated on the southwest flank of Fickle Hill (1200 feet elevation), a northwest trending ridge that lies east of Arcata. Streams flow from forested headwaters through urban zones, then through agricultural lowlands before discharging to Humboldt Bay.

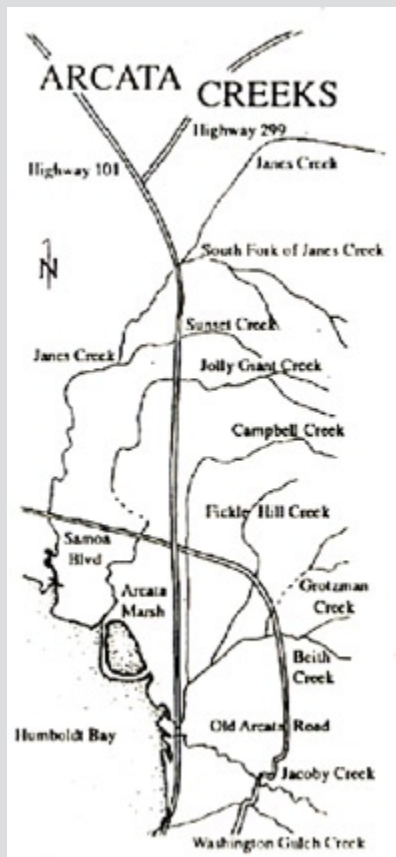
Including Jacoby Creek, there are ten drainage basins within the City, most having a year round stream within the basin boundaries. All of these basins eventually discharge into Humboldt Bay with the exception of the Mad River. The Mad River defines the northern boundary of the City, but only 360 acres of city land (6 percent) drain into that system. Extensive sloughs and wetlands are also part of the natural drainage system (DMP 1997).

Jolly Giant, Janes, Beith, Grotzman, and Campbell Creeks, support salmonid populations in their lower reaches.

Portions of Janes, Jolly Giant, Campbell and Grotzman Creeks are culverted or covered, causing degradation of creek resources. Streams such as Janes Creek have tide gates which are barriers that prevent anadromous salmonids from being able to access critical habitat. Furthermore, recreational use has degraded riparian vegetation along the lower reaches of Arcata's urban creeks.

(Continued on next page).

The City of Arcata's Environmental Services Department is actively working on stream protection and restoration. The City has a Creeks Management Plan and a Creeks and Wetlands Committee that meets monthly. The General Plan Update directly addresses stream issues in the Resource Conservation and Management Element. The policies address natural biological diversity/ ecosystem function, streams conservation and management, water resource management, and forest management among other issues. The City also has a Drainage Master Plan to address each of Arcata's streams from a hydrologic and drainage point of view.



Large-scale tectonic activity has produced a number of northwest-southwest trending faults in the region, which have created most of the watershed streams. Uplifting and folding, the differential motion at the various fault lines, and erosion have resulted in a complex pattern of exposure of rock formations in the watershed (Barnhart, Boyd, and Pequegnat 1992).

Four main geologic formations are exposed in the Humboldt Bay region. (Table II.2 and Figure II.8)The oldest is the Franciscan Formation, consisting of graywacke, sandstone, shale, chert, altered basalt and some limestone. The Franciscan is overlain by the Yager Formation, composed of interbedded shale, graywacke and conglomerate. The Wildcat Group is younger than these formations and consists predominantly of weakly lithified mudstones, along with weakly consolidated siltstone, sandstone, conglomerate, and some interbedded limestone, tuff and lignite. The youngest of the major formations is the Hookton, which consists of continental and shallow marine deposits of variable lithology (Barnhart, Boyd, and Pequegnat 1992).

Watershed	Dominant Formations	Stability
Jacoby Creek	Coastal Terrane	Highly susceptible to erosion and mass wasting
Freshwater Creek	Wildcat Group (western half of watershed) with underlying Yager Formation; Franciscan Central Belt Group (eastern half of watershed)	Wildcat sediments are highly erodible and prone to slope movement. Underlying Yager sediments have rock and sand components and are moderately resistant to erosion. Franciscan sediments are less erodible than Wildcat.
Elk River	Wildcat Group with underlying Yager Formation; Hookton Formation along southern ridgetops	Wildcat sediments are highly erodible, underlying Yager sediments have rock and sand components and are moderately resistant to erosion.
Salmon Creek	Franciscan Melange; Wildcat Group with underlying Yager Formation in the headwaters	Franciscan sediments are more stable and less erodible than Wildcat sediments. Yager sediments have rock and sand components and are moderately resistant to erosion.

Table II.2: Dominant Geology in Humboldt Bay Sub-watersheds

The underlying geology of the sub-watersheds is a major driving force for input of sediments into the stream channel. Geology plays a dominant role in quality of spawning gravels, slope stability, and the intensity of land use that can be tolerated without degrading watershed processes. Because of its relatively young age, high rate of uplift and tectonic activity, the Humboldt Bay watershed exhibits significant instability. The combined effects of high precipitation and unstable geology place North Coast rivers among the highest recorded sediment producers per unit area in the world (Halligan, 1997).



“The Blue Slide” of Franciscan Geology on Jacoby Creek

II. A. 3. Soils

The alluvial deposits around Humboldt Bay are mostly sediments of the Franciscan, Yager, Wildcat, and Hookton formations. Humboldt Bay watershed consists of a variety of soil types that are excellent agricultural and timber soils, and several are considered highly erosive.

II. A. 4. Climate and Rainfall

The Humboldt Bay region has two distinct seasons. The fall and winter season is mild but wet; spring and summer are cool and dry. The mean monthly temperature at Eureka varies by only 10 degrees Fahrenheit throughout the year, with the low mean in January (47 F) and the highest in August (57 F) (Barnhart, Boyd, and Pequegnat 1992).

Eighty-five percent of the precipitation occurs during a seven-month period from mid-October to mid-May. Average annual precipitation ranges from 36 inches at Eureka to over 50 inches per year at the highest elevations in the watershed.

The amount of precipitation varies significantly from year to year. A climactic cycle with periodicity of eight to ten years is evident from long-term rainfall records. Two periods of significant and prolonged droughts occurred from 1975 to 1995. Only five or six years over this period had precipitation equal to or exceeding mean annual precipitation for the correlative period of record.

Precipitation in the Humboldt Bay watershed arises from rain, snow, and fog-drip (fog condensing on vegetation). Snow occurs on the ridgetops occasionally during cold winter storms and rarely over the entire watershed. In the dry season the climate is moderated by summer fog that reduces solar radiation and creates an ideal habitat for a temperate rainforest. Harris (1987) has



Elk River watershed's Berta Bridge flooded during a December 2004 rain event. Major flooding is a common occurrence in both Freshwater Creek and Elk River watersheds - its cause a topic of much controversy. More a hazard and nuisance for the landowners but also leaves fish stranded in the fields as flood water recedes.

compiled evidence for the idea that the precipitation from fog drip has probably been considerably reduced by the removal of old-growth forest stands in the watershed.

II. A. 5. Hydrology



Streamflow in Humboldt Bay tributaries are the highest from November through March and the largest floods in the watershed tend to occur during December and January. During the summer and fall, flow varies little and is relatively low. Rain may come late in some years, or persist longer. In 1958, very little rain fell in November and December, while three significant floods had already occurred by the end of the year in 1964.

The magnitude, timing, and number of floods varies considerably from year to year and is not directly related to total annual rainfall, but is more closely tied to the intensity of individual storms. For example, an unusually large flood occurred in Jacoby Creek in 1955, though the total rainfall for the year was average.

Increase in sediment in stream channels has resulted in a reduction of channel capacity that is especially notable in Elk River. In addition vegetation removal, soil compaction, and increase in impervious surfaces through land use practices can result in changes in the timing and intensity of flood events.



Running pine (Lycopodium clavatum) found on the floor of the Redwood Forest

Streamflow has been measured by the U.S. Geologic Survey (USGS) at two locations within the basin. A gauge was operated on Jacoby Creek from 1954 to 1974. Watershed area above the gauge is 5.8 square miles. A gauge was operated on the Elk River near Falk from 1957 to 1967; watershed area above that gauge is 44.2 square miles. Freshwater Creek discharge has been measured since 1990 by Salmon Forever at a location upstream from Freshwater Park.

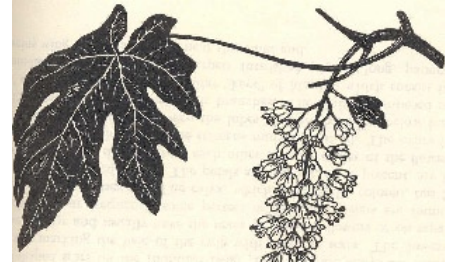
II. A. 6. Vegetation

Below are the five main vegetation communities in the Humboldt Bay watershed (not including dune and tidal marsh).

- **North Coastal Coniferous Forest.** Sitka spruce (*Picea sitchensis*) and grand fir (*Abies grandis*) are members of this community.
- **North Coast Riparian Scrub.** Found along streams, the typical overstory plant is willow (*Salix* spp.) in the lower parts of watershed streams, near the bay. Further upstream in

the watershed alder (*Alnus oregona*) and bigleaf maple (*Acer macrophyllum*) become common.

- **Redwood Forest.** Dominated by redwood (*Sequoia sempervirens*). The Northern Redwood forest contains Douglas-fir, grand fir, Port orford cedar, Sitka spruce, western red cedar and tan oak. The shrub layer contains huckleberry, rhododendron, salal, and salmonberry. The ground layer is comprised of herbaceous plants and is dominated by the sword fern.
- **Douglas Fir Mixed Hardwood Forest.** Douglas fir (*Pseudotsuga menziesii*) is the major species, found in association with tan oak (*Lithocarpus densiflora*) and other hardwoods.
- **Bald Hills Prairie.** Praries in the Humboldt Bay watershed are grazed and largely converted to introduced European species. Historically, these prairies were likely similar in composition to the prairies of the Bald Hills area in Redwood National Park.



Historic Human Footprint in the Watershed

The Humboldt Bay watershed was and still is inhabited by the Wiyot people. Ethnographic and archaeological evidence suggests the Wiyot came to the region about 900 A.D. while according to

Historic Human Footprint Timeline

- **Present - 10,000-13,000 years ago** - native American tribes
- **150-300 years ago** - European fur trappers
- **1806** - Humboldt Bay region charted by Jonathon Winship
- **1809** - Union Town established
- **1870** - Timber harvest begins in Jacoby Creek
- **1875** - Construction of the first railroad in the watershed
- **1876** - Shingle mill established at Bayside, logs were rafted to mills located in Eureka
- **1880** - Two railroads had been developed in the watershed
- **1890** - First dike built
- **1880s-1910** - Peak of first logging period
- **1918** - Construction begins on Highway 101 stretch between Arcata and Eureka
- **1920** - Apparent exhaustion of the easily accessible timber supply by 1920
- **1950s** - Resurgence of logging activity began with harvesting of remaining old growth in the headwaters of the basin, followed by second-growth cuts in the rest of the drainage, which continues to the present.

their cosmology they have been on the land since the beginning of time. Wiyot villages surrounded Humboldt Bay and were generally located close to streams, the bay shore, or in tidewater areas. At that time the bay was surrounded by salt marshes, wet meadows and forests. Stream zones were clearly the preferred location for habitation based on distribution of the villages. The Wiyot called the area Goal-la-nah, meaning a land a little above the water. The Wiyot, recognizing the life-giving qualities of the bay, were intimately tied to its seasonal and daily cycles for food, transportation and materials. Their lives depended on the productivity of the bay. The Wiyot people managed areas of the watershed to provide hazel, acorns, various basket making materials, fish and wildlife. Despite their presence there for thousands of years, the bay and surrounding lands remained essentially unchanged.

The Wiyot ate fish throughout the year, and judging from the presence of fish bones in excavated sites people inhabiting the area before the Wiyot also depended primarily on fish in their diet (Loud 1918). Probably the most common fishing technique was to place weirs and traps near the mouths of streams. They used both straight and v-shaped weirs. Different designs were used for chinook and steelhead. Dip nets were often utilized to remove fish from the weirs. Weirs were constructed in late spring or summer, depending on the weather (Benson, Fredrickson, McGrew 1977). The people preserved the salmon by splitting them into three slabs for drying on a rack of green willow poles in the sun, over a small fire and in the houses.

Sir Francis Drake may have been the first European to see the northern California coast, though he recorded nothing



An early picture of the Arcata Warf

of Humboldt Bay. Although Trinidad Bay had been explored by a Spanish expedition in 1775, Humboldt Bay was difficult to observe from the ocean. The bay was not located by sea until 1806 by an American sea captain named Jonathon Winship.

Development within the Humboldt Bay watershed began in the mid 1850s in conjunction with the inland Gold Rush, and continued with the exploitation of regional forestry and fisheries resources. An overland expedition from the Trinity gold mines, led by Dr. Josiah Gregg and L. K. Wood, viewed the bay late in 1849. The

prospect of a port to supply the mines was very attractive, and the settling and development of the bay began in 1850 (Gates 1983).

As of June, 1850, four separate townships had been claimed on Humboldt Bay: Humboldt City (near Buhne Point), Bucksport, Union (later to become Arcata), and Eureka. The siting of towns was based on the limitation of clear, flat, dry ground. Eureka was one of the few places in the central bay area that met these criteria, and was described as being surrounded by dense spruce forest to the east and marsh to the south (Glatzel 1982).

The area rapidly became a trade depot for inland gold mining operations in 1850 and 1851. Upland forested areas nearest Eureka and Arcata were cleared first, to provide residential areas and agricultural land.



The view out to Humboldt Bay from College Hill, Arcata around 1915

Following the first land claim by European Americans in 1850, the area developed quickly, partly because mining operations in the mountains to the east drew people and provided markets for goods. Agricultural products in particular were in demand; the area was a prime exporter of agricultural products such as potatoes and dairy.

Timber resources were also quickly developed. Carson Mill shipped the first cargo of redwood to Hong Kong in 1855. By the mid-1880s, docks had been built in Eureka and Field's Landing, and numerous railroad spurs were transporting logs from outlying areas such as Jacoby Creek, Freshwater Creek, and Salmon Creek. Jetties were constructed to stabilize the entrance to the bay in the 1890s. By 1914, 8.3 billion board feet of timber had been harvested and shipped from Humboldt Bay (Glatzel 1982).

European development led to the displacement of Wiyot people from their homes, food sources, traveling routes, and hunting and fishing activities. Large numbers of Wiyot people were massacred in 1860 by a small group of settlers, and five years of open warfare ensued (Gates 1983).

By 1947, one hundred years after European settlement, agriculture, timber, and other industries based on the natural resources of the area (commercial fishing, for example) were well-established as the base of the local economy.

Early transportation around the bay skirted the large expanse of tidal marshes. Like many routes used by the European settlers, Old Arcata Road was originally a trail established by the Wiyot; in 1862 it became a wagon trail and was paved around 1925 (Glatzel 1982). Although a major thoroughfare, the road had little impact on the streams and wetlands of the area because it had been sited to avoid the marshes.

Other transportation corridors have had a greater impact. In 1900, construction of the Northwestern Pacific railroad began around the eastern margins of the bay. The railroad functioned like a dike in most locations, with tide gates at almost all slough crossings (Barnhart, Boyd, and Pequegnat 1992). It allowed marshes between the railroad and Old Arcata Road to be converted to agriculture. In 1927,

Highway 101 was constructed, and most of the marshes east of the bay were diked and drained.

Higher up in the watershed, railroads were constructed to transport logs to mills around the bay. These railroads penetrated far into Jacoby and Freshwater Creeks and Elk River. A spur also ran a short distance up Salmon Creek (Clark 1969). The development of these railroads was fairly extensive, especially in Freshwater Creek and Elk River. In the Freshwater drainage, rail lines ran up McCready, Cloney and Graham Gulches, as well as Little Freshwater Creek and the South Fork. On the North Fork of the Elk River, the railroad went past the South Branch on the North Fork and up Dunlap and Browns Gulches. On the South Fork of the Elk River, lines went all the way to the Little South Fork (Carranco and Sorenson 1988).

The development of Humboldt Bay's natural resources provided economic benefits for its new residents and the region thrived through the Civil War, the Depression, and World Wars I and II.

Fisheries

Although there are no early historic fish counts in Humboldt Bay watershed, historic accounts compiled by watershed resident Susie Van Kirk (1998) provide evidence that a healthy population of salmon existed in the stream in the past.

In the early 1900s fish stocks were already in decline, and in response to concerns, the tributaries of Humboldt Bay were stocked with salmon from various rivers in the Pacific Northwest. The Price Creek Hatchery (later replaced by the Fort Seward Hatchery) was on a tributary of the Eel River.

Ferndale Enterprise (4 June 1915) - Seventy-thousand steelhead fry, the last shipment for distribution in the streams flowing into Humboldt Bay, were received Monday afternoon from the Price Creek hatchery for distribution in Elk River. This shipment is the last of 420,000 steelhead to be planted this year in Jacoby Creek, Elk River and Freshwater. About 500,000 salmon fry were received and distributed in the three streams earlier in the spring.

The impact of these non-native stocks on Humboldt Bay watershed's native salmon populations is not known. Hatchery fish can compete for food and shelter with native populations, carry diseases, and affect population genetics.

Ferndale Enterprise (28 April 1922) - Stocking Streams of Northern Humboldt--The Humboldt Fish and Game Association has received 200,000 Quinnat salmon from the Fort Seward hatchery



Historic photos of sportfishing in Freshwater Creek. Photos courtesy of Tiffany Rittenhouse.



which will be released for anglers in Freshwater, Salmon Creek, Jacoby Creek, Elk River and Ryans Slough.



An historic harvesting scene in the Arcata Bottoms

Agriculture

Much of the reclaimed marshland around Humboldt Bay was considered the best dairy land in the county. Agriculture developed rapidly around Humboldt Bay between 1865 and 1875. The amount of cultivated land increased from 9,060 acres in 1865 to 19,000 acres in 1875.

Early agricultural development took place largely in the floodplains. On much of the northeastern bayside, especially around

the Eureka slough, extensive diking occurred in the conversion to agricultural land. Up until 1903, a large expanse of tidal wetlands extended up to and sometimes beyond Old Arcata Road. By 1927, most of the wetlands had been converted to agriculture. Levees were constructed along much of the arable land in the lower stream valleys.

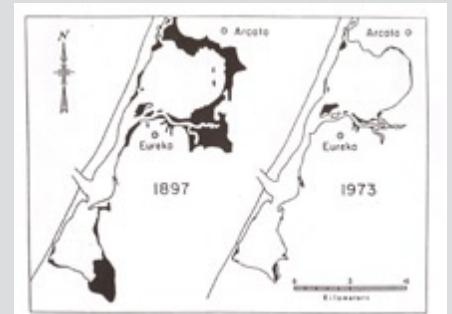


Figure II.3: Decrease in Humboldt Bay marshland distribution from 1897 to 1973 caused by diking (MacDonald 1977).

United States Coast Guard (1870) maps of the bay's eastern shoreline from Eureka slough northward reveal a coastal plain absolutely honeycombed with watercourses (streams, rivulets, and sloughs) big and little, all coursing through an extensive marsh affected by daily tides. The simplicity of today's landscape belies its historic complexity. To convert the Humboldt Bay area to agricultural use, marshland was reclaimed, stream channels were straightened, and large woody debris was removed (Van Kirk 2002).

The exportation of agricultural goods became an important part of the local economy. While farms in the hills were worth \$20-\$100 per acre in 1911, rich bottom lands went for \$100-\$500 per acre.



Log train in Freshwater Creek watershed

Timber

Timber harvesting began in the Humboldt Bay watershed in 1850. Early timber harvesting took place mostly for clearing residential areas or farmland in the bottoms, or to provide wood for local construction.

The first successful lumber mill in Humboldt County, formed in 1852 by Ryan and McDuff, was located in Eureka (Gates 1983). In 1867, a mill was built on Indian (Gunther) Island. The mills of Humboldt County sawed 20,375,000 board-feet of timber and 800,000 shingles that year (Coy 1929). Several more mills had been built by 1875, including the John Vance mill on the north side of the Mad River, also known as the 'Big Bonanza', connected to Humboldt Bay by a railroad crossing near the river mouth. A mill was constructed in Salmon Creek, and a railroad was constructed up-creek for accessing timber.

For the first couple of decades of harvest, few machines were used in timber practices. Logs were sawn by hand and moved by teams of oxen. One of the primary forms of log transport from the woods to the mills was by stream, a technique called splash-damming. Logs were piled in the streambed during the summer, upstream of a dam constructed to store higher flow caused by winter rains. When the log ponds upstream of the dams were full and the logs were floating, the splash dams were suddenly destroyed, usually by dynamite, and the logs were transported on the resulting torrent of water to the bay. (Gates 1983).



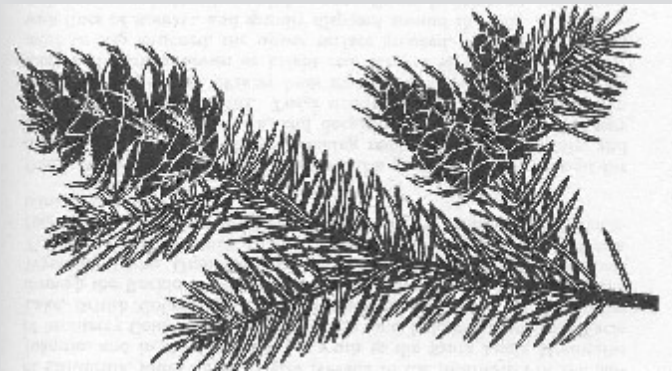
Two men use a “misery whip” saw to fell a giant redwood

In the 1880s, new methods for harvesting and milling significantly increased production. Most companies were building railroads up creeks. A rail line was constructed eight miles up the Elk River valley from Bucksport in 1885 (Gates 1983). The steam donkey, a steam-powered winch on a sled that took over the role of oxen, was invented and came into wide use in forestry practices. By the end of the decade, the band saw was in wide use throughout the county, significantly improving mill productivity. In the late 1880s, county timber production reached 190,000,000 board-feet.

Small Arcata mills began shutting down around 1890 because their timber resources around the bay had been exhausted (Gates 1983), and they lacked resources to access the upper drainages. The Elk River Mill and Lumber Company’s land in the McCloud Creek drainage was cleared by 1890.

Timber in the Upper South Fork of the Elk River was accessed by railroad above the mill at Falk, requiring nearly a dozen large wooden trestles (Gates 1983). Railroads were constructed in all of the major Humboldt Bay drainages, opening up the entire Humboldt Bay watershed to timber companies.

With the coming of diesel equipment at the end of World War II, many of the earlier forestry practices changed. Miles of roads were constructed throughout the watershed, often with stream crossings called Humboldt Crossings that did not allow for fish passage and failed during winter rains. Humboldt crossings were built of logging debris (unmarketable logs) covered with dirt. Many of the crossings still exist in the watershed and often fail during storms, pouring sediment into the streams. Timber production reached 1 billion board feet in the 1950s and 1960s.



Photos in this section courtesy of the Ericson Collection in the Humboldt Room at Humboldt State University.

II. B. Recent Trends

The Humboldt Bay area was once a complex ecosystem that supported an amazing abundance of wildlife. From ridge top oaks and old growth redwoods to meandering river estuaries, the Humboldt Bay watershed boasted rich biodiversity. Since European contact, the region's natural environment has severely deteriorated. Old growth redwood forests have been reduced to a mere few thousand acres and the original estuary system is cut off from the bay. Salmon populations are on the verge of extinction and the once-abundant elk population no longer lives in the watershed.

Significant landscape alterations have occurred in land directly adjacent to Humboldt Bay. From 1870 to around 1927, the amount of land in agriculture increased by about five times, and today only one-fifth of historic tidal wetlands remain. The amount of land used for residential and commercial/industrial uses has also increased dramatically, particularly since about 1940. Residential land use tripled between 1940 and 1980 (Shapiro and Associates 1980; Barnhart, Boyd, and Pequegnat 1992). Growth has continued in the watershed with the unincorporated area outside Eureka being one of the fastest growing regions in Humboldt County (Split Rock Ventures 2001). The predominant land uses in the watershed, as well as in Humboldt County, are still agriculture and timber production (Index of Economic Activity 2000).

In 1972, the State of California passed the Z'berg/Nejedly Forest Practice Act. This act provided the first real regulation of forest harvest practices, including protection for streams and riparian areas. For example, the construction of Humboldt stream crossings became illegal under this act, and riparian areas were given some protection from harvest and road construction.

With the exhaustion of timber resources and tighter regulations on forestry practices, production dropped to 500 to 800 million board feet in the 1970s and 1980s. Timber harvest rates increased again in the 1990s when large portions of the upper Humboldt Bay watershed were harvested.

In the 1990s, decreasing salmonid population numbers brought scientists' and policy-makers' awareness to the detrimental effects of forestry practices on salmonid habitats. The state organized the Independent Scientific Review Panel (ISRP) in 1998 to comprehensively review California Forest Practice Rules with regard to their adequacy for protection of salmonids (ISRP 1999). The ISRP recommended many changes to California Forest



Listening attentively at a Humboldt Bay Stewards (HBS) symposium. The HBS is a collaboration of organizations and individuals working to protect and enhance Humboldt Bay and its resources including the Humboldt Bay estuary which is critical salmonid habitat.



The City of Arcata acknowledges the landowners who helped to expand the City of Arcata's Community Forest at Jacoby Creek Watershed Day.

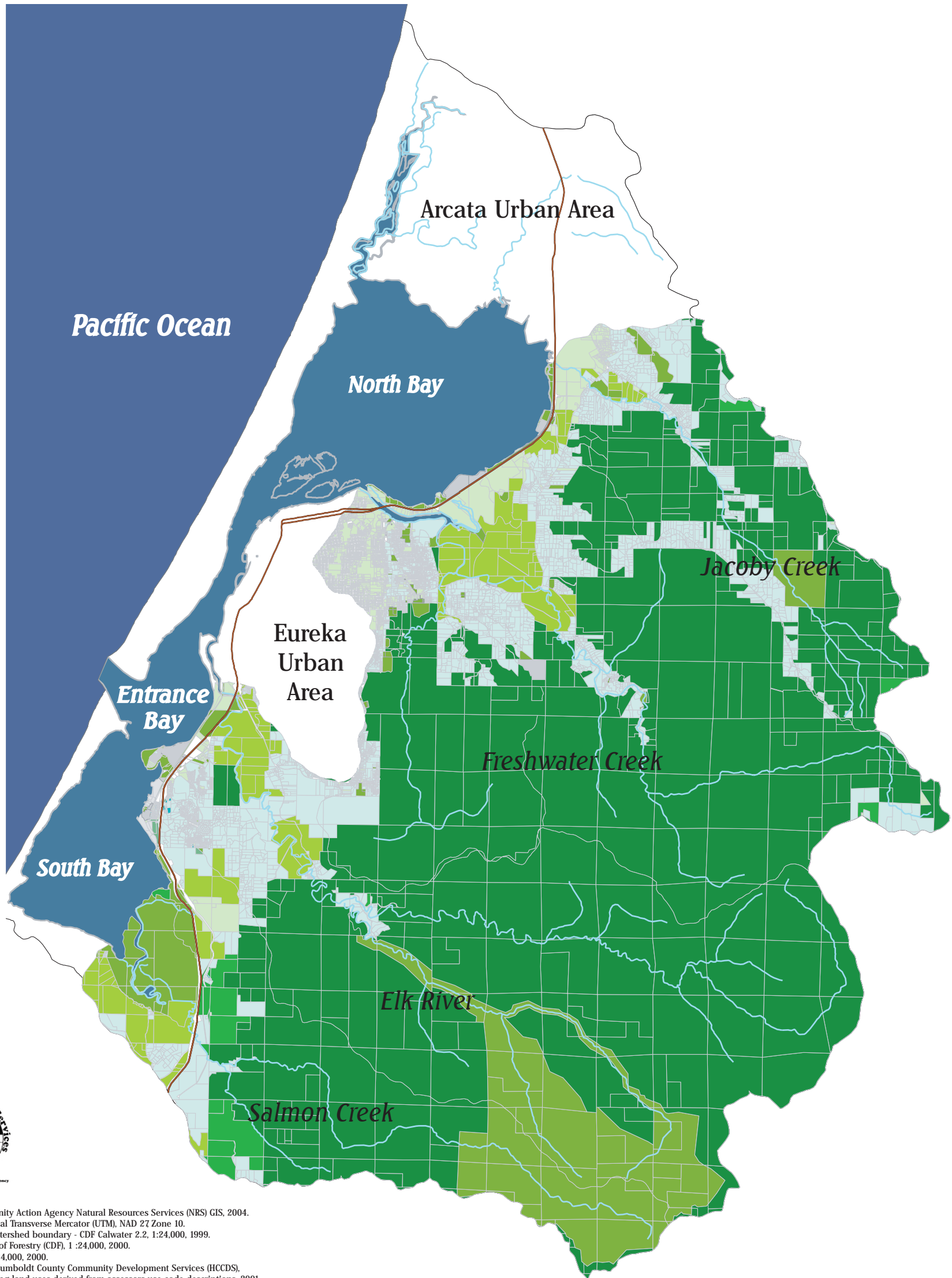


*Eureka Boat Basin fishing fleet 1955
(above) and today (below).
Photos courtesy of Bill Matson of Eel
River Watershed Improvement Group*



Practice Rules to enhance protection of salmonids and their habitat. Similarly, timber companies are developing Habitat Conservation Plans (HCPs) for the protection of salmonids and other federally listed species. In Humboldt Bay watershed, Pacific Lumber Company has been operating under a multi-species HCP developed in 1999. The restrictions of the HCP were to remain in place until the company conducted watershed analyses for Freshwater Creek and Elk River to guide future timber harvest. The Freshwater Creek watershed analysis was completed in December 2003, and the Elk River watershed analysis has been publicly released in a draft form. The results of the process have been a source of much controversy and it remains to be seen what changes will result. Green Diamond has voluntarily developed an Aquatic HCP, and currently in 2005, Green Diamond is implementing the plan (the conservation measures and monitoring are being applied) , but the plan has not yet been approved by the regulatory agencies.

**Figure II.4: Land Use
Humboldt Bay Watershed**



Map Design by
Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
Humboldt Bay Watershed boundary - CDF Calwater 2.2, 1:24,000, 1999.
Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
Streams - CDE 1:24,000, 2000.
County Parcels - Humboldt County Community Development Services (HCCDS),
generalized existing land uses derived from assessors use code descriptions, 2001.

Land Use Legend

- | | |
|---------------------------------|-------------------|
| Humboldt Bay Watershed Boundary | Residential |
| Humboldt Bay | Agriculture |
| Humboldt Bay Streams | Grazing/Timber |
| Highway 101 | Open Space/Parks |
| Industrial | Timber Production |
| Commercial | |

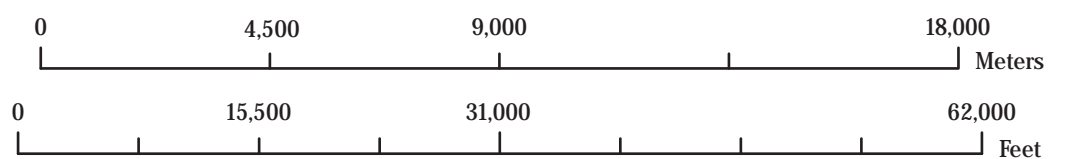
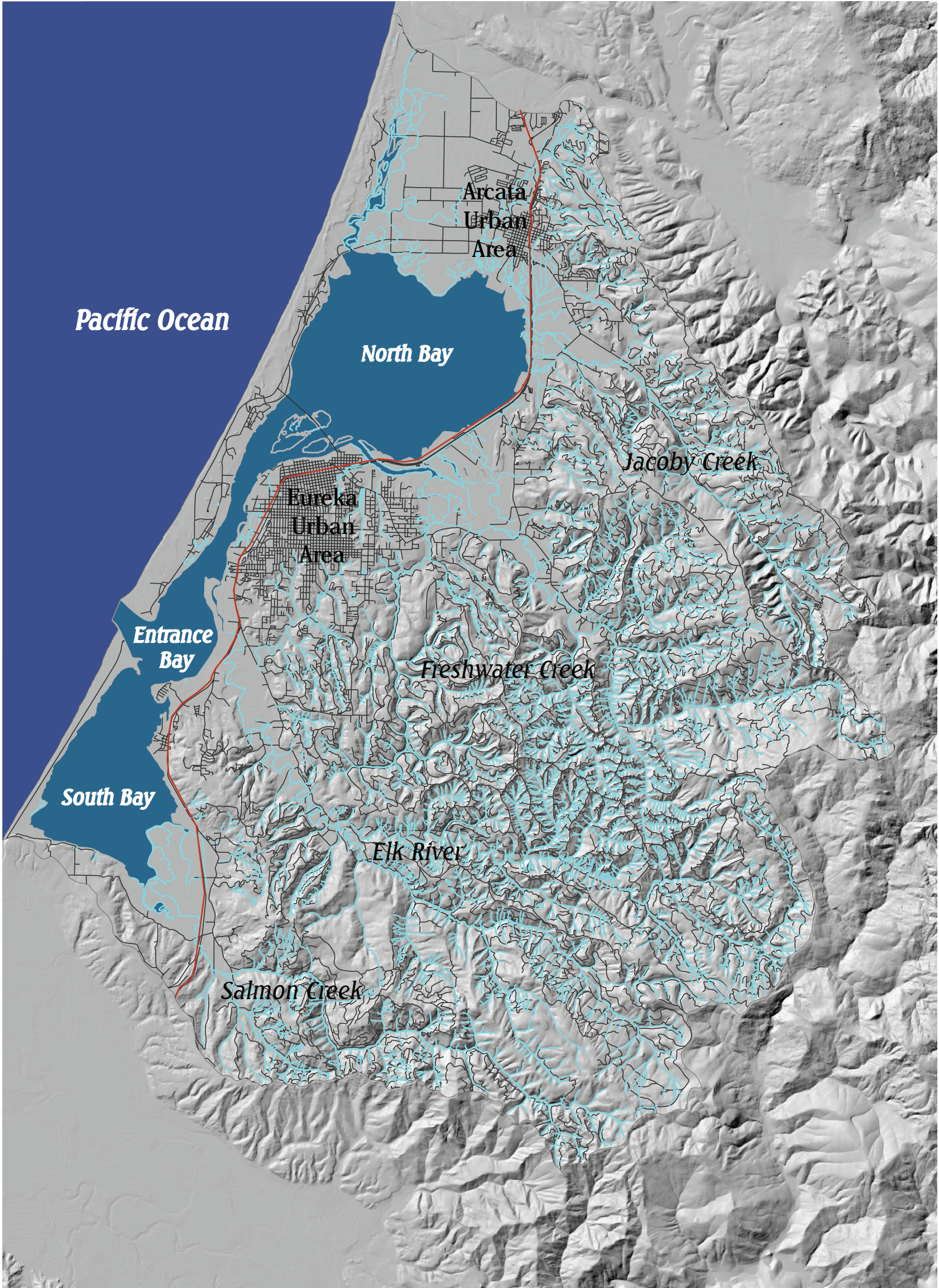
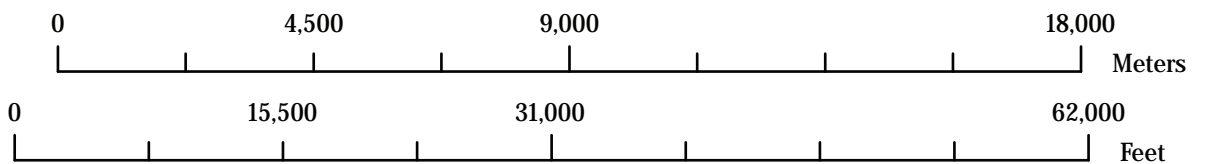


Figure 11.5: Roads
Humboldt Bay Watershed

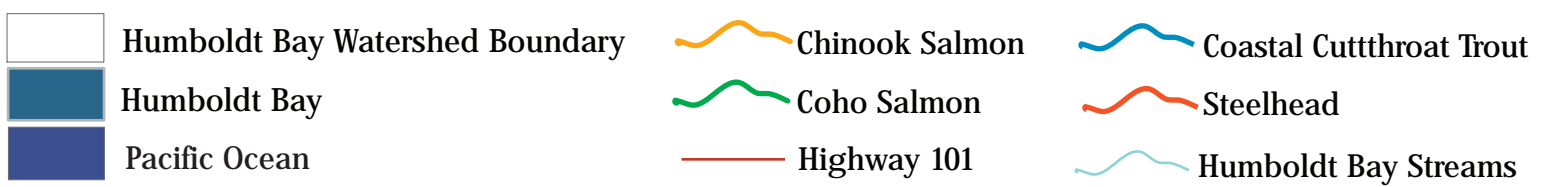


Map Design by
Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
10 Meter Digital Elevation Model - Modified Hillshade by NRS.
Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
Roads - CDE 1:24,000, 2000.
Roads data does not account for timber roads, driveways or historic legacy roads.

- Humboldt Bay Watershed Boundary
- Humboldt Bay
- Humboldt Bay Streams
- Pacific Ocean
- Roads
- Highway 101



**Figure II.6: Anadromous Salmonid Distribution
Humboldt Bay Watershed**



Map Design by
Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
10 Meter Digital Elevation Model - Modified Hillshade by NRS.
Salmonid Distribution data - Cal. Dept. of Fish and Game non-published map
and Pacific Lumber Company Habitat Conservation Plan, 1997
Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
Roads - CDE 1 :24,000, 2000

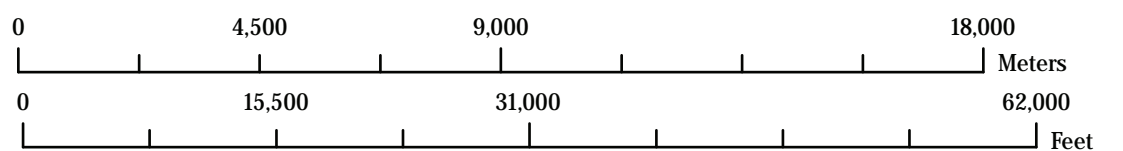
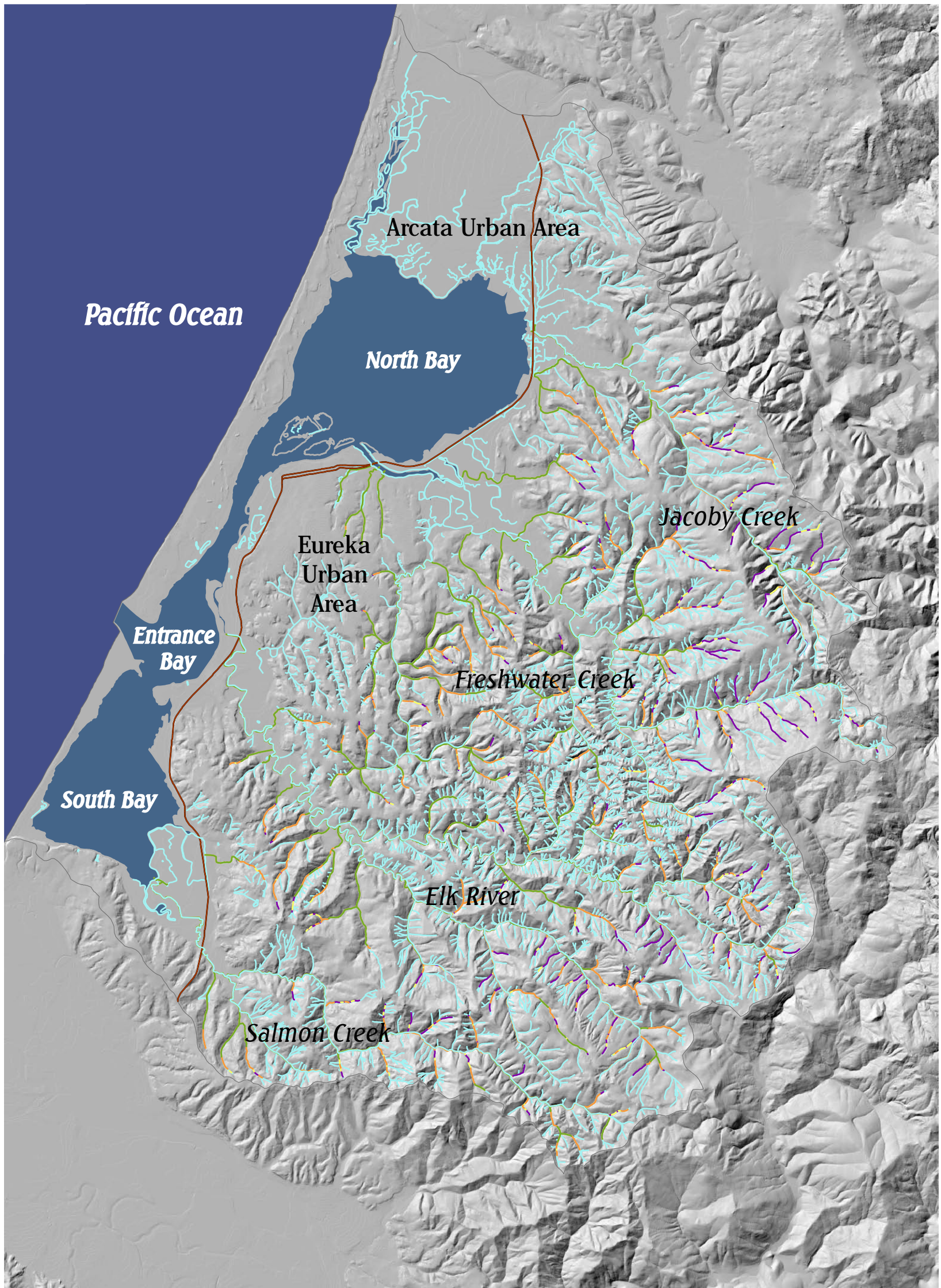











Figure II.7: Stream Gradient
Humboldt Bay Watershed



Stream Gradient Categories

-  > 15%
-  12 - 14.9%
-  4.1 - 11.9%
-  0 - 4%

-  Humboldt Bay Streams
-  Humboldt Bay Watershed Boundary
-  Humboldt Bay
-  Pacific Ocean
-  Highway 101



Map Design by Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
10 Meter Digital Elevation Model - Modified Hillshade by NRS.
Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
Streams - CDE 1:24,000, 2000.
Salmonid gradient data: Institute for River Ecosystems. Categories determined by NRS.

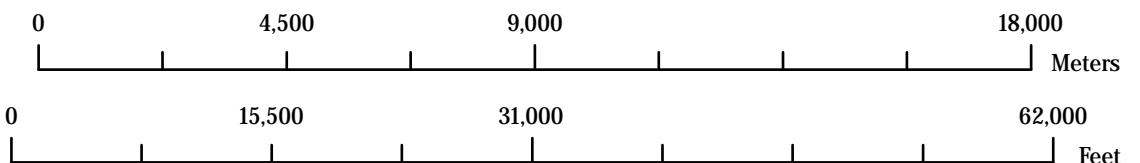
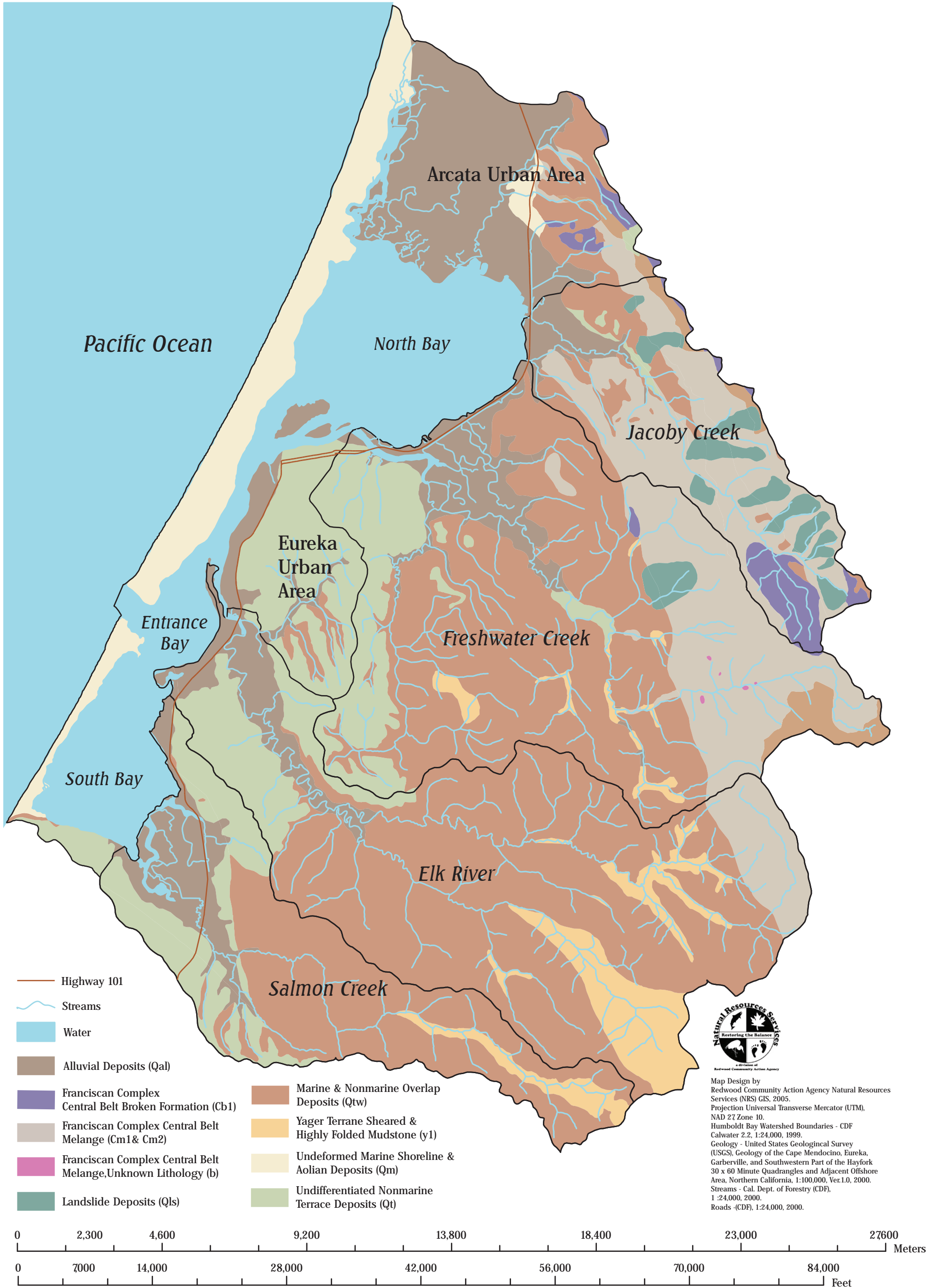


Figure 11.8: Geology
Humboldt Bay Watershed



III. Salmonid Habitat Requirements

III. A. Major Life Stages of Anadromous Salmonids

Salmonids in the Humboldt Bay watershed spawn in the fall and winter, and steelhead and cutthroat trout into the spring. All salmonids construct spawning nests, or *redds*, in the gravel bottom of streams, typically located at the tailout of pools (where the water velocity starts to increase at the lower end of a pool) or just above the top of a riffle. The redds are constructed by the female and consist of a series of pockets in the gravel in which fertilized eggs are deposited and buried to a depth of 8 to 20 inches.

The eggs incubate for around 60 days. The hatchling, or *alevin*, continues to develop in the redd as it absorbs the attached yolk sac. The juvenile fish, or *fry*, emerges from the redd between two to nine months after spawning, depending on water temperature.

Length of freshwater residence, or *rearing* time, differs for each species. Chinook spend varying amounts of time in fresh water, depending on the run; coho spend 12-15 months on average in their natal stream; steelhead rear for 1 to 4 years; and cutthroat can reside 1 to 9 years, although a 3 year residence is most common.

The juveniles migrate seaward throughout spring and early summer. As salmonids make their journey to the ocean, they undergo several physiological and morphological changes preparing them for marine life, a process called *smoltification*. Marine-adapted juveniles, or *smolts*, develop silver skin color and the ability to excrete salt water, among other modifications.

Upon reaching the ocean, they travel various directions and distances depending on species and available food supply. Coho spend 1 to 2 years in the ocean; chinook typically spend 2-4 years (may spend up to seven); steelhead spend one to five years (most California populations only spend 2 years); and cutthroat reside in the ocean less than one year (typically weeks to a couple of months). Adults eventually return to their natal streams to spawn, undergoing dramatic physiological and morphological changes as they re-enter freshwater and prepare for reproduction. Salmon species die after they spawn, while steelhead and cutthroat may return and spawn several times before expiring.

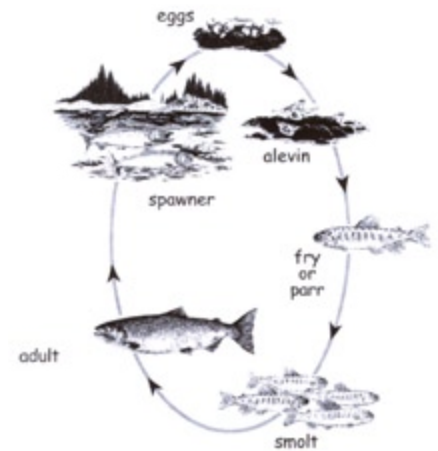


Figure III.1: Salmonid life cycle



Juvenile chinook. Photo courtesy of M. Wallace, DFG

More in-depth info on salmon life history can be found at www.krisweb.com

Healthy freshwater spawning and rearing habitat is crucial to the survival of anadromous salmon and trout. Furthermore, in addition to their intrinsic, biological and economic value, salmonids act as a barometer for overall watershed health. Pacific salmon and steelhead are indicators of properly functioning aquatic ecosystem because they require cool, clean water, complex channel structures and substrates, and low levels of silt.

III. B. Anadromous Salmonid Habitat Requirements Related to Life History Stages

Anadromous salmonids utilize a wide variety of freshwater habitats during their complex life cycles. Individual stocks differ according to periodicity (when they mature and spawn), length of freshwater residence, and spawning and rearing distribution and timing. They have evolved with the fluctuating conditions of a specific watershed or stream not only behaviorally, but biochemically, physiologically, and morphologically (Table III.1).

Rearing populations tend to prefer relatively deep pools with shelter. Pools created by large woody debris and other ‘roughness elements’ are important for rearing salmonids. For oversummering habitat, coho salmon fry prefer a mixture of different types of pools and riffles with large woody debris, undercut banks, overhanging vegetation, glides, riffles, an average water temperature of 10 to 15 degrees centigrade, and dissolved oxygen near saturation (DFG 1994). Coho tend to utilize estuaries for overwintering habitat.

Life history diversity has been the key to survival for salmonid populations in fluctuating environments and changing habitats. As human-induced changes occur, salmon and trout are confined to increasingly smaller areas of watersheds. The resulting decline in diversity of habitat leaves stocks highly vulnerable to catastrophic environmental events, such as droughts or floods. In order to preserve and recover salmonid species, **habitat diversity** needs to be preserved and restored.



Chinook salmon. Photo taken by the Yurok tribe.

In order to preserve and recover salmonid species, habitat diversity needs to be preserved and restored.

Table III.1: General Habitat Requirements by Salmonid Life Stages

Habitat Needs	Adult Migration and Spawning	Incubation (embryos/ alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Resident species may feed during migration, however most sea-run migratory adults terminate feeding once they enter freshwater	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Larval and adult aquatic and terrestrial invertebrates are the primary food source for most salmonids (about 95%). Yearling steelhead, coho, and cutthroat trout, and resident adults, may eat salmon fry and eggs when available, and other fish smaller than their gape.	Although diet varies by estuary and seasons, smolts may consume larval and juvenile fish and aquatic and terrestrial invertebrates, including crustaceans. A difference among species is, chinook prefer larger organisms and are opportunistic feeders.
Water Quality	Most adult salmonids migrate at temperature less than 14 ^o C; fall chinook migrate when temperatures are substantially warmer. Excess high temperatures may cause outbreaks of disease or low levels of dissolved oxygen (DO). High concentration of suspended sediment may cause spawning salmon runs to be delayed, diverted, or avoided.	Preferred incubation temperatures range from 4.4-14.4 ^o C; alevin stage is generally less temperature sensitive than the embryonic stages, defects and mortality increase at both higher and lower temperatures.. Dissolved oxygen levels must average greater than 8.0mg/L for embryos and alevins, with mortality and defects occurring at lower levels. DO levels are reduced by excessive fines that enter the substrate interstices, limiting available oxygen.	The preferred temperature range for juveniles and resident salmonids is 10-14 ^o C. Except for brief periods temperatures should not exceed 23-25 ^o C . Salmonids should suffer no impairments if DO concentrations remain near 8 mg/L with DO deprivation beginning at about 6 mg/L. Chronically turbid streams (exceeding 70 NTUs) are avoided, however transitory episodes of elevated turbidity have little effect.	Temperature influences the rate of growth and physiological development, also affecting responses to other stimuli. Most migration occurs before stream temperatures reach 11-12 ^o C. Migration can be influenced by human related alterations of thermal regimes. DO levels should be about 8mg/L.
Habitat Structure	Large woody debris, boulders, and deep pool habitats provide hydrological complexity, facilitate temperature stratification and thermal refugia for resting areas; riparian vegetation and large wood needed in shallow reaches to provide refuge from terrestrial predators. Areas of stable, appropriately sized gravel with minimal fine sediments for spawning.	Salmonids require gravels in the 0.6-10.2 cm size range for their redds, with low concentrations of fine sediments (<13% sediments <0.85mm) and organic material. Bedload and bank stability arising from LWD and intact upslope, floodplain or riparian zones minimize the risk of eggs being deposited within the zone of scour and fill. LWD diversifies flow; better protecting redds from the scouring effects of high flows.	Salmonid fry occupy shallow habitats along the margins of streams, moving into deeper and faster water as they increase in size. Habitat complexity in the form of LWD and associated pool habitats, undercut banks, overhanging vegetation, backwaters, and side channels along unconstrained reaches in alluvial floodplains helps provide cover and refuge from predators and storm events. LWD interacting with large boulders or bedrock create specific micro-habitats.	Migratory salmonids tend to use undercut banks, LWD, boulders, floodplains, and side channels as refugia; providing cover from predators and areas for feeding, holding, and resting. Artificial and natural obstructions may impede migration to estuaries where acclimation to salt water occurs.
Flow and Depth	Streamflow must be sufficient to allow passage over physical barriers (falls, cascades, debris jams). Chinook spawning in mainstem can utilize low flows, whereas coho, steelhead, and cutthroat migrate during periods of high flow to reach headwater spawning grounds. Minimum passage depths are approximately 12 cm for cutthroat, 18 cm for steelhead and coho, and 24 cm for chinook.	Salmonids typically deposit eggs within a range of depths and velocities that minimize the risk of desiccation as water level recedes, and which ensure the exchange of water between surface and substrate interstices is adequate to maintain high oxygen levels and remove metabolic wastes from the redd. Typically most species spawn at depths greater than 15 cm, with the exception of cutthroat, which spawn in shallower water.	Salmonids hold in water adjacent to faster waters to maximize food intake while minimizing energy expenditures, because water velocity is proportional to the amount of food delivered to an area. Smaller-sized fish tend to select shallower and slower moving waters. Newly emerged fry typically select velocities <10.0 cm/s to avoid downstream flow displacement. In summer low-flow periods, streamflow must prevent streams from becoming excessively warm or dry.	Streamflows that maintain normal temperature patterns and have short term increases, are important in facilitating downstream migration of salmonid smolts. Rate of smolt migration is correlated to streamflow, however speed of migration is poorly understood.

IV. Watershed Processes and Potential Risks to Anadromous Salmonid Habitat

Salmon and steelhead are dependent upon a high quality freshwater environment at the beginning and end of their life cycle (NCWAP, Mattole 2002). Habitat conditions for salmonids are dictated by watershed processes. Watershed processes have been affected by past and ongoing human activity, and have impacted habitat elements for salmonids.

V. A. Five Watershed Processes

Watershed processes (i.e. sediment transport, heat transfer, and nutrient, wood and water cycling) and watershed elements (e.g.. channel morphology, riparian structure, water quality) form the core of functioning salmonid habitat. Stream channels essentially act as transport systems for **water, sediment, wood, nutrients and heat** which are input into the watershed. In an undisturbed watershed, these processes occur at natural rates that sustain salmonid populations. Human alterations to the landscape of Humboldt Bay watershed have altered natural watershed processes, resulting in environmental changes that are impacting salmonid populations (Higgins, 2001). Below is a brief discussion of watershed processes followed by each watershed product, potential issues, and potential risks in Humboldt Bay watershed.

IV. A. 1. Water

Land use practices affect both summer and winter streamflows. Redwood forests influence the delivery of water to streams, especially during the dry summer months. In foggy, coastal areas, large trees collect water from the fog through the condensation on their leaves (Harr 1982). The resultant water slowly drips onto the ground, where it infiltrates or is used by the tree for transpiration. Fog drip in Humboldt Bay watershed can increase the amount of water available to the stream in drier seasons. Reduction in summer base flow can limit summer rearing habitat for salmonids. Information regarding summer base flow in Humboldt Bay tributaries is limited and it is not known at this time if this is a problem in the watershed.

Studies conducted in the Casper Creek watershed have found no difference in winter peak flows between logged and unlogged watersheds. However, there were significant differences in annual runoff rates (Ziemer 1998).



Table IV.1: Watershed Processes and Potential Impacts to Anadromous Salmonid Habitat Needs

Watershed Process	Potential Causes	Potential Impacts
Sediment Production	Increase in surface erosion, mass wasting shallow landslides, debris torrents, channel erosion	Excessive sediment fills in estuaries, lagoons, spawning gravels, rearing areas, refugia, and rearing pools. Alters invertebrate composition and densities, effects feeding behavior and overwintering survival. Alteration in channel morphology
Large Woody Debris (LWD)	Riparian zones that do not provide adequate future LWD recruitment. Decrease in amount of existing LWD within stream channel. LWD within channel old or legacy pieces near end of life	Lack of rearing habitat for juveniles, cover for spawning adults, decrease in pool formation and sediment sorting, lack of high flow refugia,
Heat Transfer	Inadequate canopy or narrow, ineffective riparian zones to properly shade streams. Shallow water and turbid water heats faster	High summer temperatures in resting, rearing and refugia pools. Poor juvenile growth and survival. This is less of a problem in Humboldt Bay watershed than inland.
Water Cycle	Alterations of watershed hydrology including changes in peak flows, water quality and summer base flows. Access to floodplains and historic habitat, inadequate circulation	Low or high flows can de-water or degrade stream reaches, impede fish migration and access, alter channel conditions, and jeopardize egg and juvenile survival during summer and overwintering.
Nutrient Cycle	Imbalance in food availability for fish, or a lack of carcasses providing vital nutrient inputs to the stream and riparian ecosystems. Excessive nutrient inputs can cause eutrophication, high biological oxygen demand (BOD), eliminate habitat and/or alter food availability.	Anadromous salmon conduct nutrients both to and from the ocean. Excessive nutrients (live stock or treatment facilities) can kill or reduce rearing populations.

Timber harvest can affect the infiltration and flow of water both through changes in the permeability of the soil and by changes in the drainage network. Changes in ground permeability are caused by compaction in harvest areas, or by compaction in the construction of roads. Areas that have been tractor yarded are especially prone to changes in runoff rates. In highly compacted areas, water is unable to enter the ground and tends to flow much more quickly overland to stream channels (Ziemer 1998).

Modifications of the drainage network by roads also increase the rate of water delivery to streams. Roads and associated ditch networks capture water and transport it to stream channels much more quickly than natural drainage routes (FEMAT 1994). The longevity of changes due to roads is as permanent as the road itself (FEMAT 1994). In watersheds on the order of 20-200 square miles, increased peak flows have been detected after road building and clearcutting (FEMAT 1994). Similar increases in peak flows have been noted following urbanization of forested and agricultural lands. Studies of Martin Slough watershed, which drains south Eureka, showed an increase in peak runoff due to urbanization of the watershed and a study being conducted by Winzler and Kelly for Martin Slough will estimate potential changes in hydrology from planned development (Redwood Community Action Agency, 2004). An increase in the frequency and magnitude of floods impacts channel morphology, spawning gravels and redds, bank erosion, riparian condition, and sedimentation.

Urbanization within watersheds decreases infiltration rates by adding large areas of impervious surfaces such as parking lots, roofs, driveways, and roads. This increase in impervious surface results in an increase in volume of surface run-off and peak flows. Research conducted in many geographical areas have concluded that stream degradation occurs at approximately 10-20% Total Impervious Area (<http://www.krisweb.com/watershd/urban.htm>).

Since 1997 residents in Freshwater and Elk Rivers have documented an increase in flood events. A recent assessment (Patenaude 2004) by the Regional Water Quality Control Board showed that the overall channel capacity in Elk River had decreased by 60% since 1965.

IV. A. 2. Sediment



Sediment accumulation in lower Elk River watershed



*Alder trunks buried in sediment in Freshwater Creek watershed
Photo courtesy of the NCRWQCB*

The supply of sediment to stream channels is a natural process, part of the gradual erosion of the landscape (Leopold, Wolman, and Miller 1964). Upland areas supply sediment to streams through slow processes like the erosion of banks of small headwater channels, or more quickly through the mass movement of large quantities of earth in landslides or debris flows (Dunne and Leopold 1978).



Mass wasting event in Elk River watershed. Photo courtesy of PALCO

The removal of vegetation in the watershed can increase the supply of sediment to streams. The amount of bare dirt exposed to rainfall is increased, thus increasing erosion (Ziemer 1998; FEMAT 1994; Spence et al. 1996). Devegetation can also cause an increase in mass movement of sediment (landslides), caused by reduction of root strength binding the soil along with changes in infiltration (Spence et al. 1996). Vegetation removal on small, ephemeral streams may result in increased erosion during storms. Changes in infiltration and drainage patterns from harvesting may alter groundwater flow rates, increasing groundwater discharge and causing erosion of groundwater transport channels (Ziemer 1998). Detailed assessment of landslides, mass wasting, and erosion have been completed in both Freshwater Creek and Elk River by Hart-Crowser for Pacific Lumber Company properties. The data from these studies can be found in the background chapters for Elk River and Freshwater.

Roads can be a major source of increased sediment (FEMAT 1994; Spence et al. 1996). Road networks in many upland areas of the Pacific Northwest are the most important source of management-accelerated delivery of sediment to anadromous fish habitats, which is often much greater than that from all other land management activities combined (FEMAT 1994). The alteration of drainage patterns increases flow velocity and concentrates flow in ditches, where it can cause erosion. Stream crossings are very susceptible to significant erosion, as culverts can become blocked during floods, resulting in crossing failures and erosion (Ziemer 1998). Finally, disruption of drainage networks by roads can result in the concentration of water on unstable slopes, resulting in an increase in the frequency of mass soil movements to the stream channel (Reid and Dunne 1984; Spence et al. 1996).

The effects of increased sediment on fish populations have been well-documented (Spence et al. 1996). Increased levels of fine sediment are detrimental to reproduction, smothering eggs in salmon redds, as well as reducing the amount of living space for aquatic insects, the primary food for juvenile salmonids (Furniss, Roelofs, and Yee 1991). Landslides may not only supply significant quantities of fine sediment, but may also result in

blockages to fish migration and extensive channel changes, with further erosion (Spence et al. 1996).

The increase in sediment production in Humboldt Bay watershed streams due to land use practices is difficult to quantify, especially given variations in natural rates of sediment inputs. Comparisons between Humboldt Bay tributaries and those in undisturbed watersheds show turbidity levels to be orders of magnitude higher for managed streams. While comparing watersheds with physical differences such as geology, size, and slope is a debated practice, the magnitude of the difference in turbidity levels is cause for concern. Both the Elk River and Freshwater Creek have been listed as water quality impaired due to high sediment production by the SWQCB, and the CDFG considers excess sediment to be the major limiting factor to salmonid production in the watershed.

IV. A. 3. Large Woody Debris

Large trees which fall into coastal streams play a dominant role in forming pools, metering sediment, trapping spawning gravels and creating a more complex stream environment. Redwoods are particularly valuable because a large tree may not decay for several hundred years (Kelly et al. 1995). Fir and spruce trees last for several decades while alder and hardwood species rot within a few years of being recruited into the stream (Cedarholm et al. 1997). In general, the larger the size of the wood, the greater its stability in the stream channel. Heavier pieces require higher flows for mobilization and longer pieces are more likely to be caught by the stream bank and its vegetation (Spence et al., 1996). Reeves et al. (1993) found “that wood is a primary element influencing habitat diversity and complexity in streams. Consequences of decreased amounts of wood include loss of cover and structural complexity, decreased availability and abundance of habitat units, and reduced varieties of current velocities and other hydraulic features” (<http://www.krisweb.com/stream/bigwood.htm>).

IV. A. 4. Heat

Temperature is an important element in salmon and steelhead habitat. Pacific salmonid species require cold water. Water temperature tolerance varies somewhat between species and also between life stages. Warm temperatures can reduce fecundity, decrease egg survival, retard growth of fry and smolts, reduce rearing densities, increase susceptibility to disease, and decrease the ability of young salmon and trout to compete with other species for food and to avoid predation (Spence et al. 1996; McCullough



Large Woody Debris survey on Elk River. Photo Courtesy of PALCO



Anchored large woody debris and boulders to enhance complexity in Morrison Gulch a tributary to Jacoby Creek. Photo courtesy of Ross Taylor and Associates

1999).

Much of the data on salmonid temperature tolerance is derived from laboratory experiments that may not reflect survival in streams. Lab experiments expose juvenile fish to varying acclimation temperatures, then raise the water temperature at different rates until 50 percent of the fish die. These tests have established lethal values for coho known as critical thermal maxima (CTM) and upper incipient lethal temperatures (UILT). It has not been established how these values relate to fish stress and mortality in nature. Fish in the wild must forage for food and avoid predation, while in laboratory environments the fish are fed and protected from predators. Stress may occur at lower temperatures in the wild as the fish must cope with all the variables of its environment (McCullough 1999). High temperatures, at this time, do not appear to be an issue in Humboldt Bay Watershed (Dana McCanne, personal communication).



CDFG's Natural Stocks Assessment Project is researching juvenile salmonids' use of the estuary. Above, a fyke net was installed by a CDFG crew in "3rd Slough" just upstream of the Highway 101 bridge to determine if juvenile salmonids move into tidal meanders from the mainstem Freshwater Slough. The result: they do!



The CDFG field crew seining lower Freshwater Slough near the Highway 101 bridge. (Photo courtesy of Mike Wallace of CDFG's NSAP)

IV. A. 5. Nutrients

Scientists have found a positive relationship between the amount of nutrients in the water and primary production (i.e., the growth of algae). Algal blooms stimulated by nutrients are followed by an algal die-off when nutrients are depleted. Settling of dead algae stimulates an increase in biological oxygen demand as populations of micro-organisms expand and consume dead algae. The expanding microbial populations thereby reduce oxygen concentration in the water column which can cause fish kills. Ammonium, nitrate, nitrite, and ortho-phosphates may be potential nutrients of concern in Humboldt Bay watershed; however, information on nutrients in Humboldt Bay tributaries is lacking.

IV. B. Potential Risks to Humboldt Bay Watershed Anadromous Salmonids

Land use practices in the Humboldt Bay watershed have been and are currently impacting salmonid habitat. The loss of this crucial habitat calls for restoration and protection actions. Below, three regions of the watershed are examined and assessed for significant land use practices that have historically or are currently impacting each segment. The categories, 'Lower, Middle, and Upper' Reaches are rough estimates related to both slope changes and land use activities.

IV. B. 1. Lower Reach

Selected Elements of Salmonid Habitat...In a Nutshell

Channel Morphology

Natural stream channels transport water and sediment. The channel cross sectional shape, profile and planform (shape when looking at the channel from high above, including the tightness of bends) are all a function of the channels' basic requirement to transport water and sediment most efficiently (Leopold, Wolman, and Miller 1964). These are also the features that create habitat for salmonid spawning and rearing, including the riffles salmonids use for spawning and the pools they use for cover.

A stream in equilibrium is said to be "at grade" but will respond to any changes in flow or sediment supply. A stream loaded in excess of its capacity will deposit the load. When a stream bed fills in as a result of bedload exceeding capacity it is said to be aggraded. Increases in bedload may make a channel much shallower and wider, which in turn reduces the ability to hold high stream flows and increases flood frequency. Conversely, a stream with reduced bedload supply may have a capacity greater than its load and will down cut in order to increase its bedload, which is called degrading (<http://www.krisweb.com/hydrol/channel.html>).

The spatial distribution of source, transport, and response reaches governs the distribution of potential impacts and recovery times for the stream system. Source reaches are considered to be those with streams with gradients > 20%, transport 4-20%, and response < 4%. (NCWAP Mattole River Basin 2003). In Humboldt Bay watershed the source and transport reaches mainly occur in the forested lands managed for timber production. The response reaches are located in the valley floors which are mainly in rural residential or agricultural production land use.

Natural channels, in response reaches, tend to be dynamic, which means they change location over time. Research indicates that channel migration is important in maintaining natural channel features.

Floodplain

Streams tend to build floodplains which are areas adjacent to the channel that are flooded regularly. In the 1950's, researchers found that the amplitude and frequency of flood events are remarkably consistent among different types and sizes of channels (Leopold, Wolman, and Miller 1964). These floods occur, on average, about every two years. As flow reaches flood stage, water begins to spread out onto the floodplain, reducing velocity within the channel itself. The floodplain thus acts to dissipate energy in the channel during high flow periods.

In altered stream channels, separated from the floodplain, the bed is subject to higher levels of scour and the natural pool and riffle sequence can be disrupted. Constraining channels through rip-rap or straightening disrupts processes that create and maintain the slow migration of the channel across the floodplain and cause degradation of stream habitat (Rosgen 1996). Constraints imposed on stream channels by development in the Humboldt Bay watershed include riprap and bank protection for infrastructure (roads, homes, bridges, railroads, pipelines) and berms and levees for flood protection. The channel of lower Elk River is relatively unconstrained and maintains a natural meander pattern, while a significant section of lower Freshwater Creek has been constricted by levees.

Estuary

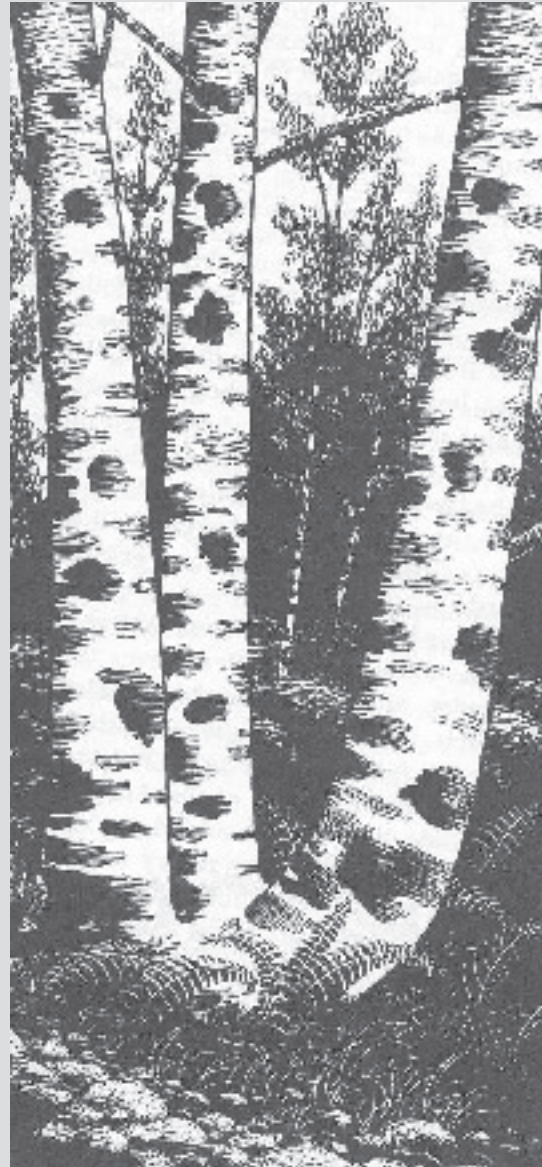
Estuaries are important areas where steelhead and salmon acclimate to the shift in salinity and prepare their internal osmotic balance for going to the ocean as juveniles and returning to spawn as adults. Much of the lowland area surrounding Humboldt Bay was once productive estuary, but today only 10 to 15 percent of this habitat remains.

Riparian Zone

The riparian zone is the area which borders a stream. Riparian vegetation plays a key role in the form and function of streams. Prichard (1998) notes the following functions of healthy riparian areas:

- Dissipation of stream energy associated with high waterflow, thereby reducing erosion and improving water quality;
- Filtration of sediment, capture of bedload, and aiding in floodplain development;
- Improvement of floodwater retention and groundwater recharge;
- Stabilization of streambanks through the development of root mass;
- Development of diverse channel characteristics to provide the habitat diversity and water depth, duration, and temperature necessary for fish production.

The vegetation of fully functional riparian ecosystems in the Pacific Northwest generally consists of large conifers or a mixture of large conifers and hardwoods (FEMAT 1993). These riparian forests are a major source of large woody debris in streams (House and Boehne 1987; Bisson et al. 1987; Sullivan et al. 1987). Riparian vegetation also contributes leaves, twigs, and other forms of fine litter that are an important component of the aquatic ecosystem food base (Vannote et al. 1980).



The estuary, or mouth of streams where freshwater meets salt, is important habitat for many salmonids. Historically, Humboldt Bay estuaries were likely very complex, though today, few backwater areas remain in the watershed. A century of diking creeks to make farmland has destroyed estuarine habitat, leaving little safe haven for rearing salmon.

Salmonid use of habitat in Humboldt Bay estuaries is not well understood. Chinook salmon juveniles, which migrate at an early age to the ocean, spend time in the estuary before going to the open ocean. A study in a coastal Oregon estuary showed that estuarine residence increases chinook survival in the ocean, probably because fish that stay in the estuary longer are larger on entering the ocean (Riemers 1973). Estuaries may also be important to cutthroat. Giger (1972) reported that some juveniles resided over the summer in the Alsea River estuary in Oregon.

The Anadromous Fisheries Resource Assessment and Monitoring Program (AFRAMP) of CDFG has been monitoring the fish assemblage in Freshwater Creek since 2000. All successful returning steelhead adults examined in Freshwater Creek spent at least two years in the freshwater environment as juveniles. Analysis of the outmigrant population in the spring of 2001 found that 90 percent of juvenile emigrants captured were age 1+ (Ricker 2002). The AFRAMP report presented three possibilities: 1) few to zero age 1+ steelhead smoltified and entered the ocean for the cohort that made up the returning 2000-2001 adult run; 2) age 1+ steelhead that enter the ocean suffer zero or very low survival to adult, or 3) this age class of fish is migrating to the lower river/estuary and either residing there for a second year or migrating back upstream to rear until age 2+.

Estuarine habitat in the Humboldt Bay watershed has been greatly reduced through land use practices. Most of the estuary system lacks significant large woody debris and other habitat complexity elements such as pools, backwaters, or side channels. Reduced habitat diversity has made survival more difficult for juvenile salmonids during downstream migration. The decrease in the size and quality of the estuary affects food supply and shelter necessary for adaptation to the salt water environment during rearing. There is high levels of suspended sediment and a lack of clean spawning gravel in the lower watershed. Spawning adults have ceased using lower reaches of the watershed that were once utilized as recently as the 1960s. Because many of the adults are forced to spawn in the main stem, (often lacking significant habitat complexity) incubating salmonids are often exposed to higher flows, resulting

Age Category	Length (inches)
O+ (YOY)	3 or less
1+	3 to 6
2+	6 or greater

Table IV.2: According to accepted fish sampling methods, juvenile salmonids are placed in general age categories according to length. YOY refers to young-of-the year.



McDaniel Slough winding it's way through agricultural land near the mouth of Humboldt Bay. Photo courtesy of Mark Andre, City of Arcata

in redds being washed out.

Poor water quality may impair salmonid feeding habits and growth rates. Many toxic pollutants are regularly washed into the Bay from industrial facilities, storm water systems, and ships, including pentachlorophenol (PCPs), petroleum hydrocarbons, furans, dioxin and others. CDFG recently cataloged 177 pollution outfalls that may affect the Bay (Barnhart, Boyd, and Pequegnat 1992). These pollutants can cause serious impacts on human and wildlife that depend on the Bay. Some of the cataloged chemicals are known to accumulate in the tissues of humans, steelhead and shellfish, with the level of compounds carried in a body increasing each time an organism is ingested further along the food chain (known as bioaccumulation). As these chemicals accumulate, a person risks developmental, reproductive, and immunological problems.

IV. B. 2. Middle Reach

The middle reaches of Humboldt Bay watershed streams are the regions most utilized for salmonid rearing habitat. AFRAMP's 2001 downstream migrant trapping for Freshwater Creek results indicated that the majority of salmonid production originated from the mainstem. An estimated 87 percent of the steelhead migrating from Freshwater Creek originated from the main stem section between tributary traps and the lower main stem trap, leaving the remaining 17 percent attributed to tributary production. An estimated 48 percent of all coho salmon smolts migrated from the tributaries (Ricker 2001).

The middle reach is where salmon spend much of their juvenile stage. Rearing habitat is crucial for fish emerging from gravels and moving downstream into the mainstem, especially in summer low flows, when in this watershed the upper reaches become ephemeral and inaccessible. Salmonid juveniles need an abundance of food and cover to sustain fast growth rates, escape predators, and avoid premature displacement downstream to the ocean. These conditions determine the survival of outmigrating fish.

The middle reach of the Humboldt Bay watershed is characterized as mostly residential and has had extensive riparian vegetation removal along its tributaries. Riparian vegetation extraction has greatly diminished salmonid habitat. Riparian cover is important for maintaining low water temperatures, especially in the summer months. Removal of riparian vegetation has resulted in temperature spikes and lack of large woody debris recruitment.

Watershed streams are leveed throughout much of their middle reaches and are now separated from their floodplains. Municipal development has altered channels in both Eureka and Arcata.

There are high concentrations of suspended sediment in the middle reach. Both the high levels of suspended sediment and the lack of clean spawning gravels cause the suffocation of embryos and alevins. Turbidity monitoring in the middle watershed measured high turbidity levels for most of the winter, potentially affecting juvenile salmonids.

Flow has not been found to be a significant problem in Freshwater Creek with regards to rearing habitat. However, low flows may affect migration by creating barriers to fish passage.

Lack of deep pools in the middle reach due to aggradation and limited in-stream structure may decrease the amount of suitable habitat for rearing juveniles and residents. Habitat surveys conducted by PALCO show a decrease in the number of deep pools and depth of remaining pools. Adult fish held in the Humboldt Fish Action Council weir on Freshwater Creek reportedly died due to low dissolved oxygen (DO) levels. Decreased DO levels may be a limiting factor during summer low flow.

IV. B. 3. Upper Reach

Land use in the upper watershed is dominated by industrial timber production. The upper area of the watershed is where the most active logging and road building has taken place and where most sediment in the system is delivered. The upper reaches also contribute most of the large wood into the channel system because the lower reaches no longer produce large woody debris.

Tributaries to the main stem increase in gradient in the upper watershed and limit anadromous migration due to steepness. Rearing and spawning is limited in the steep upper reaches. Suitable rearing habitat exists in the transition zone between the upper and middle reaches. The seasonal intermittent and low flows result in reduction of spawning utilization in the upper tributaries.

The construction of roads in the upper watershed created many fish passage barriers at stream crossings. During early development of roads, fish passage was seldom considered and crossings were constructed right in the streambed. Culverts placed at stream crossings also present a fish passage problem. Typical passage problems created by culverts include excessive drop at outlet

(too high of entry jump required); excessive velocities within culvert; lack of depth within culvert; excessive velocity and/or turbulence at culvert inlet; and debris accumulation at culvert inlet and/or within culvert. Even if culverts are eventually negotiated, excess energy expended by fish may result in their death prior to spawning. Migrating fish concentrated in pools and stream reaches below culverts are also more vulnerable to predation by birds, otters, and humans. Culverts which impede adult passage limit the distribution of spawning, often resulting in underseeded headwaters and superimposition of redds in lower stream reaches (Taylor 1999).

IV. C. Cumulative Watershed Effects in Humboldt Bay Watershed

Cumulative impacts are defined as “...the impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonably foreseeable future actions regardless of what agency (Federal or non-Federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time.” (CEQ Guidelines, 40CFR 1508.7, issued 23 April 1971.)

“Cumulative watershed effects” was not formally defined by the Council on Environmental Quality (CEQ), but in this document the term refers to cumulative effects that involve watershed processes (specifically, those cumulative impacts that influence or are influenced by the flow of water through a watershed). Such impacts may include: degraded water quality, reduced viability of aquatic and riparian species, nuisance flooding, and damage to recreational and residential properties. Because almost all watershed impacts are influenced by multiple activities, those impacts must be evaluated as cumulative rather than individual (Reid 1999).

Quantification and regulation of CWEs has been a topic of debate for many years in Humboldt Bay watershed. The last five years have seen increasing efforts to quantify and correlate cumulative effects of sediment discharge on channel aggradation, turbidity, and salmon viability, in an attempt to determine appropriate rates and approaches to timber harvest, agriculture, and other land use activities. Other watershed factors, such as traffic on unpaved roads, riparian vegetation changes, residential development, legacy effects, levee construction, separation of the stream from

the floodplain, and historic removal of LWD are also important contributors to CWE related to sediment impairment and viability of salmonid populations. Influences beyond the watershed that also contribute to the impacts of concern include results of bay and estuary management, commercial fishing, and hatchery competition.

Factors such as weather patterns, ocean conditions, tidal influences, and the inherent instability of underlying geologies are fundamental, and must always be accounted for in assessing cumulative risks.

Almost all off-site environmental impacts are cumulative impacts. The word “cumulative” indicates that the impact is influenced by multiple activities. Cumulative watershed impacts are of considerable concern because they are responsible for much of the damage to property and to public trust resources that occurs away from the site of a land-use activity (Reid 1999). Because impacts can accumulate through time and space, they may take a long time to become evident, and they may occur a long distance from the activities that generate them (Reid 1999).

Humboldt Bay watershed water quality and fisheries habitat has been and still is impacted by multiple land-use activities that have changed the amounts, delivery rates, and transportation rates of watershed products – sediment, water, and woody debris. Changes in these watershed products are the most common causes for downstream cumulative impacts.

The initial removal of all of the old-growth forest in the watershed resulted in impacts including unprecedented increases in sediment in the stream channels. The canopy of these forests held millions of gallons of water in their foliage, branches, and trunks over the ground layer, creating local microclimates, which buffered the forest floor from temperature extremes. Within the stream zone, large old-growth tree trunks defended streambanks from erosion, defined stream channels, and created deep pools in the stream which protected fish and other aquatic organisms from predators (Murray and Wunner 1988).

Humboldt Bay watershed has been impacted by increased sediment inputs, primarily generated by timber harvest activities on steep, unstable slopes in the upper watershed. Additional land uses such as riparian removal, road and levee construction, residential encroachment, removal of LWD from the stream and herbicide use in the Humboldt Bay watershed contribute to cumulative watershed

effects. Other factors contributing to CWE are past over-fishing, poor ocean conditions, erosive geology, hatchery introductions and mixed stock. Cumulative impacts from increase in sediment loads in Humboldt Bay watershed includes modification of the estuary system; reduction of channel conveyance and aggravation of flood hazard; infilling of channel pool habitat; and water quality degradation. Forests influence runoff by intercepting and evaporating rainfall before it hits the ground. Data from Caspar Creek, California (Ziemer 1998, Reid 1999) show that logging of this second-growth redwood forest has increased flood peaks in completely clearcut watersheds by an average of 27 percent, and that the effect is proportional to the amount of forest cover removed in the watershed. Impervious surfaces caused by logging, road building, and urbanization affect runoff rates, which lead to increased stream flow, and quicker responses to storm events (Tuttle, 1985).

Cumulative impacts of water withdrawal can result in lack of summer rearing habitat for juvenile salmonids, especially in drought periods.

Due to the fragile geology of Humboldt Bay watersheds, particularly in Elk River and Freshwater Creek watershed, naturally occurring events need to be considered when determining other land uses, which individually and combined, may contribute to limiting factors affecting salmonid habitat and therefore populations. Cumulative impacts affect watershed processes, which in turn affect fish species differently depending on life stage requirements.

V. Detailed Sub-watershed Information

The following section includes a compilation of relevant information found for each sub-watershed detailing historic and current watershed conditions and separated into lower, middle and upper reaches. Based on the collected information and expert input, the potential factors limiting recovery of anadromous salmonids were identified. From those, goals and objectives for each sub-watershed were developed and are found in Section VI of this document.

From north to south the main tributary streams of Humboldt Bay are Jacoby Creek, Freshwater Creek, Elk River, and Salmon Creek. These sub-watersheds have unique attributes and opportunities and challenges which distinguish them from one another. Information compiled is different for each watershed, as varying data and information was available for each sub-watershed depending upon the amount of research and attention each watershed has received, and depending on what types of landowners, businesses and programs are operating in each watershed. Freshwater Creek, for instance, has much more fish population data because the Humboldt Fish Action Council (HFAC) has a weir in the watershed and a monitoring program (now run by CDFG's AFRAMP). Additionally, much research and monitoring has occurred in the Freshwater Creek and Elk River watersheds due to listing with the State Water Resources Control Board (SWRCB) as sediment impaired watersheds. Commercial timber companies such as Pacific Lumber Company (PALCO) and Green Diamond Resource Company also provide data from their ongoing trends monitoring projects and additional research.

V. A. Jacoby Creek Watershed Overview

The Jacoby Creek watershed is part of the Northern California Coast Ranges, located between Arcata and Eureka. Twenty-six miles of perennial waterways and 49.8 miles of intermittent tributaries (Johnson 1972) drain the 16.6 square mile (13,017 acres) Jacoby Creek watershed into the northeastern portion of Humboldt Bay, near the Arcata Marsh. The main stream channel is 11.1 miles long, and is a fifth order stream. First and second order streams contribute to most of the stream mileage in this basin. The watershed is roughly rectangular in shape, approximately 9 miles long and 2 miles wide, and oriented in a northwesterly direction. The elevation ranges from sea level to 2388 feet at Boynton Prairie. Jacoby Creek's tidal marshes and lowland grass at the

mouth of the watershed provide abundant habitat for migratory waterfowl and shorebirds (Tuttle 1985). The riparian vegetation is suitable habitat for many amphibians, mammals, and birds. The upland forests provide abundant cover and habitat for a variety of mammalian and avian species, and the ridge top prairies provide adequate forage for migratory ungulates and birds. Plant communities which are native to the Jacoby Creek watershed are as follows: northern coastal salt marsh, north coast riparian scrub, north coastal coniferous forest, redwood forest, Douglas fir hardwood mixed evergreen forest, and Bald Hills prairie (Murray and Wunner 1988).

V. A. 1. Geology

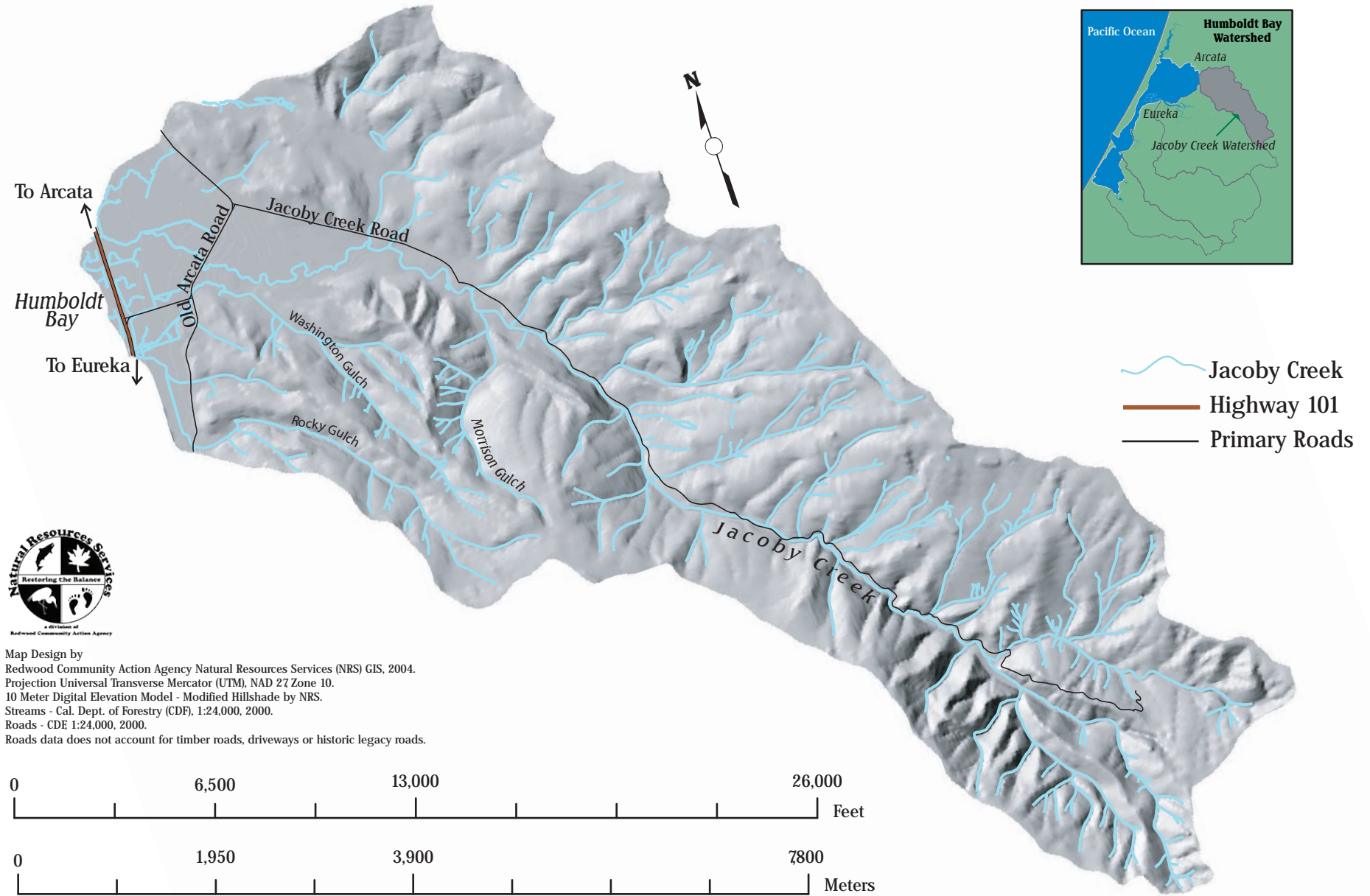
The Jacoby Creek watershed is located in a geological formation known as the central terrane. The central terrane is largely melange composed of abundant greywacke and metagreywacke, with large blocks of chert, greenstone, serpentinite and high-grade blue-schist. These geologic formations are highly susceptible to erosion and mass wasting. The upper hill slopes consist largely of Franciscan Melange and sandstones (Lehre et al. 1985; Adams, Machado, and Schyr 1996).

The geomorphologic relationship between uplift and erosion is out of balance in the Jacoby Creek drainage. According to Lehre and Carver (1985), uplift is occurring much faster than soil erosion resulting in unstable slopes as Fickle Hill (the north-eastern ridge) grows in size and relief. Both over steepened slopes and saturated soil conditions are principle contributors to soils instability and landslides, and will likely increase in the future, if exacerbated by land use activities (Adams, Machado, and Schyr 1996).

V. A. 2. Land Use

Land use designation (Humboldt County General Plan) in Jacoby Creek includes approximately 70 percent timber production lands and 26 percent residential (General Plan 1982). Although some residential development has occurred in the uplands, these areas are mainly in timber production. Developed on sedimentary deposits and Franciscan Melange, these slopes are highly productive timber-growing areas. Approximately two-thirds of the timberland is owned by industrial timber companies, including Green Diamond Resource Company and Sierra Pacific Industries.

Figure V.1: Jacoby Creek Watershed



Map Design by
Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
10 Meter Digital Elevation Model - Modified Hillshade by NRS.
Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
Roads - CDF 1:24,000, 2000.
Roads data does not account for timber roads, driveways or historic legacy roads.

Land Use Category	Acres	% of Watershed Area
Timberland	7288	67.2
Residential	2805	25.7
Agriculture	753	6.9
TOTAL	10,847	100

Table V.1: Land use within Jacoby Creek Watershed (Source: Humboldt County Tax Assessor Parcel Maps, 1995)

The proximity of the Jacoby Creek watershed to the cities of Arcata and Eureka, and the area's natural beauty make it a prime residential location. Residential development in the watershed exists as clusters along the lower slopes within the Bayside community and within the floodplains along Jacoby Creek Road and Old Arcata Road. Rural residential land use is increasing along Greenwood Heights Drive along the southern ridge of the watershed and Fickle Hill on the northern rim.

A 1980 census by the Humboldt County Planning Department recorded 2,036 people and 732 housing units in the watershed. The maximum allowable population and number of housing units based upon the 1982 zoning, would permit an additional 2,915 residents and 1,048 housing units based upon a lot size of 6,000 square feet. With increasing growth, failing septic systems and surface water contamination have been documented in portions of the watershed. This has led to a state imposed Waiver Prohibition on new septic systems in the watershed, meaning that waivers can not be provided by the County of Humboldt Environmental Health Department and the septic system must meet a specific standard.

Small commercial land use in the watershed is located mainly along Old Arcata Road, in Bayside. Until 2004, the western portion of the watershed, between Old Arcata Road and Highway 101, supported commercial ranching activity. This area was purchased by the City of Arcata with funds from the Wildlife Conservation Board and the State Coastal Conservancy and will continue to be managed for agriculture and natural resources. Most of the land previously utilized for agricultural has been extensively subdivided and is under numerous ownerships, however the soils are capable of producing truck crops for supplementary or subsistence income farms. The valley's alluvial deposits provide quality agricultural soil, approximately 753 acres of which today support some grazing and small truck farms. There is one active quarry within Jacoby Creek watershed owned by the City of Arcata. The quarry is

located on Jacoby Creek Road just east of the confluence on Rebel Creek.

The majority of land within the Jacoby Creek watershed is under the jurisdiction of Humboldt County. Land-use and development are guided by the Humboldt County General Plan and the Jacoby Creek Community Plan (last updated in 1982). The General Plan update process has produced new GIS land use data and will include an update of the Jacoby Creek Community Plan. See Table V.I for the current land use figures for the Jacoby Creek watershed.

In 2001, the CDFG developed a Land Acquisition Evaluation (LAE) for the watershed in cooperation with the City of Arcata and Jacoby Creek Land Trust. The LAE identifies and facilitates funding for conservation easements or fee title purchase with Wildlife Conservation Board monies. In 2001, the City of Arcata acquired an additional 331 acre tract of forest land which is adjacent to their existing Jacoby Creek Forest in the upper watershed. As of July 2002, 511 acres have been purchased for habitat protection with another 412 acres pending purchase by the Jacoby Creek Land Trust (JCLT) and the City of Arcata. The additional lands will be managed primarily for fish and wildlife habitat, public access, agriculture and low impact timber harvest.

V. A. 3. Salmonid Distribution (Summary of Existing Salmonid and Salmonid Habitat Data)

Jacoby Creek is home to coho and chinook salmon along with steelhead, cutthroat trout, and resident trout. The anadromous reach ends 5.5 miles up from the mouth at the “falls” on the mainstem. The main tributaries used by fish are: Golf Course Creek, Morrison Gulch (also known as Cascade Creek) and an unnamed creek tributary approximately four miles up on the north side of Jacoby Creek, locally known as Steep Creek.

Jacoby Creek and some of the lower tributaries are current and historic spawning grounds for steelhead trout and coho, and chinook. Although coho were present in Morrison Gulch the 2001 barrier removal near the confluence with Jacoby Creek has improved coho production in that tributary.

V. A. 3.1 Fish Surveys

Electrofishing

In September of 1996, the CDFG conducted an electrofishing survey of the anadromous juvenile salmonid population in

Jacoby Creek to determine the presence or absence of juvenile fish in the summer and fall months. It was the first year (1996) of quantitative sampling to compare coho and steelhead spawning success by measuring young of the year production, and also carry over production (Larry Preston, personal communication 2001). CDFG sampled four sites beginning upstream from the Old Arcata Road bridge and ending below the gauging station. The sampling produced 189 steelhead, 33 coho, 6 sculpin, 29 stickleback, and 6 Pacific lamprey.

In May of 1999 another electrofishing survey in the headwaters from 162.5 feet to 738 feet upstream of “the Falls”, found 22 resident rainbow and cutthroat trout ranging in length from 1.6 inches to 7.5 inches. Later studies by Redwood Sciences Laboratory have shown that all trout above the falls appear to be rainbow.

A May 1988 electrofishing survey from Brookwood Drive to the end of Quarry Road produced 6 stickleback, 28 coho, 5 steelhead, and 2 lamprey (CDFG 1988).

Spawner Surveys

A CDFG spawner survey from 0-7600 meters on Jacoby Creek during the 1997/1998 season found 3 redds, one of them a coho redd, one live coho salmon, and two steelhead carcasses (CDFG 1998). (The survey area was split into seven reaches and each reach was surveyed on 6 different dates).

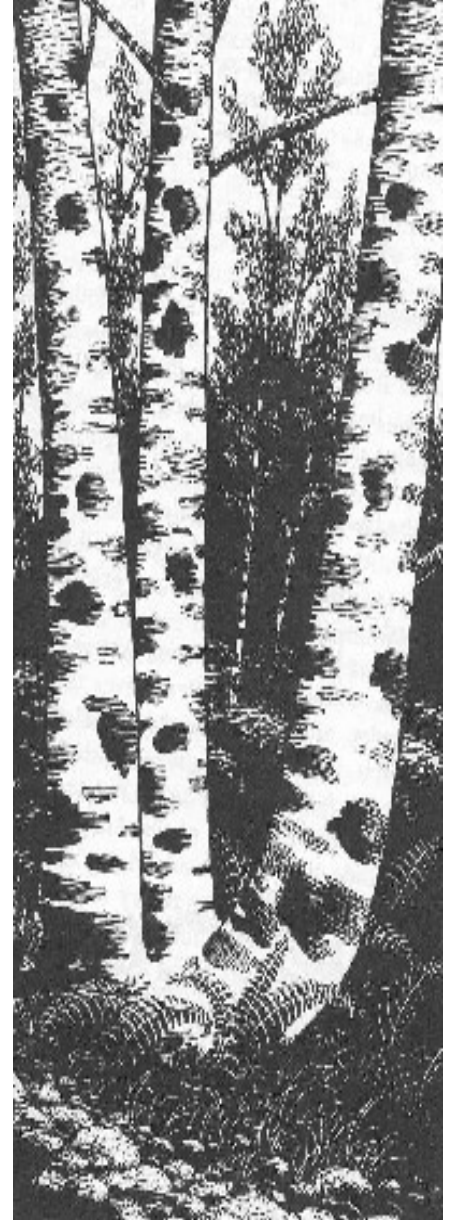
During the 1977/1978 spawning season, 123 adult coho and 217 adult steelhead were counted coming upstream. Downstream coho smolts enumerated the same year at 5,000 (CDFG 1978).

Mark and Recapture

Upstream migration of salmonids was monitored during the 1977-78 season on Jacoby Creek using a weir and trap located one quarter mile upstream from Humboldt Bay. The fish were caught, tagged and released on their way upstream, then recaptured upstream using electrofishing equipment. The purpose of the study was a salmonid population estimate, using ratios of tagged to untagged fish. Population estimates for coho was 123 (plus or minus 41) and for steelhead 217 (plus or minus 95). A Chinook smolt was also caught at the fish trap (Harper 1980).

V. A. 3.2 Habitat Surveys

In 1987, RCAA completed a habitat survey with funds from CDFG (CDFG protocols had not yet been established for habitat typing).



The habitat inventory shows the dominant habitat types of the main stem of Jacoby Creek and the percentage of those habitat types (Table V.2). The study plot was 11,390 meters of stream beginning at the mouth.

Habitat Type	Percentage of Area Surveyed
Runs	50%
Riffles	21%
Pools	29%

Table V.2: Jacoby Creek Habitat Types (RCAA 1987)

Results show that runs were the predominant habitat type found in the study area, indicating a simplified change, probably due to upstream land management activities. Instream cover for fish was not rated in this survey, however general observations and a previous study (Murray and Wunner 1980) indicated a lack of instream cover for all habitat types.

Rating	Percent Cobble Embeddedness
1	0-25%
2	26-50%
3	51-75%
4	76-100%
5	unsuitable for spawning

Table V.3: Percent Cobble Embeddedness Ratings for Salmonid Spawning Habitat

In 1996, Humboldt Fish Action Council (HFAC) “habitat typed” the stream using protocols from the CDFG’s *California Salmonid Stream Habitat Restoration Manual*. The total length of stream surveyed was 27,865 feet with additional 3,714 feet of side channel. The following information is from the *Jacoby Creek Stream Inventory Report* by HFAC, produced from their 1996 study results. See the report (available at RCAA) for more detailed information.

The stream had a suspended sediment load averaging 60% silt/clay, 40% sand, and a largely gravel bedload. Jacoby Creek channel types (Rosgen) include F4 (entrenched, meandering, riffle/pool channel on low gradients with high width/depth ratios and gravel dominant substrate), F2 (same as F4 but with boulder dominant substrate), A2 (steep, narrow, cascading, step-pool streams with high energy/debris transport).

Habitat composition included - flat water 48%, riffles 11% and pools 37%. The pools were shallow with only 22% of pools deeper than two feet.

One-hundred and fifteen of the 223 pool-tail-outs (where salmon build their redds) had embeddedness ratings of 3, 4, or 5. None had a 1 rating.

The low gradient riffles, which also provide spawning habitat, were found to be in generally good condition.

Pool shelter ratings were low – meaning cover for fish is limited. The amount of cover that existed was provided by small and large woody debris. The percent canopy cover for the stream channel was 63%, which is considered to be moderate cover. The majority of riparian vegetation was brush (54%) with coniferous trees accounting for only 13%.

A habitat survey conducted in 2004 (Cole and Barnes) identified potential limiting factors for existing coho salmon in the lower reach of the watershed. These factors included the lack of large wood (particularly conifers), low habitat complexity, and lack of connectivity to side and backwater channel habitat; consistent with effects from logging or other land management activities.

Berms running parallel to the stream and retaining walls on the south side of the creek have disconnected it from its floodplain along almost its entire length in this reach. Structures have often been built well within the floodplain, as close as ten feet from the active channel. The reach has virtually no instream shelter, save for the roots of one large legacy spruce growing within the channel. Banks are steep and well vegetated with alder and willow, as well as abundant non-natives planted by landowners. The gradient is low, nearly flat because of the lack of roughness elements, and spawning habitat is marginal or non-existent, due to the generally small size of substrate found here. Whatever small wood debris that is allowed to accumulate is prone to being washed out of the system at higher flows, if not removed by landowners first. The old alders and willows provide good canopy, as do the smaller trees; however, presently there is no source of coniferous LWD in the stream due to past logging activities. Pools were by far the dominant habitat type, comprising approximately 2,130 feet out of a 2200 foot reach (97 percent). The rest was low gradient riffle with gravel substrate. The maximum depth noted was about 3.5 feet. Very little instream cover was associated with the pools, but good overhead cover, at least 90 percent (not measured). The dominant substrate in pools was gravel and sand. Young of the year fish were observed which were most likely steelhead.

Historic Human Footprint and Conditions in Jacoby Creek Watershed

According to living Wiyot tribal representatives and archeological evidence, the Wiyot Indians have inhabited the Jacoby Creek region for thousands of years. The Wiyot territory extended from Little River north of the City of Arcata and Humboldt Bay to the Bear River Mountains south of the City of Ferndale.

The marshy nature of the shoreline between the Cities of Arcata and Eureka prevented the development of large settlements, but the canoe inlet at the mouth of Jacoby Creek provided access to three minor village sites noted to have been present around 1856 (Loud 1918). One site near the creek mouth was used during the salmon fishing season.

The route of Old Arcata Road, a major present day connector between Arcata and Eureka, follows a historical Wiyot trail which skirted the inland edge of the marshy lowlands around Arcata Bay connecting several Wiyot camps.

The decades of the 1850s and 1860s saw a gradual filtering of settlers into the Bayside area of the watershed. In April of 1850 settlers from San Francisco staked out the towns of Union (later named Arcata) and Eureka. In 1854 a wharf was constructed across the tidal flats, connecting Arcata to the Humboldt Bay, to serve ships bringing mining supplies from San Francisco.

For the first ten or twenty years of settlement in the watershed, farmers mostly settled in the current vicinity of Bayside, versus the heavily brushed and wooded areas within the valley of the watershed. As logging activity increased, first along Washington Creek, the first area in Humboldt Bay to be logged and then Jacoby Creek, the readily available cheap land, now cleared of timber, prompted many

Henry Stern and Winters went fishing to Jacoby Creek last Friday. Trout? We should say so. They brought back their baskets and pockets full of them (Arcata Union, 6 Aug. 1887).

logging men to establish small homesteads. Most homesteaders were single men who spent most of their time at work in the logging industry. When the rainy season started however, logging often came to a halt, and the men would concentrate instead on clearing their lands and building their homes (Schafran 1984). These recently logged sites were repeatedly burned and seeded with grasses by the homesteaders. This practice favored the reestablishment of redwood trees over other tree species because of the ability of redwood seedlings, saplings, and stumps to sprout after fires (Noss 2000). As logging camps were relocated, homesteads and pasturelands were created in their wake.

Wildlife in Jacoby Creek

James Beith Jr.'s 1887 account of Jacoby Creek in 1855 also noted wildlife present at arrival of the first European settlers. According to his observations, this bottom was the natural home of the elk, deer and bear, and up to 1860, they roamed in almost undisturbed abandon. "The stream was filled with speckled beauties, and the salmon--in season--crowded in thousands up this silvery pathway."

A 1973 CDFG report discusses and lists species of birds and mammals found in the region. Wildlife found in the region were no doubt more abundant historically, but represent the species that still exist. The list includes bear, mountain lion, beaver, gray fox, coyote, bobcat, ringtail cat, raccoon, striped skunk, mink, weasel, badger, blacktail jack rabbit, brush rabbit, gray squirrel, flying squirrel, chickaree, pine marten, fisher and many other rodents and small mammals that occupy various habitat types. Land birds, raptors, waterfowl and shorebirds abound throughout the entire bay region.

Between 1941 and 1978 the Jacoby Creek watershed experienced continued growth and overall residential development trends showed a five-fold increase in the watershed from 1970 to 1982. The City of Arcata has recently produced Geographical Information Systems (GIS) maps and graphics that show historic development patterns in land use from 1850 to the present.

Timber Harvest

Timber harvesting, first of fir and spruce, and later of redwood (redwoods were initially a nuisance until equipment was designed to handle and mill the immense trees) began in the Eureka region in the 1850s. By the 1870s timber harvesting reached the Jacoby Creek watershed. The Dolbeer and Carson Mill was established at Bayside Cutoff to work the Washington Creek and Rocky Gulch claims, and in 1875 the first of two railroads in the Jacoby Creek watershed was constructed to bring logs and shingle bolts from the forest to tidewater. In 1881, about two million feet of logs were transported over the Dolbeer and Carson Railroad (Elliot 1881). At the time (1881) two big companies were logging in Jacoby Creek at comparable levels totaling a conservative estimate of at least three million board feet (bd. ft.) a year. When the Jacoby Creek railroad was contemplated, its owners predicted that 8,000,000 bd. ft. would be transported the following year (*Weekly Humboldt Times* 10 Dec. 1881). A single redwood cut on George and Skiffington Carson's claim in the Indianola area scaled 50,000 bd. ft. (*West Coast Signal* 13 Oct. 1875). Late in the season, the Carsons hoped to get several million more feet to tide water before weather halted operations (*West Coast Signal* 3 Nov. 1875). On this same claim, the newspaper reported that the logging firm was "making sad havoc", having cut one thousand redwood trees in less than six months (*West Coast Signal* 3 May 1876).

Ferndale Enterprise (4 June 1915) - Seventy-thousand steelhead fry, the last shipment for distribution in the streams flowing into Humboldt Bay, were received Monday afternoon from the Price Creek hatchery for distribution in Elk River. This shipment is the last of 420,000 steelhead to be planted this year in Jacoby Creek, Elk River and Freshwater. About 500,000 salmon fry were received and distributed in the three streams earlier in the spring.

In 1876, the Flanigan and Brosnan Shingle Mill at Bayside was established, and in 1880 the company constructed a railroad along the north side of Jacoby Creek. Logs were brought to a log dump and trestle extending into the Gannon Slough, from which they were towed to mill in Eureka.

As the stands in the lower regions of the canyon were depleted, logging moved further up the gulches and slopes. The Flanigan and Brosnan Railroad was eventually extended approximately 10 miles (16 km) upstream. The peak of the early logging activity appears to have occurred between the 1880s and 1910, with apparent exhaustion of the easily accessible timber supply by 1920 (Tuttle 1985).

Agriculture

With the establishment of logging operations in the 1870s and 1880s at Freshwater and Jacoby Creeks, loggers flooded into the area. At Bayside, houses, mills, stores and schools sprang up to accommodate the increasing population. Fresh vegetables, dairy products, fruit and meat were in demand at the lumber camp cookhouses.

The small enterprise farmer, dairyman and rancher found it profitable to expand onto the timberlands being cleared of trees. The salt marshes continued to be diked off and drained and the land re-seeded with forage for dairy cows. In 1860, neither farming nor logging was taking place to any degree in the Jacoby Creek, Washington Gulch or Rocky Gulch areas. By 1880, farming in Jacoby Creek was

taking hold with oats and potatoes being the mainstay. Gradually cows began to take their place on local farms. By 1892 there was sufficient dairy production on the bottoms that a creamery was built. Farmers from Jacoby Creek began bringing in their milk to that creamery. Jacoby Creek's last dairy, the Freitas dairy, went out of business in 2000 selling its 62 acres to the Jacoby Creek Land Trust in 2001. Valley farming today consists of truck gardens and pasture for family livestock.

While logging certainly has been the dominant landscape altering activity in the Jacoby Creek watershed, diking to reclaim the bay's marshes was most significant factor in the modification of the Creek's lower hydrology and ecological integrity (Van Kirk 2002). The earliest effective barrier of tidewater flows into these marshlands, was a dike built in the 1890s. It ran from Butcher Slough to the railroad, then to the drawbridge at Gannon slough, to the mouth of Jacoby Creek, and up the bank of the creek until it was beyond the tidal influence. The next large barrier was a section of the California and Northern Railroad running between Arcata and Eureka along the northeast side of Humboldt Bay. Operation of this section of the railroad began on December 14, 1901. The raised embankment upon which the tracks were laid acted as a dike, although there were many times when exceedingly high tides or storm-whipped waters crested the rail bed (Schafran 1984).

Salmon in great numbers have been finding their way from the bay into Jacoby Creek for a week or more past. The fish are in search of spawning grounds, and are being captured by the boatload near the mouth of the creek (Arcata Union, 12 Jan. 1889).

Road Building

With the settlement of Euro-Americans, the Wiyot trail around the bay marshlands became a wagon road with primitive homesteads scattered along its length. This road became the present-day Old Arcata Road. In 1910, the Eureka and Freshwater Investment Company graveled the section of road between Bayside and Ryan's Slough. Several new bridges were constructed at the time as well. In 1918, construction began on the Eureka-Arcata stretch of U.S. 101, with grading and filling operations requiring several years to complete. By 1921, the road was graveled, but it was another four years before it was paved and opened to traffic in March 1925. After Highway 101 was completed, the old wagon road and planked boardwalk connecting Old Arcata Road at Bayside to the California and Northern Railway station at the bay, was improved and became the Bayside Cutoff. The railway station and the planked boardwalk have long since disappeared. Highway 101 between Eureka and Arcata parallels the railroad, and like the railroad its raised bed acts as a levee to further hold back the water of the bay.

Estuary Lands

The Jacoby Creek estuary covered a much larger area prior to Euro-American settlement, according to topographic and historical maps, northcoast estuary studies, and early settlers' accounts. According to these sources, the estuary began at least at the present location of Old Arcata Road at the mouth of the Jacoby Creek valley, and continued out to the bay. The estuary was connected with Rocky Gulch and Washington to the south and Beith Creek to the north. There were significant amounts of large woody debris, backwater channels, and tidal marshlands within the estuary. This provided excellent habitat for salmonid smolts on their way to the ocean. The estuarine area provided rich fishing grounds for the Wiyot people and later for Euro-American settlers.

Since Wiyot Indians were not recognized as owners of the land, “swamp and overflow lands” were sold by the government on the condition that the land is improved for agricultural purposes. Tidal marshes were considered an eyesore and valueless. By 1853, the same year that the Jacoby’s filed for their land, most of these lands were claimed for agriculture. Some bends, meanders and side channels were cut off by construction of the levees and dikes. For example, the Washington Gulch creek was cut off from the Jacoby Creek wetlands by being rerouted along the southwest side of an embankment built in 1875 by the Dolbeer and Carson Lumber Company for it’s railroad which ran from Washington Gulch to the Bay. This embankment later became the Bayside cutoff.

After completion of the diking (413 acres reclaimed), the landowners went to the Board of Supervisors to request organization of a reclamation district. Those requesting the district were holders of title to more than half of this body of swamp and overflowed lands.

Vegetation of Pre-European Jacoby Creek Watershed

Fire disturbance was infrequent in moist coastal stands, and the forest was mostly made up of shade-tolerant species that successfully reproduce in the absence of disturbance. On lowland alluvial sites, redwoods reached their greatest size, height, and age. Moving inland and up the hill-slopes toward the ridges, the redwood forests changed in composition and size perceptively. Increasing numbers of Douglas fir shared the canopy with redwood. Trees on ridges and interior hill-slopes were typically not as tall or long lived as those at lower, more moist and protected sites.

Redwoods grow best in deep, well-drained soils with a favorable moisture balance. Where Jacoby Creek approached Humboldt Bay the redwood forest gave way to more salt tolerant trees, especially Sitka spruce and red alder. Spruce and alder, along with willows, maples and cottonwoods, most likely dominated the Jacoby Creek valley bottom near the bay where soils remained water logged for much of the year (Roy 1966).

In the fall of 1887, James Beith Jr., a native of Scotland and early settler on Beith Creek, wrote a series of articles called “Local Resources, Jacoby Creek” that appeared in the Arcata Union. Paper No. 1 described Jacoby Creek as Beith first saw it on his arrival in 1855.

Twenty years ago the broad area of bottom land was crossed by the present wagon road. This undertaking created a desire for settlement. The land was covered by a dense growth of underbrush; tall spruce trees of giant dimensions reared their stately heads over the jungle, the branches straight and needle covered, reaching almost to the ground, alder, ash, willow, maple and pepperwood, royally draped in a close and shimmering emerald foliage, flung a roof over all, forming a natural conservatory. The soil was moist and yielding, even to the summer months and in winter a swamp almost impossible to cross. This natural condition prevailed over the entire bottom, with two trifling exceptions- a small opening about the center and another small patch opposite Mr. Foltz’s house. Both openings were covered with hazel and wild rose, the former utilized by the Indians as a food supply, while the latter shed around the luster of its beauty and filled the air with the fragrance of its odors. (Arcata Union, 5 November, 1887)

V. A. 4. Restoration and Conservation Efforts

Because of the considerable efforts of the City of Arcata, JCLT, and community support for conservation, the watershed has one of the best chances for salmonid recovery in Humboldt Bay watershed (CDFG 2004).

Morrison Gulch Culvert

The culvert on Morrison Gulch was a known partial barrier to salmon migration and adult salmon were videotaped attempting and failing to negotiate the jump from the pool into the culvert prior to the successful replacement of that culvert. In September of 2001 as a result of a collaborative project funded by CDFG, the State Water Resources Control Board and Humboldt County Public Works, the Humboldt County Public Works Department replaced the culvert at Morrison Gulch. Several entities including the County, Green Diamond Resource Company, and Humboldt State University (HSU) are monitoring the restoration site at Morrison Gulch to assess its success. RCAA implemented riparian restoration at this site with funding from the State Water Resources Control Board in order to enhance spawning and rearing habitat. Jump pools, grade-control structures, and large wood debris were also installed at the Morrison Gulch project site.

Road Inventories

The Pacific Coast Federation of Fish, Wildlife and Wetlands Restoration Association received a grant from the CDFG's SB 271 2000 program to conduct a sediment source assessment on the larger properties in the Jacoby Creek watershed which includes approximately 120 miles of roads. The assessment determined priority sites for sediment reduction projects (Mitch Farro, personal communication).

Jacoby Creek Forest

The City of Arcata has implemented a number of sediment reduction projects in the Jacoby Creek Forest, removing culverts, Humboldt crossings, and fill material from the stream zone.

V. A. 5. Current Salmonid Habitat Conditions (By Lower, Middle, Upper Reaches)

V. A. 5.1 Estuary/ Lower Reach (Humboldt Bay to Old Arcata Road)

The lower reach of Jacoby Creek consists of a rather simplified estuary area at the creek mouth joining the Bay. This reach is

characterized by low gradient, tidal influence and a narrow riparian corridor. This entire reach is owned by the City of Arcata and is currently used as agricultural land, with plans for habitat protection and restoration, open space, recreation, and continued grazing. The entire floodplain area (over 500 acres) is zoned Agricultural Exclusive, and is managed as pasture land.

Habitat Structure

The Jacoby Creek estuary has been simplified by

- levee construction (including the railroad bed and Highway 101),
- removal of riparian vegetation and large wood debris,
- disconnection of backwater and side channel habitat.

The historic complex saltwater-freshwater ecosystem provided important rearing habitat for smolts, but has been drastically altered in the last century. Changes in the estuary, including removal of the forest have subsequently led to a deciduous dominant riparian area, limiting the recruitment of large woody debris into the channel. Numerous documents have noted the absence of properly functioning riparian habitat especially in lower Jacoby Creek (Phil Williams and Associates 2001, Humboldt Fish Action Council 1996, JCLT 1999, City of Arcata NTMP, 1-99-033.). A lack of large diameter wood along the stream bank makes natural recruitment from these areas impossible. Any woody debris found in the lower reach has been transported from upper reaches.

Up until 1854, when the Dolbeer and Carson railroad bed was constructed along the Bayside Cutoff, Jacoby Creek was connected to Rocky and Washington Gulches. Currently, tide-gates cut off Rocky Gulch to Humboldt Bay and prevent fish access to the system. To the north, both Beith and Grotzman Creek historically connected into the Jacoby Creek estuary. During flood events coinciding with high tides and high rainfall the waters of Beith, Grotzman and Jacoby Creek still flow together. Observations report that salmon access these flooded areas for feeding during these episodic events (Randy Klein, personal communication).

There is evidence of a relatively rapid rate of sediment accumulation at the mouth of Jacoby Creek on the tidal flats due to upstream land management activities. This evidence is described through a process of gathering soil core samples that reveal embedded layers of different sized soil particles called laminations. Jacoby Creek is one of the very few areas in the bay where laminations of sediments occurs. The impacts of stream sedimentation also include the shallowing and widening of the stream (Adams, Machado, and Schyr 1996). In her study of



Jacoby Creek near the tidegate

Historically, there was a myriad of backwater channels and an abundance of large woody debris in the Jacoby Creek estuary with thick spruce forest along the stream and riparian vegetation covering a large area in the lower reach. Up until 1854, when the Dolbeer and Carson railroad bed was constructed along the Bayside Cutoff, Jacoby Creek was connected to Rocky and Washington Gulches. Currently, tide-gates cut off Rocky Gulch to the Humboldt Bay and prevent fish access to the system.



Much of Lower Jacoby Creek lacks riparian cover and instream complexity such as large wood.

cumulative impacts in Jacoby Creek, Andrea Tuttle found that the mouth of the creek grew 18 acres between 1931 and 1978 (Tuttle 1985).

Quantitative measures of sedimentation include up to 1.6 feet of aggradation from 1992-2001 based on cross-section surveys at Brookwood Bridge.

Water Quality

- **Sediment:** Salmon Forever has data for turbidity and suspended sediment at the bridge on Old Arcata Road for 2001-2003).

Randy Klein has been monitoring turbidity, suspended sediment, and discharge at the Brookwood Bridge on Jacoby Creek since 2002. The preliminary computation of suspended sediment yield for lower Jacoby Creek for water year 2003 (winter of 2002-2003) is 12,500 tons, or 1,136 ton/square mile. For 2003-2004, Klein estimates that suspended sediment yield was less than half of the 2002-2003 (Klein 2004).

Former residents of the red shack, at the mouth of the Creek, observed a large build-up of sediment in the past 20 years (Gary Friedrichson, personal communication).

- **Additional Parameters:** Nutrients accumulate in the lower reach from septic tanks and cattle in the stream. Water quality monitoring studies are currently being conducted at various sites in Jacoby Creek. Three different sites have been monitored by the City of Arcata, Department of Health Services for the Shellfish Task Force, and HSU's Wastewater Utilization Program. Water quality parameters monitored include: dissolved oxygen, temperature, pH, conductivity, hardness, turbidity, benthic organisms, and sediment accumulations. During storm events fecal coliform levels exceed safe limits at the creek mouth.

Water Quantity

- **Rainfall:** The average annual rainfall in the Jacoby Creek watershed ranges between 40 and 60 inches, with more rain falling in the upper watershed.
- **Flooding:** Flood events are common during winter storms coinciding with high tide events. The entire area between Highway 101 and Old Arcata Road is regularly flooded. Flooding in this area has minimal impact on

human activities. Bayside Cutoff is sometimes closed by flood waters, and pasture land is flooded. The floods add nutrients to the pastures, and provide feeding opportunities for salmonids. The disconnection of historic side and backwater channels, and loss of large wood structure limit the availability of slack water areas where salmonids can take refuge from high flows.

- **Flow:** Anecdotal information from agricultural landowners suggests that flows have diminished during summer periods. In combination with low flows and warmer temperatures smolts could be threatened with dangerously low dissolved oxygen levels, but more research needs to be done in order to determine if this is a concern for salmonids in the Jacoby Creek estuary. In September of 1957, a low flow of 0.6 cubic feet per second (cfs) was recorded at the United States Geologic Survey gauging station. There is a lack of information regarding the amount, timing, and impacts of rural residential water withdrawal in Jacoby Creek. In 1993, Bob Wunner, counted 26 water intakes along five miles of the main stem. “The number of intakes does not portray the number of households using the water as some intakes connect to water tanks used by several households. There are many more water intakes than the ones listed; for instance, further up Snag, Rebel, and Steep Creeks, and on Fickle Hill Creek” (Wunner 1996).

Potential Limiting Factors

- 1) **Lack of habitat created by large woody debris (LWD).**
- 2) **Lack of side and backwater channel habitat.**
- 3) **Limited Access:** For example, tide-gates have cut off fish access to Rocky Gulch completely thus limiting the habitat available to smolts which may otherwise migrate between tributaries.

V. A. 5.2 Middle Reach (Old Arcata Road along the mainstem to the confluence of Morrison Gulch)

This reach is characterized by a low to moderate gradient with primarily residential development along the stream. This reach is the most important for coho rearing (John Schwabe and Larry Preston, personal communication).

Habitat Structure

- Residential development and agriculture along Jacoby Creek has resulted in removal of riparian vegetation and

Reclaiming the Tide Lands

For many years residents of Arcata owned the tide lands adjoining the bay south to town, using them as an inferior pasture occasionally, but the salt water made the feed very inferior and the land, covered by the tide twice a day, served only as a breeding place for mosquitoes and was an eye sore as one approached the place by the railroad. But this is all in process of change. Over a year ago certain men in Arcata determined to redeem their marsh land, if possible, and immediately commenced to dike against the tide, beginning just east to the railroad embankment and working east of the place of M.P Roberts, who joined with them. From Mr. Roberts' place the work was continued east to the railroad of Flanigan, Brosnan and Co., where a flood gate was put in, and from there further east, redeeming the tide lands. Altogether, the levee is two miles long, ten feet wide at the bottom and five feet wide on top. At the present time the dyke forms a most efficient barrier against the tide, thoroughly redeeming what would otherwise be valueless marsh land. The amount of land reclaimed is about 400 acres. (Arcata Union - August 18, 1893)

LWD from the stream thereby reducing the amount of available rearing habitat.

- Channel modifications such as large wood removal, and increased sediment loads have decreased the number of deep pools in the middle reach. Between 1992 and 2001 cross section measurements at Brookwood Bridge showed a 1.6 foot aggradation of the stream bed. Habitat surveys done by the Humboldt Fish Action Council in 1996 found that only 22 percent of pools in Jacoby Creek were deeper than two feet.

The lack of large wood in the main-stem is the primary limiting factor for coho rearing within Jacoby Creek, according to CDFG Biologist, Larry Preston. The progressive loss of large pieces of coniferous wood from streams due to continued removal of logs from channels has led to widespread changes in channel form and to impaired aquatic habitat quality, especially in the mainstem of Jacoby Creek.

Water Quality

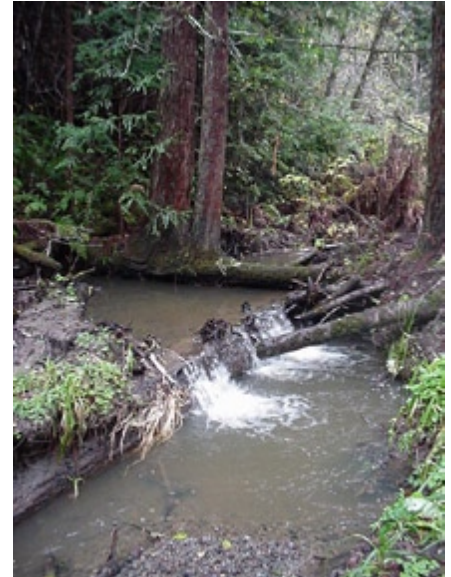
Water from Jacoby Creek and its tributaries is used for agriculture, domestic water supplies, and habitat for fish, wildlife and aquatic organisms. Water quality issues of concern in this reach of the watershed include bacterial contamination from septic tank failures, sedimentation, chemical applications, and nitrification.

- **Sediment:** Turbidity, both during storm events and chronic levels, are a cause for concern. Turbidity monitoring has been sporadic in Jacoby Creek. Salmon Forever has collected turbidity grab samples at Brookwood Bridge, Steep Creek, Morrison Gulch at South Quarry Road, and Old Arcata Road Bridge over the past few years, and assessed the last three hydrological years at these sites as well as establish cross-sections on mainstem sites. For the monitoring year of 2002, turbidity peaked at 425 NTUs at Old Arcata Road, and decreased as stage height decreased. The Jacoby Creek Land Trust received a grant to establish an automatic turbidity and flow monitoring station at Brookwood Bridge, which was installed in summer of 2002 by Randy Klein.
- **Additional parameters:** A good history of septic system failures and agency efforts to reduce the problem can be found in Adams et. al., 1996. Surveys conducted by the County Health Department with the assistance of Regional Water Quality Control Board (RWQCB) staff indicate that

discharges from septic tanks in specific areas of the Jacoby Creek watershed are resulting in health hazards and water quality impairment. In accordance with the provisions of their policy, the RWQCB prohibits the discharge of wastes from new septic tanks in the Jacoby Creek and Old Arcata Road areas in Humboldt County unless all provisions of the policy are met (Section 4-19.00 Non-Point Source and Program Strategy Implementation Plan State Water Resources Control Board, November 1999).

Water Quantity

A gauging station, operated by the U.S. Forest Service Redwood Sciences Laboratory, located at Brookwood Bridge measures flows for 14 square miles of the watershed. The station recorded a mean flow of 30 cubic feet per second (cfs), with average annual yields of 21,720 acre feet for the period of 1979 to 1983. Data collected by Tom Lisle of the Redwood Sciences Lab showed a mean annual particulate load of 6325 tons, where 5500 tons was sediment yield and 825 tons was bedload discharge (Tuttle 1985). The mean annual maximum flow is approximated at 737 cfs, with a range of peaks between 380 cfs and 2,510 cfs (Hedlund 1978).



Morrison Gulch
Photo Courtesy of Ross Taylor

Potential Limiting Factors

There is evidence that young salmonids migrate into lower areas of the stream system to feed and find shelter. Sediment from the upper watershed is transported through the stream system and may impact rearing habitat in the middle reach. Pools may be filling with fine sediment in this reach. Embeddedness ratings found in pool tail-outs indicate that spawning gravels are impacted by fine sediment (HFAC 1996).

- 1) **Lack of deep pools:** Deep pools (> 3 feet) are lacking in the middle reach. Pool depth of 3 feet or greater is desirable for salmonid rearing habitat (DFG 1998).
- 2) **Channel simplification:** Removal of LWD from the stream channel in residential areas also simplifies the channel habitat for spawning and rearing salmon and steelhead.
- 3) **Sedimentation:** The Jacoby Creek watershed is dominated by an erosive, fragile geology. Combined with management activities, such as road building, the watershed is prone to landslides and earth flows causing severe damage as seen in the 1995-1996 storm events.

V. A. 5.3 Upper Reach (The confluence of Morrison Gulch to the headwaters (including tributaries))

This reach is characterized by increasing steepness with tributary headwaters in Fickle Hill to the north and Greenwood Heights (Kneeland) to the south. The upper watershed is too steep for salmonid habitat in many places, however, there is a good population of rainbow trout above the rock falls in the upper mainstem.

Habitat Structure

Upper Jacoby Creek is characterized by a lack of fish access to tributaries to Jacoby Creek, such as Golf Course, Steep and Snag Creeks because of culvert placement (Murray & Wunner 1988; Taylor 1999) and a rock “falls” that acts as a barrier to fish migration located five and a half miles from the mouth of Jacoby Creek on the main stem. Due to the permanent barrier at the “falls”, upper Jacoby Creek does not currently provide anadromous salmonids habitat. It appears that this barrier was created when the natural channel on the right bank was filled with logs and soil to create the railroad right-of-way. Brett Harvey from Redwood Science Laboratory is currently study the resident trout population in Jacoby Creek as well as maintaining a continuous turbidity station to gather water quality and flow data.

Jacoby creek seems to be somewhat atypical with a low gradient stretch for about two miles extending from the old United States Geological Survey (USGS) gauging station in the upper reach. This is due to a channel constriction above the old gauging station, where gravel and sediment can not easily pass.

Water Quality

- **Sediment:** Sediment in the channels and tributaries can be attributed to a few main factors, including natural processes and human disturbances such as timber harvest and road building. Landslides are a source of sediment that results from the interaction of geologic and erosive forces. Active fault lines can also cause mass movement of earth. In the Jacoby Creek watershed, most of the geomorphic features related to landslides fall primarily into six categories: debris slide, debris slide slope, debris flow/torrent track, transitional/rotational slide, earthflow, and disrupted ground. These processes combined with high annual rainfall contribute significant amounts of sediment and colluvium to the main channel. In the Jacoby Creek Hydrologic Unit, slopes over 65 percent are considered

unstable and given an “extreme” rating (CDF 1998). Massive earthflows are seen on the west-facing slopes of Fickle Hill. They are comprised of the highly erosive Franciscan mélange, known locally as “blue goo”. These relatively unstable masses can flow even on gentle slopes. Another major earthflow known as the ‘Blue Slide’ is located between Snag and Rebel creeks. This slide has been heavily roaded in the past and considerable erosion has occurred at the toe of the slide.

The highest concentration of geologically fragile features in the watershed is between the Jacoby Creek Community Forest and South Fork of Jacoby Creek (including the adjacent headwaters tributaries). The headwaters contain many active slides that release large quantities of debris. About 7 percent (889 acres) of the total watershed area has steep, unstable slopes that have experienced repeated slides (JCLT 1983).

Salmon Forever and Redwood Sciences Laboratory maintain monitoring sites in the upper watershed and tributaries measuring turbidity and flow. In addition, the Redwood Sciences Laboratory installed an ISCO automatic pump sampler in upper Jacoby Creek in 2001 to study discharge and turbidity. Suspended sediment samples were collected during the rainy season of 1998-1999 on Jacoby Creek by students of HSU’s engineering department. During the storm period of November 20-22, 2001, seventy six tons of sediment was washed down Jacoby Creek.

Water Quantity

A USGS gauging station, operational from 1955 to 1964, recorded the discharge of the upper 6.1 square miles of the watershed. Average flow for the period was 15.1 cubic feet per second, yielding 10,930 acre feet per year. A high flow of 1670 cfs was recorded in December 1954, with a low flow of 0.6 cfs in September 1957 (USGS Water Supply Papers 1954-1965).

Potential Limiting Factors

1) Sediment Source: The upper watershed is a source of sediment from contributing factors such as timber harvest and related activities such as road building and natural processes including landslides and earthflows. Sediment produced in the upper reach (fines in particular) enters the system and is transported downstream to fish spawning reaches and tidal flats.

2) Access. The most common salmonid migration barriers in the upper watershed are stream crossing culverts. A fish cannot pass through a culvert if it is improperly sized or placed at an improper angle. If the angle is too steep the water velocity is too fast, or if the angle is too shallow there is not enough water for the fish to swim through. Culverts that are placed in such a way that the fish must jump excessive heights also impede passage. Culverts that are too long do not provide resting places, so the fish tire and are flushed back down stream (Douglas Jager, personal communication 1996).

V. A. 6. Opportunities and Challenges

There are significant activities taking place in Jacoby Creek watershed that will protect and restore important watershed resources. The Jacoby Creek Land Trust (JCLT), which was established in 1992, is dedicated to the preservation of land in the Jacoby Creek watershed, for natural resource habitat, historic, educational, recreational, scenic and open space values through the use of conservation easements or fee title acquisitions of land. As of 2004, JCLT has acquired over 250 acres and placed easements on over 20 acres of forest and riparian habitat.

In the 1988 Environmental Assessment Update published by the U.S. Fish and Wildlife service, the importance of the Jacoby Creek Unit (Highway 101 west) is discussed as an important area for shorebirds and waterfowl due to the freshwater input of Jacoby Creek to Humboldt Bay.

The City of Arcata has added over 300 acres of land to the Jacoby Creek Forest to be managed for recreation, wildlife habitat, and timber using low impact forestry practices. In addition, the City has acquired the entire Jacoby Creek estuary region with funds from the Wildlife Conservation Board (WCB), the State Coastal Conservancy (SCC), and the North American Wetlands Conservation Act Grant Program (NAWCA) for estuary habitat restoration and grazing.

Several other community groups are active in the Jacoby Creek area including the Jacoby Creek Protection Association which reviews Timber Harvest Plan's filed in the watershed; the Jacoby Creek School whose students conduct stream monitoring with the help of local hydrologists; and the Bayside Grange, a community center, which promotes sustainable agriculture, cultural events and local education and outreach.

The recovery of Jacoby Creek’s salmonid populations faces several significant challenges. In 2004 the watershed was listed 303(d) sediment impaired by the RWQCB. Below are some additional details of opportunities and challenges within the watershed.

Timber Harvest

Timber harvest continues to be a major activity in the watershed. The Jacoby Creek Protection Association expressed their desire to the RWQCB to consider the effects of logging and sedimentation as threats to salmonid habitat quality. “The increased intensity of timber harvesting in Jacoby Creek watershed, especially associated roads and tractor yarding, are of great concern to many residents. According to silviculture summaries, 26 percent of Jacoby Creek watershed was under timber harvest between 1988 and 2000” (Finger 2001).

Roads

Roads built for rural residential development and timber harvest activities increase the amount of fine sediment being delivered to the stream, which fills pools, clogs spawning gravels, and raises the level of the streambed, resulting in increased bank erosion. Improperly designed roads can prevent or interfere with upstream and downstream migration of both adult and juvenile salmonids, due to culvert outfall barriers, excessive water velocity, insufficient water depths in culverts, turbulence, or a lack of resting and jump pools below culverts (Furniss, Roelofs, and Yee 1991).

Flooding

In Jacoby Creek, flooding occurs in the alluvial floodplains of the lower watershed and localized areas higher in the watershed. A series of storms and severe flooding in 1996 which plugged road and driveway culverts, prompted a community meeting in February of 1996 to review the problem (Adams, Machado, and Schyr 1996). In recent times, **large wood** has been perceived as a problem for flooding and bank erosion and woody debris is frequently removed by residential landowners.

Septic

Jacoby Creek has a history of bacteria contamination beginning in the 1960s due to failing septic systems (Adams, Machado, and Schyr 1996). Attention to the fecal coliform problem increased after a 1973 California Department of Health Services study. In 1978 another study was published by the Federal Drug Administration (FDA) showing that the fecal coliform problem had increased since the 1973 study (RWQCB 1982). The study found “a 25 percent failure rate in surveyed septic tanks, as well as high levels of fecal coliform bacteria, effluent surfacing from septic tank



*Jacoby Creek Land Trust
educational signage at the Kokte
Preserve*

leach fields, and generally poor conditions for septic use” (Adams, Machado, and Schyr 1996). The annexation of Bayside became effective in April 1983 and a sewage line was constructed. With the sewerage of the most heavily developed sections of the watershed the threat of fecal contamination diminished. However, rural septic systems still pollute the creek, and both the County and the NCRWQCB have imposed restrictions on new systems. Clean up of failing systems is an ongoing challenge.

Table V.4: Limiting Conditions for Salmonid Habitat in Lower Jacoby Creek

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food Source is not a problem for adult salmonids in this watershed because adult fish do not feed during their upward migration.	The estuary is not utilized for spawning.	The estuary has been reduced in both size and complexity over the past 150 years. Reduction in side channels, riparian cover, LWD etc. may reduce the food supply while high sediment levels make feeding more difficult. Food supply and feeding behavior has not been studied in the estuary and it is unknown how much of a limiting factor food supply is.	Decreased size and quality of the estuary also reduces food supply during smoltification, when the fish are adjusting to salt water. Juveniles need to spend time in brackish waters of the estuary, and food availability is critical.
Water Quality	Elevated turbidity and suspended sediment concentrations, and pollutants from septic systems and herbicide applications may impact the use of Jacoby creek by adult salmon and steelhead.	The estuary is not utilized for spawning.	Limited information was found regarding water quality in the estuary of Jacoby Creek. Poor water quality resulting from high turbidity, and low dissolved oxygen can induce physiological stress and decrease growth rates in juvenile salmonids thus dramatically reducing survival rates. Chemical toxicity due to herbicide and pesticide use in the watershed is known to affect sense of smell in fish, among other effects, and interfere with imprinting in salmonids.	Poor water quality may impair feeding habits and growth rates. Size of salmonids at migration directly relates to chances for ocean survival.
Habitat Structure	The estuary habitat has been simplified over the past 150 years. The stream lacks significant large woody debris and riparian trees for future wood recruitment. Side channels have been separated from the main stem by levees and channelization. Migrating adults have reduced areas for resting and avoiding high flows.		It is unknown whether or not the estuary is regularly utilized for rearing.	Reduced habitat complexity (lack of backwater channels and LWD) in the estuary affects food supply and shelter necessary for adaptation to the salt water environment (smoltification). Simplification of habitat from a variety of activities including removal of riparian habitat.
Flow and Depth	There is a lack of information regarding flows and adult migration in lower Jacoby Creek. A 150 years ago the estuary area connected Jacoby, Beith, Grotzman, Washington and Rocky Creeks, this probably resulted in straying of fish and mixing of genetics and allowed fish to avoid areas that had experienced significant high intensity trauma.		Flows have not be identified as a significant problem for Jacoby Creek with regards to rearing habitat in the estuary.	Flow has not been identified as a significant problem on juvenile migration. However, low flows may result in low levels of Dissolved Oxygen. In Salmon Creek lethal DO levels have been measured in the estuary during summer months.

Table V.5: Limiting Conditions for Salmonid Habitat in Middle Jacoby Creek

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food Source is not a problem for adult salmonids in this watershed because adult fish do not feed during their upward migration.	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Riparian cover measured in 1996 was 60%, with only 20% conifers. Riparian degradation can reduce the food supply of juvenile and resident salmonids, while high sediment levels make feeding more difficult.	Same as rearing.
Water Quality	Limited data available for Jacoby Creek. Elevated turbidity and suspended sediment concentrations may reduce visibility, fill pool habitat, and degrade spawning gravels. Herbicide and pesticide residues can impact migrating salmonids, unknown if this occurs in Jacoby Creek.	Dissolved Oxygen (DO) levels, which are very important during incubation, are significantly reduced when there are high levels of fine sediment present in gravel. The elevated levels are most likely present in Jacoby Creek, thus reducing the amount of DO available in the gravel and causing higher rates of mortality.	The middle reach is the main rearing habitat in Jacoby Creek. High turbidity levels can decrease growth rates in juvenile salmonids thus dramatically reducing survival rates. Salmon Forever monitoring has measured turbidity measurements as high as 450 ntu. Chronic turbidity information is lacking. Discharges from septic systems, pesticides and herbicides on Jacoby Creek have an unknown impact on rearing and resident fish.	Same as rearing.
Habitat Structure	There are currently fish passage problems at Golf Course and Snag Creek. The lack of large woody debris in the system and disconnection of side and backwater channels have reduced cover and resting areas for migrating salmon. Falls is a barrier 5.5 miles upstream.	There is a lack of clean spawning gravel(s) in this reach of Jacoby Creek. This is a depositional area and much of the sediment from upstream has settled here. At Brookwood Bridge over 1.6 feet of sediment has been deposited in the past 5 years. Coho spawning did occur at Brookwood Bridge area in 2002. No information was found regarding the survival rates of embryos in Jacoby Creek redds.	This reach of the stream system is the primary rearing area. Removal of large woody debris has reduced the number and quality of pools, shelter, and changed channel morphology. The lack of LWD in this reach is thought to be the main limiting factor for salmonids in Jacoby Creek.	Juveniles use LWD and boulder-associated pools, floodplains and side channels as refugia and cover from predators. These refugia areas are lacking in the middle reach. Combined surfaces area of all pool in middle reach account for only 17% of wetted surface area. Lack of resting areas in the form of side channels and pools may result in migrating juveniles being pushed to the bay too soon.
Flow and Depth	Because of degradation over the last 150 years, the watershed has lost much of its capacity for water retention. This has resulted in increased flood frequencies.	Flooding and high peak flows can wash out redds and smother gravels used for spawning.	Flows have not been identified as a significant problem for Jacoby with regards to rearing habitat. However, low flows may affect migration by creating barriers to fish passage.	Flow has not been identified as a significant problem on juvenile migration.

Table V.6: Limiting Conditions for Salmonid Habitat in Upper Jacoby Creek

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food Source is not a problem for Adult salmonids in this watershed because adult fish do not feed during their upward migration.	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Canopy cover is fair to excellent in the upper reaches providing shade and source areas supplying terrestrial insects to watercourses. Limited information was found regarding aquatic invertebrates in upper watershed.	Same as rearing.
Water Quality	Landslides and other sources of sediment originate in the upper watershed. Much of the area is steep with highly erodible soils. Turbidity levels measured over past year are much lower than those of Freshwater Creek, but much higher than undisturbed watersheds. The upper watershed is a transport reach and most of the suspended sediment moves through this area rapidly.	Sediment impacts to redds include scour and smothering when fine sediment infiltrate gravels. Chronic turbidity has not been monitored in upper Jacoby Creek. Gravel embeddeness measurements (1996) show 2/3 of pool tailouts with values of 3 or 4.	Limited data found specific to upper Jacoby Creek. Poor water quality resulting from high turbidity can decrease growth rates in juvenile salmonids thus dramatically reducing survival rates. Data on size of juveniles and growth rates has not been found for upper Jacoby Creek. Since 2001, Brett Harvey of RSL is studying resident rainbows and turbidity above the Falls.	Same as rearing.
Habitat Structure	Road and railroad construction created barriers to migration for both adult and juvenile anadromous species. Culverts on Golf Course, and Snag Creeks, are partial fish passage barriers. One mile upstream from the confluence of Rebel Creek, a rock falls acts as a barrier to fish migration. Above the Falls there is a healthy population of resident rainbow trout. A lack of high quality spawning gravel may be limiting, there is a lack of solid information regarding spawning habitat in this reach.	Embeddeness values in this reach (1996) indicated a lack of clean spawning gravel(s) Much of the spawning habitat is located in Morrison Gulch.	Rearing habitat is limited in upper watershed due to steep gradients, and lack of access. The percentage of pool habitat, and pool shelter rating in this reach are fair to good. High turbidity levels may impact feeding ability.	Resident rainbow currently dominate Jacoby Creek above the Falls. These non-anadromous trout are trapped by migration barriers. Culverts on Golf Course and Snag Creek impede juvenile passage.
Flow and Depth		No data found specific to Jacoby Creek. Reaches with confined channels and high peak flows can result in scour of redds (where spawning conditions exist).	Limited data found specific to Jacoby Creek. During summer low flow months rearing in the upper reaches is limited. Water withdrawals are not controlled and in drought years could have significant impacts on rearing salmonids. Cumulative impact of the removal of forest vegetation results in higher peak flows and lower summer flows.	No information was found regarding flows and juvenile migration in Jacoby Creek.

Figure V.2: Land Use Jacoby Creek Watershed

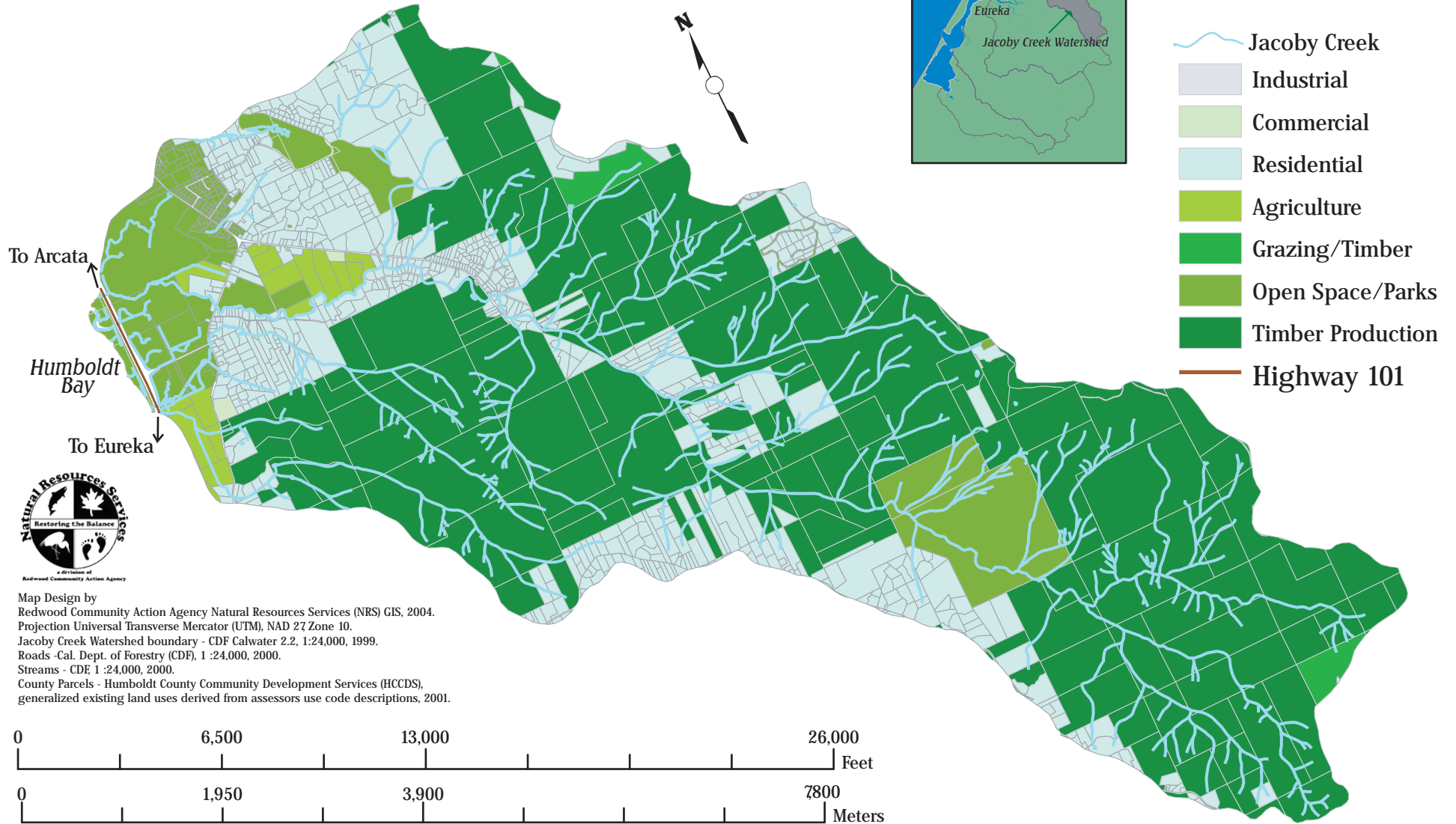
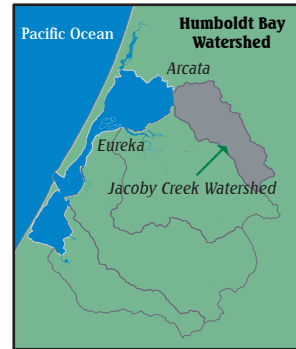
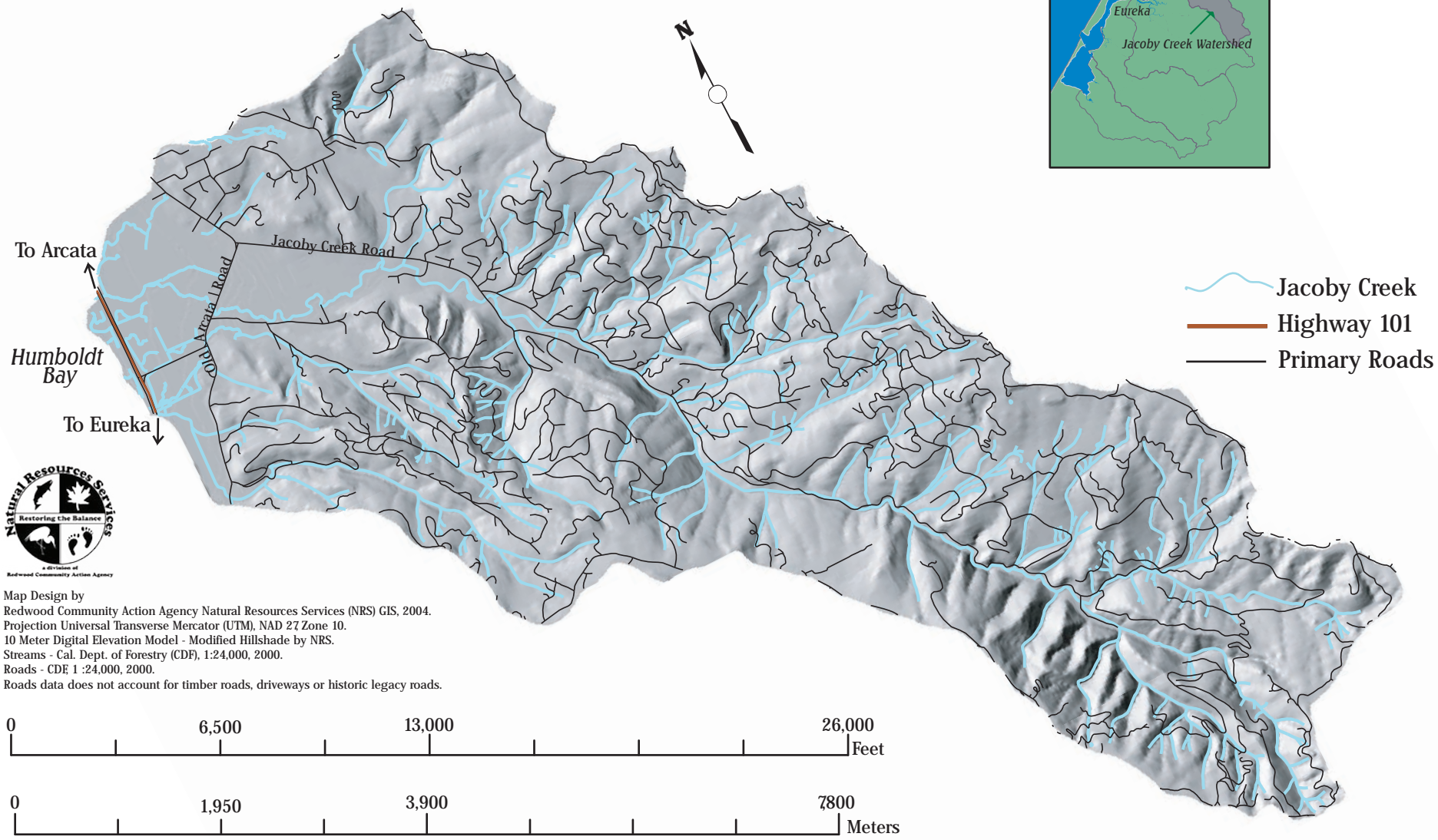
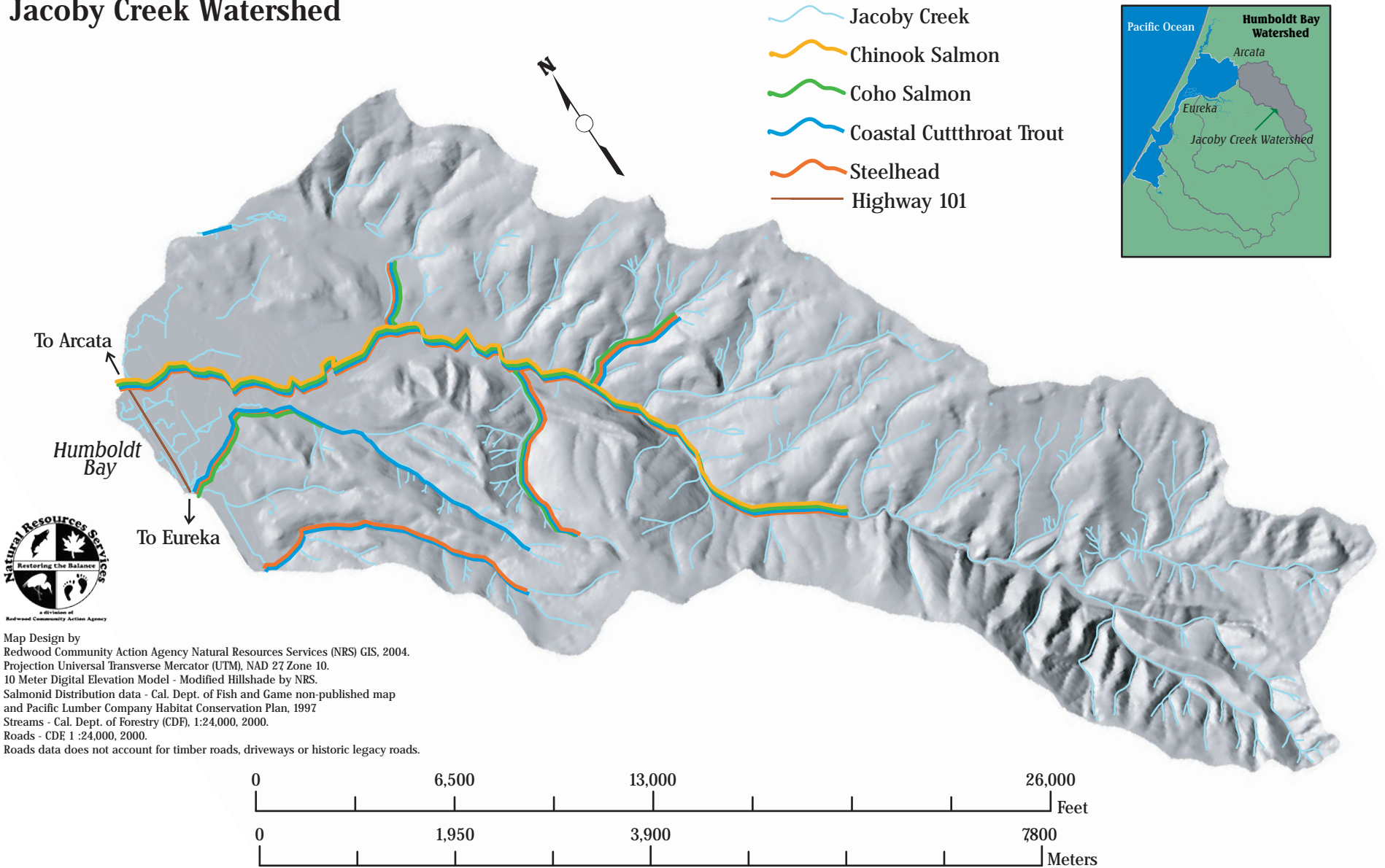


Figure V.3: Roads Jacoby Creek Watershed



Map Design by
Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
10 Meter Digital Elevation Model - Modified Hillshade by NRS.
Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
Roads - CDE 1 :24,000, 2000.
Roads data does not account for timber roads, driveways or historic legacy roads.







Figure V.4: Anadromous Salmonid Distribution Jacoby Creek Watershed

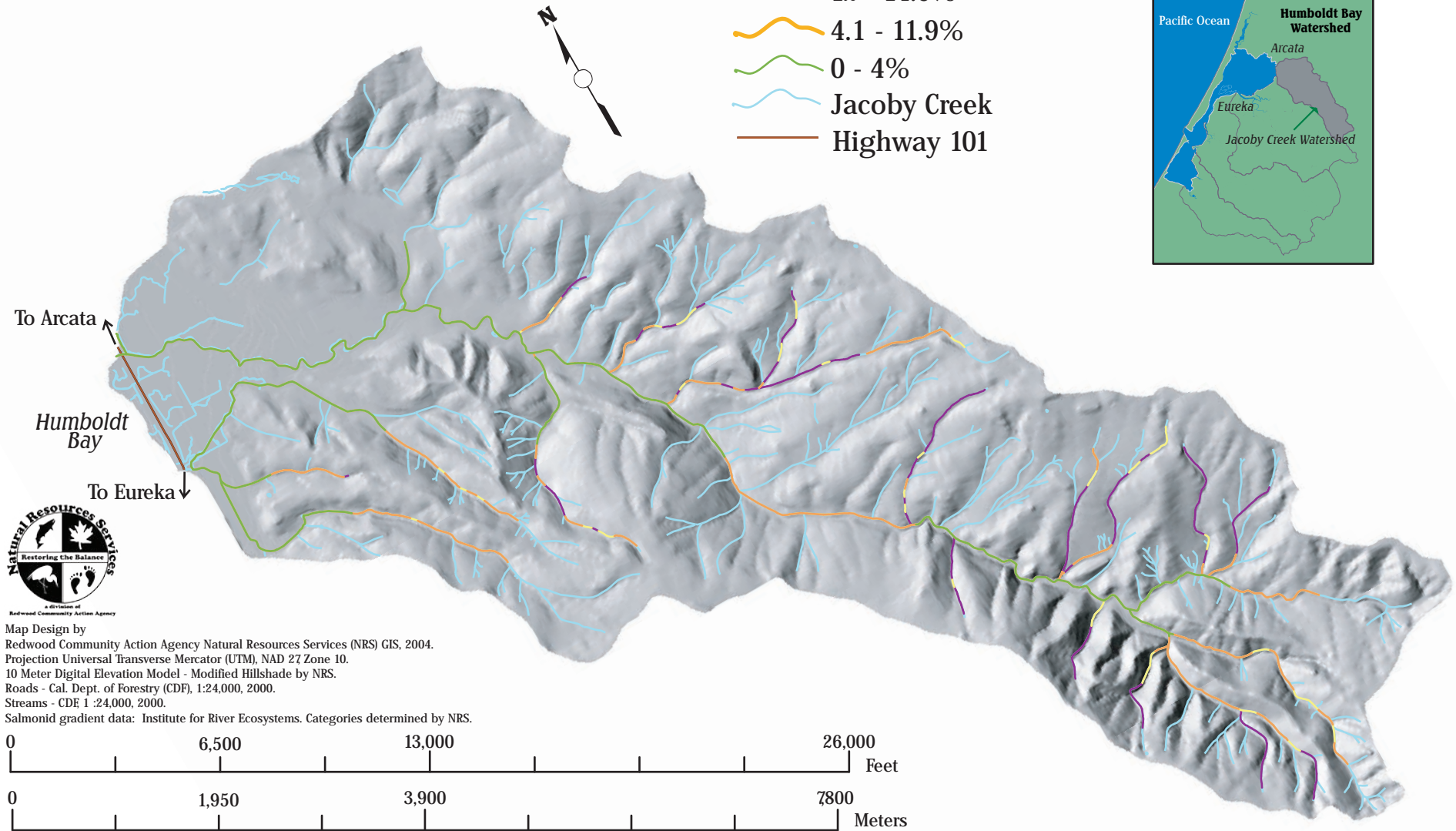
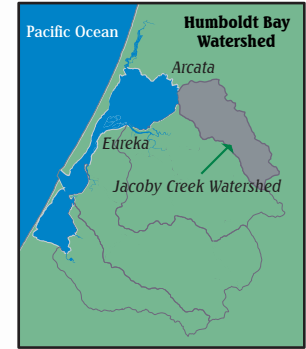


Map Design by
 Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Salmonid Distribution data - Cal. Dept. of Fish and Game non-published map
 and Pacific Lumber Company Habitat Conservation Plan, 1997
 Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Roads - CDE 1 :24,000, 2000.
 Roads data does not account for timber roads, driveways or historic legacy roads.

Figure V.5: Stream Gradient Jacoby Creek Watershed

Stream Gradient Categories

-  > 15%
-  12 - 14.9%
-  4.1 - 11.9%
-  0 - 4%
-  Jacoby Creek
-  Highway 101



Map Design by
 Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Streams - CDE 1 :24,000, 2000.
 Salmonid gradient data: Institute for River Ecosystems. Categories determined by NRS.

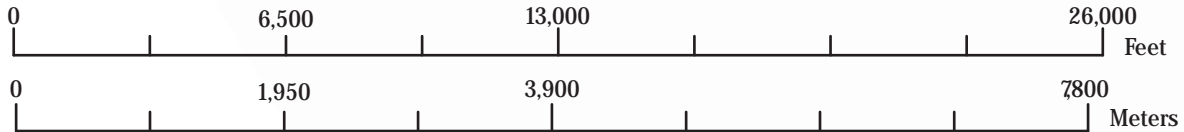
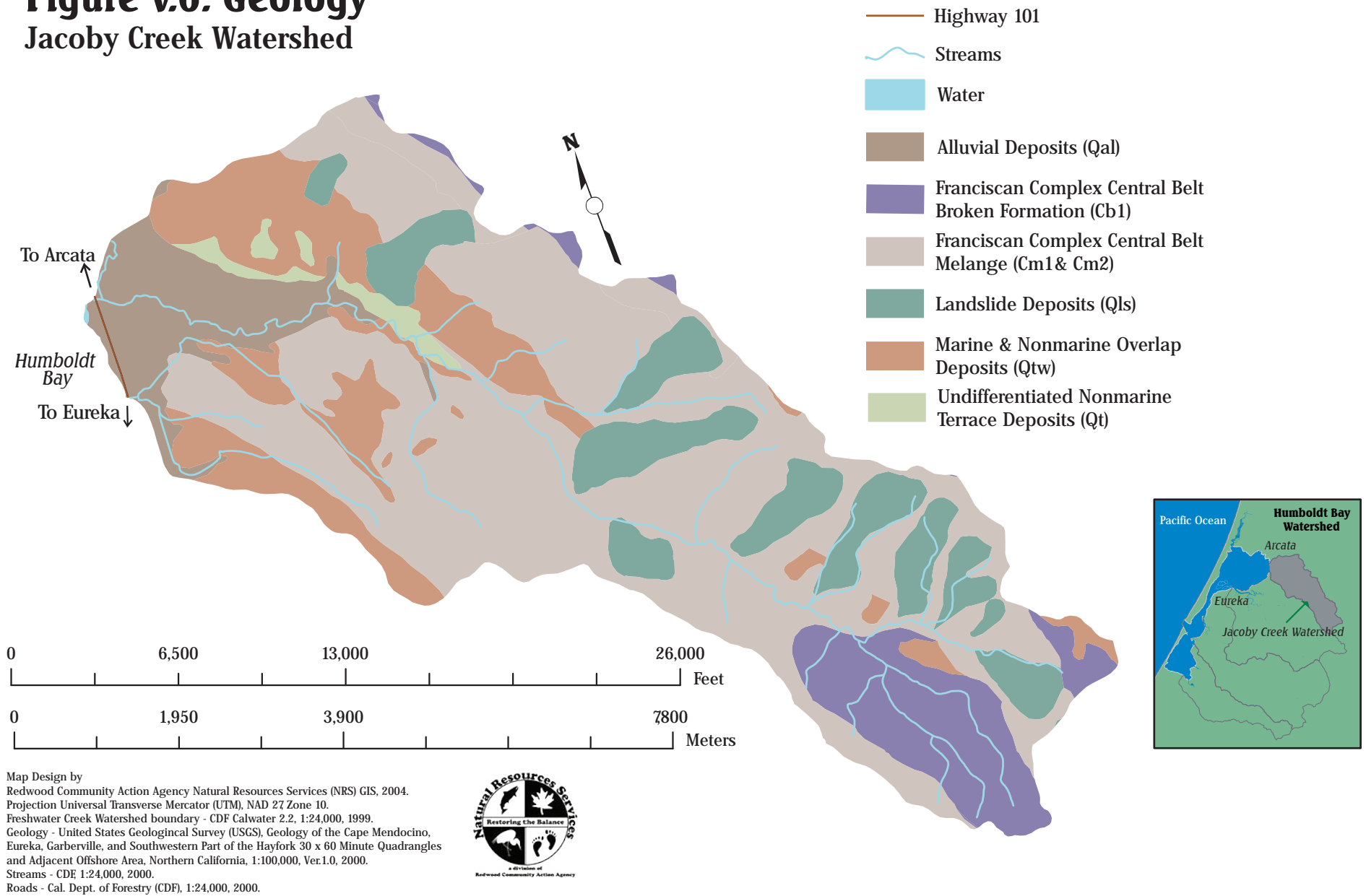


Figure V.6: Geology Jacoby Creek Watershed



V. B. Freshwater Creek Watershed Overview

Freshwater Creek watershed (Figure V.7) is located approximately five miles east of Eureka. Freshwater Creek is a fourth order stream and drains 31 square miles into Freshwater Slough which joins Eureka Slough, eventually entering Humboldt Bay at the north end of Eureka. In this document the significant salmonid producing watershed Ryan Creek, which enters Freshwater Creek at Freshwater Slough, is mapped and discussed as being a part of the Freshwater Creek watershed. Ryan Creek is considered a separate watershed from Freshwater Creek, but is included in this section due to funding limitations. For a more in depth look at Ryan Creek, see the inset section on page 91.

Elevations in the watershed range from 823 meters at the headwaters to sea level at the mouth. The dominant vegetation type is coastal coniferous forest with a majority being second- and third-growth redwood. Redwoods are the dominant tree species throughout the watershed.

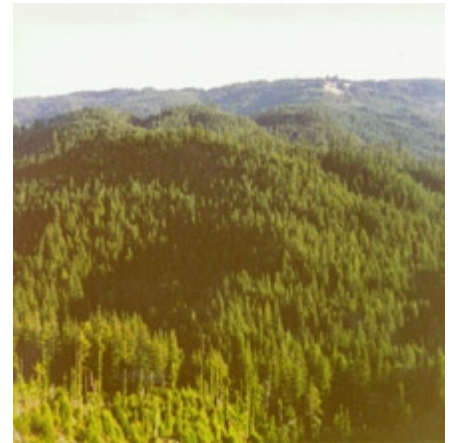
The Freshwater watershed is located in the fog belt; as a result, summer air temperatures are low and the potential for stream heating is minimized (PALCO 2001). Approximately 90% of annual precipitation occurs between October to April. Average rainfall for the area is forty-five inches occurring primarily from October through May.

The Freshwater Creek watershed, like other watersheds in Humboldt Bay, has experienced sustained periods of disturbance due to logging, road building, residential building, and agriculture.

According to a study of the historic decline of salmon, by the 1980s and early 1990s, Freshwater Creek had one of the last seven populations of coho salmon numbering in the hundreds annually in all of northwestern California (Brown et al. 1994).

V. B. 1. Geology

Freshwater Creek watershed consist of primarily three groups: the Wildcat Group, the Franciscan Central Belt Group, and the Yager Formation. The most dominant geologic types in the Freshwater Creek watershed, the Franciscan Assemblage and the Wildcat Group, are locally known for instability and relatively high erosion rates. The Wildcat Group is found most extensively in the western portion of the watershed. The eastern portion of the watershed is



A Freshwater Creek watershed view



Freshwater Creek has the most comprehensive records of salmonid population than any other tributary of Humboldt Bay because of the presence of the Humboldt Fish Action Council (HFAC) which has been conducting adult salmonid trapping operations in Freshwater Creek for the past two decades, and now, the Anadromous Fisheries Resource Assessment and Monitoring Program (AFRAMP) which operates their program from the HFAC facility.

composed primarily of Franciscan Central Belt Group (PALCO 2001) (Figure V.13).

V. B. 2. Land Use



Approximately 77 percent (24 square miles) of the Freshwater Creek watershed is owned and managed for timber by the Pacific Lumber Company (PALCO) and private residences and several ranches comprise most of the remainder of the basin.

The land adjacent to the lower ten miles of Freshwater Creek is primarily used as cattle grazing land. Upstream from Howard Heights Road 6.5 miles along mainstem of Freshwater Creek (16 miles from mouth), the watershed is comprised mainly of small residential parcels. A number of small home sites and several large ranches occupy acreage around the eastern perimeter of the watershed in the Greenwood Heights and Kneeland areas. Freshwater County Park, the only public land in the watershed, was acquired by Humboldt County in 1929 (Figure V.9).

The primary paved public roads in the watershed include Old Arcata Road which passes through the watershed near the mouth, Greenwood Heights Drive which follows the ridgeline on the north side of the watershed, and the Freshwater-Kneeland Road which travels up the Freshwater valley from the mouth, intersecting Greenwood Heights Drive by way of Graham Gulch (Figure V.7)

V. B. 3. Salmonid Distribution

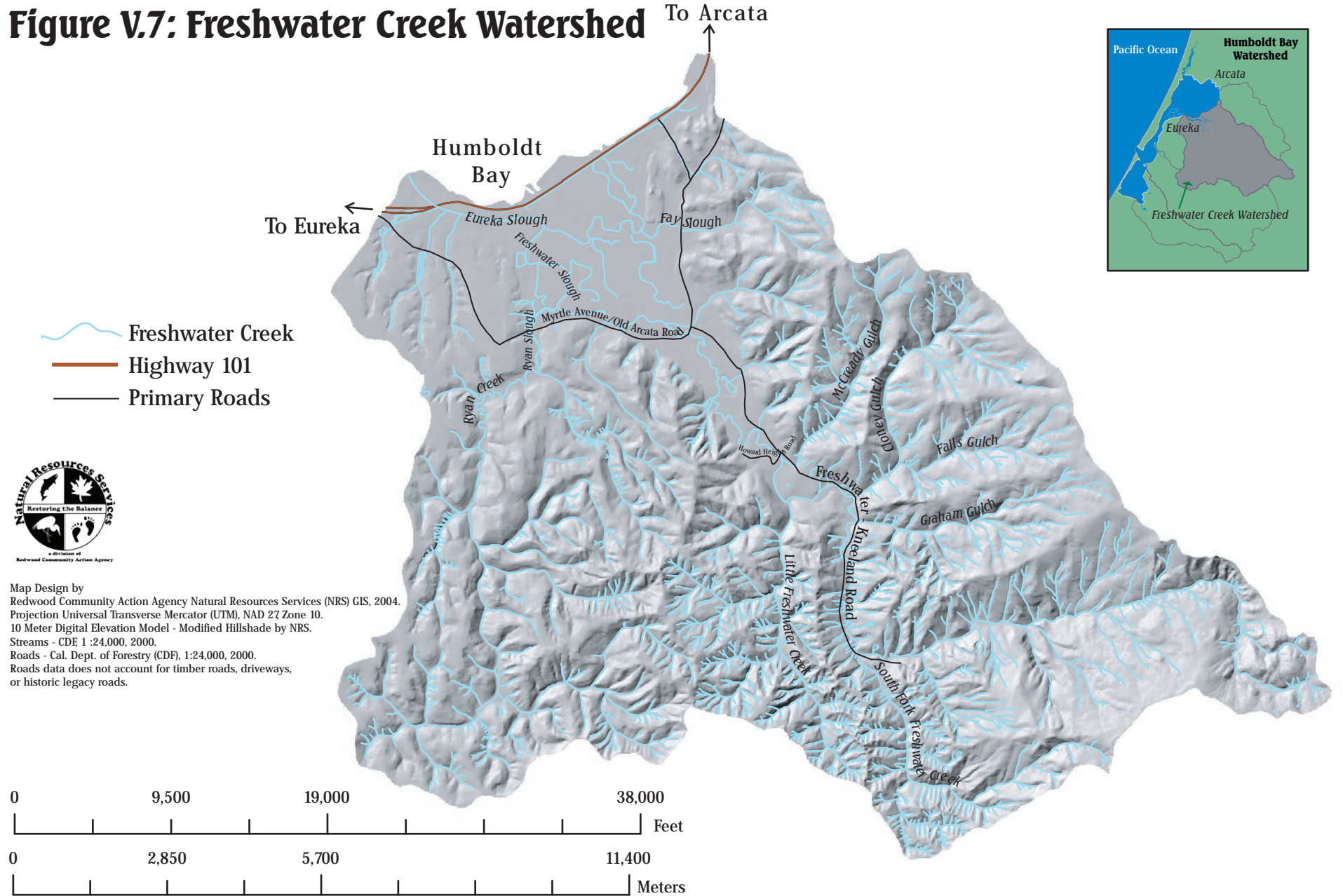


Carcasses found during spawner surveys conducted yearly on Freshwater Creek

Freshwater Creek and its tributaries provide approximately fourteen miles of spawning habitat for salmon and steelhead. The primary habitat is in the lower mainstem and the lower gradient reaches of Cloney Gulch, Upper Freshwater (the main stem after the confluence with the South Fork), and McCready Gulch. Ryan Creek a significant tributary within the watershed also provides habitat, and is such a significant tributary that a “Close-Up of Ryan Creek” is provided on page 91 of this document. On the mainstem, a twenty-foot waterfall prevents anadromous access beyond nine miles from the mouth.

The five main tributaries, Little Freshwater, Graham Gulch, Cloney Gulch, McCready Gulch and South Fork Freshwater each provide from 1.2 to 2.5 miles of anadromous fish habitat (PWA 1999). Spawning gravel is more abundant in these streams than in other areas of the watershed since they flow across the Franciscan geology. Salmon and steelhead are found in other streams as

Figure V.7: Freshwater Creek Watershed



Map Design by
 Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Streams - CDF 1:24,000, 2000.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Roads data does not account for timber roads, driveways,
 or historic legacy roads.

well but less frequently. Trout are present in most streams with sufficient flow, migratory access and low to moderate gradients (Higgins 2001). Although there is substantial overlap in habitat, chinook tend to occupy the mainstem of Freshwater Creek, with steelhead and coho in the larger tributaries and cutthroat in the smaller headwaters. In some cases, cutthroat trout are located upstream of natural anadromous migration barriers, which would indicate at least some individuals of this species have residualized into a residential life history.

There are several types of fish data for Freshwater Creek. These include: weir counts, electrofishing surveys, downstream migrant trapping results, and redd and carcass surveys. These data do not allow precise estimation or adult salmon or trout populations but may be used to show population trends and changes in fish community structure. The Humboldt Fish Action Council (HFAC) had been conducting adult salmonid trapping operations in Freshwater Creek for the past two decades and has been engaged in artificial propagation efforts, instream habitat restoration, monitoring, and research activities since the early 1970s. Today, AFRAMP is conducting monitoring using the HFAC facility. HFAC and AFRAMP have compiled historical fish information including biological information, operations and methods data, and habitat surveys. This information is available through HFAC and AFRAMP whose contact information can be found in Appendix B.

V. B. 3.1 Fish Surveys

2003-2004 Fish Population Monitoring

AFRAMP conducted four types of population monitoring for anadromous salmonids during the 2003-2004 season. 731 +/- 50 coho (C.I. 95%) were estimated for Freshwater Creek adult salmonid escapement (Ricker 2004). The type of monitoring employed and dates monitored are as follows:

- Adult Upstream Migration (November 15, 2003 through March 31, 2004) (Figure V.8)
- Spawner Surveys (November 15, 2003 through March 23, 2004)
- Adult steelhead Downstream Migration (February 3, 2004 through April 30, 2004) (Table V.7)
- Juvenile Downstream Migrant Trapping (March 13, 2004 through June 6, 2004) (Table V.7)



Doug Kelly of the Humboldt Fish Action Council checks the weir to see if any spawners are working their way upstream

Monitoring adult escapement (fish returning from the ocean) canover time can indicate growth rates of that population (Ricker 2003).



How can PIT tags add to our knowledge of Freshwater salmonids?

In 2003, AFRAMP began tagging adult and juvenile salmonids with a PIT tag. This life-long tag was given to all juveniles over 70 mm at the DSMT sites and adult salmonids at the weir on their upstream migration. The assumption is that a portion of the tagged sample will return after a number of years in the ocean to spawn and die in Freshwater Creek. When they do, information on growth, survival, and life history should become clear.

This tag was also given to returning adults to track salmonid movement within the basin. In the initial stage of this technology, adults have been observed repeatedly moving in and out of multiple sub-basins. This sort of information could be used to validate restoration efforts by using pre- and post-project monitoring (Richter 2004).

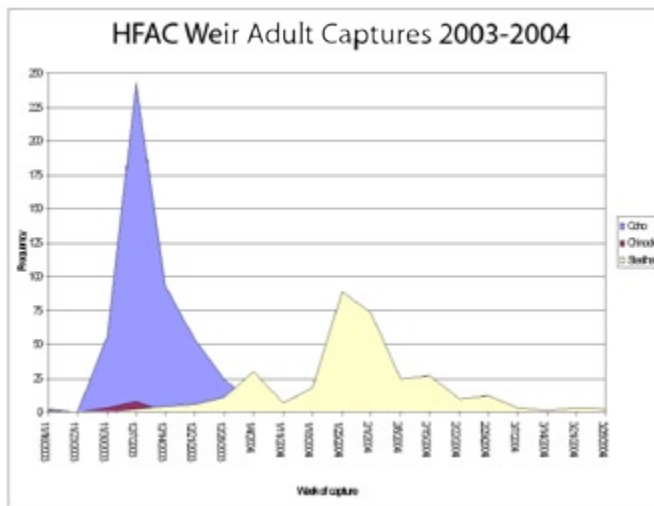


Figure V.8: Adult salmonid captures at the HFAC weir during the 2003-2004 season

	Live fish in trap						Mortalities in trap				
	YOY	1+	PS	Smolt	Resident	Adult	YOY	1+	PS	Smolt	Total
Coho	56260	0	340	2269	0	0	132	0	2	11	59014
Steelhead	11730	184	449	58	4	26	23	2	2	0	12478
Chinook	1599	0	0	0	0	0	7	0	0	0	1606
Cutthroat	0	4	168	10	49	4	0	0	0	0	235

Table V.7: AFRAMP’s 2003 Freshwater Downstream Migrant Trap (DSMT) Summary

The above numbers are simply counts and do not show the whole picture without efficiency information. AFRAMP will be producing a report in the fall of 2004 that will discuss the mark-recapture information and produce efficiencies for all of the traps, which will lead to an abundance estimates of each species for different life stages. This information may help steer restoration efforts to appropriately address vulnerable life stages and habitat needs (Richter 2004).

Without the efficiency and mark-recapture information, some assumptions can still be observed. In 2003-2004, the majority of spawning, for all species together or separate was found to be in the mainstem above the confluence with Graham Gulch. The Upper Mainstem has the highest number of steelhead pre-smolts, smolts, and coho smolts. One may assume that this area has the highest quality rearing habitat for these species during those life stages. Cloney Gulch and Little Freshwater Creek produced the highest yield of coho pre-smolts; therefore, one may assume that those areas have the best habitat for those salmonids. South Fork Freshwater Creek produced the most residential adult cutthroat, so it is likely that they have found preferred habitat in that reach.

All these assumptions may be skewed by the efficiency of the individual traps, so until that information is computed, they must remain assumptions (Righter 2004).

Downstream migrant trapping on Freshwater was conducted by the CDFG Steelhead Research and Monitoring Program (S-RAMP), which is currently AFRAMP, for the 2000-2001, 2001-2002, and 2002-2003 trapping seasons. Juvenile salmonid trapping was conducted at seven locations between March 22 and June 12, 2001. The S-RAMP report estimated that 10,745+/-608 steelhead and 6080 +/- 299 coho salmon smolts emigrated from Freshwater during the study period. The estimate is of abundance presented are only for the period from March 22 to June 12, and do not include fish migrating earlier or later. Two hundred and eighty-eight chinook salmon were captured at the lower main stem trap between March 22 and May 9. Therefore an estimated 2131+/- 83 chinook salmon emigrants passes the trap from May-June 5. An estimated 87 percent of the steelhead migrating from Freshwater Creek originated from the mainstem section between the tributary traps and the Lower Mainstem trap, leaving the remaining 17 percent attributed to tributary production. An estimated 48 percent of all coho salmon smolts migrated from the tributaries (Ricker 2001). Adult steelhead escapement estimates made by S-RAMP is 99+/-23 for the year 2001. These are actual fish surveyed, total population estimates would be higher than numbers presented.

Hatchery Fish in Freshwater

Concern over dwindling numbers of fish in the Humboldt Bay watershed prompted stock introductions in Freshwater Creek as part of State and local hatchery operations. Salmon and steelhead were occasionally planted in Freshwater from 1900 to 1950 and in the early days of HFAC enhancement efforts (Higgins 2001).

Ferndale Enterprise (25 June 1926) "The commercial fishermen operating outside Humboldt bar for salmon are making poor catches these days. There are about 150 boats working out of Eureka and the average catch is about 200 pounds to the boat. It is the general opinion that the salmon are being exterminated by the outside fishing and that the scarcity of fish is now becoming noticeable."

Higgins noted that hatchery supplementation by the Humboldt Fish Action Council HFAC (a practice which is no longer happening) may have increased adult salmon returns therefore masking declines of naturally spawning populations. The HFAC hatchery program for Freshwater Creek may have inflated adult chinook and coho salmon returns in some trapping years since 1978. Coho have a three year life history and adult returns could have been affected through 1998. Chinook may spawn from two years old (jacks) to five years old. Therefore, adult returns will reflect recent planting through 2005-06. The returning hatchery fish make it more difficult to discern natural chinook salmon numbers in Freshwater Creek.

Historic Human Footprint and Conditions Freshwater Creek Watershed

The Wiyot Indians lived in the Freshwater Creek watershed for thousands of years and fished Freshwater Creek for salmon, a major part of their diet. Salmon has great importance to Wiyot people as demonstrated by their work, food, and a rich artistic heritage. The sloughs of Jacoby, Ryan and Freshwater Creeks were of particular significance because they were areas of dense and active native habitation. The Wiyot traveled the Freshwater Creek watershed by trails and camped along the creeks during salmon season.

An archeological study of native sites in Freshwater conducted around 1910 found remains of two sites along the river that confirmed stories of native settlements in the area. A pioneer stated that a village was located on a shell deposit near the old brickyards on Eureka Slough. Another site near Freshwater Corners was a camp site for salmon fishing on Freshwater Creek and for making excursions to the top of the ridge for acorns (Loud 1918).

The town of Freshwater was also known historically as Garfield and Wrangletown, which owes its beginnings to the timber industry boom beginning in the 1800s. Freshwater Creek watershed had extensive reserves of old growth redwoods when logging began in the early 1860s. At one time its population of loggers was as high as 600 during the timber boom. During the late 1850s, settlements spread over the agricultural lands near the bay, and began to crowd the more remote valleys and prairies lying in and beyond the redwood belt. Historical accounts of the area show Freshwater as an important economic resource and documents the changes it has undergone.

Humboldt Times (13 Feb. 1949) Freshwater--Suburban Life Is Better by Chet Schwarzkopf -- "...Logging operations commenced around Freshwater corner in 1860. The huge logs were dragged to Freshwater slough by ox teams and floated down to the company's mill, which was located on Eureka slough not far above the present Highway 101 bridge.

At that time, the present center of Freshwater was deep in an untouched wilderness--but not for long. Gradually, the Excelsior loggers worked upstream and in a few years, the first cabins were built around where the Coeur store now stands. Then, in the latter 1870s, the company started its logging railroad, and the town began to develop in earnest, for the site it occupied was a natural. In the early [18] '80s, Pat McLain of Eureka built a store and hotel there, and a number of other businesses soon sprang up. In time, the town boasted of a butcher, barber, tailor, shoemaker, two bowling alleys, two groceries, and a confectionery, as well as a blacksmith shop and three livery stables. And, needless to say, a number of saloons--at times as high as seven in number--sprang up.

Freshwater Watershed Historical Timeline

- 1850s and 1860s** - *Excelsior Redwood Company begins operations in Freshwater*
- Early 1870s** - *Wrangletown named*
- 1880** - *Railroad built from slough to Graham Gulch*
- 1884** - *Little Red Schoolhouse built*
- 1892** - *Old Kneeland Road Built*
- 1894** - *Excelsior closes*
- 1900** - *Excelsior resumes logging*
- 1902** - *Pacific Lumber buys Excelsior*
- 1932** - *Freshwater Grange #499 established*
- 1941** - *Old-growth logging completed*
- 1970s** - *Observable decrease in chinook and coho salmon returns*

It was during its hey-day era that Freshwater came to be known as “Wrangletown,” although its official district is Garfield and the town’s post office was called Freshwater after the stream that flows through it.”

Agriculture

Even before the town of Freshwater came into existence there were small farmers operating in the valley. Farmers had the formidable task of first removing stumps from 5 to more than 20 feet across. Diking and levee building on the Bay to create roads and railways had the effect of also creating pasturelands in the lower basin. Land was intentionally reclaimed along Freshwater Slough for pastureland at the turn of the century. Settlers and loggers displaced the scattered and seasonal homes of the Wiyot Indians in the prairies around Freshwater and promoted cattle-raising as well as seeding and grazing in the filled-in lower basin.

Timber Harvest

Logging in the Freshwater Creek watershed began in the 1860s, probably with steam donkey and/or oxen yarding in the School Forest sub-basin of the lower watershed. Steam donkey and railroad logging spread up the drainage in the 1870s, 1880s, and 1890s to include McCready Creek (1870s), and lower Cloney Gulch (1880s and 1890s). A small area in the upper end of the mainstem, below Kneeland Road, was also harvested in the late 1800s. This early period of logging in Freshwater Creek ended around the turn of the century.

Railroad logging operations recommenced in the 1920s along the main stem of Freshwater Creek, within Little Freshwater Creek and in the downstream reaches and ridgetop areas of the South Fork. By the end of the 1930s, the remainder of Little Freshwater creek, the South Fork and most of the mainstem had been clearcut. Between 1940 and 1954 the small amount of remaining old growth in the watershed (located mostly in upper Cloney and Falls Gulch areas) had been harvested. This marked what can be considered the end of first cycle logging on what are now Pacific Lumber Company lands in Freshwater Creek watershed (PWA 1999).

Intensive logging in the watershed altered the vegetation along stream corridors. Much of these riparian areas were not allowed to recover in the lower watershed due to urbanization and conversion for agriculture.

Before the railroads and roads were built to bring the trees to the mills, logs were often skidded down creeks and gullies by oxen and dumped into the riverbed. Once there, they remained until such a time as the weather furnished enough water to

Miscellaneous Industry in Freshwater

The original railroad bridge over Eureka Slough was called a draw-bridge though it actually was a pivot type bridge, swinging to one side. It allowed boats to pass towing rafts of logs and lighters loaded with shakes and shingles from the shingle mills and brickyard. Shingle mills were on both Ryan Slough and Freshwater Slough while the brickyard was on Freshwater Slough. A large shingle mill was above the brickyard on Freshwater Slough which later became the Sweasy Dairy. There were several family operated shake bolt mills further up the valley. George Pinkerton had a shake mill a half-mile up from present day Freshwater Park. Tom Cloney had an operation up Cloney Gulch. There were shake mills up Graham Gulch and McCready Gulch and one just a few miles from Kneeland. Also tanbark and ship knees (fir root for ribs on ship construction) were hauled down from Kneeland by the wagonload (Community Organization of Wrangletown 1976). The first rock for Humboldt Bay’s jetty was hauled from the Graham and McCready gulches in Freshwater canyon. The railroad took it down to Ryan slough where it was put on barges and towed across the bay.

float the logs down to tidewater, where they could be arranged in rafts then towed down to the mills to be cut into lumber. In the 1960s through the early 1980s, tractors sometimes yarded logs down small stream channels and concurrently sidecast or deposited soil and debris in channels. The remains of these deposits continue to gully and erode, delivering sediment to downstream areas (PWA 1999).

Railroads and Roads

In 1880 the South Bay Railroad Company began the Freshwater Railroad at the marsh which began near the mouth of the slough and extended up 7 miles. Plans were to extend the railroad further into the gulches. Railroad construction in Freshwater occurred during two phases. The early phase lasted from the 1860s through about 1900. This construction accompanied early harvesting in the lower watershed in the School Forest, McCready, Cloney, Graham and lower Freshwater Creek areas. After a 20-year lull in activities, a second period from about 1920 through 1940 saw renewed harvesting and railroad construction in the upper watershed.

Newspaper accounts from as late as the 1940s report historic observations of fish abundance in Freshwater Creek indicating that there was once thought to be an inexhaustible number of fish in its creeks.

Humboldt Times (15 May 1858) - "A party of gentlemen, twelve in number, went fishing one day this week to Fresh Water Creek, about three miles below this place, and caught, cleaned, cooked and ate three hundred and eight speckled trout [cutthroat] and returned home the same day."

Railroad construction from the 1860s to the 1930s was responsible for accelerated erosion and sediment delivery in the watershed. Some railroad grades, particularly in lower Freshwater Creek, Cloney and Graham Gulches, were constructed within or adjacent to stream channels resulting in greater stream impacts, while others were built on ridge tops and stable terraces (PWA 1999).

Most (but not all) large stream channel crossings along the rail lines employed trestles rather than fills, so impacts of direct sedimentation at large crossings were minimized. Although excavation was minimized in most areas, railroad grade construction often employed extensive sidecasting and the filling of small streams with logs, organic debris and soil.

Between 1966 and 1974, approximately 49 miles of haul road were built averaging 6.1 miles per year. Between 1974 and 1987 an additional 24.5 miles of road were constructed in upper McCready Gulch, in lower Little Freshwater Creek and in the upper parts of the main stem, all areas which had first been

Observations made by long-time residents estimated that spawning populations in Freshwater Creek were approximately 1200-1400 fish in the 1910s through the 1930s. Local residents also remarked that spawning once occurred from as low as present day Freshwater Farms up to the swimming hole at Freshwater Park. By the 1940s there was an observable decline in the number of fish in the creek, thought to be due to a combination of logging, fishing, population growth and associated degraded water quality (Ellinwood 1985).

logged in the middle and late 1800s (PWA 1999). The majority of stream crossings in these sub-basins were constructed as "Humboldt" log crossings. When roads were constructed, organic debris was pushed into the stream channels and then buried by soil. The use of Humboldt stream crossings instead of culverts was

a common road building practice used in the 1960s and 1970s and created a legacy road problem that has been a continuing source of sediment into the stream channel (PWA 1997).

Year	Coho YOY	Coho 1+/smolt	Trout YOY	Steelhead 1+	Steelhead Smolts	Chinook	Coastal Cutthroat	Trapping Days
Mainstem Freshwater								
1996	922	18	288	38		5	12	43
1997	1116	5	507	114	28	0	27	43
1999*	3894	105	2418	107	689	7150	19	94
2000	954	174	1324	107	37	0	20	60
South Fork Freshwater								
1996	100	37	8	19		0	17	51
1997	215	37	0	10	0	0	40	42
1999	No data							
2000	1778	64	486	41	10	0	58	63
Graham Gulch								
1996	7	35	173	151		3	7	67
1997	44	0	4	54	7	3	13	61
1999	No data							
2000	0	1	733	109	24	0	2	64
Cloney Gulch								
1996	7142	260	185	160		215	40	94
1997	2641	184	346	87	43	0	39	67
1999	869	140	11	39	141	0	45	76
2000	652	317	5	48	9	0	24	67
McCready Gulch								
1996	3124	116	8	12		0	127	81
1997	3135	52	1	10	1	0	54	75
1999	165	1	25		1	0	73	76
2000	493	68	61	4	0	0	71	60
Little Freshwater Creek								
1999	311	112	0	64	206	1	40	63
2000	131	227	4	127	15	0	64	71

* Trap moved downstream from previous location. Comparisons with other years not appropriate.

(Total number of salmonids trapped per day in the 1999 season was significantly less than in the 1996 and 1997 seasons excluding the mainstem trap site. In 1999 the mainstem Freshwater trap site was moved much lower in the watershed than in the 1996 and 1997 trapping years. The higher yearly totals of salmonids in 1999 is due largely to the relocation of trap. Coho YOY and smolt numbers were much lower in McCready Gulch and in Cloney Gulch in 1999.)

Table V.8: HFAC/AFRAMP Downstream Migrant Trapping Summaries of the 1996-2000 Trapping Data

A Freshwater Creek Tributary Close-Up: Ryan Creek

Ryan Creek, a major system in the Freshwater watershed that drains 9,400 acres into the Freshwater Slough, hosts various life stages of coho salmon, steelhead trout, and coastal cutthroat trout, and is an important spawning area for coho in Humboldt Bay watershed. Historically, considered unlikely to host significant numbers of anadromous salmonids due to a limited number and quality of spawning substrate by some biologists, it is interesting to note that coho seem to be doing quite well there! Green Diamond aquatic biologists estimate (preliminary data) 4695 +/- 111 coho smolts in Ryan Creek during spring 2004 (Michaels 2005, personal communication).

The largest challenge to conducting fish surveys and establishing population estimates for Ryan Creek watershed is the brownish-black color of the water in the main stem due to the presence of natural tannins, creating low visibility especially when the water level is low during the summer and fall. However, some surveys have been completed over the years and findings are as follows: The mainstem of Ryan Creek, Bear, Bob Hill and Henderson Gulches, and a July 1995 DFG survey found 230+ coho (3 inches or less, also referred to as young-of-year, or YOY), 21+ steelhead (3 to 6 inches), and 7 cutthroat trout ranging from 0+ to 2+ (6 inches or greater). Observations made and reported to DFG by Brian Michaels, Green Diamond Aquatics Field Coordinator on August 20, 2001, approximated 10 to 15 year of young per pool (2001). Presence/absence surveys conducted by Green Diamond Resource Company in April and May of 2001 found coastal cutthroat trout by electro-fishing at the uppermost extent of fish habitat. Electro-fishing in the mainstem conducted by Gary Flosi of DFG resulted in the presence of 0+ coho, 0+ and 1+ steelhead, and 0+, 1+, and 2+ cutthroat trout. However, the more stealthy adult steelhead have not been directly observed in the watershed.

The geology of the watershed is mostly a variation of Wildcat, coastal Franciscan Complex dominated by mudstones and siltstones of soft sedimentary origin. Soils are predominantly silty in nature and mostly include the Larabee soil series 15 to 20 feet deep. These soils when exposed are subject to rill and gully erosion. Due to the underlying parent material most streams are lacking in coarse rocky substrate and hard gravel. Stream channels of the Ryan Creek watershed are generally silty with a substrate of soft gravels and cobbles. Natural gravels are soft and easily weathered, with the exception of one tributary to the East Fork of Ryan Creek, and a portion of Bear Gulch, which cut into the underlying Yager formation which produces a supply of harder gravels including chert, to downstream lower gradient channels. These areas provide the majority of the quality spawning habitat in the drainage.

The altitude of Ryan Creek is 400 feet in the upper portion of the creek. The mainstem has a very gentle gradient, with low stream energy. Stream side vegetation is dense with an understory of salmonberry, ferns, and blackberry. Overstory vegetation is a mixture of large conifers and alders. The



In Ryan Creek, the 2002 spawning year was the best it has been since 1987 (Moore 2002). According to aquatic biologists Matt House and Brian Michaels of Green Diamond, more than 220 adult coho were observed in 2002. Fish length ranged from 12 to 36 inches.

Class I and larger order Class II watercourses are characterized by U shaped valleys with low gradient stream channels. Large organic debris is plentiful and defines most of the habitat structure. Over the last 10 years Class I and II channels have been significantly downcutting, exposing rocky substrate (where it exists) and log corduroys. Large woody debris is moderately abundant which provides structure for fish habitat.

The Human Footprint in the Watershed

Approximately 7,200 acres of the Ryan Creek watershed is owned by Green Diamond Resource Company and is managed for timber production (Green Diamond's property in the Ryan Creek watershed is often referred to as the McKay tract). Green Diamond acquired ownership of the Ryan Creek watershed from Louisiana Pacific in 1998. Trees love the soil found in the Ryan Creek watershed. Five to six foot diameter trees that are 80 to 90 years old are not uncommon in the McKay Tract according to forester Greg Templeton. Ninety-four percent of the watershed is densely vegetated with coniferous trees. Timber stands are generally of even age distribution ranging from 5 to 110 years old.

"It is of interest that coho in Ryan Creek can apparently successfully spawn, incubate, hatch, and emerge from redd sites of such poor quality. It would be interesting to know what the in-redd mortality of eggs and alevins is. I would hypothesize of the five watershed products (wood, water, sediment, nutrients, and temperature), coho production in Ryan Creek is most limited by the small amount and poor quality of its spawning gravels, and the high percentage of fine sediment in spawning areas. Ryan Creek as a whole is able to compensate for this in part by the presence of LWD, dark habitat, low gradient, cool water, good overwintering areas, good overstory and understory canopy, sufficient pool habitat, and proximity/easy access to Ryan Slough and Humboldt Bay." (Moore 2002)

Approximately one percent of the watershed is agricultural pastureland. Pasture land surrounding the mouth of Ryan Creek and Ryan Slough was used to graze livestock for many decades, as frequent flooding of the lowland flats provides nutrient rich silt supporting a luxuriant growth of tall grasses and forbs. During this time the banks of lower Ryan Creek and Ryan Slough were cleared of vegetation. Over the last 10 years willows have choked the channel with a dense tangle of stems and branches leaving the first mile of the stream choked with vegetation (Templeton 2002, personal communication).

The proximity of the watershed to the city of Eureka has an impact on the watershed. While gates restrict primary road access, there are many unauthorized points of entry adjacent to urban areas. Unauthorized recreational uses include motorcycle riding, mountain bikes, poaching, jogging, walking and horseback riding. Motorcycle dirt bike riders have the greatest impact by using both existing and abandoned dirt roads during the winter. Dirt bikes cause continued disturbance of the road surface which can lead to rutting, breaching of waterbars and channelize runoff.

Five percent of the watershed is in urban development including portions of the city of Eureka and communities of Cutten, Ridgewood, and Mitchell Heights. The encroachment of urban development into the wildland areas of Ryan Creek will have continued effects over time. Future developments are planned along the western boundary of the watershed. New subdivisions require paved streets that concentrate runoff onto forested areas. The county requires that developers acquire drainage easements from adjacent timberland owners. In the past both LP and Simpson have required developers to mitigate the effects of concentrated runoff before granting easements. New homes will also increase exposure to trespass, vandalism and fire to forested areas. Arson fires occur almost every year on the McKay Tract. New homes and the influx of people from large urban areas to rural ones also impact the

continued practice of forest management on wildland areas. Successful forest management along this urban interface will depend on cooperation, education and open communication between neighbors and forest landowners. In the opinion of environmental scientist Mark Moore, the future of Ryan Creek will lie in low impact timber harvesting and diligent road maintenance, all with the goal of minimizing sediment input into the fluvial network.

What seems to be “working” for the coho?

The gradient of the perennial streams in Ryan Creek are low, averaging 1 to 5 percent (coho tend to prefer a gradient of 3 percent or less for spawning). A large storm event uncovered a new spawning reach when about 3000 feet of low gradient stream channel on a large tributary to the East Fork of Ryan Creek was flushed of very old sediment deposits uncovering a bed of fine gravel originating from the Yager geologic formation. This reach is now the principal coho spawning habitat for the watershed. The middle and lower reaches of the watershed provide tremendous rearing habitat through the summer.

According to Green Diamond forester Greg Templeton who has over twenty years experience in the watershed, the watershed is one of significant improvement and restoration. Stream channels are downcutting, transporting stored sediment, and exposing underlying gravels and bedrock. This is evidenced by a significant increase in available fish habitat since 1976, 1982, and 1995 DFG surveys. Based on recent surveys by Green Diamond biologists and observations by the tract forester, fish have been detected in over 16 miles of stream on the McKay Tract. This can be compared to the 1995 CDFG survey which measured approximate 6 miles of fish bearing streams. This may be due to reduced harvesting and road building activities, the use of less impactful harvesting techniques, higher rainfall events from 1992-1999, habitat restoration projects carried out by the landowner and State agencies, and the natural recovery processes of the watershed (Templeton 2002, personal communication).

Other Improvements in the Watershed

During the 1970s restoration work was done to remove log jams along the main stem of Ryan Creek under the direction of the State Department of Fish & Game. Land management activities and timber harvests since 1988 on the McKay Tract in Ryan Creek have focused on rehabilitation and less impactful logging systems in addition to timber production. Several miles of roads near main watercourses have been decommissioned and replaced by roads located higher on ridges. Many acres of ground over 45 percent slope have been changed from tractor logging to cable logging. All the culverts on the main R-Line haul road were replaced, resized and rock armored in 1995. In 2001 and 2002 four large culverts on fish streams along the R-Line were replaced with bridges to improve fish migration. In 2002 and 2003 the R-8 road along Guptil Gulch was upgraded by installing new ditch relief culverts, replacing failing culverts and rerocking the road surface. Dust abatement is used on all active roads, and straw mulching and grass seeding on cut banks and fills to reduce fines entering the watercourses. Logging activities are normally restricted to May through October to eliminate operations during wet soil conditions. All of these combined management practices have led to a significant improvement to watershed conditions and fisheries habitat (Templeton 2002, personal communication).

The Ryan Slough culvert on Mitchell Road was replaced in 2001 to allow upstream migration of fish to nearly 15,000 feet of anadromous habitat. Four permanent channel cross-sections and a longitudinal profile have been established at the site (Tetra Tech, 2000).

In 1998 Green Diamond forester Greg Templeton developed a long-term plan for improving road conditions in the McKay tract with the goal of reducing the cumulative effects of sedimentation and surface erosion caused by roads and drainage structures. Priority was given to the 5.5 miles of the R-Line that parallels Ryan Creek. This long-term plan identifies areas of concern and proposes mitigation measures. Topics include culvert replacements, bridges, roadside berms, vegetated buffers, road abandonments, ditches and road surface stabilization measures. The plan also discusses new road realignments to eliminate roads within WLPZ's and relocate them to higher ridgetop areas. Long term strategies for abandonment and realignment will slightly reduce overall road density over the long term, with priority given to abandon roads adjacent to watercourses and with steep gradients. Many of these projects have been completed from 1998 to 2003.



In 2003 Green Diamond and DFG, installed a motorized rotary screw trap and placed it in the channel about 2 miles from the mouth. The trap needs to be motor operated since even in spring the discharge can be too low to turn the trap. The motor driven screw trap, if successful, will allow an annual outmigrant population estimate of coho smolts for most of the Ryan Creek drainage.

Matt House, Simpson's Aquatic Resources Coordinator and Fisheries Biologist, conducted an evaluation of stream crossings on fish bearing streams in Ryan Creek. The larger crossings on the R-Line were given first priority. The evaluation identified sites where fish passage could be improved and areas with significant erosion potential. Priorities were developed for scheduling improvement projects, including a combination of installing bridges, resizing culverts, additional fill protection and pulling out unnecessary crossings. By 2002 new bridges were installed on four major fish bearing crossings on the R-Line to replace existing culverts. Additional enhancement work is planned along Guptil Gulch and the East Fork of Ryan Creek.

Ryan Creek Watershed is one of four watersheds that will participate in Green Diamond Resource Company's Experimental Watershed Program. Class III sediment monitoring and turbidity monitoring began last year as part of this program and will continue (approximately five years of initial trend monitoring are expected in order to set appropriate biological objectives and threshold values). Road related mass wasting monitoring in Ryan Creek Watershed is also scheduled for the future as a component of Green Diamond's Aquatic Habitat Conservation Plan (AHCP) (Diller 2002, personal communication).

Potential Limiting Factors and Future Monitoring

Even though conditions are currently improving, large amounts of fine sediment are still present. Existing watercourse conditions in the Ryan Creek drainage are a product of past land use practices, natural geologic conditions and climactic events that influence peak flows and soil saturation. There have been several periods of heavy logging impacts to the watershed. These activities in addition to natural hydrological events have delivered large quantities of silt and large organic debris into

the watercourse channels in the low gradient storage reaches of the watershed. Over the last decade stream channels have cut deeply (up to 5-15 feet) into these low gradient storage reaches. Bedrock, soft gravels and even some mudstone boulders are exposed. Oxen corduroys can be seen at a relative high position in the sediment depositions. These corduroys were placed in the stream channel in the 1880s-1890s and mark the first logging impact. The observation that channels have recently downcut well below the corduroys, indicates that large amounts of stored sediment were present prior to the first logging entries. Sediment production, transport, and deposition play key roles in determining the quality of salmonid spawning, rearing, and resident habitat (Templeton 2002).

Limiting factors for fisheries production in this watershed may be the limited amount and quality of spawning substrate in the upper reach. However the middle and lower reaches provide tremendous rearing habitat through the summer. Something is working well, despite the huge impact man has made in the watershed, considering the fact that more than 200 adult coho returned to spawn in their natal stream in 2002. Another possible limiting factor may be the lack of water in late summer in the upper reaches. This could possibly limit the over-summer rearing habitat and thus the survival of year-of-young (YOY) coho. Green Diamond is attempting to exploring these potential limiting factors in the Ryan Creek watershed (Michaels 2003, personal communication).

Green Diamond fisheries biologists have tried snorkeling, minnow traps, seining, and electrofishing, but conditions are tannic and the soft geology causes “clouding” thus preventing the efficient use of these methods of population assessment. In order to get *some* numbers, though they are rough, Green Diamond fisheries biologists have combined single pass snorkeling, and visual observation with an electrofishing calibration in the uppermost mile of the watershed where the water is less tannic and have had considerable coho numbers. They captured quite a few fish seining as well, but determined to find a way to more systematically estimate outmigrant populations, Green Diamond and DFG installed a motorized rotary screw trap to get an idea of how productive this stream really is or is not. Combined with other surveys like spawning surveys and summer estimates we may begin to understand why coho still persist in this watershed, in apparently good numbers, regardless of management history. But without this research everything is speculation. *Data forthcoming!*

V. B. 3.2 Habitat Surveys

Habitat surveys include channel typing, riparian and LWD surveys, cross-sections, substrate sampling and rates of sedimentation. Several habitat surveys have been conducted by CDFG (1994, 2000, 2004), Coastal Stream Restoration Group (2001), Pacific Lumber Company (1994-2004) and Humboldt Fish Action Council through the years. PALCO will also be conducting habitat surveys throughout the life of their Habitat Conservation Plan. While the surveys were conducted in different reaches with different methods of collection, there is useful comparable information that can give some indication of changes in habitat quality and quantity in the watershed. The most recent habitat surveys conducted by CDFG in 2004 are not yet available.



Several surveys exist for comparison of changes in channel function and rates of sedimentation. The 1975 Army Corps of Engineers flooding study made measurements of bed elevations that have been used for repeatable cross-sections to estimate channel aggradation. CDF revisited three cross-section sites in the lower Freshwater in 1998, as did PALCO in 1999 when collecting data for the Freshwater Watershed Analysis report. CDF estimated that there had been 6 inches to a foot in aggradation between sites since 1975. PALCO estimated aggradation levels up to 4ft (at Steele Lane Bridge) and found other sites with one foot or less (Jeff Barrett, personal communication). In some areas there was degradation and bedrock exposure (common in mainstem Graham-Little Freshwater). John Bair, riparian biologist, revisited a site downstream of Howard Heights Road in 2000 and found evidence of severe bank accretion (PALCO 2000; Bair 2001).

Other comparative studies include substrate sampling. Gravel freeze core samples of sediment less than 1 mm from Freshwater Creek was collected in 1988 by Keith Barnard (Barnard 1992). Samples were collected within one meter of coho redds with some sites very near PALCO shovel sampling sites and are representative of gravel conditions at the time (Higgins 2001; Barnard 1992).

According to PALCO's Freshwater Creek watershed analysis, "Upper Freshwater appears to provide the best winter rearing habitat in the basin, followed by middle to upper Little Freshwater and middle McCreedy Gulch. Relatively poor winter rearing conditions exist in Lower Freshwater and the School Forest due to heavily embedded substrates that restrict juvenile migration and the ability of juvenile salmonids to utilize the sub-basin" (PALCO 2001).

The Pacific Lumber Company Freshwater Watershed Analysis Report (2001) found high rates of embeddedness in the upper reach indicating that fine sediment is filling gravels in pools. The average of all stations surveyed in 1999 was 22.9 percent fine sediment less than 0.85 mm whereas levels less than 16 percent are considered desirable for salmon and steelhead according to PALCO. High embeddedness is an indicator of potential sediment impacts (Jeff Barrett, personal communication). The upper reaches of mainstem, South Fork and gulches are primarily used for spawning. Good spawning and rearing conditions in these reaches are the cornerstone to a healthy genetic diversity and replacement capability of fish.



V. B. 4. Opportunities and Challenges

Today Freshwater experiences only a small percentage of the returning fish that had historically spawned and reared in the basin. The ecological health of Freshwater Creek has received a lot of attention by watershed groups, residents, and landowners in recent years. Most of the attention to sources of impairment in the watershed is given to PALCO and their current timber harvesting practices, but other sources of impairment exist including legacy effects from historic logging practices, development, agricultural practices.

Timberlands/Roads

The Freshwater Creek watershed is primarily managed for timber, which has an impact on the beneficial uses of the watershed. North Coast Regional Water Quality Board staff determined that harvest and related activities contributed significantly to adverse impacts through increased landsliding, sediment generation and deliveries (2000).



Increased harvest rates over a relatively short period of time, along with very high turbidity levels raised concerns over survival of these species. Currently, turbidity and fine sediment levels have degraded habitat for salmonids in the watershed and agency representatives have determined that maintaining status-quo will not allow for recovery (RWQCB 2000). Freshwater Creek was listed as an impaired waterway by the Water Quality Control Board in December of 1997 in part due to elevated levels of fine sediment. The Regional Water Board Authority plans to have a draft Total Maximum Daily Load (TMDL) analysis and adoption by the Regional Water Board in August 2006. The TMDL will “identify numeric or measurable indicators and target values that can be used to evaluate the total maximum daily load and the restoration of water quality in the watershed.” The process will

include public participation through meetings with stakeholders, coordinate with agencies/organizations, and public review of drafts.

A variety of processes are responsible for sediment production and delivery in the Freshwater Creek watershed, including current and legacy timber harvest and related activity. Residents, environmental groups, fisheries biologists, geologists, and fish monitoring groups have blamed sediment for many problems within the watershed. Resources that are impacted by increased suspended sediment loads include, but are not limited to, fish and their food sources, aggradation of stream beds resulting in the loss of salmon redds, and sedimentation of the Humboldt Bay and estuary.



PALCO biologists testing turbidity

In the late 1960s the lower basin's second growth forests were commercially thinned. Clearcut harvesting rates increased to an average of just under 400 acres per year (2.6 percent of the basin per year) for the recent period (1990-1997), while overall harvest rates (clear cutting plus partial cutting) have rose to an average of over 1,200 acres per year (7.8% of the basin per year) by the year 1998. Previously, the average had been 175 acres per year with the highest rate of harvest recorded in the 1930s at nearly 600 acres per year (FWWA 2001). These logging activities have not been evenly spread over the upper watershed. Some sub-basins such as McCready and Cloney Gulches, South Fork Freshwater and Little Freshwater have been over 50 percent harvested over approximately a 11-year period (including clear cuts and commercial thins).



Salmon Forever cross-section at Graham Gulch. Comparison of cross-section data from year to year can reveal changes in sediment load and aggradation.

Second cycle logging of Freshwater's second growth trees occurred sporadically, but most substantially beginning in 1987 (PWA 1999). Logging and road construction increased from 1987 to 1997. Roads built from 1987-1994 include many short ridge spur roads built off the old ridge-top railroad grades in Little Freshwater Creek and around the headwaters of Graham Gulch and Cloney Gulch. Most of the 35 miles of new roads constructed between 1994 and 1997 in Freshwater Creek occurred along ridges in the western half of Little Freshwater Creek and on ridges in the South Fork (PWA 1999). Based on PALCO road surveys in 2001, approximately 24 miles (12%) of roads in their ownership deliver runoff directly to streams. An estimated 80 additional miles (38%) are within 200 feet of a stream and are believed to deliver a portion of their sediment to streams (PALCO 2001). Sediment delivery from roads is predominately fine silt and clays.

Approximately 15,400 acres, or 77 percent of the watershed is owned and managed for timber by the Pacific Lumber Company. Pacific Lumber Company is currently allowed by CDF a harvesting rate of 3.2% or 500 clear-cut equivalent acres per year within their Freshwater watershed property (PWA 1999). Since 1999, the Pacific Lumber Company has operated under a Habitat Conservation Plan which requires additional restrictions, but many do not believe that the HCP adequately addresses cumulative watershed impacts, including water quality.

All parties agree that there are unnaturally high levels of sediment in the creek system, in some cases above thresholds suitable for salmon. There is also agreement that the main source of sediment input is the upper watershed. Points of contention however, surround quantitative sources of sediment, its relationship to rate of timber harvest and road construction in the watershed, and its contribution to cumulative watershed effects. PALCO maintains that roads are the problem while outside reviewers believe that rate of harvest is the main culprit. Rates of harvest have been calculated for Freshwater and neighboring sediment-impaired waterways. The divergent results, 80 clearcut equivalent acres per year (0.9 percent of the watershed) according to methodology by Redwood Sciences Laboratory, and 500 clear-cut equivalent acres per year (5.8 percent of the watershed) allowed by CDF, have been a point of heated debate and an important issue undertaken by an independent science review panel appointed by Water Quality Board staff.

Flooding and channel aggradation problems in the watershed have been attributed to the increased rate of logging and downstream changes by residents and agriculture. Several groups including the Freshwater Working Group and the Humboldt Watershed Council have been in litigation and mediation with Pacific Lumber Company to address disputes over logging rates, high turbidity and subsequent impacts to an already degraded watershed.

There is agreement that the presence of sand and fine sediment in pool and riffle habitat reduces the quality and may reduce the quantity of rearing habitat in many locations in the Freshwater watershed. Residents and other parties have monitored the output of tributaries that have experienced recent logging in order to correlate impacts to fish population and increased turbidity of these areas. Studies conducted in Oregon have found reduced fish species diversity in heavily logged watersheds (Reeves et al 1993). Evidence suggests that fish will avoid those areas recently disturbed until it is allowed to recover.

Development

The 1983 Freshwater Community Plan (the most current community plan) states that new development would increase the covering of the soil by buildings by less than 0.5 percent. The community plan land-use designation reduced plan densities in these areas so as to prohibit the creation of additional building lots located entirely within floodplain areas. The planning area includes approximately 1000 acres of prime agricultural soils. This land is along Freshwater Creek and Myrtle Avenue. Three hundred and fifty acres of this land has been subdivided into parcels of less than 10 acres in size. One hundred and sixty acres of prime agricultural soils are within the Timberland Production Zone and two hundred acres are in parcels larger than 10 acres dispersed along Freshwater Creek and Ole Hansen Road. Density increases are not allowed by the plan in these areas. The remaining two hundred and ninety acres of the planning area's prime agricultural soils are in large acreage parcels at the mouth of Freshwater Valley. An area of 270 contiguous acres for agricultural use along Freshwater Creek was retained to reduce environmental impacts of development. The addition of a maximum potential of 429 additional dwelling units was considered for its increased traffic and on-site wastewater disposal problems (County of Humboldt Planning Department 1983).

V. B. 5. Restoration and Conservation Efforts

Much of the early restoration work involved planting chinook and coho fry from nearby stream systems into Freshwater Creek by Humboldt Fish Action Council (HFAC), a private non-profit organization. Other efforts consisted of clearing large woody debris from streams by the California Conservation Corps (CCCs). In 1985, HFAC was awarded a grant by the CDFG to set up a semi-permanent weir trap on Freshwater Creek and trap chinook and coho salmon for taking eggs and eventual release into the system. The trap is still operational, but HFAC is no longer taking eggs or rearing fish.

Salmonid habitat restoration work was performed in the watershed throughout the 1980s. Prior to 1985, CCC crews performed removal and modification of jams composed of LWD. From 1985 to the present, habitat restoration crews from Redwood Community Action Agency (RCAA), Coastal Streams Restoration Group (CSRG), Pacific Coast Fish, Wildlife & Wetlands Restoration Association (PCFWWRA), and HFAC have been funded to work with willing landowners to stabilize stream banks, conduct riparian replanting, exclude cattle from the stream corridor, improve fish passage through road culvert replacement, monitor fish presence/

absence, modify LWD jams and improve spawning and rearing habitat. In late 1986, the Humboldt Fish Action Council joined in a cooperative effort with CDFG and Humboldt State University, under the direction of Dr. Terry Roelofs, Professor of Fisheries, to intensively evaluate the fisheries of the Freshwater Creek basin. Dr. Roelofs, assisted by his fisheries students and HFAC volunteers, began a long-term study of the basin (Barnard 1992).



South Bay lowlands

The Fisheries Restoration Grants Program of CDFG has provided funding for stream restoration and research such as an enhancement program for the lower reaches of Freshwater Creek by the Coastal Streams Restoration Group. A series of pool enhancement sites were selected in the lower reach of Freshwater for LWD, rootwad, and boulder placement in 2000-2001. More recent restoration efforts are underway or scheduled to take place, such as culvert replacement and riparian enhancement.

V. B. 6. Current Salmonid Habitat Conditions (By Lower Middle, Upper Reaches)

V. B. 6.1 Estuary/Lower Reach (Humboldt Bay to Three Corners at Old Arcata Road)

The mouth of Freshwater Creek is known as Eureka Slough. This salt and freshwater environment is important in the life and development of anadromous fish in Freshwater Creek. The estuary is characterized by a low gradient and is influenced by tidal action. Levees confine the channel but levee breaks allow overflow to floodplains. There is some tidal influence above this reach, with salt water pockets observed above the HFAC weir during high tides.

The lower 3.7 miles of Freshwater Creek is characterized by a low gradient, silty stream bed with very little salmon spawning habitat. Six miles of the mainstem of Freshwater Creek beginning at Howard Heights Road provides some coho spawning habitat (Barnard 1992).

In surveys done by HFAC during summer flows, salinity levels were measured to identify tidal influence in the lower watershed. Tidal influence was documented all the way up to Howard Heights Bridge. The slough between Three Corners and Devoy Road gradually loses all salinity. Between Devoy Road to Park Street is a transitional tidal area and gradually becomes more marine from Park Street to the Bay (Jud Ellinwood, personal communication).

Habitat Structure: There is little observable LWD in the lower reach and channel complexity is lacking. The current lack of deep pools is a strong indication that large-diameter woody debris is of critical importance in these streams. The current lack of deep pools also strongly suggests that pools have been aggraded. Most of the wood-formed pools in Freshwater are formed by relict old-growth. When these logs decay, there will be nothing of equivalent size to replace them for the foreseeable future.

In a habitat survey conducted in September 2001 on the lower reach of Freshwater Creek, most of the pool tail-outs were unsuitable for spawning due to the dominant substrate being silt/sand/clay or small gravel. Twenty of the twenty-five pool tail-outs had embeddedness ratings of 50-100%.

Below Three Corners there is little to no riparian vegetation and in many places, there is only grass right up to the bank. Above Three Corners the riparian vegetation consists mostly of willows and shrubs, unsuitable for recruitment of long-term LWD. The amount of cover that exists is being provided primarily by small woody debris and undercut banks in all habitat types. Large wood and boulders contribute a small amount of cover.

Water Quality: The most significant water quality limiting factor in the lower watershed are high levels of fine sediment. Sediment in Freshwater watershed has been monitored and assessed by multiple parties. The main studies include Pacific Watershed Associates' Sediment Source Investigation (1999), Pacific Lumber Company's Freshwater Creek Watershed Analysis (2001), and Drs. Leslie Reid and Tom Lisle's review of the Freshwater Creek Watershed Analysis (2001). Salmon Forever, a nonprofit monitoring group, also collects water quality data in Freshwater Creek along with Redwood Sciences Laboratory and Humboldt State University. PALCO's watershed analysis results have not been accepted by many of the downstream residents and scientific reviewers. In addition, a "Dissenting Report" was prepared on behalf of the Humboldt Watershed Council (Higgins 2001). Although the watershed analysis will guide management of PALCO's timberlands, it has done little to bring consensus among the disputing parties.

Salinity measurements and temperature have been monitored recently in the lower reach following an enhancement project and in preparation for a wetland restoration project at Freshwater Farms and Fulton Property. Temperature ranges measured were suitable for salmon however high temperatures have been recorded by CDFG in the lower slough, temperatures ranging between

21-23°C during mid-day. Dissolved oxygen levels have not been widely considered a limiting factor because of generally cool coastal water temperatures and lack of dairies on Freshwater Creek but more monitoring of DO levels needs to be done.

Water Quantity: Freshwater residents report that flooding events in the watershed have become more frequent in recent years (1995-2001). Flooding events are generally associated with storm events in combination with a high tide. Flooding impacts in this reach are minimal since the estuary has few stream-side structures. Grazing pasture along the lower creek is inundated by winter floods and residents report the creek jumping the levee and having on occasion taking cattle downriver (Butch Parton, personal communication).

Although high peak flows can be a nuisance to creek-side landowners, water quantity does not appear to be a limiting factor for fish. In some cases, large storm events that inundate floodplains and backchannels provide additional habitat and nutrient access for fish.

Potential Limiting Factors: Poor winter rearing conditions exist in Lower Freshwater due to heavy embedded substrates which restricts salmonids from using interstitial spaces in the streambed, as well as lack of cover, poor access to flood plains and low large wood complexity. Aggradation in localized portions of some stream reaches, including channel segments in the lower mainstem where flooding is of concern, is due to fine sediment and sands (PALCO 2001).

Habitat simplification, including channelization, diking, and removal of instream wood as observed in lower Freshwater have negative effects on the quality of fish habitat. There is a virtual lack of backwater channels due to the levees in this reach. Simplification of the estuary habitat reduces the rearing habitat of smolts as they acclimate to the saltwater environment. Lack of refugia in the lower reach also can cause smolts to be prematurely forced into the ocean environment at smaller sizes leaving them vulnerable to ocean conditions (Sigler 1980). There is a lack of, and a need for, data regarding the size of outmigrating fish for Freshwater Creek and a lack of scientific knowledge of the role of estuary utilization for salmon (Wallace 2003).

V. B. 6.2 Middle Reach (Three Corners to the confluence of Graham Gulch)

A gradient change occurs below Pacific Lumber Camp Road where the valley also widens. This reach is characterized by a very low gradient (less than 0.5%), unconfined channels and floodplains subject to inundation at high flows.

Habitat Structure: Levees confine the channel in the lower reach (Three Corners to Freshwater Park). This reach is a zone of tidal influence with fine bed sediment, interspersed with gravelly areas. Salmon use this area primarily for rearing and may spawn there in low water years (Higgins 2001). There are a high number of pools, mostly corner pools. Substrate is predominantly gravel and sand with small cobble subdominant in the upper reaches.

Large wood frequency is low and the riparian zone is narrow due to agriculture and residential encroachment. In many places, the extent of riparian vegetation is one tree wide. Although the streambank vegetation can provide some velocity refugia, winter rearing habitat is poor with low amounts of complex LWD cover in pools and limited access to floodplains until flows overtop the banks during storm events. In the middle reach, LWD recruitment potential is limited in the long and short-term. Residents have reported that existing large wood has been buried by aggradation in some reaches of lower Freshwater (Reid and Lisle 2001).

Bank erosion is prevalent in places (PALCO 2001, CDFG 1994). Cross-sections and observations made by residents indicate significant bank accretion in other places where sediment has been deposited. Deposition of sand and silt on stream banks is a cause of concern regarding the effect it has on flood conveyance (Reid 2001). Bank accretion has been attributed to decreased channel capacity and the seemingly short span of time that sediment has accumulated corresponds with increased flooding in the watershed.

Two road crossings in the lower reaches of McCready Gulch and Graham Gulch were identified as either seasonal or permanent migration barriers for salmonids (Taylor 1999). The McCready Gulch crossing was located on an old county road and was replaced in 2002. The Graham Gulch county road crossing is constructed of a sectional steel pipe. It is a partial barrier to adults and a complete barrier for juveniles due to jump height (PALCO 2001). The County is planning on replacing the Graham Gulch culvert sometime in the next 5 years.

Water Quality: As in other reaches, high levels of suspended sediment are the significant limiting factor for water quality in regard to salmon and steelhead in the middle reach of Freshwater. Salmon Forever has been monitoring turbidity in Freshwater Creek for over 5 years at their site located on the mainstem at the confluence of Graham Gulch. In 2000, a moderate rainfall year for Northern California, more than 4,500 metric tons (9 million pounds) of sediment passed the mainstem Freshwater Creek ISCO pump sampling station. For 2001 hydrologic year it was calculated that 1.08 million pounds of sediment flowed past the station (a drier year). It can be assumed that total sediment transport through Freshwater Creek is much greater since the sampling station is located upstream from three major tributaries (Clark Fenton, personal communication).

The reach between Little Freshwater to Three Corners is a very low stream gradient and reduced stream velocity encourages deposition of fine sediment. Coarse sediment is limited in this reach and gravel is highly embedded. The landslide in Graham Gulch is a long-term sediment source with a reactivated toe jam contributing a large portion of fine and coarse sediment into the mainstem.

Failure of septic tanks in the watershed have been reported during winter months due to saturated ground. Several repairs have been done with alternative systems such as mound and sand filter systems. The Freshwater Community Plan completed in 1983 required new residences to have alternative systems installed. The Shellfish Task Force did limited monitoring on the lower reach of Freshwater Creek for temperature and bacteria and fecal coliform for the period of January to May, 2000 (Dave Spanosa, personal communication).

Temperatures are not considered a limiting factor and are adequate for salmonid survival and year-round growth. Optimal temperatures allow feeding throughout the winter months in coastal streams such as Freshwater Creek. Water temps in the spring range from 54-60 °F (HFAC 1999).

Water Quantity:

The Redwood Sciences Laboratory review of the PALCO watershed analysis, cited field evidence such as cross-sections which consistently showed aggradation in the portion of Lower Freshwater with aggradation in the range of at least 1 to 3 feet (Reid 2001; PALCO 2001). Due to relatively entrenched nature of the channel, peak flows have the potential to scour redds, although

only limited spawning occurs here (where willows and bank vegetation are absent).

Monitoring sites have been established on mainstem Freshwater Creek at Howard Heights Bridge, Pacific Lumber Camp Road, Freshwater County Park Bridge, and on the tributaries of McCready, Cloney, and Graham Gulch. The mainstem Freshwater Creek monitoring station is operated by Salmon Forever in conjunction with USFS Redwood Sciences Laboratory and samples are analyzed at the Sunny Brae Lab. It monitors hydraulic data including stage (water height in feet), water discharge, streambed morphology, turbidity, estimated sediment concentration, water temperature and rainfall. The McCready Gulch station is operated by HSU. Data for both locations is available in 15' time increments. Hydraulic data definitions at monitoring sites are not uniform.

Hydrological information including discharge, turbidity, and stage are available for water years 1999-2000 at Redwood Sciences Laboratory's website.

Potential Limiting Factors: Turbidity is being monitored during and after storm events by Salmon Forever and U.S.D.A Redwood Sciences Laboratory, Watershed Watch and PALCO. Data for the 2002 hydraulic year showed that turbidity at Howard Heights Bridge averaged 200 NTU at a 6ft. stage, to 400 NTU at an 8ft. stage and then an average of 600 NTU at a 10 feet stage. Although thresholds are disputed, these levels of suspended sediment are much higher than a commonly cited threshold (25 NTUs) for both juvenile and adult salmon if sustained over a week. The timeframe in which peak flows are reached in Freshwater includes periods of alevin feeding, elevated suspended sediment limits visibility and ability to find food.

Erosion from harvested stream slopes, riparian vegetation removal, roads and direct drainage ditches, cattle-crossings and urban development are all human contributors to high sedimentation in the watershed. High turbidity also caused by increased sediment compromises habitat conditions needed for fish development and survival. Abundance of fine sediment due to the unconsolidated geology combined with a very low stream gradient and reduced stream conveyance encourages deposition of fine sediment in the middle reach.

Impaired riparian conditions and channelization are also significant limiting factors along the middle reach. Mature conifer forest along the stream has been replaced with open hardwoods such

as willow, maple, and alder. These riparian species may provide shade but restrict channel meander and do not provide large wood recruitment.

V. B. 6.3 Upper Reach (The mainstem above the confluence of Graham Gulch, Upper Freshwater, and South Fork Freshwater)

This reach is characterized by a moderate to low gradient on the mainstem to South Fork and increasing steepness in elevation upstream with little flooding. The upper mainstem made the largest contribution of emigrating fish from Freshwater Creek last year (2001) with 9 percent of the steelhead and 26 percent of the coho salmon from the basin wide yield (Ricker 2001). Overall, tributaries contributed 17 percent or 1812 steelhead and 48 percent or 2919 coho salmon to the entire emigrating yield. Upstream adult migration ceases when it reaches high gradient reaches, waterfalls, and/or impassable boulder roughs in each of the sub-basins.

A series of natural migration barriers are located downstream of the Road 15 bridge in Upper Freshwater Creek. No fish were observed during the PALCO Watershed Analysis surveys and two years of electrofishing surveys above this point. There are some riffles in the Upper South Fork that become intermittent during summer low flows and create seasonal juvenile migration barriers (PALCO 2001).

Habitat Structure: In the lower reaches of Upper Freshwater and South Fork, middle portions of Little Freshwater, and McCready Gulch, the substrate is primarily small cobble and gravel. Pool-forming wood frequency is moderate with the exception of lower reach - South Fork to Graham Gulch - which has very low frequency of LWD. A few pools are formed by scour along bedrock. The upper reaches have more suitable rearing habitat with boulder and LWD-forming pools, however, low flows and steep gradient restrict utilization in the upper reaches of South Fork and Upper Freshwater (PALCO 2001).

In the South Fork, a dense network of debris jams retain sediment. Fine sediment storage is much higher in South Fork than in the upper mainstem. Unstable banks are one of the primary factors for recruitment of LWD into this channel type (PALCO 2001).

Embeddedness results, although limited to surveys in 1991, 1992 and 1999, indicate that fine sediment is abundant and that some significant pool filling had occurred during this study period. Habitat surveys conducted in 1992-1999 for Pacific Lumber

Company show an increase in the percent of pools filled in gulches and upper reaches. In the North Fork for example, pools went from less than 2 percent filled to just less than 50 percent filled between 1992 to 1999 (Higgins 2001).

Water Quality:

Management related activities such as timber harvesting and road construction on sediment inputs to streams are the largest contributor of fine sediments in the watershed. The upper watershed and gulches are the location of the majority of timber harvest in Freshwater Creek. Pacific Watershed Associates' Sediment Source Investigation conducted for Pacific Lumber Company on their Freshwater property identified and prioritized road-related sites with future sediment delivery. The majority of sites are within McCready, Cloney and Graham Gulches which contain the highest density of abandoned logging roads.

Herbicide and pesticide use in the watershed is of concern to community members. Pesticides and other chemicals can cause neurological damage to fish as pollutants move through the food chain. The California Department of Pesticide Regulation Database shows forestry application for the years 1996-1999 totaling 1676 acres treated in Freshwater Creek watershed. The total acreage sprayed can be assumed to be much greater with residential and unregulated use throughout the watershed. Monitoring of chemical toxicity levels in Freshwater is not being conducted by agencies at this time.

Three locations are monitored for water temperature by PALCO in the Freshwater Creek Basin: McCready Gulch, Little Freshwater Creek and the upper North Fork. The floating weekly average water temperature at the three locations measured in 1999 was 16.8 °C. None of the floating weekly average temperatures exceeded 16.8 °C; therefore, all had temperatures suitable for supporting coho salmon (PALCO 2001).

Water Quantity:

The upper reaches experience intermittent or ephemeral flow which restricts spawning activity during summer months. Graham Gulch, for example, has been observed as flowing underground during summer months. However, peak flows from episodic events in this reach could scour redds in reaches that support spawning (PALCO 2001).

Potential Limiting Factors: Given the generally good riparian conditions in the upper reach, the most likely limiting factor in the upper watershed is that it is the source of fine sediment. Turbidity

levels may also be a limiting factor for spawning fish in the upper watershed. If turbidity levels are too high when fish are ascending they will avoid those tributaries with turbid waters (Sigler 1980). This may be an indication of what is happening with the dropping viability of spawning numbers in Cloney and Graham Gulch, and Lower Freshwater Creek, where reductions in the number of spawning fish is evident in some years (Pat Higgins, personal communication).

A lack of instream LWD may be a limiting factor in the upper watershed.

According to PALCO habitat surveys, the South Fork has prevalent bank erosion and streamside landslides. V^* measurements in the upper mainstem, Graham Gulch and South Fork indicate that fine sediment is accumulating in pools to a significant degree and sediment in pools dramatically increased in Graham Gulch and the upper mainstem during the 1990s. Unstable banks are present in some of the habitat units.

Table V.9: Existing Salmonid Habitat Conditions in Lower Freshwater Creek

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food source is not a problem for adult salmonids because adult fish do not feed during their stream migration.	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Riparian degradation reduces the food supply of juvenile and resident salmonids, while high sediment levels make feeding more difficult (reduced visibility). Chronic turbidity in Freshwater Creek is considered a limiting factor. High velocity make it difficult for juveniles to catch food and reduces the availability of invertebrates that are a food source.	Poor riparian and in-stream habitat in the Freshwater Creek watershed may reduce food supply and alter feeding habits during downstream migration. The decreased size and quality of the estuary also reduces food supply for anadromous salmonids during smoltification.
Water Quality	High concentrations of suspended sediment and turbidity exist in Freshwater Creek and directly impact the usage of this watershed by adult salmon and steelhead. There is little to no good spawning habitat in the lower watershed. Spawning salmonids must use the upper watershed and tributaries for adequate spawning gravel. Temperature in the lower watershed is not known to be a limiting factor for adult migration.	Dissolved Oxygen (DO) levels, which are very important during incubation, are significantly reduced when there are high levels of fine sediment present in gravel. Elevated levels of sediment are present in Freshwater Creek, thus reducing the amount of DO available in the gravel and causing higher rates of mortality.	Poor water quality resulting from high turbidity and suspended sediment, (such as those found in the Freshwater Creek watershed) can decrease growth rates in juvenile salmonids thus dramatically reducing survival rates. Fish size when entering the ocean is directly related to the rate of survival.	The poor water quality may impair feeding habits and growth rates. Studies show that resident trout and juvenile salmon use the estuary longer than previously thought. If there is not adequate habitat in the lower watershed salmonids are forced out of the system early and reduces the chances of survival in a marine environment.
Habitat Structure	Freshwater Creek lacks significant large woody debris and other creators of habitat complexity, especially in the lower basin. Due to the high concentration of sediment throughout, the watershed lacks significant clean spawning gravels as well. Access to Fay Slough is limited by the tidegate.	The lack of clean spawning gravel and high levels of suspended sediment in this watershed results in the suffocation of many embryos and alevins. Because many adults are forced to spawn in the main stem, (often lacking significant habitat complexity) incubating salmonids are often exposed to higher flows, often resulting in the redds being “washed out.”	Simplification of habitat from a variety of activities including removal of and riparian habitat, especially in the lower reaches of the watershed, provide for a difficult rearing environment. Pools created by LWD and other forms of scour, are also important for resident populations. The estuary lacks habitat complexity in the forms of LWD, pools, backwaters and side channels.	Reduced habitat complexity (lack of backwater channels and LWD) in the watershed has made it more difficult for juvenile salmonids during downstream migration. The decrease in the size and quality of the estuary affects food supply and shelter necessary for adaptation to the salt water environment.
Flow and Depth	Because of degradation over the last 150 years, the watershed has lost much of its capacity for water retention. This has resulted in increased flood frequencies. Levees and the Highway 101 over-pass has restricted the channel. Aggradation in the lower reach has also decreased flow capacity. Along with high tides, a storm event causes a serious flood risk. Observations during these events has reported the river jumping the dikes and flooding ag land.	Historic observations recorded that spawning took place between Three Corners and Freshwater Park. This reach no longer supports spawning and incubation. There is adequate flow and depth, however, other factors that can limit salmonid embryo survival.	Flows have not been identified as a significant problem for Freshwater with regards to rearing habitat. However, low flows may affect migration by creating barriers to fish passage.	Flow has not been identified as a significant problem on juvenile migration.

Table V.10: Existing Salmonid Habitat Conditions in Middle Freshwater Creek

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food source is not a problem for adult salmonids in this watershed because adult fish do not feed during their upward migration.	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Riparian degradation reduces the food supply of juvenile and resident salmonids, while high sediment levels make feeding more difficult. (reduced visibility). Chronic turbidity in Freshwater Creek is considered a limiting factor.	Poor riparian and in-stream habitat in freshwater watershed may reduce food supply and alter feeding habits during downstream migration.
Water Quality	High concentrations of suspended sediment and turbidity exist in Freshwater Creek and directly impact the usage of this watershed by adult salmon and steelhead. Habitat surveys conducted by HFAC found good temperatures with the exception of temperature spikes in sections without canopy cover.	Dissolved oxygen (DO) levels, which are very important during incubation, are significantly reduced when there are high levels of fine sediment present in the gravel. Elevated levels of fine sediment are present in Freshwater Creek, thus reducing the amount of DO available in the gravel and causing higher rates of mortality.	Poor water quality resulting from high turbidity and suspended sediment, (such as those found in Freshwater Creek watershed) can decrease growth rates in juvenile salmonids thus dramatically reducing survival rates. Fish size when entering the ocean is directly related to the rate of survival. Adult fish held in the HFAC weir died due to low DO levels. Decreased DO levels may be a limiting factor during summer low flows because of elevated water temperatures.	Chronic high turbidity levels exist in the watershed which may affect the over-wintering of juvenile salmonids.
Habitat Structure	Due to the high concentration of sediment throughout, the watershed lacks significant clean spawning gravels. Culverts on McCreedy and Graham Gulch remain an obstacle to fish migration during low flows (scheduled to be replaced).	The lack of clean spawning gravel(s) and high levels of suspended sediment in this watershed results in the suffocation of many embryos and alevins. Because many adults are forced to spawn in the main stem, (often lacking significant habitat complexity) incubating salmonids are often exposed to higher flows, resulting in the redds being “washed out.”	Simplification of habitat from a variety of activities including removal of riparian habitat, provide for a difficult rearing environment. Pools created by LWD and other forms of scour, are also important for resident populations. Riparian cover is important for creating refugia especially in summer months. Riparian vegetation removal along the middle reach results in temperature spikes and lack of LWD recruitment.	Low flows in the upper watershed and tributaries make it difficult for migrating juveniles to access good habitat in the upper reaches and move from one area to another to feed, and may result in over-crowding and competition for suitable habitat.
Flow and Depth	Because of degradation over the last 150 years, the watershed has lost much of its capacity for water retention. This has resulted in increased flood frequencies.	There are adequate flows for incubation however, during storm events flooding may occur and wash-out redds.	Flows have not been identified as a significant problem for Freshwater with regards to rearing habitat. However, low flows may affect migration by creating barriers to fish passage. Habitat surveys conducted by PALCO showed a decrease in the number of deep pools and depth of remaining pools. Lack of deep pools in the middle reach due to aggradation and limited in-stream structures may decrease the number of suitable habitat for rearing juveniles and residents.	Flow has not been identified as a significant problem on juvenile migration.

Table V.11: Existing Salmonid Habitat Conditions in Upper Freshwater Creek

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food source is not a problem for adult salmonids because adult fish do not feed during their upward migration.	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Canopy cover is abundant in the upper reaches providing shade (North and South Forks), and source areas supplying terrestrial insects to watercourses (PALCO 2001).	
Water Quality	High concentrations of suspended sediment and turbidity exist in Freshwater Creek and directly impact the usage of this watershed by adult salmon and steelhead. Habitat surveys conducted by HFAC found good temperatures with the exception of temperature spikes in sections without canopy cover.	Dissolved oxygen levels and temperature are not known to be a limiting factor in the upper watershed. High levels of embeddedness were found in gravels in the upper and mid-reaches. Chronic turbidity in Freshwater Creek during incubation and emergence could affect the abundance and survival of fry emigrating from this stream.	Poor water quality resulting from high turbidity and suspended sediment, (such as those found in Freshwater watershed) can decrease growth rates in juvenile salmonids thus dramatically reducing survival rates. Fish size when entering the ocean is directly related to the rate of survival.	Chronic turbidity in tributaries impacts feeding, growth and social behavior in fish. Juveniles rearing in turbid waters may leave the freshwater system early and at smaller sizes decreasing the chance of survival (Sigler 1981). Fish counts from the last 5 years show a decline in the output of tributaries (Higgins 2001, HFAC data 1996-2001).
Habitat Structure	Tributaries to Freshwater Creek increase in gradient in the upper watershed and prevent anadromous migration due to steepness. Good cobble and gravel substrate in riffles for spawning. There is adequate LWD with the exception of the lower reach (below South Fork) which has poor frequency of LWD. Access to Graham Gulch tributary may be limited by culvert. Potential for future degradation of marginal (and declining) habitat quality (Taylor, 1999).	The lack of clean spawning gravel(s) and high levels of suspended sediment in this watershed results in the suffocation of many embryos and alevins. Because many adults are forced to spawn in the main stem, (often lacking significant habitat complexity) incubating salmonids are often exposed to higher flows, often resulting in the redds being "washed out."	There is a good percentage of canopy cover in upper reach. Rearing in the upper reach is limited in the steep upper reaches; but in the lower South Fork and mainstem there is suitable rearing habitat where pools exist.	Decline of deep pools (greater than 3 feet) show a trend that rearing habitat is being degraded in the upper watershed.
Flow and Depth	The upper reaches experience intermittent or ephemeral flow which restricts spawning activity. (Low and intermittent flows may be a factor in the loss of summer steelhead runs in Freshwater Creek.)	Reaches with confined channels and high peak flows may result in scour of redds (where spawning conditions exist).	During summer low flow months rearing in the upper reaches is limited. Pool filling in the upper watershed has reduced the number of deep pools (<3ft depth) in the upper watershed.	Low flows and steep gradient restrict utilization in the upper reaches of South Fork and upper Freshwater (PL 2001).

Figure V.9: Land Use Freshwater Creek Watershed

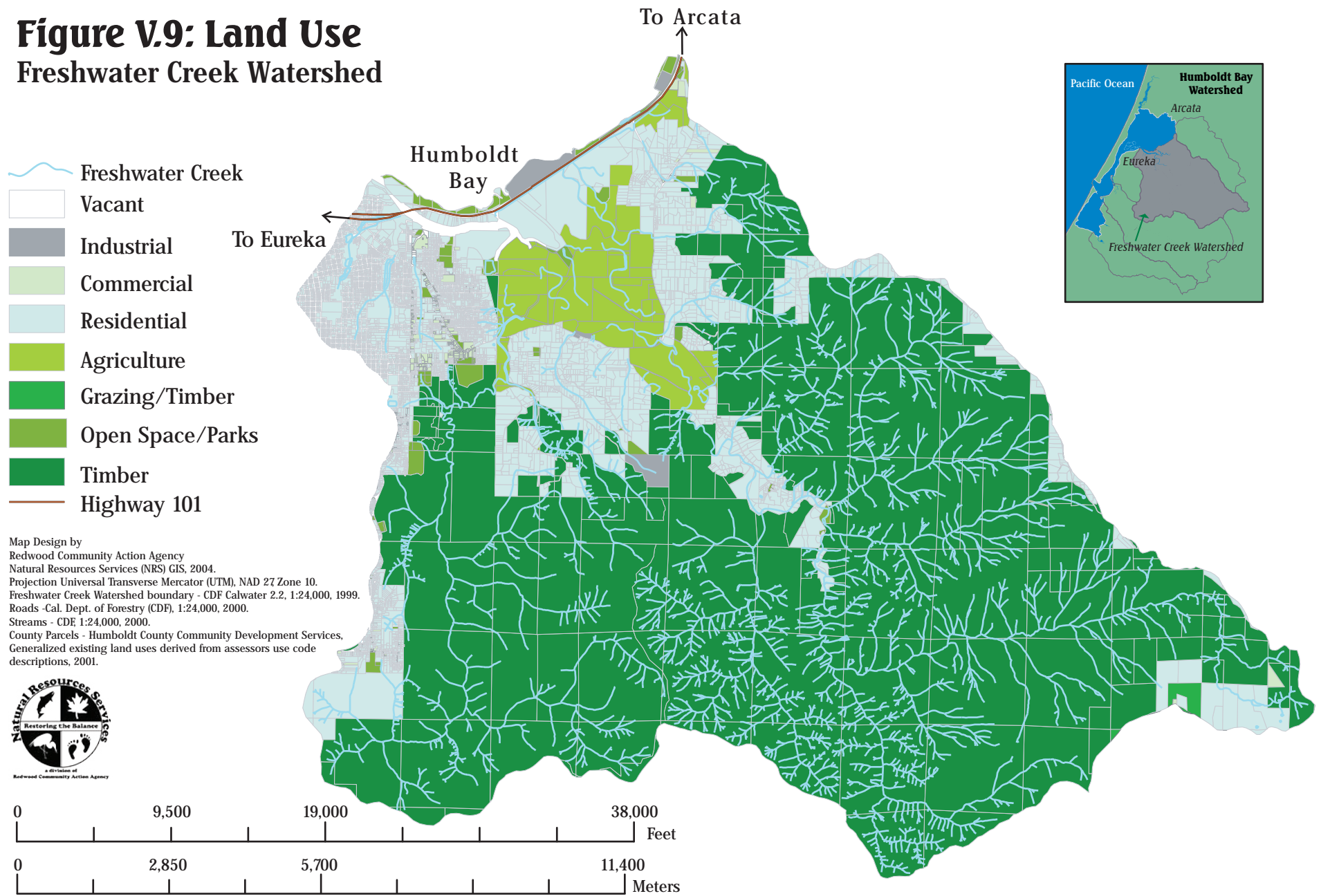
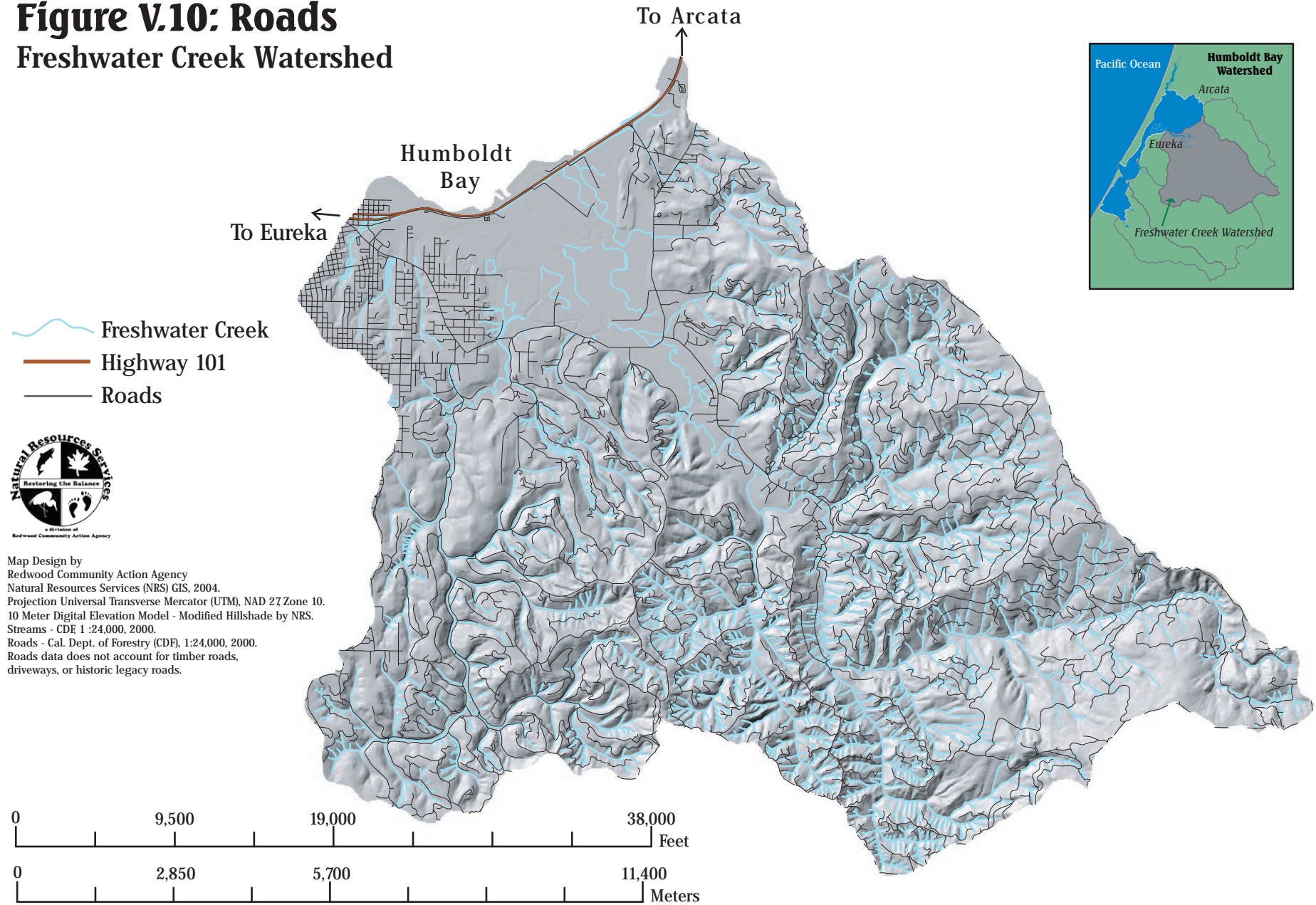


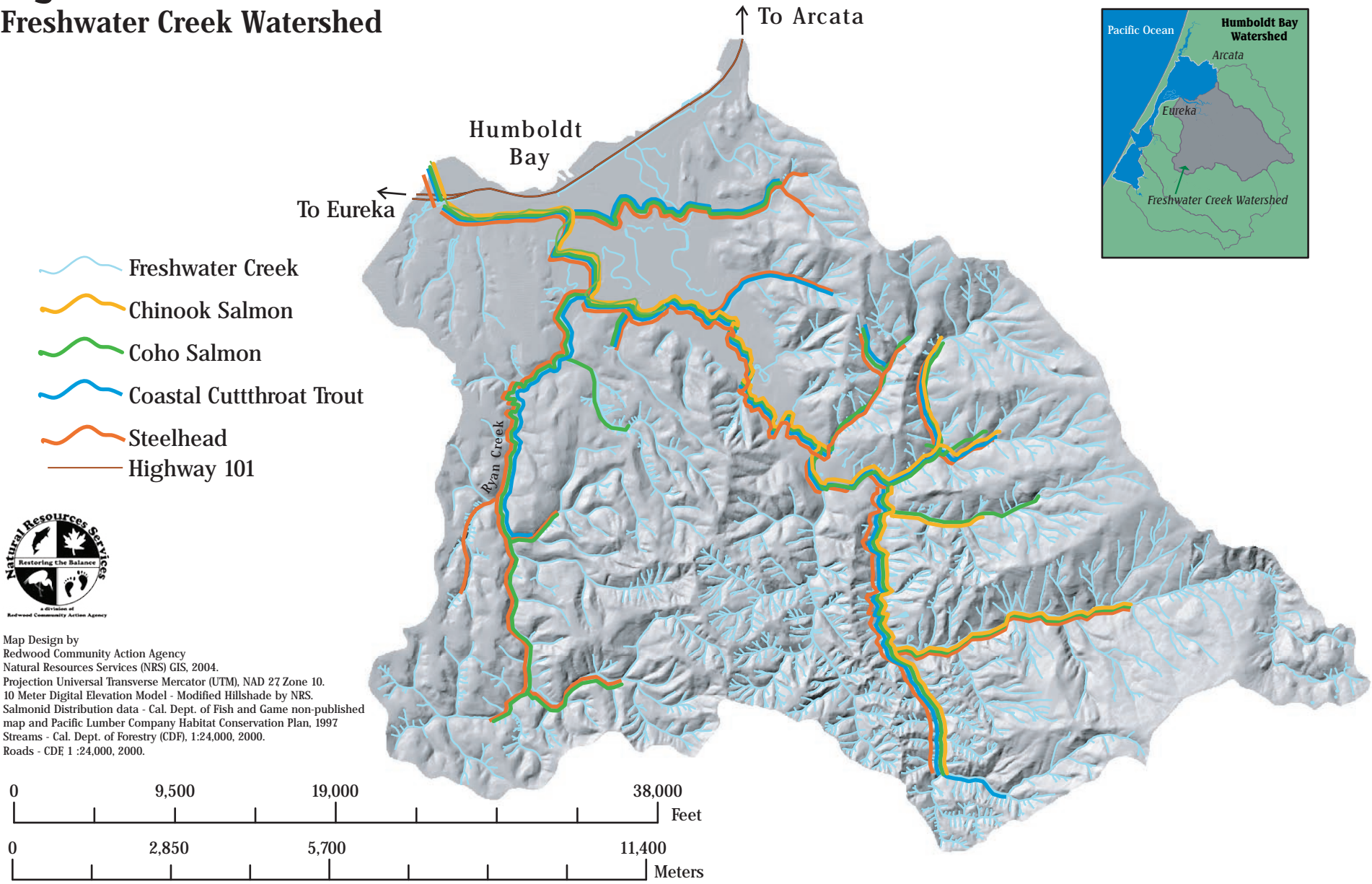
Figure V.10: Roads Freshwater Creek Watershed



Map Design by
 Redwood Community Action Agency
 Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Streams - CDF 1 :24,000, 2000.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Roads data does not account for timber roads,
 driveways, or historic legacy roads.

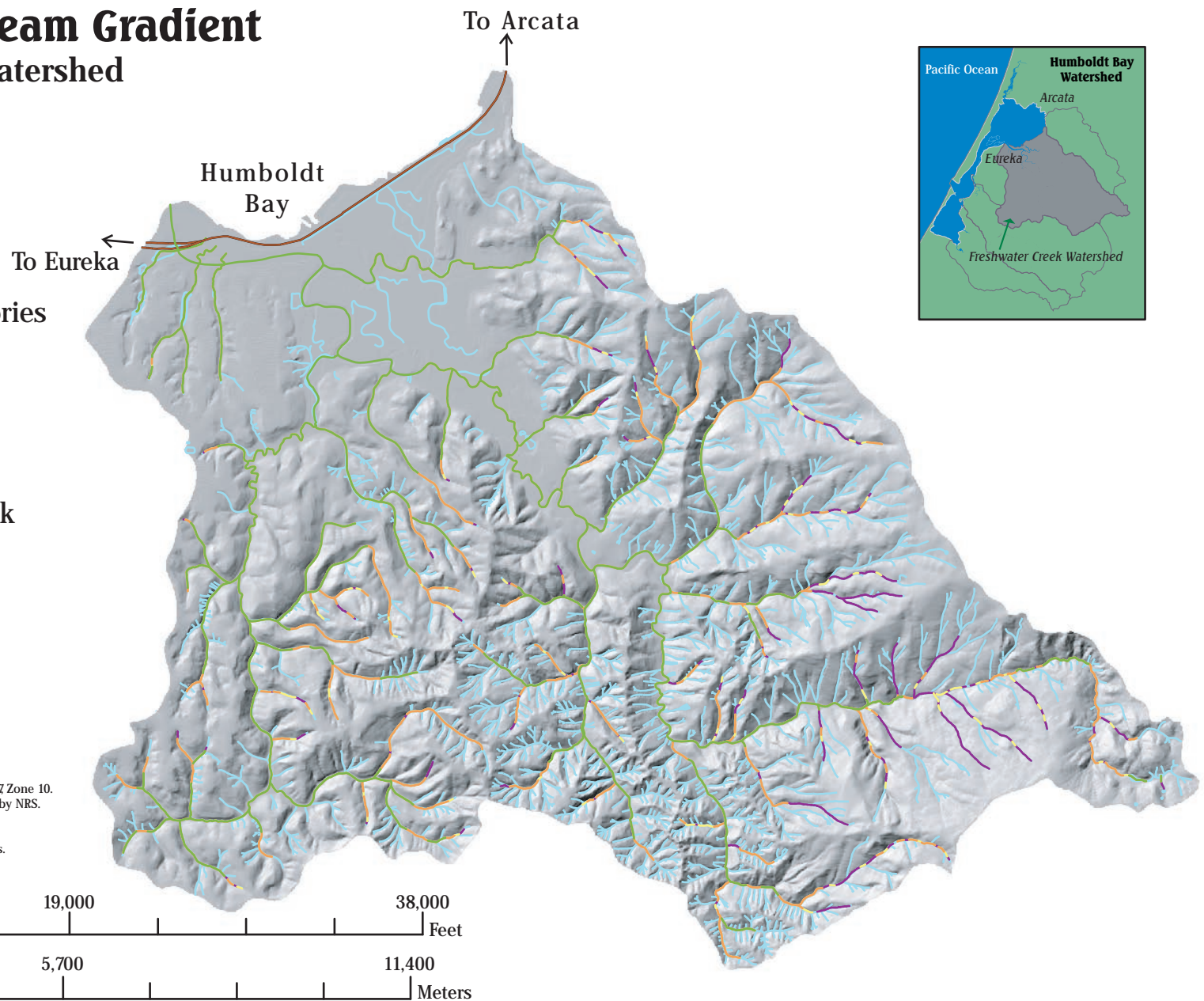
Figure V.11: Anadromous Salmonid Distribution

Freshwater Creek Watershed









Map Design by
 Redwood Community Action Agency
 Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Salmonid Distribution data - Cal. Dept. of Fish and Game non-published
 map and Pacific Lumber Company Habitat Conservation Plan, 1997
 Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Roads - CDE 1 :24,000, 2000.

Figure V.12: Stream Gradient Freshwater Creek Watershed



Stream Gradient Categories

-  > 15%
-  12 - 14.9%
-  4.1 - 11.9%
-  0 - 4%
-  Freshwater Creek
-  Highway 101



Map Design by
 Redwood Community Action Agency
 Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Streams - CDE 1 :24,000, 2000.
 Salmonid gradient data: Institute for River Ecosystems.
 Categories determined by NRS.

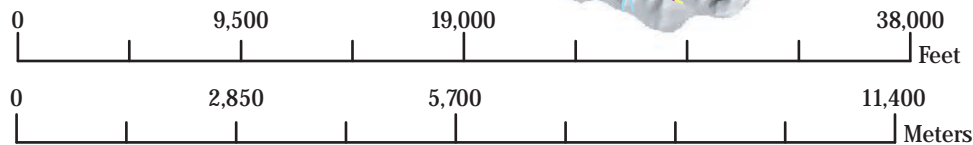



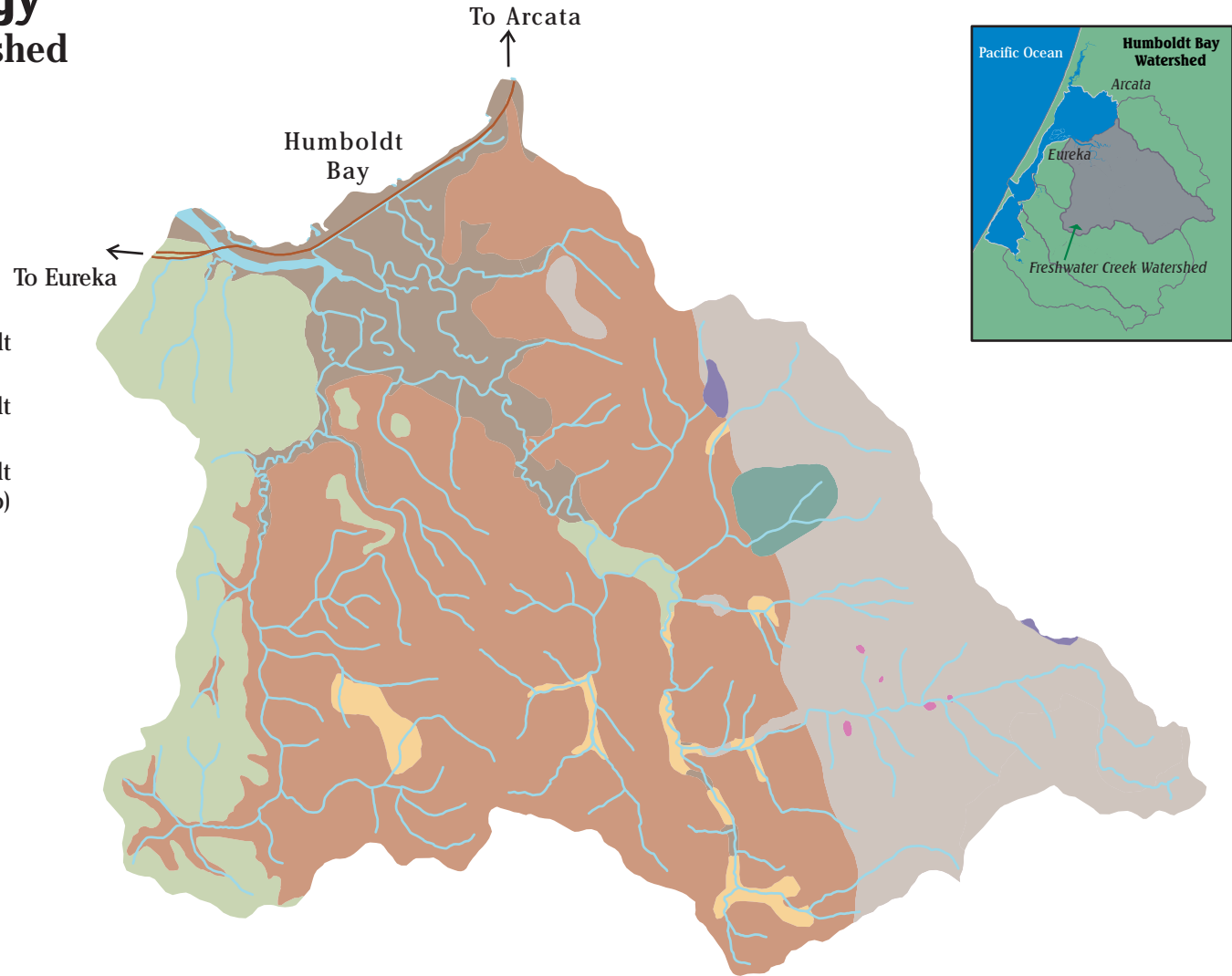


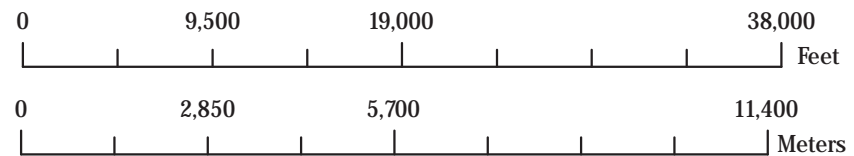
Figure V.13: Geology

Freshwater Creek Watershed

-  Highway 101
-  Streams
-  Water
-  Alluvial Deposits (Qal)
-  Franciscan Complex Central Belt Broken Formation (Cb1)
-  Franciscan Complex Central Belt Melange (Cm1 & Cm2)
-  Franciscan Complex Central Belt Melange, Unknown Lithology (b)
-  Landslide Deposits (Qls)
-  Marine & Nonmarine Overlap Deposits (Qtw)
-  Yager Terrane Sheared & Highly Folded Mudstone (y1)
-  Undifferentiated Nonmarine Terrace Deposits (Qt)



Map Design by
 Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 Freshwater Creek Watershed boundary - CDF Calwater 2.2, 1:24,000, 1999.
 Geology - United States Geological Survey (USGS), Geology of the Cape Mendocino,
 Eureka, Garberville, and Southwestern Part of the Hayfork 30 x 60 Minute Quadrangles
 and Adjacent Offshore Area, Northern California, 1:100,000, Ver.1.0, 2000.
 Streams - CDE 1:24,000, 2000.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.



V. C. Elk River Watershed Overview

The Elk River watershed comprises an area of 33,840 acres. It is a fifth order stream and drains directly into Humboldt Bay, south of Eureka near Fields Landing. The Elk River watershed consists of approximately 1,444 streams totaling 329 miles (Conroy 1999), and is comprised of two primary branches, the North Fork and South Fork, both fourth order streams (PALCO 2000). Elevation ranges from 0-2,400 feet from mouth to ridgeline. Elk River watershed is much steeper than other watersheds in Humboldt Bay. This combination of geology and slope makes management a difficult task for timber and agriculture landowners. This watershed is considered to have exceptional forest growth capabilities, but once the soil is exposed it is susceptible to landslides. The upland forests are principally coast redwood, Douglas fir and Sitka spruce, with minor components of western hemlock, grand fir, Pacific madrone, and tan oak.

The natural vegetation in Elk River is coniferous forest, dominated by coastal redwood. Douglas fir and tan oak naturally occur in association with redwood over large areas of the upper watershed. Other forest trees include grand fir, Sitka spruce, western red cedar, western hemlock, and red alder in riparian zones. Natural understory species include salal and evergreen huckleberry (Jones & Stokes 2002).

Annual precipitation near Humboldt Bay and at the ridgelines is 40 and 55 inches, respectively.

V. C. 1. Geology

Elk River has some unique features that separate it from other watersheds in Humboldt Bay. Elk River is dominated by Wildcat hillslopes in the North and South Fork, while small areas of Yager in upper streams and Franciscan in upper North Fork exist. Hookton Formation, a sandy erosive geology, is present under tributaries to the main stem in the southern ridges of the watershed. The lower main stem is underlain by quaternary alluvial deposits. Marine and non-marine sedimentary rocks of the Wildcat group underlie the majority of the Elk River watershed. Undifferentiated Wildcat, an erosive and unstable geologic group, underlies 69 percent of the watershed. Older rocks of the Yager Formation underlie the Wildcat Group in the upper watershed. The Wildcat Group typically underlies most of the forested areas and upper slopes, while the Yager Formation is exposed in the stream bottoms and inner gorges of the main tributaries (Jones and Stokes 2003).



*Future Large Woody Debris (LWD)
for Elk River fish habitat*



Elk River Spit at the mouth

The large block of Franciscan rocks in the upper, eastern portion of the North Fork basin comprises about 15 percent of the total watershed (PWA, 1998).

V. C. 2. Land Use

Land use and ownership within the watershed is diverse (Figure V.16), but is predominantly commercial timberlands owned and managed by the Pacific Lumber Company. On the South Fork, Green Diamond Resource Company owns the McCloud Creek sub-basin, which is managed for timber harvest. PALCO owns most of the remaining lands in the South Fork basin.



Cattle in Elk River Watershed during a flood

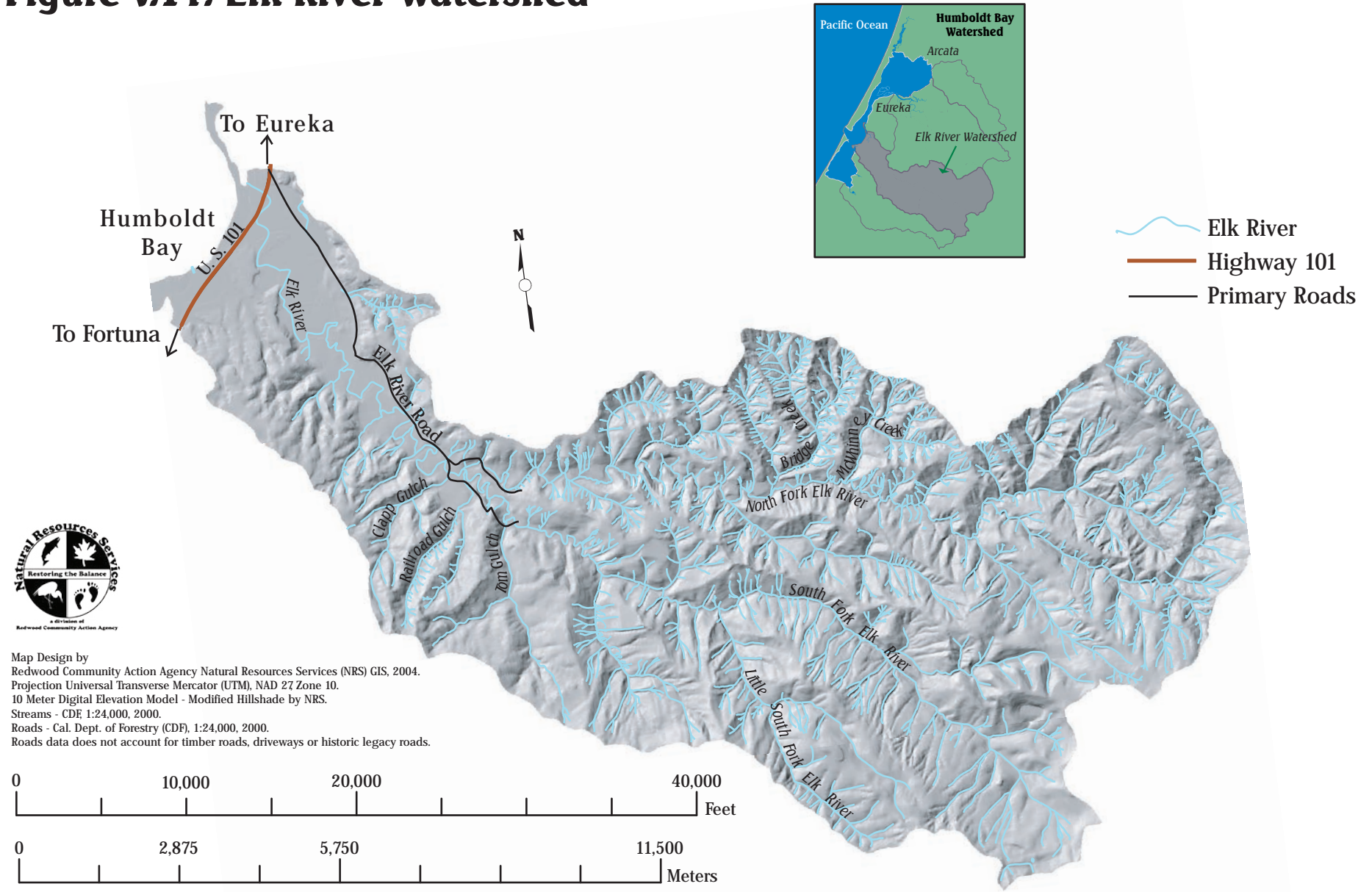
The upper South Fork Elk River lies within the management of the Bureau of Land Management (BLM), as part of the 7,400 acre Headwaters Forest Reserve. Corridors managed by BLM within the South Fork Elk River are composed of recently logged coniferous forests surrounded by private timberlands.

Residential areas in the Elk River watershed include the land along the river corridor, Elk River Road, Ridgewood Heights, and Humboldt Hill. Lands along Elk River Road, from the edge of Eureka to the northwest just above the confluence of North and South Forks, are in rural residential use (Jones & Stokes 2002). Ridgewood Heights and Humboldt Hill are the two major residential areas in the Elk River watershed besides the Elk River neighborhood, which lies along the river corridor and Elk River Road. The Ridgewood Heights neighborhood is characterized by both urban and rural land uses. Humboldt Hill is primarily residential in character. Both of these areas expect to see an increase in residential development in the coming years (Humboldt County, 1995).

Agricultural lands include the land along the lower and middle reaches of Elk River. Prime agricultural lands along Elk River exist mostly on the south side of the river and on the gentle slopes of Humboldt Hill area. Cattle grazing predominates streamside property along the lower and middle reach of Elk River, with more intensive residential development along tributaries such as Martin Slough Creek to the north and creeks draining from Humboldt Hill to the south.

The Elk River Wildlife Sanctuary comprises 294.6 acres at the mouth of the Elk River and serves as the City of Eureka's wastewater treatment facility, outdoor recreation site, and wildlife area. The Wildlife Sanctuary is managed through a partnership

Figure V.14: Elk River Watershed



Map Design by
 Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Streams - CDE 1:24,000, 2000.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Roads data does not account for timber roads, driveways or historic legacy roads.

between DFG and the City of Eureka. The 104 acre Elk River Wildlife Area, located just south of Elk River Road, is owned and managed by DFG primarily for terrestrial wildlife.

V. C. 3. Salmonid Distribution

Salmonids present in the Elk River watershed include coho salmon, chinook salmon, steelhead trout, anadromous (sea-run) cutthroat trout, and resident rainbow trout (Figure V.18). All five species use the main stem of Elk River and many of its tributaries for adult and juvenile migration, rearing, and spawning (Hart Crowser 2003).

V. C. 3.1 Fish Surveys

Unlike Freshwater Creek, there has been no comprehensive monitoring program on Elk River. Several fisheries population studies have been conducted in the Elk River. Electroshocking, spawner, carcass, and red surveys have been conducted by PALCO, the Institute for River Ecosystems (IRE), Natural Resources Management (NRM), and Department of Fish and Game (DFG). Although such surveys have been conducted over the years, variation in timing and effort, along with relatively short monitoring duration, makes trend analysis difficult. Albeit, survey results do provide usable absence/presence data (Hart Crowser 2003). PALCO has also been conducting e-fish surveys since 1998. Fish spawner surveys have been conducted in North and South Fork Elk River by DFG as early as the 1950s. Compiled below are the total numbers of coho, chinook, and redds found during spawner surveys from 1986 to 2002. There is no appropriate level of interpretation included with this information due to the incongruent nature of its collection. Fish trend monitoring is complicated by the cyclic flux of salmonid populations.



Historic Runs in Elk River

Elk River fisheries were once considered one of the best for recreational anglers. The splash dam at the Falk Mill was a popular fishing spot; salmon and steelhead became trapped in the pond below the dam where they were easily caught. A fish ladder was installed as early as 1898, but eventually the dam was removed to allow fish passage.

According to an article by Chet Schwarzkopf in 1949, heavy runs of salmon and steelhead came up Elk River to follow its forks into the hills to spawn. "We used to be able to hear them churning over the riffles across the road at night," says older resident Sherman Stockhoff.

Longtime resident Kristi Wrigley documented historical fishing, noting a decline from the mid-1940s through early 1950s. This was seen in small order creeks such as Lake, McWhinney, and Bridge Creek on the North Fork of the Elk River. According to Wrigley, fishing did not improve until the mid-1980s to 1990 when numerous good size trout (10 inches or more) and larger numbers of salmon returned to spawn (Wrigley 2003).





The Institute for River Ecosystems (IRE) employs multiple pass snorkeling surveys using electroshocking to validate counts for juveniles. This dive on Little South Fork Elk on July 6, 2001 was for coho presence surveys (for CDFG) by IRE. There were YOY-coho, YOY-trout (probably steelhead) and a juvenile chinook observed in the unit (4th pool up from the mouth) as well as 5 pacific giant salamanders counted. Diver is Josh Boyce, photo by Devin Stevens.

Year	NORTH FORK				SOUTH FORK			
	Surveys	Chinook	Coho	Redds	Surveys	Chinook	Coho	Redds
1986	6	4	399	554	6	3	40	57
1987	8	24	913	557	3	27	86	121
1988	6	28	181	293	13	17	52	199
1989	-	-	-	-	12	3	49	60
1990	6	16	140	88	4	2	55	32
1991	6	46	62	408	5	62	29	365
1992	5	2	14	116	1	7	20	42
1993	6	52	216	534	-	-	-	-
1994	7	3	447	408	4	3	473	325
1995	5	13	41	141	-	-	-	-
1996	3	0	29	24	3	0	4	52
1997	8	5	7	42	2	4	0	8
1998	3	0	0	0	-	-	-	-
1999	7	6	8	42	8	2	8	41
2000	6	16	0	6	6	1	6	6
2001	3	0	0	0	1	0	0	2
2002	-	-	-	-	12	0	1109	311

Surveys in the same year make the same site visits within short periods of time and may double count live fish.

Table V.12: Elk River Carcass and Live Adult Survey Summary (DFG, compiled by Jennifer Aspittle for the Regional Water Quality Control Board (RWQCB))

V. C. 3.2 Fish Habitat Surveys

Numerous habitat surveys have been conducted on the North and South Forks of Elk River and its tributaries above the confluence with the main stem. Fish habitat in the Headwaters Forest includes approximately five miles of the South Fork Elk River, including its headwaters at Elkhead Springs, and the entire Little South Fork Elk River.

Between the years 1982 and 1983, DFG personnel conducted stream surveys in the smaller Elk River tributaries, including: Clapp, Railroad, Dunlap, Tom, Bridge, McCloud, Browns, Shaw, Hill, and Doe Creeks. In 1980 and 1983 DFG conducted stream surveys of Little South Fork Elk River. During the early 1990s, CCC technical advisors conducted habitat inventories on North Fork tributaries, including: Little North Fork Elk River (1994),

Bridge Creek (1990/1994), Lake Creek (1990/1994), McWhinney Creek (1990/1994), North Branch (1990), and South Branch (1994). In 1994, DFG conducted habitat surveys of the following South Fork tributaries: Little South Fork Elk River, Line Creek, and Tom Gulch. Results of these surveys form much of the basis for the “Salmonid Habitat Conditions” information contained in this document.

In October 1999, an instream and hillslope monitoring plan for the North Fork Elk River watershed was developed for the NCRWQCB by PALCO. Survey and monitoring parameters included sediment sampling, pebble counts, stream profiles (longitudinal profiles and cross-sections), macroinvertebrate sampling, temperature, canopy cover, large woody debris (LWD), e-fishing, and spawner surveys. North Fork Elk River Monitoring Plan Reports for 1999-2001 are available from PALCO.

V. C. 4. Restoration and Conservation Efforts

During the 1970s and 1980s, the Sierra Club, California Conservation Corps, and CDFG maintained a program of woody debris removal. This program was intended to remove fish passage barriers and to allow easier passage of floodwaters. Since that time, this practice has been re-evaluated and it is thought that removal of LWD can have adverse biological effects on fish habitat. In-stream large wood placement in the North Fork and its tributaries was conducted by PALCO, funded by DFG, between 1987 and 1997. This restoration effort included the placement of 282 in-stream structures to improve aquatic habitat (Conroy 1999).

Soon after the Headwaters Forest came into public ownership, road decommissioning began in the Elk River watershed (restoration planning documents include PWA 2000a, 2000b, 2001). Within the Headwaters Forest, BLM initiated an interim watershed restoration and emergency sediment reduction program in 2000 to reduce the threat of immediate erosion and to prevent further deterioration of streams. In addition, BLM is performing trail maintenance along South Fork Elk River to reduce sedimentation to the South Fork and Little South Elk River (Jones & Stokes 2002).

The Elk River Wildlife Area Wetland Enhancement Project, completed by CDFG in 2001, included excavation of two shallow, open-water habitat sites, installing a flashboard riser water-control structure, and removing an existing culvert. This project was completed on CDFG’s 104 acre parcel south of Elk River Road.

Elk River’s Urban Stream - Martin Slough

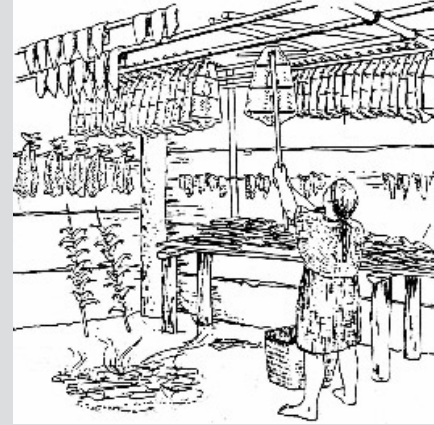
Tide gates on lower Martin Slough are barriers to fish passage and are suspected of backing up flow from the slough, creating flooding problems. Fish once spawned in the Fern Canyon area but the habitat has been compromised (Melvin McKinney, personal communication). Urban development in the Martin Slough watershed is thought to have increased runoff concentrations and peak flows. Plans for conducting a sediment and watershed analysis for Martin Slough are in the works. The Natural Resources Services Division of RCAA is working on an enhancement plan for Martin Slough with the goal of restoring the natural functioning of sections of Martin Slough. Public education, riparian zone enhancement, and tidegate modification will be elements of the plan.



*Martin Slough during December
2002 Flood*

Historic Human Footprint and Conditions in Elk River Watershed

In 1850 a Wiyot village called *ikso'ri* was located on a sandpit at the mouth of Elk River. Approximately two miles from the mouth of Elk River another Wiyot site was located beside the current location of the Elk River schoolhouse. Wiyot people used this site as a camp where they caught and dried salmon. The “Old Nation,” *wigidokowok* in Wiyot, lived at this site, *chwanochkok*, which had many myths attached to it. Wiyot people navigated by canoe up Elk River on their way to Kneeland Prairie. This and other prairies or “open patches” were of great value to Wiyot people. The prairies were burned annually for seed gathering and maintenance of grazing land for game (Loud 1918).



Timber Harvest

Elk River was settled by European's in the late 1800s. Soon afterwards, the lowlands were cleared of timber for pastures. The town of Falk, settled in 1884, was a logging mill town and the center of activity for logging in the South Fork Elk River. The mills and the town of Falk were dismantled and removed by the early 1970s. There was at least one small mill and several lumber camps in the North Fork Elk River. Historic articles indicate that a huge amount of timber came out of the watershed by way of the predominant method of transport – the river itself.

Humboldt Times (Feb. 1873) “Immense - We understand that the quantity of logs in and on the banks of Elk River, awaiting high water in that stream, aggregates between twenty-six and twenty-seven million feet.”

Daily Humboldt Times (9 March, 1879) “Logs Down- The heavy rain of Friday night and yesterday had the desired effect of raising the water in Elk River and we understand that the logs in both forks came down. There is now a solid line of logs in Elk River from the bridge up the stream a distance of nearly eight mile, containing in the neighborhood of nearly fifty million feet.”

1870 - Elk River diverted
1870 - 1880 Levees constructed
1884 - Town of Falk settled
1886 - Elk River Railroad operational from Bucksport to Falk
1931 - Depression closed smaller mills including Elk River Mill
1936 - The Elk River Mill and Lumber Company re-opened
1950 - Pacific Lumber Company purchased Dolbeer Carson properties

Logging in the North Fork Elk River watershed began in the 1880s, with steam donkey and oxen yarding in the lower watershed. Steam donkey and railroad logging in the adjacent Freshwater Creek watershed to the north spilled over into the northern ridges and slopes of the North Fork Elk River in the 1920s. Railroad logging expanded into the upper Doe Creek, McWhinney Creek, Bridge Creek, and Browns Gulch in the 1930s. In the 1930s and early 1940s railroad logging and early tractor logging spread south along the main stem North Fork as well as the entire North Branch North Fork Elk River. Aerial photography indicates that by 1940, much of the Elk River

watershed had been clearcut harvested of the most accessible timber. Road building was not significant in most of the watershed at this time.

In the pre-1950 period, approximately 8,100 acres of Pacific Lumber Company lands in the North Fork had been logged. The 1948 and 1954 North Fork Elk aerial photos show increased road and skid trail density and provide evidence that tractor yarding and truck hauling had become predominant by this time. Large areas, including steep slopes, unstable features, and stream channels, located mostly in the central portion of the watershed, were clearcut. Aerial photos from 1965 show the greatest density of roads and skid trails, as well as the greatest evidence of mass wasting in this area for the photographic record (Marshall 2002). Most of the upper watershed was harvested by tractor logging and most of the haul roads were placed near streams, which introduced large amounts of sediment into stream channels. This sediment continues to transport through stream channels today resulting in a significant legacy effect (PWA 1998).

Agriculture

During the 1940s and 1950s, Chet Schwarzkopf wrote a series of pieces on the history of settlement along the Humboldt Bay for the *Humboldt Times*. In a February 1949 article, Chet noted that “Ranchers were attracted to [Elk River valley] by its deep and rich soil... The stream that flows through the valley is different from most. You see no sand bars and riffles. It cuts down through rich, dark soil all the way – a solid built-up by thousands of years’ accumulation of leaf mold. Even in its upper canyons where it runs swiftly, Elk River’s banks have no sand and are covered with undergrowth and ferns.”

Preliminary management plans for the Elk River Wildlife Area identified historical agriculture lands in the lower reach of Elk River. The area presently beneath the sludge lagoons was used for agriculture in the 1870s. In 1948 grazing is evident in the area north of what was to become Pound Road, and in the tidal marsh south of Pound Road by 1959. Grazing in these areas continued until 1982 (NRPI Senior Practicum 2000).

Road Building

The first roads in the watershed were those routes used for railroads. In order to transport the lumber from the Elk River Mill in Falk, eight miles from tidewater, the Elk River Railroad venture completed the railroad from Bucksport to Falk and opened for service in 1886. An engine house and shops were built at Jones Prairie below Falk. A logging railroad was built several miles up the South Fork of Elk River into the timber land. In 1931 a line was built from Dolbeer and Carson’s timber lands on the North Fork to Camp Carson. The North Fork was wide enough for trestles to be built within the stream bottoms which reduced the amount of soils that were directly sidecast into the river. Within the narrower tributaries, railroad grades were built directly adjacent to the watercourse where large wood and soil frequently filled streams (Rice 2002). On December 15, 1950, the Pacific Lumber Company purchased the Dolbeer Carson properties, which included the Bucksport and Elk River Railway. In early 1953 the last logging train made a run with logs for the Eureka Mill (Carranco et al. 1988).

According to road inventories conducted by Pacific Watershed Associates (PWA), by 1954 approximately 29 miles of logging haul road had been constructed within the North Fork Elk River (PWA 1998). Periods of historic road construction in the North Fork Elk are as follows (PWA 1998):

- From 1954 to 1966 – 22 miles;

- From 1966 to 1974 – 25 miles; and
- From 1974 to 1987 – 9 miles.

Road construction between 1954 and 1998 generally consisted of spur roads that were used to enter portions of the watershed for first entry logging of old growth.

Estuary Lands

The Elk River estuary is the largest estuary on Humboldt Bay. The lower portions of Elk River floodplain were tidal wetlands prior to 1850 (Shapiro and Associates 1980). Dikes were initially built between 1870 and 1880 to create agricultural land and provide dry walkways for draft animals towing logs down to Elk River (Base 1982).

In the 1870s, the mouth of the river was diverted across the base of the spit. A southern jetty was built in 1892 to protect the new course of the river, and by 1899 a northern jetty was completed.

Up until the early 1930s, Elk River flowed under the Highway 101 bridge and North West Railroad bridge straight into the bay. In the early 1930s a cofferdam was built just west of the railroad bridge diverting Elk River to the north. Between 1910 and 1930 the Elk River spit began to grow, coinciding with first cycle logging, which utilized splash damming and other practices that contributed a vast amount of sediment into the system. This sediment is most likely what caused the formation of the spit.

During low tides, teamsters hauled gravel from the mouth of Elk River for contractors in Eureka making concrete sidewalks. Slowly, the sandy bay area between the Elk River wharf and the Standard Oil pier filled in with mud and silt (Madsen 1976). The sandbar has built up over the years and continues to grow. The mouth of the estuary has degraded a few feet in the last couple of years and observers report that the railroad, levees, and the Highway 101 bridge constrict the river (Melvin McKinney, personal communication).



The City of Eureka and lower Elk River watershed. The Elk River corridor winds north through agricultural land pictured in the lower left corner of this aerial photo.

V. C. 5. Opportunities and Challenges

The major concern to residents in the Elk River watershed is flooding, with increased harvest rates and suspended sediment levels of Elk River dominating the sociopolitical issues in the watershed. Some positive changes with regards to watershed health have occurred due to citizen involvement and the resulting focus on these watersheds. Of concern to some Elk River residents is the observed decrease in water quality and increase in flood frequency and severity. Floods, resulting in two feet of water on the road at the North Fork concrete bridge, now occur eight times a year. Floods that result in four feet of water at the bridge occur one to two times a year (Wrigley, personal communication). Four consecutive winters (1995 through 1998) had flooding at or greater than the 1964 flood levels. Flood stages during New Year's Day 1997 and November 22, 1998 were higher than any flood previously observed by residents in the Elk River valley (Conroy 1999). Many residents believe that timber harvesting and management related activities have adversely affected the drainage basin by increasing storm water runoff, reducing the time to peak runoff, and increasing the duration of storm peak flows. Timber company officials maintain that recent flooding problems result from two successive wet winters, compounded by residential development on the floodplain (Conroy 1999). Bill Conroy's 1999 study of the relationship between rainfall and runoff in Elk River concluded that there were no significant changes from historic to current times between the relationship of total precipitation and runoff volume, or between total storm precipitation and peak discharge rate.

After reviewing Eureka rainfall pattern records from the past 111 years, photos from 1973-1986 flooding events, data on sediment and channel conditions and flood conveyance capacity in the watershed, and relevant scientific studies, PALCO has determined that there is "a credible body of scientific evidence that indicates that the flooding in Elk River (and Freshwater) are problems not likely associated with harvesting activities." The PALCO document, *An Analysis of Flooding in Elk River and Freshwater Creek Watersheds in Humboldt County, California*, in summary, concludes that the flooding magnitude and frequency is not a result of cumulative impacts of timber harvest, but instead a result of long-term weather patterns. Several experts from the area of forest hydrology involved with PALCO's analysis agree with their findings. Litigation over the damage caused by flooding in the Elk River watershed has been brought by Elk River residents against PALCO, who had recently resumed logging in the North Fork for the years 1990-1996 (Wrigley 2003). The debate over what causes



North Coast Regional Water Quality Control Board staff collecting information for the Total Maximum Daily Load Process. Photo courtesy of Adona White.



flooding in the watershed is likely to continue until the flooding stops, upstream management changes, and/or a settlement is reached.



Watershed resident and apple farmer, Kristi Wrigley, standing next to her sediment buried Waltana apple tree. This variety of apple tree does not branch until three or four feet from the base of the trunk.

The upper South Fork Elk River lies within the management of Bureau of Land Management (BLM) as part of the Headwaters Forest Reserve, a 7,400-acre reserve. Roads in the basin remain a source of sediment. Direct rainfall and concentrated runoff entrain sediment from road and landing surfaces and generally deliver directly to nearby streams. Where roads crossed streams, “Humboldt crossings” (logs placed in the stream parallel to stream flow and covered with soil) or culverts were installed. Skid trails are extensive throughout the watershed, and often contribute sediment to streams. The South Fork Elk headwaters area (Elkhead Springs) has the highest density of skid trails. Most of the older skid trails have re-vegetated (Jones & Stokes 2002). Pacific Lumber surveys have found that legacy effects of first cycle logging in the channels that do not have enough power to scour sediment, have resulted in continued slow sediment delivery from these streams. Most of these sites are in the upper tributaries which have low flows (Jeff Barrett, personal communication).

Sediment

In December of 1997, the EPA listed Elk River as an “impaired and degraded waterway” (Section 303d of the Clean Water Act) due to high levels of suspended sediment. The North Coast Regional Water Quality Control Board (NCRWQCB) has proceeded with actions concerning the water quality of Elk River. Although it was never settled as to whether or not PALCO was responsible for the water quality change, in 1998, PALCO and the NCRWQCB reached a stipulated agreement that PALCO would provide drinking and agricultural water to residents of the watershed who had depended upon Elk River as their domestic water source. Currently, the NCRWQCB staff is engaged in the Total Maximum Daily Load (TMDL) process for Elk River, has held several public meetings and is conducting a number of detailed studies in the watershed.



Elk River sediment

NCRWQCB staff will be collecting winter monitoring data for 2002-2004 to further develop a sediment budget for the Elk River watershed including the Martin Slough watershed. NCRWQCB staff has also submitted required paperwork to the California Board of Forestry and Fire Protection (BOF) for Sensitive Watershed Nomination for Elk River. The Sensitive Watershed Nomination was prompted by petitions submitted by the Humboldt Watershed Council requesting that the BOF issue waste discharge requirements and take action against PALCO for alleged improper

logging practices. This course of action is separate from the TMDL process with a potentially longer completion process.

In an attempt to determine bulk sediment rates, transport, and sediment sources, as well as frequency and duration of high suspended sediment levels, multiple stakeholders have conducted water quality assessments. As seen below, there is much controversy over the findings

PALCO found that there is little chance that the recent increases in flooding are due solely to some cumulative effect of their operations (PALCO 1999). See Figure V.15 below for PALCO's Elk River sediment budget.

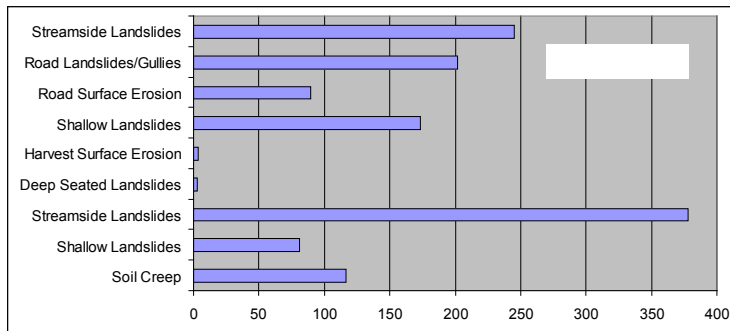


Figure V.15: PALCO's findings on Sediment Delivery in Elk River Watershed

Randy Klein, hydrologist, and Jeffery Anderson, engineer, as requested by NCRWQCB, conducted a review of the PALCO Elk River Watershed Flooding analysis, which compared flooding, erosion and transport capabilities of Elk River. The assessment used a volume of 62,700 tons of sand-sized erosion for the 1988-97 period (or 6,270 tons/year) and a volume of 186,000 tons (or 4,429 tons/year) of sand-sized erosion from the inclusive 1956-97 period. According to Klein, because of drier conditions between 1988 and 1994, one can assume that most of this erosion occurred in the latter part of the 1990s (the uncharacteristically low rainfall/runoff period of 1988-94 would be more likely assumed to coincide with low erosion, sediment transport, and deposition). Considering the lack of high flows for the earlier period and the occurrence of high flows and increased watershed erosion in WY1996-97, it is more likely that a large part of the loss of channel capacity occurred in the latter part of the 1990s.

J. Rose Patenaude, in preparation for the NCRWQCB's Elk River Sediment TMDL, found in her assessment of flooding in the lower Elk River that channel conveyance capacity has diminished



Cross-sections are performed after significant hydrologic events in order to monitor changes in channel morphology.



Elk River flooding

significantly over the past 36 years to 60% of carrying capacity (Patenaude 2004).

Under the environmental mitigations agreed to by their Habitat Conservation Plan (HCP), PALCO is now conducting an Elk River watershed analysis for their property in the watershed similar to the process used for their Freshwater Creek watershed analysis. The watershed analysis will be used to “develop appropriate site specific forest management practices in order to protect fish and wildlife, improve water quality, and assure economic stability” (PALCO 2003). PALCO requested public participation through hearings and comment as part of the analysis process. The agency review draft was completed during fall of 2003 and the public draft is anticipated by the end of 2003.

Logging road construction has accelerated in recent years as areas of second growth are opened for harvesting. According to a PWA sediment assessment for the North Fork, 932 acres were harvested in Elk River between 1974 and 1987 (72 acres/yr). In the 1980s harvest areas included Clapp Gulch and Railroad Gulch area. Between 1987 and 1994, 2,419 acres were harvested (346 acres/yr.), with a total of 22 miles of road construction. Between 1994 and 1997 most harvesting activities were in the North Fork Elk River. Between 1994 and 1997, 2,616 acres were logged (872 acres/yr.) and a total of 26 miles of roads were built (PWA 1998). As of 1998, there were approximately 222 miles of roads in the North Fork watershed. In 1999, California Department of Forestry and Fire Protection (CDF) placed a moratorium on Timber Harvest Plans (THP) until key information was developed related to sediment, flooding, and cumulative watershed effects. Very little harvesting occurred in the watershed between 1999 and 2001. Since the logging moratorium was lifted in Elk River in 2002, PALCO has resumed logging and road construction on their property. Currently, CDF allows a harvesting rate for PALCO in Elk River watershed of 600 clearcut-equivalent acres per year. These are “interim management” prescriptions while PALCO finishes its watershed analysis as agreed to in their HCP.



Young timber on a recently logged slope

Road construction proposed and constructed since 2000 includes 5.28 miles in the South Fork and 9.33 miles in North Fork on Pacific Lumber Company property. According to NCRWQCB information, road density in North Fork Elk River is 6.1 mi/mi². A road inventory on BLM land in South Fork has found 19.6 miles of logging road thus far, with 68 stream crossings, and an estimated 16 landslides (Jones & Stokes 2002). Road densities are much higher in sub-basins such as Elkhead Springs where spur roads were skidded to retrieve trees.

Timber: Logging practices have undergone cycles of changes from pre-industrial logging to current commercial logging practices. Tax incentives have changed for landowners that make clearcuts more feasible. According to PALCO, an increase in logging in Elk River is in part due to trees becoming mature for a 60-year rotation cut. Current CDF law requires that harvest be spread out geographically in order to disperse impacts. Regulation has required significant changes in preparing and mitigating timber harvest. In part due to citizen pressure, PALCO has adopted interim measures under the HCP for PALCO property in Elk River until the completion of the Elk River Watershed Analysis.

Development: The increase in development has led to an increase in septic system construction and potentially the expansion of City of Eureka water and sewer services into the Elk River valley. The impact to fish is unknown, but contamination of fecal coliform and other pollutants from runoff could increase and enter the river. West of Highway 101, the Elk River Wildlife Sanctuary serves as the City of Eureka's wastewater treatment facility, outdoor recreation site, and Wildlife Sanctuary. Monitoring of the Eureka Wastewater Treatment Facility has documented repeated violations of permit requirements for sewage bypass. Sewage discharges (303,585 gal. in 1998) from lift stations have entered via Martin Slough into the Bay. Although the City of Eureka's treatment facility does not discharge into Elk River Slough, storm water runoff does enter through drainage ditches and marshes. Storm water runoff monitoring in the City of Eureka is scheduled to begin in 2004 through Phase II Regulations (issued by the EPA, administered by the State Water Resources Control Board) of the National Pollutant Discharge Elimination System (NPDES).

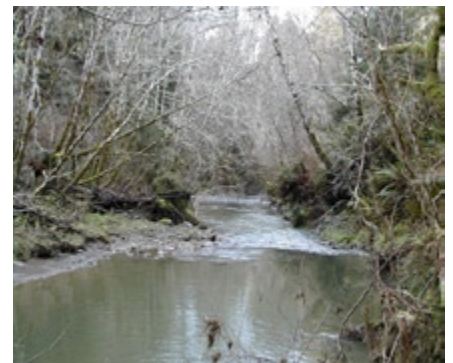
V. C. 6. Current Salmonid Habitat Conditions (By Lower, Middle, Upper Reaches)

V. C. 6.1 Estuary/Lower Reach

Description: The lower reach is characterized by the slough, which diverges just east of Highway 101 into Swain Slough and Elk River. Martin Slough, whose headwaters are in Sequoia Park, drains into Swain Slough at Elk River Corners. The tidal influence reaches above Spruce Point, at which point, the river begins to meander through very low gradient valley bottom - 0.13% in the first 5.9 miles and 0.08% in the next ten miles (Dudik 1998). This reach lacks streamside canopy cover in many places and is marginal grazing land prone to saltwater intrusion. At least two



Elk River along the DFG property near the mouth



A typical view of middle Elk River

major types of riparian habitat are present in the Elk River estuary: alder/willow woodland, red alder, and willow/wax myrtle.

Habitat Structure: The channel in lower Elk River appears to have aggraded approximately 6 feet since 1958 according to longitudinal profiles (O’Conner 2001). Trenching investigations in lower Elk reveal major sediment horizons dating from historic flood events such as those which occurred in 1955 and 1964. Historic sediment deposition may be experiencing slight channel down cutting as indicated by recent channel measurements (Rice 2002).



The lower reach of Elk River east of the Highway 101 overpass lacks access to backwater channels for fish refugia. Backwater habitat was likely once abundant before levees were built. In places such as Elk River Wildlife Area, back channels still remain, but tidal flows are controlled by tidegates. Below the bridge, the river drains through the spit. During high tide, adjacent areas with large wood and back channels are immersed. Habitat this low in the watershed may not be helpful to smolting juveniles because of marine conditions.

Simplification is apparent in the lower watershed. Much of the lower river has been constricted by levees and undergone riparian vegetation removal. At an Elk River landowner meeting, it was pointed out that the levees have been there long before there was a large decline in salmon populations (10/13/00). Of concern to some landowners is the dominance of thick willow stands along sections of the lower and middle reach and their contribution to flooding. In the past, landowners cleared out willows along stream banks for wood.

Water Quality: PALCO’s bulk sediment analysis, pebble counts, and macroinvertebrate data consistently show that Elk River is being impacted with sediment transported from upper reaches to the lower gradient reaches of this watershed (PALCO 1999). Bank composition in the lower Elk River is predominately sand, silt, and clay. Sediment flushing mechanisms in the Elk River mouth are not hindered by tide gates, but it is unknown how quickly sediment is washed out of the system or total sediment loads are transported.

Water quality is affected by residential development in the watershed especially along Martin Slough drainage and areas along the south ridge in the middle watershed. Many houses have septic systems adjacent to creeks. On Martin Slough, urban runoff from storm drains, roads, and gulches feed into Elk River just east of Highway 101. Urban runoff can contain pollutants such

as petro-chemicals, fertilizers and pesticides, fecal coliform, and pharmaceuticals; water quality sampling for these substances has not been done. Sludge application by the Eureka Waste Water Treatment Plant occurs on grazing pasture just west of Highway 101 adjacent to Elk River.

Water Quantity: The lower reach of Elk River is a floodplain, historically containing many acres of salt and freshwater marsh. The lower floodplain is seasonally inundated with moving water across roads and fields. Floods are exacerbated by high tides. Saltwater intrusion in the ground water table is most severe in summer months.

The levee on the west side of the river east of Highway 101 was breached in the 1980s to restore tidal action to ditches excavated by Department of Transportation for mosquito abatement. This area of approximately 20 acres has water retention capabilities and drains fairly quickly during low tides.

Potential Limiting Factors: Above the Wildlife Area, Martin Slough tide gates are a barrier to fish passage and are suspected of backing-up flow from the slough, thus creating flooding problems. CDFG has removed tide gates within the Wildlife Area. Urban development in the Martin Slough watershed is suspected of causing increased runoff concentrations and peak flows. Recommendations made by a preliminary hydrological assessment of Martin Slough include restoring a dedicated floodway, introducing a muted tidal cycle by installing an open tidal culvert, and adding more gated culverts to reduce flooding (Klein and Anderson 2001).

LWD is lacking in the lower watershed and any wood fragments are too small to create complex habitat. LWD is viewed as problem by landowners because of flooding issues, but it is also known to be necessary for coho to thrive (Elk River Subcommittee 10/13/00).

V. C. 6.2 Middle Reach

Description: The middle reach, beginning below Spruce Point, is characterized by a low gradient with a narrow strip of riparian vegetation. This reach is bordered predominately by agriculture and rural residential land extending to Jones Prairie and the confluence of the North and South Forks of Elk River. From the county bridge for a distance of approximately 2 miles upstream, the stream gradient increases to approximately 0.5%.



East Elk Valley



North Coast Regional Water Quality Control Board Staff testing water quality on Little South Fork Elk River. Photo courtesy of Adona White.

Habitat Structure: This reach extends some distance through ranch land with characteristics similar to the lower reach, such as: low gradient, steep erosive banks, fair to poor riparian composition, and seasonal flooding. In one large bend, the river has begun to search out a new meander and may, in future floods, change course.

Riparian vegetation providing shade to this reach is composed of grass, Himalayan berry, alder, and willow. At the upper end of the middle reach a recent growth of vegetation, including a redwood plantation, on the adjacent floodplain may be influencing flooding at and above the confluence (Rice 2002; J. Barrett, personal communication). Encroachment of vegetation in the floodplain can slow the passage of floodwaters and back up water.

An accumulation of debris in the 1-1.5 mile low gradient section of stream near the forks has created a sediment deposition zone. This reach has been suggested for potential dredging to remove the sediment accumulation and relieve flooding above.

Water Quality: Elk River residents reported that river water during summer months remains muddy and silty (Dudik 1998). Due to the poor water quality in recent summers, residents have been unable to pump water from the creek. Poor water quality can negatively impact salmonid habitat by decreasing benthic macroinvertebrates, which are a primary food source for larger organisms. Aquatic inventories in the upper portions of North Fork Elk River show a healthy population of insects whereas the lower drainage inventories revealed average to poor ratings of insect populations (PALCO 2000).

Poor water quality may be due to the increase in discharge into the river from the number of cattle pastured in the Elk River valley. A historical use of the land, cattle numbers have increased since the 1970s. Cattle accessing the river may defecate in the water, leading to an increase in the nutrient and temperature levels of the water, which may cause problems for fish. In addition, barns used for cattle are located along the floodplain and are prone to flooding, which can lead to nutrient deposition when barns are flushed during high water. Discharge can also come from bank erosion, caused by cattle trampling vegetation, compacting soil, and eating riparian vegetation.

Water Quantity: Bill Conroy's 1999 study of the relationship between rainfall and runoff in Elk River concluded that there were no significant changes from historic to current times between the



Berta Bridge during flood. Photo courtesy of Salmon Forever

relationship of total precipitation and runoff volume, or between total storm precipitation and peak discharge rate.

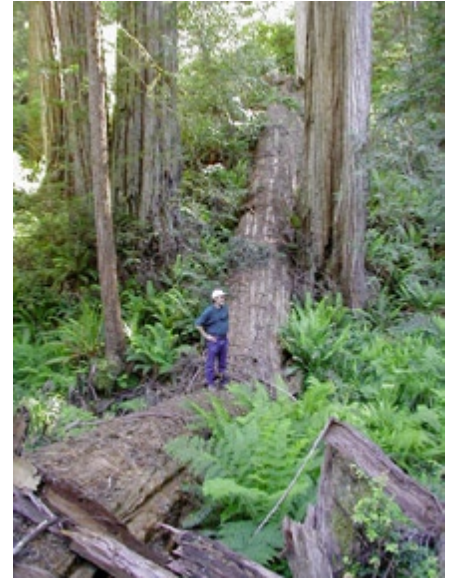
Elk River residents have reported an increase in flood frequencies at the county bridge and road beginning approximately in 1992-1993 (Dudik 1998). It has been speculated that flooding at the county bridge coincides with extremely high tides in conjunction with heavy rainfalls (Dudik 1998). There is recorded incidence of flooding after a 1"-2" in 24 hour storm event at the concrete bridge and Wrigley Road (Wrigley 2003, personal communication).

In prior years, flooding seemed to occur only during high, intense rainfall events. Residents have attributed recent flooding to timber harvest practices in the watershed claiming that sediment from roads, landslides, and deforestation are responsible for sudden peak flows. On New Year's Day in 1997, flood stage was at least one foot higher than any other recorded flood. Prior to that event, the December 22, 1964 flood had the highest observed flood stage. Major floods occurred in the basin in the winters of 1955, 1996, 1974, and 1995-1997 (Cafferata 1997). More recently, there was flooding at the North and South Fork confluence in 2002 and 2003 with water two feet above Elk River road (Wrigley 2003).

The USGS performed discharge measurements and recorded stream stages at their gauging station, about 1000 yards downstream of the confluence of the North and South Fork, from 1957 until 1966. The gauge was re-established and is now operated by PALCO. Crest stage data is being collected on the main stem downstream from the North and South forks confluence, on the North Fork upstream from its confluence with the main stem, and on the South Fork upstream from its confluence with the main stem (Klein 2001).

Potential Limiting Factors: At a public meeting in November of 2000, Elk River residents expressed their two main concerns as flooding in the downstream area and erosion in the upper reaches. Landowners near tidelands would like to remove alder and willow to increase water flow and reduce flooding, which could subsequently make banks less stable and more erosive (Landowner meeting November 2000).

Aggradation and decreased channel conveyance has simplified habitat and increased flooding. Reports of silting over of gravels have decreased available suitable spawning habitat. NCRWQCB staff has identified aggradation as a leading factor in increased flooding in Elk River. A field inspection team in 1997 viewed a site in the lower Elk River where the USGS station was located.



Headwaters Forest Reserve

Six feet of sediment deposit was recorded at the gauge site from 1967 to 1997 (O'Connor 2001). The inspection team observed the channel to be highly aggraded with fine sediment. Conroy's research and USGS records indicate bankfull capacity was reduced 60% from 1967 to 1997 in some areas (RWQCB 2003). Resident observations indicate that significant aggradation had occurred during the 1987-1997 period (Cafferata 1997).

V. C. 6.3 Upper Reach South Fork Elk River

Description: The South Fork Elk River includes many major and minor tributaries including McCloud Creek, Tom and Railroad Gulches, and Little South Fork. The South Fork and Little South Fork are managed by BLM (1947 acres), Green Diamond Resource Company owns much of the McCloud Creek watershed, and the remainder is managed by Pacific Lumber Company. The upper reach, a heavily vegetated, largely undisturbed watershed, produces high-quality stream flow to help maintain suitable aquatic habitat conditions in the downstream reaches of the Little South Fork. Lower Little South Fork has a steep gradient with returning second growth.

Habitat Structure: The geology of the Elk River watershed affects instream conditions in the basin. While main stem sections often provide relatively good spawning habitat, particularly in upper reaches, tributaries like Tom, and Railroad Gulches are affected by Hookton Formation geology along the southern ridges. The Hookton Formation is composed of sand and small gravel, is highly erodible, and does not tend to produce suitable spawning conditions (Jeff Barrett, personal communication). The Wildcat Formation found in the upper watershed is composed of soft, poorly consolidated loams and contributes mud and silt that can smother spawning gravels (Jones and Stokes 2003).

A fish abundance study has been ongoing since 1999 in North and South Fork by the Institute for Forestry and Watershed Management using e-fishing and snorkel surveys. In general, South Fork has been characterized as having a good, healthy looking habitat with gravel exposed in many places (Dana McCanne, personal communication). The Draft Headwaters Management Plan (2003) characterizes South Fork Elk River as having numerous deep pools, but containing large amounts of fine sediment. Given that the highest densities of roads found in the watershed are in the headwaters of South Fork (Elkhead Springs), a lot of runoff is being channeled directly into streams. 31% of Upper South Fork remains unharvested.

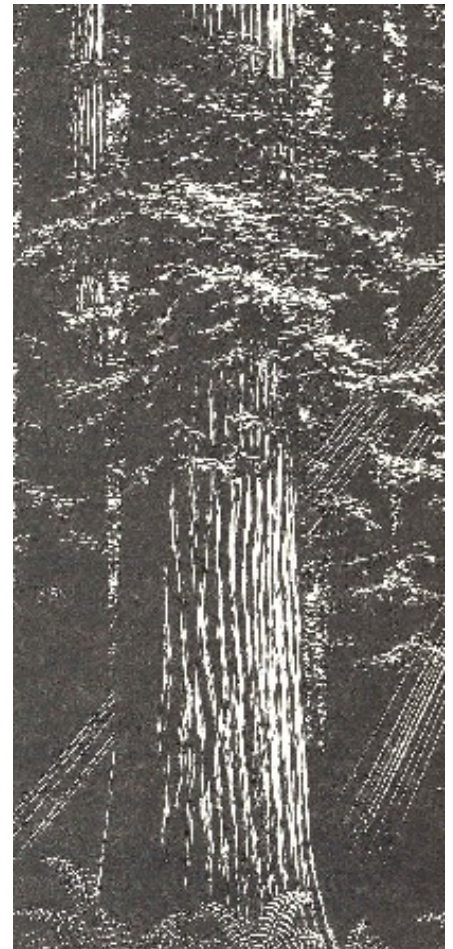
Water Quality: Water quality has been monitored by several parties in an attempt to get a good picture of turbidity and discharge conditions. Stream discharge, continuous stage, staff gauge, and crest stage data are presently being collected by Salmon Forever on the South and North Forks along with occasional grab samples in the upper South Fork watershed (Klein 2001). Salmon Forever monitoring site are located: on South Fork, upstream of the confluence with the main stem; confluence of South Fork and Tom Gulch; South Fork at Falk; two sites on South Fork between McCloud Creek and Little South Fork; on Little South Fork above confluence (see map). Salmon Forever installed continuous turbidity sampling within the Headwaters Forest on the South Fork beginning in the 2001 winter (this data is not reliable due to equipment failure).

During the 2001-2002 winter, for purposes of comparison with the North Fork, PALCO also collected turbidity data for South Fork Elk River, main stem Elk River, and two tributaries to the main stem (Railroad and Clapp Gulches). Results from PALCO's monitoring showed that the North and South Forks each had similar turbidity levels across the range of discharges sampled, with South Fork averaging 23% greater turbidity than North Fork.

Turbidity levels in the main stem were approximately 72% greater than levels in the North Fork. Turbidity levels in Clapp Gulch and Railroad Gulch were greater, 2,212% and 1,347% respectively, than levels in the main stem (PALCO 2000).

In recent aerial photos of land logged in the 1980s, you can still see extensive skid trails that have not revegetated. These highly disturbed areas with extensive roads are most likely channeling sediment. Harvested areas contain many roads and abundant sediment in the river channel. Many roads have been prioritized for decommissioning due to ongoing and potential sediment delivery. Road removal has begun within the Headwaters Forest. South Fork, including Little South Fork appears to carry high sediment loads during the rainy season. Sediment introduced into both streams has most likely decreased the size and depth of many pools (Jones & Stokes 2002). Water temperature may be of concern in the upper watershed where low flows, slow waters, and shallow pools can elevate summer water temperatures.

Water Quantity: Transport capacity on Class II and III streams in the upper watershed may have lost natural water retention as roads and harvesting have compacted soils and brought subsurface flows above ground (Adona White, personal communication). The loss



of water retention may have lead to increased peak flows during storm events.

Potential Limiting Factors: Fine sediments from land management and natural geologic sources are a limiting factor for the South Fork Elk River. Landslides, from both managed and unmanaged areas, are an important sediment source and often occur on steep slopes immediately adjacent to streams (inner gorges). Former roads, landings, and skid trails are also a significant source of sediment in the South Fork with a large number of failed sites contributing sediment to the stream. There are also a large number of stream crossings, or Humboldt crossings, and culverts which need removal (PWA 2000). As part of their Resource Management Plan, BLM has identified specific sites for decommissioning, removal, and restoration. Within the Headwaters Forest, road-to-trail conversion and trail repair is being planned and developed.

V. C. 6.4 Upper Reach North Fork Elk River

Description: The North Fork Elk River contains many major and minor tributaries including: Dunlap and Browns Gulch, McWhinney, Bridge, and Lake Creeks, and the North and South Branch. The North Fork Elk River is managed for timber production by PALCO, which owns 13,189 acres (92%) of the 14,336 acre watershed with private residential parcels in the lower section.

Habitat Structure: The North Fork Elk drains into a narrow valley with a sudden decrease in gradient which channels sediment and debris into a sharp bend in the river. This area of lower North Fork has experienced changes in bank composition and channel morphology (Kristi Wrigley, personal communication). What has been called the “bowling-alley effect” by landowners, can be seen in the stream reach as it has straightened and decreased in depth. According to Kristi, the majority of the changes occurred from 1995 to 1999.

In the North Fork Elk River a flat floodplain, located above the confluence with the main stem and South Fork, has been characterized as the best coho reach in Humboldt Bay by PALCO fisheries biologists (Jeff Barrett, personal communication). This low gradient reach, however, acts as a trap, or resting place for sediment, preventing it from moving quickly through to lower reaches.

A field inspection team, made up of agency staff and landowners, visited sites in 1997 in the North Fork Elk River and observed channel changes that had apparently occurred in a relatively short duration of time. Observations made by Peter Cafferata of CDF noted that the large storms of 1993 to 1997 had “routed stored sediment from lower order tributary watersheds down to the lower gradient storage reaches of Elk River and caused significant amounts of landsliding associated with old roads and landings to occur, generating considerable volumes of new sediment to route downstream” (1997).

PALCO monitoring results for North Fork (2000) indicated that pool depth was of concern in the upper watershed. Pools surveyed were abundant and associated with adequate large wood, but did not meet properly functioning condition (PFC) targets for pool depth. LWD is probably neither as abundant nor as large as desired targets would warrant (Rice 2002).

Water Quality: Interviews on January 17, 1998 with long-time residents in the lower reach of North Fork documented degradation of the water quality and beneficial uses of the water including taste, odor, and increased frequencies for the maintenance and replacement of water treatment appliances due to siltation (Dudik 1998). NCRWQCB staff report that twelve residences on North Fork draw water from the river for personal use (Adona White, personal communication).

Sediment delivery studies done by PWA determined sediment delivery for the North Fork Elk River on behalf of PALCO (1998). Sources of sediment in the North Fork Elk River watershed include mass wasting (deep-seated landslides, shallow-rapid debris, and debris torrents), fluvial erosion (gullies, channel erosions, and stream bank erosion), and surface erosion. The sediment delivery studies reported that persistent processes occur every winter, regardless of occurrence of high magnitude storms. Storm events increase the rate of these fluvial processes, some of which are management related (PWA 1998). Suspended (fine-grained) sediment can move quickly from their source to site of deposition. Reid concluded that the fine-grained nature of the sediment in North Fork Elk River demonstrates that it has been generated by recent and on-going activities (2002).

From 1999 to 2001 PALCO maintained seven monitoring stations in North Fork Elk River and its tributaries and one station on the main stem (PALCO 2000). A pilot turbidity monitoring program for storm events was not started at these monitoring stations until the 2001 winter (Gretchen Oliver, personal communication). In

2003 there were 15 monitoring stations maintained by PALCO in the upper watershed.

Water Quantity: Historical rainfall data has been collected by longtime residents Kristi Wrigley and Ralph Kraus since 1970. Flood dates and heights have also been recorded by North Fork residents. More recent flooding, such as the December 27 and 28, 2002 flood, was recorded as being 2.5 feet higher than the December 1964 flood at the Wrigley Ranch. Flooding at the North and South Fork confluence occurred multiple times in the winters of 1995, 1996, 2002, and 2003 after 2.5 inches or less (average of 1.34 inches) of rain in a 24 hour period (Wrigley 2003). A two inch rain in a 24 hour period is a fairly rare event over the historic record.

Limiting Factors: Observed changes in the North Fork include: pool filling, substrate size, substrate composition decreasing from cobble-gravel and small pebbles to an almost exclusively silt-clay structure, and LWD flushing from the system (Dudik 1998).

Recently generated and historically stored sediment has been transported downstream in Elk River and appears to be depositing in lower reaches of the river where stream gradients are gradual. The increased sediment storage may be raising the effective bankfull stage at distances further upstream than in the past, which may be moving flood events further upstream than in the past (Dudik 1998).

Many residents and NCRWQB staff have concluded that the rate of harvest over a short period of time in Elk River has had associated impacts. Total harvest area determined for the North Fork Elk River by NCRWQCB staff was 5,035 acres or an average of 504 acres per year (3.8%) between 1987 and 1997 (RWQCB 2000). Dr. Leslie Reid, biologist for the Forest Service's Redwood Science Lab, evaluated appropriate cutting rates for the North Fork Elk River based on past disturbance and geological setting. Reid found that areas harvested less than 15 years ago were approximately 1300% (13 times) more likely to experience landsliding and sediment delivery than background landslide sediment yield rates (Reid 1998). Landslide occurrence and sediment delivery to watercourses increased dramatically during the period from 1994 to 1997.

Table V.13: Existing Salmonid Habitat Conditions in Lower Elk River

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food Source is not a problem for Adult salmonids in this watershed because adult fish do not feed during their upward migration.	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Riparian degradation reduces the food supply of juvenile and resident salmonids, while high turbidity levels make feeding more difficult. reduced visibility). High velocity make it difficult for juveniles to catch food and reduces the number of micro-invertebrates that are a food source. Especially important in lower gradient reaches and mainstem Elk	Poor riparian and in-stream habitat reduce food supply and alter feeding habits during downstream migration. The decreased size and quality of the estuary also may reduces food supply during smoltification. No studies have been done in lower gradient reaches of the watershed, however the streambed consists of fine sediment and muds not conducive to macroinvertebrates
Water Quality (Local Watershed Experts surveyed by HBWAC Agreed that addressing sediment delivery rates is the highest priority in Elk River)	Chronic, high concentrations of suspended sediment and turbidity exist and directly impacts the usage of this watershed by adult salmon and steelhead. There is limited good spawning habitat in the lower watershed. Spawning salmonids must use the upper watershed and tributaries for adequate spawning gravel. Especially significant for chinook salmon.	Dissolved Oxygen (DO) levels, which are very important during incubation, are significantly reduced when there are high levels of fine sediment present in gravel. Elevated levels of sediment are present and habitat surveys show gravels are embedded thus reducing the amount of DO available in the gravel and causing higher rates of mortality.	Poor water quality resulting from high levels of turbidity and suspended sediment, can decrease growth rates in juvenile salmonids thus dramatically reducing survival rates. Fish size when entering the ocean is directly related to the rate of survival. Monitoring of Elk River turbidity shows there is a chronically high level of suspended sediment in the water column. Excess nutrients from dairy ranches in the lower watershed may be effecting dissolved oxygen levels. WQ monitoring data is sparse for the lower watershed.	Poor water quality may impair feeding habits and growth rates. Studies show that resident trout and juvenile salmon use the estuary longer than previously thought. If there is not adequate habitat in the lower watershed salmonids are forced out of the system early and reduces the chances of survival in a marine environment.
Habitat Structure	Tidegates on Swain and Martin Sloughs pose are partial barriers for migrating adults. A few spawners have been observed above tidegates in recent years. There is a lack of large wood, clean gravels, and cover especially in the low gradient reaches and main stem Elk River. Other barriers may also exist in the watershed. Culverts on county roads, and PALCO lands have been assessed.	Large wood for sorting of gravels and metering of sediment is lacking in the watershed. Geology also determines where good spawning gravels are located (in Yager Formations).	Simplification of habitat from a variety of activities including removal of riparian trees and instream woody debris have degraded rearing habitat. Large inputs of sediment have filled pools, embedded gravels, and altered channel capacity reducing it by as much as 60% in some areas. The estuary lacks habitat complexity in the forms of LWD, pools, backwaters and side channels. The connection between the river and its floodplain has also been reduced.	Reduced habitat complexity (lack of backwater channels and LWD) in the watershed has made it more difficult for juvenile salmonids during upstream migration. The decrease in the size and quality of the estuary affects food supply and shelter necessary for adaptation to the salt water environment.
Flow and Depth			Channel capacity in the storage reaches of Elk River has been significantly reduced by aggradation. This has lead to more frequent flood events that may affect rearing of juvenile salmonids.	

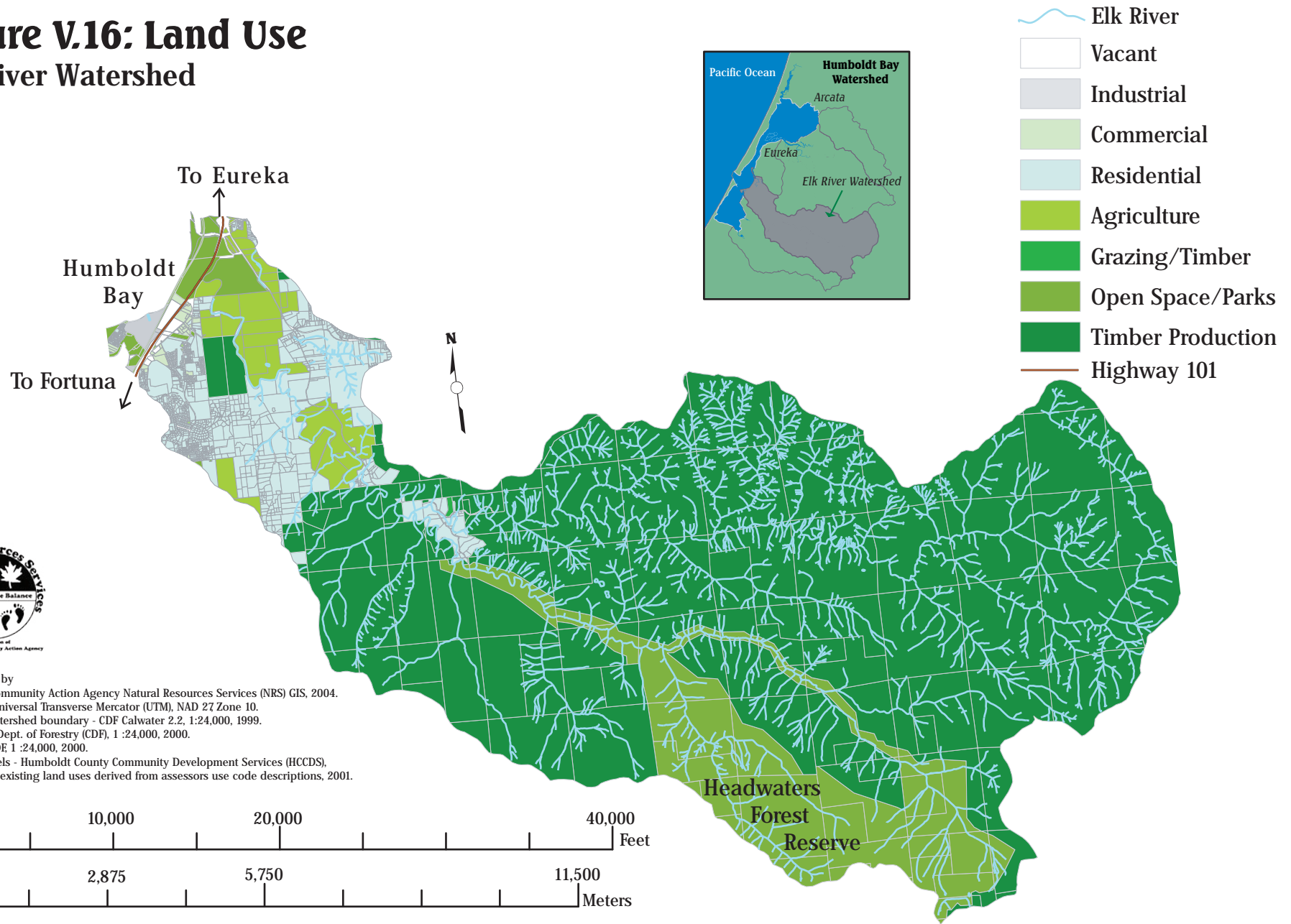
Table V.14: Existing Salmonid Habitat Conditions in Middle Elk River

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food source is not a problem for adult salmonids in this watershed because adult fish do not feed during their upward migration.	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Riparian degradation reduces the food supply of juvenile and resident salmonids, while high sediment levels make feeding more difficult. (reduced visibility). Chronic turbidity is considered a limiting factor. High velocity make it difficult for juveniles to catch food and reduces the number of micro-invertebrates that are a food source.	
Water Quality	Highly turbid waters may reduce spawning since fish are known to avoid sediment impaired reaches. Although there is spawning in the upper middle reach, it's use as a spawning reach was once more common.	Redds can become smother due to small fines. Sediment has been demonstrated as a limiting factor in this reach and may attribute to redd loss.	The middle reach of Elk River is bordered by residential and agriculture land. A thin strip of trees make up the riparian are leaving little buffer between ag land and the stream channel. There may be impacts to water quality from agriculture runoff and septic systems, but monitoring for organic compounds has not been down in this reach.	
Habitat Structure	Clean spawning gravels in the upper middle reach is a limiting factor. Some areas of gravel are returning after large pulses of sediment were routed to lower gradient reaches from the upper watershed in the winters of 1996-1998. Gravels are highly embedded but may still be being used for limited spawning.	This reach shows evidence of aggradation with fine sediment. Residents also report the loss of gravels in this reach due to recent aggradation. Loss of gravels is a limiting factor for spawning and fines can smother redds and make emergence impossible.	Simplification of habitat from a variety of activities including removal of riparian habitat, provide for a difficult rearing environment. Pools created by LWD and other forms of scour, are also important for resident populations. Riparian cover is important for creating refugia especially in summer months. Riparian vegetation removal along the middle reach results in temperature spikes and lack of LWD recruitment.	
Flow and Depth			Flooding occurs during the winter season in this reach threatening property but there is no evidence that this has adversely affected fish.	

Table V.15: Existing Salmonid Habitat Conditions in North and South Fork Elk River

Habitat Requirements	Adult Migration and Spawning	Incubation (embryos & alevins)	Rearing (juveniles and adult residents)	Juvenile Migration
Food Source	Food source is not a problem for adult salmonids in this watershed because adult fish do not feed during their upward migration.	During incubation, the yolk sac of salmon embryos and alevins are digested as a source of nutrients.	Benthic macroinvertebrate indices in North Fork suggest good biotic stream conditions (PALCO 2001).	
Water Quality		High percentage of fine sediment has been observed in the aquatic environment (Michlin 1998).	Residents report that river water during summer months remains muddy and silty. Turbidity has reported to be elevated year round from past years (pre-1995). Large storm events in 1995-1997 may have routed stored sediment from lower order tributary watershed down to the lower gradient reaches of North Fork Elk and caused landsliding, generating large volumes of new sediment (Cafferata 1997). Winter monitoring done by PALCO found that South Fork averaged 23% greater turbidity than North Fork.	
Habitat Structure	Loose of suitable spawning gravels and riffles has been observed by North Fork residents. Gravels are beginning to return as fine sediment is moving through the system. A thick, sticky mud covers the channel bottom which may be a limiting factors for spawning.		The steep upper North Fork enters into a narrow valley above the confluence at the Wrigley property with a change in gradient This reach in the first place sediment deposits from the upper headwaters and moves through in large slumps over a period of winters (Wrigley 2002). This reach has experienced bank erosion and aggradation, as well and channel simplification (pool fill, large wood being washed out, loss of cobble-gravel). Pool depths and LWD in North Fork do not meet PFC targets.	Barriers exist, notably the Graham Gulch culvert, prevents juveniles from accessing the reach.
Flow and Depth			Channel aggradation in the lower North Fork could result in increased over-bank flooding (Conroy 1999). In a 1994 habitat survey in the North Fork Elk River, 44% of the survey length was made up of pool habitat types with 71% had a depth of 2 feet or greater (DFG). Residents report pool filling. Assessments on upper South Fork by BLM found a high volume of sediment generated from roads and crossings. Sediment introduced into South Fork and Little South Fork has most likely decreased the size and depth of many pools (Jones & Stokes 2002).	

Figure V.16: Land Use Elk River Watershed



Map Design by
 Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 Elk River Watershed boundary - CDF Calwater 2.2, 1:24,000, 1999.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Streams - CDE 1:24,000, 2000.
 County Parcels - Humboldt County Community Development Services (HCCDS),
 generalized existing land uses derived from assessors use code descriptions, 2001.

Figure V.17: Roads Elk River Watershed

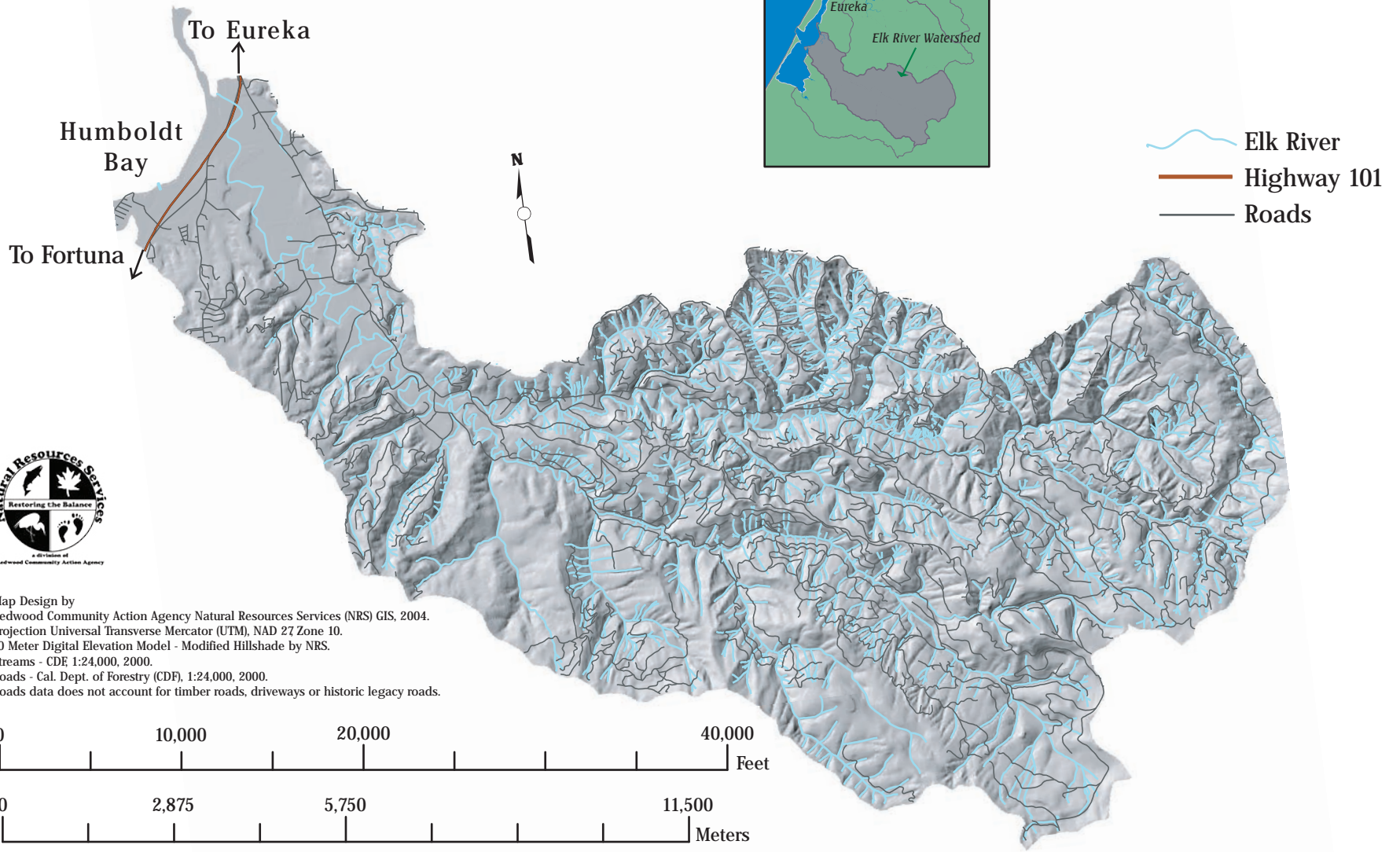
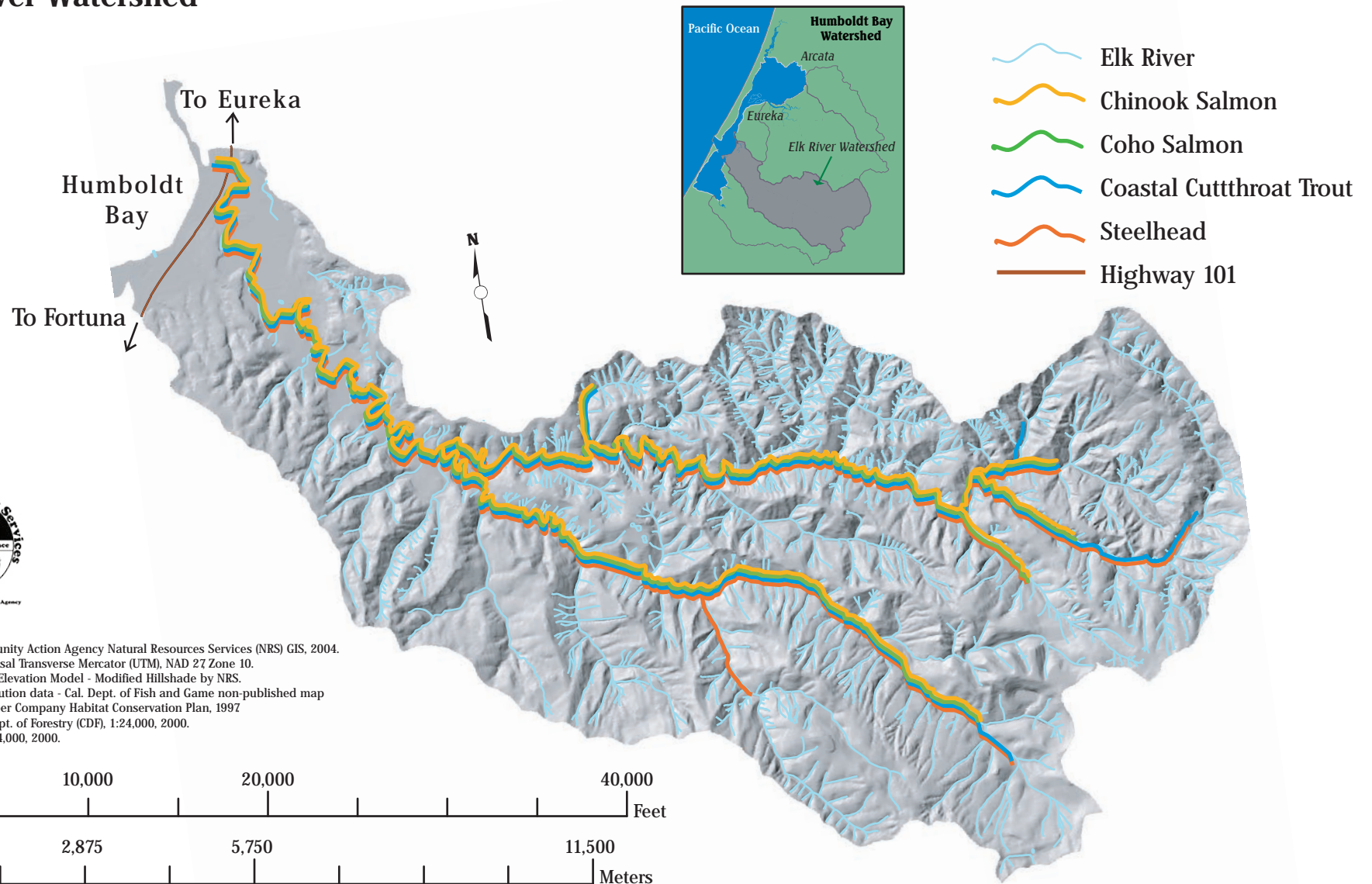


Figure V.18: Anadromous Salmonid Distribution Elk River Watershed



Map Design by
Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
10 Meter Digital Elevation Model - Modified Hillshade by NRS.
Salmonid Distribution data - Cal. Dept. of Fish and Game non-published map
and Pacific Lumber Company Habitat Conservation Plan, 1997
Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
Roads - CDE 1 :24,000, 2000.

Figure V.19: Stream Gradient Elk River Watershed

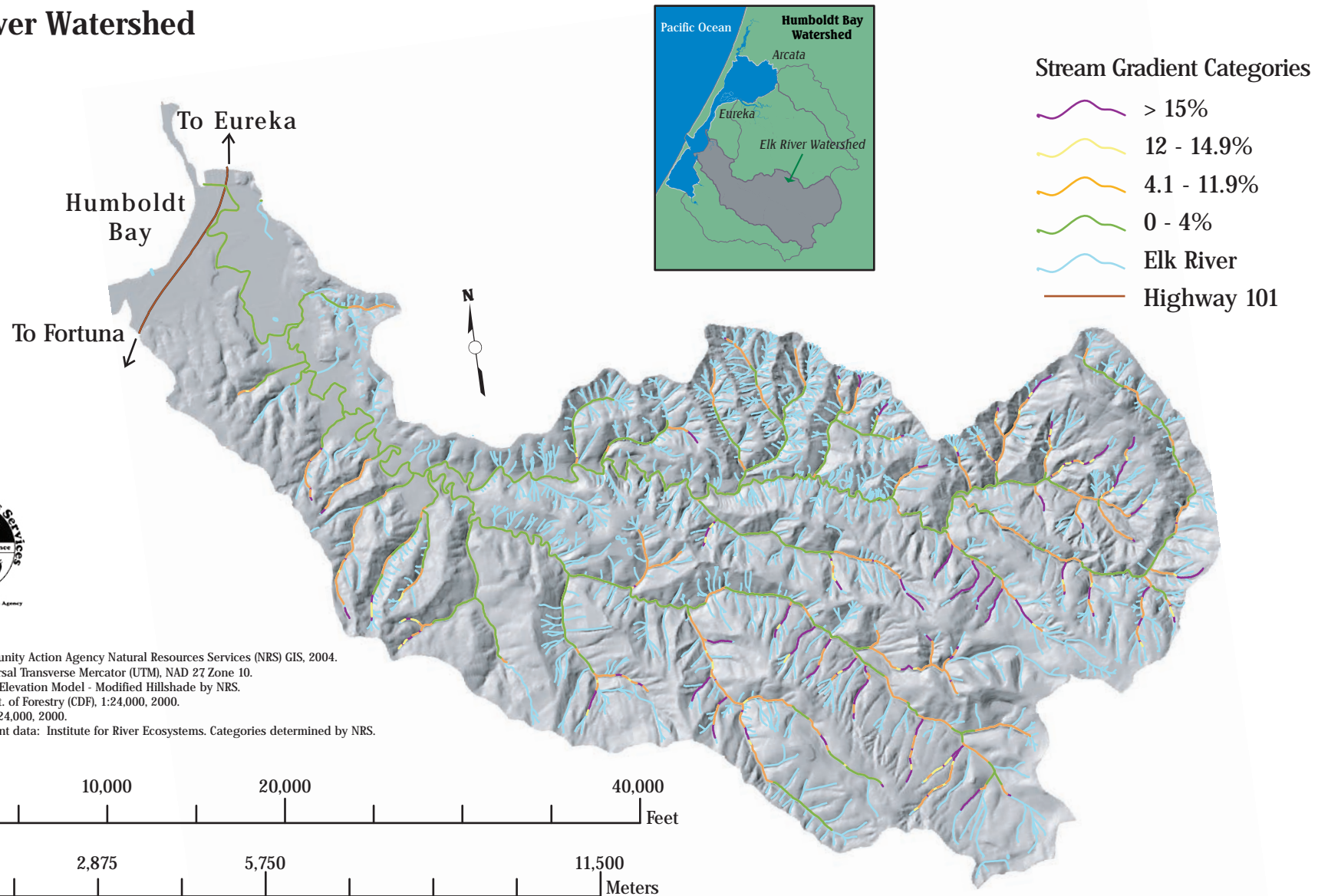
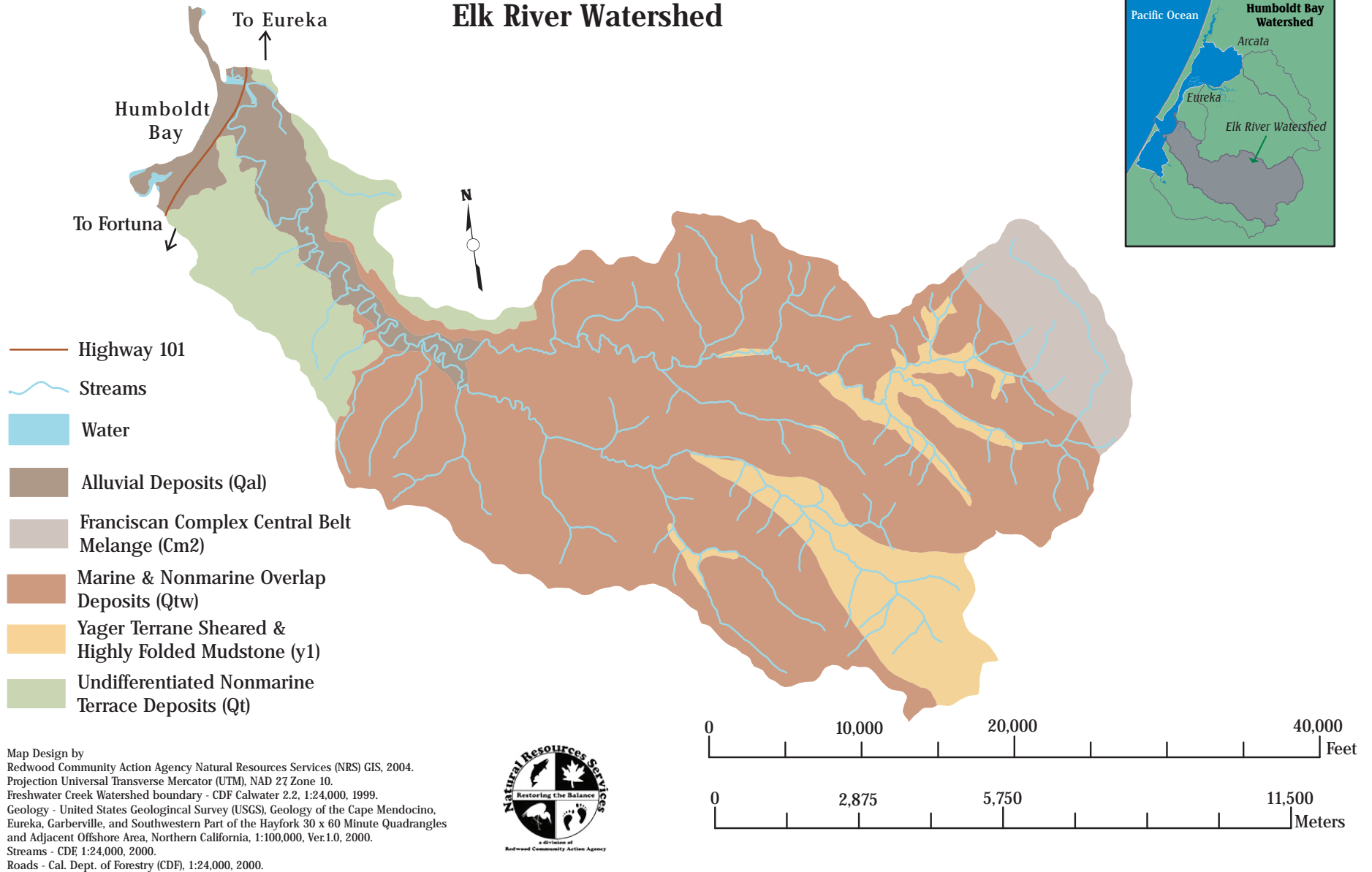


Figure V.20: Geology Elk River Watershed



V. D. Salmon Creek

Salmon Creek is located between the cities of Eureka and Fortuna and flows into Hookton Slough. Salmon Creek has 14 miles of stream and drains a watershed area of approximately 23.5 square miles. Elevations range from sea level to 1,500 feet.

The Salmon Creek watershed drains to the northwest and has a well developed alluvial floodplain valley that extends from Humboldt Bay several miles upstream. Salmon Creek drains low (2,000-foot) hill in the upper parts of the watershed and lower (800-foot) ridges on its northern and southern margins. Little Salmon Creek drains into Salmon Creek through a low-gradient moderately broad valley for the first three miles above its confluence with the mainstem. Upstream, hills pinch the channel and form a narrow valley with moderately steep slopes on either side (Hart Crowser 2003).

The natural vegetation is coniferous forest, dominated by coastal redwood. Douglas fir, tan oak, grand fir, Sitka Spruce, western red cedar, and western hemlock are also present, and red alder and willows in the riparian zone. Natural understory species include evergreen huckleberry and salal.

The climate of the Salmon Creek area is rainy temperate with an average annual precipitation of 152.4 cm (60 in.) along the upper reaches of the watershed (Monroe et al. 1973). Similar to other streams on the northcoast, Salmon Creek is characterized by moderate to heavy flows from November through March and very low to barely perceptible flows during the rest of the year (FWS 1989).

V. D. 1. Geology

The Salmon Creek watershed is underlain by several geologic formations. Two main types of rocks occur in the Salmon Creek watershed, the older and more resistant, underlying, hard sedimentary rocks of the Yager Formation and the more prevalent geologically younger, softer rocks known as the Wildcat Group. The Yager Formation is present in the inner gorges and stream bottom in the upper watershed. The Table Bluff Fault runs along Tompkins Hill to the south of Salmon Creek. The Little Salmon Creek Fault runs along the eastern side of the Refuge (PCFWWRA et al. 2003).



The Interpretive Center on the Salmon Creek estuary is part of the Humboldt Bay National Wildlife Refuge Complex

V. D. 2. Land Use



*Spawning coho in Salmon Creek.
Photo Courtesy of Dave Fuller,
BLM.*

Land use in this area includes dairy farming, cattle ranching, non-industrial and industrial timber production, refuge for wildlife and recreation, and rural residences.

The lowest one-third of the watershed flows across pastureland, reclaimed around the turn of the century from the tidal flat of Humboldt Bay, and the lower 5,000 feet of stream flows through the 1081 acre U.S. Fish and Wildlife Service Humboldt Bay National Wildlife Refuge (HBNWR) which is managed for recreation and wildlife.

The middle one-third of the watershed is covered with a dense stand of 30 to 55 year-old trees in addition to scattered old-growth trees. Approximately 75 percent of the trees in this area are redwoods and the remainder are Douglas fir, grand fir, tan oak, alder, and madrone (Huber 1992). The upper two-thirds of the watershed includes privately owned timberlands and a portion of the 7472 acre Headwaters Reserve currently managed by Bureau of Land Management. All of the headwaters of Salmon Creek are within the Reserve. The Reserve's watersheds are typical of the north coast region where intensive management of the land for timber production has occurred over the last four decades or longer. Logging began on the Reserve in the 1800s (Jones and Stokes 2003). Commercial timberlands in the watershed are owned by Green Diamond Resource Company (4330 acres) and Pacific Lumber Company (620 acres) for timber management. Most of the PALCO ownership is located at the head of Little Salmon Creek. Between Highway 101 to the west and Green Diamond Resource Company property to the east, lie several private holdings.

A system of natural gas wells and pipelines is distributed throughout the timber area of Salmon Creek (Hart Crowser 2003).

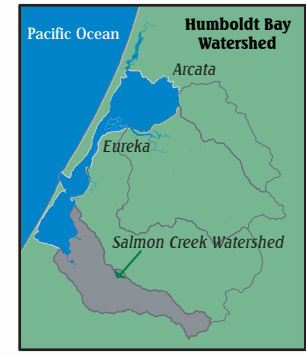
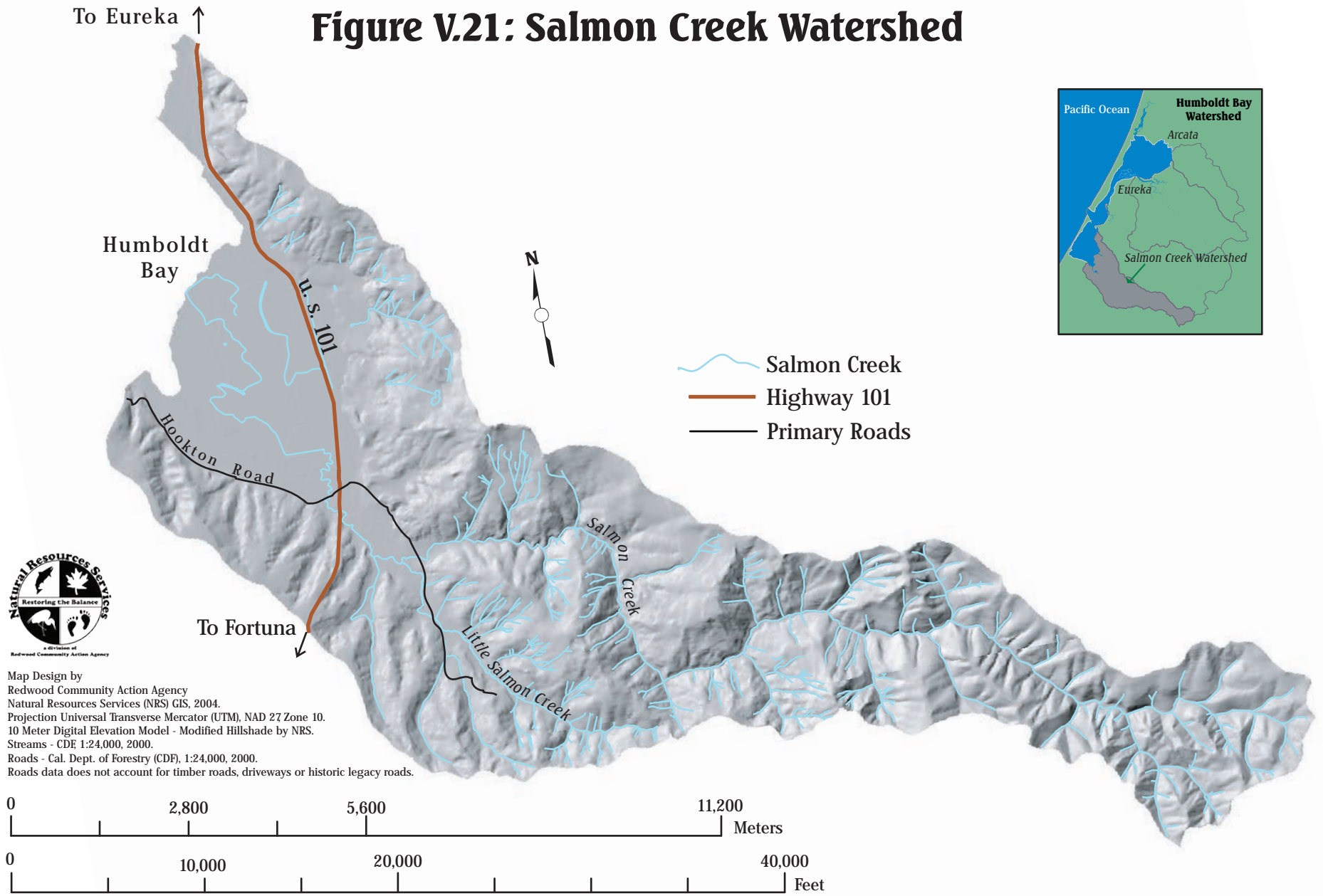
V. D. 3. Salmonid Distribution

Coho salmon, chinook salmon, steelhead trout, and sea-run coastal cutthroat trout occur in Salmon Creek up to the Headwaters Forest Reserve boundary. A non-anadromous population of cutthroat exists within the Reserve boundaries.

Year	Coho	Chinook	Steelhead
1990	23	17	41
1992	1	1	17
1993	15	1	17
1994	6	1	19
1995	11	5	20

Table V.16: HBNWR Adult Migrant Trapping Data. Source: (PCFWWRA et al. 2003)

Figure V.21: Salmon Creek Watershed



V. D. 3.1 Fish Surveys

Upstream adult migrant trapping within the Humboldt Bay National Wildlife Refuge was conducted between 1990 and 1995 (Table V.17).

Spawning Season	Total Numbers Adults Observed (Live and Dead)			Total Numbers Juveniles Observed			Source
	Chinook	Coho	Steelhead	Chinook	Coho	Steelhead	
1989						149	USFWS
1989						37	CDFG
1990	3	16	12				USFWS
1990						12	CR
1991	17	23	41				USFWS
1994	1	6	19				HBNWR
1995	1	5	11	20			HBNWR
1996					34	28	SRC
2001							SRC
1991-1992	1	1	17				USFWS
1992-1993	1	15	17				USFWS

Table V.17: Migrant Trapping Data in the Humboldt Bay National Wildlife Refuge

V. D. 3.2 Fish Habitat Surveys

A habitat inventory was conducted on Salmon Creek during August 1997. The total length of the stream surveyed was 53,851 feet, or 10.2 miles of the total 14 miles of reach, plus an additional 3,129 feet of side channel.

Flatwater habitat types comprised 57% of the total length of the survey, riffles 13%, and pools 30%. A total of 286 pools were identified of which 93% were main channel pools, 2% backwater pools, and 6% scour pools. The pools are relatively deep, with 120 of the 286, or 42%, pools having a maximum depth greater than 3 feet.

Salmon Creek has six channel types, based on the Rosgen stream classification methodology: DA5, F5, C4, F4, F2, and B3. The survey began at the confluence of Little Salmon and Salmon Creeks and worked upstream. The channel types were as follows:

0 - 4,394' DA5
4,394' – 12,724' F5

Historic Fish runs

Salmon Creek once supported abundant runs of native anadromous salmonids. Habitat loss and degradation is the human-caused factor that has had the greatest effect on the abundance of anadromous salmonids. Other factors that have contributed to low abundance relative to historical conditions include commercial and sportfishing harvest, changes in ocean temperature and prey availability, entrainment in diversions, continued habitat degradation, contaminants, species interactions (e.g. presence of or predation by nonnative species), and artificially propagated stocks (Jones and Stokes 2003).

12,724' – 23,769' C4
23,769' – 31,588' F4
31,588' – 37,304' F2
37,304' – 47,040' B3
47,040' – 53,851' F2

The survey, conducted by members of the Watershed Stewards Project, noted that of the 286 pool tail-outs inventoried, 148 of them were believed to be unsuitable for spawning. Seventy-nine, or 27.5%, due to the dominant substrate being silt/sand/clay or gravel being too small to be suitable and 28% due to the dominant substrate being boulders/bedrock/wood.

V. D. 4. Opportunities and Challenges

The Humboldt Bay National Wildlife Refuge at the mouth of Salmon Creek was initially established in the early 1970s because it was recognized by US Fish and Wildlife Service as an important habitat for migrating waterbirds. A few acres of saltmarsh were acquired at in the early 1970s specifically to preserve habitat for the black brandt (USFWS 1974). In 1988, 1,081 acres along the Salmon Creek was acquired for the Refuge.

A survey was conducted in 1980 by the US Army Corps of Engineers on the Humboldt Bay wetlands. It highlighted the South Bay, and particularly the Salmon Creek delta and Hookton slough, as an important habitat preserve.

Opportunities for protection and restoration in the watershed are prevalent with the Headwaters Forest Reserve encompassing the entire headwaters of Salmon Creek, and the Humboldt Bay National Wildlife Refuge at the mouth. Goals of the BLM include restoration and preservation of old-growth and aquatic ecosystems, and a resource monitoring and evaluation program. Restoration based on PWA inventories that has already begun and will continue includes logging road and landing decommissioning, excavation of stream crossings, slope stabilization, sediment reduction actions (installing water bars, improving road drainage, eliminating water diversions, trail repair to reduce sediment yield and protect and enhance stream habitats within and downstream of the Reserve (Jones and Stokes 2003).

Historic Human Footprint and Conditions in the Salmon Creek Watershed

Prior to European settlement Wiyot Indians inhabited the Salmon Creek region. The existence of Native American settlement of northern California has been dated to at least 2,000 years ago, and was followed by surrounding Athabascan-speaking groups who settled in the remaining unoccupied territory of Humboldt Bay.

Before the first extensive settlement by Europeans in the 1850s there were approximately 1000 (Barnhart et. al., 1992) Wiyot Indians inhabiting the Humboldt Bay region. The Wiyot called the extensive saltmarsh areas Goal-ala-na, or land a little above water (Wiyot Tribe 2000). According to Nina Hapner of the Wiyot Tribe, the Wiyot maintained a seasonal fishing village adjacent to the Salmon Creek Delta and tribal history places South Bay as one of their best fishing areas (Love 2003).

Timber Harvest

Timber harvesting, first of fir and spruce and later of redwood, began in the Eureka region in the 1850s (Elliot 1881). Around the 1870s and 1880s, lumber and shingle mills like the Carson Mill Company, later renamed Millford Land & Lumber, was erected on and around Salmon Creek. A bridge crossing constructed by the Carson Mill was laid with two-inch thick redwood planks for the purpose of transporting the lumber from this mill on Salmon Creek to the market. The mouth of Salmon Creek was an ideal place for a dam to be built to sufficient height to create a large millpond covering several acres and filled with floating logs (Richmond 1920).

There were extensive plans to secure the supply of logs for the Carson mill. For convenience, three dams were placed at certain points along Salmon Creek and by means of opening the gates, they allowed the force of the water to “slosh” the logs down to the main pond at the mill where they would be sawed into lumber. On Jan 19, 1879, The Humboldt Times reported a log jam below the upper dam on the creek. When a heavy rainfall hit the area, the dam broke, allowing enough water to flow down the shallow creek for 1600 logs to roll through. This mill was considered to be one of the best lumbering plants, making Salmon Creek one of the busiest sections in Humboldt County of that day (Richmond 1920).

Other entrepreneurs also tried to harness the waters of Salmon Creek for their profit. Mr. Elim Long for instance, dreamed of constructing a shingle mill near his farm. He pondered manipulating the creek for the power to operate his machinery such that he was compelled to dam up the stream and construct

Historical Timeline for Salmon Creek Watershed

pre-1800 - Wiyot peoples occupied villages around Salmon Creek
1806 - Humboldt Bay “discovered” from sea, and mapped
1849 - Gold rush inland drives development of bay area
1860 - Indian Island massacre
1860s - First logging in Salmon Creek watershed
1870s - Carson Mill built at mouth of creek
1880s - Logging continues in watershed, railroad constructed
1883 - Hookton Slough dredged
1890s - Stocking of fish begins in Humboldt Bay streams
1900 - Formation of south bay reclamation district
1904 - Construction of levees for reclamation of tidal marsh
1940s - Logging of middle Salmon Creek re-opened
1988 - Humboldt Bay Wildlife Refuge established
1999 - Headwaters Forest purchased

a flume to carry sufficient water to a giant waterwheel to turn the spindles of his shingle mill. After construction was complete, the plan ultimately failed because of the lack of sufficient power to make it profitable. The consequence was that the Long shingle mill was never operated to any extent. The structure remained for many years, in fact, long enough for it to pass as an antique (Richmond 1920).

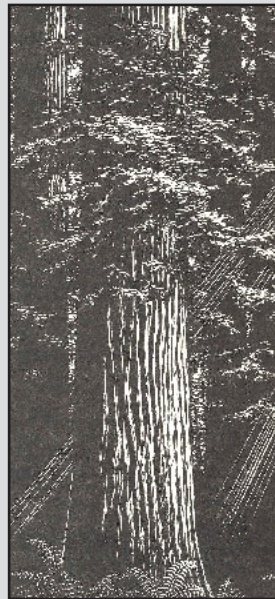
Part of the middle one-third of the watershed was first logged around 1900 and again in the mid-1950s. The rest of the area was first logged between the late 1930s and the early 1960s. Only part of the upper one-third of the watershed has been logged (Huber 1992). The Millford Land & Lumber Company was sold in 1902 (Melendy 1959). It was relocated to Fields Landing by its new owner. Because of improved transportation facilities and logging methods, it was no longer necessary to run the mill on Salmon Creek. The industry again turned towards the Arcata Bay as its main facility. The area remained relatively unused for timber production until 1940 when Eureka re-opened Salmon Creek logging to supply timber to the Arcata Sawmill (HS, 8 June 1940). Fred H. Lunblade Company ran the operation. Five thousand board feet of redwood were sent out per day to the Arcata Redwood Company.

Tidal Reclamation

Historically Salmon Creek flowed into the bay through relatively large multi-channeled alluvial floodplains which included a dynamic transition of habitats from riparian to saltmarsh, and from creek channel to tidal slough. Since that time Salmon Creek has been channelized and diverted to maximize drainage, spread silt, sub-irrigate pasture, and provide drinking water for livestock during the dry season. As a result, flows reach the bay only through tidegates at three different locations (FWS 1989).

In the early 1850s, there were over 7,000 acres of pristine tidal wetlands (Barnhart 1992). In 1868, the State of California put tidal and freshwater wetlands up for sale at \$1/acre. In the next two years, 562,503 acres would be sold and reclaimed in Humboldt Bay. By 1964, 91 percent of this area had been drained, diked and developed, mostly for agricultural land or industrial uses.

According to the 1865 Official Township Map of Humboldt County, the Salmon Creek delta was undeveloped except for a dock near the mouth of the creek. The US Coast Survey Map from 1870 shows a farm adjacent to the saltmarsh by the old route 101 but the location of the creek is not apparent.



Historic Vegetation

Before European settlement, the majority of the Salmon Creek watershed was covered by ancient redwood forests that existed in the area for millions of years. In the low elevations, the redwood forests were dominated by redwood with scattered western hemlock, western red cedar and grand fir. Sword fern, oxalis, huckleberry, salal, elderberry, cascara, rhododendron, and other evergreen shrubs dominated the forest understory. Fire was infrequent in coastal stands, and the forest was dominated by shade tolerant species that successfully reproduce in the absence of disturbance. Trees on ridges and interior hill-slopes were typically not as tall or long lived as those at lower, moist, protected sites. Where Salmon Creek approached Humboldt Bay, the redwood forest gave way to more salt tolerant trees, especially Sitka spruce and red alder. Spruce and alder, along with willows, maples and cottonwoods most likely dominated the valley bottoms near the bay where soils remained water logged for much of the year (Roy 1966).

To accommodate for the influx of lumber, the Hookton channel, which the Creek drains into, was dredged in 1883 (USACOE 1977). This became one of the main channels in the South Bay, running past the lumber outpost of Field's Landing. The Eel River and Eureka Railroad began construction of a rail line from Fields Landing to Salmon Creek in 1880. The railroad cut through the eastern edge of the historic tidal reaches of Salmon Creek (Coast & Geodetic Survey map 1927).

Three tide-gates are located at the mouth of Salmon Creek. These gates were first installed during levee construction in the early 1900s. The gates have been retrofitted at least once to increase access for adult migrating salmonids.

Although the construction of the Eel River & Eureka Railroad cut off some tidal flow to the delta area, it was not until 1900 that the reclamation truly began. On August 21, 1900, the Board of Supervisors passed a petition by Z. Russ & Sons for the formation of a reclamation district of 1,585.44 acres of marsh at the head of the South Bay, in and around Salmon Creek and Hookton Slough. However, because Russ did not apply in the proper time, the Board of Harbor Commissioners for Humboldt County passed it up to the state by refusing to grant permission to dyke sloughs and streams emptying into South Bay, and Russ had to settle with the War Department, who governed California's navigable waters. A letter from the War Department indicated that the closing of the streams was prohibited and they would have to dyke the banks instead.

V. D. 5. Restoration and Conservation Efforts

Within the Wildlife Refuge a constructed meandering channel was built in 1993 to reroute the creek from a straight channel ditch. Levees were also upgraded in 1980s and currently there are 7 different tidegate locations in the Refuge (PCFWWRA et al. 2003).

The Lower Salmon Creek Delta Salmonid Habitat Enhancement Opportunities document prepared by Pacific Coast Fish, Wildlife and Wetlands Restoration Association along with Michael Love & Associates and Graham Matthews & Associates in August 2003, proposes recreating saltmarsh and intertidal habitat within the existing lower Salmon Creek corridor. The report also details several options for restoring salmonid habitat within the Refuge property through tidegate removal, modification, creating seasonal freshwater wetlands, and increasing tidal prism, among other alternatives (PCFWWRA et al. 2003). The second phase of this program will be selection and funding of the optimal alternative.

Pacific Watershed Associates conducted road inventories in Salmon Creek on both Green Diamond Resource Company and then PALCO (now BLM) ownerships. The field inventory identified future sediment sources from logging roads in the watershed, including 57 miles on Simpson lands in the lower basin and 21 miles on former Pacific Lumber Company (now BLM) lands in the upper watershed. A variety of treatments have been applied to prevent erosion and sediment delivery to stream channels from roads and other eroding areas. Erosion prevention work completed in 2000-2001 consisted of the permanent decommissioning of over 7.0 miles of high risk, abandoned logging roads and recontouring restoration of over 5.0 miles of road in Headwaters Forest Reserve. In Salmon Creek, an additional 18 roads, totaling 8.45 miles and incorporating at least 78 discrete erosion sites, are targeted for erosion prevention treatment over the next two years (2002-2003) (PWA 2002).

In 1999, the upper headwaters of Salmon Creek were purchased by the US government and established as part of the Headwaters Preserve to protect the last unprotected large stand of old-growth redwood forest, now managed by the BLM (Jones & Stokes 2003). CDFG and the BLM have completed the Headwaters Forest Reserve Proposed Resource Management Plan (RMP).

In 2003, the Pacific Lumber Company completed the public review draft of the Elk River/Salmon Creek Watershed Assessment, per the requirements in its Habitat Conservation Plan. The analysis includes a Fisheries Assessment designed to identify and delineate

the fisheries resources and habitat conditions within freshwater areas of the Elk River and Salmon Creek watershed analysis area, in the Salmon Creek watershed specifically, the assessment includes Little Salmon Creek. The information collected will be used to evaluate habitat conditions, habitat areas of concern, and the vulnerability of habitats within the channel geomorphic units to changes in inputs that may result from silviculture practices (Hart Crowser 2003).

Road inventories in Salmon Creek have focused on the identification of on-going and future sediment sources. In 2000-2001, substantial resources were targeted towards completing many of the prescribed erosion prevention treatments in the Salmon Creek watershed. Over \$1.6 million has been expended in the road decommissioning effort alone (PWA 2002). The Bureau of Land Management is continuing to decommission roads in the Headwaters Preserve.

V. D. 6. Current Salmonid Habitat Conditions

A primary impact of past and present land management activities to anadromous fish habitat in the Elk River and Salmon Creek watersheds has been the introduction of massive sediment loads into the streams and their tributaries as well as other channel modifications. Stream channels have become clogged with sediments, reducing pool frequency and depth, and perhaps contributing to increased frequency of flooding (BLM 2000).

BLM has estimated that at least 50 miles of former logging roads are part of the Headwaters Reserve, although a full inventory has not yet been completed. Some of these roads have not been maintained for many years and some have been maintained. The BLM has made a partial inventory of the abandoned system of roads and their potential to yield sediment into watercourses (PWA 2000).

Landslides are also an ongoing source of sediment in the watershed. Many landslides in Salmon Creek occur where it flows over the Wildcat Group rocks (Kilbourne and Morrison 1985). Conversely, few landslides exist where the stream channel is in the Yager Formation, even where Wildcat Group rocks overlie the Yager Formation (Kilbourne 1985). Differences in the strength and durability of these bedrock units explain differences in slope stability along the stream channel. Where Wildcat Group rocks are exposed in the stream channel, rapid erosion removes the toes of slopes. These destabilized slopes tend to fail more readily than in

areas where the harder and stronger Yager Formation is exposed in the channel.

Prior to the initiation of stream clearance work conducted in the early 1970s, pools between riffles in Salmon Creek were probably deeper than at present because more logs would produce more plunge-pools. Even so, the highly erodible nature of the Wildcat Group sedimentary rocks and the occurrence of major storms and earthquakes in the area suggest that the pools and gravels were frequently filled with fine sediment, similar to the present conditions (Huber 1991).

V. D. 6.1 Estuary/ Lower Reach

The tide gates at the Bay to Tompkins Hill Road

Located mainly within the U.S. Fish and Wildlife Humboldt Bay Refuge, to the west of Highway 101. There is also a dairy ranch located on Hookton Road that is currently not operating. The bridge over the creek at Hookton Road constricts the channel and flooding at this location is common. This reach is characterized by a low gradient, tidal influence and a narrow riparian corridor. The floodplain area is zoned Public Facility and Agricultural Exclusive, and is managed as pasture land and for wildlife habitat.

The Salmon Creek estuary has been simplified by

- levee construction (including the railroad bed and Highway 101),
- installation of tide gates
- removal of riparian vegetation and large wood debris,
- disconnection of backwater and side channel habitat, and
- channelization.

There once were a myriad of backwater channels and abundant wood in the estuary, with thick spruce forest along the stream and riparian vegetation covering a large area in the lower reach. Much of the riparian vegetation in the lower Salmon Creek has been altered leaving the predominant riparian trees a variety of willow species and a few remnant spruce. This complex saltwater-freshwater ecosystem likely provided important rearing habitat for smolts.

The Salmon Creek estuary once had multiple channels that flowed into the bay farther north through White Slough and smaller channels connecting Salmon Creek with Hookton Slough. A levee begins to run along the left bank of Salmon Creek immediately downstream of Hookton Road cutting it off from historic channels. Frequent deposition of sediment has led to the formation of

natural levees along the stream banks and filling adjacent seasonal wetlands. Within the Wildlife Refuge the constructed meandering channel.

Water Quality

Water quality monitoring studies were conducted at various sites in Salmon Creek by the U.S. Fish and Wildlife Service's Environmental Contaminants Division (John Henderson). Monitoring was conducted in 1999-2000. Parameters monitored included temperature, dissolved oxygen, and biological assays on amphibians. Dissolved oxygen levels were found to be well below thresholds required for salmonids during low flow summer months. This is attributed to high nutrient levels and interference from the tide gates resulting in a lack of tidal flushing. Preliminary studies done by Pacific Coast Fish, Wildlife and Wetland Restoration Association installed stations in spring 2002 to facilitate monitoring water levels and corresponding water quality parameters during various tidal stream flow conditions. Parameters included temperature, conductivity, salinity, and dissolved oxygen. Within the upper estuary temperatures were adequate but low DO levels of 30-40% saturated were recorded (PCFWWRA et al. 2003).

The Army Corps of Engineers submitted a report of alternatives for the improvement of Hookton Slough in 1977 that provided some alarming news for the South Bay. The primary water quality problem in the waterway was listed as low oxygen levels and excess bacteria counts after and during heavy rains. The potential sources are noted as urban, rural, and agricultural run-off, sewage, discharge from fishing boats, dredging and log storage. Because of the numbers of oyster and clam beds and eelgrass near the Salmon Creek mouth, high nutrient levels are of special concern. When excess algae appear to feed off the nutrients, they can shade out eelgrass beds. Also excess silt loads can fill in the areas colonized by the eelgrass and suppress further growth, cutting off the food source to the shellfish beds.

The water temperatures recorded during August 5-30, 1997, ranged from 59 to 76 Fahrenheit. Air temperatures ranged from 62 to 77 degrees Fahrenheit. The highest water temperatures were recorded in the first three stream reaches where the water temperatures ranged from 61 to 76 degrees Fahrenheit. The water temperatures range in the first three stream reaches, if sustained, is near the threshold stress level for salmonids. The water temperatures recorded in the upper three stream reaches ranged from 62 to 66 degrees Fahrenheit, a more suitable temperature range for salmonids. To make any further conclusions, temperatures would

need to be monitored throughout the warm summer months, and more extensive biological sampling would need to be conducted (Campbell & Miles 1997). John Henderson of the USFWS has been monitoring Salmon Creek water quality parameters since 1999.

Water Quantity

The average annual rainfall ranges between 40 and 60 inches. Data clearly illustrates the difference in rainfall regimes between the lower elevations. During a 1982 College of the Redwoods student survey of stream discharge, the highest flow was recorded in early April at 1.8×10^4 gpm and the lowest flow was recorded in mid-June at 9.9×10^2 gpm (Baseline Data 1982).

Average flows for the months of May, June, and July are 8.1, 3.2, and 0.9 cubic feet per second (cfs), respectively. The average flow for February is 54.5 cfs (U.S. Fish and Wildlife Service 1987).

Frequent flooding occurs in the watershed and as a result, logs and debris collect at Tompkins Hill Road Bridge. The lower portion of the watershed is frequented by flooding and in 1955, three of sediment was laid down (Holgerson, personal communication).

Flood events are common during winter storms coinciding with high tide events. The area between Highway 101 and Hookton Road is regularly flooded. Flooding in this area has minimal impact on human activities, except for residents of Hookton Road.

Potential Limiting Factors

- 1) Lack of estuary rearing habitat,
- 2) Lack of large woody debris
- 3) Lack of side and backwater channel habitat.
- 4) Lack of access. Tidegates impede access to Salmon Creek, and prevent tidal flushing.
- 5) Poor Water Quality. Dissolved oxygen levels during low flow periods may present a significant problem for juvenile and rearing fish.

Nutrients accumulate in the lower reach from dairy management upstream. Recently, the Natural Resources Conservation District and US Cooperative Extension is working with a dairy rancher on Salmon Creek to improve runoff management.

V. D. 6.2 Middle Reach

Highway 101 along the mainstem to above Tompkins Hill Road and including Little Salmon Creek

This reach is characterized by a low to moderate gradient with primarily agricultural development along the stream. This reach is important for coho rearing.

Habitat Structure

Agricultural development along Salmon Creek has resulted in removal of riparian vegetation and large woody debris from the stream thereby reducing the amount of available rearing habitat.

Water Quality

Water quality issues of concern in this reach of the watershed may include contamination from the dairy operation and sedimentation from roads and mass wasting events.

Three in stream stations managed by the Bureau of Land Management for collecting sediment samples were used to collect data in Salmon Creek. Samples were collected in September and October of 1994, 1996, 1997, and 1998. Stream stations were placed in the upper half of the watershed, one at the northeast fork of the headwaters, while the other resides within two miles downstream. Of 36 samples taken from the watershed, the average percent of fine sediment less than 0.85mm was found to be 26.3 percent.

Water Quantity

Within low-lying portions of the basin the stream frequently overtops its banks and inundates adjacent pasturelands. In summer and early fall flows decline to less than one cubic feet per second (cfs) (PCFWWRA et al. 2003).

Potential Limiting Factors

The Salmon Creek watershed is dominated by an erosive, fragile geology. Combined with management activities, such as timber harvest and road building, the watershed is prone to landslides and earth flows causing severe damage as seen in the 1995 – 1996 storm events.

High nutrient loads and subsequent low dissolved oxygen present in the water may be of concern but extensive monitoring of these parameters has not been conducted. Other water quality concerns are high suspended sediment concentrations resulting in high turbidity.

V. D. 6.3 Upper Reach

Extends from above Little Salmon Creek to the headwaters

This reach is characterized by increasing steepness with tributary headwaters in Headwaters Reserve. A barrier prevents fish migration a quarter mile above the lower boundary of the Reserve. Non-anadromous cutthroat trout, resident rainbow trout, sculpin and three-spine stickleback are found in the upper drainage (Jones & Stokes 2002).

Habitat Structure

Riparian habitat in upper Salmon Creek is unique in that it traverses pristine old growth conifers, now preserved in the Headwaters Reserve, and areas of intensive timber harvest. Much of the portion of Salmon **Creek located** within the Headwaters Reserve is dominated by old-growth redwood forest riparian area, abundant large woody debris, and deep pools.

Earthflows and transitional/rotational slides are the dominant erosive geologic features in the Salmon Creek watershed. They are comprised of the erosive Franciscan mélange, known locally as ‘blue goo’. These relatively unstable masses can flow even on gentle slopes. The highest concentration of geologically fragile features is above the confluence of Salmon Creek and Little Salmon Creek extending up to its headwaters (Kilbourne 1985).

Water Quality

Data from Pacific Lumber Company, as well as observations from BLM personnel, show the streambed of Salmon Creek within the Reserve to contain a high level of fine sediment (or silt). BLM in their Headwaters Reserve Management Plan identified sediment and turbidity as major water quality problems. “Large sediment loads have contributed to the degradation of water quality parameters such as turbidity. The introduction of large volumes of fine sediments, which are easily suspended, increases turbidity resulting in reduced reproductive success in salmonids (BLM 2000).

Sediment in the channels and tributaries can be attributed to a few main factors. Landslides are a source of sediment that results from the interaction of geologic and erosive forces. In the Salmon Creek watershed, most of the geomorphic features related to landslides fall primarily into six categories: debris slide, debris slide slope, debris flow/torrent track, transitional/rotational slide, earthflow, and disrupted ground. These processes combined with high annual rainfall contribute significant amounts of sediment and colluvium

to the main channel. Massive earthflows are seen in areas of the watershed.

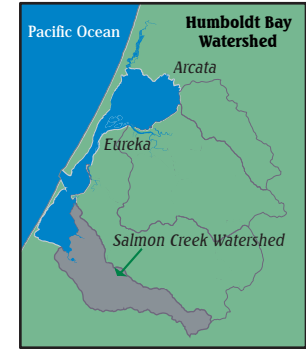
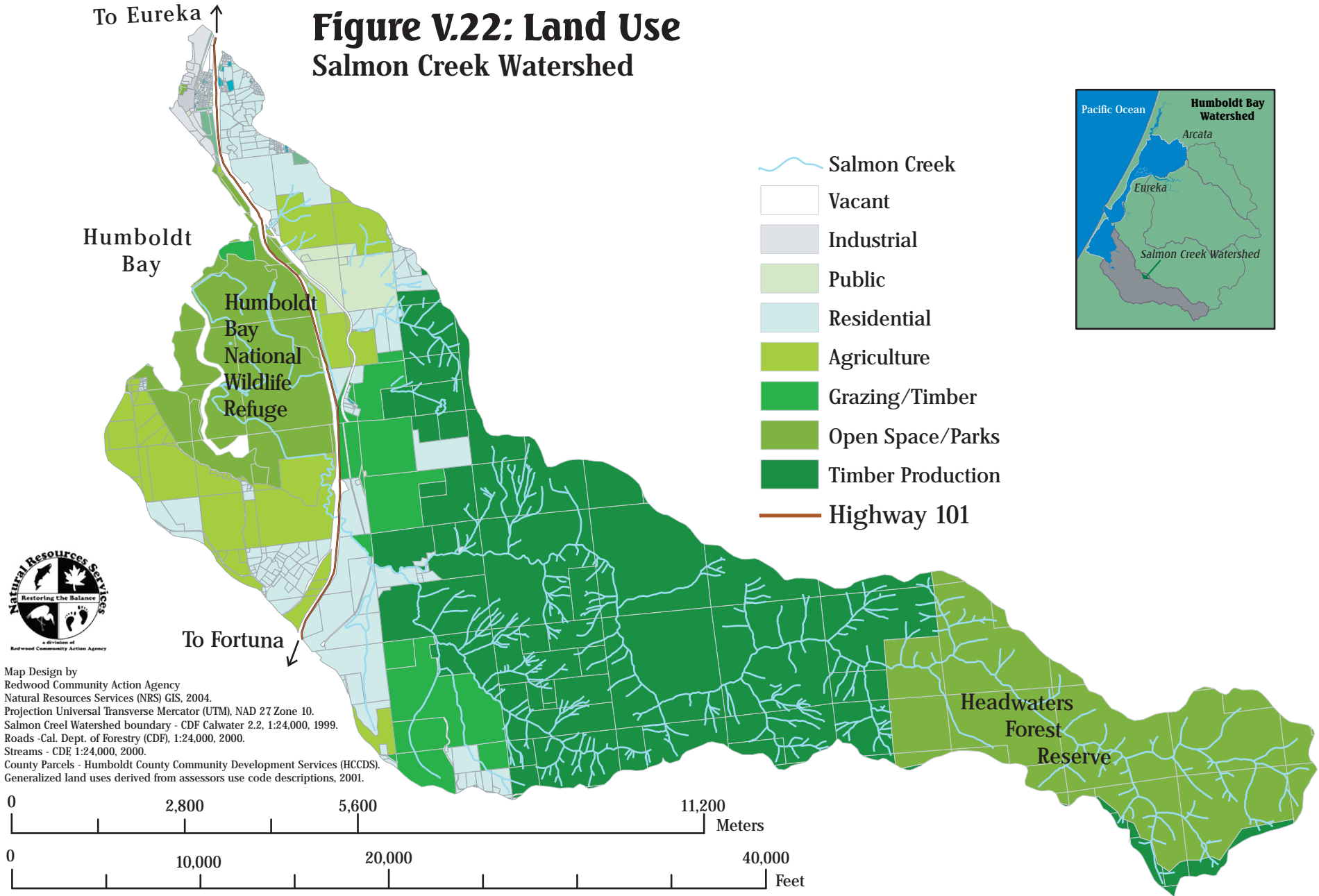
Data from Pacific Lumber Company show that summer water temperatures in Salmon Creek remain cool, never exceeding 60 degrees.

Potential Limiting Factors

The upper watershed is a source of sediment from contributing factors such as landslides, road and crossing erosion, and earthflows. Sediment produced in the upper reach enters the system and is transported downstream.

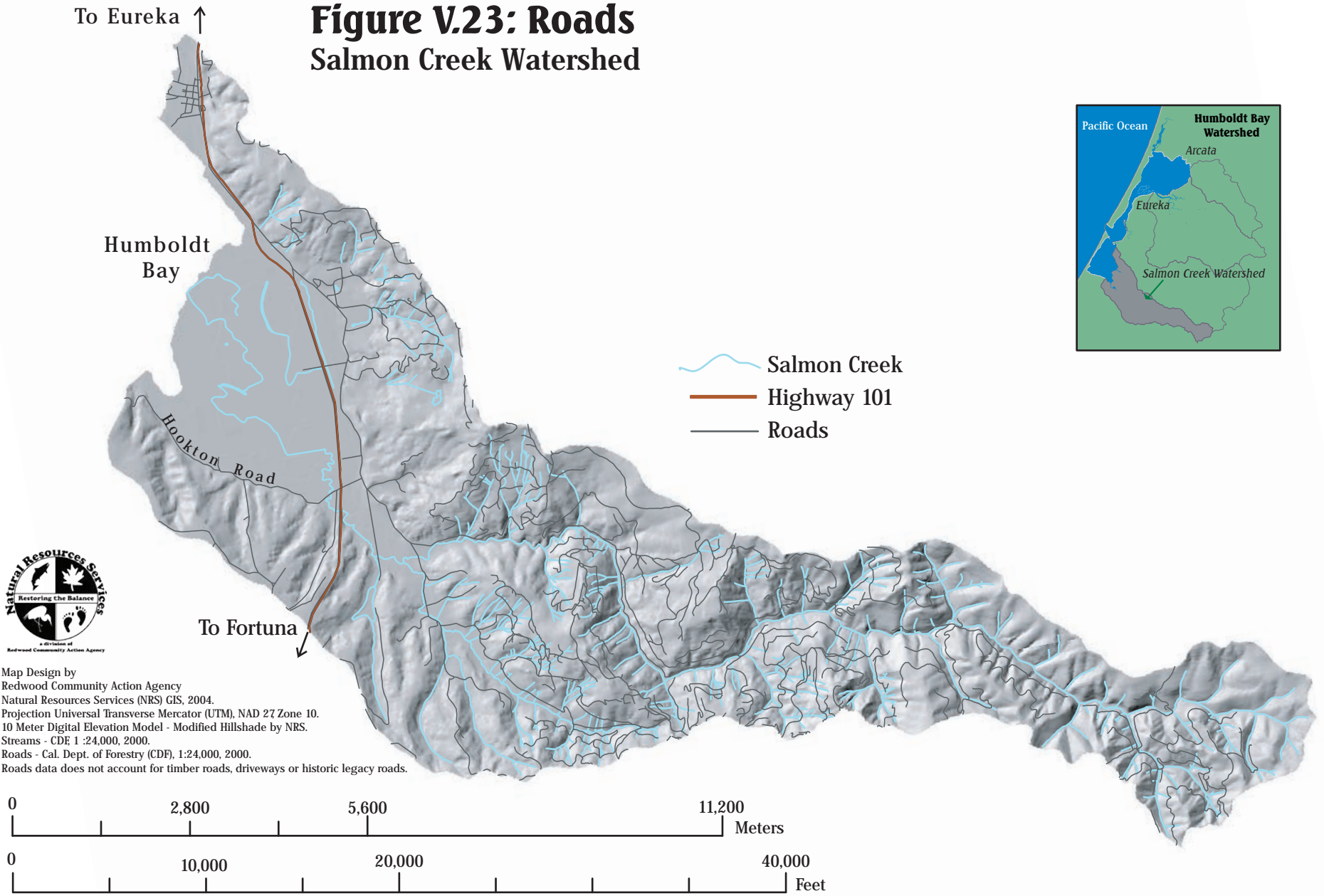
Given the high amount of rainfall in this region, the frequency of damaging seismic activity, and a history of road failures, it is possible that a catastrophic erosion event will occur in the Elk River and Salmon Creek watersheds. The BLM has identified a need for action in the protection and restoration of anadromous fisheries habitat in the Headwaters Forest Reserve.

Figure V.22: Land Use Salmon Creek Watershed



Map Design by
 Redwood Community Action Agency
 Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 Salmon Creek Watershed boundary - CDF Calwater 2.2, 1:24,000, 1999.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Streams - CDE 1:24,000, 2000.
 County Parcels - Humboldt County Community Development Services (HCCDS).
 Generalized land uses derived from assessors use code descriptions, 2001.

Figure V.23: Roads Salmon Creek Watershed



Map Design by
 Redwood Community Action Agency
 Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Streams - CDE 1 :24,000, 2000.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Roads data does not account for timber roads, driveways or historic legacy roads.

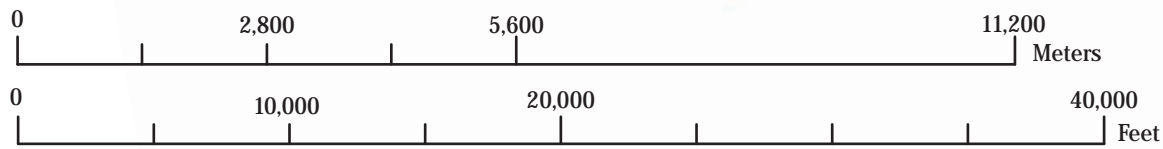
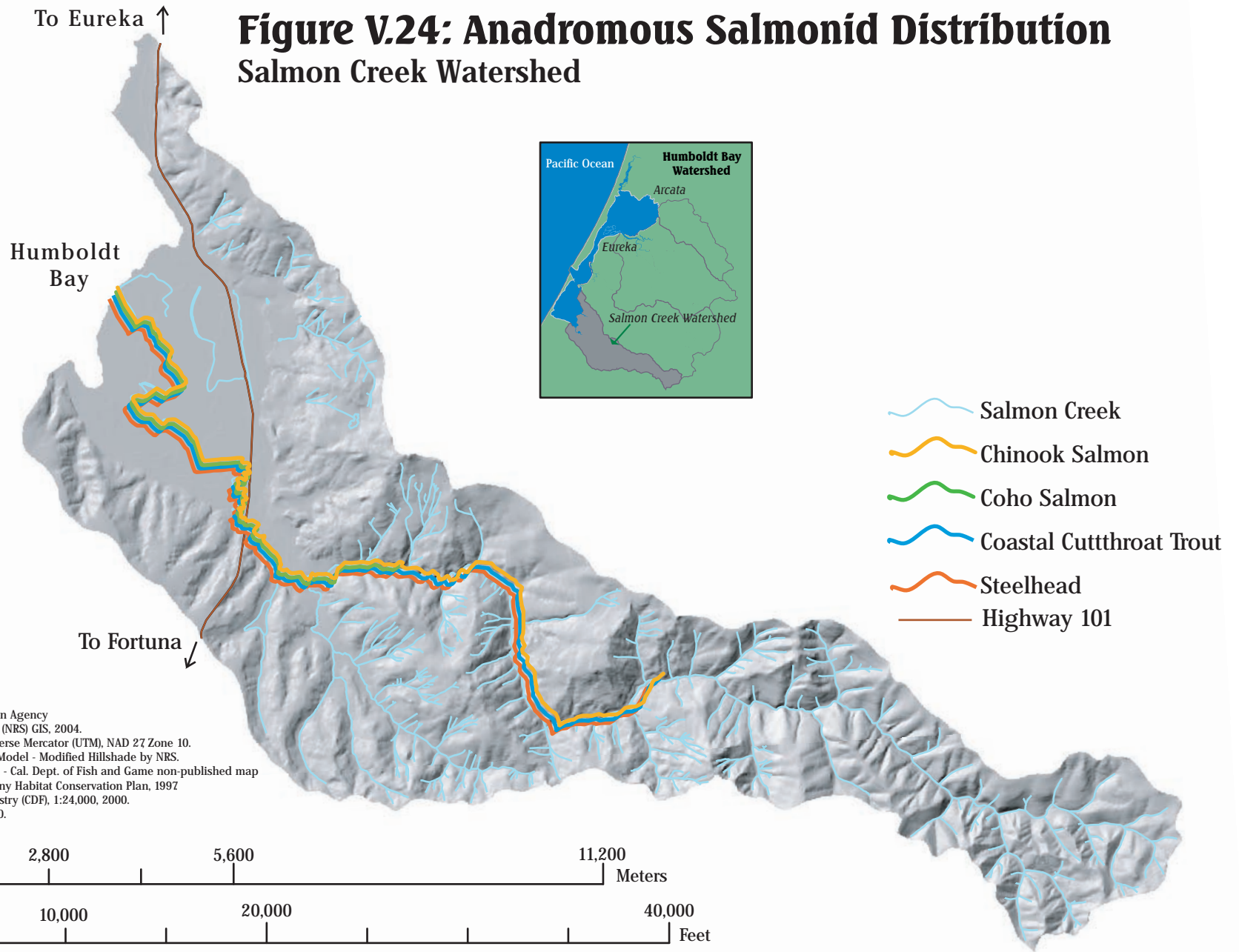
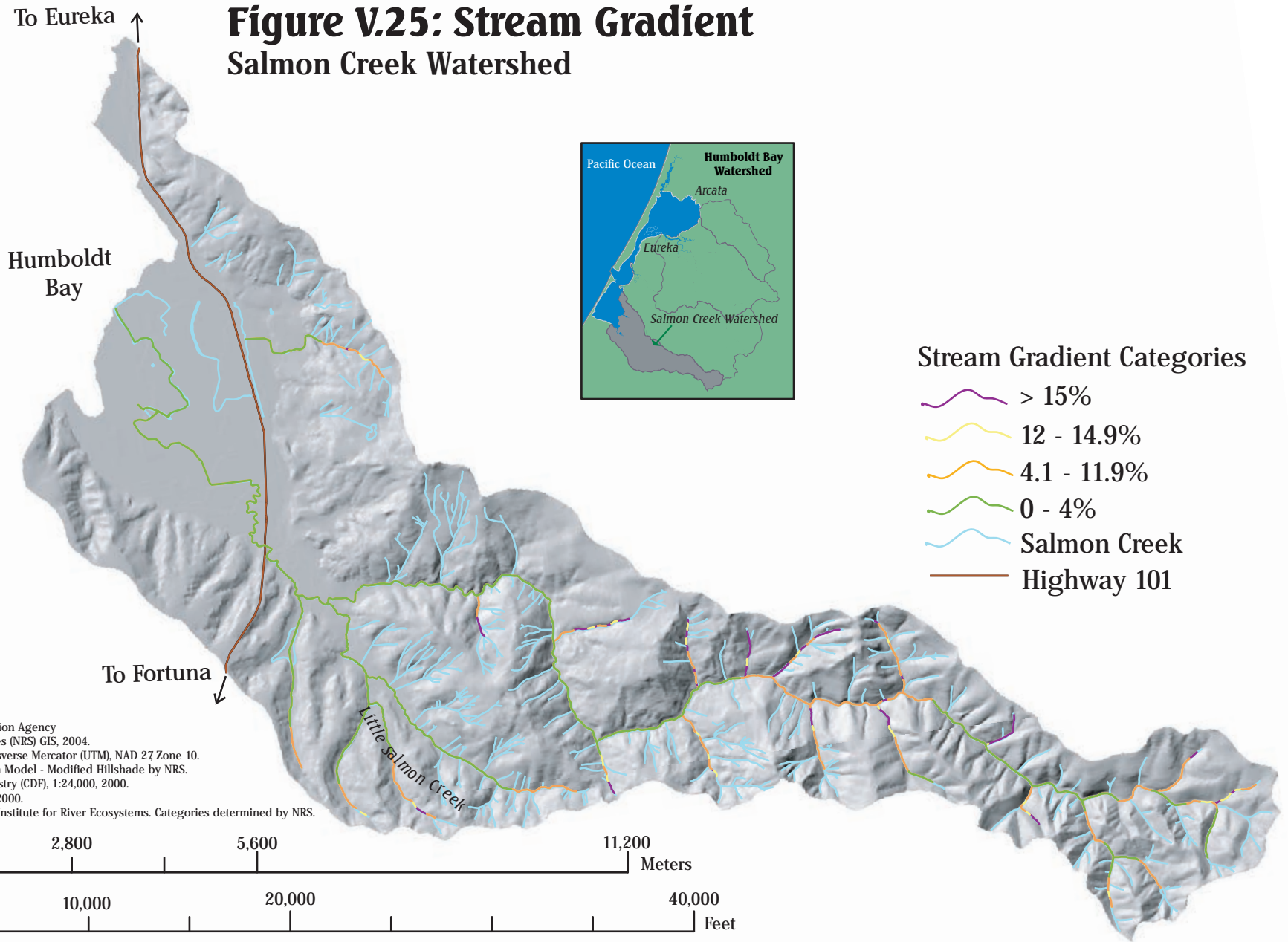


Figure V.24: Anadromous Salmonid Distribution Salmon Creek Watershed



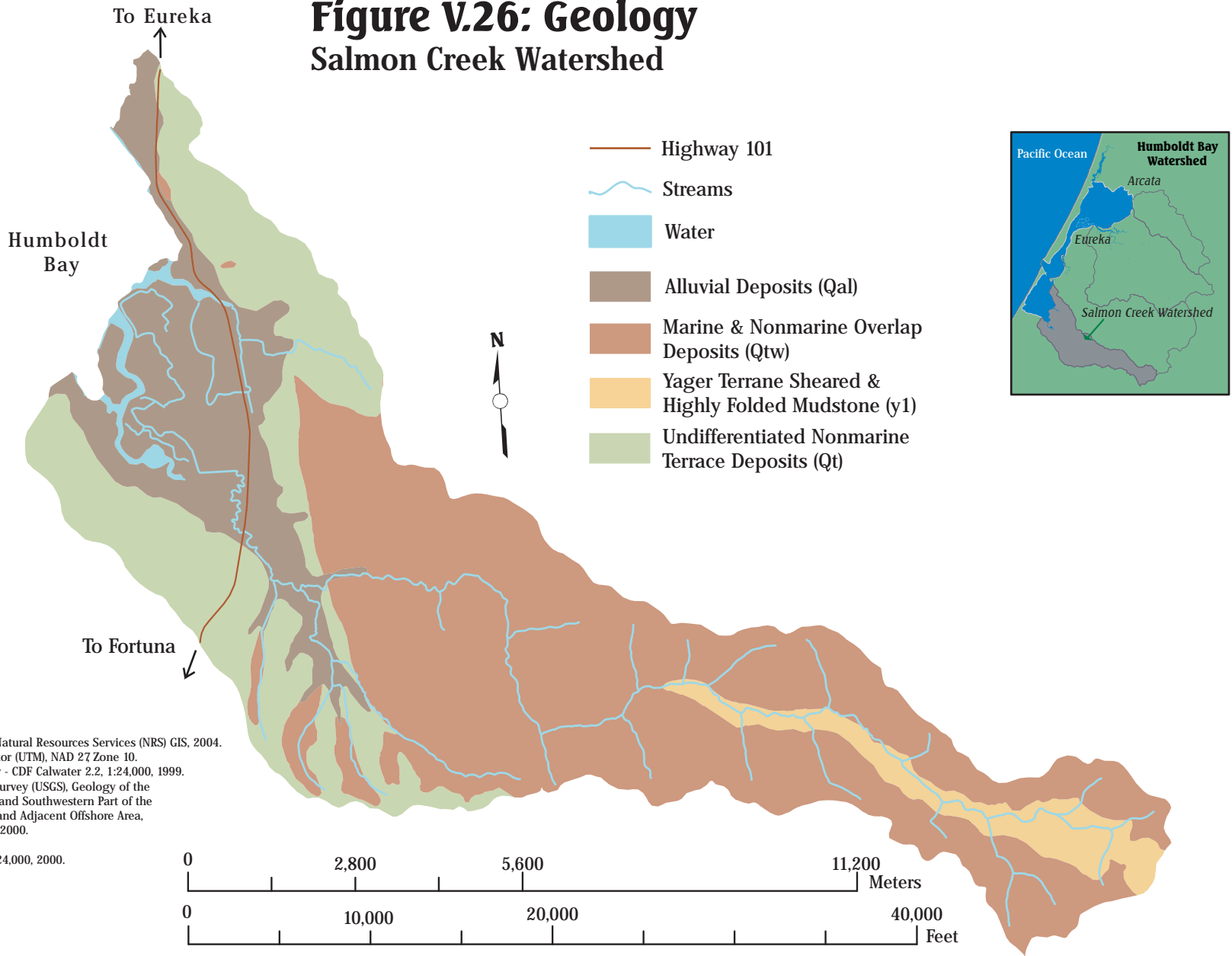
Map Design by
 Redwood Community Action Agency
 Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Salmonid Distribution data - Cal. Dept. of Fish and Game non-published map
 and Pacific Lumber Company Habitat Conservation Plan, 1997
 Streams - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Roads - CDE 1 :24,000, 2000.

Figure V.25: Stream Gradient Salmon Creek Watershed



Map Design by
 Redwood Community Action Agency
 Natural Resources Services (NRS) GIS, 2004.
 Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
 10 Meter Digital Elevation Model - Modified Hillshade by NRS.
 Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.
 Streams - CDE 1 :24,000, 2000.
 Salmonid gradient data: Institute for River Ecosystems. Categories determined by NRS.

Figure V.26: Geology Salmon Creek Watershed



Map Design by
Redwood Community Action Agency Natural Resources Services (NRS) GIS, 2004.
Projection Universal Transverse Mercator (UTM), NAD 27 Zone 10.
Freshwater Creek Watershed boundary - CDF Calwater 2.2, 1:24,000, 1999.
Geology - United States Geological Survey (USGS), Geology of the
Cape Mendocino, Eureka, Garberville, and Southwestern Part of the
Hayfork 30 x 60 Minute Quadrangles and Adjacent Offshore Area,
Northern California, 1:100,000, Ver.1.0, 2000.
Streams - CDF 1:24,000, 2000.
Roads - Cal. Dept. of Forestry (CDF), 1:24,000, 2000.

VI. Humboldt Bay Watershed Goals and Objectives

The following goals and objectives have been identified and agreed upon by the Humboldt Bay Watershed Advisory Committee as the actions necessary to protect and restore natural watershed processes (i.e. the natural rates of delivery of water, sediment, heat, organic materials, nutrients, and other dissolved materials) in order to provide habitat characteristics favorable to salmonids during all life stages. Prioritizing specific locations in each watershed is a future objective of the group.

This portion of the document is intended to guide future projects and to assist funding organizations in ascertaining the needs of the Humboldt Bay watershed.

How to View and Use the Goals and Objectives Framework:

The icons to the left of the objectives indicate that a particular objective has been worked on to some level (in most cases at a small scale) in the sub-watershed to which each symbol refers (see next page for the icons used in this section). When an icon is present, refer to the tables beneath each set of objectives for more information on the work that has been completed or is in progress regarding that objective. Protocols for some of the objectives are in the California Salmonid Stream Habitat Restoration Manual. Page numbers to reference are indicated in parenthesis after the objective.

The goals are organized into the following categories:

- A. HABITAT STRUCTURE**
 - I. Floodplain
 - II. Estuary
 - III. Channel
 - IV. Large Woody Debris
 - V. Riparian Habitat
- B. WATER QUALITY**
 - I. Suspended Sediment
 - II. Temperature and Dissolved Oxygen
 - III. Other Pollutants
- C. WATER QUANTITY**
- D. CUMULATIVE WATERSHED EFFECTS**
- E. SALMONID POPULATION STUDIES**
- F. COORDINATED MONITORING**
- G. EDUCATION, COLLABORATION, AND INCENTIVE PROGRAMS**
- H. PLAN EFFECTIVENESS AND COORDINATION**

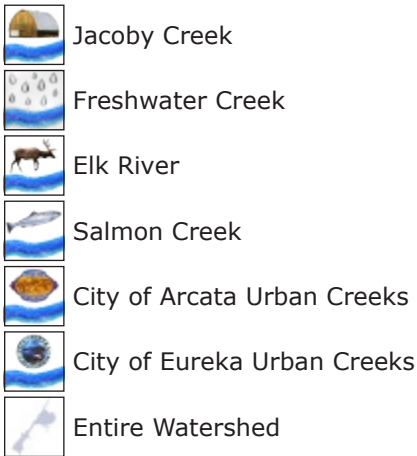


Collaboration Around the Bay

Many agencies, organizations, watershed groups, and individuals are working to enhance conditions in Humboldt Bay watershed tributaries, including salmonid habitat. Many projects and programs, adaptive land management, education, and in some cases regulation, still needs to be completed in order to provide suitable habitat for salmonids while supporting the social and economic structures in the watershed. This next section provides a glimpse at what is being done and what remains to be done with regards to goals and objectives that have been identified and agreed upon by Humboldt Bay Watershed Advisory Committee stakeholder representatives.



Icons Used in This Section



Acronyms Used in This Section

BLM - Bureau of Land Management
CoA - City of Arcata
CoE - City of Eureka
CoH - County of Humboldt
CRA - California Resource Agency
CDFG - California Department of Fish and Game
DWR - Department of Water Resources
GD - Green Diamond Resource Company
HBK - Humboldt Bay Keepers
HBS - Humboldt Bay Stewards
HBWAC - Humboldt Bay Watershed Advisory Committee
HFAC - Humboldt Fish Action Council
HSU - Humboldt State University Foundation
IRE - Institute for River Ecosystems
JCLT - Jacoby Creek Land Trust
NAWCA - North American Wildlife Conservation Act
NOAA - National Oceanic and Atmospheric Administration -
National Marine Fisheries Service
PALCO - Pacific Lumber Company
PCFWWRA - Pacific Coast Fish, Wildlife, and Wetland
Restoration Associates
PWA - Pacific Watershed Associates
RWQCB- Regional Water Quality Control Board (North Coast
Region)
SACER - Scientific Advisory Committee on Estuarine Research
SCC - California State Coastal Conservancy
SWRCB - State Water Resources Control Board
USFWS - United States Fish and Wildlife Service
WCB - Wildlife Conservation Board
SHRM - CDFG Salmonid Stream Habitat Restoration Manual



In an effort to allow Jacoby Creek to flow more naturally within its floodplain, Jacoby Creek Land Trust removed an asphalt berm (about 300 yards) at their Kokte Preserve property. After the berm removal burlap mats and mulch were placed on the bare soil to decrease sedimentation and erosion.



A. HABITAT STRUCTURE

I. Floodplain

The floodplain capacity and function in Humboldt Bay watershed has been substantially reduced over the last 150 years by the construction of levees, Highway 101 and other roads, railroads, clearing of the floodplain woodland, leveling of floodplain fields, removal of large woody debris, and upstream timber harvest. These physical changes may be limiting the basin's ability to support salmonids due to a reduction in overall habitat complexity, a lack of backwater and side channel sites (important rearing habitat), a loss of connectivity between the stream and its floodplain, and diminished nutrient inputs (lack of connectivity).

GOAL A: Maintain and restore floodplain processes that benefit salmonids.

Objectives:

1. Identify and quantify changes in floodplain and stream channel connectivity over the past 100+ years using historic maps, air photo analysis, historic records, and interviews with long-term residents. *(SHRM II-8 through II-10)*
2. Identify locations where historic backwater, side-channel, old meanders, and floodplains could be reconnected to stream channel. *(SHRM III-22 through III-26, III through III10)*
3. Identify and map small freshwater tributaries that provide summer cool water flow to the estuary (important summer rearing habitat for young of the year coho). *(SHRM II-1 through II-7, Section III, V-15 through V-17)*
4. Determine the feasibility of re-establishing connectivity. Consider impacts to built infrastructure (roads, bridges, buildings, water and power lines, etc.) and existing land use (agriculture, public resources, etc).
5. Select three or more priority projects to reconnect floodplain and stream habitat based on criteria developed by agency personnel, agricultural representatives, and scientific advisors. *Such criteria should consider physical, biological, administrative, and social issues.*

See Riparian Goals in Section V.

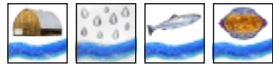
Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A5	Jacoby Creek/Kokte	JCLT	WCB and USFWS	Implementation

II. Estuary

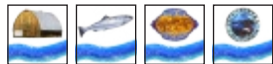
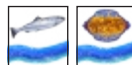
Estuaries provide critical nursery habitat for all juvenile salmonids migrating to the ocean by providing a feeding area and place to acclimatize to higher salinities. Juveniles that do not have access to estuarine habitat may migrate to open water at a smaller size and be more susceptible to predation. Salmonids have lost access to refugia of backwater channels of Elk River, Freshwater Creek, and Salmon Creek because tidal flows are controlled by tidegates .

GOAL A: Maintain and restore estuary processes that benefit salmonids.

Objectives:



1. Identify changes in estuarine tidal connectivity over the past 100+ years using historic maps, air photo analysis, historic records, and interviews with long-term residents. *(SHRM II-8 through II-10)*
2. Identify locations where historic estuary habitat (sloughs, wetlands, stream channels) could be reconnected to the main stem channel. *(SHRM III-22 through III-26, II-1 through II-10)*
3. Identify suitable locations for the placement of large woody debris (LWD) to enhance backwater habitat. *(SHRM III-49 through III-56, XI-12)*
4. Map (GPS) all levee locations and assess current functionality for flood control. *(SHRM v-15 through V-17)*
5. Map (GPS) all tide-gate locations and assess current functionality for fish passage and flood control. Assess the quality of potential habitat behind each tide-gate. *(SHRM Section III, V-15 through V-16)*
6. Develop high resolution (~1 foot contour) topographic information.
7. On streams without tide-gates, determine the extent of tidal influence by monitoring the extent of the salt-water wedge during low-streamflow and high-streamflow periods.
8. On streams with tide-gates determine the extent of tidal influence by using elevation studies during low-streamflow and high-streamflow periods. *(SHRM III-4 through III-5, III22 through III-26)*
9. Delineate estuary habitat types such as salt marsh, brackish marsh, tidal mud-flats, freshwater wetlands, and freshwater tidelands noting seasonal influences.
10. Select additional priority sites for further analysis and feasibility including landowner contact and agreement.
11. Monitor juvenile salmonids use of the estuary. *(SHRM IV-1 through IV-6)HM Section VIII)*





McBain and Trush recently completed construction of a 'fish friendly' tide gate allowing fish passage into Rocky Gulch.

Photo credit D. Mireau



DFG field crew measuring and recording biological data from juvenile salmonids captured in upper Freshwater Slough

Photo credit M. Wallace NSAP, DFG

12. Develop effectiveness monitoring projects for estuary projects around Humboldt Bay.

See Riparian goals in Section V.

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A1	Jacoby Creek/Estuary	City of Arcata	WCB, SCC	Design
	Jacoby Creek/Rocky Gulch	Rodoni Family,McBain and Trush	DFG, NOAA	Implementation
	Freshwater Creek/FW Farms	Freshwater Farms, McBain and Trush	DFG, NOAA	Design
	Freshwater Creek/FW Farms	NRLT	SCC	Acquisition
	Salmon Creek/Estuary	HBNWR, PCFWWRA, Mike Love and Assoc	USFWS, DFG, NOAA	Design
	Arcata Urban/McDaniel Slough	City of Arcata	NAWCA, SCC, WCB, DFG	Implementation
	Arcata Urban/Butcher Slough	City of Arcata	NAWCA, SCC, WCB, DWR	Implementation
A5	Salmon Creek/Estuary	HBNWR, PCFWWRA, Mike Love and Assoc.	USFWS, DFG, NOAA	Permitting
	Arcata Urban/All tributaries to Bay	City of Arcata	City of Arcata	Complete
A6	Jacoby Creek/Estuary	City of Arcata	CoA, JCLT, SCC	Complete
	Salmon Creek/Estuary	HBNWR	USFWS	Complete
	Arcata Urban/All tributaries to Bay	City of Arcata	City of Arcata	Complete
	Eureka Urban/Martin Slough	City of Eureka	DWR, SCC	Complete
A7	Arcata Urban/Butchers Slough	City of Arcata	City of Arcata	Complete
	Freshwater Creek/Slough	McBain and Trush	DFG	Complete

Table continued on next page



PALCO Biologists taking flow discharge measurements



Salmon Forever ISCO pump sampler set-up at Terry Roelof's in Freshwater (FTR)

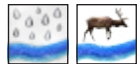
A10	Humboldt Bay	SACER, RCAA, HBWAC	DFG, SCC, SWRCB, HBS	Conceptual
A11	Freshwater Creek	NSAP of DFG	DFG, NOAA	Monitoring
	Elk River	NSAP of DFG	DFG, NOAA	Planning

III. Channel

Human modifications of the channel include construction of levees, roads, railroads, stream crossings, dredging, splash dams, placement of fill and bank armor, grazing, channel diversion, direct filling, and removal of large wood. Changes in riparian vegetation, species and size has also effected the channel. These modifications have simplified the channel and decreased the quality of instream aquatic habitats. Increased sediment and peakflow inputs from industrial timber harvest activities have changed the channel morphology, and reduced channel and sediment transport capacity. Long-term residents have documented increased peak flow stage and increased frequency of flood events. The impacts of increased sediment delivery (i.e. aggraded pools and spawning gravels) include the loss of spawning and rearing habitat in Elk River.

GOAL A: Maintain and restore balance between delivery of sediment to the channel and sediment transport capacity of Humboldt Bay watershed.

Objectives:



1. Determine management and natural sediment loads to sub-watersheds through use of sediment budgeting techniques, including review of aerial photographs, hillslope surveys, instream surveys, and models. Update the sediment load estimates as new aerial photos and sediment source inventories becomes available. *(SHRM-A-1 through X-B-8, II-8 through II-10, II-12 through II-14, X-1 through X-47)*
2. Work with upslope landowners to identify sediment inputs: complete erosion inventories (road, landslides, mass wasting) for each sub-watershed and prioritize these areas for erosion inventories by potential to contribute sediment to streams (slope, geology, road and skid road density, land use practice). *(SHRM II-12 through II-14, X-1 through X-47, X-A-1 through X-B-8)*
3. Improve timber harvest practices and enforce existing forest practice rules to reduce erosion (e.g., reduction of skid trails, increased riparian buffers, retention of canopy, rate of harvest, recruitment of LWD).
4. Avoid disturbance on areas with high potential for mass wasting and manage using geologically appropriate methods.



5. Retain soils in the upper watershed through management practices including retention of large wood on landscape and retention of vegetative cover on steep slopes. *(SHRM VII-83 through VII-86)*
6. Target attainment of all priority actions identified in existing erosion/road inventories in the next 10 years.
7. Monitor trends in in-channel sediment conditions utilizing techniques such as V-star, channel cross-sections, and longitudinal profiles. *(SHRM Section VIII, X-76, parts of III-1 through III-26, VI-12 through VI-16)*
8. Establish and maintain long-term sites to collect baseline data and observe trends in channel morphology including channel cross-sections and longitudinal profiles. *(SHRM VI-12 through VI-16, parts of III-1 through III-26, Section VIII, X-76)*
9. Conduct monitoring and other studies to determine how sediment loads affect habitat conditions (including long-term trends monitoring). *(SHRM III-27 through III-48, Section IV)*



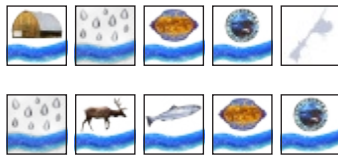
NCRWQCB staff assessing sediment related channel conditions in Elk River for the TMDL development

Photo credit A. White, NCRWQCB

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A1	Freshwater Creek/Upper	PALCO, RWQCB	PALCO, RWQCB	Implementation
	Freshwater Creek	Salmon Forever	Salmon Forever, SWRCB	Implementation
	Elk River/Upper	PALCO, RWQCB	PALCO, RWQCB	Implementation
	Elk River	Salmon Forever	Salmon Forever, SWRCB	Implementation
A2	Jacoby Creek/CofA ownership	PCFWWRA/City of Arcata	DFG, City of Arcata	Complete (roads)
	Freshwater Creek/PALCO ownership	PALCO, PWA, Hart-Crowser	PALCO	Complete (roads)
	Elk River/PALCO ownership	PALCO, PWA, Hart-Crowser	PALCO	Complete (roads and some landslides)
	Salmon Creek/BLM ownership	BLM, PWA	BLM	Complete (roads)
	Salmon Creek/Green Diamond ownership	Green Diamond, PWA, PCWWRA(?)	Green Diamond, DFG	Complete (roads)



Fish have limited access to this habitat at Freshwater Farms in Freshwater Creek watershed



A3, A4, A5	Jacoby Creek	City of Arcata	City of Arcata	Implementation
A7,A8, A9	Jacoby Creek	RSL, Randy Klein	USFS, SWRCB	Monitoring
A7, A8, A9 Cont.	Freshwater Creek/PALCO ownership (at 9 stations)	PALCO	PALCO	Monitoring
	Freshwater Creek	RWQCB, Salmon Forever	RWQCB, SWRCB	Monitoring
	Elk River/PALCO ownership (at 7 stations)	PALCO	PALCO	Monitoring
	Elk River	SF, RWQCB, BLM	RWQCB, SWRCB	Monitoring
A9	Freshwater Creek	HFAC, DFG, AFRAMP	DFG, NOAA	Monitoring
	Freshwater Creek/PALCO ownership	PALCO	PALCO	Monitoring

GOAL B: Establish access to suitable habitat for both adult and juvenile salmonids.

Objectives:

1. Inventory passage barriers including log jams and culverts for fish passage barriers, and prioritize barriers in need of replacement or removal. *(SHRM Section IX)*.
2. Using prioritization criteria established in the Humboldt County culvert inventory, replace, remove or upgrade structures identified as barriers to fish passage with bridges or properly sized culverts to ensure fish passage, and proper streamflow and velocity, sediment and debris routing. *(SHRM IX, VII-47 through VII-61)*

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
B1	Jacoby Creek	Arcata High School's Cedar Lab	n/a - volunteer	Complete
	Freshwater Creek (Ryan Creek-McKay Tract)	Green Diamond	Green Diamond	Implementation-mostly complete
	Humboldt Bay	County of Humboldt/Ross Taylor	DFG, NOAA	Complete (County roads)
	Arcata Urban/within Arcata City Limits	City of Arcata	City of Arcata	Complete

B1 cont.	Eureka Urban/Martin Slough	City of Eureka	DWR, SCC	Complete
	Eureka Urban/Martin Slough	City of Eureka	City of Eureka	Complete
B2	Freshwater Creek	HFAC, PALCO, Green Diamond, DFG	DFG, PALCO, GD	Various phases
	Elk River, Golf Course Rd.	PALCO, DFG	PALCO, DFG	Various phases
	Salmon Creek	Green Diamond, BLM	Green Diamond, BLM	Various phases
	Urban Streams Arcata and Eureka	City of Arcata, City of Eureka	City of Arcata, City of Eureka	Various phases

GOAL C: Maintain and restore channel conditions that support spawning and rearing habitat.

Objectives:

1. Identify and map current and known historic (based upon long-time resident observation and limited historic surveys) spawning and rearing reaches for chinook, cutthroat, coho, and steelhead and quantify the change in available habitat. *(SHRM Section III, V-1 through V-17)*
2. Ensure adequate cover is provided in spawning reaches (see LWD and riparian goals below). *(SHRM III-43 through III-56)*
3. Analyze percent and timing of residence in seasonal habitats for each species. *(SHRM Section IV)*
4. Determine the existing percent of fine sediment in all known spawning reaches and how they compare to the acceptable range identified by local research. *(SHRM III-1 through III-42, Section V)*
5. Reduce the input of fine sediments in the vicinity of known spawning reaches in all areas that contribute (see Goal A above). *(SHRM VII-63 through VII-97, X-47 through X-71, XI-14)*
6. Monitor the percent of fine sediment and gravel embeddedness in all spawning reaches. *(SHRM III-1 through III-42, Section V)*

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
C1	Freshwater Creek	DFG, HFAC, IRE	DFG, PALCO, NOAA	Monitoring
	Humboldt Bay	IRE, DFG	NOAA, DFG	Monitoring



Morrison Gulch large wood
 Photo courtesy of R.Taylor and Assoc.

C3	Freshwater Creek	IRE, DFG, AFRAMP, NSAP	DFG, NOAA other misc.	Research, Monitoring
C6	Freshwater Creek/Elk River	PALCO, NCRWQCB	PALCO, SWRCB	Monitoring. (Only in some reaches)

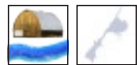
IV. Large Woody Debris

Instream large woody debris (LWD) serves several critical functions in aquatic ecosystems, including sediment and nutrient retention (especially in first and second order streams) and salmonid habitat enhancement. Large wood is important for pool formation, maintaining pool depth, grade (stream channelbed slope) control, instream cover, bedload sorting, and macro-invertebrate habitat. Much of the LWD in the middle and lower reaches of Elk River has been removed or buried. Lack of LWD has reduced available rearing habitat.

GOAL A: Protect and maintain instream LWD.

Objectives:

1. Identify, map, and protect existing high quality rearing habitat associated with LWD. (SHRM III-38, III-40 through III-56, V-15 through V-17, XI-12)
2. Protect existing instream LWD from removal by landowners (especially of concern in lower reaches). (SHRM XI-12)
 - a) Work with Humboldt County and DFG to educate landowners about existing streamside management policies.
 - b) Conduct a workshop on “wood, flooding and fish.” Invite landowner representatives to share their perspectives about wood.
 - c) Develop a “large wood response crew” and emergency funds to assist landowners in determining the habitat value of instream wood while addressing flooding and erosion concerns.
 - d) Remove and stockpile LWD which threatens existing structures so it can be placed where needed for habitat in other restoration projects.
3. Protect coniferous trees from logging in riparian zones to provide future recruitable LWD





GOAL B: Increase the amount of instream LWD where appropriate.

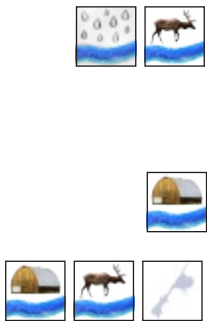
Objectives:

1. Inventory reaches for LWD to determine where additional wood is needed. *(SHRM Section III)*
2. Identify suitable locations for placement of either anchored or free-floating LWD structures (by channel gradient, appropriate distance from infrastructure, potential to provide habitat). *(SHRM Section III)*
3. Contact landowners with suitable locations for LWD enhancement projects.

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
B1	Jacoby Creek	HFAC, DFG	DFG	Complete (last done in 1996)
	Freshwater Creek	HFAC, DFG	DFG, NOAA	
	Freshwater Creek/PALCO ownership	PALCO	PALCO	Complete
	Freshwater Creek/GD ownership	Green Diamond	Green Diamond	Complete
B2	Freshwater Creek/sections mostly private land	HFAC	DFG	Continuous

GOAL C: Maintain and restore the long-term supply LWD (see riparian habitat section below).

Objectives:



1. Determine the potential for LWD of sufficient size (to remain in place and function as habitat enhancement element) that can be recruited from the current riparian corridor and identify reaches with insufficient LWD recruitment potential. Map location, width, species composition and size class of riparian corridor. *(SHRM Section III, II-11 through II-12)*
2. Prioritize reaches for protection and/or restoration (connectivity, other habitat values, established protection such as conservation easements, etc.).
3. Protect high quality riparian habitat through conservation easements, acquisition, enforcement of regulations, and education.

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
C1	Freshwater Creek/PALCO ownership	PALCO	PALCO	Complete
	Elk River/PALCO ownership	PALCO	PALCO	Complete
C2	Jacoby Creek	JCLT	JCLT/DFG	Planning
C3	Jacoby Creek/JCLT easements	JCLT	DFG, WCB, JCLT	Implementation
	Elk River/Headwaters Forest Reserve	BLM	various State and Federal agencies	Acquisition
	Humboldt Bay	DFG, CDF, SWRCB	Landowner	Implementation (Regulation)
	Humboldt Bay	HBWAC	DFG, SCC, NOAA	Implementation

V. Riparian Habitat

A healthy riparian area is essential for habitat complexity, LWD recruitment, refugia for salmonids and other aquatic species, as well as offering shade and nutrient input. Diminished riparian habitat in Elk River has led to increased erosion, bank destabilization, lack of cover and complexity for fish habitat. The dominant species in the lower and middle reaches are willow, Himalayan blackberry, grasses, and alder.

GOAL A: Maintain existing riparian habitat that is beneficial to the aquatic and terrestrial ecosystem.

Objectives:

1. Define the target riparian vegetation structure/ desired conditions in upper, middle and lower reaches of HB tributary streams (including criteria such as riparian zone width to support functional processes, species composition, herb, shrub, and canopy cover, presence of large conifers and hardwoods).
2. Map existing riparian corridors including width, species composition and size class for all tributaries of Humboldt Bay. (*SHRM II-1 through II-7, II-11 through II-12, Section III*)
 - a) Identify where existing riparian habitat is close to target conditions defined in Objective 1.
 - b) Determine the potential for LWD of sufficient size to be recruited from the current riparian corridor.
 - c) Identify the current level of riparian habitat protection offered by HCPs, conservation easements, THP and



other regulations or management practices.

- d) Identify areas of High quality riparian habitat that are at risk of being degraded work with landowners, agencies, and conservation organizations to provide protection.

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A2, A2b	Freshwater Creek/Palco ownership	PALCO	PALCO	Complete
	Elk River/PALCO ownership	PALCO	PALCO	Complete
A2d	Jacoby Creek	JCLT, City of Arcata	DFG, JCLT, CoA	Implementation

GOAL B: Restore degraded riparian habitat where appropriate.

Objectives:

1. Identify areas with degraded riparian habitat and insufficient large wood recruitment potential from the map developed under Goal A. (SHRM I-1 through II-7, II-11 through II-12, Section III)
2. Specify the general types of restoration methods needed and estimate a cost for each. (SHRM Section VI, Section VII, X-38 through X-71, XI-9 through XI-B-16)
3. Prioritize restoration list of degraded riparian habitats based on:
 - a. willing landowners
 - b. benefit to fish
 - c. cost of restoration (prime habiatt vs. cost benefit to get most for money)
 - d. proximity to other riparian habitats that meet target conditions
 - e. proximity to protected riparian corridors (protected by easement or public lands)
 - f. final area restored
4. Using the prioritized list of potential riparian habitat restoration sites, develop site specific riparian restoration plans including planting location, species composition, livestock management, weed and pest control measures, and maintenance requirements. (SHRM same as objective 2 above)
5. Assist landowners in obtaining funding and permits for enhancement projects by introducing landowners to





federal and local assistance programs.

6. Establish riparian conservation easements, and/or provide incentives for increasing riparian corridor width.
7. Establish a monitoring program to evaluate success of restoration projects. (*SHRM Section VIII, X-71 through X-76*)

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
B3	Jacoby Creek	JCLT	DFG, NOAA	Planning
	Freshwater Creek	HFAC	DFG	Planning (some Imp.)
	Elk River/Headwaters	BLM	BLM	Planning
B4	Jacoby Creek	BLM	BLM	Planning
	Freshwater Creek	BLM	BLM	Planning
B5	Freshwater Creek/Fulton Ranch	HFAC/CSRG	DFG, Coastal Stream Restoration Group	Complete
B6	Jacoby Creek	JCLT	JCLT	Continuous

B. WATER QUALITY

I. Suspended Sediment

Suspended sediment affects salmonids because high levels of suspended sediment impairs their ability to see prey and can also damage juvenile salmonid gill tissues. Turbidity which results from suspended sediment may diminish or eliminate aquatic plant growth which leads to the loss of associated snails and aquatic invertebrates that serve as a food source for young fish. Each salmonid species has different turbidity and suspended sediment exposure thresholds (concentration and duration). Extended exposure to “chronic” turbidity levels can limit opportunities for fish to feed and in-turn limit growth and survival. High levels can cause fish mortality, and may therefore inhibit fish production in the Elk River watershed. Suspended sediment levels in Elk River are frequently high during the winter months. Since Elk River is among the remaining streams producing coho salmon, turbidity and suspended sediment levels are of particular concern for fisheries resources.



GOAL A: Assess and continue to monitor stream discharge and turbidity and suspended sediment concentration (SSC) in Elk River.

Objectives:

1. Promote research on the effects of turbidity on different species and life stages of salmonids.
2. Review existing turbidity and SSC data, determine gaps in data, and develop a watershed-wide turbidity monitoring plan.
3. Monitor restoration and mitigation projects to assess sediment reduction effectiveness (road decommissioning, erosion control techniques, etc). (*SHRM X-76*)
4. Pursue grant money to support companies and volunteers with training and equipment.
5. Provide forums for monitoring groups to collaborate and ensure sufficient coverage of monitoring sites.
6. Facilitate free sharing of data and methods through meeting facilitation of interested parties and through the establishment of a centralized data repository. (*SHRM V-1 through V-17*)

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A1	Freshwater Creek/Elk	AFRAMP, TRUSH, RSL, (some by PALCO - HCP regs.)	none	Conceptual
A2	Humboldt Bay	RCAA	SWRCB	Planning
A3	Elk River	BLM, RWQCB	BLM, RWQCB	Monitoring
	Salmon Creek	BLM, RWQCB	BLM, RWQCB	Monitoring
A4	Humboldt Bay	RCAA	RCAA	Continuous
A5	Humboldt Bay	RCAA, RSL	RSL, SWRCB	Continuous, Planning
A6	Humboldt Bay	RCAA	SWRCB	Planning

GOAL B: Reduce suspended sediment to levels that are suitable to salmonids during all life stages.

Objectives:

1. Work with upslope landowners (especially PALCO and Green Diamond) to identify and reduce sediment

inputs. (SHRM II-12

- a) Identify areas in watershed where erosion inventories (road, landslides, mass wasting) are still needed.
 - b) Prioritize these areas for erosion inventories by potential to contribute sediment to streams (slope, geology, road and skid road density, land use practice).
2. Improve timber harvest practices to reduce erosion (e.g., reduction of skid trails, increased riparian buffers, reduction of winter harvest operations, reduction of soil compaction).
 3. Determine management and natural sediment loads to sub-watersheds through use of sediment budgeting techniques, including review of aerial photographs, hillslope surveys, instream surveys, and models. Update the sediment load estimates as new aerial photos and sediment source inventories becomes available. (Both PL and Regional Water Board are estimating these sources; updates will be needed).
 4. Conduct monitoring and other studies to determine how sediment loads affect habitat conditions.
 5. Prioritize sub-watersheds for restoration activities based upon sediment loads and/or instream habitat conditions.
 6. Identify areas of high mass wasting potential and manage using geologically appropriate methods.
 7. Retain soils in the upper watershed through management practices including retention of large wood on landscape and retention of vegetative cover on steep slopes.
 8. Target attainment of all priority actions identified in existing erosion/road inventories in the next 10 years.

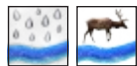
II. Temperature and Dissolved Oxygen (DO)

Water temperature is not well documented in Humboldt Bay watershed. While temperature is generally not a limiting factor in coastal streams, high temperatures have been reported in upper tributaries and in the estuary in summer months. The relationship between temperature and fish use of different reaches is not known in Humboldt Bay watershed, however it is well documented in the literature that high temperatures and low dissolved oxygen levels can reduce habitat quality and stress salmonid species. There is not a comprehensive monitoring program for dissolved oxygen or temperature in Humboldt Bay watershed.

GOAL A: Monitor temperature and dissolved oxygen in Elk River.

Objectives:

1. Support existing water temperature monitoring activities.





2. Establish additional water temperature monitoring stations.
3. Evaluate if DO monitoring is needed; work with landowners throughout the watershed to conduct pilot scale DO monitoring during low-flow, higher temperature periods and evaluate if DO is a problem.

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A1	Freshwater Creek/PALCO ownership	PALCO	PALCO	Monitoring
	Elk River/PALCO ownership	PALCO	PALCO	Monitoring
A3	Salmon Creek	HBNWR	HBNWR	Monitoring

GOAL B: Maintain or attain temperature and dissolved oxygen levels beneficial to salmonids during all life stages.

III. Other Pollutants

Pollutants which are known to affect salmonids are not well documented in Elk River. Urban, forestry, and agricultural runoff is not regularly monitored and contains household, agricultural, and forestry petrochemicals, pesticides, heavy metals, and nutrients. These pollutants may impact the quality of Elk River's aquatic habitat, riparian community, and species diversity. Though nutrients are not monitored in Elk River, duck weed (indicative of high nutrient in the water column) is present in both lower North Fork and Lower South Fork. These areas are upstream of livestock, thus indicating other sources of nutrients are potentially present.

GOAL A: Identify potential pollutants and determine which pollutants pose risks to Humboldt Bay fisheries.

Objectives:

1. Identify or develop instream water quality targets for fish in regards to pollution levels.
2. Review existing information by contacting agencies who have done past monitoring.



Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A2	Humboldt Bay	RCAA	SWRCB	Planning

GOAL B: Support monitoring of herbicides, organic pollutants and other bioaccumulants.

Objective:

1. Work with the County Agriculture Department and landowners to identify information about applications to determine if a feasible monitoring program exists to identify concentrations in watercourses. Due to the difficulty and cost of detecting chemicals in the water column, a monitoring program could include, at a minimum: what chemical was applied (including toxicity, risk level), where the chemical was applied (provide maps), when the chemical was applied, application method, volume and rate of application, concentration, solvents or mixing agents, and inert ingredients.
2. Identify location and type of receptors sensitive to chemicals (e.g. endangered species, plants, amphibians, drinking supplies).
4. Work with regulatory agencies to provide technical and regulatory oversight, require reporting of uses.
5. Seek funding to assist the program.

GOAL C: Maintain and improve water quality for all salmonid life stages in which to thrive.

Objective:



1. Educate the community of water quality issues regarding the effects of fertilizers, herbicides, pesticides, household chemicals and livestock on salmonid habitat.



2. Work with landowners to identify whether feasible alternatives less dependent on herbicide use are available.
3. Work with landowners and managers to implement practices and projects that will reduce nonpoint sources of water pollution (i.e. Best Management Practices).

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
C1	Humboldt Bay	RCAA,	SWRCB	Implementation
C3	Humboldt Bay	NRCS	NRCS	Continuous

C. WATER QUANTITY

Long-time residents have documented changes in water transport and peak flows in the Elk River watershed. The capacity of the channel to collect and convey floodwaters has been altered and increased soil compaction from roads has resulted in changes in the timing of water delivery to streams. High winter flows may impact overwintering salmonids by flushing eggs and fry out of the system or stranding them in the floodplain when the water recedes.

GOAL A: Identify existing water rights and historic water supply and beneficial uses.

Objectives:

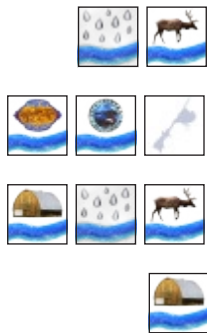
1. Inventory and evaluate all small water diversions for agricultural, forestry, and residential use.
2. Outreach to landowners about potential impacts from water diversions, and appropriate usages to protect salmonids.
3. Compare quantity of withdrawals with flow and determine effect of withdrawals on aquatic habitat.

GOAL B: Maintain and restore suitable high and low flow conditions (flow and velocity) to ensure juvenile summer and winter rearing habitat and adult salmonid migratory access.

GOAL C: Maintain and restore natural flow regimes and water retention capacity.

Objectives:

1. Identify current in-channel sediment utilizing techniques such as Vstar, channel cross-sections, and longitudinal profiles.
2. Maintain natural infiltration rates for rainfall by minimizing creation of impervious surfaces in urbanizing parts of the watershed.
3. Minimize soil compaction through improved timber management practices (e.g., reduce use of skid roads and heavy equipment on forest soils, use shovel yarding on slopes <45% and cable logging on slopes >45%).
4. Maintain and enhance surface roughness (retain forest floor litter, organic soil layer, and woody debris) on hill slopes.
5. Establish and maintain long-term sites to collect baseline data and observe trends in channel morphology





Headwaters Forest Reserve road decommissioning. Decommissioning old logging roads may help to reduce adverse CWE's caused by sediment.

Photo courtesy of BLM



(e.g., flood frequency estimates for bankfull events).

6. Quantify riparian water rights currently available in each sub-watershed.

7. Monitor, maintain and restore deep pool habitat for adequate water storage for low flows by providing large wood structure, and reducing sediment input (see objectives for LWD, sediment).

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
C1	Freshwater Creek/Elk River	RWQCB, PALCO	RWQCB, PALCO	Ongoing, monitoring
C2	Arcata Urban/project specific	City of Arcata	City of Arcata	Various stages
	Eureka Urban/project specific	City of Eureka	City of Eureka	Various stages
	Humboldt Bay	County of Humboldt	County of Humboldt	Various stages
C3	Jacoby Creek	City of Arcata	City of Arcata	Implementation
	Freshwater Creek/Elk River	PALCO	PALCO	Implementation
C4	Jacoby Creek/Com-muntiy Forest	City of Arcata	City of Arcata	Implementation

C. CUMULATIVE WATERSHED EFFECTS

GOAL A: Reduce adverse cumulative watershed effects.

Objectives:

1. Better identify how to reduce adverse CWE and work with landowners to implement those practices.
2. Identify and monitor indicators of CWE.
3. Ensure/incorporate positive and negative results of restoration projects, changes in timber management and agricultural practices into CWE assessments.
4. Create and maintain a database for Humboldt Bay Watershed “pieces of the puzzle” for better data storage, usage, and sharing.



Salmon Forever staff and volunteers surveying cross sections on Graham Gulch a Freshwater Creek tributary.



Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A2	Freshwater Creek, Elk River	ISRP	RWQCB	Complete

GOAL C: Share cumulative watershed effects evaluation methods information with stakeholders.

Objectives:

1. Provide workshops or newsletters to stakeholders on the measurement and recognition of CWE.

E. SUPPORT HUMBOLDT BAY WATERSHED SALMONID POPULATION STUDIES THAT ARE CONSISTENT WITH FEDERAL AND STATE-WIDE PROGRAMS

Objective:

Check out www.calfish.org for a multi-agency cooperative program designed to gather, maintain, and disseminate fish and aquatic habitat data and data standards.

1. Identify tributaries and reaches supporting the most productive salmonid populations and describe beneficial habitat characteristics.
2. Identify bottle necks to salmonid life history stages

These areas (identified in objective 1 and 2) should be the areas set as priorities for restoration.

F. COORDINATED MONITORING

Monitoring is essential for understanding watershed processes, the status of salmonid populations, the quantity and quality of aquatic habitat, and recovery related to improved management practices, sediment reduction measures, and the implementation of restoration projects. Long-term coordinated monitoring is particularly needed to establish background levels and current impaired levels of suspended sediment and turbidity.

GOAL A: Support a comprehensive monitoring and evaluation program in Humboldt Bay watersheds with chemical, biological, and physical parameters.

G. EDUCATION, COLLABORATION, AND INCENTIVE PROGRAMS

The Humboldt Bay watershed is highly productive for agriculture and timber. Additionally, with the acquisition of the Headwaters Forest Reserve the South Fork Elk River is a destination for local and visiting recreationists. Humboldt Bay has recently and will continue to experience development pressures as Humboldt County becomes increasingly built-out. Because of the diverse land-use interests in the watershed, cooperation and collaboration are necessary in order to maintain and restore salmonid populations in the Humboldt Bay watershed.

GOAL A: Provide forums for sharing of information and a climate of mutual cooperation.

Objectives:

1. Identify salmonid related education needs in the watershed through community and landowner outreach.
2. Facilitate a well informed watershed community with regards to watershed land-use and salmonid habitat issues.
3. Identify salmonid viability issues (thresholds, etc.) that stakeholders in the watershed disagree upon and design forums and a framework to reach agreement.
 - a) Stakeholder, regulatory and scientific agreement upon a range for background sediment delivery to Elk River, which takes into consideration climatic conditions (e.g. wet, average, or dry years).
 - b) Stakeholder, regulatory and scientific agreement upon a range of acceptable turbidity and suspended sediment levels for salmonids in Elk River for various rainfall and stream flow regimes.
 - c) Stakeholder, regulatory and scientific agreement on the measurement and recognition of CWE.



Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
A1	Jacoby Creek	JCLT	JCLT	Ongoing
	FreshwaterCreek	HFAC, AFRAMP		Ongoing
	Humboldt Bay	RCAA	DFG, SCC	Implementation



GOAL B: Identify socio-economic impacts of watershed management and future solutions.

Objective:

1. Support the development and analysis of socio-economic indicators, including social, natural resource and financial indicators, for Humboldt Bay watershed residents to assist in understanding the cost:benefit ratio of management decisions made within the watershed.
2. Explore the feasibility of establishing a visitor’s center in the watershed.
3. Discourage subdivision development in TPZ zoned parcels.
4. Maintain large TPZ zoned parcels and/or forest conservation easements to reduce or prevent sediment delivery should rural estates spread there.
4. If zoning changes occur, work to ensure that subdivisions do not result in adverse affects to salmonid species or habitat.

Objective	Watershed/Site	Entity(ies)	Funder(s)	Phase
B1	Humboldt Bay	HB Stewards	HBS, donors	Planning

GOAL C: Work with local resource agencies to provide incentives for landowners who choose to protect and/or restore private lands for fisheries habitat values.

Objectives:

1. Conservation easements
2. Rewards and recognition for good stewardship efforts

GOAL D: Support a watershed stakeholder group to assist in planning and coordinating activities.

H. PLAN EFFECTIVENESS AND COORDINATION GOALS

GOAL A: Encourage use of the Salmon and Steelhead Conservation Plan (SSC Plan) to seek and obtain funding to achieve the Plan’s objectives.



Objectives:

1. Encourage coordination for project funding and integrate individual projects into funding partnerships.
2. Coordinate with funding agencies to use the Plan as a funding guide.

GOAL B: Establish a process to evaluate the Plan's effectiveness, including prioritization of actions, implementation, evaluation of outcomes (validation monitoring), and a revision of plan objectives as necessary.

Objectives:

1. Establish a technical review team for adequate evaluation of restoration actions.
2. Establish milestones to revisit the Plan and review implemented projects on an ongoing basis (recommended annually).
3. Establish an adaptive management program (information feedback loop) to gauge the effectiveness of conservation and restoration actions, and recommend adjustments.

References

- Adams, M. Conroy, R. Machado, and H. Schyr. 1996. *Ecosystem Analysis at the Watershed Level. A Group Project Conducted in Jacoby Creek Watershed, Humboldt County California.*
- Allen, M. A. and T. J. Hassler. 1986. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest) -- Chinook Salmon." In: *U.S. Fish Wildlife Services Biological Report 82(11.49)*; U.S. Army Corps of Engineers, TR EL-82-4. pg. 26.
- Alm, Andrew. 1983. Access stirs property rights issue. *Times-Standard*, March 2.
- Anderson, Jeffrey K. - Consulting Engineer. 2001. *Elk River Flooding Review*. California Regional Water Quality Control Board.
- Arcata Union (AU) Arcata, 1886-1995
- Barnard, Keith. 1992. *Physical and Chemical conditions in Coho Salmon Spawning Habitat in Freshwater Creek, Northern California*. Masters Thesis, Humboldt State University: Arcata, CA. Study done in 1987-1988).
- Barnard, Keith. 1987. *Freshwater Creek Salmonid Habitat Restoration Project*. Natural Resources Division, Redwood Community Action Agency.
- Barnhart, Roger A. 1986. "Species Profiles: Life Histories and Environmental Requirements of Coastal Fishes and Invertebrates (Pacific Southwest) -- Steelhead." In: *U.S. Fish Wildlife Services, Biological Report 82(11:60)*; U.S. Army Corps of Engineers, TR EL-82-4. pg. 26.
- Barnhart, Roger A., Milton J. Boyd, and John E. Pequegnat. 1992. *The Ecology of Humboldt Bay California: An Estuarine Profile*. U.S. Department of the Interior, Fish and Wildlife Service Biological Report.
- Bartosh, Heath and Deanna Phelps. 2001. *Salmon Creek Watershed Historical Assessment*. Humboldt State University, Natural Resources Planning Senior Practicum: Arcata, CA.
- Base, Dana. 1982. *Composition, Status, and Changes of Birds and other Wildlife on a Tidal Marsh Restoration Site on Humboldt Bay*. Masters Thesis. Humboldt State University: Arcata, CA.
- Baseline Data on the Water Quality, Invertebrates, and Teleosts of Salmon Creek, California*. 1982.
- Benson, J. R., D. A. Fredrickson, and K. C. McGrew. *Archaeological Reconnaissance of the Humboldt Bay Area*. Prepared for the Humboldt Wastewater Authority: Eureka, CA.
- Berry, Michael C. *A Study of the Growth and Development of Humboldt County, 1850-1900*. Masters Thesis, Humboldt State University: Arcata, CA.

- Beschta, R. L., W. S. Platts, J. B. Kaufmann, and M. T. Hill. 1994. "Artificial Stream Restoration - Money Well-Spent or an Expensive Failure?" In: *Universities Council on Water Resources Annual (UCWR) Conference Proceedings*, Big Sky, Montana, 2-5 August 1994. UCWR, University of Illinois: Carbondale.
- Bisson, P. A., R. E. Bilby, M. D. Bryant, C. A. Doloff, G. B. Grette, R. A. House, M. L. Murphy, K. V. Koski, J. R. Sedell. 1987. "Large Woody Debris in Forested Streams in the Pacific Northwest: Past, Present, and Future." In: Salo, E. D., T. W. Cundy, des. *Streamside Management: Forestry and Fishery Interactions*. Contribution Number 57. University of Washington, Institute of Forest Resources: Seattle, Washington.
- BLM - Bureau of Land Management. 1994a. *Percent Fine Sediment (<0.85mm): Salmon Creek, Humboldt County, California*. United States, Department of the Interior, Data Table.
- BLM - Bureau of Land Management. 1994b. *Stream Stations in Headwaters Reserve*. United States, Department of the Interior, GIS Map.
- Brown L. R., P. B. Moyle, and R. M. Yoshiyama. 1994. "Historical Decline and Current Status of Coho Salmon in California." *North American Journal of Fishery Management*, 14:237-26.
- Bryant, G., and Lynch, J. 1996. Factors for Decline: A supplement to the Notice of Determination for West Coast Steelhead under the Endangered Species Act.
- Buchanan, Catherine Lynn, et al. 2001. *Watershed Sediment Study and the Connection to Humboldt Bay*. Humboldt State University, Department of Environmental Resources Engineering.
- Bunnell, F. L. and A. C. Chan-McLeod. 1997. "Terrestrial Vertebrates." In: P. K. Schoonmaker, B. von Hagen, and E. C. Wolf. *The Rainforests of Home: Profile of a North American Bioregion*. Washington, DC: Island Press. pg. 103 - 130.
- Busby, Peggy J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, F. W. Waknitz, and I. V. Lagomarsino. 1996. *Status Review of West Coast Steelhead from Washington, Idaho, Oregon, and California*. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-27.
- Cafferata, Peter H. 1997. *Forest Practice Regulation and Forest Practice Act*. Prepared for The California Resources Agency, Department of Forestry and Fire Protection.
- Cafferata, Peter, and Hugh Scanlon. 1998. *Freshwater Creek Cross-Section Remeasurement*. California Department of Forestry and Fire Protection.
- California Advisory Committee on Salmon and Steelhead Trout. 1988. *Restoring the Balance*. Annual Report to the Legislature and Dept. Fish & Game, Sacramento, CA.
- Campbell, Lisa and Sandra Miles. 1997. *Salmon Creek Habitat Inventory*. Americorps Watershed Stewards Project. California Department of Fish and Game, Humboldt County.

- Carranco, Lynwood and Henry Sorenson. 1988. *Steam in the Redwoods*. The Caxton Printers, Ltd.: Caldwell, Idaho.
- Cederholm, C. J., R. E. Bilby, P. A. Bisson, T. W. Bumstead, B. R. Fransen, W. J. Scarlett, and J. E. Ward. 1997. Response of juvenile coho salmon and steelhead to placement of large woody debris in a coastal Washington stream. *North American Journal of Fisheries Management*. 17(4): 947-963.
- CDF - California Department of Forestry and Fire Protection. 1998. "California Forest Practice Rules." In: *Forest Practice*. California Department of Forestry: Sacramento, CA.
- Clark, D. 1969. *A Historical Study of the Arcata and Mad River Railroad*. Masters Thesis, Humboldt State University: Arcata, CA.
- Cole, Wendy. 2004. Draft Freshwater Creek Watershed Analysis. Prepared for California Department of Fish and Game.
- Cole, Wendy, and Barnes, Jerry. 2004. Habitat Survey of Lower Jacoby Creek for RCAA.
- Coy, Owen C. 1929. *The Humboldt Bay Region 1850-1875; a Study in the American Colonization of California*. The California State Historical Association: Los Angeles, CA. xiii. pg. 346.
- Conroy, William. 1999. *A Comparison of Rainfall-Runoff Relations in Elk River, a Small Coastal Northern California Watershed*. Masters Thesis. Humboldt State University: Arcata, CA.
- Community Organization of Wrangletown. 1976. *Freshwater Chronicle and Cookery*.
- Davis, Ronald. E. 1989. Salmon Creek Fish Count. Prepared for R.J. Pierce, Fisheries Department, Humboldt State University.
- Derksen, Jan. 1998. *Klamath Resource Information System*. CD-ROM. Information Accessed: March 2001.
- Division of Mines and Geology. 1997. *Engineering Geologic Review of Timber Harvesting Plan 1-97-222 HUM*. Prepared for California Department of Forestry and Fire Protection.
- DFG - California Department of Fish and Game. 1994a. *Petition to the California Board of Forestry to list Coho Salmon (Oncorhynchus kisutch) as a Sensitive Species*.
- DFG - California Department of Fish and Game. 1994b. *Stream Inventory Report - Freshwater Creek, Humboldt County*.
- DFG - California Department of Fish and Game. 1994c. *Stream Inventory Report - Elk River, Humboldt County*.
- DFG - California Department of Fish and Game. 1995. *Stream Inventory Report - Ryan Creek, Humboldt County*.

- DFG - California Department of Fish and Game. 1997. *Stream Inventory Report - Salmon Creek, Humboldt County*.
- DFG - California Department of Fish and Game. 1998. *California Stream Habitat Restoration Manual*. Third Edition.
- DFG - California Department of Fish and Game. 1998. Spawner Surveys- Jacoby Creek.
- DFG - California Department of Fish and Game. 2000. *Stream Inventory Report - Freshwater Creek, Humboldt County*.
- DFG - California Department of Fish and Game 2004. Personal communication with Michael Lau.
- Downie, S.T., C.W. Davenport, E. Dudik, F. Yee, and J. Clements. 2002. Mattole River Watershed Assessment Report. North Coast Watershed Assessment Program. California Resources Agency, and California Environmental Protection Agency, Sacramento, California.
- Driscoll, John. 2002. Where the Stream Meets the Sea. *The Times-Standard*, February 10.
- Dudik, Elmer. 1998. *Interview of residents in the North Fork Elk River Watershed, Humboldt County*. Prepared for North Coast Regional Quality Control Board.
- Dunne, Thomas, et al. 1999. *An Analysis of Flooding in Elk River and Freshwater Creek Watersheds, Humboldt County, California*. Reviewed by The University Committee on Cumulative Watershed Effects. University of California, Berkeley.
- Dunne, T. and L. B. Leopold. 1978. *Water in Environmental Planning*. W. H. Freeman and Company: New York, NY. pg. 818.
- Dunne, T., J. Agee, S. Beissinger, W. Dietrich, D. Gray, M. Power, V. Resh, and K. Rodrigues. 2001. A scientific basis for the prediction of cumulative watershed effects. The University of California Committee on Cumulative Watershed Effects. University of California Wildland Resource Center Report No. 46. June 2001. 107 pp.
- DWR - California Department of Water Resources. 1978. "Land use within the California coastal zone." *California Department of Water Resources, Bulletin 207*: pg. 161.
- Dyett and Bhatia. 2002. Humboldt 2025 General Plan Update Reports: Natural Resources and Hazards: A discussion paper for community workshops.
- Eddy, J. M. 1893. *In the Redwoods Realm: Humboldt County, CA*. Humboldt County Chamber of Commerce. D. S. Stanely & Co., Printers and Publishers: San Francisco, CA.
- Ellinwood, Jud. 1985. *Humboldt Bay Tributaries Salmon: An Oral History*. Interviews with Ross Bragdon, Sam Mitchell, Nels Rossig, and Ernie Wahlund.

- Falls, James N. Division of Mines and Geology. 1997a. *Reconnaissance Engineering Geologic Evaluation of Watershed Conditions in the Elk River Drainage, Humboldt County, California*. Prepared for California Department of Forestry and Fire Protection.
- Falls, James N. Division of Mines and Geology. 1997b. *Completion Inspection of a Portion of Timber Harvest Plan 1-94-360 HUM*. Prepared for California Department of Forestry and Fire Protection.
- FEMAT (Forest Ecosystem Management Assessment Team). 1993. "Forest Ecosystem Management: An Ecological, Economic and Social Assessment." In: *Report of the Forest Ecosystem Management Assessment Team*. 1993-793-071. U.S. Government Printing Office.
- Fenton, Clark. 2001. *Salmon Forever Field and Lab Operations Report, Freshwater Creek*. 2001.
- Ferndale Enterprise (FE) Ferndale, 1878-present
- Flosi, Gary and Forrest Reynolds. 1994. California salmonid stream habitat restoration manual. State of California Department of Fish and Game. 2nd edition.
- Francis, Ann. 1999. *A Conservation Strategy for the Jacoby Creek Land Trust*. California State Coastal Conservancy.
- Franklin, J. F. 1993. "Preserving Biodiversity: Species, Ecosystems, or Landscapes." In: *Ecological Applications*. Vol. 3. pg. 202-205.
- Freshwater Community Advisory Committee. 1983. *Hearing Draft, Freshwater Community Plan, Humboldt County, California*. County of Humboldt Planning Department.
- Frissel, C. 1993. *A New Strategy for Watershed Restoration and Recovery of Pacific salmon in the Pacific Northwest*. Prepared for the Pacific Rivers Council: Eugene, OR.
- Furniss, M. J., T. D. Roelofs, and C. S. Yee. 1991. "Road Construction and Maintenance." In: *American Fisheries Society Special Publication*. Vol. 19. pg. 297-324.
- FWS - United States Fish and Wildlife Service, 1989. *Management Plan: Humboldt Bay National Wildlife Refuge*, Humboldt County, CA. United States Department of the Interior.
- FWS - United State Fish and Wildlife Service, Pacific Region. 1998. *Salmon of the Pacific Coast*. Washington.
- Gates, Jon Humboldt. 1983. *Falk's Claim: The Life and Death of a Redwood Lumber Town*. Moonstone Publishing: Seattle, WA.
- Giger, R. D. 1972. "Ecology and Movement of Coastal Cutthroat Trout in Oregon." In: *Fisheries Restoration Report; Number 6*. Oregon State Game Commission, Corvallis, OR: pg. 61.
- Glass, Domoni. 2002. Draft Freshwater Creek Watershed Analysis Cumulative Effects Assessment Review. Prepared for Pacific Lumber Company, Scotia, California.

- Glatzel, K. A. 1982. "An Historical Overview of Land Use Surrounding Humboldt Bay." In: *Proceedings of the Humboldt Bay Symposium*. Humboldt Bay Symposium Commission. C. Toole and C. Diebel, Editors: Eureka, CA.
- Grant, G. E. 1988. "The RAPID Technique: A New Method for Evaluating Downstream Effects of Forest Practices on Riparian Zones." In: *General Technical Report PNW-GTR-220*. Portland, OR: U.S. Department of Agriculture, Forest Service, Pacific Northwest Research Station: pg. 36.
- Groot, C. and L. Margolis, et al. 1998. *Pacific Salmon Life Histories*. British Columbia: University of British Columbia Press.
- Hagans, D. K. and P. T. Higgins. 1996. *Analysis of Stream Channel Recovery of the North Fork Garcia River Using a Modified RAPID Methodology*. Performed under contract to Coastal Forest Lands, Inc. Willits, CA: pg. 5.
- Harper, W. 1980. Age growth and migration of coho salmon and steelhead trout in Jacoby Creek, CA. Masters thesis, Humboldt State University, Arcata, CA. HSU library: QL 638.S2 H37.
- Harr, R. D. 1982. "Fog Drip in the Bull Run Municipal Watershed, Oregon." In: *Water Resources Bulletin*. Vol. 18, No. 5. pg. 785-789.
- Harr, R. D. 1983. "Potential for Augmenting Water Yield Through Forest Practices in Western Washington and Western Oregon." In: *Water Resources Bulletin*. Vol. 19. No. 3. pg. 383-393.
- Harris, Steven. 1987. *A Relationship of Convection Fog to Characteristics of the Vegetation of Redwood National Park*. Masters Thesis, Humboldt State University: Arcata, CA.
- Harris, R.R., W.G. Duffy, S.D. Kocher, J. Gerstein, F. Kearns, D. Lindquist, D. Lewis, J. Leblanc, W. Weaver, N.M. Kelly, M.A. Wilzbach, M. Wheeler, S. Frazey. 2003. California Coastal Salmonid Restoration Monitoring and Evaluation Program: Interim Restoration Effectiveness and Validation Monitoring Protocols. Prepared for California Department of Fish and Game, Sacramento, California.
- HartCrowser. 2004. Public Review Draft of Elk River/Salmon Creek Watershed Analysis, Scotia, California. Prepared for Pacific Lumber Company, Scotia, California.
- Hassler, T.J. and C.M. Sullivan, and G.R. Stern. 1991. Distribution of coho salmon in California. Final report submitted to California Department of Fish and Game, contract no. FG7292. US Fish and Wildlife Service, California Cooperative Fishery Research Unit. Humboldt State University. Arcata, CA. 23 pp.
- HCOC - Humboldt County Chamber of Commerce. 1891. *Humboldt County Statistics*. Standard Publishing Company: Eureka, CA.
- Hedlund, E. 1978. *An Historic Resources Inventory of the Old Arcata Road-Myrtle Avenue Corridor*. Humboldt County Public Works Department, Natural Resources Division: Eureka, CA.
- Henderson, John. 1999. CA-Impacts to Humboldt Bay NWR From Forestry and Dairy Activities in the Salmon Creek Watershed.

- HFAC - Humboldt Fish Action Council. *Summary Reports, Biological Surveys: 1985-2002*. Unpublished. Eureka, CA.
- HFAC - Humboldt Fish Action Council. 1999. *Downstream Migrant Trapping Report*.
- HFAC - Humboldt Fish Action Council. 2000. *Downstream Migrant Trap Results on Freshwater Creek: 1996-2000*.
- HFAC - Humboldt Fish Action Council. 2002. *Seasonal Totals: 2001-2002 Upstream Adult Weir Counts*.
- Higgins, P. E., S. D. Dobush, and D. Fuller. 1992. *Factors in Northern California Threatening Stocks with Extinction*. Humboldt Chapter of the American Fisheries Society: Arcata, CA. pg. 25.
- Higgins, Patrick. 2001. *Freshwater Creek Watershed Dissenting Report*. <http://www.pcffa.org/fwfish.htm>
- House, R. A. and P. L. Boehne. 1987. "The Effect of Stream Cleaning on Salmonid Habitat and Populations in a Coastal Oregon Drainage." In: *Western Journal of Applied Forestry*. Vol. 2. pg. 84-87.
- Huber, Oscar L. 1992. "Sedimentation in a Highly Erodible Watershed, Salmon Creek, Humboldt County." Department of Mines and Geology. California Geology.
- Humboldt Bay Interagency Task Force. 1989. *Waterfront Access Recommendations, Elk River Area*.
- Humboldt County Economic Almanac*. Various Years. County of Humboldt.
- Humboldt County. 1977. *Agricultural Statistics, 1940-1977*. Eureka, CA.
- Humboldt County. 1997. *Report of Agricultural Production for Humboldt County*. Eureka, CA.
- Humboldt County. 1999. *Humboldt County Demographic Almanac*. Ed: Phyllis Lammers. State Board of Equalization, Timber Tax Division.
- Humboldt County General Plan Volume II, Jacoby Creek Community Plan. December 21, 1982. <http://www.co.humboldt.ca.us/planning/Genplan/Jacoby/Index.htm>
- Humboldt Standard (HS) Eureka, 1876-1967
- Humboldt Times (HT) Eureka, 1854-1967
- Humboldt Watersheds Independent Scientific Review Panel. 2002. *Final Report to the North Coast Regional Water Quality Control Board*.
- Humboldt Watersheds Independent Scientific Review Panel. 2003. *Phase II Report: Independent Scientific Review Panel on Sediment Impairment and Effects on Beneficial Uses of the Elk River and Stitz, Bear, Jordon and Freshwater Creeks*. Prepared for North Coast Regional Water Quality Control Board.

- Ihle, Curtis. 2001. *Lower Freshwater Creek Cover Enhancement Program Fulton Property: 2000-2001*. Coastal Stream Restoration Group.
- Ingwerson, J. B. 1985. "Fog Drip, Water Yield, and Timber Harvesting in the Bull Run Municipal Watershed, Oregon." In: *Water Resource Research*. Vol. 21, No. 3. pg. 469-473.
- Jackson, L. L., N. Lopoukhine, and D. Hillyard. 1995. "Ecological Restoration: a Definition and Comments." In: *Restoration Ecology*. Vol. 3. pg. 71-75.
- Johnson, O. W., M. H. Ruckelshaus, W. S. Grant, F. W. Waknitz, A. M. Garrett, G. H. Bryant, K. Neely, and J. J. Hard. 1999. *Status Review of Coastal Cutthroat Trout from Washington, Oregon and California*. NOAA Technical Memo. NMFS-NWFSC-37. pg. 292.
- Johnson, W. N. 1972. *A Study of Some Water Quality Characteristics and Possible Logging Influences on a Small Stream on the North Coast of California*. Masters Thesis. Humboldt State University: Arcata, CA.
- Jones and Stokes. 2002. *Headwaters Forest Reserve Draft Resource Management Plan/EIS/EIR*. Prepared for US Department of the Interior, Bureau of Land Management and California Department of Fish and Game.
- Jones and Stokes. Headwaters Forest Reserve Proposed Resource Management Plan and Final EIS/EIR Volume I. Prepared for USDI Bureau of Land Management and California Department of Fish and Game. September 2003.
- Jordan, F. 1913. *California Blue Book, 1911*. Compiled by Frank Jordan, Secretary of State: Sacramento, CA.
- Kauffman, J. B., R. L. Beschta, N. Otting, and D. Lytjen. 1997. "An Ecological Perspective of Riparian and Stream Restoration in the Western United States." In: *Fisheries*. Vol. 12, No. 5. pg. 12-24.
- Kier (William M.) Associates. 1995. *Watershed Restoration - A Guide for Citizen Involvement in California*. NOAA Coastal Program Decision Analysis Series No.8. NOAA Coastal Ocean Office, Silver Spring, MD.
- Kilbourne, Richard. 1985. *Geology and Geomorphic Features related to Landsliding, McWhinney Creek, 7.5-minute quadrangle*. Humboldt County, California: Department of Conservation, Division of Mines and Geology, OFR 85-3 S.F., scale 1:24,000.
- Kilbourne, Richard, and S. D. Morrison. 1985. *Geology and Geomorphic Features Related to Landsliding, Fields Landing 7.5-minute quadrangle*. Humboldt County, California: Department of Conservation, Division of Mines and Geology, OFR 85-4 S.F., scale 1:24,000.
- Klein, Randy D. 2001. *Elk River Flooding Review*. Prepared for California Regional Water Quality Control Board.
- Klein, Randy D. 2001. *Elk River Hydrologic Monitoring Investigation of Historical and Recent Information Sources*. Prepared for Redwood Community Action Agency.

- Klein, Randy D. 2002. *Proposed Direct Testimony in Support of Salmon Forever*. Prepared for the North Coast Regional Water Quality Board Hearing: April 18, 2002.
- Klein, Randy D. and Jeffrey K. Anderson. 2001. *Martin Slough Restoration: Preliminary Hydrological Assessment*. Prepared for Redwood Community Action Agency.
- Kondolf, G. M., R. Kattelman, M. Embury, D. C. Erman. 1996. "Status of Riparian in Sierra Nevada Ecosystem Project: Final Report to Congress, Vol. II, Assessments and scientific Basis for Management Options." In: *Wildland Resources Center Report, Number 37*. University of California, Centers for Water and Wildland Resources: Davis, CA. pg. 1009-1030.
- KRIS - Klamath Resource Information System. 1998. Website: <http://www.krisweb.com/>
- Leopold, L. B., M. G. Wolman, and J. P. Miller. 1964. *Fluvial Processes in Geomorphology*. W. H. Freeman and Company: San Francisco, CA. pg. 522.
- Lisle, T. and S. Hilton. 1991. Fine sediment in pools: An index of how sediment is affecting a stream channel. As FHR Currents # 6 . US Forest Service, Region 5. Eureka, CA . 7 pp.
- Lisle, T. 1999. *Channel Processes and Watershed Function. Using Stream Geomorphic Characteristics as a Long-term Monitoring Tool to Assess Watershed Function*. Fish, Farm, and Forests Communities Forum: Sacramento, CA.
- Loud, Llewellyn L. 1918. *Ethnogeography and Archaeology of the Wiyot Territory*. Berkeley, University of California Press.
- Lundborg, Holly. 2002. *Request for Elk River and Freshwater Creek Watershed Information*. Prepared for The Pacific Lumber Company by the Regional Water Quality Control Board.
- Madsen, Robert H. 1976. *Why was Elk River diverted? Answer remains a mystery*. The Humboldt Historian: July/August Issue.
- Marshall, Gerald J. Division of Mines and Geology. 2002. *Rapid Review of Engineering Geologic Conditions for Specific Timber Harvest Plans in the Elk River Watershed*. Prepared for California Department of Forestry and Fire Protection.
- McCarthy, J. W. 1979. *Bits of the Past*. Artcraft Printers, Eureka, CA.
- McCullough, D. A. 1999. A review and synthesis of effects of alterations to the water temperature regime on freshwater life stages of salmonids, with special reference to chinook salmon. Published as EPA 910-R-99-010 . Prepared for the U.S. Environmental Protection Agency (EPA), Region 10. Seattle, Washington. 291 pp.
- McEwan, D. and T. A. Jackson. 1996. *Steelhead Restoration and Management Plan for California*. California Department of Fish and Game. pg. 234.

- Meledy, H. Brett. 1959. "Two Men and a Mill." In: *California Historical Society Quarterly*. Volume XXXVIII, No. 1.
- Michlin, Lee. Executive Officer EPA. 1998. *California Regional Water Quality Control Board, North Coast Region, Letter to Mr. Tom Herman, Pacific Lumber Company Re: Review of Sediment Budgets and Inventory for Bear Creek and North Fork Elk River by Dr. Leslie M. Reid*. USDA Forest Service Pacific Southwest Research Station, Redwood Sciences Lab.
- Monroe, G. W., S. J. Thompson, P. G. Swatzrell, B. M. Browning, and J. W. Speth. 1973. *The Natural Resources of Humboldt Bay*. California Department of Fish and Game. pg. 160.
- Montgomery, D. R., G. E. Grant, K. Sullivan. *Watershed Analysis as a Framework for Implementing Ecosystem Management*. Water Resources Bulletin Number 31. pg. 369-385.
- Moore, Mark. 2002. *Note to Ryan Creek File*. California Department of Fish and Game.
- Murray, A. and R. Wunner. 1980. *A Study of the Jacoby Creek Watershed, Humboldt County, CA*. Jacoby Creek Canyon Community, Inc.: Bayside, CA.
- Murray, A. and R. Wunner. 1988. *The Jacoby Creek Watershed: Past, Present and Future*. Natural Resources Division of the Redwood Community Action Agency: Eureka, CA.
- Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grand, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. *Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California*. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-NWFSC-35. pg. 443.
- Naiman, R. J., T. J. Beechie, L. E. Benda, D. R. Berg, P. A. Bisson, L. H. MacDonald, M. D. O'Connor, P. L. Olson, and E. A. Steele. 1992. "Fundamental Elements of Ecologically Healthy Watersheds in the Pacific Northwest Coastal Ecoregion." In: *Watershed Management: Balancing Sustainability and Environmental Change*. Springer-Verlag: New York. pg. 127-188.
- Nakamoto, R. J. 1998. Effects of timber harvest on aquatic vertebrates and habitat in the North Fork Caspar Creek. . In: Ziemer, Robert R., technical coordinator. Proceedings of the conference on coastal watersheds: the Caspar Creek story, 1998 May 6; Ukiah, CA General Tech. Rep. PSW GTR-168. Albany, CA: Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture; 87-95.
- National Research Council. 1996. *Upstream: Salmon and Society in the Pacific Northwest*. National Academy Press: Washington, DC.
- Natural Resources Planning Senior Practicum, Humboldt State University. 2001. *Waterfront Recommendations For the Elk River Wildlife Area*. Prepared for the Natural Resources Services Division of Redwood Community Action Agency.
- Nawa, R. K. and C. A. Frissell. 1993. "Measuring Scour and Fill of Gravel Stream Beds with Scour Chains and Sliding Bead Monitors." In: *American Journal of Fisheries Management*. Vol. 13. pg. 634-639.

- NCWAP - Downie, S.T., C.W. Davenport, E. Dudik, F. Yee, and J. Clements. 2002. Mattole River Watershed Assessment Report. North Coast Watershed Assessment Program. California Resources Agency, and California Environmental Protection Agency, Sacramento, California.
- Nehlsen, W. J., J. E. Williams, and J. A. Lichatowich. 1991. "Pacific Salmon at the Crossroad: Stocks at Risk from California, Oregon, Idaho and Washington." In: *Fisheries*. Vol. 16. pg. 4-21.
- National Marine Fisheries Service (NMFS). 2001. Status Review Update for Coho Salmon (*Oncorhynchus kisutch*) from the Central California Coast and the California portion of the Southern Oregon/Northern California Coasts Evolutionarily Significant Units. NMFS, Southwest Fisheries Science Center.
- NOAA - National Oceanic and Atmospheric Administration. 1998. "Endangered and Threatened Species: Proposed Endangered Status for Two Chinook Salmon ESUs and Proposed Threatened Status for Five Chinook Salmon ESUs; Proposed Redefinition, Threatened Status, and Revision of Critical Habitat for One Chinook Salmon ESU; Proposed Designation of Chinook Salmon Critical Habitat in California, Oregon, Washington, Idaho." In: *Federal Register*. Vol. 63, No. 45. Proposed Rules. National Marine Fisheries Service (NMFS), National Oceanic and Atmospheric Administration (NOAA), Commerce. pg. 40.
- Northwest Coalition for Alternatives to Pesticides. 1999. Do Pesticides Contaminate Our Rivers, Streams and Wells? *Journal of Pesticide Reform*. Summer 1999 • Vol.19, No. 2. 1
- Noss, Reed, ed. 2000. *The Redwood Forest: History, Ecology and Conservation of the Coast Redwoods*. Island Press.
- NRMC - Natural Resources Management Corporation. 2001. *Ryan Slough Road Inventory*. Eureka, CA.
- O'Connor, M. D. and R. R. Ziemer. 1989. Coarse woody debris ecology in a second-growth Sequoia sempervirens forest stream. Proceedings of the California Riparian Systems Conference: protection, management, and restoration for the 1990's. September 1988, Davis, California. U.S. Department of Agriculture, Pacific Southwest Forest and Range Experiment Station (PSW): p. 165-171. Gen. Tech. Rep. PSW-110. 7 pp.
- PALCO - Pacific Lumber Company. 1998. Sustained Yield Plan/Habitat Conservation Plan for the properties of the Pacific Lumber Company, Scotia Pacific Holding Company, and the Salmon Creek Company. Public Review draft. July (CD ROM).
- PALCO - Pacific Lumber Company. 1999. *Monitoring Plan for the North Fork Elk River Watershed Results Report*.
- PALCO - Pacific Lumber Company. 2000. *Elk River Monitoring Plan Results*.
- PALCO - Pacific Lumber Company. 2001a. *Elk River Monitoring Plan Results*.
- PALCO- Pacific Lumber Company. 2001. Draft Report Freshwater Watershed Analysis.
- PALCO - Pacific Lumber Company. 2001b. *Freshwater Creek Watershed Analysis*.

PALCO - Pacific Lumber Company. *An Analysis of Flooding in Elk River and Freshwater Creek Watersheds, Humboldt County, California.*

Pacific Fishery Management Council. 1987. *Review of 1986 Ocean Salmon Fisheries.* Pacific Fishery Management Council: Portland, OR. pg. 104.

Pacific Coast Fish, Wildlife and Wetlands Restoration Association, M. Love and Associates, G. Matthews and Associates. 2003. *Final Draft Lower Salmon Creek Delta Salmonid Habitat Enhancement Opportunities, Humboldt Bay National Wildlife Refuge Humboldt County, California.* Prepared for California Department of Fish and Game and Humboldt Bay National Wildlife Refuge.

Patenaude, Rose J.. 2004. *Preliminary Assessment of Flooding in Lower Elk River.* Prepared for Elk River Sediment TMDL, North Coast Regional Water Quality Control Board, Santa Rosa, California.

Pollard, W. R., et al. 1997. *Field Identification of Coastal Juvenile Salmonids.* Harbour: Canada, BC.

Pollock, Michael Ph.D. 2001. *A Review of PALCO's Freshwater Creek Watershed Analysis Riparian Function Assessment Draft.* Prepared by The Watershed Program, Northwest Fisheries Science Center.

Prichard, D. 1998. *Riparian Area Management: a User Guide to Assessing Proper Functioning Condition, and the Supporting Science for Lotic Areas.* Bureau of Land Management Technical Reference 1737-15. Denver, CO 80225-0047.

Proctor, C. M., J. C. Garcia, D. V. Galvin, G. B. Lewis, L. C. Loehr, and A. M. Massa. 1980. "An Ecological Characterization of the Pacific Northwest Coastal Region." In: *FWS/OBS-79/11-15.* U.S. Fish and Wildlife Service. pg. 1746.

PWA - Pacific Watershed Associates. 1996. *Summary of erosion prevention and erosion control plan for the Little Freshwater Creek watershed.* Prepared for Pacific Lumber Company. 10 p.

PWA - Pacific Watershed Associates. 1998a. *1997 McCready Road Decommissioning Project, Freshwater Creek: Final Report.* Prepared for PCFWWRA.

PWA - Pacific Watershed Associates. 1998b. *Sediment Source Investigation and Sediment Reduction Plan for the North Fork Elk River.*

PWA - Pacific Watershed Associates. 1999. *Sediment Source Investigation and Sediment Reduction Plan for the Freshwater Creek Watershed, Humboldt County, CA.*

PWA - Pacific Watershed Associates. 2000a. *Summary Report, Phase 1: Headwaters Watershed Assessment and Restoration Planning, Humboldt County, California.* Prepared for Bureau of Land Management, Arcata Area Office.

PWA - Pacific Watershed Associates. 2000b. *Summary Report: 1999-2000 Salmon Creek Road Decommissioning Project for the Salmon Creek Watershed, Humboldt County, California.*

- PWA - Pacific Watershed Associates. 2001. *Cost Estimate for Road Decommissioning in the Headwaters Forest Reserve, Humboldt County, California.*
- RCAA- Redwood Community Action Agency 2004. Martin Slough Project.
- Reeves, G. H., F. H. Everest, and J. R. Sedell. 1993. Diversity of juvenile anadromous salmonid assemblages in coastal Oregon basins with different levels of timber harvest . Transactions of the American Fisheries Society. 122(3): 309-317.
- Reeves, G. H., L. E. Benda, K. M. Burnett, P. A. Bisson, and J. R. Sedell. 1995. "A Disturbance-Based Approach to Maintaining and Restoring Freshwater Habitats of Evolutionary Significant Units of Anadromous Salmonids in the Pacific Northwest." In: *American Fisheries Society Symposium No. 17.* pg. 334-349.
- Reid, L. M. and T. Dunne. 1984. "Sediment Production for Forest Road Surfaces." In: *Water Resources Research No. 20.* pg. 1753-1761.
- Reid, L. M. and S. Hilton. 1998. Buffering the Buffer. *Proceedings of the Conference on Coastal Watersheds: The Caspar Creek Story.* USDA Forest Service Pacific Southwest Forest and Range Experiment Station, Redwood Sciences Lab: Arcata, CA. http://www.psw.fs.fed.us/Tech_Pub/Documents/gtr-168/08reid.pdf
- Reid Ph.D, Leslie. 1999. *Forest Practice Rules and Cumulative Watershed Impacts in California.* USDA Forest Service Pacific Southwest Research Station Redwood Sciences Laboratory.
- Reid, Dr. Leslie. 2000. *Calculation of appropriate cutting rate in North Fork Elk River Watershed.* USDA Forest Service Pacific Southwest Research Station, Redwood Sciences Laboratory.
- Reid Ph.D., Leslie and Thomas Lisle Ph. D. 2001. *Review of Freshwater Creek Watershed Analysis.* USDA Forest Service Pacific Southwest Research Station, Redwood Sciences Laboratory.
- Reid, Dr. Leslie. *Review of Sediment Budgets and Inventory for Bear Creek and North Fork Elk River.* USDA Forest Service Pacific Southwest Research Station, Redwood Sciences Lab.
- Reimers, P. E. 1973. "The Length of Residence of Juvenile Fall Chinook Salmon in Sixes Rivers, Oregon." In: *Community Resources Report.* Vol. 4, No. 2. Oregon Fish. pg. 1-43.
- REO - Regional Ecosystems Office. 1995. *Watershed Analysis: Direction for Completion of a Federal Agency Guide to Watershed Analysis.* File No. 485. REO: Portland, OR.
- Rice, Wayne RPF. 2002. *Archers Timber Harvest Plan, Section IV Cumulative Effects Analysis.* THP 02-103 HUM - Bridge Creek, North Fork Elk River. SCOPAC.
- Richmond, Reverend George M. Nov/Dec 1990. *Tales of the South Bay, The Old Plank Road.* Humboldt Historian. pg. 9-10.

- Ricker, Seth. 2001. *Results of the Juvenile Downstream Migrant Trapping Conducted on Freshwater Creek*. Steelhead Research and Monitoring Program, California Department of Fish and Game.
- Ricker, Seth. 2002. *2000-2001 Escapement and Life History Patterns of Adult Steelhead in Freshwater Creek*. Steelhead Research and Monitoring Program, California Department of Fish and Game.
- Rieman, B., D. Lee, J. McIntyre, K. Ovetton, and R. Thurow. 1993. "Consideration of Extinction Risks for Salmonids." In: *Fish Habitat Relationships Technical Bulletin No.14*. USDA Forest Service Intermountain Research Station: Boise, Idaho.
- Righter, P. 2004. Assessment of Salmonid Distribution Freshwater Creek. November 2003 - June 2004. Prepared for Natural Resources Division of Redwood Community Action Agency, Eureka, California.
- Rosgen, D. 1996. *Applied River Morphology*. Wildland Hydrology: Pagosa Springs, CO.
- RWQCB - California Regional Water Quality Control Board, North Coast Region. 2000. *Proposed Regional Water Board Actions in the North Fork Elk River, Bear Creek, Freshwater Creek, Jordan Creek and Stitz Creek Watersheds*.
- RWQCB - California Regional Water Quality Control Board, North Coast Region. 2003. *Sensitive Watershed Nomination for the Elk River Planning Watersheds, Humboldt County California*.
- Scanlon, Hugh. 1997. *Forest Practice Regulation and Timber Taxation; Forest Practice Act; North Fork Elk River Field Trip Results*. Prepared for California Department of Forestry and Fire Protection.
- Schafran, W. C. 1984. *Bayside: Through the Years*. The Center for Community Development. Humboldt State University: Arcata, California.
- Sedell, J. R., F. N. Leone, and W. S. Duvall. 1991. "Water Transportation of Logs." In: *American Fisheries Society Special Publication No.19*: pg. 325-368.
- Shapiro & Associates. 1980. *Humboldt Bay Wetlands Review and Baylands Analysis*. Prepared for U.S. Army Corps of Engineers, San Francisco District: Seattle, WA.
- SHN Consulting Engineers and Geologists, Inc. 2002. *Trench Investigation of Recent Sediment History Along the Elk River, Revision 1*. Prepared for Stoel Rives.
- Sigler, John W. 1980. *Effects of Chronic Turbidity on Feeding, Growth and Social Behavior of Steelhead Trout and Coho Salmon*. A Dissertation, University of Idaho Graduate School.
- Snyder, William. 2002. *Official Response to Significant Environmental Points Raised During the Timber Harvesting Plan Evaluation Process*. THP 1-00-030 HUM. California Department of Forestry and Fire Protection. pg. 78.

- Spence, B. C., G. A. Lomnický, R. M. Hughes, and R. P. Novitzki. 1996. *An Ecosystem Approach to Salmonid Conservation*. Funded jointly by the U.S. EPA, U.S. Fish and Wildlife Service, and National Marine Fisheries Service. TR-4501-96-6057. Manual Technical Environmental Research Services Corp., Corvallis, OR.
- Spittler, Thomas E. 1997. Division of Mines and Geology. *Memorandum to Craig Anthony, Deputy director for Resource Management, CDF. Subject: Preliminary Engineering Geological Review of the Freshwater Creek Watershed. November 7, 1997.*
- SRP - Scientific Review Panel. 1992. *Report of the Scientific Review Panel on California Forest Practice Rules and Salmonid Habitat*. Prepared for the Resources Agency and the National Marine Fisheries Service: Sacramento, CA. pg. 181.
- Sullivan, K. T., E. Lisle, C. A. Doloff, G. E. Grant, and L. M. Reid. 1987. "Stream Channels: The Link Between Forests and Fish." In: Salo, E. D., T. W. Cundy, des. *Streamside Management: Forestry and Fishery Interactions*. Contribution Number 57. University of Washington, Institute of Forest Resources: Seattle, WA. pg. 39-97.
- Taylor, R. 1999. Final Report: Humboldt County Culvert Inventory and Fish Passage Evaluation. Funded by SB-271 CDFG contract :FG 7068-IF.
- Taylor, Ross N., M.S. 1999. *Final Report: Humboldt County Culvert Inventory and Fish Passage Evaluation*. Funded by SB-271 California Department of Fish and Game contract #FG 7068-IF.
- Templeton, Greg. 1998. *Strategies to Improve Road Conditions in McKay Tract*. Updated 12/01/02.
- Templeton, Greg. 2002. *Simpson Timber Harvest Plan 1-02-307*. Section IV: Cumulative Impact Assessment.
- Test, James A. 1982. *Jacoby Creek Community Plan: Data Base and Draft Environmental Impact Report*. Publisher: City of Arcata, CA.
- Tetra Tech Manufacturing, Inc. 2000. *Ryan Slough Fish Passage Design Report*. Redwood Community Action Agency: Eureka, CA.
- Thompson, R. W. 1971. "Recent Sediments of Humboldt Bay, Eureka, California." In: *Final Report PRF#789-G2*. Humboldt State University, College of Natural Resources: Arcata, CA. pg. 62.
- Triska, F. and J. Sedell. 1976. *Biological Impacts of Organic Debris in Pacific Northwest Streams*. Oregon State Logging Debris Symposium II. Oregon State University: Corvallis, OR.
- Trzeciak, Lynne. 1984. *Salmon Creek Stream Survey of January 17/26, 1984*. California Department of Fish and Game, Untitled Stream Survey Form, dated 3/15/1984.
- Tuttle, A. E. 1985. *Cumulative Impact Assessment in Coastal Wetland Watersheds: Jacoby Creek, Humboldt County, CA*. Ph D dissertation, University California: Berkeley, CA.

- University of California Committee on the Scientific Basis for the Analysis and Prediction of Cumulative Watershed Effects. 1999. *Review of an Analysis of Flooding in Elk River and Freshwater Creek Watersheds, Humboldt County, CA*. Center for Forestry.
- U.S. Army Corps of Engineers. 1975. *Flood Plain Information: Freshwater Creek, Humboldt County, CA*. U.S. Army Engineer District, San Francisco.
- U.S. Army Corps of Engineers. 1977. *Evaluations of Alternatives for Improvement of Hookton Channel*. U.S. Army Engineer District, San Francisco.
- Van Kirk, R. R. and S. G. Ahern. 1984. *Socio-economic Profile of Non-resident Sportfisherman and Their Economic Impact on Humboldt and Del Norte Counties, California*. Humboldt County Fish Action Council: Eureka, California. pg. 20.
- Van Kirk, S. 1988. "The Fisheries of Humboldt Bay and Tributary Streams." In: *KRIS Coho*. Compilation of historic newspaper accounts, compiled by S. Van Kirk. Institute for Fisheries Resources.
- Van Kirk, S. 2002. *Early Descriptions and Land Uses Jacoby Creek and Vicinity*. Historical information, Jacoby Creek, CA.
- Vannote, R. L., G. W. Minshall, K. W. Cummins, J. R. Sedell, and C. E. Cushing. 1980. "The River Continuum Concept." In: *Canadian Journal of Fisheries and Aquatic Sciences No. 40*. pg. 452-461.
- Warner, Susan A. California Regional Water Quality Control Board. 2002. *Request for Technical Reports Pursuant to California Water Code Sections 13267(b) for Elk River TMDL Development Monitoring*. Prepared for The Pacific Lumber Company.
- Weitkamp, L. A., T. C. Wainwright, G. J. Bryant, G. B. Milner, D. J. Teel, R. G. Kope, and R. S. Waples. 1995. *Status Review of Coho Salmon from Washington, Oregon, and California*. NOAA Technical Memorandum NMFS-NWFSC-24. U.S. Department of Commerce.
- Welsch, D. J. 1991. *Riparian Forest Buffers; Function and Design for Protection and Enhancement of Water Resources*. USDA publication NA-PR-07-91. <http://willow.ncfes.umn.edu/buffer/cover.htm>
- WFPB - Washington Forest Practices Board. 1997. *Board Manual: Standard Methodology for Conducting Watershed Analysis*. Version 4.0. Washington Department of Natural Resources, Forest Practices Division: Olympia, WA.
- Wheatley, Mark E. California Coastal Conservancy. 2000. *Palco Marsh*. City of Eureka.
- White, Adona. California Regional Water Quality Control Board. 2002. *Elk River Peak Flow Analysis*. Prepared for California Regional Water Quality Control Board.
- White, Adona. 2003. *Presentation to Humboldt Bay Watershed Advisory Committee: September 17, 2003*.

Williams, Philip & Associates, Ltd. 2000. *Restoration Concepts and Scope of Work for the Preparation of a Wetland and Riparian Restoration Plan for the Lower Jacoby Creek*. California State Coastal Conservancy.

Wunner, R. C. 1986. *Long Term Improvement of the Jacoby Creek Watershed*.

Ziemer, R. R. 1998. "Proceedings of the Conference on Coastal Watersheds: The Caspar Creek Story." In: *General Technical Report PSW-GTR-168*. Pacific Southwest Research Station, Forest Service, U.S. Department of Agriculture: Albany, CA. pg. 149.

APPENDIX A. Humboldt Bay Area Planning Documents In Progress (Compiled by Susan Shlosser, UC Cooperative Extension Sea Grant)

Date		Title (availability of plan)	Author	Timeframe	Planning Area	Collaborators	Current Activity	Plan Objectives
1982	1	Volume II. Humboldt Bay Area Plan of Humboldt County Local Coastal Program (this is part of the Humboldt County General Plan): http://elib.cs.berkeley.edu/cgi-bin/doc_home?elib_id=2067 http://www.planupdate.org/	Humboldt County	1982-2002	13,000 acres around Humboldt Bay	public, Coastal Commission, service districts	updating plan	Addresses bay wetlands, agriculture conversion, shoreline erosion, industry/energy issues, snowy plover biological information water and sewer infrastructure, public access
1989	2	Humboldt Bay National Wildlife Refuge Management Plan (<i>local libraries</i>)	US Fish and Wildlife Service	1989 to present	Humboldt Bay National Wildlife Refuge	public	plan used as guidance document for management and future development	Increase brant use of Humboldt Bay, obtain optimum levels of habitat diversity, provide optimum wintering and migratory water bird use of wetlands, maintain tidal ecosystem, restore lower end of Salmon Creek, increase public understanding and education of
1997	3	Eureka General Plan includes Local Coastal Land Use Plan in Appendix B. http://www.eurekawebs.com/cityhall/cityclerk/docs/Eureka_General_Plan.pdf	City of Eureka	1997-2007	City of Eureka and some Humboldt Bay tidelands	public	plan used for management and policy development	General plan focuses on all aspects of the City of Eureka. Sections 3 (Transportation), Section 4 (Public facilities and Services, Section 5 (Cultural and Recreational Resources) and Section 6 (Natural Resources) establish a framework for protecting natural resources in the Eureka area, preserving agriculture, conserving open space, and protecting air quality.
1999	4	Management Plan for Commercial Shellfishing in Humboldt Bay, California Eureka Sea Grant Office (443-8369)	California Department of Health Services	1999 to present	Humboldt Bay certified shellfish growing waters	Calif. Dept. of Health Services, Sea Grant, shellfish growers, Humboldt Bay Harbor, Recreation, and Conservation District (HCRCD), Cities of Eureka and Arcata, Calif. Dept. of Fish and Game	Management and regulation of shellfish harvest	Management of shellfish harvest for notification of shellfish closure due to marine biotoxins, accidental sewage or other spills.

Date		Title (availability of plan)	Author	Timeframe	Planning Area	Collaborators	Current Activity	Plan Objectives
1999	5	Watershed Management Initiative http://www.scbwmi.org/PDFs/PlanningObj.pdf	North Coast Regional Water Quality Control Board	1999 - present	Regional Water Quality Control Board Region 1: Del Norte, Humboldt, Trinity, Siskiyou, Mendocino, Sonoma, Marin, Counties	North Coast Regional Water Quality Control Board, public, state and federal agency, EPA	not currently active due to rotational schedule of North Coast Regional Water Quality Control Board	Water quality protection and improvement, beneficial uses of marine waters including fishing, shellfish harvest, contact and non-contact recreation, protection of rare, threatened and endangered species, protect ground and surface water uses for municipal supply.
2002	6	Humboldt Bay Strategic Plan	HBHRCD	2002-2006	Humboldt Bay shoreward to high tide line	public, local, state and federal agencies	Implementation of current plan	Policy and management for day-to-day operation of HBHRCD
2002	7	Arcata General Plan 2020 http://www.arcatacityhall.org/2020/2020/GPfinal/Chapter4/ch_4-res_mgmt.html	City of Arcata	2000-2020	City of Arcata	public	general application of plan	Protection of open waters and tidelands of Arcata Bay, public access to Arcata Bay, coastal dependent and public trust uses of Arcata tidelands, diking, dredging, filling and shoreline structure permitting, protection of aquaculture
2002	8	Clean Water Act Section 303(d), Total Maximum Daily Load (TMDL) www.usepa.gov	North Coast Regional Water Quality Control Board	2002-2006	Humboldt Bay and watershed	North Coast Regional Water Quality Control Board, public, agency contacts, EPA	none active in Humboldt Bay	Elk River scheduled for July 2009, Freshwater Creek scheduled for July 2008
2003	9	Humboldt Bay Salmon and Steelhead Conservation Plan http://www.rcaa.org/nrs/projcurr/bayenhance.htm	Humboldt Bay Watershed Advisory Committee	1997- present	Humboldt Bay watershed approximately 200 square miles	environmental and citizens groups, landowners, watershed groups, education, commercial and sports fishing, agriculture, city government, state and federal agencies	Complete third draft of plan by September 2004 to include all Humboldt Bay tributaries	Improve watershed anadromous salmonid populations and related resources while considering regional social and economic needs

Date		Title (availability of plan)	Author	Timeframe	Planning Area	Collaborators	Current Activity	Plan Objectives
2003	10	South Spit Management Plan (<i>local libraries</i>)	Bureau of Land Management, Calif. Dept. Fish and Game	2003 to present	South Spit of Humboldt Bay	CDFG, Coastal Conservancy	short term plan to improve public access, protect snowy plover, long term management plan in development	http://www.ca.blm.gov/arcata/southspit.html
2003	11	Indian Island Cultural and Environmental Restoration Plan http://www.wiyot.com/	Wiyot Tribe	2003 - ?	Indian Island - 80 acres northeast of the Highway 255 bridge	Coastal Conservancy	implement plan	Restoration of cultural sites (midden, dance grounds and sacred sites), environmental objectives to control erosion, restore tidal creek meanders, remove non-native plants, clean up and remediation of hazardous materials, restore salt marsh habitat, remove dikes to restore hydrology, eelgrass restoration and water quality.
2004	12	Humboldt Bay Management Plan http://humboltdbay.cnrs.humboldt.edu/con_rec/management_plan.htm	HBHRCD	2004-2014	Humboldt Bay shoreward to high tide line includes 235 parcels, addresses but does not manage sphere of influence from high tide to Coastal Zone Boundary (about 5,500 parcels)	public, state and federal agencies, local community organizations, environmental groups	draft plan in review by Task Force	Compliance with the California Environmental Quality Act (CEQA), National Environmental Policy Act (NEPA), Coastal Zone Management Act (CZMA), Clean Water Act (CWA): identify resource management needs and develop mechanisms to implement desired management.
2004	13	Port of Humboldt Bay Harbor Revitalization Plan http://humboltdbay.cnrs.humboldt.edu/	HBHRCD	2003	Central portion of Humboldt Bay			THIS PLAN IS NOW INCORPORATED INTO THE HUMBOLDT BAY MANAGEMENT PLAN

Date		Title (<i>availability of plan</i>)	Author	Timeframe	Planning Area	Collaborators	Current Activity	Plan Objectives
2004	14	Tsunami mapping and mitigation plan <i>http://sorrel.humboldt.edu/~geodep/t/earthquakes/rctwg/toc</i>	Humboldt State University, L.Dengler, J. Patton	in review	Mad River to Table Bluff	Calif. Dept. of Mines and Geology, Humboldt State University, numerous state and federal agencies, local groups and organizations	Review of draft plan	Hazard reduction, mapping, planning and mitigation for tsunami preparedness
2004	15	Lower Salmon Creek Delta Salmonid Habitat Enhancement	Pacific Coast Fish, Wildlife, and Wetlands Restoration Association	2004- ?	lower Salmon Creek delta within Humboldt Bay National Wildlife Refuge	USFWS, CDFG	obtain necessary permits	Restore salmonid habitat in lower Salmon Creek estuary and delta.
	16	Dune Management Plan	Humboldt County and California Coastal Conservancy		Dunes of Humboldt County		development of plan	

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

American Fisheries Society Humboldt Chapter

Mike Wallace
P.O. Box 210
Arcata, CA 95521
Phone: 707-822-3702
Fax: 707-822-2855
E-mail: mwallace@dfg.ca.gov

Free slide and video talks about fish and fish habitat for K-12 age groups. Resource for area educators about fishery issues and aquatic education curriculum.

AmeriCorps Watershed Stewards

Gina Bauer
1455-C Sandy Prairie Ct.
Fortuna, CA 95540
Phone: 707-725-8601
Fax: 707-725-8602
E-mail: coho@northcoast.com

Watershed Steward Program volunteers are involved in monitoring, habitat surveys, and education. Americorps places volunteers with government agencies and non-profit groups.

Arcata High School Biology Department

Louis Armin-Hoiland
1720 M Street
Arcata, CA 95521
Phone: 707-822-1731

Student program active in stream restoration and monitoring. Daylighted more than 1/4 mile of Jolly Giant Creek and restored wetland, riparian, and pond habitats.

Audubon Society Redwood Region Chapter

Chet Ogan, President
P.O. Box 6343
Eureka, CA 95502
Phone: 707-442-9353
E-mail: cogan@fs.fed.us
Website: www.northcoast.com/~rras/

Lobbies for protection and conservation of wildlife and other natural resources, at local and national

levels. Local field trips, lectures, and presentations. Docent training program.

California Coastal Commission North Coast District

Bob Merrill
P.O. Box 4908
Eureka, CA 95502-4908
Phone: 707-445-7833
Fax: 707-445-7877
E-mail: bmerrill@coastal.ca.gov

Regulates land management practices on public and private lands in the coastal zone of California.

California Coastal Conservancy

Karyn Gear
1330 Broadway, Suite 1100
Oakland, CA 94612
Phone: 510-286-4171
Fax: 510-286-0470
E-mail: kgear@scc.ca.gov

Works with citizen groups, government, and private landowners to protect California's coastal resources. Provides funding for local projects including watershed planning, restoration, and acquisition of conservation properties. Public access, trails.

California Coastal Conservancy

Michael Bowen
1330 Broadway, Suite 1100
Oakland, CA 94612
Phone: 510-0720
Fax: 510-286-0470
E-mail: mbowan@scc.ca.gov

California Conservation Corps Salmon Restoration Program

Mel Kreb, District Director
1500 Alamar Way
Fortuna, CA 95540

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Phone: 707-725-5106
Fax: 707-725-1748
E-mail: mel_kreb@ccc.ca.gov
Website: www.ccc.ca.gov

Natural resources conservation program to inventory existing in-stream structures and repair if necessary. Provides employment and training to young adults.

California Dept. of Fish and Game Coastal Restoration Evaluation & Monitoring

Barry Collins
1455 Prairie Creek Rd. Suite J
Fortuna, CA 95540
Phone: 707-725-1068
Fax: 707-725-1086
E-mail: bcollins@dfg.ca.gov
Website: www.dfg.ca.gov

Monitoring and evaluation program for fisheries restoration projects. Works cooperatively with public and private agencies.

California Dept. of Fish and Game Fisheries Restoration Grants Program

Scott Downie
1455 Sandy Prairie Ct. Suite J
Fortuna, CA 95540
Phone: 707-725-0368
Fax: 707-725-0384
E-mail: sdownie@compuserve.com
Website: www.dfg.ca.gov

Fishery habitat and watershed assessment and enhancement; watershed surveys. DFG habitat plans for Eel and Mattole basins developed in cooperation with landowners and restorationists.

California Dept. of Fish and Game

John Schwabe
619 Second Street
Eureka, CA 95501
Phone: 707-441-2006
Fax: 707-445-6664
E-mail: jschwabe
Website: www.dfg.ca.gov

Fish habitat specialist; operates volunteer program; contract manager; specializes in riparian habitat and instream structure placement.

California Dept. of Fish and Game

Gary Flosi
1455 Sandy Prairie Court, Suite J
Fortuna, CA 95540
Phone: 707-725-1072
Fax: 707-725-1025
E-mail: gflosi@dfg.ca.gov
Website: www.dfg.ca.gov

Fisheries biologist for north coast region. Works with public and private organizations to assist in habitat enhancement.

California Dept. of Fish and Game

Mark Wheatley
1455 Sandy Prairie Court, Suite J
Fortuna, CA 95540
Phone: 707-725-7195
Fax: 707-725-1025
E-mail: mwheatley@dfg.ca.gov
Website: www.dfg.ca.gov

Senior Biologist for North Coast watersheds including Humboldt Bay. Works with public and private groups in habitat enhancement especially fish barrier removal.

California Dept. of Fish and Game

Michelle Gilroy
619 Second Street
Eureka, CA 95501
Phone: 707-441-2006
Fax: 707-445-6664
E-mail: mgilroy@dfg.ca.gov
Website: www.dfg.ca.gov

Marine and fisheries biologist for north coast region. Works with public and private organizations to assist in habitat enhancement.

North Coast Regional Water Quality Control Board

Adona White and Mathew Buffleben
5550 Skylane Boulevard
Santa Rosa, CA 95403-1064
Phone: 707-576-2672
Fax: 707-523-0135
E-mail: whita@rb1.swrcb.ca.gov
Website: www.swrcb.ca.gov

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Involved in assessment, monitoring, basin planning, and regulations affecting water quality in California. Funding source for restoration projects improving water quality. TMDL for Elk River and Freshwater.

California Trout, Inc.

Tom Weseloh
1976 Archer Road
McKinleyville, CA 95519
Phone: 707-839-1056
Fax: 707-839-1054
E-mail: caltrout@reninet.com
Website: www.caltrout.org

Local representative of statewide association who addresses policy, management and plans affecting wild trout, native steelhead, and their waters. Facilitates restoration work in numerous northern California creeks.

Center for Environmental Economic Development

Dan Ihara
P.O. Box 4167
Arcata, CA 95518
Phone: 707-822-8347
Fax: 707-822-4457
E-mail: ceed@humboldt1.com

Training, planning and funding assistance for small businesses and community groups to develop environmentally-beneficial business and employment. Research, evaluation, assessment of environmental and economic systems.

Center for Resolution of Environmental Disputes

Elizabeth Watson
P.O. Box 154
Bayside, CA 95524
Phone: 707-839-4840 or 826-5421
Fax: 707-826-5450
E-mail: ew1@humboldt.edu

Provides mediation and facilitation services in environmental disputes.

City of Arcata Environmental Services

Mark Andre, Juli Neander
736 F Street
Arcata, CA 95521
Phone: 707-822-8184

Fax: 707-822-8018
E-mail: mandre@arcatacityhall.org

Manages and restores Arcata's community forests, streams, wetlands, and natural areas. Directs Adopt-A-Stream program; riparian restoration work; water treatment marshes. Restoring estuary habitat in Jacoby and Janes Creek watersheds.

City of Arcata Environmental Services Humboldt Bay Shellfish TAC

Julie Neander
736 F Street
Arcata, CA 95521
Phone: 707-825-2151
Fax: 707-825-2158
E-mail: jneander@arcatacityhall.org

Advise and assist the regional water quality control board in developing strategies to reduce water pollution affecting shellfish growing areas.

City of Eureka Community Development Services

Joel Canzoneri
531 K Street
Eureka, CA 95501
Phone: 707-441-4163
Fax: 707-441-4138

Facilitates City development projects through permitting processes, interacting with affected reviewing agencies, and developing and implementing wetland mitigation plans.

Coastal Stream Restoration Group

Curtis Ihle
53 Kingston Road
Fieldbrook, CA 95519
Phone: 707-839-8238
E-mail: curtisihle@yahoo.com

Implements erosion control, bank stabilization, riparian and instream restoration projects.

Diane Higgins Environmental Educational Consultant

Diane Higgins
4649 Aster Road
McKinleyville, CA 95519

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Phone: 707-839-4987

Fax: 707-442-8823

Environmental education consultant. Wrote much of the fisheries curriculum that is used in elementary schools.

Assessment methodology classifies coastal California watersheds & streams for restoration priority. Aquatic Field Protocols handbook.

Douglas Parkinson and Associates

Douglas Parkinson
890 L St.
Arcata, CA 95521
Phone: 707-826-0844
Fax: 707-822-8842
E-mail: dpa@humboldt1.com

Fisheries Focus

Paula Yoon
1686 Old Arcata Road
Bayside, CA 95524
Phone: 707-822-3577
Fax: 707-269-2630
E-mail: pfyoon@sprintmail.com

Fisheries work throughout the western United States, including stream investigations, monitoring, and habitat typing. Trains field crews.

Public education specialist for watershed management, fisheries habitat and socioeconomics. Certified Mediator for natural resources issues.

Environmental Protection Information Center (EPIC)

P.O. Box 397
Garberville, CA 95542
Phone: 707-923-2931
Fax: 707-923-4210
E-mail: epic@wildcalifornia.org
Website: www.wildcalifornia.org

Fisherman's Marketing Association

Peter Leipzig
320 Second Street
Eureka, CA 95501
Phone: 707-442-3789
Fax: 707-442-9166
E-mail: fma@trawl.org

Information and resource center. Organizes and litigates to protect Headwaters forest. Supports local environmental activists in Humboldt and Mendocino counties.

Largest fisheries marketing association in the U.S. Conducts research for industrial fisheries management.

Environmental Restoration Services

Matt Smith
30,000 Highway 299
Blue Lake, CA 95525
Phone: 916-719-5696
Fax: 707-668-4171

Freshwater Farms

Rick Storre
5851 Myrtle Avenue
Eureka, CA 95503
Phone: 707-444-8261
Fax: 707-442-2490
E-mail: rick@freshwaterfarms.com

Design and construction of instream structures, and erosion control. Backhoe and excavator service. State license and Fish Habitat Restoration license.

Native plant nursery focusing on wetland and riparian ecosystems. Native seed collection and seed bank; contract growing. Wetland Education Center and wetland delineation services.

Fish Farm and Forest Communities Forum Technical Committee

Gary Rynearson
P.O. Box 1247
Eureka, CA 95502
Phone: 707-442-1735

Freshwater Watershed Working Group

Jan Kraepelin
E-mail: jankrpln@humboldt1.com

Dedicated to the preservation of environmental quality, with a focus on landowner education, habitat enhancement and impacts of upslope land management practices.

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Friends of the Dunes Preserve

Carol Vander Meer
P.O. Box 186
Arcata, CA 95518
Phone: 707-444-1397
Fax: 707-444-1397
E-mail: fod@arcatanet.com
Website: www.friendsofthedunes.org

Environmental education includes docent-led walks, field trips, lectures, presentations. Conducts exotic plant control measures and removal projects.

Graham Matthews & Associates (GMA)

Graham Mathews
PO Box 1516
Weaverville, CA 96093
Phone: 530-623-5327
Fax: 530-623-5328

Specializes in hydrologic and hydraulic data collection and analysis, geomorphology, stream restoration design with over 17 years experience.

Humboldt Bay Harbor, Recreation and Conservation District

David Hull
P.O. Box 1030
Eureka, CA 95502-1030
Phone: 707-443-0801
Fax: 707-443-0800

Oversees and coordinates various uses of Humboldt Bay including dredging, shipping, mariculture, recreation and conservation. Two meetings per month.

Humboldt Bay Municipal Water District

Carol Rische
828 Seventh Street
Eureka, CA 95501
Phone: 707-443-5018
Fax: 707-443-5731

Water facility located on the Mad River; therefore involved with management of Mad River watershed. Provides water for the Humboldt Bay region, including Arcata and Eureka.

Humboldt Bay Stewards

Maggy Herbelin, Chair
2619 Ridgeway Lane
Eureka, CA 95501
Phone: 707-445-2401
Email: herbelin@tidepool.com

Education, outreach and advocacy for sustainable development of Humboldt Bay's natural, economic, social, cultural, and human resource capital.

Humboldt County Community Development Department

Kirk Girard, Director
3015 H Street
Eureka, CA 95501
Phone: 707-445-7541
Fax: 707-445-7446
Email: kgirard@co.humboldt.ca.us
Website: www.co.humboldt.ca.us/planning

Land use planning and zoning. Ensures implementation of Humboldt County General Plan and orderly growth and development. Currently updating General Plan 2025.

Humboldt County Farm Bureau

Katherine Ziemer
5601 S. Broadway
Eureka, CA 95503
Phone: 707-443-4844
Fax: 707-443-0926
E-mail: humboldtffb@aol.com

Voluntary, non-governmental organization of rural ranch families, local businesses, and concerned citizens seeking solutions to social and economic challenges. Assists with cooperative resources management.

Humboldt County Resource Conservation District (HCRCD)

5630 S. Broadway
Eureka, CA 95503
Phone: 707-444-9708
Fax: 707-442-7514

Facilitates funding of habitat restoration projects; watershed development plans; provides landowner assistance with TMDLs, permitting, and ranch management plans.

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Humboldt Fish Action Council

Doug Kelly
P.O. Box 154
Eureka, CA 95502
Phone: 707-269-0488-office
707-441-1581-trapping/rearing facility
Fax: 707-269-0489
E-mail: dkelly@reninet.com

25 years experience in cooperative resource planning, habitat restoration, and monitoring of Humboldt Bay tributaries. Fish rearing facility on Freshwater Creek. Landowner outreach. Volunteer program.

Humboldt State University (HSU) Department of Fisheries

Terry Roelofs
Humboldt State University
Arcata, CA 95521
Phone: 707-826-3344
Fax: 707-826-4060
E-mail: tdrl@axe.humboldt.edu

Specializes in biology and habitat requirements of salmonids. Numerous research studies with students throughout Northcoast watersheds. Community education/outreach.

HSU Department of Forestry

Larry Fox
Humboldt State University
Arcata, CA 95521
Phone: 707-826-4280

Specializes in GIS and satellite imagery. Currently conducting a large wildlife habitat mapping project in central California.

HSU Department of Wildlife

Rick Botzler
Humboldt State University
Arcata, CA 95521
Phone: 707-826-3724
Fax: 707-826-4060
E-mail: rgb2@humboldt.edu

Specializes in ecology and habitat requirements of birds, cervids, and furbearers, plus wildlife diseases.

Numerous research studies with students throughout Northcoast. Community education presentations.

Humboldt Watershed Council

Mark Lovelace
Humboldt Watershed Council
(707) 822-1166
sheds@humboldt1.com
Website: www.humboldt1.com/~sheds/

Works to protect resources of Humboldt County watersheds through education, active involvement in political processes, advocacy, and legal action when necessary. Member supported non-profit organization.

Humboldt Water Resources

Laura Kadlecik and Mike Wilson
PO Box 165
Arcata, CA 95518
Phone: 707-826-2869
Fax: 707-826-2869
E-mail: water@humboldt1.com

Consulting firm specializing in watershed management, wetlands and range land rehabilitation, and agricultural wastewater treatment.

Institute for River Ecology

Dana McCanne
Institute for Forest and Watershed Management
Humboldt State University
1 Harpst St
Arcata, Ca 95521
(707) 825-7350 x3

Conduct research and monitoring for salmonid abundance throughout northern California, Develop and test regional sampling designs for salmonid population estimation.

Jacoby Creek Land Trust

Susan Ornelas
P.O. Box 33
Bayside, CA 95524
Phone: 707-822-0900
E-mail: jclandtrust@yahoo.com

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Protection of land and resource values in the Jacoby Creek watershed for resource, scientific, historic, agricultural, and recreational purposes. Help landowners establish conservation easements.

Jacoby Creek Watershed Protection Association

Liz Finger
P.O. Box 6
Bayside, CA 95524
Phone: 707-826-0128

Monitors land use activity plans for Jacoby Creek watershed, including timber harvest plans, subdivisions, development, and road building. Propose modifications as necessary.

Jeff Anderson Engineering

Jeffrey K. Anderson
P.O. Box 841
Arcata, CA 95518-0841
Phone: 707-822-9252
Fax: 707-822-9252
E-mail: jkaengr@humboldt1.com

Assesses hydrology, hydraulics, and water quality of watersheds, wetlands, and surface waters. Develops management and restoration plans for these systems. Active in estuary restoration planning.

Jon Lee Consulting

Jonathon Lee
2250 Wilson Street, Apt. C
Arcata, CA 95521
Phone: 707-826-1641
Fax: 707-822-8516
E-mail: jlee@humboldt1.com

Aquatic macroinvertebrate collection, processing and analysis to establish baseline data and determine degradation or recovery of running water habitats.

Karuk Tribe

Dept. of Natural Resources
Leaf Hillman or Harold Tripp
P.O. Box 282
Orleans, CA 95556
Phone: 530-627-3446 or 627-3440
Fax: 530-627-3448

Watershed restoration; road decommissions; erosion control. Instream structures; stream surveys; water quality testing and temperature monitoring. Fish hatchery.

Keith Barnard Consulting

Keith Barnard
P.O. Box 951
Blue Lake, CA 95525
Phone: 707-668-5843

Environmental planning for river systems, including Eel River, Trinity River, and Mad River. Gravel mining issues, geomorphology, total station and computer mapping.

LACO Associates

Frank Bickner
P.O. Box 1023
Eureka, CA 95502
Phone: 707-443-5054
Fax: 707-443-0553
E-mail: lacoassoc@northcoast.com

Environmental, geology and engineering consulting for water quality, surface, geomorphic and groundwater hydrologic studies. Erosion control systems. Construction management services.

Legacy - The Landscape Connection

Curtis Jacoby
P.O. Box 59
Arcata, CA 95518
Phone: 707-825-8582
Fax: 707-826-9408 (call first)
E-mail: legacy@legacy-tlc.org

Working to devise a landscape-level biodiversity conservation strategy. Building a regional geographic information system.

Manila Community Services District

Manila Dunes Access Area

Beverly Prosser
1901 Park Street
Manila, CA 95521
Phone: 707-445-3309
Fax: 707-445-3309 (call first)

Focus is protection and enhancement of Manila's beach and dunes. A collaborative project to restore the

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

dune ecosystem provides work for disadvantaged youth.

McBain and Trush

Scott McBain or Bill Trush
P.O. Box 663
Arcata, CA 95518
Phone: 707-826-7794

Assesses impacts of regulated flows on river ecosystems. Includes monitoring, education, geomorphology analyses, and gravel mining recommendations. International scope.

MFG, Inc.

Steven Levesque
1165 G Street, Suite E
Arcata, CA 95521-5817
Phone: 707-826-8430
Fax: 707-826-8437

National environmental consulting firm.

Michael Love & Associates

Michael Love
1660 Central Ave.
McKinleyville, CA 95519
Phone: 707-839-7687
E-mail: mlove@northcoast.com

Specializes in providing hydrologic and hydraulic analysis for natural resources management used for road and culvert assessments, effectiveness monitoring of stream crossings for fish passage, and flow frequency analysis for fish passage design.

N.O.A.A. Fisheries Service

Greg Bryant
1655 Heindon Rd.
Arcata, CA 95521
Phone: 707-825-5162
Fax: 707-825-4840
E-mail: greg.bryant@noaa.gov

Responsible for Section 4 listings, critical habitat designations, and recovery planning for coho and chinook salmon, steelhead, and coastal cutthroat trout in California.

Natural Resources Management Corp.

Gary Rynearson or Dennis Halligan

1434 3rd St. / P.O. Box 1247
Eureka, CA 95502
Phone: 707-442-1735
E-mail: fish@nrmcorp.com

Environmental consulting focusing on forest management. Includes fisheries, wildlife, and botanical surveys, watershed analysis, road inventories, and restoration plans.

Natural Resources Services

Redwood Community Action Agency

Sungnome Madrone or Ruth Blyther
904 G Street
Eureka, CA 95501
Phone: 707-269-2066
Fax: 707-445-0884
E-mail: nrs@rcaa.org; Website: www.rcaa.org

Non-profit specializing in natural resources restoration design, planning and construction; outreach; education and community development.

North Coast Earth First!

PO Box 28
Arcata, CA 95518
Phone: 707-825-6598
Fax: 707-825-7996
E-mail: ncef@humboldt1.com
Website: www.humboldt1.com/~ncef/

Uses nonviolent civil disobedience to save the last unprotected tracts of ancient coast redwood forests in the Humboldt County / Klamath / Siskiyou bioregion.

Northcoast Environmental Center

Tim McKay
879 Ninth Street
Arcata, CA 95521
Phone: 707-822-6918
Fax: 707-822-0827
E-mail: nec@igc.org
Website: www.necandeconews.to

Leading Northcoast environmental organization. Public information and referral center, with comprehensive library. Reviews THPs; litigates. Monthly newspaper ó Econews.

Pacific Coast Federation of Fishermen's

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Associations Habitat Office

Glen Spain, Northwest Regional Coordinator

P.O. Box 11170

Eugene, OR 97440-3370

Phone: 541-689-2000

Fax: 541-689-2500

E-mail: fish1lfr@aol.com

Website: www.pond.net/~pcffa

Addresses a wide range of habitat issues, including water policies, flows, and diversions. Projects funded through PCFFA, Salmon Stamp and other sources.

Pacific Coast Joint Venture

Ron LeValley

Address: 1497 Central Avenue

McKinleyville, CA 95519

Phone: 707-839-0900

E-mail: ron_levalley@pcjv.org

Website: <http://northamerican.fws.gov/jvdir.html>

Local steering committee for federal North American Waterfowl Plan. Local steering committee for federal North American Waterfowl Plan. Plans acquisitions and develops habitat and waterfowl projects for funding.

Pacific Coast Fish, Wildlife & Wetlands Restoration Association (PCFWWRA)

Mitch Farro

P.O. Box 4574

Arcata, CA 95518

Phone: 707-839-5664

Fax: 707-839-5664

Fisheries, wildlife and wetlands habitat restoration throughout Northcoast counties. Habitat typing; instream structures; hatch box programs; roads inventories and removals.

Pacific Dunes High School

Science Department

1611 Peninsula Drive

Manila, CA 95521

Phone: 707-444-8532

Private school in Manila. Special programs for environmental education. Use dunes for outdoor classroom and individual projects.

Pacific Lumber Company

Jeff Barrett

P.O. Box 37

Scotia, CA 95565

Phone: 707-764-4408

Fax: 707-764-4400

E-mail: barrett@scopac.com

Owns 200,000 acres of industrial forestland in Humboldt County. Watershed assessment and monitoring in Humboldt Bay watersheds.

Pacific Watershed Associates

Danny Hagans or Bill Weaver

P.O. Box 4433

Arcata, CA 95518

Phone: 707-839-5130

Fax: 707-839-8168

E-mail: pwa@northcoast.com

Provides erosion and sedimentation consulting. Developed roads/erosion inventory system for identifying and prioritizing sediment sources. Geomorphic and hydrologic studies.

Patrick Higgins Consulting Fisheries Biologist

Patrick Higgins

791 Eighth Street, Suite N

Arcata, CA 95521

Phone: 707-822-9428

Fax: 707-822-5702

E-mail: phiggins@humboldt1.com, krisweb.com

Monitoring and assessment of fisheries populations and habitat. Development of Klamath Resources Information System (KRIS) GIS database.

Redwood Regional Watershed Center

1686 Old Arcata Road,

Bayside, CA 95524

707-822-3577

Focuses on education, research and interpretation of watershed-based management; engages in support for decentralization

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

of state and federal watershed initiatives to the local regional level.

Salmon and Steelhead Recovery Coalition

Richard Giengier
P.O. Box 286
Whitethorn, CA 95589
Phone: 707-923-2931
E-mail: rgrocks@humboldt.net

Educates citizens regarding environmental issues and habitat concerns. Works to protect and restore forests and watersheds of the Upper Mattole River.

Salmon Forever

Clark Fenton and Jesse Noell
1658 Ocean Drive
McKinleyville, CA 95519
Phone: 707-839-7444
Fax: 707-839-7447
E-mail: clarkstr@humboldt1.com

Research and collection of monitoring data to enable enlightened debate on issues related to salmon, forest and watershed health.

Salmon Troller's Advisory Committee Commercial Salmon Stamp

Jimmy Smith
6367 Purdue Drive
Eureka, CA 95501
Phone: 707-443-0108

Commercial Salmon Stamp is a self-imposed tax on the local salmon fishery for increase of salmon populations. Funds salmonid rearing facilities, habitat restoration, and education.

Salmonid Restoration Federation

Dana Stoltzman
P.O. Box 784
Redway, CA 95560
Phone: 707-223-1770
E-mail: srf@northcoast.com

Salmonid Stream Habitat Field School offers courses in watershed and stream habitat restoration and protection. Annual statewide California Salmonid Restoration Conference.

Scientific Advisory Committee for Estuarine Research (SACER)

Andrea Pickart
6800 Lanphere Road
Arcata, CA 95521
Phone: 707-822-6378
Fax: 707-822-6378 (call first)
E-mail: andrea_pickart@fsw.gov

Facilitate and coordinate research on Humboldt Bay.

SHN Consulting Engineers & Geologists

David Imper
812 W. Wabash
Eureka, CA 95501
Phone: 707-441-8855
Fax: 707-441-8877
E-mail: dimper@shn-eng.com

Environmental consulting focusing on CEQA/ NEPA documentation, wetlands delineation, rare plant surveys, native plant mitigation planning, and watershed restoration planning.

Sierra Club Redwood Chapter, North Group

Diane Beck
P.O. Box 238
Arcata, CA 95518
Phone: 707-268-3200
Fax: 707-443-1139 (call first)
E-mail: jkaufman@igc.org

Lobbies for protection and conservation of wildlife and other natural resources, at local and national levels. Political campaign endorsements. Local outings and lectures.

Sierra Pacific Industries

Bill Blackwell
P.O. Box 1189
Arcata, CA 95518
Phone: 707-443-3111
Fax: 707-442-4954

Owns 50,000 acres of forestland in Humboldt County. Involved in habitat restoration in South Fork Trinity River, Van Duzen River, Redwood Creek, and Maple Creek

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Green Diamond Resource Company

Bernard Bush
PO Box 68
Korbel, CA 95550
Phone: 707-668-4483
Fax: 707-668-4402

Owens 265,000 acres of industrial forestland in Humboldt County. Conducts watershed assessment and monitoring in 16 watersheds, tributaries of Redwood Creek, Klamath River, Mad River and Humboldt Bay. Conducts watershed enhancement projects in conjunction with timber harvests, such as road maintenance and decommissioning. Has a history of working cooperatively with local restoration groups.

Six Rivers Trout Unlimited

Doug Kelly
P.O. Box 129
Bayside, CA 95524
Phone: 707-822-3826
Fax: 707-822-8481

Focus is protection and enhancement of native trout populations. Local group activities include stream restoration, riparian planting, hatch box programs, and public education.

South Bay School Wetlands Learning Center

6077 Loma Avenue
Eureka, CA 95503
Phone: 707-443-4828
Fax: 707-443-3690
E-mail: hborickard@cs.com
Web site: www.humboldt.k12.ca.us/sobay_sd/district/

Description: Ecological restoration and monitoring educational project for the freshwater marsh called South Bay Wetland.

Spencer Engineering

Scott Kelly
1933 Central Avenue, Suite 3
McKinleyville, CA 95519
Phone: 707-498-9246
Fax: 707-839-4012

E-mail: spencer@humboldt1.com

Water quality monitoring and sampling plans; standards and criteria; hydrologic and hydraulic analyses; flood hazard mitigation; bank protection plans.

Table Bluff Reservation Wiyot Tribe

Cheryl Seidner
1000 Wiyot Dr.
Loleta, CA 95551
Phone: 707-733-5055
Fax: 707-733-5601
E-mail: wiyotone@yahoo.com

Manages Wiyot tribal lands near Loleta. Developing a 20-acre area with wetlands to grow and harvest materials used in historic Wiyot cultural practices, including basketry.

U.S. Army Corps of Engineers Eureka Project Office

David Ammerman
P.O. Box 4863
Eureka, CA 95502
Phone: 707-443-0855
Fax: 443-7728
E-mail: dammerman@smtp.spd.usace.army.mil

Agency charged with the protection of the nation's waterways. Issues permits required for activities in wetlands or waterways of the U.S. Implements flood control projects.

U.S. Bureau of Land Management

Dan Averill
1695 Heindon Road
Arcata, CA 95521
Phone: 707-822-2300
Fax: 707-825-2301

Manages BLM lands for multiple use, including the Headwaters Forest Reserve, King Range/Lost Coast, and Manila Dunes. Involved in cooperative partnerships with local citizen groups.

U.S. Bureau of Land Management

Lynda Roush
1695 Heindon Road

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Arcata, CA 95521
Phone: 707-825-2300
Fax: 707-825-2301
E-mail: lroush@ca.com.gov

Cooperative watershed analyses, restoration planning, and project implementation on BLM lands, primarily in Mattole River, South Fork Eel River, and Lacks Creek basins.

U.S. Farm Service Agency

Katie Delber
5630 S. Broadway
Eureka, CA 95503
Phone: 707-442-6058 ext. 2
Fax: 707-442-7514
E-mail: katie.delber@ca.usda.gov

Administers environmental, conservation and farm production adjustment programs to assist farmers and landowners in protecting, enhancing, and wisely using natural resources.

U.S. Fish and Wildlife Service

Andrea Pickart
6800 Lanphere Road
Arcata, CA 95521
Phone: 707-822-6378
Fax: 707-822-6378 (call first)
E-mail: andrea_pickart@fsw.gov

International, non-profit group purchases and manages critical and unique habitats. Conducts scientific research of ecosystems on lands under its management.

U.S. Fish and Wildlife Service Humboldt Bay National Wildlife Refuge

Eric Nelson
1020 Ranch Road
Loleta, CA 95551
Phone: 707-733-5406
Fax: 707-733-1946
E-mail: eric_t_nelson@fws.gov

Manages 9,500 acres around Humboldt Bay. Includes habitat restoration, cooperative grazing program, wildlife management, hunting, interpretive trails, and research. Salmon Creek estuary restoration project to be implemented 2005.

U.S. Fish and Wildlife Service Coastal California Fish and Wildlife

Paula Golightly
1655 Heindon Rd.
Arcata, CA 95521
Phone: 707-822-7201
Fax: 707-822-8136
E-mail: paula_golightly@fws.gov

Administers "Partners in Wildlife" Watershed Restoration program. Projects are selected for funding and implemented on private lands.

U.S. Fish and Wildlife Service Coastal California Fish and Wildlife Office

Bruce Halstead
1655 Heindon Rd.
Arcata, CA 95521
Phone: 707-822-7201
Fax: 707-825-4840
E-mail: bruce_g_halstead@fws.gov

Enforces Endangered Species Act for marbled murrelets and northern spotted owls. Involved in review and approval of Habitat Conservation Plans.

U.S.F.S. PSW Redwood Sciences Lab Watershed Division

Tom Lisle or Brett Harvey
1700 Bayview Drive
Arcata, CA 95521
Phone: 707-825-2930
Fax: 707-825-2901
E-mail: tel7001@humboldt.edu

Researches watershed processes including erosion, sedimentation, and stream channel dynamics. Also fisheries biology and habitat assessments.

U.S.F.S. PSW Redwood Sciences Lab Wildlife Division

Hart Welsh
1700 Bayview Drive
Arcata, CA 95521
Phone: 707-825-2956
Fax: 707-825-2901
E-mail: hwelsh@fs.fed.us

APPENDIX B

CONTACT LIST FOR HUMBOLDT BAY WATERSHED

Monitors wildlife populations on private, state, and National Forest lands. Studies habitat associations and impacts of land management practices.

U.S. Natural Resources Conservation Service

Tom Hedt
5630 S. Broadway
Eureka, CA 95503
Phone: 707-444-9708
Fax: 707-442-7514
E-mail: thomas.hedt@ca.usda.gov

Offers technical assistance aimed at helping landusers protect, enhance and wisely use soil, water, and other natural resources. Funding, incentive programs, and education.

University of California Cooperative Agricultural Extension

Yana Valachovic, Forest Advisor
Gary Markegard, Agriculture & Ranch Advisor
5630 S. Broadway
Eureka, CA 95503-6999
Phone: 707-445-7351
Fax: 707-444-9334
E-mail: yvala@co.humboldt.ca.us;
ggmarkegard@ucdavis.edu

Extension Forest Advisor. Provides technical assistance and information resources to land owners, local agencies, and timber producers. Klamath Bioregional Council organizer.

U.C. Sea Grant Extension Program

Susan Schlosser
2 Commercial Street, Suite 4
Eureka, CA 95501
Phone: 707-443-8369
Fax: 707-445-3901
E-mail: scmcbride@ucdavis.edu

Provides technical assistance to people involved in fishing and aquaculture. Conducts aquaculture research. Organizes workshops and educational forums.

Washington Elementary School

Jeff Self
3322 Dolbeer Street

Eureka, CA 95503
Phone: 707-441-2547
Fax: 707-441-3323
E-mail: jself@humboldt1.com

Fisheries education program. Salmon incubation and rearing program in the classroom.

Winzler and Kelly Consulting Engineers

633 Third Street
Eureka, CA 95501
Phone: 707-443-8326
Fax: 707-444-8330

Watershed evaluation; resource monitoring; project design. Specialize in wetlands delineation and mitigation, stream investigations, and erosion control.

APPENDIX C. Next Steps

The SSCP provides a foundation for development of site specific restoration and protection projects. In its current form it is not a detailed strategic plan that provides information on who, what, where, how for site specific projects. HBWAC has specified the long term goals that were acceptable to all interest groups represented. The SSCP was developed as a guide for future restoration and HBWAC will work to ensure it is utilized by the many diverse entities currently involved in restoration and conservation efforts throughout the watershed.

As funding and new information allows, HBWAC will work in cooperation with restoration, land management, community and government entities to ensure implementation of the SSCP objectives and movement towards obtaining the long term goals. This will include continuing to assist pilot project start up, facilitate coordination between entities, and building resource for a more comprehensive watershed restoration program. HBWAC will also update and improve the Humboldt Bay Watershed SSCP-creating new iterations and implementing watershed-wide planning, data management, education and socioeconomic objectives.

The following is a list of improvements and next steps for the next iteration. The list includes comments to the draft that HBWAC received, but could not incorporate in this final draft due to funding restraints.

1. Develop a detailed implementation or “Strategic Plan” from the Goals and Objectives, with prioritized restoration sites, tasks, timelines, and estimated costs. This was started as part of the RCAA contract with State Coastal Conservancy by developing six priority riparian restoration projects and six priority technical studies.
2. Develop the Ryan Creek watershed chapter, as a unique watershed chapter from Freshwater Creek.
3. Add more detailed information to the Salmon Creek watershed background chapter. This was not a focus of current funding as were Jacoby, Freshwater and Elk.
4. Add a more detailed analysis of the social and economic factors of timber harvest, salmonid populations, rural development, agriculture, and restoration fiscal costs and benefits.
5. Add more detail for each goal and objective such as the purpose, how they will improve habitat, how they are to be achieved, the purpose, effect, and expected outcomes.

6. Coordinate with researchers, including graduate students, to implement priority studies in the watershed.
7. Continue to coordinate with other planning efforts such as the Humboldt County General Plan Update, the Humboldt Bay Management Plan, the California Coho Recovery Strategy, Elk River and Freshwater TMDLs, The Nature Conservancy Aquatic Conservation Strategy for California North Coast Region, and federal salmonid recovery plans.