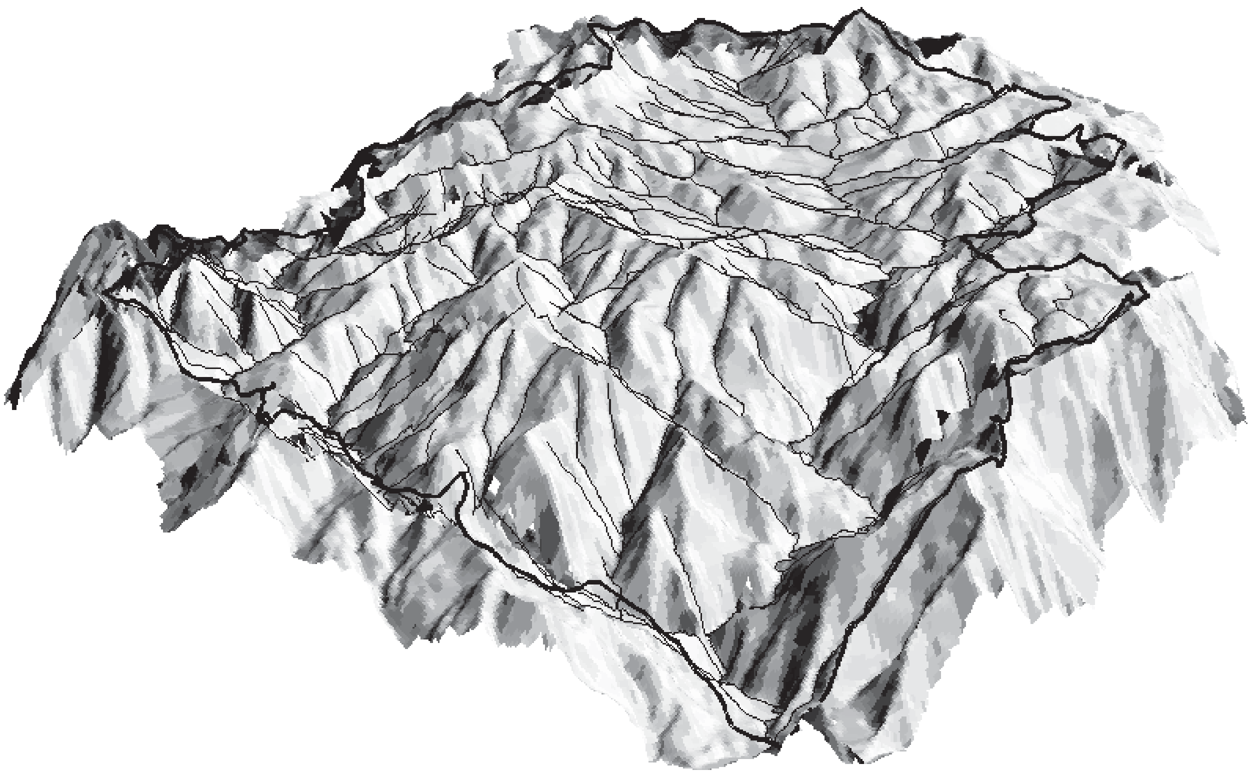
Butter Creek Watershed Analysis



United States Department of Agriculture

Forest Service

Pacific Southwest Region

Hayfork Ranger District
Shasta-Trinity National Forests
Klamath Province

COVER:

This image, viewed from the northwest, is a 10 meter panchromatic SPOT image draped over a 3D Digital Elevation Model of the Butter Creek Watershed. The viewing angle is approximately 30°.

Executive Summary

The intent of Watershed Analysis is to develop and document a scientifically based understanding of the processes and interactions occurring within a watershed. This understanding, which focuses on specific issues, values, and uses within the watershed, is essential for making sound management decisions. Watershed Analysis thus provides the opportunity to restore, protect and sustain natural ecosystems by achieving an acceptable balance between commodity production and sound biological sustenance within a watershed (USDA FS, USDI BLM, 1994b).

In early 1994, the Shasta-Trinity National Forests identified the Butter Creek watershed of the South Fork Trinity River basin, a Key Watershed, as its "pilot" area for watershed analysis. Forest Service and other agency personnel were organized into an interdisciplinary team with the purpose of analyzing, documenting, and publishing a scientific analysis concerning the complex inter-relationships between the geology, soils, hydrology, fisheries and wildlife, landscape ecology, vegetation communities, natural disturbance processes (fires, floods, earthquakes, forest insects and pathogens) and human values within the Butter Creek watershed.

The combined efforts of this interdisciplinary team has culminated in this publication which addresses the eight step process outlined in "A Federal Guide for Pilot Watershed Analysis" (FEMAT, 1994). The Butter Creek Watershed Analysis summarizes the accumulation of years of field data and personal knowledge into a single document designed to assist the local line officer (District Ranger) in appropriately managing the natural resources of the watershed to not only renew and sustain its ecological functions, but also for the enjoyment and use by the neighboring human populace.

Briefly, this document captures information on the current conditions of the watershed while exploring through time an indepth review and analysis of the natural variability and disturbance regimes affecting or impacting the ecosystem functioning and well-being of the Butter Creek watershed. Based on the subjective knowledge of the team's professionals and current Forest Service ecosystem management emphasis guidelines, this document further focuses on the desired watershed conditions which the Forest Service would manage towards attainment in 50 to 100 years. The document addresses the team's key findings and management recommendations for implementation aimed at restoring the Butter Creek watershed to ecological function as a resilient, sustainable ecosystem.

More specifically, Chapter I is primarily devoted to a description of the current environmental and social conditions existing within the confines of the Butter Creek Watershed. The chapter also contains, where appropriate, discussions of the watershed's potential conditions, e.g., carrying capacities, capabilities and potential natural communities of vegetation. Included are natural disturbance events and regimes, processes, human influences and human values. Finally, there is a list of the Key Questions developed for the Butter Creek ecosystem. The Key Questions were formulated utilizing an interdisciplinary process and drive the Watershed Analysis.

Chapter II of the Butter Creek Ecosystem Story describes the distribution, type and relative importance of environmental processes. Included is a description of the landscape and the mechanisms by which environmental changes have occurred over time. Land use activities which have generated change are examined for magnitude and trend.

This chapter attempts to define the natural range of variability for the different resources and processes. The strategy of this Watershed Analysis is to first determine the natural range of variability and then assess current status of the key elements. From these, recommendations are provided for restoration where current conditions are not within natural ranges and maintenance where they are. Since natural disturbance regimes are the most important causal agents in variability of characteristics of key ecological elements, an understanding of their timing, spatial patterns and magnitude is essential to the analysis.

This chapter describes natural disturbance regimes operating in the Butter Creek watershed and ranges of variability for key elements through time, from the formation of the Klamath Mountains to the present. The reliability, applicability and precision of the information to Butter Creek increases in the time periods nearest to the present. The Native American Age provides a glimpse of natural ranges that reflect low levels of human caused disturbance in a climatic regime similar to that of today.

Four different time-frames were evaluated and are discussed in this chapter. These include the Geologic Age (400 million years before present to 10,000 years before present), the Native American Age (10,000 years ago to 1840), the European Settlement Age (1840 to 1950) and the Modern Age (1950 to 1994).

Chapter III is written in three parts: the first part a description of beneficial uses and values, including present condition in relationship to associated values and uses, the second part is a listing of Desired Future Conditions; the third part is a narrative description of the future conditions and trends the team anticipated to occur.

Chapter IV captures the essence of the analysis. The intent of the first section of this chapter is to integrate the recommendations which were made in this chapter, and to define specifically what practices, analyses and activities should occur and where they should be performed. This section is meant to be the “core” recommendations of the team. The second objective of this chapter is to present Key Findings. These findings have already been presented in the previous chapters, however we wanted to highlight what we believed were the key outcomes of this Watershed Analysis. A third objective is to identify areas of concern and to make recommendations for site analysis, project initiation and locations needing treatment. The final objective of the chapter is to document non-resolvable key questions and to discuss data gaps.

Butter Creek Interagency/Interdisciplinary Team

Interdisciplinary Team:

Karyn Wood .... District Ranger, Hayfork Ranger District
Don Haskins .... Team Leader, Writer/Editor, Forest Geologist, Shasta-Trinity National Forests
Sheila Logan .... Terrestrial Group Leader, Editor, Zone Ecologist, Mendocino and Shasta-Trinity National Forests
Darrel Ranken .... Aquatic Group Leader, Forest Hydrologist, Shasta-Trinity National Forests

Core Team:

Jane Bardolf .... District Biologist, Hayfork Ranger District
Maria Boroja .... Wildlife Biologist, USDI Fish and Wildlife Service, Sacramento Field Office
Bill Brock .... Fisheries Biologist, USDI Fish and Wildlife Service, Trinity River Basin Field Office
Sherry Chilcott .... District Archaeologist, Hayfork Ranger District
Paula Crumpton .... Forest Wildlife Biologist, Shasta-Trinity National Forests
Yvonne Everett .... Landscape Ecologist, U.C. Berkeley
Ann Garland .... Deputy Fire Management Officer, Shasta-Trinity National Forests
Richard Irizarry .... Forest Fisheries Biologist, Shasta-Trinity National Forests
Jim Komar .... Soil Conservationist, USDA Natural Resources Conservation Service, Weaverville Field Office
Bob Mobley .... Information Systems Management, Shasta-Trinity National Forests
Ken Smith .... Writer/Editor, Resource Officer, Shasta Lake Ranger District
Mark Stevens .... Transportation Planner, Trinity Zone, Engineering
John Veevaert .... District Hydrologist, Big Bar and Weaverville Ranger Districts

Extended Team:

Patty Aberg .... GIS Analyst, Shasta-Trinity National Forests
Paula Anderson .... Ecologist, Shasta-Trinity National Forests
Dan Angello .... Planning Forester, Shasta-Trinity National Forests
Anna Arnold .... Planning Officer, Hayfork Ranger District
Richard Baron .... GIS Analyst, VESTRA Resources, Inc.
Melinda Carlson .... Ecologist, Shasta-Trinity National Forests
Gary Chase .... Hydrologic Technician, Graphics and Desktop Publishing, Shasta-Trinity National Forests
Ann Chrisney .... Wildlife Biologist, USDI Fish and Wildlife Service, Sacramento Field Office
Bill Clark .... Fuels Specialist, Hayfork Ranger District
George Cruz .... District Hydrologist, Yolla Bolla Ranger District
Gregg DeNitto .... Pathologist, Shasta-Trinity National Forests
Heidi Dias .... Wildlife Biologist, Shasta-Trinity National Forests
Jan Fox .... GIS Analyst, Shasta-Trinity National Forests
Michelle Gilroy .... Fisheries Biologist, Hayfork Ranger District
Karol McGuire .... GIS Analyst, Shasta-Trinity National Forests
Julie Nelson .... Forest Botanist, Shasta-Trinity National Forests
Sue Pappalardo .... Botanist, Shasta-Trinity National Forests
Vivian Parker .... Botanist, Final Edits, Shasta-Trinity National Forests
Dave Schultz .... Entomologist, Shasta-Trinity National Forests
Wayne Steffes .... Civil Engineer, Shasta-Trinity National Forests
Rich Teixeira .... Minerals Geologist, Klamath Province, USDA Forest Service

Dedication

As we come to the end of this long and bittersweet journey, the Butter Creek Team dedicates our work to three friends who made our road less rocky and our journey more enjoyable:

To **Bill Shands**, our mentor, who taught us to build a bridge of trust with the community,

To **Sharon Lingemann**, our friend, whose honesty, enthusiasm and eagerness to learn was an inspiration, and

To **Ken (Snuffy) Smith**, our colleague, who good naturedly kept us organized and on-target.

Watershed Analysis is an iterative process which never ends. Therefore, it must be emphasized that this is a dynamic document. Some sections of the document are relatively brief and somewhat incomplete compared to other sections. As more information becomes available, and if there is a need, those sections will be updated.

Table of Contents

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

Table of Contents (continued)

List of Figures

Chapter I

List of Tables

Chapter I

Chapter II

Chapter IV

List of Plates

Chapter I

Chapter II

Chapter IV

Butter Creek Ecosystem Story

Introduction

The intent of this report is to document a Watershed Analysis performed by an interagency, interdisciplinary team of scientists for the Butter Creek Watershed, located on the Hayfork Ranger District, in the Shasta-Trinity National Forests.

Background

In April 1993, President Clinton commissioned an interagency scientific team to develop a set of alternatives for management of ecosystems within the range of the northern spotted owl. This effort culminated in the report by the Forest Ecosystem Management Assessment Team (FEMAT) entitled: "Forest Ecosystem Management: An Ecological, Economic, and Social Assessment", in July 1993 (Thomas, 1993).

The FEMAT report was utilized as a cornerstone in the development of the Final Supplemental Environmental Impact Statement (FSEIS) for "Amendments to Forest Service and Bureau of Land Management Planning Documents Within the Range of the Northern Spotted Owl". The Record of Decision (ROD) for this FSEIS was signed in April, 1994 (USDA Forest Service and USDI Bureau of Land Management, 1994b).

Due to accelerating concerns about declining fish populations, protection and improvement of aquatic and riparian ecosystems are key components of the FEMAT report. The report presents a broad strategy for maintaining or restoring the distribution, diversity and complexity of watershed and landscape-scale processes and characteristics.

A significant part of the President's Plan is the Aquatic Conservation Strategy. As defined in the ROD, there are nine objectives for the Aquatic Conservation Strategy:

1. Maintain and restore the distribution, diversity and complexity of watershed and landscape-scale features to ensure protection of the aquatic systems to which species, populations and communities are uniquely adapted.

2. Maintain and restore spatial and temporal connectivity within and between watersheds. Lateral, longitudinal and drainage network connections include floodplains, wetlands, upslope areas, headwater tributaries and intact refugia. These network connections must provide chemically and physically unobstructed routes to areas critical for fulfilling life history requirements of aquatic and riparian-dependent species.

3. Maintain and restore the physical integrity of the aquatic system, including shorelines, banks and bottom configurations.

4. Maintain and restore water quality necessary to support healthy riparian, aquatic and wetland ecosystems. Water quality must remain within the range that maintains the biological, physical and chemical integrity of the system and benefits survival, growth, reproduction and migration of individuals composing aquatic and riparian communities.

5. Maintain and restore the sediment regime under which aquatic ecosystems evolved. Elements of the sediment regime include the timing, volume, rate and character of sediment input, storage and transport.

6. Maintain and restore in-stream flows sufficient to create and maintain riparian, aquatic and wetland habitats and to retain patterns of sediment, nutrient and wood routing. The timing, magnitude, duration and spatial distribution of peak, high and low flows must be protected.

7. Maintain and restore the timing, variability and duration of floodplain inundation and water table elevation in meadows and wetlands.

8. Maintain and restore the species composition and structural diversity of plant communities in riparian areas and wetlands to provide adequate summer and winter thermal regulation, nutrient filtering, appropriate rates of surface erosion, bank erosion and channel migration and to supply amounts and distributions of course woody debris sufficient to sustain physical complexity and stability.

9. Maintain and restore habitat to support well-distributed populations of native plant, invertebrate and vertebrate riparian-dependent species.

There are four components of the Aquatic Conservation Strategy: Watershed Analysis, Riparian Reserves, Watershed Restoration and Key Watersheds.

1. **Riparian Reserves**: Lands along streams and unstable and potentially unstable areas where special standards and guidelines direct land use.
2. **Key Watersheds**: A system of large refugia comprising watersheds which are crucial to at-risk fish species and stocks and provide high quality water.
3. **Watershed Analysis**: Procedures for conducting analysis that evaluates geomorphic and ecological processes operating in specific watersheds. This analysis should enable watershed planning that achieves Aquatic Conservation Strategy objectives. Watershed analysis provides the basis for monitoring and restoration programs and the foundation from which Riparian Reserves can be delineated.
4. **Watershed Restoration**: A comprehensive, long-term program of watershed restoration to restore watershed health and aquatic ecosystems, including the habitats supporting fish and other aquatic and riparian-dependent organisms.

"Key Watersheds...serve as a system of areas to be managed to provide high quality habitat for at-risk anadromous fish stocks, bull trout and resident fish species. Key Watershed designation does not preclude regularly scheduled timber harvest and other activities. However, Watershed Analysis is required in these areas before any management activities can take place and the results of the analysis must be incorporated into the decision-making process. The exception is: in the short term and until Watershed Analysis can be completed, minor activities such as those that would be categorically excluded under the NEPA regulations (except timber harvest) may proceed, consistent with Riparian Reserve standards and guidelines." These are documented on pages C-31-38 of the ROD.

Four Key Watersheds have been designated by the ROD on the Shasta-Trinity National Forests. They are: 1) New River; 2) North Fork Trinity River; 3) Canyon Creek; and 4) South Fork Trinity River, upstream from the confluence with Hayfork Creek. The Butter Creek watershed lies within the South Fork Trinity River Key Watershed.

Watershed Analysis, as presented by the FEMAT scientists, has a broad, ecosystem management context. The concept of Watershed Analysis is embodied in the FEMAT philosophy. It is also required before new management activities can take place in specific land allocations identified in FEMAT. These include Key Watersheds, Riparian Reserves and Released Roadless Areas. Watershed analysis is a cornerstone for implementation of the FEMAT philosophy.

What is Watershed Analysis?

The FEMAT scientists drafted a reference for Watershed Analysis, "A Federal Guide for Pilot Watershed Analysis" (FEMAT, 1994), to be used for the initial wave of Watershed Analyses. Their intent is to use the procedure for the first "pilot" Watershed Analyses, then based on reviews of the Watershed Analyses, revise the guide as needed.

The Watershed Analysis process is used to develop and document a scientifically based understanding of the processes, functions and interactions occurring within a watershed in both terrestrial and aquatic ecosystems. This understanding, which focuses on specific issues, values and uses within the watershed, is essential for making sound management decisions. Protecting beneficial uses, such as those identified by the States in water quality standards and criteria under the Federal Clean Water Act, is a fundamental motivation for Watershed Analysis. Because of the linkages between headwater areas, valley floors and downstream users, watershed analyses should encompass the entire watershed; from the highest ridge to the mouth of the trunk river and include all ownerships.

There is mandate for federal land managers to analyze and manage ecosystems. Over the last 3 years, the Forest Service has moved toward an ecological approach to land management, including all components and species, in order to protect and sustain the natural systems that society depends on. To do this requires an understanding of how the requirements of various species overlap and affect one another in an area before development of a management strategy for ecosystem sustainability. Watershed Analysis provides a vehicle to efficiently identify and balance multi-species concerns. This requires an understanding of the interactions between land-use activities, natural disturbance regimes and the biological, physical and social processes and conditions within an area. Developing this understanding is the essence of Watershed Analysis.

Watershed analysis is an intermediate analysis between land management planning and project planning. Given the Desired Future Conditions, goals and objectives, management area boundaries, and standards and guidelines from Forest Plans, Watershed Analysis identifies and provides recommendations and the scientific basis for implementing Forest Plans. The results of the Watershed Analysis may show that a forest plan amendment is necessary. When this is the case, and the Forest Supervisor decides to proceed with a plan amendment, the Watershed Analysis may be used to support the NEPA analysis for the amendment (USDA, Forest Service, 1994i).

Watershed Analysis <u>is not</u> a decision process in that it does not produce a formal decision notice or record of decision as required by the National Environmental Policy Act (NEPA). Watershed Analysis is an intermediate level of analysis which derives information from larger scale plans (River Basin, Provincial, Forest, District) and which provides information to smaller scale site analyses, both of which are formal decision points under NEPA. Watershed analyses will also provide information to river basin planning and receive information from site analyses.

Watershed Analysis, and the resultant documentation of that analysis, is one of several tools the local line officer (Forest Supervisor or District Ranger) will utilize in making management decisions about the watershed and selecting projects to implement in the watershed to achieve Desired Future Conditions. Watershed analyses are never finished. They are iterative analyses which in addition to providing the line officer with results of analyses and recommendations for land management activities, also document what is known and not known about the watershed. As additional information becomes available, it is added to the Watershed Analysis file. The line officer can then use this collective information to decide on a course of action for the watershed.

Land Allocation, Management Prescriptions and Land Designations

The Record of Decision (USDA Forest Service and USDI Bureau of Land Management, 1994b) provided for a total of seven land allocation categories: Congressionally Reserved Areas, Late Successional Reserves, Adaptive Management Areas, Managed Late Successional Areas, Administratively Withdrawn Areas, Riparian Reserves and Matrix Lands. Four of these land categories are found within the Butter Creek watershed. They are as follows:

Late Successional Reserves (LSR), in combination with the other allocations and standards and guidelines, will maintain a functional, interactive, late-successional and old-growth forest ecosystem. They are designed to serve as habitat for late-successional and old-growth related species including the northern spotted owl. There are 8,115 acres of the South Fork LSR within the Butter Creek watershed.

The **Adaptive Management Area** is designed to develop, test and monitor new management approaches to integrate and achieve ecological, economic and other social and community objectives. A 900 acre portion of the Hayfork AMA lies within the Butter Creek watershed.

The **Riparian Reserves** are areas along all streams, wetlands, ponds, lakes and unstable or potentially unstable areas where the conservation of aquatic and riparian-dependent terrestrial resources receives primary emphasis. The purpose of the reserves is to protect the health of the aquatic and riparian systems and dependent species. The reserves also provide incidental benefits to upland plant communities and wildlife species. The areal extent of the Riparian Reserve will be analyzed through Watershed Analysis.

Matrix lands are all federal lands remaining outside of the other six land allocation categories. It is also the area in which most timber harvest and other silvicultural activities may occur. However, the designation of Key Watershed, as an umbrella land management emphasis over the entire Butter Creek watershed, provides for the prioritization of watershed restoration activities over all others. Activities which do not contribute to a healthy watershed are not emphasized. It is foreseen that timber harvest and silvicultural activities may be used as tools for accomplishing watershed restoration and maintaining healthy forests within the watershed, but harvest activities will not be driven solely by the desire for commodity outputs. There are over 13,450 acres of Matrix Lands within the Butter Creek watershed.

Under the draft Forest Plan (USDA Forest Service, 1993b), the following land management prescriptions lie within the Matrix Lands in the Butter Creek watershed: Riparian Management, Wildlife Management and Commercial Wood Products Emphasis.

The U.S. Fish and Wildlife Service designated critical habitat for the northern spotted owl on August 13, 1991 in a Final Rule published in the Federal Register. More recently, the U.S. Fish and Wildlife Service, USDA Forest Service, along with many other agencies, worked together to amend USDA Forest Service planning documents within the range of the northern spotted owl. The Record of Decision (USDA FS and USDI BLM, 1994b) includes this collaborative work to implement new land allocations, standards and guidelines.

With the Late Successional Reserve allocations in the ROD, many critical habitat units became part of LSRs. However, some critical habitat units did not evolve into LSRs. New consultation procedures for the northern spotted owl are currently being developed to become consistent with the ROD. The U.S. Fish and Wildlife Service may revise the need for critical habitat units following the implementation of the Recovery Plan for the northern spotted owl. However, critical habitat units are currently in place because they remain recognized by the Final Rule, as published in August, 1991, in the Federal Register.

A portion of a Critical Habitat Unit is located in the eastern portion of the Butter Creek watershed. It was established for dispersal, or connectivity, for the northern spotted owl, rather than for nesting, roosting, or foraging. It comprises approximately 3000 acres within the Butter Creek Watershed, located primarily within Matrix Lands and Riparian Reserves.

For consultation with the US Fish and Wildlife Service, suitable habitat is analyzed by two concentric circles around northern spotted owl activity centers. The inner circle, or territory, is a 0.7 mile radius from the activity center. The outer circle, or home range, is a 1.3 mile radius from the activity center.

Public Involvement

Awareness of the full range of values, resource needs, and public expectations associated with the Butter Creek watershed is fundamental to the analysis. This full range is achieved by interacting with those in the agency and outside the agency who might have an interest or knowledge about the resources of the watershed.

In the case of the Butter Creek watershed, the need for a watershed-based, ecosystem management strategy was recognized and an analysis started long before the Watershed Analysis process documented here was even formulated. As a result, extensive and intensive sensing has already occurred and is incorporated into this analysis.

Public involvement was initiated with a public meeting which was held in July, 1993. Public involvement has continued with:

- ❑ Public meetings and open houses to provide information exchange
- ❑ Smaller groups, empowered by the group at large meeting to work on specific problems
- ❑ Field trips to view and discuss resources, management issues and potential treatments and projects
- ❑ Minutes of meetings sent out to interested parties
- ❑ Consultant Bill Shands, of the Pinchot Institute for Conservation, providing assistance in consensus management with the local public group.

The concerns and interests of the various public groups and government agencies have been utilized in formulating the Desired Conditions and Key Questions. A complete listing of all the input is available in the analysis file at the Hayfork Ranger District office.

Watershed Analysis Process

Watershed Analysis addresses a broad range of landscape processes, both terrestrial and aquatic. Many sophisticated techniques are necessary to adequately complete the task requiring a highly skilled team. This Watershed Analysis was carried out by an interagency interdisciplinary team of resource professionals who are familiar with the Butter Creek watershed. The process depended strongly on interdisciplinary cooperation at each step to keep the analysis focused on relevant issues and to ensure that the work was neither overly detailed nor vague.

Watershed Analysis is an iterative process. During the Butter Creek Watershed Analysis, as new data became available or new issues surfaced, the team looped back to previously completed steps to incorporate the new information before proceeding. Often two or more steps were being worked on concurrently or later steps were completed before early ones because the information or skills were more readily available. Frequent team meetings, including several team site visits, were held to ensure coordination and consistency and to promote interdisciplinary and interagency analysis.

Watershed Analysis is also an evolving process. The Watershed Analysis for Butter Creek, as documented herein, will be amended or replaced as new information becomes available, is analyzed, and provides significant new insight into the processes and interactions occurring within the watershed. The "new information" which might cause the need for a re-analysis could be:

- a catastrophic event such as a wildfire or disease/insect epidemic
- results of monitoring
- results of project implementation
- data from a new resource survey or
- analysis in a similar watershed which resulted in different conclusions.

Further analysis might be triggered by a line officer recognizing the need to upgrade the tool she or he is relying upon or a public group or specialist recommendation to the line officer. There is no specified schedule for additional analysis; it could be next month, next year, or next decade.

The Butter Creek Watershed Analysis team utilized an eight step process which is described below. These steps are described in detail in "A Federal Agency Guide for Pilot Watershed Analysis", (FEMAT, 1994). The following step descriptions include the purpose of the step, the process that was utilized, and where in this document the information developed in the step may be found.

Step 1: Identify Issues, Describe Desired Future Conditions, Formulate Key Questions

The purpose of this step is to focus Watershed Analysis on the important questions, so that efforts are concentrated on the processes and functions most directly related to Desired Future Conditions and the values and uses of people. The Issues and Key Questions are identified at the end of Chapter I, the Desired Future Conditions in Chapter III.

The important issues, values and uses were framed based on the entire watershed. The issues and values are a combination of river basin issues, specialists' familiarity with the watershed, existing documentation, public involvement and current land use patterns.

Preliminary Desired Future Condition statements were then developed to describe the future conditions that are to be achieved. These DFCs lead to a set of Key Questions. These are the questions that Watershed Analysis will attempt to answer—the team's expectations for the analysis.

Step 2: Identify Key Processes, Functions and Conditions

The purpose of this step is to identify the primary processes and functions that influence the resources at issue and the ability to attain Desired Future Conditions. Also included in this step is identification of appropriate analysis methods to evaluate existing conditions, the cause-effect relationships that are responsible for the existing conditions, and the trend in conditions over time and space. This information is displayed in Chapters I and II.

A primary goal of Watershed Analysis is to understand the causes and effects of physical and biological impacts occurring in a particular watershed. The objective of Step 2 is to move from the key questions to the specific cause-effect mechanisms most likely to influence conditions of concern. These mechanisms will largely determine watershed conditions and ecosystem functions and processes to be evaluated during Watershed Analysis. The preliminary DFCs developed in Step 1 provide the basis for identifying the primary mechanisms needing analysis. Comparing existing conditions with the objectives allows analysts to isolate those parts of the physical and biological systems that are most sensitive to change, most responsive to stimulus, or most restrictive in meeting the Desired Future Conditions.

Step 3: Stratify the Watershed

The purpose of Step 3 is to simplify fieldwork and analysis by identifying areas that can be evaluated as uniform units, ie., identifying patterns of landscape form and function that define sensitivity to important environmental changes and displaying these patterns on interpretative maps. The results of the stratification are apparent throughout the document and the analysis models in the project file.

Within the watershed, subareas which are relatively uniform in character are identified within which particular processes are active at similar rates and the process responds relatively uniformly throughout the subarea to storms, fires, land-use activities, or other disturbances. Stratification schemes are likely to vary for many of the resource areas.

Appropriate stratification strategies are identified during this step, the strata are defined, and results are used to plan fieldwork and analysis.

Step 4: Assemble Analytic Information

This step involves the compilation of information needed for analysis. A wealth of data exists for most areas, but it usually is held in a variety of places and formats and requires some effort to identify and acquire. The data acquired appears throughout the document, appendix and project file. Inventories used for this analysis are described in **Appendix A**.

Watershed Analysis is not an end point, requiring the ultimate data base, but an iterative learning process, the first round of which should be generally based on present information and understanding, which will improve with time.

Step 5: Describe Past and Current Watershed Conditions

The purpose of Step 5 is to characterize the conditions in the watershed that are important to addressing the key questions. This step sets the stage for predicting trends. Current watershed conditions are described in Chapter I while Chapter II describes the past conditions.

This step answers questions about past and current conditions, such as:

- ❑ What watershed conditions existed before human disturbance?
- ❑ What is the natural range of variability of important conditions?
- ❑ Which conditions have been resilient to change and which have not?
- ❑ What impacts and altered conditions currently exist in the watershed?
- ❑ Where are they? How severe are they? What are their causes?

Step 6: Describe Condition Trends and Predict Effects of Future Land Management

The purpose of Step 6 is to evaluate the trend in important conditions, and predict how land management might affect these over time. Conclusions are drawn on the mechanisms that lead to important change, and this understanding is used to evaluate and map site sensitivity. This information is documented in Chapters II, III and IV.

This step draws heavily on information gained in step 5 to:

- ❑ Assess site sensitivity
- ❑ Describe future changes
- ❑ Address impact trends and recovery rates
- ❑ Predict impacts from future triggering events based on existing land use
- ❑ Relate environmental change to land-use activities
- ❑ Predict impacts from future land use

Step 7: Integrate, Interpret and Present Findings

The purpose of this step is to integrate information and understanding gained through Watershed Analysis into products useful for project planning and design as well as broader-scale planning and assessments. This document and the associated maps, appendices and project file represent this step.

A final set of Desired Future Conditions were arrived at during this step. Also in this step the results of the analysis were used to identify the watershed processes and ecosystem concerns that will need to be addressed at a project-planning scale in different parts of the watershed. Advice, recommendations and prescriptions are usually not site-specific, but are on the scale of the sub-stratification units defined during Step 3.

Riparian Reserve design begins with the Watershed Analysis. A watershed-wide context is necessary for the design of a Riparian Reserve system that is ecologically appropriate and efficient.

Sections dealing with restoration, transportation planning, monitoring, cumulative effects analyses and general planning are also included in Chapter IV.

Step 8: Manage Information, Monitor and Revise

The purpose of Step 8 is to keep track of existing and new information about the analysis watershed, to act as a repository for monitoring plans and results, and to establish criteria for updating and revising the Watershed Analysis.

CHAPTER I
Current Conditions

Chapter I is primarily devoted to a description of the current environmental and social conditions existing within the confines of the Butter Creek Watershed. The chapter also contains, where appropriate, discussions of the watershed's potential conditions, e.g., carrying capacities, capabilities and potential natural communities of vegetation. Included are natural disturbance events and regimes, processes, human influences and human values. Environmental changes through time along with the sequence of human interactions with the ecosystem are described in more detail in Chapter II.

The first portion of this chapter is a narrative description of the Butter Creek ecosystem, illustrating the sequencing and interrelationships between various ecosystem components. The headings for the various resource components have been inserted to aid the reader in locating descriptions of specific ecosystem components. All of the components of the riparian ecosystem are discussed in one section, following the separate descriptions of the aquatic and terrestrial environments. This was done in an attempt to give the reader a complete picture of this complex ecosystem. This level of knowledge is critical to understanding the riparian ecosystem discussions in subsequent chapters, especially the rationale for the Riparian Reserve findings and recommendations presented in Chapter IV.

In the latter portion of the chapter is a list of issues for the South Fork of the Trinity River watershed and for Butter Creek. These were developed by the interdisciplinary team. Finally, there is a list of the Key Questions developed for the Butter Creek ecosystem. The Key Questions were formulated utilizing an interdisciplinary process and will drive the Watershed Analysis. The Key Questions have been separated by ecosystem component and are in the same order as the narrative, to aid the reader in referring between the sections. Some Key Questions overlap two or more components of the ecosystem but are listed only once to avoid unnecessary duplication.

Geographic Setting

The Butter Creek watershed is located in Trinity County, on the Hayfork Ranger District of the Shasta-Trinity National Forests. Butter Creek is a tributary to the South Fork Trinity River. The mouth of Butter Creek lies approximately 3 1/2 river miles upstream of the village of Hyampom (**Figure 1**). The South Fork Trinity River is approximately 620,000 acres in size, and is one of four large tributary watersheds of the Trinity River Basin. Butter Creek flows into the South Fork Trinity River 33 river miles upstream from the confluence of the South Fork with the Trinity River at Salyer. The Trinity River is a major tributary to the Klamath River.

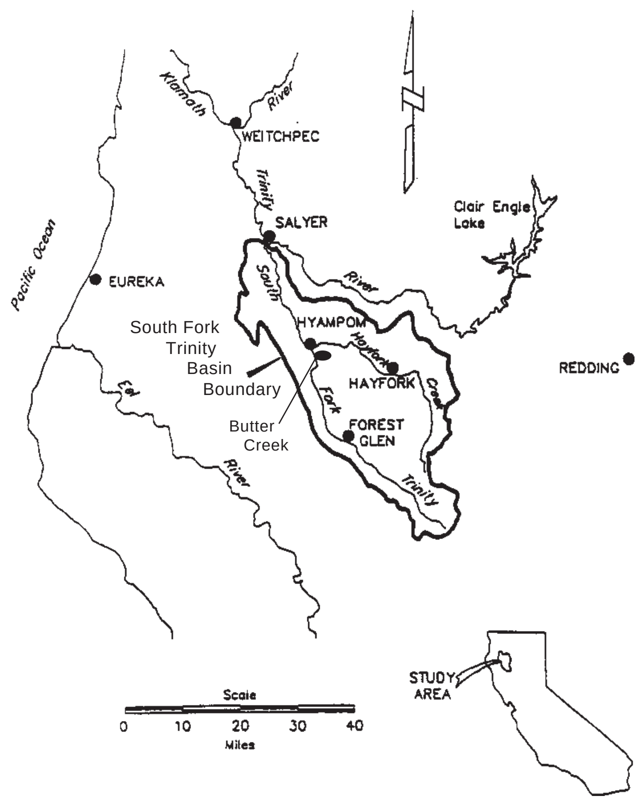


Figure 1 - Location Map

The South Fork Trinity River watershed can be broken into three smaller units; The Upper South Fork, Hayfork Creek and lower South Fork. The Upper South Fork is a collection of watersheds which lie along the main stem of the South Fork Trinity River, above the confluence with Hayfork

Creek at Hyampom. The Upper South Fork totals 222,204 acres in area, and is comprised of eight smaller watersheds ranging in size from 22,000 to 31,000 acres. Butter Creek is one of the these eight (Haskins and Irizarry, 1988).

The Butter Creek watershed is 23,490 acres in area, and is comprised of two major tributary drainages, Butter Creek and Indian Valley Creek. Butter Creek drains the northern portion of the watershed, while Indian Valley Creek drains the southern area. Subwatersheds which comprise the Butter Creek tributary include Upper Butter, middle Butter, South Butter, First Butter and Butter Creek. The entire Butter Creek tributary watershed is 8,418 acres in area. The Indian Valley tributary of the Butter Creek watershed is 13,715 acres in area. Subwatersheds include Buck Gulch, Cold Camp Creek, Corral Gulch, Cow Gulch, First Indian Valley Creek, Friend Mountain Creek, Headwaters Creek, Indian Valley Canyon Unit, middle Indian Valley Unit, Rail Gulch, Seven Road Creek, Sheep Creek and Upper Indian Valley Creek. The Confluence Unit, Long Creek and North Creek drain into Butter Creek below the confluence of Indian Valley Creek. These three subwatersheds total 1357 acres (**Plate 1, Table 1**).

Elevations range from 1460 feet at the mouth of Butter Creek to over 4800 feet at some of the prominent peaks, including Limedyke and Friend Mountain. The highest point in the watershed is 4895 feet in the headwaters of Cow Gulch watershed. The lower portion of the watershed has steep slopes and both Butter Creek and lower Indian Valley Creek are incised in deep canyons. The upper portion of the watershed has relatively subdued topography, characterized by gently sloped hills and valleys. At an elevation of approximately 3900 feet, Indian Valley is the broadest of the upland valleys. The U.S. Forest Service fire guard station is a prominent site in the valley. **Plate 2** is an elevation map for the watershed showing 500 foot elevation bands.

Plate 3 is a slope map of the watershed, while **Figure 2** is a comparative histogram for slope classes for all subwatersheds within the Butter Creek watershed. Watersheds which have the steepest slopes are on the left side of the figure, while the more gently sloping subwatersheds are at the right side of the figure.

Table 1	**ACRES by SUBWATERSHED**
Subwatershed Name	**Subwatershed Acres**
Buck Gulch	584
Butter Creek	2,320
Canyon Unit	1,619
Cold Camp Ck.	1,069
Confluence	476
Corral Gulch	2,097
Cow Gulch	378
First Butter Ck.	513
First IV Ck.	1,020
Friend Mtn Ck.	663
Headwaters Ck.	584
Indian Valley Ck.	1,207
Long Ck.	306
Middle Butter Unit	1,673
Middle IV Unit	1,541
North Ck.	575
Rail Gulch	397
Seven Road Ck.	638
Sheep Ck.	518
South Butter Ck.	2,055
Upper Butter Ck.	1,857
Upper IV Ck.	1,400
Total	**23,490**

Currently, there are thirty-five parcels of private land within the Butter Creek watershed for a total of approximately 1280 acres. Sierra Pacific Industries owns 2 parcels located in T.1N, R.7E, parts of Sections 1 and 2, HBM. California Wine Company owns one parcel located in T.2N, R.7E, part of Section 7, HBM. The rest of the parcels are owned by private individuals who either live on these properties or use them as recreational residences. They are located in T.2N, R.6E, Sections 1, 12, and 13, HBM; T.2N, R.6E, parts of Sections 5, 6, 7, and 8, HBM; T.2N, R.8E, parts of Sections 29, 30, and 32, HBM. The parcels in the Indian Valley area were acquired in 1906 under the Timber and Stone Act of 1878. The others were acquired between 1906 and 1930 under the Homestead Act of 1862.

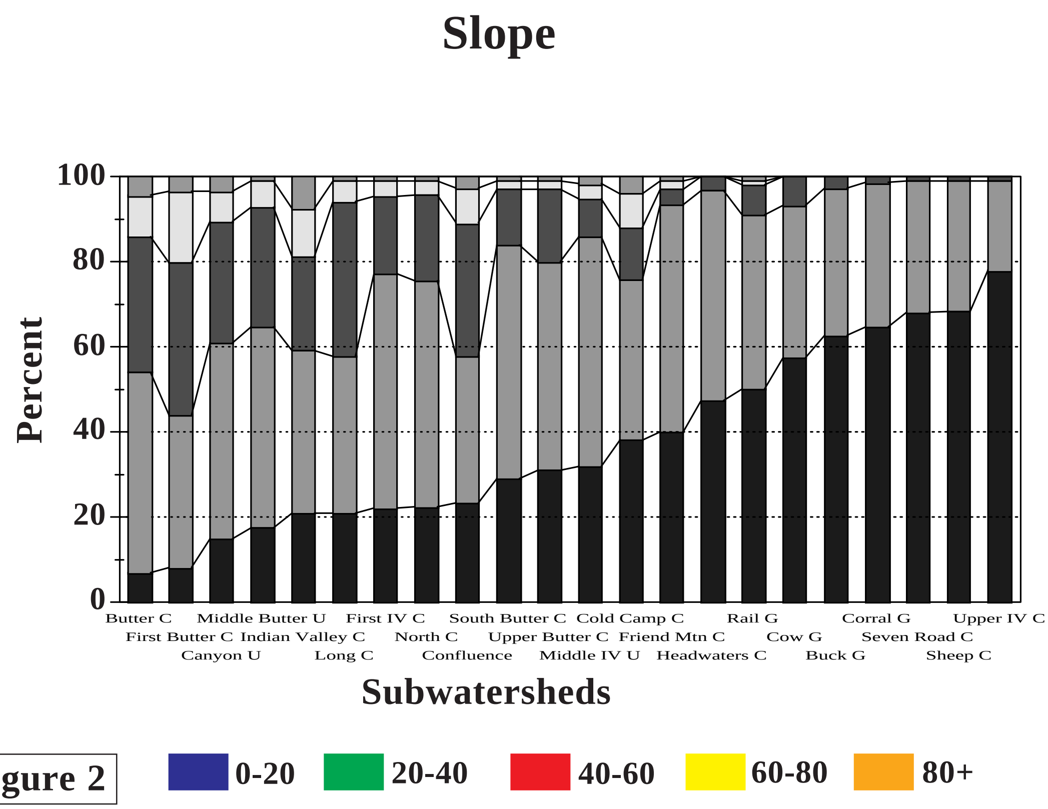


Figure 2

The Physical and Aquatic Environment

Air Quality

The Butter Creek watershed lies within the North Coast Air Basin. The Trinity County portion of the Air Basin is designated unclassified for carbon monoxide, attainment for sulfur dioxide, non-attainment for particulate matter (PM-10), attainment for sulfates, attainment for lead, and unclassified for hydrogen sulfide according to state ambient air quality standards.

Trinity County is designated as unclassified for ozone, carbon monoxide, nitrogen dioxide, sulfur dioxide and PM-10, according to national ambient air quality standards.

The PM-10 designation of non-attainment occurs state-wide. PM-10 is generated by dust producing activities, diesel smoke, wildfire, controlled burning, slash burning and wood stoves.

Geology

Bedrock and Surficial Geology

The Butter Creek watershed is located within the Klamath Mountain geologic province, one of the more complex provinces in North America. It is a west-facing arcuate-form region which extends from northwestern California into southwestern Oregon (**Figure 3**). It consists predominantly of marine arc-related volcanic and sedimentary rocks of Paleozoic and Mesozoic ages (Irwin, 1981). Oceanic plate-related ultramafic and associated ophiolitic rocks are also important components. Granitic plutons intruded many parts of the province during Jurassic and early Cretaceous time (Irwin, 1985). Structurally, the province consists of a series of north to northwest-trending slices of ancient crustal blocks which have collided to form an imbricate eastward-dipping sequence of volcanic, sedimentary and oceanic crustal rocks.

The province has been subdivided into four major lithotectonic units that from east to west are called the Eastern Klamath belt, the Central Metamorphic belt, the Western Paleozoic and Triassic belt and the Western Jurassic belt (Irwin, 1972).

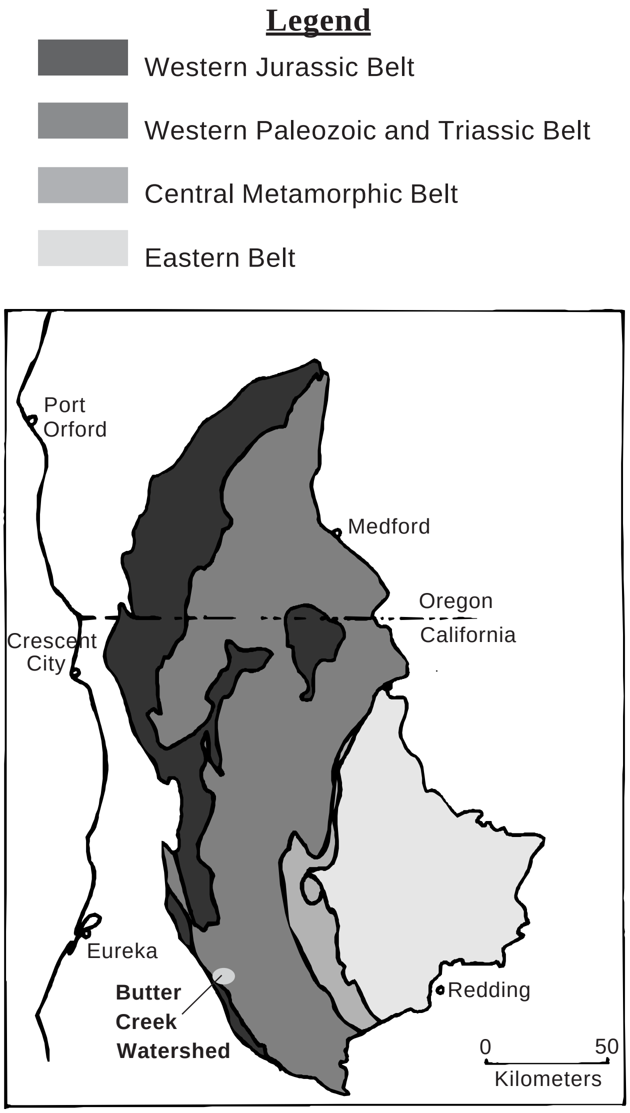


Figure 3 - Generalized Geologic Map of Klamath Mountain Geologic Province

The Butter Creek watershed straddles the western portion of the Western Paleozoic and Triassic Belt and the Western Jurassic Belt. The main subunit within the Western Paleozoic and Triassic Belt which is found within the analysis area is known as the Rattlesnake Creek terrane. The main subunit within the Western Jurassic Belt in the watershed is the Galice Formation. The Rattlesnake Creek terrane underlies nearly the entire Butter Creek watershed. This terrane consists of a wide variety of rocks, including abundant ultramafic rock, gabbro, diabase, pillow basalts, chert, various metamorphosed mafic volcanic rocks, granite, diorite, limestone, phyllite, sandstone and conglomerate. Plutons of diorite are scattered throughout the terrane. The rocks are greatly disrupted by folding and faulting, and their original relations are further obscured by widespread mass wasting deposits.

A general description of a melange is that of a wide variety of seemingly unrelated bedrock blocks of widely ranging lithologies, ranging in size from a few acres to hundreds of acres, lying juxtaposed. These blocks are separated by a matrix of highly sheared serpentine-rich fault gouge, and in a sense, these blocks are floating in this matrix.

The scheme used when mapping within melanges identifies the boundaries of the large blocks, but also the boundary of the highly sheared melange zones containing only blocks of lesser size. A block larger than 200 acres is considered a large block and is mapped as a separate lithologic block. The highly sheared zones containing small bedrock blocks are mapped as serpentine melange.

The Galice Formation occupies the westernmost portion of the analysis area. The lithology consists of phyllite and semischist. It is separated from the Rattlesnake Creek terrane to the east by a sharp, eastward dipping, northwest trending fault known as the Bear Wallow fault. This fault runs from the west side of Limedyke Mountain across Long Creek, lower Butter Creek and up through North Creek within the lower portion of the watershed. Relict bedding in the Galice strikes west-northwest and dips to the northeast at 45 to 50 degrees. Foliations trend northwest with a shallow plunge to the east. Jointing is highly variable with no consistent orientation noted.

Two other stratigraphic units are mapped within the watershed: Quaternary alluvium and Quaternary landslide deposits. Quaternary alluvium is comprised of unconsolidated alluvium deposited by fluvial processes while Quaternary landslide deposits are comprised of unconsolidated colluvium deposited through mass wasting. **Plate 4** is a map of the lithologies for the Butter Creek watershed.

Geomorphology

There are two general geomorphic types in the Butter Creek Watershed: fluvial and mass wasting. Fluvial features cover approximately 10 percent of the watershed while mass wasting features cover the remaining 90 percent. The Klamath Mountains have been uplifted and eroded at least several times in their most recent history.

There are many remnants of the old eroded surface throughout the Klamath Mountains. In the analysis area this is well illustrated by the Indian Valley uplands. The eastern half of the watershed has relatively gentle slopes, with alluvial channels meandering through the landscape. Older terraces are often found above younger active floodplains. Slope processes in the uplands are dominated by gradual soil creep, and isolated slides and flows within serpentine-rich melange areas. Many of the rock outcrops are deeply weathered. In the western portion of the watershed, Butter Creek and its tributary, lower Indian Valley Creek, have deeply incised themselves into the upland surface. In the span of approximately six miles, Indian Valley Creek and Butter Creek plunge nearly 2900 feet. The channel incisement into relatively incompetent rocks have contributed to the occurrence of mass wasting features in the canyonlands. Large mass wasting features are well developed at the edges of the upland area as the deeply weathered, highly sheared serpentine melange is over-steepened through adjacent downcutting. Mass wasting features include deep-seated slump earthflows, translational-rotational slides and smaller, shallow-seated debris slides. Inner gorges are well developed in the canyonlands. **Table 2** lists all of the geomorphic features mapped within the watershed. The features and processes are described by Haskins and Chatoian (1993). **Plate 5** is a map showing the distribution of the different types of mass wasting features in the Butter Creek watershed.

Slope Stability Hazards

Slope Stability Hazard, as defined by the U.S. Forest Service in Region 5, (Haskins and Chatoian, 1993) is the division of the land surface into like areas and the relative ranking of these areas according to degrees of actual or potential natural hazard from landslides or other mass movement on slopes. Natural hazard means the probability of occurrence within a specified period of time, and within a given area of a potentially damaging phenomenon. As described by Varnes (1984), there are three basic principles to slope stability hazard evaluation:

1) The past and present are keys to the future
2) The main conditions that cause landsliding can be identified
3) Degrees of hazards can be estimated

Slope stability hazards within a major portion of the watershed range from none (Hazard = 1), to extremely unstable (Hazard = 10) (**Table 3**). The slope stability hazards for the Butter Creek watershed were ascertained by the absence or presence of conditions which have contributed to past and present slope failures. First, mass wasting features were mapped at a scale of 1:24,000 on aerial photographs. Then, utilizing information such as bedrock lithology and structure, photo-interpretation of evidence of recent slope movement and reconnaissance field study, ratings were given for each mapped feature.

Through studying the pattern and occurrence of past and present mass wasting events, patterns emerged. Mass wasting in the Galice Formation is generally controlled by bedrock structure. Translational slides and internested translational rotational slides are developed on dip slopes, and generally fail or are at risk of failure when slope angles exceed 75 percent. Some debris slide prone slopes were mapped in the lower watershed within the Galice Formation on anti-dip slopes where slope steepness exceeded 90 percent. Many of the failures were adjacent to or within the valley inner gorge.

Mass wasting in the Rattlesnake Creek terrane is somewhat more complex, due to its lithologic and structural diversity. However, it is apparent that large active slump-earthflows are developed in the serpentine melange lithologic map unit within the canyonlands. Varied mass wasting processes are occurring within these complex features and movement varies from slow to rapid. Toe zones are intermittently active and highly unstable, as are some axial zones. The majority of the large blocks within the Rattlesnake Creek terrane are relatively stable, exhibiting dormant mass wasting features. Exceptions occur where slope steepness exceeds 75 percent. Under these conditions varied activities can be expected to exist.

Site analysis will be required to fine-tune these evaluations prior to project implementation. **Plate 6** is a map of the existing slope stability hazards for the Butter Creek watershed.

In general, the distribution of the mass wasting hazards is a function of slope and material. By evaluating the spatial distribution of mass wasting hazards on a subwatershed basis the inherent

Table 2	BUTTER CREEK GEOMORPHIC MAP UNITS				
Map Unit	**Process**	**1st**	**2nd**	**3rd**	**4th**
114/120	Fluvial	Stream Channel/ Floodplain			
125A	Fluvial	Stream Terrace	Depositional		
1056	Mass Wasting	Slide	Rotational	Main Scarp	
1056A	Mass Wasting	Slide	Rotational	Main Scarp	DS Main Scarp
1058	Mass Wasting	Slide	Rotational	Bench	
1058B	Mass Wasting	Slide	Rotational	Bench	Nested Bench
1059	Mass Wasting	Slide	Rotational	Toe Zone	
1059A	Mass Wasting	Slide	Rotational	Toe Zone	Nested Toe Zone
1060B	Mass Wasting	Slide	Rotational	Lateral Scarp	DS Lateral Scarp
1066	Mass Wasting	Slide	Translational	Main Scarp	
1067	Mass Wasting	Slide	Translational	?	?
1068	Mass Wasting	Slide	Translational	Bench	
1068B	Mass Wasting	Slide	Translational	Bench	Nested Bench
1069	Mass Wasting	Slide	Translational	Toe Zone	
1070	Mass Wasting	Slide	Translational	Lateral Scarp	
1076	Mass Wasting	Slide	Rotational/ Translational	Main Scarp	
1078	Mass Wasting	Slide	Rotational/ Translational	Bench	
1110	Mass wasting	Flow	Debris Avalanche		
1111	Mass Wasting	Flow	Debris Avalanche	Source Zone	
1151	Mass Wasting	Flow	Soil Creep	Colluvial Hillslope	
1152	Mass Wasting	Flow	Soil Creep	Colluvial Ridgetop	
1160	Mass Wasting	Flow	Earth Flow		
1161	Mass Wasting	Flow	Earth Flow	Main Scarp	
1163	Mass Wasting	Flow	Earth Flow	Bench	
1231	Mass Wasting	Complex	Slump/Earthflow	Toe Zone	
1231A	Mass Wasting	Complex	Slump/Earthflow	Toe Zone	Nested Toe Zone
1232	Mass Wasting	Complex	Slump/Earthflow	Primary Scarp	
1232A	Mass Wasting	Complex	Slump/Earthflow	Primary Scarp	Nested Prim Scarp
1232B	Mass Wasting	Complex	Slump/Earthflow	Primary Scarp	DS Prone Prim Scarp
1233	Mass Wasting	Complex	Slump/Earthflow	Secondary Scarp	
1233A	Mass Wasting	Complex	Slump/Earthflow	Secondary Scarp	Nested Sec Scarp
1234	Mass Wasting	Complex	Slump/Earthflow	Lateral Scarp	
1234A	Mass Wasting	Complex	Slump/Earthflow	Lateral Scarp	Nested Lat Scarp
1234B	Mass Wasting	Complex	Slump/Earthflow	Lateral Scarp	DS Lateral Scarp
1235	Mass Wasting	Complex	Slump/Earthflow	Bench	
1235A	Mass Wasting	Complex	Slump/Earthflow	Bench	Nested Bench
1236	Mass Wasting	Complex	Slump/Earthflow	Floating Block	
1237	Mass Wasting	Complex	Slump/Earthflow	Sag Pond	
1250	Mass Wasting	Complex	Internested Rotational/ Translational Slides		
1261	Mass Wasting	Complex	Inner Gorge	Primary	

Table 3	ACRES by SLOPE STABILITY HAZARD				
		Mass Wasting Hazards (Acres)			
Subwatershed	**Acres**	**Low**	**Moderate**	**High**	**Extreme**
Buck Gulch	584	509	75		
Butter Creek	2,320	130	1,944	246	
Canyon Unit	1,619	110	1,167	342	
Cold Camp Ck.	1,069	294	714	61	
Confluence	476	60	286	125	5
Corral Gulch	2,097	2,022	55	20	
Cow Gulch	378	378			
First Butter Ck.	513	10	441	62	
First IV Ck.	1,020	355	650	15	
Friend Mtn Ck.	663	416	247		
Headwaters Ck.	584	578	6		
Indian Valley Ck.	1,207	120	549	517	21
Long Ck.	306	29	207	69	
Middle Butter Unit	1,673	502	1,054	117	
Middle IV Unit	1,541	888	502	133	18
North Ck.	575	6	403	167	
Rail Gulch	397	328	69		
Seven Road Ck.	638	365	273		
Sheep Ck.	518	165	353		
South Butter Ck.	2,055	183	1,745	127	
Upper Butter Ck.	1,857	1,341	516		
Upper IV Ck.	1,400	1,138	262		

sensitivity or potential for sediment production can be ascertained and compared on a relative basis. **Figure 4** is a comparative histogram of the distribution of landslide hazards for each of the subwatersheds within Butter Creek. Subwatersheds at the left side of the figure have the greatest level of hazards, while the ones on the right have the relatively lowest hazards.

Seismic Hazards

Seismic hazards for the Butter Creek watershed are tectonically related to the subduction of the Pacific plate beneath the North American plate, and the northern-most extension of "San Andreas" right lateral slip. Relatively deep epicenters of seismic events have been located in the vicinity of Butter Creek which are related to plate subduction. Recent investigations have revealed that significant events have occurred and a threat of a large magnitude deep seated earthquake remains. The Grogan fault lies 6 miles northwest of Butter Creek. It is believed to be an active northern splay of the San Andreas Fault (Wallace, 1990). It trends north-northwest, which is typical of faults in the Klamath and Coast ranges. In addition, the South Fork Mountain Fault, which separates the Coast Range from the Klamath Range lies directly adjacent to the Butter Creek watershed. Although

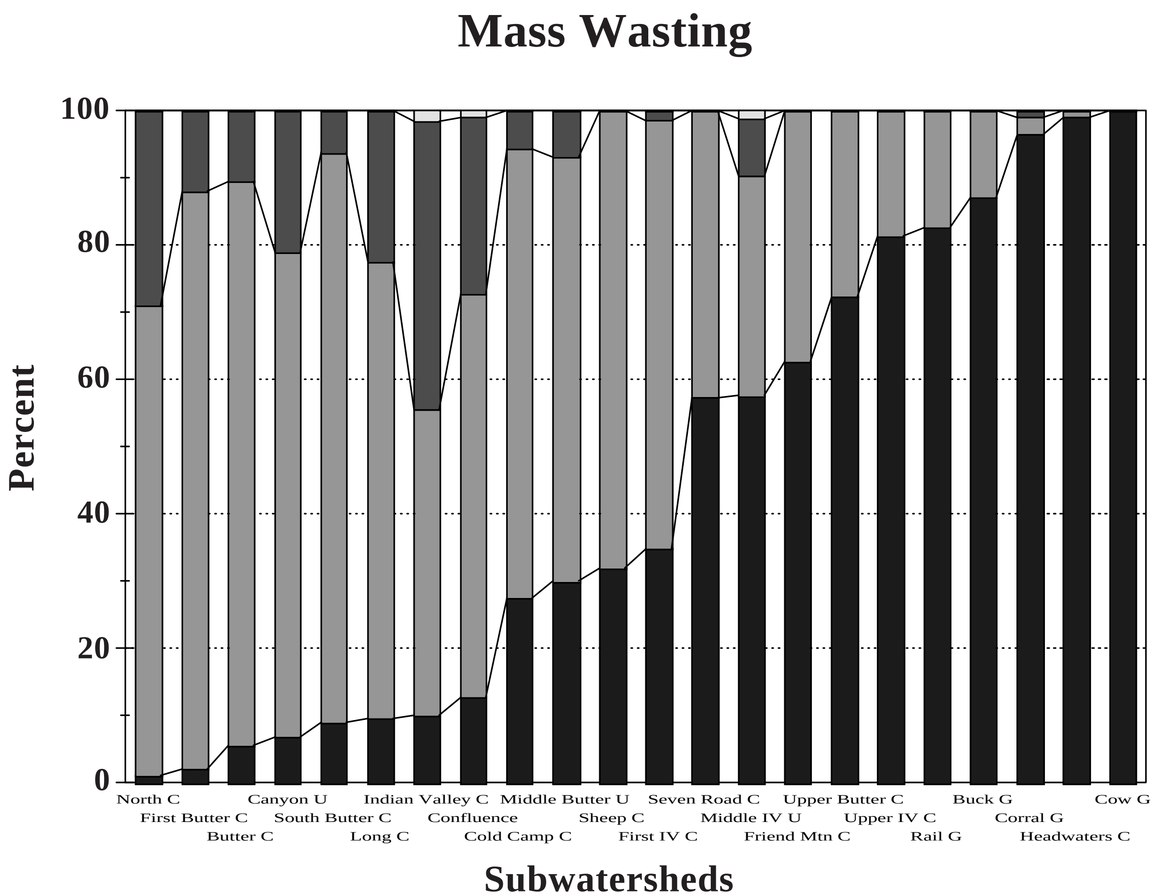


Figure 4

evidence is lacking for recent seismic activity on the fault, it parallels the Grogan Fault, so may be a more inland splay of "San Andreas" tectonics.

Mineral Resources

Mineral resources which occur in the Butter Creek watershed include copper, chromite and manganese. There has not been significant production of any of these commodities from the analysis area and surface disturbance resulting from mining related activities has been minimal. Copper occurs as sulfides, oxides and carbonates in quartz veins in areas of serpentine or dioritic rocks. Two copper occurrences have been identified in the area and consist of small prospects in the serpentine melange area east of Limedyke Mountain. Both are small inactive prospects with no reported production and minimal surface disturbance. There is a moderate potential for additional small copper occurrences being identified in the serpentine, serpentine melange and diorite bedrock units of the Rattlesnake Creek terrane within the area. Small amounts of gold may be associated with the copper sulfide-bearing quartz veins.

Chromite and manganese have only been produced in the Klamath Mountains during World Wars I and II and during the Korean War when foreign sources were limited and the U.S. Government provided economic incentives for domestic production. Chromite occurs in clustered podiform masses in serpentine and peridotite. The chromite bodies are usually small, on the order of a few tons up to 10,000 tons. Six chromite occurrences have been identified in the analysis area along Oak Ridge. Production of chromite ore is only reported from two of the sites, the Yellow Pine mine (206 tons in 1942) and the Oak Ridge mine (17 tons in 1953). Both sites lie in T. 2 N., R. 7 E., H.M., section 10. There is a moderate potential for additional small subeconomic podiform chromite deposits being identified in serpentine and serpentine melange units in the Rattlesnake Creek terrane within the area.

Manganese occurs as manganese-bearing bedded chert in melange terranes that contain oceanic crustal rocks. This is typical of the Rattlesnake Creek terrane in the analysis area. One manganese prospect has been identified at Snow Camp. Workings consist of small pits with no reported production. There is a moderate potential for additional small subeconomic manganese bearing bedded chert deposits being identified in the melange units of the Rattlesnake Creek terrane within the area.

Soils

Soils of the Butter Creek Watershed

Some general properties used to characterize forest soils and their basic patterns of soil evolution in the Butter Creek Watershed are soil depth, soil color, gravel content, clay content, particle size distribution and certain chemical properties (Zinke and Colwell, 1963). External to soil properties are the whole host of spatial and temporal phenomenon, perhaps dominated by a soil's geomorphic position, that play a role in a soils character, function and productivity.

From a soil science perspective, the geologic rock types within the Butter Creek Watershed can be grouped into two major types; large blocks of metasedimentary and metavolcanic rocks in the Galice and Rattlesnake Creek terrane and serpentine melange. In the large block type, moderately steep and steeply sloping areas have soils which are very gravelly. They have a limited moisture holding capacity. Soils on gentler slopes tend to be finer-textured (higher clay content), have less coarse fragment content, reflect more weathering (brownish or reddish color), and generally are productive forest soils (except where shallow or very gravelly) (Norgren et al., 1990).

The serpentine melange bedrock map unit is rich in serpentine as well as small blocks of a variety of other lithologies. Soils derived from these rocks tend to be found on "softer" landscapes, yet are not limited to gently sloping areas. Serpentine weathers into acidic soils that are high in magnesium, iron and montmorillinitic clays, and low in calcium, sodium, potassium and phosphorus. In particular, the uncommonly low ratio (about 1 to 50) between exchangeable calcium and magnesium (USDA-SCS, 1987a) places significant limits on soil productivity. Only specialized plants which have adapted to these conditions can populate these soils. Many of these populations are endemic to serpentine soils.

Table 4 lists the soil series (soils of discrete, relatively uniform and repeatable character) occurring within the Butter Creek watershed, and their taxonomic classification, as defined in the reference publication Soil Taxonomy (USDA SCS, 1975). **Table 5** defines the soil map units, or groupings of soils that are too intricately mixed to be mapped as single taxa units given the scale of mapping which are found within the Butter Creek watershed.

More than 80 percent of the Butter Creek watershed is occupied by six soil series: Abegg, Casabonne, Deadeye, Deadwood, Kindig and Marpa. Of lesser extent, but of significance in terms of interpretations for land managers are the serpentinitic soils (Dubakella, Grell and Weitchpec) and the Clover soil (in the Maddox Lake and Butter Creek Meadows areas). These soils will be discussed further below. **Plate 7** is a map of the distribution of site productivity for the watershed.

Soils are generally mapped as complexes which are natural groupings of individual soils as they occur on the landscape. These complexes reflect soil series that are discrete from one another in characteristics, but are not readily definable because of the intricate mixing of soil types across the landscape. For example, the most common soil complex in the watershed is the Deadwood-Marpa Complex, 5 to 35 percent. Here, the Deadwood soil is the dominant member in this complex, followed by the Marpa series.

The Deadeye and Deadwood soils are shallow soils (less than 20 inches in depth) that tend to occupy gentle to very steep, convex surfaces on mountain sideslopes and headwall areas. They are generally associated with crown scarps of deep-seated mass wasting features. These soils have significant limitations in productivity related to low available water holding capacity, amounts of coarse fragments in the soil profile, position on the landscape and available rooting depths. They may also reflect an influence of adjacent serpentinitic soils.

Table 4	SOIL SERIES and INTERPRETATIONS					
Soil Name	**Available Water Holding Capacity Top 20 Inches (Inches)**	**Erodibility (K Factor)**	**Seedling Survival**	**Forest Service Site Class**	**Rooting Depth (Inches)**	**Fertilization Potential**
Chaix	1.90	0.45	M	5	36	L
Neuns	1.99	0.15	M	4	24	L
Casabonne	3.51	0.10	H	3	60	H
Kindig	2.16	0.15	H	3	60	H
Abegg	1.83	0.30	H	4	60	H
Marpa	2.57	0.15	H	5	24	L
Deadeye	1.33	0.20	L	5	15	L
Deadwood	1.45	0.25	L	5	15	L
Clover	0.33	0.20	L	6	60	L
Dubakella	2.40	0.15	M	6	33	L
Dunsmuir	3.32	0.15	H	5	24	H
Grell	0.90	0.20	L	7	11	L
Weitchpec	2.30	0.20	M	5	38	M
Lithic Xerorthents	1.50	0.20	L	6	18	L

Moderately deep soils (20 to 40 inches in depth) of the Marpa and Neuns series occupy concave or convex positions on gently sloping to very steep hillslopes. They are often associated with the colluvial ridges and hillslopes in the uplands. While more productive than the Deadeye and Deadwood series, these soils tend to be of only moderate productivity due to coarse gravel contents in surface horizons, soil depth and droughthiness. The Marpa soil typically has finer textures, occurs on gentler surfaces, and has less limitations for management than the Neuns soil, but does not appear significantly more productive.

The deep (60 inches) Kindig, Casabonne and Abegg soils occur on gentle to very steep mountain sideslopes, the upland area, or in association with mass wasting features in inner gorges of lower Indian Valley Creek and lower Butter Creek. These soils are the most productive soils found in the watershed, with a range from almost no management limitations to somewhat significant limitations related to very steep sideslopes and high surface gravel content.

Of lesser extent within Butter Creek watershed but of significance for management reasons are those soils derived from ultramafic rock types. In Butter Creek, the soil series derived from ultramafic rock types are the Dubakella, Grell and Weitchpec series. Soils derived from ultramafic rock types often have less coarse fragment content in the surface horizons than those of metasedimentary or metavolcanic origins. Soil depths of these soil types are generally moderately deep to shallow. Nutrient imbalances significantly limit the vegetative communities that can occur on these soil types. The three series all are of low to moderate productivity, and are limited by doughthiness.

Soils formed from local granodiorite intrusions occupy a minor portion of the Butter Creek watershed. Soils derived from granodiorite include the Chaix, Chawanakee, Hugo, Holland and Hotaw series. The Chawanakee series is a shallow, unproductive series typically occupying ridgetops and south-facing headwall areas. The Hugo series, on the other hand, is typically greater than 50 inches deep, fine-loamy in character, and is a more weathered and productive soil than any other series mentioned above. This soil can typically be found on lower, sheltered slopes.

The Chaix, Holland and Hotaw series are typically 20 to 40 inches deep and occupy various positions

Table 5	**BUTTER CREEK SOIL MAPPING UNITS**		
Soil Map Unit	**Slope**	**Soil Name**	**Percent of Map Unit**
50	A	Xerofluvent	90
55	A	Riverwash	100
99	C	Rock Outcrop	85
100	C	Lithic Xerothents	90
215	B	Chaix Neuns	60 20
320	A	Casabonne Kindig	50 35
321	A,B	Casabonne Abegg	40-50 35-40
325	B	Kindig Casabonne Neuns	35 30 25
360	A,B	Marpa Casabonne	50-55 30-35
361	B	Marpa Casabonne	40 35
424	A,B	Deadeye Neuns	40-45 40
425	A,B,C	Neuns Deadwood	50-45 30-40
426	B,C	Neuns Deadwood	55-45 35
515	A,B	Deadwood Marpa	55 30
516	A,B	Deadwood Marpa	70-65 20
517	A	Deadwood Marpa	50 30
525	B,C	Kindig Neuns	45-40 40
526	C	Clover Neuns	40 40
527	B,C	Clover Neuns	40 30
535	B,C	Neuns Kindig Deadwood	40 30 20

Table 5 (continued)	BUTTER CREEK SOIL MAPPING UNITS		
Soil Map Unit	**Slope**	**Soil Name**	**Percent of Map Unit**
536	B,C	Neuns Clover Deadwood	40-35 30-25 0-25
545	A,B,C	Deadwood Neuns	50-45 30-40
546	B,C	Deadwood Neuns	40-45 40-35
547	B,C	Deadwood Neuns	40-45 40-35
555	B,C	Deadwood Rock Outcrop	50 30-40
610	A,B	Dubakella Dunsmuir	50 30
620	A,B	Grell Dubakella Dunsmuir	40-50 30-20 20-15
640	A,B	Dubakella Grell Rock Outcrop	35-30 30 20-25
650	A,B	Grell Weitchpec	45 30
651	A,B	Dubakella Weitchpec	45 35

on the landscape. Soils derived from granodiorite are some of the most sensitive soil types to ground-disturbing activities due to their coarse granular textures, droughthiness, non-cohesive nature and generally limited productivity. Granodiorite soils that are greatly disturbed by management activities such as timber yarding, road and skid trail construction, tractor piling and broadcast burning may take decades to recover from the cycle of soil erosion that is initiated by these types of disturbance.

The soils of the Butter Creek watershed typically have significant percentages of coarse gravel content within the soil profile. Soils with high gravel contents are classified as being skeletal soils. Skeletal soils with greater than 35 percent rock fragment component affects soil manageability in two basic ways: potential limiting factors associated with rock fragments themselves, and the reduction in fine soil volumes within the solum. Rarely does rock fragment type affect soil functions or limits in forest soils. Perhaps the most common impacts might be their influence on bulk density and on heat transfer. Typically, rock fragments will increase the soils weight per unit area, or bulk densities. On the other hand, rock content has potentially significant affects on thermal transfer in soils, or how rapid, how deep, and for how long heat is held by soil. Thermal transfer increases progressively faster with increased rock fragment content, penetrates deeper into the soil profile, and holds heat longer. Although there are some benefits from these characteristics (such as earlier spring warming, allowing vegetation to exploit available soil water early in the growing season), the implications of these characteristics for management include reduced soil productivity and planting difficulties.

More significant are the influence rock fragments have on available water holding capacity and porosity of soil. Steinbrenner (1979) found the dominant effect of increased rock fragment content on forest soils was a reduction in fine soil volumes for the vegetation to exploit, leading to lower site index. This effect has potentially significant management ramifications with regard to seedling survival, appropriate species to be planted, nutrient and water supplies, and heat transfers (Childs, 1981).

The Clover soil occurs on less than 200 acres but is significant due to the occurrence of a heavy gravel mulch 6 to 12 inches thick on the soil surface. The gravel mulch, with its coarse nature, has almost no water-holding capacity ; 0.33 inches of water in the top 20 inches of the soil profile. This characteristic severely limits the plantability, regenerative capacity and the potential for seedling survival on this type. Proposed management activities on this soil should be very carefully considered prior to implementation.

Surface Erosion Hazards

The moderate slopes of much of the watershed combined with the generally inherent low erodibility of the soils results in a surface erosion hazard of low or moderate for much of the watershed (**Plate 8**). High erosion hazards can almost exclusively be linked to slopes in excess of 65 percent, or as a secondary process of localized landsliding. High coarse gravel contents within the matrix of fine-grained, not-readily detachable clayey soils also reduce the erosion hazard rating on some soil types occurring on moderately steep to steep surfaces.

Organic litter and surface rock fragments enhance a soils resistance to chronic erosion cycles following disturbance (Childs, 1981). Soil erosion losses may be limited by surface gravel contents that increase soil macroporosity and therefore reduce the risk of overland flows. This phenomenon, however, can occasionally be counter-balanced by the fact that shallow soils with high coarse content (on steep slopes) have a limited capacity to hold water, increasing runoff and potentially increasing the hazard of soil erosion.

Soil erosion is often a secondary process following the onset of active landsliding, and is therefore difficult to evaluate by a conventional soil erosion hazard rating. A soil's geomorphic position on the landscape, the complexity of the bedrock lithology (such as the serpentine melange), hydrologic soil group ratings, permeability differences between surface and subsurface horizons and rooting depth may also influence erosion and sediment production rates as secondary erosional processes in landslide features.

The spatial distribution of erosion hazards is also an indication of the relative sensitivity of the different subwatersheds within Butter Creek. **Figure 5** is a comparative histogram comparing the distribution of surface erosion hazard within the different subwatersheds. Watersheds on the left side of the figure are interpreted as being more hazardous, while the ones on the right are considered to be less hazardous.

Hydrology

As previously described, Butter Creek is a 23,490 acre watershed which has been further subdivided into 22 subwatersheds. Water flows from the top of the Butter Creek watershed, at 4900 feet in elevation, to the bottom at 1460 feet, in approximately 15 miles. The stream plunges 3500 feet in only 15 miles compared to the remainder of the South Fork of the Trinity/Trinity/Klamath drainage network that drops only 1400 feet in over 105 miles from the mouth of Butter Creek to the ocean. The difference in average gradients between Butter Creek and the downstream channel network means that Butter Creek is generally an erosional, sediment producing and transporting system, while the downstream network is generally a sediment storage system. **Plate 9** is a map of the stream system and flow regimes for the Butter Creek watershed.

Climate

The Butter Creek watershed has a Mediterranean type climate with warm to hot summers with little precipitation and moderately wet winters. Mean annual air temperature is close to 50 degrees Fahrenheit for the watershed as a whole. The summer mean is around 70 degrees, with a summer maximum mean of 90 degrees. Night time minimum mean temperature drops off to around 45 degrees in the summer months. The upland areas of Indian Valley and Butter Creek Meadows are known as notorious cold air “sinks” and generally have cooler air temperatures, both summer and winter. Winter temperatures average 40 degrees, with a mean minimum of 30 degrees. Again the upland valleys are cooler than the mean for the watershed (Barrett, 1966).

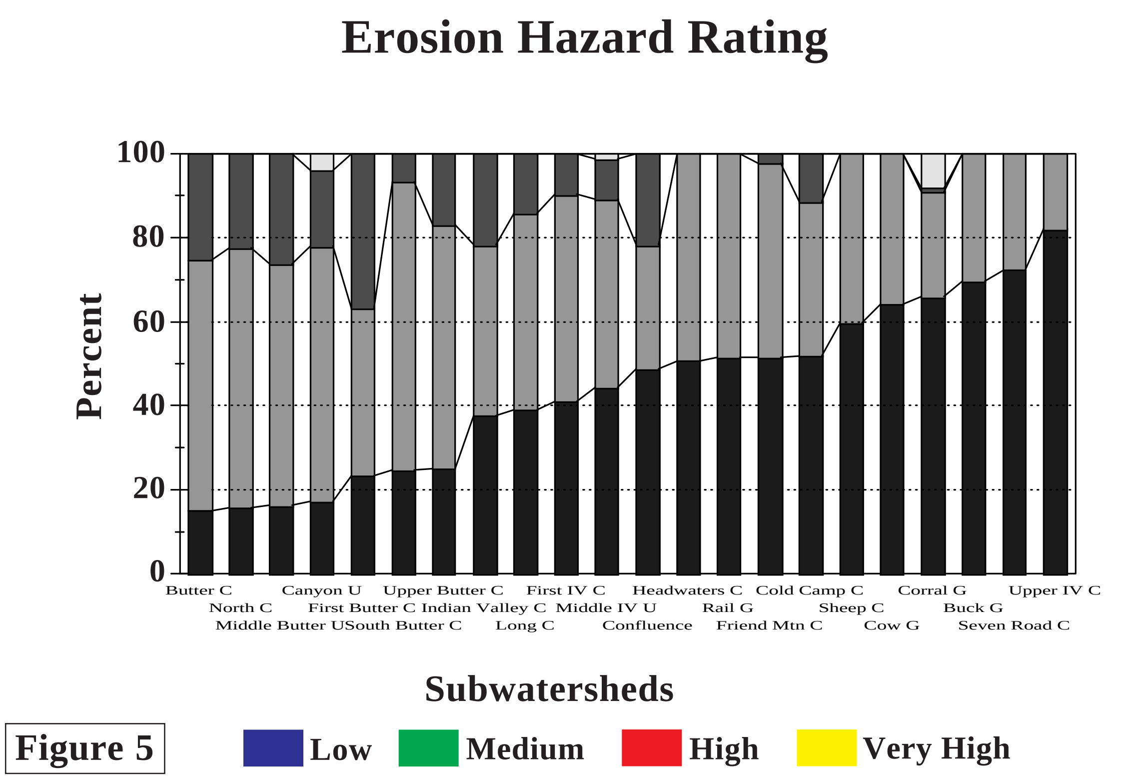


Figure 5

Most of the annual rainfall occurs between October and April. Average annual precipitation is near 40 inches at the confluence of Butter Creek and the South Fork Trinity River. Precipitation increases with elevation and from north to south across the watershed. Average annual precipitation is over 60 inches in the Indian Valley basin located above 4000 feet in the southeastern corner of the watershed. Much of the annual precipitation falls as snow in this upland basin because of its cold air characteristics.

Although precipitation averages for the summer months are normally very small, there are occasional summer thunderstorms that produce high intensity, short duration rainfall events. These events tend to be very localized in nature, and are quite unpredictable. Winter storms, however, are “frontal” in nature, and bring precipitation across a large area for days at a time. The Butter Creek watershed is susceptible to rain-on-snow events. This condition occurs when a warmer than normal winter storm occurs while there is a moist snow pack on the ground. Under the proper conditions the result is a large runoff event as the precipitation melts the snow pack and releases large quantities of water to the stream network (Christner & Harr, 1982, Harr, 1986).

Winds are generally light in the area except for winter storms and occasional gusts associated with localized thunderstorms. Fifty miles per hour winds which accompany storms occur on the average of once in every two years. Winds of up to 80 mph have a recurrence interval of once in fifty years. Winds are influenced by local terrain and tend to be much stronger in passes and over ridgetops. Wind direction is variable, but from the northwest or the southeast 80 to 85 percent of the time (Barrett, 1966).

Channel Types and Stream Conditions

The Butter Creek watershed functions as a typical forested watershed in the Klamath Mountain province. The watershed cycles the water, brought in as precipitation, back to the atmosphere and through the surface stream network in a manner based on the nature of the geology, soils and vegetation of the watershed. As a result of geomorphic development of the Butter Creek watershed, there are two types of stream functions and runoff regimes present. The upland area has low to moderate gradient alluvial channels (low is less than 2 percent, moderate is 2 to 4 percent), moderate to deep soils, and the greatest snowfall.

As a result, runoff is slower to respond to rainstorms and is more seasonal in nature due to the amount of snow accumulation and meltwater runoff. Channel formation in the upland area is unique due to the geologic processes which eroded then uplifted the former lowland areas. Over the period of uplifting the stream channels developed in a stable condition on a relatively steep (4 to 10 percent) landscape. The channels are alluvial and have been historically controlled by vegetation and large woody debris.

When channels on a low gradient (less than 2 percent) landscape are destabilized and then readjust to a stable condition, they recover to a low gradient, meandering channel form. The channels in the uplands area of Butter Creek experienced the downcutting, but subsequent readjustment has left them in a steeper gradient, less sinuous form. They will not return to a meandering form like a low gradient channel would be expected to do. These conditions are important factors to consider when determining desired future condition for the stream channels of the upland portion of the Butter Creek Watershed.

In general, the steeper, canyonlands portion of the watershed has shallow soils and steep gradient, bedrock-confined stream channels. Runoff from this area is typical of storm response flow regimes that respond quickly to rainstorm events. Streamflows remain low during the summer dry months. Winter flows fluctuate from almost a low flow condition to very high flood events within a few hours or days of a rainstorm, depending on intensity and duration.

Figure 6 is a graph of the drainage densities for the subwatersheds of Butter Creek. Generally, most of the higher drainage density subwatersheds are located in the upland portion of Butter Creek watershed, and most of the low drainage density subwatersheds are located in the canyonlands portion. Drainage density may be an indication of the ability of a watershed to deliver water and its sediment to the stream system, although is only one of many such factors. It is influenced by the parent material, geomorphology and fluvial development of the watershed, to name but a few factors. Drainage density can be used to assess the sensitivity of the various subwatersheds in the Butter Creek watershed.

Water Quality and Quantity

Historical records of precipitation and storm runoff reveal that long periods of relatively mild events

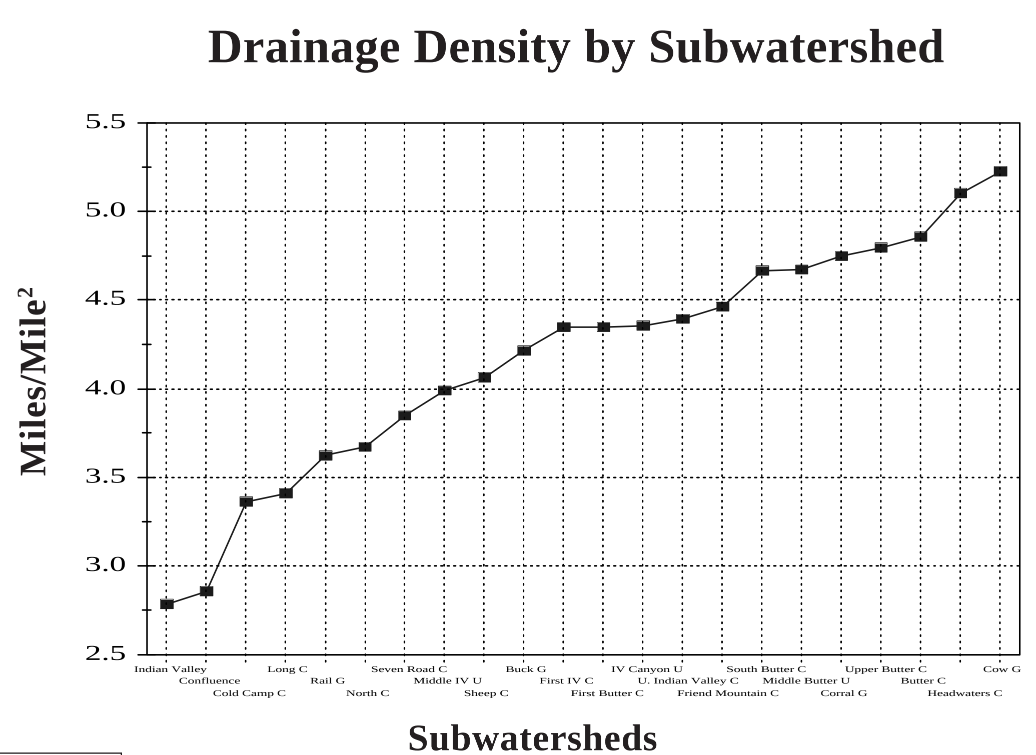


Figure 6

have been interspersed with occasional catastrophic events. High precipitation and flood events have been noted in 1862, 1891 and in 1955. A USGS gaging station located on the South Fork Trinity River below Hyampom calculated peak flood flows of 88,000 cfs in 1964 and 69,000 cubic feet per second (cfs) in 1974 (USGS, 1971). Annual and bankfull peak flows are less than half the magnitude of the historic large flood events. These flows are more important, however, to the quantity and size of the sediment transported through the Butter Creek system over the long term.

Utilizing USGS flow data records for the South Fork Trinity River base flow conditions for Butter Creek were calculated. Typical low flows from the watershed are near 3 cfs during the latter part of the summer dry season. The extreme low flow year for the basin was 1977, when Butter Creek flows were calculated to be less than one cubic foot per second. Notable changes in low flow conditions occurred following the 1987 fires. Streams like the upper reaches of Cold Camp Creek and the tributaries of Seven Road Creek were observed to increase in base flow within a few days or weeks of the fire. This increase in local base flow quantity can be expected to diminish as revegetation and transpiration increase.

The quality of water produced from the Butter Creek watershed is excellent during baseflow conditions. There are few human developments within the watershed that could produce associated pollutants such as pesticides, fertilizers, sewage, industrial wastes, etc. There is a limited amount of dispersed cattle grazing and therefore a low potential for local, short duration bacterial pollution. Giardia is potentially present in all mountain streams in the area and can be expected to be in Butter Creek as well. Testing for alkalinity and Total Dissolved Solids have shown no evidence of chemical pollutants or any extreme concentration of dissolved minerals (USDA FS, 1991). Measurements of pH have been between 7 and 8, which is consistent with other pH measurements measured throughout the South Fork Trinity River system, in managed and unmanaged watersheds (USDA FS, 1991).

Monitoring of water temperature has been done throughout the South Fork Trinity River basin, including Butter Creek, at various times during the last several years. Some data has been collected as early as the 1950s by the U.S. Geological Survey (USGS, 1971). A California Division of Fish and Game stream survey report for Butter Creek recorded water temperatures of 59 degrees on September 10, 1952, and 63 degrees on September 16, 1952 (CDFG, 1952). These temperatures correspond to temperatures recorded for the time of year in recent years (USDA FS, 1990, 1991, 1994a). Although it is generally believed that water temperatures have been elevated due to removal of riparian vegetation, recent monitoring efforts have not produced data to confirm this belief. Water temperatures appear to be consistent with other streams of similar size and elevation in the South Fork Trinity River watershed.

Quantity of water, in the form of large flood events and annual peak flows, has an influence on the water quality, in the form of sediment loads. Large runoff events have triggered and reactivated landslides along Butter Creek and Indian Valley Creek, contributing large quantities of sediment to the downstream system. Because of steep stream gradients Butter Creek and its tributaries are able to transport the majority of all but the largest sediment produced by large flood events out of the watershed and into the South Fork Trinity River. However, large volumes of sediment were deposited in the lower gradient anadromous reach, during the 1964 flood event.

Under annual and bankfull peak flow events the stream system seems to be sediment-rich in the fine-size component. Although Butter Creek is a high energy stream system, it is not flushing out all fine sediment in the anadromous, lower gradient stream reach. As peak flows recede, the fine sediment load; contributed from the watershed upstream; drops out and becomes a rather large component of the stream bed material. There is also a high percentage of cobble and boulder-size material in the anadromous section of Butter Creek, but a low percentage of the gravel size component.

During extreme flood events the system is able to flush all but the very largest sediment out of the channel in steep reaches, and deposit large volumes of sediment in the low gradient reaches. It is during these extreme events that landslides are triggered, introducing large boulder-size material to the system. When the flow regime returns to normal conditions the flows continue to move the material out of the system, except for the larger size materials. Since the present size distribution of lower Butter Creek contains a high proportion of fine material there must be a continual source of fine sediment entering the system upstream.

Water quality and quantity have been altered from pre-settlement conditions by disturbances to the Butter Creek watershed in a manner typical of other forested mountain watersheds in the Pacific Northwest. As described in FEMAT (page V-20, 1993), timber harvest and associated activities can alter the amount and timing of streamflow by changing on-site hydrologic processes. These activities, which include harvest, thinning, yarding, road building and slash disposal can produce changes that are either short-lived or long-lived depending on which hydrologic processes they alter and the intensity of the alteration. Thus, changes in the hydrologic system caused by road building are most pronounced where road densities are greatest. Similarly, the effects of clearcut logging on hydrologic processes are greater than those resulting from thinning.

Changes in hydrologic processes can be grouped into two classes according to causal mechanisms. One class consists of changes in flow regime resulting from removing forest vegetation through harvest. These changes, which are most pronounced in the vicinity of harvested areas immediately following harvest, gradually diminish over time as vegetation regrowth occurs. Processes that depend on the areal extent and size of forest vegetation include interception, transpiration and snow accumulation and melt. These processes, most of which are at least partially energy-dependent, all increase the amount or timing of water arriving at the soil surface and the resultant delivery of water to the stream system. The longevity of changes in these processes brought about by timber harvest generally is on the order of three to four decades and is related to vegetation characteristics such as tree height, leaf area, canopy density and canopy closure (FEMAT, 1993).

A second class of changes in hydrologic processes consists of those that control infiltration and the flow of surface and subsurface water. This class is dominated by the effects of forest roads. The relatively impermeable surfaces of roads cause surface runoff that bypasses longer, slower subsurface flow routes. Where roads are insloped to a ditch, the ditch extends the drainage network, collects surface water from the road surface and subsurface water intercepted by roadcuts, and transports this water quickly to streams. The longevity of changes in hydrologic processes resulting from forest roads is as permanent as the road. Until a road is removed or the drainage system altered to more closely mimic natural drainage patterns, the road will likely continue to affect the routing of water through a watershed (FEMAT, 1993).

In watersheds on the order of 20-200 square miles, increased peak flows have been detected after roading and clearcutting occurred. Higher flows result from a combination of wetter, more efficient water-transporting soils following reduced evapotranspiration, increased snow accumulation and subsequent melt during rainfall, surface runoff from roads, extension of drainage networks by roadside ditches and possibly reduced roughness of stream channels following debris removal and salvage logging in riparian zones (FEMAT, 1993). These higher flows associated with management disturbances have resulted in what has been termed cumulative watershed effects.

Cumulative watershed effects appear to result from the combination of changes to hydrologic processes not only from increased peak flows, but also in erosion and sedimentation rates within watersheds in response to disturbance activities including timber harvesting, site preparation, roading and wildfires. This combination can lead to an acceleration in deleterious off-site impacts, including channel aggradation, degradation, bank undercutting, inner gorge mass wasting and an entire assemblage of impacts to beneficial uses. Specifically, it appears that cumulative impacts are a function of three major factors: (1) the amount of sensitive ground and its relative hazard level within a watershed; (2) the type, level and chronology of land disturbing regimes within a watershed which can influence changes in peak stream- flows, erosion and sedimentation; and (3) the location of those activities relative to sensitive grounds.

For the past 14 years, the Shasta-Trinity National Forests have used a management model to evaluate cumulative watershed effects during timber sale planning. The Shasta-Trinity Equivalent Road Area Model (Haskins, 1986), defines surface erosion potential, mass wasting potential, slope gradient and peak flow characteristics as the primary sensitive land determinants. These characteristics are used to define a watershed's sensitivity and therefore, its threshold of concern (TOC). Historically, there was an attempt to keep management levels, in terms of Equivalent Road Area (ERAs), below the threshold of concern defined for the watershed. During timber sale planning, Best Management Practices were prescribed, including streamside management zone objectives for all streams potentially affected by the proposed activities. If the TOC was exceeded, management and restoration activities were implemented to lower the disturbance levels to acceptable levels.

The first cumulative effects analysis performed for the Butter Creek watershed assessed the potential for management induced peak flow increases. First, the ERA method was utilized to evaluate levels of harvesting and roads for each subwatershed, discussed above, as key contributors to increases in peak flows. **Table 6** shows existing ERA levels for each of the subwatersheds. The highest ERA levels are 19.2 percent in the Seven Road subwatershed, 15.8 percent in Rail Gulch, 15.3 percent in Cold Camp Creek and 12.4 percent in Headwaters Creek. All of these high ERA levels are related to the 1987 fire and salvage activities.

Table 6 TOTAL PERCENT ERA by SUBWATERSHED

Subwatershed	Channel Type*	WSHD Size	Percent ERA 1990s
Buck Gulch	A	584	6.3
Butter Creek	B C	2,320	5.4
Canyon Unit	B C	1,619	8.3
Cold Camp Ck.	B C	1,069	15.3
Confluence	B C	476	3.8
Corral Gulch	A	2,097	8.7
Cow Gulch	A	378	8.4
First Butter Ck.	B C	513	3.3
First IV Ck.	B C	1,020	6.0
Friend Mtn Ck.	A	663	9.6
Headwaters Ck.	A	584	12.4
Indian Valley Ck.	B C	1,207	4.9
Long Ck.	B C	306	3.8
Middle Butter Unit	A	1,673	10.3
Middle IV Unit	B C	1,541	7.0
North Ck.	B C	575	2.7
Rail Gulch	A	397	15.8
Seven Road Ck.	A	638	19.2
Sheep Ck.	A	518	8.7
South Butter Ck.	A	2,055	9.5
Upper Butter Ck.	A	1,857	11.1
Upper IV Ck.	A	1,400	6.5
Total		**23,490**	

*A = Alluvial Channels
BC = Bedrock Confined Channels

Table 7 documents the acres of plantations for each subwatershed. There are over 5,000 acres of plantations within the Butter Creek watershed, which is nearly 20 percent of the area. Similar to the above analysis, subwatersheds with the greatest area in plantations include Seven Road Creek (78.1 percent), Cold Camp Creek (57.4 percent), Rail Gulch (51.4 percent) and Sheep Creek (30.1 percent).

The watershed is well roaded, with over 159 miles of road present. As shown on **Table 8**, road densities range from a low of 1.2 miles per square mile in the Long Creek subwatershed, to 7.3 miles per square mile in the Headwaters subwatershed. Other subwatersheds having high road densities include Rail Gulch (6.8), Cow Gulch (6.1), Cold Camp Creek (5.4) and middle Butter unit (5.3). The average road density is roughly 4.3 miles of road per square mile, which is relatively high. The majority of upland watersheds are heavily roaded, while the canyonlands are not.

Each of these methods indicate that Seven Road, Rail Gulch and Cold Camp subwatersheds are at greatest risk for peak flow increases and potential cumulative effects.

The present condition of the stream network of Butter Creek reflects the historic flood events, the normal flow regime, and the watershed's response to some of the recent disturbances to the soils and vegetation of the area, such as roads, timber harvest and wildfires. In general, the response has been more water flowing in the streams with higher peak flows relative to the conditions under which the channels were formed. This can result in off-site cumulative effects, including channel destabilization and inner gorge landsliding which contribute to degraded water quality and fish habitat.

A second cumulative effects analysis evaluated the sediment sources within the Butter Creek watershed. Since the present condition of lower

Table 7	ACRES of PLANTATIONS by SUBWATERSHED		
Subwatershed	**Subwater-shed Size**	**Totals**	**Percent of Watershed**
Buck Gulch	584	71	12.2
Butter Creek	2,320	318	13.7
Canyon Unit	1,619	390	24.1
Cold Camp Ck.	1,069	614	57.4
Confluence	476	10	2.0
Corral Gulch	2,097	321	15.3
Cow Gulch	378	28	7.4
First Butter Ck.	513	59	11.5
First IV Ck.	1,020	113	11.1
Friend Mtn Ck.	663	139	21.0
Headwaters Ck.	584	139	23.8
Indian Valley Ck.	1,207	169	14.0
Long Ck.	306	40	13.1
Middle Butter Unit	1,673	445	26.6
Middle IV Unit	1,541	243	15.8
North Ck.	575	15	0.2
Rail Gulch	397	204	51.4
Seven Road Ck.	638	498	78.1
Sheep Ck.	518	159	30.1
South Butter Ck.	2,055	498	24.2
Upper Butter Ck.	1,857	424	22.8
Upper IV Ck.	1,400	188	13.4
Totals	**23,490**	**5,085**	**21.7**

Butter Creek includes a high proportion of fine sediment it is evident that there is a considerable source of fine sediment upstream. Sources of the fine sediment are threefold: 1) The Maddox Lake and Confluence slump-earthflows; 2) a variety of smaller point sources such as small slides, un-vegetated erodible soils and unstable channel banks in the uplands, and 3) non-point sources associated with roads and the 1987 burned areas.

The earthflows are developed within the serpen-tine melange and therefore have a very large clay and silt component due to their highly sheared lithology. Both of these features are active and deliver sediment directly into the lower Indian Valley Creek and lower Butter Creek. Periodically, the features become quite active and deliver large amounts of sediment to the system. In addition, there are many smaller landslide features which deliver several cubic yards to several hundred cubic yards periodically to the stream system. These mass wasting features are located through-out the canyonlands and lower Butter Creek. Secondary processes, such as surface erosion, also contribute sediment to the fluvial system from active or recently active mass wasting features.

Many alluvial stream channels in the uplands have been destabilized in the past and have not fully recovered to a stable condition. During large storm events, stream banks are scoured and some downcutting continues in the upper reaches and tributaries, providing above-background sediment to the system. There are also small scattered soil types having granodiorite parent material within the watershed that are considered highly erodible. These soils contribute accelerated sedimentation after surface disturbances have resulted in in-creased surface runoff.

As described previously, there are 159 miles of road within the watershed, and road density is

Table 8	MILES of ROAD and ROAD DENSITY by SUBWATERSHED		
Subwatershed	**Subwatershed Size (acres)**	**Total Miles**	**Road Density Mi/Mi2**
Buck Gulch	584	3.60	3.90
Butter Ck.	2,320	10.53	2.91
Canyon Unit	1,619	9.88	3.90
Cold Camp Ck.	1,069	8.98	5.38
Confluence	476	3.45	4.66
Corral Gulch	2,097	15.95	4.86
Cow Gulch	378	3.64	6.16
First Butter Ck.	513	1.18	1.47
First IV Ck.	1,020	7.65	4.81
Friend Mtn. Ck.	663	4.81	4.62
Headwaters Ck.	584	6.64	7.30
Indian Valley Ck.	1,207	4.97	2.63
Long Ck.	306	0.57	1.18
Middle Butter Unit	1,673	13.92	5.36
Middle IV Unit	1,541	11.68	4.85
North Ck.	575	2.62	2.91
Rail Gulch	397	4.21	6.79
Seven Road Ck.	638	4.26	4.25
Sheep Ck.	518	2.11	2.60
South Butter Ck.	2,055	15.44	4.81
Upper Butter Ck.	1,857	15.43	5.32
Upper IV Ck.	1,400	7.26	3.32
Totals	**23,490**	**158.77**	

great. The majority of the roads have native surfaces, and thus not always resistant to surface erosion. Field observations indicate that road drainage is not well controlled in the watershed. There were many sections which have rills and evidence of water running down long segments of road. County road 316 is insloped and generally carries water 400 to 600 feet before being cross-drained. Some sections were not draining according to design. Where this road surface drainage connects to the active stream system the runoff produced delivers its fine-grained sediment load downstream.

The fires of 1987 burned approximately 43 percent of the watershed. Large woody material was burned within intermittent stream channels. Large wood in these channels serve as grade control structures and sites of sediment storage. When the wood is burned out the channels become destabilized and large quantities of stored sediment are released downstream. In addition, many of the fire-killed trees were salvage harvested, causing further site disturbance. Subsequent reforestation, watershed restoration efforts, natural processes of revegetation and dead trees falling into the intermittent stream channels have helped the area move toward hydrologic recovery.

A third cumulative effects analysis determined the relative sensitivity of the 22 subwatersheds in the Butter Creek watershed. We initially evaluated the utility of using physical characteristics such as slope steepness, mass wasting hazards, surface erosion hazards and channel density to rank the watersheds. After numerous discussions we decided that the best way to rank the watersheds, in terms of their sensitivity to peak flows and sediment, was on the basis of process. There are two different channel types, which we have previously described: upland alluvial channels and canyonland, bedrock confined channels. Each have different processes and factors which affect their stability and function.

The upland channels were destabilized initially when significant riparian vegetation was removed as a result of over-grazing in the late 1800s. Many of these channels responded by downcutting and gullying headward. In the intervening years the channels adjusted, re-established floodplains, and again approached stability. Subsequent down-cutting and adjustments were made in tributaries and in the main channels as other upland disturbances and the large runoff events of 1955 and 1964 occurred. Presently the upland channels are less sensitive to cumulative effect changes, primarily because they have eroded down to bedrock controls and have adjusted sufficiently to normal stormflows and sediment loads.

The bedrock confined channels have not been directly affected by management disturbances. They are, however, the site of active mass wasting, triggered by peak flows undercutting toe zones of slides and inner gorge debris slides. The channels are stable, but the immediate side slopes remain sensitive to peak flow destabilization.

As shown in **Table 6**, the following watersheds predominantly have alluvial channels: Buck Gulch, Cow Gulch, Upper Butter Creek, middle Butter Unit, South Butter Creek, Corral Gulch, Headwaters Creek, Rail Gulch, Seven Road Creek, Sheep Creek, Friend Mtn. Creek and Upper Indian Valley Creek. The remaining watersheds, including middle Indian Valley Unit, Cold Camp Creek, Indian Valley Canyon Unit, First Indian Valley Creek, First Butter Creek, Butter Creek, North Creek, Indian Valley Creek, Confluence Unit and Long Creek are considered to have bedrock confined channels.

Fisheries

The Butter Creek Setting

The Trinity River drains a mountainous area of nearly 3,000 square miles and is the largest tributary to the Klamath River. Up to one-half of the total annual migrations of salmon and steelhead entering the Klamath River from the ocean originate from and spawn within the Trinity River. At the turn of the century, it is estimated that the annual populations of chinook salmon entering the Klamath River approximated one-half million.

Numbers of salmon and steelhead within the entire river system have declined by 90 percent since the early 1900s, with much of this decline occurring within the past four decades. The primary reasons include the effects of accelerated human disturbances in the watershed, fish harvest and natural events such as floods and droughts.

Intensive commercial harvest of the resource peaked in the late 1970s and early 1980s at a time when the habitat in the river was just beginning to recover from the effects of the 1964 flood. A drought ensued in 1987 and continues today. These two factors are only the most recent contributors to wild salmonid stock declines within the Trinity River Basin. Many of these stocks appear close to being threatened with extinction if population declines do not reverse soon.

The South Fork Trinity River is the Trinity River's largest tributary, draining nearly 1,000 square miles. It is still northern California's largest undammed river. Despite the lack of dams, diversions and urban development, the native salmonid resource has dwindled in magnitude similar to the fractions occurring in the mainstem Trinity as a consequence of all the other aforementioned factors.

Anadromous and Resident Fish Habitat

Even though the South Fork Trinity River watershed is gradually recovering from the catastrophic impacts of the 1964 flood event, populations of fall and spring chinook salmon and summer steelhead have not responded, despite harvest closures. It may no longer have the capability to produce the large number of wild chinook or steelhead as it did at one time. By concerted agreement the river is currently managed as a wild free-flowing system without any hatchery mitigation efforts unlike the mainstem Trinity River which is heavily subsidized by releases from the Trinity River Hatchery.

The mainstem South Fork Trinity River (below Hyampom Valley) remains high to moderately impacted (low habitat quality) from the flood of 1964. Overall, however, the quality of the South Fork Trinity River Basin is improving. Tributaries to the mainstem Trinity River and the South Fork have been rated as having moderate to high quality anadromous fish habitat at the present time.

The Butter Creek watershed is located in the midriff of the South Fork Trinity River basin about 3.5 miles upstream of the its confluence with Hayfork Creek, in upper Hyampom Valley. Anadromous fish habitat is found only in the lower 1.6 miles of Butter Creek (**Plate 10**). Upstream migration is physically limited by a waterfall barrier. Resident fish habitat is not only found in the lower 1.6 miles of Butter Creek, but also for 10 miles above the anadromous fish waterfall barrier in both upper Butter and upper Indian Valley Creeks.

Butter Creek is one of eleven high priority subwatersheds or river areas identified as important to the recovery or continued stability of anadromous fish stocks in the upper South Fork Trinity River basin (Irizarry et al., 1985).

Recent habitat typing surveys have noted an insufficient frequency and volume of pool habitats in the anadromous reach of Butter Creek compared to what would be expected along a stream reach of the size and characteristics of Butter Creek. Personal communications with Tom Lisle (1994) and Chris Knopp (1994) has promoted the idea that historic, bedrock-defined pools may have been filled with very large rubble and boulders originating from inner gorge landsliding during the 1964 flood event. Much of this material may be so large that the average range of peak flow events may be unable to transport it. Wherever true, this material may need to be reduced in size by physical and chemical processes before it can be transported, thus allowing these pools to regain original depth. Management options to physically remove this material are limited by cost-effectiveness considerations, thus making the effect of this phenomenon irreversible within the time frame of decades or centuries.

As discussed in the Hydrology portion of this chapter, the lower anadromous section of Butter Creek has a large proportion of fine-sized sediment as a component of the bedload. This fine sediment fraction is being supplied to the anadromous reach from the watershed upstream in a manner that allows for accumulations in volumes higher than other tributaries of the South Fork Trinity River in similar geologic terrain (USDA FS, 1990). Presence of this excess fine sediment is another detriment to the quality of fish habitat in the anadromous reach of Butter Creek.

Anadromous Fish Stocks at Risk

Higgins et al. (1992a) identified "49 naturally spawning Pacific salmon and anadromous trout stocks at varying degrees of risk, in the north coast region of California from Russian River north to the Oregon border. Of these, 20 are at high risk of extinction, three are at moderate risk of extinction and 26 are of special concern."

Higgins et al. (1992a) classified Pacific anadromous salmonids in northwestern California stocks into three risk categories: A = high risk of extinction, B = moderate risk of extinction and C = stock of concern. As it pertains to the Trinity River Basin, the following fish stocks were identified according to the aforementioned delineation:

1. Spring Chinook Salmon
   South Fork Trinity River (A)
   Trinity River (C)
2. Fall Chinook Salmon
   South Fork Trinity River (C)
3. Coho Salmon
   Trinity River (C)
4. Summer Steelhead
   South Fork Trinity River (A)
   North Fork Trinity River (B)
   New River (B)

Currently, fall and spring chinook populations are present in the South Fork Trinity River. Coho salmon are extirpated from the South Fork except for an occasional stray from the Trinity River Hatchery. Although not currently found in the South Fork Trinity River, coho salmon did utilize the basin as late as the early 1950s. Neither chinook salmon race is currently present in Butter Creek although occasional chinook pairings spawn at its confluence with the South Fork. It is unknown as to whether the anadromous habitat of lower Butter Creek can currently support either chinook or coho salmon.

Two races of steelhead are indigenous to the South Fork Trinity River: the spring-run (summer) steelhead and the winter-run steelhead. The U.S. Forest Service recognizes the summer steelhead as a sensitive species owing to its limited habitat preferences and low population numbers. Winter steelhead and Pacific lamprey also currently utilize the South Fork basin. Winter steelhead enjoy a wide distribution in the basin as attested to by a large number of the tributary habitat typing surveys.

Winter steelhead are predominant anadromous fish species in lower Butter Creek. Although present in small numbers in the South Fork, utilization of Butter Creek by summer steelhead for spawning and rearing remains largely undocumented.

Recently, petitions have been received by the National Marine Fisheries Service (NMFS) to list coho salmon and by the US Fish and Wildlife Service to list all steelhead trout as threatened species.

Juvenile Steelhead Densities

Young-of-the-year (Age 0+) steelhead juveniles in Butter Creek were observed and measured at a density that rivalled some of the least disturbed tributaries to the Trinity River (0.256 fish per square meter). This density suggests that the available spawning habitat for steelhead (approximately 12,500 square meters or 0.4 percent of the total stream substrate area) may be fully utilized by spawning adults and is of reasonably accommodating quality. Results of bulk sampling of stream substrates in 1989, that included gravel deposition areas, averaged 37.4 percent fine material less than 3.35mm in diameter in the anadromous reach of Butter Creek (USDA FS, 1990).

The densities of Age 1+ and Age 2+ steelhead in Butter Creek matched results of other tributaries in the South Fork Trinity River that began with many less Age 0+ steelhead juveniles. Because water temperatures were never measured above 65 degrees F., other habitat variables are apparently limiting for steelhead beyond Age 0+. A relative lack of pools and cover in conjunction with high water velocities in winter associated with the steep gradient (2.5 to 7.5 percent) may be reasons why older steelhead juveniles do not hold and rear in large numbers within lower Butter Creek. Additionally, existing cover is provided primarily by large rock substrate with woody material seldom found (Brock, 1994).

Other Fish Stocks

Within lower Butter Creek, stream surveys have documented not only the presence of juvenile steelhead, but also Pacific lamprey, rainbow trout, speckled dace and the Klamath small-scale sucker. Resident rainbow trout are the only trout species currently found upstream of the anadromous fish barrier.

The Terrestrial Biological Environment

Vegetation

Current vegetative conditions were analyzed with the use of the 1992 Ecological Unit Inventories of potential natural vegetation community and existing vegetation for the watershed. This procedure consisted of photo interpretation and vegetation community delineation of aerial photographs from 1990. Delineated stands were classified according to LMP timber stratification (USDA FS, 1993b), wildlife habitat stage (Mayer and Laudenslayer, 1988) and seral stage (USDA FS 1994b). The delineations and classification were extensively field verified and additional data collected.

Landscape Ecology

To adequately describe broad vegetative patterns and disturbance regimes the watershed may be subdivided into three areas. These are the 1987 burned areas, the Indian Valley uplands and the Butter Creek canyonlands.

As has been previously discussed, the Indian Valley upland area is a relatively flat area with low gradient alluvial streams, including most of Indian Valley Creek. It is characterized by middle to late seral coniferous forests which are highly fragmented by numerous, well dispersed, plantations. An extensive road network has been established throughout the area.

The 1987 burned area is predominately located in the upland portion of the watershed. It is characterized by extensively burned sites, which are the result of the 1987 wildfires. Due to the fire and subsequent salvage activities, extensive plantations with patches of remnant, late seral, mixed conifer stands are present. Roading is also extensive in the burned area, averaging greater than five miles per square mile.

The Butter Creek Canyonlands is the area that lies within the lower, steeper portions of the Butter Creek watershed. It is comprised of closed canopy, late seral, Douglas-fir and mixed conifer forests. Road density is lower than the upland, averaging less than three miles per square mile.

Plant Communities

Current vegetation patterns based on the LMP timber stratification of vegetation types in the Butter Creek Watershed tend toward fragmentation and a movement from mixed conifer and Douglas-fir dominated communities to ponderosa pine over time. Fifteen vegetation types have been mapped in Butter Creek (**Table 9, Plate 11**). The matrix, the most abundant and connected vegetation type, consists of mixed conifer forest (CX). With an area of 8661 acres, the matrix covers just over one third of the landscape. Most of this is found in the Indian Valley Uplands. Douglas-fir forest (DF) makes up the matrix land of the Butter Creek Canyonlands and is the third most prominent vegetation type in the watershed. Over 4100 acres of DF are mapped, which make up nearly one fifth of the watershed. A large portion of the watershed is comprised of plantations, which are distributed in a patchy manner. The smaller patches are the result of clearcut harvest while the continuous large patches are the result of salvage logging after fire (UX). The majority of these have been replanted to ponderosa pine. These plantations comprise 5020 acres, or 21 percent of the landscape. Much of this fragmentation has occurred in the mixed conifer and Douglas-fir forested areas. The remaining area has a patchy distribution with vegetation communities reflecting the highly diverse topographic elements and its disturbance regimes. Topographic elements of most influence are slope and aspect. Fire is the disturbance regime having the most effect on the distribution of these communities.

Table 9	1990 TIMBER STRATUM - VEGETATION TYPES		
Vegetation Type	**Percent of Watershed**	**Acres**	**Number of Patches**
Douglas-fir	32.7	7,680	163
Jeffrey Pine	2.7	641	24
Ponderosa Pine	1.6	376	9
Mixed conifer	36.9	8,661	173
Hardwoods	1.9	448	8
Montane shrubs	1.0	227	5
Herbs	1.4	335	1
Grass	0.002	37	3
Streamside	0.002	52	5
Plantations	21.3	5,018	333
Cultivated	0.001	12	1

Plant community seral stage information follows the same trend. For the watershed as a whole 27 percent is in late seral and old forest conditions, 45 percent in mid-and early mature stages and 29 percent in very early mature plantations and shrub or herb seral stages (**Table 10, Plate 12**).

Table 10	**1990 ECOLOGICAL SERAL STAGE DISTRIBUTION**			
Seral Stage	**Percent of Watershed**	**Acres**	**Number of Patches**	**Max Patch Size**
Old Forest	5.4	1,273	32	308
Late Mature	21.2	4,983	109	460
Mid Mature	30.5	7,151	157	773
Early Mature	15.0	3,523	70	348
Very Early Mature	19.8	4,659	334	244
Shrub	4.5	1,048	11	717
Herb	3.6	853	17	200
Totals	**100**	**23,490**	**730**	

Nearly one third of the early seral stage acres, however, are in the area burned over in 1987. For the most part, these are post-1987 fire plantations and shrub fields. The 1987 burned area has a seral stage distribution of 12 percent in remnant late seral and old-growth, 35 percent in mid-seral stages and 53 percent in very early, shrub and herb seral stages. The Indian Valley Upland has a seral stage proportion of 30 percent in late seral and old growth, 48 percent in mid-seral and 22 percent in plantations, shrub and herb seral stages. The Butter Creek Canyonlands, with relatively little timber harvest activity, has a seral stage distribution of 32 percent in late seral and old-growth, 52 percent in mid-seral stages and 16 percent in very early, shrub and herb seral stages.

There are several plant communities found in the Butter Creek watershed that are small in areal extent, but contribute to the overall diversity of the landscape. These include the white oak communities near the mouth of Butter Creek, the Oregon ash and other wetland communities at Maddox Lake, and dry meadows throughout the watershed.

Potential Natural Terrestrial Vegetation Communities

The vegetation patterns and plant community composition and structure of the Butter Creek flora are controlled by four environmental gradients. They are elevation, precipitation, soil texture as it determines available water capacity of the soil and the chemical composition of the soil-forming parent rock.

A standardized, hierarchical classification system for potential natural communities is used by federal agency ecologists as well as academicians and non-governmental organizations (USDA Forest Service, 1993d). The plant association is a potential natural plant community of definite floristic composition and uniform appearance. It is the lowest level of potential natural community classification. For analysis at the watershed level, mapped plant associations were aggregated into groups with like environmental indications and responses, also known as sub-series. The series is the next highest level of hierarchical classification. Series level analysis is useful for broad, general regional and provincial questions. The series found in the Butter Creek watershed are described here to facilitate the understanding of the environmental conditions that the series indicate.

There are five distinct potential natural vegetative series within the Butter Creek watershed (**Plate 13**). At higher elevations where temperatures are cooler and soil moisture is abundant, a few white fir plant associations are found in Butter Creek. Jeffrey pine is the climax species in frost pockets and on highly serpentinized soils. As soil temperatures and winter air temperatures decrease, Douglas-fir plant associations dominate. Mixed conifer series occur on warmer, drier sites characterized by high plant moisture stress, soil drought and lighter snowpacks. Grey pine and canyon live oak series associations are found on harsh, dry, low elevation sites with skeletal soils and rock outcrops.

There are 2322 acres of white fir series potential natural communities in the watershed. Most of these forests are found in the Indian Valley uplands, near Friend Mountain and Corral Gulch. These stands are dominated by white fir with lesser amounts of Douglas-fir, incense cedar and sugar pine.

The moist white fir group or sub-series is associated with stream courses near Corral Gulch. California hazelnut and dwarf Oregon grape are the common understory indicators of these plant associations. They are most commonly found on densely forested riparian areas or moist lower slopes. The common species found in the herbaceous layer include Hooker's fairybells, rattlesnake plantain, bedstraw, stream yellow violet, one-sided wintergreen and false Solomon's seal.

A portion of the moister white fir plant associations have huckleberry oak as a common understory indicator. These occur on north and west facing draws and ridges where cool temperatures and shallow slopes are common. They are found in Corral Gulch and on northwest facing slopes near upper Butter Creek.

The mesic white fir plant associations are found between 3000 and 4000 feet elevation. Giant chinquapin is a common hardwood associate on mesic north and east facing slopes. Snowberry and prince's pine are the primary indicators for these associations. The herb layer in the mesic group may be quite diverse, species such as wintergreen, prince's pine, wild iris, starflower, trail-plant, little prince's pine and hawkweed are common.

Jeffrey pine dominates on highly serpentinized substrates and in cold pockets, primarily on upper Indian Valley Creek. There are 939 acres of Jeffrey pine in the Butter Creek watershed. These forests may also include smaller amounts of Douglas-fir, incense cedar, sugar pine and ponderosa pine. The dominant shrub species on the harsher sites is buckbrush. The dominant herbs include wild iris, prince's pine, yarrow and hawkweed. The grass layer is often quite dense and diverse due to the open stand conditions. The grass layer is dominated by California fescue, Idaho fescue, bluegrass and western fescue.

The plant associations of the Douglas-fir series can be segregated into three distinct groups indicating variation in environmental conditions within the series. They are: moist/riparian (605 acres), mesic/canyon live oak (4277 acres) and dry/California fescue (801 acres).

The conifer canopy for the most part is comprised of Douglas-fir, white fir, sugar pine, ponderosa pine and incense-cedar. The most common hardwood species are canyon live oak, madrone, giant chinquapin and black oak.

The moist Douglas-fir plant associations are found consistently along the South Fork of the Trinity River and the corridor of upper Indian Valley Creek from the mouth to the confluence with Corral Gulch, where it changes to Jeffrey pine plant associations. For the most part, big leaf maple is consistently found on these sites. Common understory associates include California hazelnut, dwarf Oregon grape, snowberry and poison oak. Common herbaceous species include swordfern, Hooker's fairybells and false Solomon's seal.

The mesic Douglas-fir plant associations are dominated by the presence of Canyon live oak, which can be quite dense. This association is commonly found throughout the Butter Creek portion of the watershed. The shrub layer contains wild rose and snowberry. The herb layer in comprised of prince's pine, wintergreen, hawkweed, rattlesnake plantain, wild iris, trail plant, little prince's pine, starflower, twinflower and bedstraw. The grass layer may be diverse, with western fescue, mountain brome, California fescue and oniongrass as the most common species.

The dry Douglas-fir plant associations are dominated by an overstory predominately of Douglas-fir with white oak in about one half of the sites in Butter Creek. The shrub layer is sparse but may include poison oak and wild rose. The herb layer may include mountain sweetroot, yarrow, bedstraw and wild iris. The grass layer is prominent, with California fescue being the dominant species along with smaller amounts of Lemmon's needlegrass and bromes.

The mixed conifer plant associations are the most widespread in the watershed. They dominate in the Indian Valley uplands. It is useful to subdivide this series into three broad groupings based on climatic indication. These are mixed conifer/riparian-mesic, mixed conifer/dry and the very extensive mixed conifer/canyon live oak.

There are 6948 acres of the mixed conifer/riparian-mesic group in the Butter Creek watershed. Most of the riparian mixed conifer associations are found along the lower reaches of South Butter Creek and Cold Camp Creek. The more mesic associations are found extensively in the Indian

Valley uplands, specifically in Corral Gulch, Upper Indian Valley Creek, Cold Camp Creek and the Indian Valley Canyon Unit. These plant associations are found on all aspects but are most common on east and north slopes. They occur on more productive soils than the other groups in the mixed conifer series.

The overstory of this group is usually comprised of various combinations of ponderosa pine, white fir, giant chinquapin, Douglas-fir, incense cedar and smaller amounts of sugar pine. The common understory species include California hazelnut, Oregon grape, snowberry, wild iris and prince's pine.

The mixed conifer/dry plant associations are the least extensive of the mixed conifer groups, covering 2905 acres. The dry plant associations are intermediate in productivity, occurring primarily on west and south slopes. They are most common in the Friend Mtn. unit, upper First Indian Valley Creek and Butter Creek.

The group is characterized by an overstory comprised of several conifer species including ponderosa pine, white fir, incense cedar, Douglas-fir and sugar pine. The understory is usually shrub poor, except where huckleberry oak or wedgeleaf ceanothus occur in abundance. Common herbaceous species include California fescue, wild iris and white hawkweed.

The most common plant associations in the mixed conifer series are those of the mixed conifer/ canyon live oak group, comprising 4128 acres of the watershed. These plant associations occur extensively in the canyonlands and other steep sites with rocky soils, commonly on south or west slopes. The sub-watersheds in which this group is common include upper Butter Creek, middle Butter Unit, South Butter Creek and lower Indian Valley Creek. These plant associations are characterized by an abundance of canyon live oak in the overstory and understory, accompanied by Douglas-fir, ponderosa pine, incense cedar, madrone and to a lesser extent, white fir.

The gray pine plant associations are fairly rare (226 acres), but ecologically quite important. They represent some of the least productive and most sensitive sites in the watershed. They occur in small adjacent areas of lower Butter Creek and lower Indian Valley Creek. They are found on dry, south-facing slopes having skeletal rocky soils. They are characterized by the presence of large amounts of canyon live oak with scattered individual gray pines.

Riparian Vegetation Communities

Variability of riparian vegetation composition in the Butter Creek Watershed can be explained by variation in soil, geomorphology, stream flow regime and temperature (as seen by change in elevation). Within the Butter Creek watershed, the geomorphology can be used to divide it into two distinct areas: a portion of the Indian Valley Uplands, characterized by drainages with side-slopes of gently sloping topography, and the Butter Creek Canyonlands, with drainages having side-slopes of moderate to steeply sloping terrain.

The Indian Valley Upland includes Indian Valley Creek and tributaries down to and including Corral Gulch, and the upstream one half of the Butter Creek watershed. Most of the smaller streams become dry in the summer and early fall months. During a field check of streams in March 1994, after a very dry winter, many of the ephemeral and intermittent channels of this area did not have free flowing water. The sideslopes of these drainages are generally dry and usually have mixed conifer plant associations, with an overstory of Jeffrey pine, ponderosa pine, incense cedar and some Douglas-fir. The overstory streamside vegetation can also be classified as mixed conifer.

The flow regime of individual streams affects the composition of the understory vegetation. In a continuum from the driest ephemerals to the wettest perennial stream (Indian Valley Creek), the understory streamside vegetation ranges from herbaceous vegetation such as grasses and rushes on the dry sites, to a high cover of shrubs such as willow, gooseberry and Oregon grape along with herbs on mesic sites, to willow and herbs with no overstory on wet sites.

Soils associated with moderate sideslopes in the uplands, and steep sideslopes of the canyonlands, occur throughout the rest of the watershed. Drainage densities are lower for these areas. Even on the steepest of slopes, the vegetation looks moister than the vegetation along similar streams of the uplands. During a field check in March 1994, water was still flowing in most of the intermittent streams in the steeper areas. This is in contrast to the uplands where shrubs were observed along ephemeral streams. This contrast between flow regimes in the uplands and canyonlands is due to deeply incised drainages in the canyonlands area lower in the watershed and intercept groundwater.

Within the canyonlands group, changes in elevation as well as stream flow regime are associated with differences in vegetation composition. The elevation of this watershed varies from 1460 to 4895 feet, thereby resulting in a gradient in overstory vegetation from a dominance of Douglas-fir in the lower elevations to white fir in the higher elevations. Sideslope overstory vegetation is normally Douglas-fir, canyon live oak and some ponderosa pine between 1700 to 4460 feet. From 3150 to 4460 feet, the overstory vegetation composition is white fir, Douglas-fir, canyon live oak and ponderosa pine.

The Douglas-fir dominated communities vary depending upon flow regime, stream width and, once again, elevation. The vegetation composition along ephemeral streams does not vary substantially with elevation. Shrubs such as honeysuckle, elderberry and gooseberry are consistently found. The overstory composition differs between the intermittent and perennial streams. Big leaf maple can be found along both intermittent and perennial streams throughout the Douglas-fir communities. Where the perennial stream is wide enough for direct sunlight to penetrate to the stream, alder becomes part of the overstory composition. At higher elevations, from 2100 to 4460 feet, pacific yew also becomes part of the vegetation composition. Shrubs found along intermittent and perennial streams include California hazel, Oregon grape, dogwood and, in the low elevations, poison oak.

Riparian plant communities with an overstory dominated by white fir can be categorized into three plant communities dependent upon flow regime and elevation. Along ephemeral streams, understory vegetation is dominated by shrubs such as California hazel, pinemat manzanita, Oregon grape, deer brush, snowberry and others. The other two communities are found along intermittent and perennial streams. Between 3150 and 4070 feet, big leaf maple and Pacific yew can be found with an understory of shrubs listed above. Above 4070 feet, big leaf maple is absent, leaving only Pacific yew and white fir in the overstory. Willow can be a consistent component of the shrub layer.

The Douglas-fir and white fir communities overlap between 3150 and 4460 feet. The overlap is probably due to sideslope depth of drainage (steepness), aspect, variation in soil moisture retention and possibly errors in classification. Sideslope depth affects the amount of solar radiation the vegetation is exposed to. In general, relative humidity surrounding riparian areas varies with the depth the drainage is incised and the steepness of the sideslopes. These two factors protect the riparian areas from solar radiation. These conditions should reduce the lower elevation limit to which white fir can dominate, especially when the stream is perennial or intermittent.

Using this same rationale, drainages with shallow, less steep sideslopes are less protected from solar radiation and have lower relative humidity. Under these conditions, Douglas-fir tends to dominate, especially when the stream is ephemeral. Aspect is also important in modifying the amount of solar radiation the vegetation is exposed to, especially along ephemeral drainages. Southerly slopes receive more radiation than the north facing slopes. Therefore, conditions would be less favorable for white fir on south slopes than on north slopes at the lower elevations of the white fir range. Vegetation along ephemerals would be affected most because these drainages lack soil moisture which might compensate for the increased solar radiation. Soil moisture retention also affects the range of white fir. Soils with high moisture retention can reduce lower elevation limit for white fir by increasing the available moisture and increasing the tree's ability to transpire in the warmer elevations.

Detailed descriptions of the riparian plant communities may be found in **Appendix B** and are on file at the Shasta-Trinity National Forest Supervisor's Office.

Riparian Condition

Riparian conditions along the streams and springs within the Butter Creek watershed reflect the same conditions and events that were noted for stream channel conditions. Present riparian form and function are in a degraded condition relative to pre-human disturbance. Riparian conditions are most altered in the upland area where streams have downcut and water tables have been lowered resulting in a net loss of wetland and riparian habitat. There are also many roads located within or crossing riparian areas in the uplands.

In the bedrock confined channel reaches of the stream channel system, riparian areas have been less affected because there is less human disturbance and the system is not as sensitive. Throughout the watershed, on National Forest System lands, streamside management zones (SMZs) have been used for intermittent and significant ephemeral stream channels since 1980. Prior to this time only perennial streams were protected. Based on this, approximately one half of the clearcut harvest units in Butter Creek have SMZs. The effectiveness of the zones in maintaining riparian function is variable. Ephemeral streams have been impacted by harvest activities, piling and burning. Intermittent and perennial streams were generally only impacted by selective harvesting. An analysis of streams and plantation locations indicates that nearly 12 percent of all streams in Butter Creek are in plantations. There are 599 acres of plantations within the interim Riparian Reserves. These plantations may require treatment to assure the restoration of riparian ecosystem function in the most timely manner.

Plant Species of Concern

Sensitive and Endemic Plants

The Butter Creek watershed is part of an area of the Klamath Province noted for its high level of plant species diversity. The relationship between habitat, climate and edaphic diversity, and correlated plant species diversity has been well documented (Mason, 1946, Stebbins and Major, 1965, Kruckeberg, 1969). In particular, a high proportion of ultramafic soils and serpentine rock intrusions in the area has given rise to a unique assemblage of plant species which have evolved on those sites. These plants are known as serpentine endemics, since they are restricted in nature to these sites. Throughout the world, serpentine endemic species are often considered rare, since their habitats are limited and island-like, leading to unique adaptations and an increased potential for endangerment.

One Forest Service listed sensitive plant, Niles' madia (*Madia doris-nilesiae*), is known to occur in the Butter Creek project area. Sensitive plants are those which are known or highly suspected to occur on National Forest System lands and are considered viable candidates for federal or endangered classification under the Endangered Species Act of 1973. There are five populations of Niles' madia within the area and one just outside and adjacent to the watershed boundary; suitable habitat for this species occurs intermittently throughout the watershed, on rocky serpentine slopes at elevations ranging from 2400 to 4400 feet. Approximately 25 populations total are known for this serpentine endemic which is only known from the Shasta-Trinity National Forests, in Trinity and Tehama Counties.

In addition, several other plant species occur within the watershed area which are considered "watch list" species (Skinner and Pavlik, 1994). While not listed as sensitive, these plants may be locally common to a specific habitat on the Shasta-Trinity National Forests (e.g., serpentine-Jeffrey pine woodland), but are rare or uncommon elsewhere in the state. Management for these plants is the same as for sensitive species.

Rare plants in the Butter Creek watershed may be grouped into several natural ecological groupings based on their preferred habitats. These groupings include the serpentine endemics, rock dwellers and forest plants. There are no obligate riparian sensitive plant species in the Butter Creek watershed area.

Serpentine endemics: The serpentine endemics, as mentioned above, are adapted to heavily serpentinized, rocky or gravelly ultramafic substrates, often called serpentine barrens or semi-barrens. The openness of these sites is naturally maintained by the infertility of the substrate and a soil chemistry that is inhospitable to most plants. The amount of suitable habitat available for this group of plants is governed by geological and climatic events, ie., how much suitable ultramafic substrate is exposed at the right elevation and aspect. It is not presently known if any of these plants require fire for germination. Fire plays a minor role in maintaining these habitats, because the plants are often not close enough to each other to carry a fire across such a site. Weathering of the substrate over geological time will eventually make it unsuitable as habitat for these plants. This group of plants will either adapt at the same time scale to the new habitat or disperse to more recently exposed ultramafic outcrops. The serpentine assemblage includes these watch list species: Dubakella Mountain buckwheat (*Eriogonum libertini*), Beegum onion (*Allium hoffmanii*), Siskiyou onion (*A. siskiyouense*), serpentine milkweed (*Asclepias solanoana*) and Tracy's lomatium (*Lomatium tracyi*). Dubakella Mtn. buckwheat is considered endemic to the Shasta-Trinity National Forests, since over 90 percent of all known populations of the plant occur here. Four of the known forty-two populations of this species occur in the analysis area. It occurs at elevations between 2400 and 5500 feet.

The sensitive species Niles' madia (*Madia doris-nilesiae*), an annual plant, is adapted to ultramafic soils which are more weathered and somewhat less serpentinized, and which may support open Jeffrey pine woodland with wedgeleaf ceanothus and manzanita. This plant grows in openings between the shrubs. The habitat is maintained by fire, which opens up the shrub layer and provides both nutrients and light for the madia. Although the amount and distribution of suitable ultramafic soil determines the upper limit of habitat potentially available for Niles' madia in the Butter Creek watershed, the fire regime strongly influences the amount of habitat actually available for colonization by this species in any given year. Without fire, not only is the absolute quantity of habitat decreased, but the available microsites become more isolated from each other, making colonization of new sites less likely.

Potential sources of threats include mining, overgrazing, altered soil chemistry from the use of fertilizers and mulching, seeding of exotic grasses on serpentine, and noxious weeds or environmental pest plants. Threats from logging are minimal since these species do not generally occur in areas suitable for sustainable timber management. Salvage and/or hazard tree removal in serpentine habitats is likely to benefit several of these species by releasing them from competing vegetation.

Rock dwellers: Pale-yellow stonecrop and Heckner's stonecrop (*Sedum laxum* ssp. *flavidum* and *S. laxum* ssp. *heckneri*) have been reported from the Butter Creek Caves area of the watershed. Pale yellow stonecrop is currently listed as a sensitive species, but the Forest Botanist has proposed de-listing this subspecies due to its relative abundance and lack of threat status on the Shasta-Trinity National Forests. Its status will continue as a watch list plant, along with its close relative Heckner's stonecrop. These succulent plants are obligate rock dwellers, and are found on ultramafic, volcanic and metasedimentary rock outcrops. Distribution of suitable habitat is determined by geology and climate. These plants are not known to be restricted to any particular plant community, and have been found in serpentine chaparral, Jeffrey pine woodland and mixed conifer forest. They do not appear to be aspect dependent. Weathering of their rock habitat will eventually eliminate some suitable habitat over time, but presumably other rock outcrops will be produced. These taxa have occasionally bene-fitted from road cuts which produced a rock face suitable for colonization. Landslides probably aid in dispersal of these species. Fire is relatively unimportant in maintaining suitable habitat, except where fire exposes previously shaded rock outcrops that then become better habitat for the sedums. Detrimental effects to rock dwellers may occur from rock quarrying, road building and collecting.

Forest: Forest dwelling plant assemblages in the watershed tend to be widespread; fewer rare plant species are found in the forest, since the forest habitat is dominant and does not present a rare or unique set of conditions. Exceptions are those plants which are fire or disturbance dependent, require openings or are otherwise poor competitors, or those which are dependent on old-growth forests. Fire dependent species would have prospered from the periodic burning which Native Americans practiced. It is not presently known, however, which of the plants of concern occurring in the analysis area are obligate fire followers (seeds require fire for germination). Many annuals and pioneer native plants find suitable habitat along roadsides and plantations, exploiting those niches in lieu of the prehistoric fire-created habitats of their evolutionary past.

Redwood lily (*Lilium rubescens*), a watch list species, grows in chaparral, chamise, or among shrubs in open mixed conifer forest. Periodic fire is important to this species. Its bulbs may remain dormant for many years until fire or mechanical disturbance creates favorable conditions for blooming and reproduction.

Lady's slipper orchids (*Cypripedium montanum* and *C. fasciculatum*) have been identified in the ROD as old-growth associates declining throughout their range in North America (USDA FS, USDI BLM 1994b). They are dependent upon late-seral, stable environments for viability and may be threatened by timber harvest activities. It is also thought that these plants are threatened by fire suppression, since they are likely to benefit from the kind of low-intensity fires which kept the understory clear in pre-historic times. These species are poor competitors.

Noxious weeds and Exotic Pest Plants

There are several exotic plant species of concern in the Butter Creek analysis area. These include yellow star thistle (*Centaurea solstitialis*), bull thistle (*Cirsium vulgare*) and cheat grass (*Bromus tectorum*). All are pioneer species adapted to exploiting newly disturbed habitats quickly and competitively. High levels of disturbance are directly related to high densities of exotic pest species. They may be introduced by livestock grazing, or on heavy equipment along road systems, natural fuels reduction buffers and clearcuts. Noxious weeds and exotic pest plants pose a threat to native plant communities and overall biological diversity.

Yellow star thistle has colonized much of the private pasture land on lower Butter Creek and is common along county road 316 in that vicinity. The county road is the primary vector for the spread of yellow star thistle in the watershed. Cheat grass has successfully colonized serpentine rock outcrops, and may represent a threat to maintenance of those unique habitats in the future.

Natural Disturbance Regimes

Fire Regimes

Fire regimes describe the recurring combination of fire occurrence, behavior, effects and subsequent development that is typical of a certain type of vegetation. Factors that shape fire regimes are climate, topography, soil characteristics, vegetation and ignition patterns. Fire regimes are measured by the length of fire return intervals, severity of fire events and to some extent the size of the area burned (Agee, 1989). Fire return intervals are also related to burn frequency. Burn frequency measures the proportion of area burned for a period of time. In addition to spatial variability, fire regimes vary through time.

Fire is an important natural disturbance agent in the Butter Creek Watershed. Fire has had a significant affect on the structure and function of the ecosystems within the watershed. It is useful to stratify the watershed into landscape types and examine a general characterization of the fire regimes as the ecosystem response to fire and hazard and risk differ with each vegetation type. These areas are defined as the Indian Valley Upland Area, the 1987 Burned Area and the Butter Creek Canyonlands area.

Risk as it is referred to in this document is defined as a wildfire agent or cause such as lightning, chainsaws or campfires. Risk management would eliminate or reduce sources of firebrands (intense heat sources).

Hazard as it is referred to in this document is defined as a rating assigned to a fuel complex that reflects its susceptibility to ignition, the wildfire behavior and severity it would support, and/or the suppression difficulty it represents. A fuel complex is defined by kind, arrangement, volume, conditions and location. Hazard ratings are generally subjective, ranging from very low (grasses and other green fuels) to extreme (cured grass and heavy conifer slash) (Deeming, 1990). Threat refers to all the factors combined which contribute to the condition of a fire: fuels, risks, topography, climate, fire mitigating factors and human factors.

Although over half of the area in the watershed is characterized by low to moderate risk, the high-risk areas occur across all portions of the watershed. The present condition of high fuel levels across the watershed creates a high likelihood of fire spread from high risk areas into areas of low risk. During the late 1970s and early 1980s, the Hayfork Ranger District attempted to build an effective fuelbreak system throughout the District. Partial fuelbreaks exist within the watershed. These partial fuelbreaks need to be reconstructed and interconnected to be used effectively as a fuelbreak system.

Currently, due to past years of fire suppression, fire severity varies from infrequent high severity fires that regenerate stands to frequent low severity fires that kill seedlings and saplings and maintain an open understory. Fire severity is closely linked to forest type, both current vegetation and potential natural community. The general relationships between fire and specific vegetative communities is described in a following section.

Indian Valley Upland - The Indian Valley upland area is located in the relatively flat, upland area of the watershed, including most of Indian Valley Creek. It is characterized by middle to late seral coniferous forest which are highly fragmented by numerous well-dispersed plantations. An extensive road network is established throughout the area.

Portions of the Indian Valley upland area were burned with light to moderate intensity in 1987 by the Friendly, Cold and Trinity Fires. The area is located within a high lightning fire occurrence zone. Fuel loadings for this area are estimated at between 25 to 75 tons per acre based on spot fuel inventories.

The 1987 Burned Area - The 1987 Burned Area is also located in the upland portion of the watershed within the high lightning fire occurrence zone. It is characterized by extensively burned sites, which are also the result of the 1987 wildfires. Fuel loadings are low to moderate and are estimated at 10 to 40 tons per acre, based on spot fuel inventories.

Butter Creek Canyonlands - The Butter Creek Canyonlands area lies within the lower steeper portions of the Butter Creek watershed. It is comprised of closed canopy, late seral, Douglas-fir and mixed conifer forests. Moderate timber harvesting has occurred in this area. The remaining timber stands may also have higher fuels buildup and understory regeneration than expected under pre-suppression conditions. The Canyonlands were impacted by the lightning-caused Cold Fire in 1987. Fuel loadings for this area are estimated at 20 to 70 tons per acre based on spot fuel inventories.

Fire History

For thousand of years, fire shaped the composition and structure of North American forest, woodland, shrubland and grassland ecosystems (Pyne 1982) and is a significant component of ecosystem functioning. Fire, because of the climate of the Klamath Mountains, has created stands and controlled stocking and stand density. Prior to the fire suppression era, the dominant fire regime of this landscape consisted of frequent low to moderate intensity ground fires. Historically, frequent low intensity fires formed and maintained healthy stands. Suppressing fires for over 80 years has resulted in unhealthy, overstocked stands encroached heavily be fire intolerant vegetation.

Presently, fire starts that cannot be contained by initial attack fire suppression forces during the first shift usually build into high intensity stand replacement type fires. Once stands became reestablished after catastrophic fire, lower intensity fires maintained woody material and understories at low levels until portions of the stands began to deteriorate and more fuel was once again available for hot, stand destroying fires (USDA FS, 1994k).

Unpublished data collected in 1991 in the vicinity of Bluff Lake along the meadows near High Camp Creek indicated fire frequencies of every seventeen years for the period 1461 to 1944. In the Thompson Ridge area on the Happy Camp Ranger District, Skinner and Tanner (1994) have estimated historic fire return intervals for the area to be between 15 and 25 years. Fire return intervals in the vicinity of the Shasta-Trinity Divide of the Klamath Mountains pre-1850 ranged from 7 to 50 years depending on the vegetation type. The average pre-1850 fire return interval was 17.1 years for all sites. Evidence indicates that these fires were most likely late season burns, probably late summer through early fall (Wills and Stuart, 1994, Agee, 1993a).

Weather patterns in the Butter Creek Watershed are such that long, dry periods in summer are often accompanied by lightning storms. These storms result in frequent ground strikes with minimum precipitation. Thus, lightning has historically been a significant ignition source. The vast majority of lightning fires self-extinguish at small size under natural conditions, given the absence of extreme fire weather (van Wagtendonk 1986; Keeley 1982). Prior to human intervention, lightning fires that did persist could burn from days to months with periods of increased intensity during hot, dry, windy conditions, and decreased activity and intensity at night and during periods of wetter weather.

Presently, the watershed might be characterized as having an infrequent, high intensity fire regime. Williams and Rothermel (1992) discuss the interaction of likely fire behavior and drought in various fire regimes. They contend that drought has major impacts on fire regimes where fire is infrequent and intense because of the greater influence of long-term drying on large materials and duff. These systems are also more susceptible to crown fires. In fact, drought years may be the only years when extensive fire occurs in these ecosystems.

Overstocking, a side-effect of successful fire suppression, make ponderosa pine and mixed conifer systems more sensitive to drought as well. In this era of high-technology fire suppression, the combination of drought and fuel build-up may result in a higher frequency of catastrophic fires, compared to historic times.

Fire has played and will continue to play an important role within the Butter Creek landscape. Fire occurrence information from 1910 through 1993 shows a total of 107 starts during the 83 year period (**Table 11**). Natural starts resulting from lightning have been the primary source of the identified starts within the area. Based on fire history information, the majority of the lightning strikes have occurred above 3000 feet with over 98 ignitions, although starts have occurred randomly across the watershed at all elevations (**Plate 14**). Most fires have tended to be relatively small, with the exception of a 1,870 acre fire in 1920 and five fires in 1987 totalling more than 10,000 acres. Drought may have had a major influence on the number of natural fire ignitions during the 1980s. There were approximately 20 fires within a 4 year period. This equates to 22 percent of the total natural ignitions for the 83 year period.

Effects of Fire Exclusion

The change in the frequency and severity of fires has had significant ecological consequence in Northern California. Prior to effective suppression, fire was an important force in maintaining the ecosystem structure and function of many of the vegetation types of the Klamath Province. Fire was instrumental in creating the variety of vegetative patterns and successional stages across the landscape. Nutrient cycling and other ecosystem processes have been strongly effected by the lack of fire. The attempt to exclude fire has changed the character and function of forested systems on many scales. Until recently, many of the changes were not readily discernible.

Fire exclusion practices are creating forest conditions that will most likely lead to large stand replacing fires similar to those experienced during the past seven years. The vegetative conditions of dense, multi-layered stands with a large number of shade tolerant species and accumulations of ground fuels create conditions favorable for large fires with severe fire effects. The large number of understory trees and shrubs that have encroached due to the lack of ground fires create potential fuel ladders, moisture competition and excessive fuel.

Table 11	FIRE HISTORY						
DECADE	Lightning	Human	Smoking	Incendiary	Misc.	Total	Acres
1910-1919	16	1	0	0	1	18	28
1920-1929	14	0	0	0	1	15	1,870
1930-1939	8	1	1	0	0	10	1
1940-1949	7	0	0	0	0	7	0.5
1950-1959	13	0	0	0	0	13	72
1960-1969	1	1	1	0	0	3	16
1970-1979	10	5	1	0	1	17	2
1980-1989	19	0	0	1	0	20	10,094
1990-1993	2	2	0	0	0	4	0.5
Totals	**90**	**10**	**3**	**1**	**3**	**107**	**12,084**

There have been only 14 recorded human-caused fires during the 83 year period and these have generally occurred along the main road systems. Human caused fires occur both as concentrations and random patterns but constitute only 13 percent of all fires.

High severity fires at present, are outside the Natural Range of Variability primarily in the extent of the area affected by high severity. It must be recognized that there were always patches of high severity within the areas burned by mostly low-moderate severity fires. These fire patterns have created complex stand structures and patch patterns characteristic of the Klamath Mountains. Impacts can include soil erosion, loss of soil organic matter and structure, soil cover, mineral nutrients, soil microorganisms and hydrophobic soil effects. Off site effects can include physical, biological and chemical changes in water quality. The risk of flooding is much higher following fire due to a reduction in infiltration and an associated increase in surface runoff.

By continually suppressing fires, resource management agencies have greatly changed the forest fuel complex. By perpetuating the continuous accretion of small surface fuels, vertical fuels and large woody material, a scenario has been created in which crown fires will occur with greater frequency, fires will be larger and far more destructive to forest resources, and increasingly become more difficult and costly to control. These catastrophic fire events will also be more dangerous to control, represent more of a threat to private property and life and have an increased potential for high particulate matter emissions.

Continuing to suppress low to moderate severity fires insures that the fires that will affect most of the landscape are the high severity, stand replacement events. Suppression forces are quite successful at suppressing low to moderate severity fire, but are unable to deal effectively with severe events until severe burning conditions subside. Thus generally, only severe events will affect significant portions of the landscape.

High fuels levels and the presence of conditions that will accelerate the spread of fire within forest stands increase the need for protection of private land, investments, genetically superior trees, rust resistant sugar pine trees (when identified) and key wildlife habitat from fire starts within the watershed. This may be accomplished through natural fuels reduction buffer or density and fire ladder reduction thinnings.

The major travel routes in Butter Creek (2N01, 2N03, 2N07, 2N10, 3N08, 3N10, 2N08 and County Rd. 316) are key areas where there is a high risk of fire due to heavy use patterns. This is especially dangerous during the fall hunting season. Intensive natural fuels reduction along these travel corridors will greatly reduce the risk of human caused fire starts in the watershed.

The Effects of Fire on Vegetation

Disturbance processes result in a variety of changes in vegetation structural characteristics including; species composition, stand condition and patch size and shape. For instance, depending on the severity of the disturbance, the seral stage progression can be markedly disrupted and communities returned to early successional states. Historically, plant communities were maintained by repeated, low intensity disturbances, such as frequent low intensity fires. There are numerous factors associated with a particular disturbance and the resulting changes. These factors include the type, duration, intensity, frequency and timing of the disturbance, as well as the operational environment following the disturbance.

Light ground fires may trigger secondary succession in lower canopy layers. Occasional small patches may burn intensely, killing vegetation through the upper canopy. This type of fire regime would tend to create a fine-grained pattern of seral patches. The less frequent, high intensity fire would tend to kill or consume all vegetation, sometimes initiating primary succession, where plants must be seeded from outside sources. More frequently, succession is initiated through sprouting vegetation or seeds stored in the soil.

Fire exclusion and control has led to an increase in the cover and density of vegetation including trees, shrubs and grasses. Fire exclusion tends to favor large trees over grasses and herbs in the forested and non-forested plant community interface.

Fire effects for the major vegetation types in Butter Creek follow.

Mixed Conifer Forest - Fire regimes in the mixed conifer forest are far more complex and variable than those of other vegetation types in the Klamath province. Mixed conifer forests contain ponderosa pine, Douglas-fir, white fir, sugar pine and smaller amounts of other species. Many of these species tend to regenerate in pure clumps (Bonnickson and Stone, 1981, Thomas and Agee 1986). Although they generally occupy wetter and cooler sites than ponderosa pine forests (Martin 1982), they are drier and warmer than Douglas-fir forests. Fire effects (frequency and intensity) varies with site conditions such as aspect, position on slope, vegetation, slope and ignition sources. There may be more litter on the ground in the mixed conifer forest than in other types. Successful fire suppression has resulted in less frequent high intensity surface fires as well as large stand replacing fires. With the continuation of present trends, stands will convert to a fire regime of infrequent, very high fire intensity with uniformly severe effects, including very large catastrophic fire events (USDA FS, 1994j).

Pre-suppression era fires generally helped create and maintain forests in the Klamath Mountains that were generally more open and had fire resistant trees, such as ponderosa pine, sugar pine and Douglas-fir, as the most characteristic dominant trees. Stands contained a diversity of species and age classes but relative densities were lower. Many of the fires were of large extent and would burn for months. As would be expected, there was a good deal of site-by-site variation in terms of fire behavior, periodicity and effects on associated vegetation.

There was a great deal of variation in pre-suppression era fire intensity and effects within similar sites even within a single fire (Parsons et al. 1989). Where fuel buildup and high intensity conditions occurred at the time of burning, small areas of stand replacing fires would occur. Within these newly created openings or gaps, patches of regeneration were established. Within large gaps, fire tolerant (and shade intolerant) species were favored, given proper seedbed conditions. Unburned patches were left throughout the low intensity fire areas, where the fuel profile was discontinuous and/or the fire burned during low intensity burning conditions. Each patch represented a distinct aggregation of trees which developed successionally as an independent entity. This created a complex mosaic of aggregations of age and size classes with patch sizes typically ranging from 1/2 to 5 acres . On sites of lower quality where discontinuous vegetation was interspersed with rock outcrops, fire was less frequent (Bonnicksen and Stone 1982, McBride and Sugihara 1990).

Fire suppression activities have led to retarding rates of fire disturbance which has allowed the ingrowth of fire intolerant species, specifically incense cedar and white fir. Many of the larger pines have either died or were systematically harvested. Natural regeneration of all species has occurred in greater numbers, further increasing stand densities. Smaller size classes now account for a higher percentage of the total stand. The increasing competition for available light, water and nutrients creates stress on vegetation, facilitating suppressed growth, lack of vigor and damaging attacks by insects and pathogens.

Current fire intensity levels reflect the loss of historic fire cycles. These changes are less than for ponderosa pine forests, but far greater than in white fir forests. The mortality and increase of biomass has subjected these stands to less frequent, severe stand replacing fires of large size. The vegetation that has grown as a result of fire exclusion has a multi-layer structure creating a fuel ladder which accommodates enhanced horizontal and vertical fire movement, resulting in crown fires.

Douglas-fir Forest - Douglas-fir forests in the Klamath region includes some of the driest forests where Douglas-fir is the dominant tree (Agee 1989). The present fire regime varies from high intensity surface fire to stand replacing fire. Many of the effects noted for mixed conifer forest also apply to Douglas-fir, but to lesser extent due to the more mesic temperature and moisture regimes that characterized the Douglas-fir zone. The short needles also lead to lower severity fires because of the more compact fuel beds they help facilitate. This may help the short needle conifers to survive fires when younger even though they have thin bark (Agee, 1990, 1991) and Wills and Stuart (1994).

White fir Forest - Small patches of white fir exist throughout the watershed. Throughout the Klamath mountains fire return intervals are occurring on a 30 year cycle (Skinner, 1994). Most sites are colonized soon after a disturbance and rapid regrowth occurs. Retarding rates of fire disturbance allows the ingrowth of fire intolerant species such as white fir in other forest types.

Ponderosa pine forest - Present fire regimes are characterized by high intensity surface fire or frequent stand replacement fires. Intensity levels range from low to extreme, with most representing the higher end of the scale. Given the present artificially extended fire interval, these stands will convert to an infrequent, high intensity fire regime with uniformly severe effects.

The early suppression of fire caused immediate changes in pine stands throughout the forest. White fir, incense cedar and seedlings and saplings are now common in the understory of these pine stands. The selective removal of high quality, large diameter pine over the past 50 years has hastened the dominance of other species, largely white fir and incense cedar (McKelvey and Johnston 1993). These factors have led to a change from single species stands to the mixed species stands seen today.

Fire has perpetuated the dominance of ponderosa pine on sites where it is the potential climax species as well as sites where it is seral to more shade tolerant tree species. Shrub and herbaceous vegetation is varied and abundant except under dense stands (Wright 1978). With the exception of certain manzanita species, all of the shrubs are vigorous sprouters and some are prolific seeders following stimulation by fire. Seeds of annuals are abundant and regenerate quickly following fires.

Fires historically were common in the ponderosa pine belt. These fires thinned stands and helped maintain an “open and park-like” forest with an understory of herbs and shrubs (Biswell 1973 and Hall 1976). Generally, ponderosa pine seedlings and saplings are able to withstand low severity fires, as are pole size and mature trees. Moderate to high severity fires will usually kill trees that are smaller than pole size. The principal cause of mortality in small trees following fire is crown scorch rather than damage to the cambium or roots.

Historic fire return intervals were generally less than 10 years in the ponderosa pine forest. Recent data shows that these periods have lengthened. This relates to the loss of 4-5 fire cycles. Fire exclusion has led to increased stand densities of suppressed ponderosa pine and invasion of more shade tolerant species such as white fir and incense-cedar especially at the interface with the mixed conifer forest. Regeneration of pines and other shade intolerant species including hardwoods has declined. Insects and pathogens are more successful attacking these stands. Fuel complexes feature higher densities of snags, a greater component of large downed woody material and large quantities of fine fuels. Horizontal and vertical fuels continuity is greatly enhanced with continuing fire exclusion. These elements often lead to fast-moving, intense fires. Increases in white fir may moderate the fire environment except under the more extreme drying conditions. The shorter needles and reduced depth of the fuelbed further increase periods between fires.

Climatic factors, including periods of drought, windy fall seasons and accumulating fuelbeds will ultimately lead to large, catastrophic, stand replacing fires, if existing fire suppression strategies continue. Following large severe fires, shrubs may occupy sites for very long periods. If pine is quickly reestablished on the site, it can attain a superior position. However, shrubs may maintain a continual cycle of fire and shrub regeneration. This is especially true if the site is sufficiently degraded and cannot support the seedlings or if competition from shrubs is too severe for seedling establishment.

Meadows - Wet meadows in the Butter Creek Watershed are disappearing or becoming smaller. This is attributed to several factors which include a lowering of the groundwater table related to channel downcutting, and fire suppression allowing the encroachment of upland vegetation into the meadows. Prior to fire suppression, fires were a regular process in the maintenance of meadows. A late season fire could frequently be carried through meadows once the herbaceous growth had cured. This type of fire would generally kill most tree seedlings attempting to occupy the site.

Riparian areas - The mesic conditions associated with riparian areas can provide a barrier to fire spread and can slow fires considerably. The cooler temperatures, humidity, less flammable vegetation and topographic position combine to reduce fire intensities except under the most extreme conditions. Occasionally stand replacing fires do occur within riparian areas and the effects to vegetation and channel conditions can be severe. Narrow stream corridors are more likely to have frequent and higher intensity fires than broad stream channels.

Riparian areas can be both directly and indirectly affected by fire (Agee 1993). Direct effects are those associated with burning within the riparian zone itself. Lower intensity fires often kill the above ground component of most shrubs and deciduous trees. However, many of these species resprout. Direct and indirect effects of sub-lethal fire to conifers and deciduous trees include introduction of rot, formation of “cat-faces” or basal wounds and the development of hollow lower boles. These features provide important habitats for some wildlife, but they also structurally weaken trees, making them more susceptible to windthrow. Fire effects on upslope areas may be more important to riparian habitats than fire actually occurring within the riparian zone. These indirect effects include the movement of sediment, biomass or water through riparian zones.

Plantations - There are approximately 5085 acres of plantations within the watershed in all age classes. Many were planted in the 1980s. There are nearly 670 acres of 1960 and 1970s era plantations that may be overstocked or have been thinned without fuels treatment. These overstocked plantations and thinned plantations with accumulated slash present a high fuel hazard. Untreated thinning slash poses a high hazard condition and an increased likelihood of stand loss when combined with fairly active fire conditions. More rapid fire spread and longer flame lengths may be expected. Concentrations of dead and down woody material will contribute to torching, spotting and crowning.

Forest Health

Forest Insects

The Butter Creek watershed contains mature pine stands which are very susceptible to *Dendroctonus* beetle attack, such as the stands around the Indian Valley Guard Station. It also contains several hundred acres of older pine plantations which have trees of the age, size and density to be susceptible to group kills by *Dendroctonus* bark beetles.

Available soil moisture is one of the most important limiting factors on trees in the inland West. A prolonged dry period during the summer is normal in much of the region. Long term studies of tree rings indicated that the amount of precipitation received from year to year varies widely. These studies conclude that protracted periods of drought should also be considered normal. Estimates of the amount of water used in evapo-transpiration vary from roughly 20 to 200 gallons of water per tree per day. The exact amount of water used by each tree per day will vary widely with tree species, tree size, aspect, wind speed and other factors. In stands which do not have periodic removals of trees by fire or harvesting, the amount of biomass available for evapo-transpiration increases with time. The increase is due to both an increase in the size of each tree, as well as an increase in the number of trees due to natural regeneration.

Particularly during drought periods, evapo-transpiration in areas with a large amount of biomass may deplete enough soil moisture to reduce the resin flow in conifers. Reduced resin flow in conifers will increase their susceptibility to bark beetles. Bark beetles in the genus *Dendroctonus* are particularly well adapted to exploit drought-stressed pines for breeding habitat. *Dendroctonus* beetles utilize a highly effective aggregating pheromone during their initial attack. In densely stocked pine stands, an attack by *Dendroctonus* bark beetles may result in a group kill of dozens of trees.

Forest Pathogens

Native pathogens have not caused major disturbances at the landscape level in the Butter Creek watershed. Rather, they have created smaller, localized disturbances that have altered stand structure and diversity. Some of their effects on trees include reduced rates of growth, branch mortality, decay and mortality. This produces snags, decadence and openings.

Numerous native pathogens are present in this watershed. Several species of dwarf mistletoe (*Arceuthobium* spp.) can be found on different members of the Pinaceae. They are relatively host specific with a long life cycle and slow rate and distance of spread. Two-story stands with the same species in both layers is ideal for the spread and intensification of dwarf mistletoes. Single story, mixed species stands are not affected as dramatically. In general, dwarf mistletoe appears to have faster, more dramatic effects in pines than true firs, although high levels of dwarf mistletoe will eventually cause mortality in these latter species also. In other areas of the west, dwarf mistletoes are more severe on droughtier sites of lower productivity. Most of the area affected by the intense fires of 1987 will not be affected by dwarf mistletoes for many decades. Stands that have been selectively harvested and have not had periodic ground fires may have or buildup high levels of dwarf mistletoe if it is present. Periodic ground fires help to keep dwarf mistletoe at low levels by killing heavily infected trees and killing witches' brooms that grow close to the ground.

Stands that are overstocked and develop high levels of dwarf mistletoe and witches' brooms are predisposed to stand replacing fires.

Organisms causing root disease have not been observed in the watershed, but likely are present. Black stain root disease (*Leptographium wageneri*) is present in a Douglas-fir plantation south of the watershed. It primarily kills trees in small groups. Any plantations in the Butter Creek watershed that have high stocking of Douglas-fir may develop infections by this fungus. Probable sites of infection are in association with areas of significant disturbance, especially roads and skid trails. Annosus root disease (*Heterobasidion annosum*) probably occurs at low levels in pines, especially on the driest sites. Like black stain, it kills in small groups, but all size classes are usually affected. Incense-cedar may also be infected and killed within root disease centers in association with pines. Harvesting activities that leave large pine stumps are conducive to buildup of this fungus if the stumps are not treated. However, the amount of inoculum and level of infection is relatively low in this area. A different biological species of this fungus infects true firs. In this host, *H. annosum* causes more root and butt decay rather than tree mortality. This can result in some windthrow, but usually this is limited. Regeneration of true firs in infected sites may be killed. Statewide surveys for annosus root disease in true firs indicated that this disease is less common in the northwestern area of the state than elsewhere. It is more common in older red fir stands. Based on this information, the level of annosus root disease in true fir in the Butter Creek watershed is expected to be low.

Numerous decay and canker causing fungi are also present in Butter Creek. These organisms usually increase stand decadence by causing heartrot and branch and top mortality. The decay fungi may accelerate nutrient cycling by initiating the break down of woody material while trees are alive and standing. Most of the native canker causing fungi are facultative saprophytes and are weakly parasitic. Their parasitic capability increases when their host has a reduced ability to defend itself. This occurs when the host is under an external stress. The common stress-causing factors in Butter Creek for most tree species include drought, poor site quality, overstocking, and a shift toward shade tolerant species. This shift in species composition is a result of fire suppression and indicates overstocked conditions, leading to stress.

In addition, the more shade tolerant species seem to be more prone to canker fungi, particularly when under stress.

One non-native pathogen is present in the Butter Creek watershed; *Cronartium ribicola*, the cause of white pine blister rust. It infects sugar pines and various species of *Ribes*. It has minimal effect on the *Ribes*, sometimes causing premature defoliation in the summer. It has a devastating effect on sugar pines, killing small trees within a few years to a few decades. On larger trees, it does not have as significant an effect in many cases because of the limited number of infections and the location of the infections on the long limbs. In some situations, however, even large trees may be affected by the blister rust if enough limbs are killed and the tree becomes susceptible to successful insect attack. Observations indicate that trees in the 10-20 inches dbh range are now showing signs of infection from the 1970s as tops and entire trees die. Regeneration of sugar pine is becoming increasingly difficult in California, especially in areas that are moist in the fall. Resistance to successful infection has been identified in sugar pine, but no resistant trees have currently been identified in this watershed or the breeding zone it is in.

There is a concern about the genetic viability of sugar pine throughout its range. It appears that white pine blister rust has had a negative effect on the sugar pine population in Butter Creek. Dead and diseased trees are numerous throughout the watershed.

Stand Density Induced Effects

The effects of fire suppression on forest stand density are well documented (Agee, 1993b). Forest stands are far more densely stocked today than they would be under the fire regimes with which they evolved over millennia. Shade tolerant trees and shrubs have become established where they normally would have been eliminated by frequent ground fire. The result of this is increased competition for water and nutrients. Due to this competition, forests are carrying vegetation densities beyond the natural range of variability, which are not sustainable over time. Stands that are stocked beyond carrying capacity tend to exhibit poor vigor and growth and are not resilient to environmental stressors. They are more susceptible to mortality during periods of drought, insect infestations and other environmental stresses.

Plantation Health

Many of the plantations within the watershed are overstocked and are also susceptible to competition induced mortality. Higher vigor and more productive growth can be attained by plantation enhancement treatments. This is of particular importance for older plantations within the Riparian Reserves, wildlife corridors and spotted owl activity centers where it is desirable to obtain rapid canopy closure to restore ecosystem function and suitable spotted owl habitat.

In addition, species diversity is lacking in a majority of the plantations. Most sites were traditionally planted with ponderosa pine or a mixture of ponderosa pine and Douglas-fir. Natural regeneration of conifers and hardwoods occupy a minor proportion of the plantations. This has led to a conversion from mixed species forest to a less diverse forest. To assure resilient, productive and healthy forests in the future, species diversity should be highlighted in any enhancement treatments.

Wildlife Populations

The majority of wildlife species in the Butter Creek watershed are common to the Klamath Mountains. Common species include Pacific giant salamander, rubber boa and great blue heron. Coast Range species present in Butter Creek include the Olympic salamander and Town-send's warbler. Based on the California Wildlife Habitat Relationship database (Timossi, 1993) and numerous survey results, we estimate that overall there are 13 amphibians, 17 reptiles, 142 birds and 53 mammal species present within the watershed. **Appendix C** contains a list of the species assumed to currently exist within the watershed. The list was derived from an analysis of the California Wildlife Habitat Relationship database, a review of habitats in the watershed and the Hayfork Ranger District Random Wildlife Sightings Record (USDA Forest Service; on file at the Ranger District Office).

Some species, known to have once been common in the watershed, are now present in small numbers and are difficult to detect. In recent years, for example, there has been only one recorded sighting of porcupine within the vicinity of the watershed (UDSA FS 1994g). District personnel familiar with the area indicate porcupines have not been seen for 15 years or more. The porcupine population has decreased, probably because of an eradication program. Porcupines forage on the tips and bark of young conifer trees. Ponderosa pine, a species commonly used in reforestation, was a preferred food. There may be only a few porcupines remaining in the Butter Creek watershed. Another example of a wildlife species once common in Butter Creek, but now rare, is the beaver. Beaver populations declined principally because of fur trapping efforts during the past century and grazing of domestic livestock which alter riparian vegetation, preferred forage of the beavers.

Some larger mammals presumably once common throughout the area no longer reside in the watershed or in the region. The grizzly bear, wolf and Roosevelt elk all roamed the Butter Creek watershed at one time. Prior to 1850, grizzly bears were abundant throughout California; however with settling in the region, grizzly was widely hunted and is no longer present in the state. It is likely that some wolves did at least pass through the watershed, although wolves were sometimes confused with coyotes (Jameson and Peters, 1988). Roosevelt elk once grazed the then more abundant grassy areas of Indian Valley. These three species suffered a rapid decline in population levels throughout the western states under the influence of the European settlers.

Some species currently inhabiting the watershed were not present on the west coast just a few decades ago. These non-native species include European starling, brown-headed cowbird, bullfrog and Virginia opossum. These species were either introduced or encroached on available habitat.

Species of Special Concern

One federally listed Endangered species, the American peregrine falcon, nests in the watershed. The northern spotted owl, a Threatened species, is also found in the watershed. The bald eagle, an Endangered species, forages along the South Fork Trinity River to the west of the watershed. The marbled murrelet, another Threatened species, was not included in this analysis as the

Zone 2 range is just outside of the watershed boundary and no birds have been found within Zone 2 in California. The Zone 2 boundary in this area is within 25 to 45 miles from the Pacific coastline.

There are no known or suspected active bald eagle nest sites within the watershed. The historic fisheries in the South Fork of the Trinity River presumably provided a stronger forage. Therefore, eagles potentially nested in and adjacent to the watershed in the past. Although suitable nesting trees exist, line of sight forage viewing quality and a reliable prey base is lacking. Most of the fish bearing streams are resident trout streams. An anadromous fish reach is present at Butter Creek. This extends 1.5 miles up from the South Fork River. Suitable nesting habitat consists of a group of large diameter trees or snags, usually ponderosa pine, sugar pine or Douglas-fir, with well spaced large limbs. One of the group of trees must have an open crown to serve as a nest tree. Nests are generally within one mile of a permanent body of water containing an adequate prey base of fish and waterfowl. The eagles also require open, easily approached hunting perches along feeding areas. These may be large snags, broken topped trees or rock outcrops.

Bald eagles do forage within the watershed, principally along the South Fork of the Trinity River. There is an existing nesting territory nine miles north of the watershed. Due to the reduced fisheries resource since the 1960s, it is possible that there are not enough fish to support another pair of eagles. It is possible that the limiting factor is the lack of a reliable prey base.

One peregrine falcon pair nest within the Butter Creek watershed. All known suitable nesting habitat is fully occupied within the watershed. Suitable habitat consists of high cliffs with ledges for nesting and perching. Nest cliffs are typically near a body of water. Peregrines require an adequate prey base, consisting primarily of birds, within a few miles of the breeding site. Historic and current distribution of peregrine falcons in the watershed are more that likely very similar based on habitat requirements for this species.

Peregrine populations in the United States, including northern California, suffered serious declines due to the use of the pesticide DDT after World War II. Recovery efforts for this species have been very successful despite continued problems caused by pesticides. The Butter Creek watershed was naturally re-occupied by peregrines in the late 1980s as populations across the state increased.

Four northern spotted owl pairs live within the watershed. Two of the owl activity centers are within the Late-Successional Reserve (RC 330). The majority of the watershed (75 percent) has been surveyed for this species. The unsurveyed habitat may support additional owls. Suitable nesting habitat for this species is typically conifer or mixed conifer and hardwood forest, with 40 percent or more crown closure and large diameter trees. Spotted owls nest in cavities that form in decadent or broken topped trees and snags. A multi-layered canopy that simultaneously provides cover while allowing for easy flying passage is preferred. Their prey base of small mammals depends on the presence of snags and large down woody material.

Currently, fragmentation of suitable habitat is the limiting factor, along with the lack of contiguous dispersal corridors for juvenile owls. The least fragmented owl habitat is in the northwestern portion of the watershed. There are 3020 acres of United States Fish and Wildlife Service designated Critical Habitat (CA-35) for the northern spotted owl within the watershed (**Plate 12**). An estimated 1291 acres (43 percent) of this is currently suitable nesting habitat. The remaining area is presently too open or early seral from past fires and timber harvesting to be presently suitable for nesting.

There are 8115 acres of recently designated Late-Successional Reserve (LSR) within the watershed (**Plate 15**). Approximately 3824 acres (47 percent) of this is suitable owl nesting habitat. The LSRs are designed to serve as habitat for late-successional and old-growth related species. In this analysis and others, suitable spotted owl nesting habitat is used as an indication of late-successional conditions. Historic distribution of habitat for this species is reflected by the presence of late mature and old forest seral stages. Historically, late mature and old forest seral stages made up 45.3 and 9.6 percent of the watershed, respectively, compared to the present value of 21.3 and 5.4 percent. These data indicate that suitable habitat for the northern spotted owl would have been about twice as abundant historically as it is today. Current limiting factors affecting owls within the Butter Creek watershed are the fragmentation of existing suitable habitat and the lack of contiguous dispersal corridors for juvenile owls.

The existence of the willow flycatcher, a USDA Forest Service Sensitive species, has not been confirmed in the watershed but has been found on adjacent Ranger Districts. Its presence in the watershed is suspected, although there are no recorded sightings. Historic grazing pressures, along with current grazing systems may limit the amount of suitable habitat for the species. To assess the presence of the willow flycatcher, mist net surveys in the Indian Valley riparian area are being conducted by the Pacific Southwest Forest and Range Experimental Station's Redwood Science Laboratory.

It is currently unknown to what extent other species of special concern and USFWS candidate species inhabit the watershed, such as the northern goshawk and american pine marten.

Wildlife Habitat

The 12 California Wildlife Habitat Relationships (WHR) habitat types, as defined by Mayer and Laudenslayer (1988), which are found within the Butter Creek Watershed, are displayed in **Table 12**. **Appendix C** displays the wildlife species that are associated with each WHR type. **Plate 13** displays the distribution of WHR habitat types in the Butter Creek watershed.

Forested habitat types are most abundant in the watershed. Of these, Klamath Mixed Conifer is the most abundant, with over 8,460 acres identified in all size classes. It is most common in the eastern and southern portions of the watershed. Montane Hardwood-Conifer WHR type occurs on another 4,690 acres and Douglas-fir 4,260 acres. They are scattered throughout the watershed but are most common in the northern and western portions. There are 3,190 acres of the Ponderosa Pine WHR type and 640 acres of Jeffrey Pine type. Chaparral is the next most abundant vegetation with 1110 acres of Mixed Chaparral WHR type and just 100 acres of Montane Chaparral. The remaining terrestrial types are 590 acres of Montane Hardwood, 400 acres of Perennial Grassland and 70 acres of Montane Riparian. There are 12 Wetland sites (known as Fresh Emergent Wetland or Wet Meadow types) and almost 50 miles of perennial streams providing Riverine habitat type. **Appendix D** is a table showing acres by size class for each WHR type.

Analytical Framework

All of the wildlife species on the Shasta-Trinity National Forest have been placed within fourteen

Table 12 — 1990 WILDLIFE HABITAT RELATIONS (WHR) TYPES

WHR Types	WHR	Acres	Percent of Watershed
Fresh Emergent Wetland	FEW	14	0.1
Mixed Chaparrel	MCH	1,105	4.7
Perennial Grassland	PGS	398	1.7
Montane Riparian	MRI	71	0.3
Montane Chaparrel	MCP	95	0.3
Montane Hardwood	MHW	588	2.5
Montane Hardwood-Conifer	MHC	4,687	20.0
Klamath Mixed Conifer	KMC	8,457	36.0
Douglas-Fir	DFR	4,258	18.1
Jeffrey Pine	JPN	641	2.7
Ponderosa Pine	PPN	3,191	13.6

guilds (Crumpton and Dias, 1994). The guilds are based on the major habitat needs of wildlife on the Forest. **Appendix C** also shows the guilds and the Butter Creek wildlife species that are associated with each. An analysis of both the WHR types and the guilds associated with each species provides a clearer picture of wildlife conditions in the watershed. For example, aquatic habitat is divided into three guilds: general aquatic habitat, slow moving aquatic habitat and fast moving aquatic habitat. This differentiates those species that are found in generally warmer backwaters or wetlands from those that need cooler swift running water and those that can be found in either.

These guilds were assembled to provide a cursory overview of potentially available habitat in the watershed. Further surveys and ground truthing of vegetative communities are necessary in order to validate the usefulness of the utility of these guilds. The WHR types and guilds associated with them do not provide spatial relationships of habitats. Spatial configurations of habitats are necessary in order to determine the quality and quantity of habitat available for many species.

Terrestrial wildlife are placed in the most appropriate guild. Forest guilds include the riparian, late seral forests, hardwoods, cavities/snags, dead and down component. Non-forest guilds are chaparral, general open habitat, shrubs, talus/rock and cliffs/caves.

For this watershed, particular wildlife guilds of concern are described: hardwoods, riparian, wetlands, snags and dead and down.

Hardwoods - Historically, the quantity and quality of this habitat was very different because of historic Native American burning and other modern factors (Griffen and Muick 1990). The watershed has a few stands of black oak hardwood and a large amount of canyon live oak. The loss of hardwood stands throughout California is a concern. Conifers have encroached upon many black oak sites due to fire exclusion. Thus it is likely that acorn production is lower than site capability. Several species rely on acorn production: acorn woodpecker, band-tailed pigeon, deer and bear for example. While deer and bear can forage in shrublands also, these two birds do not. The acorn woodpecker is not currently a concern, but the band tailed pigeon is. According to Breeding Bird Survey results numbers have decreased in the state. If acorn production can be increased, the black oak stands in the Butter Creek watershed will contribute to the maintenance of this bird species.

Riparian - Although 70 acres of Montane Riparian habitat was mapped within the watershed, many acres were not recorded during the terrestrial inventory. Therefore Riparian Reserve acreage will be much higher. This WHR classification refers to habitat containing primarily hardwood overstory trees such as bigleaf maple, cottonwood and alder and/or shrubs found on moist sites. This WHR classification for riparian types is nested within the Riparian Reserve concept. So many species of wildlife depend on this habitat that it is typical to find the greatest wildlife diversity here if key components are present in adequate amounts. Several species of concern in the West are riparian obligates: yellow-legged frog, northern red-legged, western pond turtle, Cascades frog, tailed frog, southern torrent salamnder and Del Norte salamander.

In the West, low quantities of fish, riparian vegetation, large woody material and nearby snags have decreased the abundance and richness of riparian dependent wildlife. In general based on recent cursory surveys by fish biologists and PSW scientists, that is presumably the case in the watershed. There is a potential for larger wildlife population levels if habitat is restored and reserves established.

Riparian vegetation and cover provide important habitat for wildlife such as the warbling vireo, yellow-breasted chat, long-legged myotis and fisher. Water conditions and fish abundance directly affect wildlife populations as many are dependent upon stream environments. Great blue heron, osprey and otter require adequate quantities of fish. In addition to the live vegetation, water and fish, large logs in streams link the realms together. For example, the western pond turtle depends upon stream logs for temperature regulation (basking).

Remote canyonland portions likely have a moderate density of large snags and woody material. But because of past fires and timber harvest in the upland portions of the watershed, large woody material and snags for future recruitment are in low to moderate densities in the watershed. Potential large woody material was removed during timber and salvage harvest operations, thus leaving small diameter wood for stream recruitment. Coupled with the low precipitation rates of the last 8 years, there has been very little movement of these logs into stream courses. Woody material that may become collected in the anadromous portion of Butter Creek would not provide long-term habitat because pieces could not become substantially anchored within the cobble and small boulder nature of this reach.

Wetlands - Most of the wetlands (including fresh emergent wetlands, wet meadows and springs) throughout the watershed have been impacted by one or more of the following: road building, grazing, timber harvesting and erosion of adjacent channels (Bardolf, 1993). Some sites have been altered to provide water sources for fire suppression or livestock. Road building has occasionally created a wetland site by altering water flow or surfacing an underground spring. These activities have changed the character of wetland vegetation and function. There has been a significant loss of the quantity and size of wetlands in the watershed. Some of the loss is due to succession and encroachment due to fire exclusion. The principal impacts, though, are due to channel downcutting and straightening. This lowered water tables, dried adjacent wetlands, eliminated the natural overbank flooding, decreased the meandering nature of streams adjacent to wetlands, and decreased the ability for wetlands to develop naturally.

Snags and down logs - Large snags and logs provide one of the most important terrestrial components for wildlife in the watershed. Large snags and logs provide wildlife habitat and do not contribute to fuel loading concerns as do fine fuels. Snags provide cavities for nesting wildlife, loose bark for roosting bats, and future down logs, while providing important structural diversity in the forest (**Appendix D**). In the watershed, 34 species depend upon snags and 12 depend on downed wood. Insectivorous birds, such as woodpeckers and swallows require snags for feeding or nesting. Many other species benefit from these decadent structures also. The Trinity Forest as a whole has a moderate density of large snags 15 inches or greater based on results of 1992 old growth inventory measurements (USDA FS 1992b). Large snag and log densities are lowest in the upland areas of the watershed due to recent wildfires, salvage operations and woodcutting. In the more remote canyonlands to the north, a higher density is likely because of drought related mortality and previous existence of soft snags. With a low amount of large snags, large down log densities will remain low. Large snag and log recruitment in the Indian Valley and upland areas will be low because of the lower amount of large trees compared to the canyonlands.

Biological Corridors

Biological corridors, or linkages, provide travel space or very important living space. Corridors link habitat types and provide dispersal areas for edge-sensitive species. A corridor provides a principally linear passage although many species movements are more complex. Some species travel many miles in one day (deer) while others do not go more than a few meters (Southern torrent salamander) in their entire lives. There are diurnal and seasonal movements (fisher and bear, respectively) as well as major migrations and dispersement (yellow warbler and spotted owl, respectively). Some movements are elevational (otter) and others are between habitat types (western pond turtle) or through contiguous stretches of similar habitat (acorn woodpecker). Movements occur between water, food, cover, breeding sites and to avoid disturbance such as vehicular traffic. Some species follow stream courses, others use game trails and a few cross ridgetops via saddles. The entire range of complexity of wildlife meanderings occurs within and through the Butter Creek Watershed.

Dispersal habitat for juvenile owls and travel corridors for deer and fisher are lacking in the eastern portion of the watershed. Within the Butter Creek watershed a conscious selection of the major stream course corridors and overland linkages was chosen for their ability to provide wildlife habitat, travelways and dispersal areas (**Plate 17**). The major stream courses selected were Indian Valley Creek and Butter Creek. Linkage to Hayfork Creek would be provided for by selection of a corridor along Grassy Flat Creek extending over the ridge to Butter Creek. These corridors were selected because of the large number of species, as shown in **Appendix D**, that utilize aquatic, riparian and adjacent forested habitats. These streams were also selected because they traverse the entire watershed, link the Late-Successional Reserve and Critical Habitat Area as well as provide for dispersal to other watersheds. Width of these corridors and the management of these corridors were determined in the analysis process.

Where cover is currently present (generally in the western canyonlands portion of the watershed), the Riparian Reserve system would provide adequate corridor width. Forested stands adjacent to the Butter Creek canyonlands provide cover of secure travel except for about 2 miles at the headwaters. Wider corridors, in the fragmented eastern headwaters portion were designed to create a 1/4 mile buffer. The wildlife travelways along Indian Valley Creek are lacking cover in the upland headwaters (the upper 4.5 miles) because of the 1987 burned area, current and past grazing and recreation use for example. Many young plantations lie within the wider corridors, which do not meet the vegetation and down wood material qualities desired for the corridors, and would need treatments in increase cover.

The Human Dimension

Human Values

Contemporary Human Values

Trinity County, one of California's original counties established by the legislature in 1850, is a versatile county which has become a recreational paradise because of the inviting valleys, wooded mountains, alpine lakes, sparkling streams and clean air. The population of Trinity County is 13,500 with the majority of people residing in or near Weaverville.

Trinity County is characterized by rural communities and lifestyles in which many of the residents gain their incomes from resource based occupations such as farming, ranching, logging, recreation and tourism. There is also a growing sector of the population that includes retired and business people from large population centers that maintain a second residence in the county in preparation for retirement. The county has one of the highest rates of unemployment and one of the largest welfare programs in the state on a per capita basis. The unemployment rate for 1992 was 16.6 percent (sixth highest figure in California) up 2.2 percent from 1991. Approximately 1,939 persons in Trinity County are receiving public assistance (Trinity County, 1993).

Total wage and salary employment in Trinity county decreased from 3,075 jobs in 1991 to 3,000 jobs in 1992. The 75 jobs lost during 1991-1992 occurred in construction, manufacturing and government. A sluggish statewide economy, reduced timber harvesting activities and federal government cutbacks largely contributed to employment declines in these industry divisions. The downward trend is expected to continue in the government division while all other industry divisions are expected to remain stable through 1994 (Trinity County, 1993).

In manufacturing, the lumber and wood industry's employment trend has declined steadily over the past few years, most recently due to the restrictions on timber harvesting activities within northern spotted owl habitat. Despite these restrictions, some county mills have sustained operations and are expected to maintain 1992 employment levels through the forecast period.

Government is expected to lose a total of 100 jobs by the end of 1994. Seventy-five federal government jobs will be lost as a result of United States Forest Service restructuring and continued federal budget cutbacks. Local government employment is expected to decline by 25 jobs during the forecast period due to reduced local revenues and spending.

Drought conditions also affected Trinity County's tourist and recreation related industries during the historical period reducing the influx of tourist to the area and causing retail trade and services employment to remain flat. These industries are not expected to see significant improvement without improvement in the overall state and local economy.

Hayfork (population 2,626) and Hyampom (population 301) are the communities located adjacent to the analysis area. Hayfork is a timber dependent community where the social and economic situation of the community is intertwined with the lumber industry. While timber plays a major role in this community, secondary occupations dealing with the recreation industry and government industries also make a significant contribution.

Native Americans indigenous to this area are the Wintu. Many of these people still maintain traditional values and practices. Native Americans commonly maintain a continuing interest in the area. In some cases, this interest is in the production of forest commodities which continue to provide employment opportunities. Other individuals are concerned with management practices that may affect traditional commodities obtained from the forest. The availability of these products for personal and/or spiritual use is of concern. They are also concerned with outputs and management activities that may impact traditional spiritual and/ or religious activities.

Information gathered from interviews and public involvement meetings indicates that concerns of the local community are many. A healthy forest was one of the most important issues expressed. A healthy forest including wildlife, fisheries, watersheds, human consideration and diversity of use was desired.

The public supports continued management of the forest but there are strong opinions as to how this should be accomplished. Pesticide/herbicide use and clear cut harvesting are strongly opposed. Salvage logging, uneven aged management, thinning projects and selective harvesting are some of the management practices the public wants utilized in implementation of projects in this area.

Fire utilization as a management tool to obtain a healthy forest was well supported. Many felt that fire should be used to reduce fuel loading and provide fire protection. Maintaining roads to assist with fire suppression was strongly urged. Many individuals suggested fire utilization to open up the landscape as it was before. They stated that burning should be done like the Native American Indians and ranchers use to do. The area was open and not full of all the undergrowth.

Continued public involvement, community management and the potential to create local jobs is extremely important to the residents of the area. Economic considerations to keep jobs “local” was seen as important in order to maintain an economic basis for local communities. Sustainable timber harvest, alternative forest products and local contracting were suggested as ways to keep employment local. Restoration and rehabilitation projects which benefit the ecosystem and create local employment were expressed as important issues for the area. Recreation opportunities such as hiking, camping, hunting, cross country skiing and wildlife viewing were suggested. Many individuals are aware that recreation use provides an economic basis for local communities.

Prehistoric and Historic Values

Previous archaeological inspection has been conducted within the Butter Creek watershed. Approximately 12,360 acres have been surveyed for heritage resources. Thirty-three recorded sites have been identified within this area to date. Of these sites, 25 represent prehistoric sites, 7 represent historic sites and 1 site contains both prehistoric and historic components.

The majority of the prehistoric sites that have been identified within the analysis area are habitation sites comprised of lithic scatters which often contain groundstone and stream smoothed cobbles. These sites are thought to have been utilized seasonally in association with hunting and gathering activities. Other prehistoric sites that have been identified within this area include quarry sites, hunting sites, religious and spiritual sites.

Historic sites identified include cabins sites that were associated with homesteading or mining activities. Historic trails, earthen ditch lines with wooden flumes and can dumps have also been identified.

At the present time three of these recorded heritage resources have been determined to be eligible properties to the National Register of Historic Places and six sites were determined not eligible. Sixteen sites will require additional research to determine their eligibility and eight sites need to be evaluated.

Ethnographically, the Butter Creek Watershed is assigned to the Nor-El-Muk Wintu. The Nor-El-Muk were reported to have occupied the Trinity River to about Big Bar or Canyon Creek, as well as the area around Hayfork Creek, extending south to South Fork Mountain (DuBoia 1935). The Wintu speak a language that is part of the Wintuan family of languages. Also included in this language family are the Nomlaki and Patwin languages of the corresponding central and southern Wintun groups. All of these fall into the broader Penutian Stock, which includes a number of Northern and Central California languages (Theodoratus, 1981).

Historically, the Butter Creek watershed was utilized for homesteading, grazing, ranching and farming. Many of the settlers who inhabited this area were men who discovered that they could make a living by supplying miners with hay, grain, vegetables, fruit, meat and dairy products. Evidence of mining activity is present in this area but it appears that most of this was associated with the depression era.

Recreation

Motorized recreation is on the increase in all areas of the National Forest. Ever since the Butter Creek area was roaded, local residents have used the access for purposes of hunting, fishing and camping. Black-tailed deer and black bear as well as a variety of waterfowl and upland game birds are commonly hunted. The easy access and large number of areas available for camping have made the Indian Valley portion of the watershed a popular base camp for hunters. Intensive use of the Indian Valley are has resulted in compaction from vehicular use, removal of dead and down woody material, stream bank disturbance and instream disturbances. In mid-September 1994, there were 143 hunter camps within the upper Indian Valley area (Jaegel, personnel communication).

Currently, traditional forms of recreation such as hiking, skiing and equestrian use are on the increase and newer forms of recreational activities such as dirt and mountain biking and use of quad runners are on the rise. The extensive transportation system provides opportunities for these forms of recreation to take place and attracts visitors from many distant locations.

This recreation use has brought with it environmental damage and the potential for additional damage. In addition to the effects of concentrated recreation in the Indian Valley area during hunting season, other recreational impacts include firewood cutting and other damaging activities within riparian areas and rutting of roads by late season hunting.

Aesthetics

Wildlife viewing, photography and nature study have all been on the rise as our society has become more and more urban based. Increasingly, people come to the forest to escape the hustle and bustle of daily life. Although the Butter Creek watershed does not provide wilderness-like experiences, many enjoy the solitude and the opportunity to enjoy nature and quietly observe wildlife in its natural setting. More and more, people are fulfilling spiritual needs by communing with nature and by enjoying the simple pleasures of the outdoors.

Commodities and Economics

With the decline in the harvest of timber on National Forest Lands there has been a shift in the types of products being extracted from the forest. The extensive transportation system in Butter Creek has made it an easy area to access for these special products with include: firewood, mosses, cones, herbs, wildflowers and products for the floral trade.

Trapping continues to be performed today although the economic importance of it is relatively small. A new, albeit illegal, market for wildlife has opened with the reputed medicinal value of black bear gallbladders that have a high value on the black market. This has become a problem locally and could significantly impact the bear population.

The Forest is committed to community stability for the timber dependent communities of northern California. There are many efforts currently underway to diversify the economies of these areas. These include Jobs-in-the-Woods programs, emphasis on special forest products and cooperation with local groups working on job retraining and contracting and a community based Geographic Information System.

With the dwindling timber harvest on public lands, people in forest dependent rural communities are seeking alternative sources of income. Special forest products are increasingly recognized as underutilized and potentially lucrative resources that may partially help to fill the need. Products ranging from mushrooms, pine cones, lichen-covered sticks and medicinal herbs to value-added wildcrafting products such as floral wreaths, manzanita burls and madrone furniture, are being gathered from public lands throughout the Pacific Northwest.

The mandate of the USDA Forest Service is shifting to include working with rural people and communities to develop strong, diversified and sustainable rural economies consistent with sustainable ecosystem management principles (Thomas, 1994). Special forest products are recognized as an important component of such efforts and a National Strategy for Special Forest Products is currently under development.

The Butter Creek Watershed is part of the 80 percent portion of Trinity County which is managed by Federal agencies. Interest in special forest products as a potential source of income is growing. Current permits for special forest product harvest are granted on a ranger district wide basis and it is difficult to specify exactly what the current interest and harvest volumes of special forest products in Butter Creek are. However, the trend on the Hayfork Ranger District may be assumed to be indicative of growing interest in special forest products in the area. In 1990 and 1991 only one use permit was logged on the district. In 1992 there were suddenly 16 permits; in 1993 there were 18. In the first six months of 1994 there have already been 10 permits solicited.

Special Use Permits on the Hayfork Ranger District have been issued to allow collecting rights for pine cones, mushrooms, beargrass, ferns, conifer seedlings, manzanita, dogwood, prince's pine, boughs, items for the commercial floral trade, yarrow and other miscellaneous products. There is also a consistent demand for Christmas tree cutting permits. There were 400 Christmas tree permits sold on the district in 1993. In addition, there may be considerable volume of harvesting occurring without permits.

The potential income from gathering is increasing as local entrepreneurs seek out and develop markets. Over 250 products from the forests in the Klamath Mountains have a known market value. The potential value varies greatly with the product, its availability and accessibility, and with the knowledge, skill and stamina of the gatherer. Some products are plentiful for long seasons, others are harvestable for only a few weeks every year. The 1994 yarrow (*Achillea lanulosa*) crop (dried flower heads are sold for herbal teas) is yielding $6 - $18 per hour for pickers, depending on experience. Prince's pine (*Chimaphila umbellata*), a flavoring for certain soft drinks and a medicinal herb, is valued at $1.50 to $2.00 per pound of dry weight. Pine cones are less valuable, but they are readily available in seasons when other crops are less plentiful.

The Human Imprint

Timber Harvest

Since 1957, over 315 million board feet of timber has been harvested from the Butter Creek watershed. Over 5,000 acres is presently comprised of plantations, many of which can require periodic maintenance (**Plate 18**) in order to meet multi-resource objectives, including wildlife habitat and fuel hazard reduction. Maintenance activities include grubbing of vegetation which is competing for soil moisture, vexar tubes to protect seedlings from deer browse, and pre-commercial and commercial thinning to increase tree spacing and reduce fuel loads and fire ladders. Some plantations which are not well established sometimes require re-planting or interplanting of poorly stocked areas, to increase tree density to acceptable levels. In addition, many acres have been selectively harvested (**Plate 19**).

Transportation

The Trinity River Basin was accessed first with trails and later with roads for mining purposes. In more recent years, the need for access to important timber reserves and private lands accelerated the development of the road system. With this expansion of the road network throughout the basin, nearly all drainages of the Trinity River, outside of the wilderness, were entered and timber harvest conducted.

The South Fork Trinity River was entered extensively for both the timber and mineral resources. Some of the early road building techniques were not to modern standards and road placement was sometimes poor, leading to road failures from mass wasting, which contributed sediment to streams. Today many of the problems have been corrected, but there remain some isolated problem areas. The transportation system in the South Fork is currently used extensively for recreation and land management projects.

Over 159 miles of road lie within the Butter Creek watershed (**Plate 20**). **Table 8** lists miles of road within each subwatershed and the road density for each of the subwatersheds.

With the high average road density of 4.33 miles per square mile for the entire watershed, and up to 7.3 miles per square mile in one of the subwatersheds, habitat capability for wildlife has decreased. Traffic causes disturbance to deer, for example, by affecting their metabolic rate and use of food needed for growth and reproduction. Roads that are closed to vehicular traffic do not result in significant disturbance, and are often used for foraging and travel by wildlife. As miles of open road use increases, the relative usability for deer decreases (Brown, 1985). For bear, an average of 1/2 to 2 miles per square mile of open road density provides a moderate level of habitat capability. From a wildlife perspective, it is desirable to manage open road density to a level less than 1.5 miles per square mile of area.

Culverts on road crossings of mapped streams throughout the Butter Creek watershed were sampled and evaluated for flow capacity, condition and drainage maintenance needs by a civil engineer (Steffes, 1994). Cross drains and minor 18 inch culverts draining swales or depressions were not evaluated. He found 142 culverts within the Butter Creek watershed, of which he determined that 94 to 115 did not meet the 100 year flow requirement outlined in Standards and Guideline RF-4, on page C-33 of the ROD (USDA and USDI, 1994b). There was a range in culverts not meeting the ROD flow requirement because two Crest Stage Gages are located in the vicinity of the watershed which had significantly different peak flows. He therefore evaluated all culverts using peak flows for both gages.

Eight culverts which did not meet the 100 year flow need to be replaced to allow fish passage, defined by Standard and Guideline RF-6. One culvert which met the 100 year flow also needs to be replaced to allow fish passage.

He generally found that the majority of culverts were no longer at grade at the outlet, therefore were “shotgun” culverts. They had created their own energy dissipators through erosion. He also found that in some cases maintenance was needed to cut down shrubs and alders which were growing across culvert inlets. No analysis was performed regarding the risk that these culverts posed to the Riparian Reserve, as defined by the ROD. However, replacement costs were estimated to be over $8,000 per mile of road, or 1.2 million dollars for the watershed.

Two bridges are located within the watershed, both crossing Butter Creek. An analysis will be performed this year to evaluate how well they meet the 100 year flow requirement.

The transportation system was also surveyed for surface type. Over 66 percent of the system within the Butter Creek watershed is native surfaced, nearly 30 percent has aggregate surface, 1.9 percent is asphalt surfaced and 1.7 percent is chip sealed.

Livestock Grazing

The Indian Valley allotment lies within the upland portion of the watershed. Currently, one permittee is utilizing the allotment. Maximum use is limited to 55 cow/calf pairs. The use period extends from May 15 to October 31. Recent activities have focused on dispersing use in the Seven Road subwatershed by putting in several water developments higher in the watershed to discourage the concentrated use the riparian area on the main channel was getting. Other areas are still noted for their heavy use, including upper Indian Valley Creek and Cold Springs Creek. An Allotment Management Plan was most recently prepared in 1984.

Issues for the Butter Creek Watershed

The following issues were identified by the Butter Creek Watershed Analysis Team. Broader issues for the South Fork of the Trinity River were first identified, then more specific ones for Butter Creek were documented.

South Fork of the Trinity River Issues

- Anadromous Fish Habitat
- Biological Diversity
- Riparian Habitat
- Water Quality
- Geologic Instability
- Flow Regimes—Main Stem
- Potential for Catastrophic Fires
- High Road Density
- Estuary Conditions Affected by Sediment
- Non-uniform Land Management (private vs. public)
- Cultural/Social/Economic Expectations
- Old Growth and Riparian Endemic Species
- Stocks at Risk
- Cumulative Watershed Effects
- Fish Harvest
- Conflicting Legislation
- Heritage Resources

Butter Creek Issues

- Anadromous Fish Habitat
  - Cover and pool habitat—lower Butter Creek
  - Underutilized salmon habitat
  - Upstream migration barrier
  - Steelhead rearing habitat
  - Chinook presence or absence
  - Chinook spawning habitat limited
  - Large woody debris—presence and recruitment potential
- Stocks at Risk
  - Chinook and Steelhead
  - Fish harvest—in basin and ocean
  - Trinity hatchery influence
- Inland Fisheries
  - Habitat capability
  - Populations
- Biological Diversity
  - Landscape Diversity
    - Distribution of vegetation types
    - Unbalanced seral stages
  - Landscape Elements
    - Corridor problems
    - Fragmentation
  - Species Diversity
    - Sensitive plant and animal populations
    - T&E plant and animal populations
    - Species of concern—noxious weeds, porcupines
    - Historical wildlife
  - Habitats of Concern
    - Late seral
    - Hardwoods
    - Wetlands
- Riparian Habitat
  - Degraded within burned areas
  - Grazing conflicts
  - Road conflicts
  - ‘64 flood-induced effects
  - Recreation conflicts
  - Species composition and diversity
  - Private water diversion
  - Private logging practices
  - Wildlife species of concern

- Bank instability
- Recruitment of large woody material

Social/Cultural

- Lack of traditional resource materials
- Trails and use patterns
- Fisheries
- Forest products

Water Quality

- Temperature
- Sediment
- Baseflow in Indian Valley
- Domestic use
- Livestock/grazing

Geologic Instability

- Natural landslides
- Management induced landslides

Potential for Natural Fires

- Fuel ladders
- Fuel loading
- Private property
- Human/natural starts
- Fire behavior

Transportation System

- High road density
- Riparian/road conflicts
- Roads as sediment sources
- Road condition—maintenance
- Transportation system needs—long range

Multi-Ownership

- Private land practices

Cumulative Watershed Effects

- Burned areas
- Salvage harvesting
- Road network
- Historic harvesting
- Sensitive lands
- Sensitive channel types
- Sensitive habitats

Key Questions for Analysis

Key Questions were derived from evaluating the issues which the team identified. These are the questions that this Watershed Analysis will attempt to answer. They provide a focus for the team and drive the analysis. The Key Questions listed in this section were arrived at through a series of rigorous, interdisciplinary discussions from a much longer list of questions. Some of the questions discarded were pre-analysis questions while others were either not important to answer or were portions of larger-scale questions.

For some of the Key Questions, data is not currently available to be able to conduct a reasonably credible analysis. Key Questions in this category are listed in Chapter IV along with a rationale for not answering them at this time.

Key Questions were determined and analyzed utilizing an interdisciplinary team and on an integrated resource basis. The questions are listed here, however, by the ecosystem component to which they are most directly linked and are in the same order as the narrative description above for the Butter Creek Watershed. This same order and labeling will be utilized throughout the document in order to allow the reader to more easily locate and link pertinent data.

Geology

What are the landslide hazards for the entire watershed?

What effects occurred downstream from slide sites in the Butter Creek Watershed?

What factors influence the location of landslides in the Butter Creek Watershed?

How much sediment is delivered from slides in the Butter Creek Watershed to stream systems?

What management practices have had the greatest influence on landslide activity?

What is the location of the sites where management has occurred which has the greatest risk for mass wasting occurrence?

What are the general guidelines for avoiding initiating landslides?

How much sediment has been delivered from the slides to stream systems?

Soils

What relationships exist between the patterns of soil groups and the historic disturbance (pre-1950) regime in the watershed?

How do soil erosion processes manifest themselves in the watershed, and what is the magnitude of erosion from each contributor?

What are the mechanisms for delivery of soil to the stream system, and what are their relative contributions to sediment production?

What conditions exist or have the potential to exist that jeopardize the long-term sustainability of the soil resource and all of its functions?

Can current or desirable future conditions in Butter Creek Watershed meet or exceed the Soil Quality Standards and, if not, what additional measures might be necessary?

What special or unique values of the soil resource occur in Butter Creek and how do they contribute to a vital and healthy ecosystem?

How resistant and/or resilient are soil groups found in the watershed to disturbances, either individually or cumulatively?

What might be the expected rates of recovery of the soil environment (physical, chemical, biological) following disturbance?

Does the current forest stand structure in Butter Creek provide for the sustained recruitment of an appropriate quantity of litter and duff?

Climate and Hydrology

Water Quality

What are the processes within the Butter Creek watershed that control the natural range of variability of sediment production?

Where in the Butter Creek watershed are the present sediment production conditions outside the natural range of variability?

What are the effects of present sediment production on beneficial uses of Butter Creek and the South Fork Trinity River?

If sediment effects are identified, what human actions should be modified or implemented to bring the present fine sediment production within the natural range of variability?

What is the natural range of variability of sediment production in watersheds similar to Butter Creek?

What is the natural range of variability of water quality parameters addressed in water quality standards within the Butter Creek watershed?

What are the processes within the Butter Creek watershed that control the natural range of variability of water temperature?

Where in the Butter Creek watershed are the present water temperatures outside the natural range of variability?

What are the effects of present water temperature conditions on beneficial uses of Butter Creek and the South Fork Trinity River?

Channel Conditions

Where in the Butter Creek watershed are the present channel conditions outside the natural range of variability?

What are the processes within the Butter Creek watershed that control the natural range of variability of channel conditions?

What are the effects of present channel conditions on beneficial uses of Butter Creek and the South Fork Trinity River?

If human activities are contributing to channel degradation, what human actions could be modified or implemented to bring the present channel conditions within the natural range of variability?

Cumulative Watershed Effects

What are the primary water and sediment routing mechanisms in the watershed?

What is the gross sediment budget for the watershed?

What are the sensitive land types, and how are they distributed?

What factors seem to contribute to defining the sensitive land types in the watershed?

What are the sensitive channel types and how are they distributed?

What factors contribute to stream channel sensitivity?

What is the sensitivity on a subwatershed basis?

What is the disturbance history of the watershed?

What is the history of rain-on-snow events in the watershed?

What is the climate for the Butter Creek watershed?

What are the streamflow characteristics (flow regimes) of the watershed, including peak streamflows, baseflow, etc?

What effect did the 1964 flood have on the watershed?

What is the drainage density?

Fisheries

Anadromous Fish Populations

Are the number of returning adult steelhead sufficient, on the average, to fully utilize existing spawning habitat?

Are there factors, unrelated to habitat limitations, that can account for the apparent disproportionate reduction of age 1+ and 2+ steelhead juveniles in relation to age 0+ production?

Anadromous Fish Habitat

What is the existing condition of the steelhead spawning and rearing habitat?

Are there specific habitat components lacking that can account for the apparent disproportionate reduction in age 1+ and 2+ juvenile steelhead in relation to age 0+ juveniles?

Is spawning and rearing habitat available and suitable to support viable and self-sustaining populations of chinook and coho salmon?

What past (pre-1950) and present (post-1950) activities within the Butter Creek watershed have contributed to the degradation of anadromous fish habitat?

Are there stream reaches where riparian vegetation is inadequate and, if so, is there potential to establish riparian vegetation?

Resident Fish Populations

What is the distribution of resident rainbow trout in the upper Butter Creek watershed?

Resident Fish Habitat

What is the existing condition of the resident rainbow trout spawning and rearing habitat?

Are there specific habitat components lacking that can account for the apparent low numbers of resident rainbow trout?

Is spawning and rearing habitat available and suitable to maintain viable and self-sustaining populations of resident rainbow trout?

What past (pre-1950) and present (post-1950) activities within the Butter Creek watershed have contributed to the degradation of resident rainbow trout habitat?

Vegetation and Plant Species of Concern

What is the current composition and structure of vegetation communities and populations?

What is the natural range of variability of landscape patterns, seral stages, patch sizes and juxtaposition?

Where does connectivity need to be maintained?

What is missing that may need to be restored?

What are the forest health conditions?

What is the effect of the current vegetative conditions on ecological processes?

What are the locations of Threatened, Endangered and Sensitive (TES) plant species, watch list plant species and old-growth associated plant species?

What are the historic ranges of the TES, watch list, and old-growth associated plant species?

What are the characteristics of suitable habitat for TES, watch list and old-growth associated plant species?

What surveys are needed for TES, watch list and old-growth associated plant species?

Are there populations of noxious weeds and what are the vectors for their invasion?

What (if any) are the disturbance regimes needed for viable populations of TES, watch list and old-growth associated plant species?

What is the condition of TES, watch list and old-growth associated plant species?

Fauna

What wildlife species occur in the watershed, both current and historically?

Are there problems associated with the current species diversity?

What is the current and historic distribution of habitats and elements?

Are there habitat deficiencies?

For each TES species in the watershed, what are their habitat needs and how much habitat is currently occupied and how much is unoccupied?

For each TES species in the watershed, what are the current, historic and potential population levels?

For each TES species, are there opportunities to promote recovery?

What configuration of corridors is needed to provide maximum benefit?

Prehistoric and Historic Human Values and Uses

What are the dominant social and cultural contexts represented in this area?

What are the significant prehistoric and historic sites in this area?

What are the prehistoric and historic settlement patterns in this area and how have they changed through time?

What landscape elements are impacting prehistoric and historic sites and where is this occurring?

What historic contexts will likely continue into the future?

What are the major economic considerations in this area ?

What are the expectations of the local community for the watershed ?

Contemporary Human Values

What are the major social contexts associated with the watershed?

What are the major economic consideration in this area?

What are the expectations of the local community for the watershed?

Timber Harvest

What is the historic timber harvest level from the Butter Creek watershed?

What harvest levels are thought to be ecologically and environmentally sustainable from the watershed?

Special Forest Products

What products are currently being harvested, in what volume and from which locations?

Are there any known impacts of current harvest levels on the resources harvested (increases or decreases in yields due to harvest, effects on other species or ecosystem functions)?

What were historic patterns of harvesting in the area?

What products have potential for harvest in future (anticipate demand)?

What harvest methods and volumes, if any, are sustainable (including cumulative effects) for each product currently harvested in Butter creek watershed?

Transportation System

What is the impact of the transportation system on Riparian Reserves?

What effect does road placement have on wildlife, including bears and deer?

Fire and Fuels

What are the current fire regimes?

What is the historic fire occurrence and the timing of historic events in the Butter Creek Watershed?

What are the fuel characteristics in the Butter Creek Watershed?

What has been the effect of fire suppression on the identified attributes? (Disturbance regimes)

What is the scope of stand replacing fires under the historic fire regime?

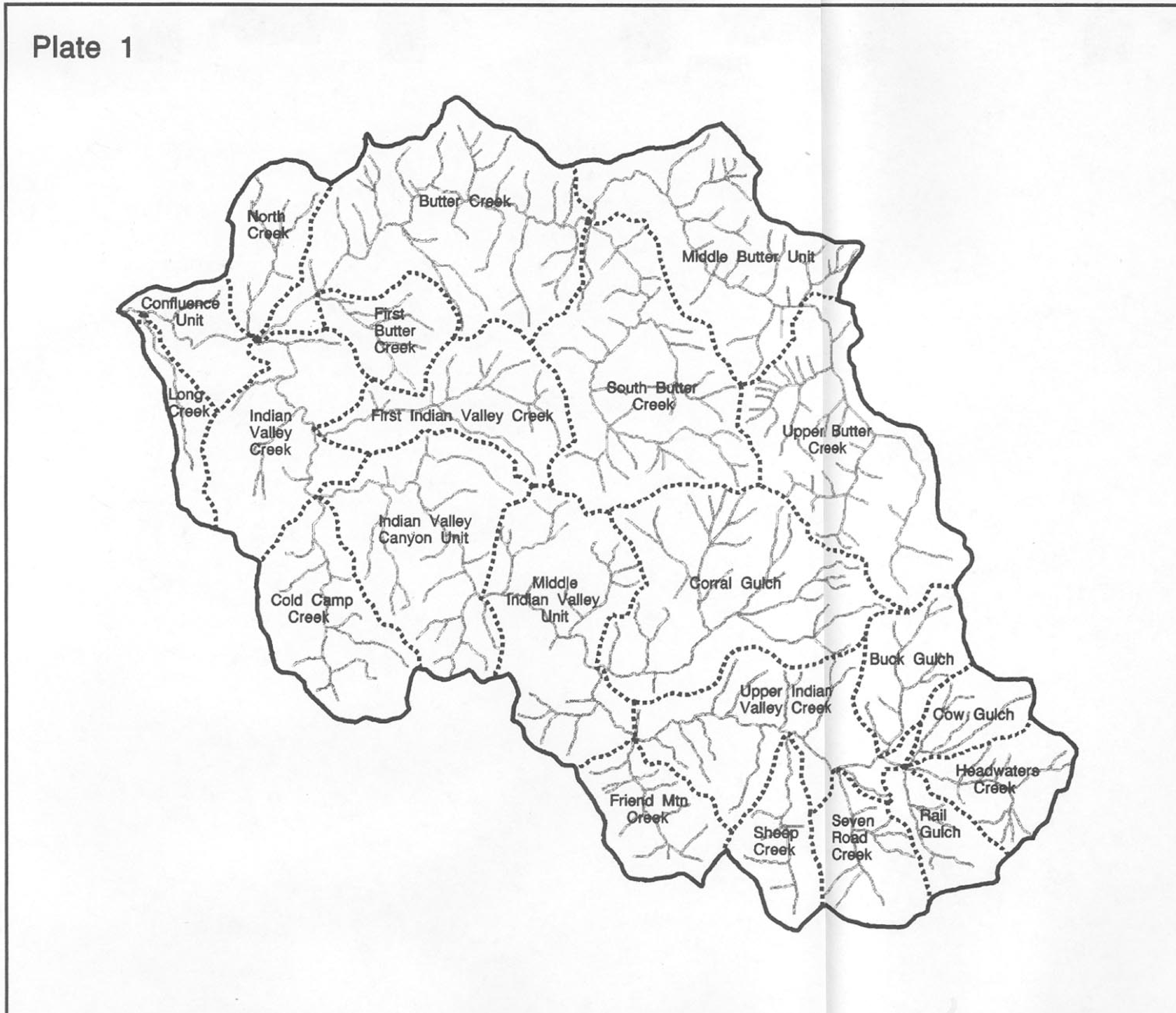
What is the potential risk of wildfire and what effect might wildfire have on key resources?

Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

Sub-watersheds



Subwatershed Boundary
Butter Creek Watershed Boundary
Streams

N W E S

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers
0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, CA September 14, 1994 Sources: U.S.D.A. Forest Service

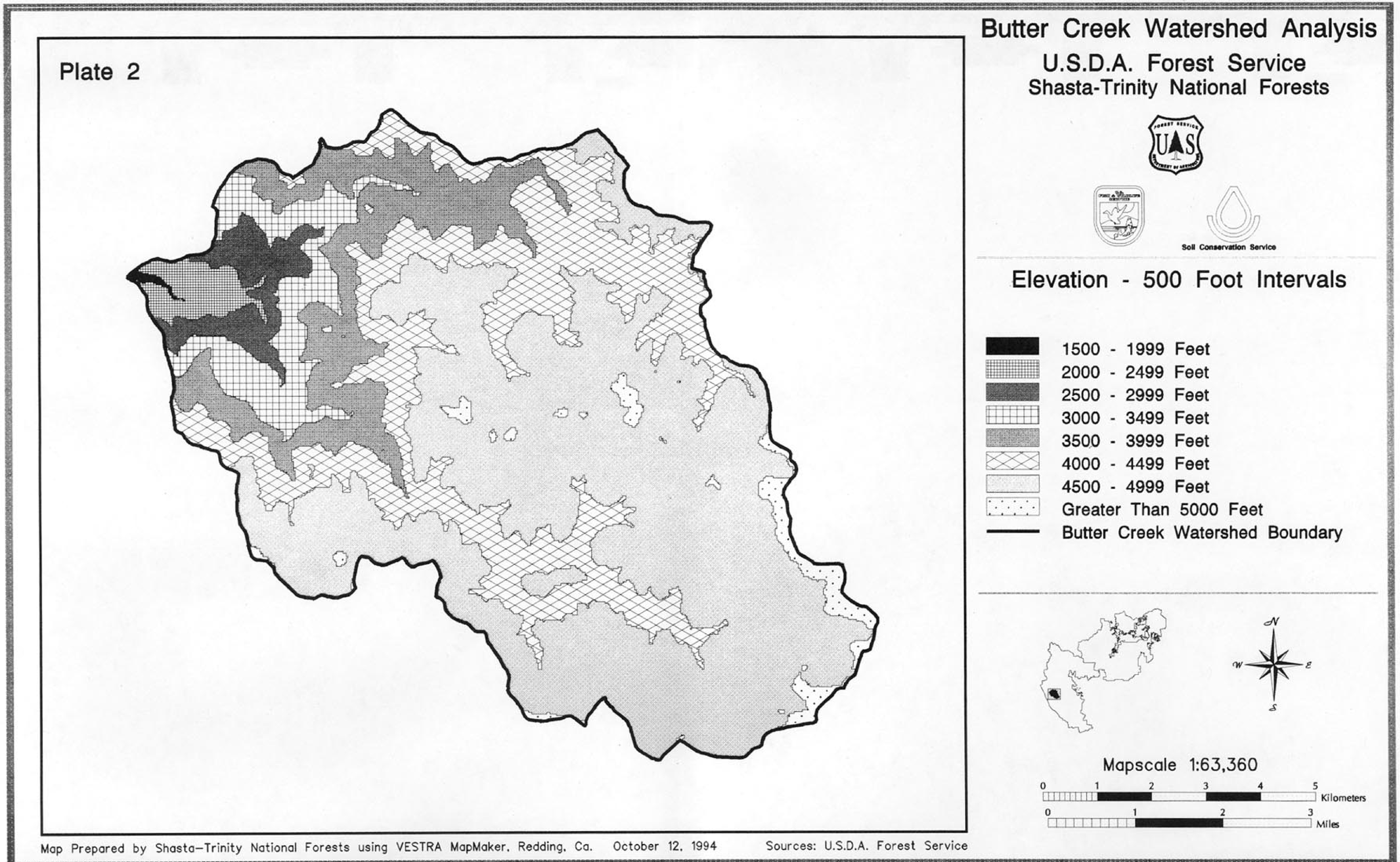
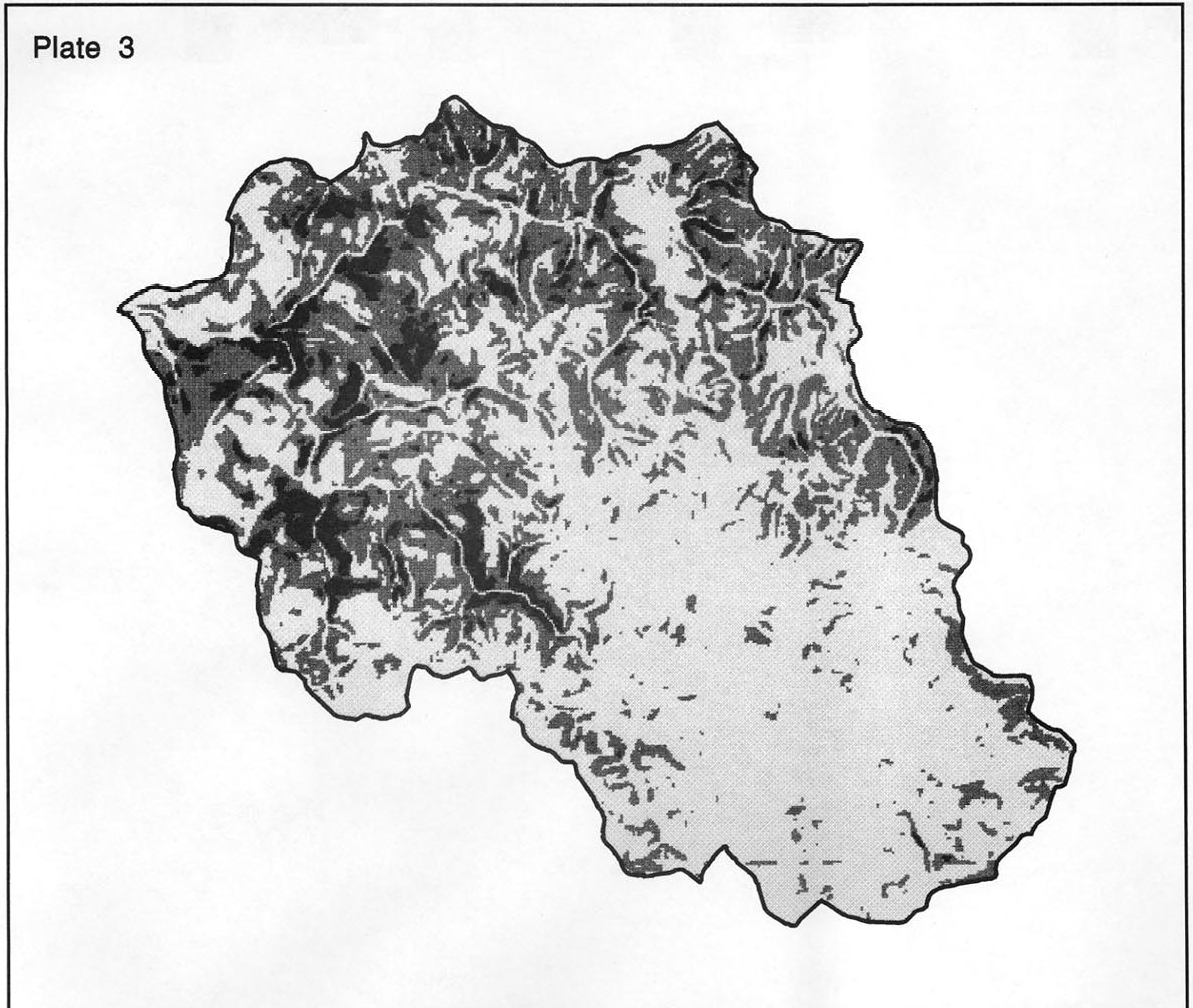


Plate 2
Butter Creek Watershed Analysis
U.S.D.A. Forest Service
Shasta-Trinity National Forests
Soil Conservation Service
Elevation - 500 Foot Intervals
1500 - 1999 Feet
2000 - 2499 Feet
2500 - 2999 Feet
3000 - 3499 Feet
3500 - 3999 Feet
4000 - 4499 Feet
4500 - 4999 Feet
Greater Than 5000 Feet
Butter Creek Watershed Boundary
N
W
E
S
Mapscale 1:63,360
0 1 2 3 4 5 Kilometers
0 1 2 3 Miles
Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. October 12, 1994
Sources: U.S.D.A. Forest Service



Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

Slope Percent

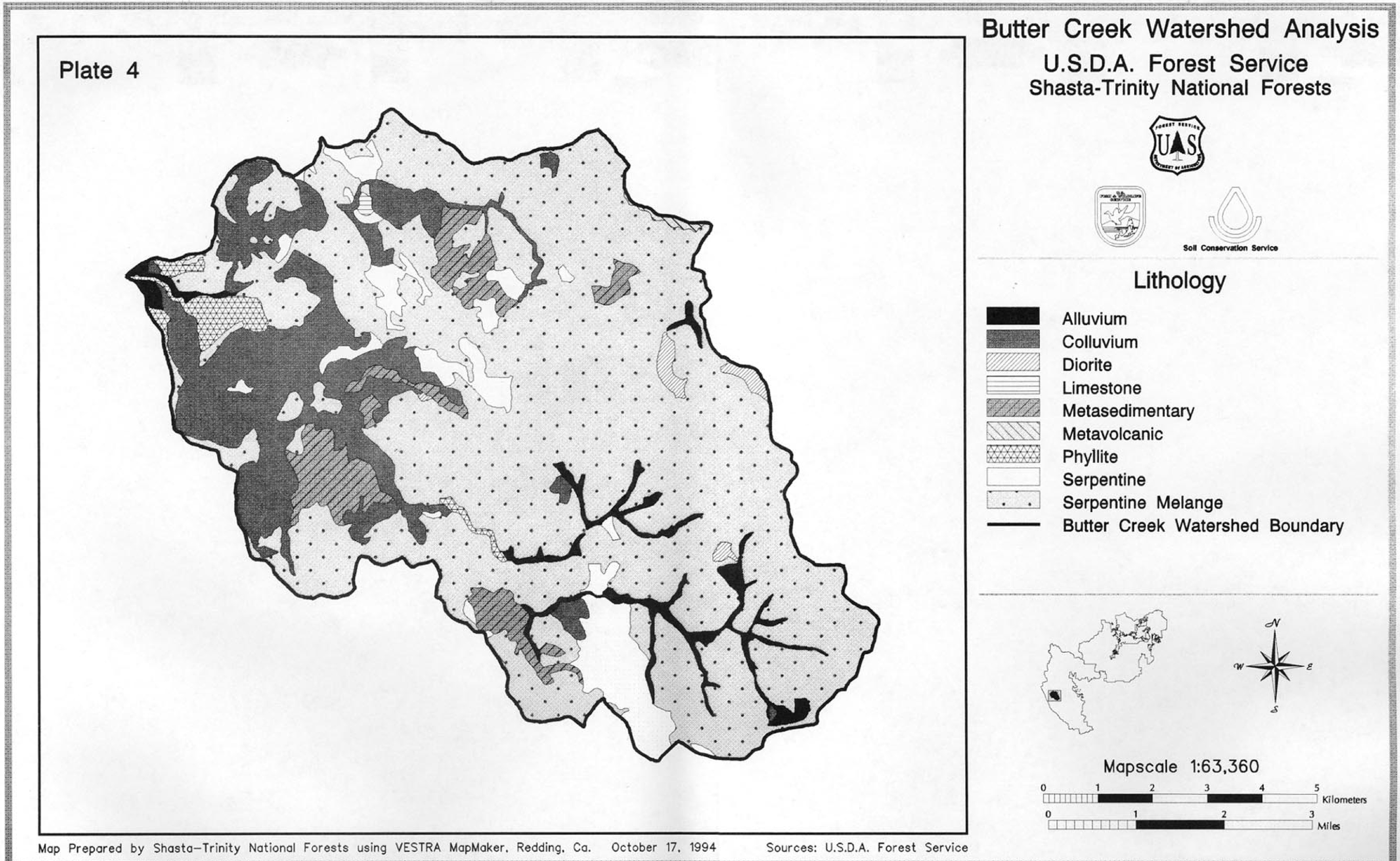
- 0.0% - 30.0% Slope
- 30.1% - 60.0% Slope
- Greater Than 60.0% Slope
- Butter Creek Watershed Boundary

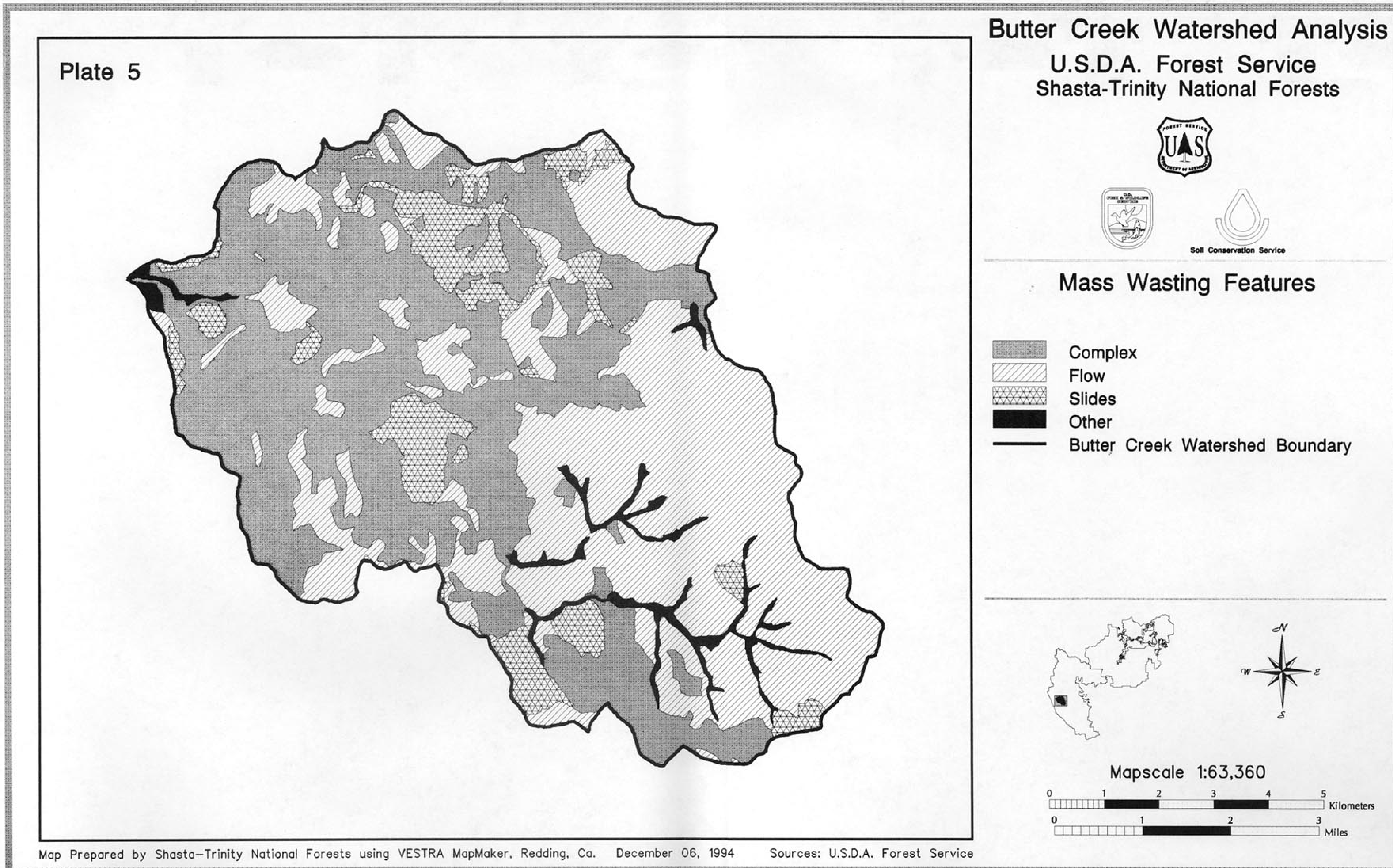
Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. October 17, 1994 Sources: U.S.D.A. Forest Service


Butter Creek Watershed Analysis
U.S.D.A. Forest Service
Shasta-Trinity National Forests
Plate 4
Soil Conservation Service
Lithology
Alluvium
Colluvium
Diorite
Limestone
Metasedimentary
Metavolcanic
Phyllite
Serpentine
Serpentine Melange
Butter Creek Watershed Boundary
N
W
E
S
Mapscale 1:63,360
0 1 2 3 4 5 Kilometers
0 1 2 3 Miles
Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. October 17, 1994
Sources: U.S.D.A. Forest Service

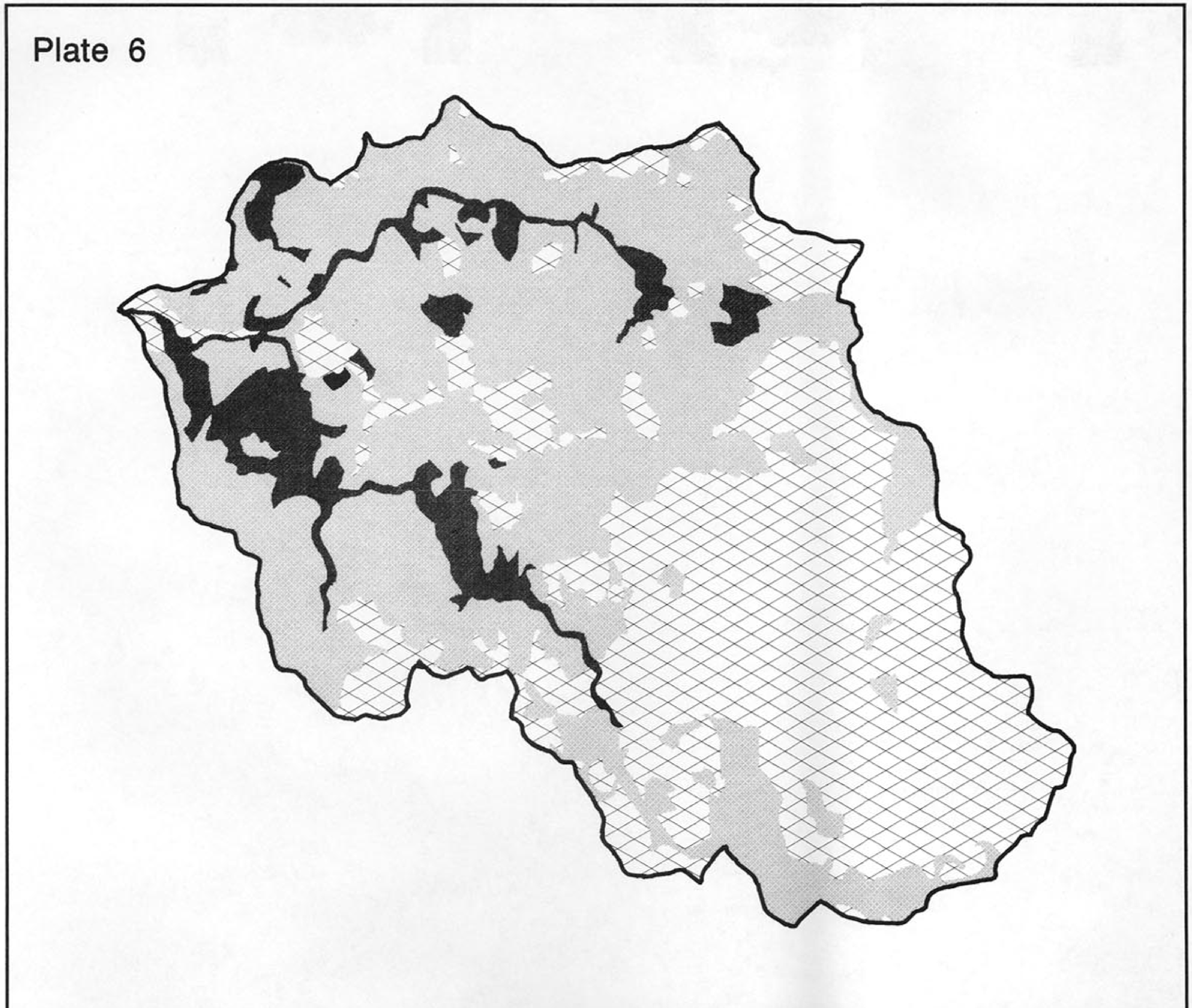

Butter Creek Watershed Analysis
U.S.D.A. Forest Service
Shasta-Trinity National Forests
Soil Conservation Service
Plate 5
Mass Wasting Features
Complex
Flow
Slides
Other
Butter Creek Watershed Boundary
N
W
E
S
Mapscale 1:63,360
0 1 2 3 4 5 Kilometers
0 1 2 3 Miles
Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994
Sources: U.S.D.A. Forest Service

Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

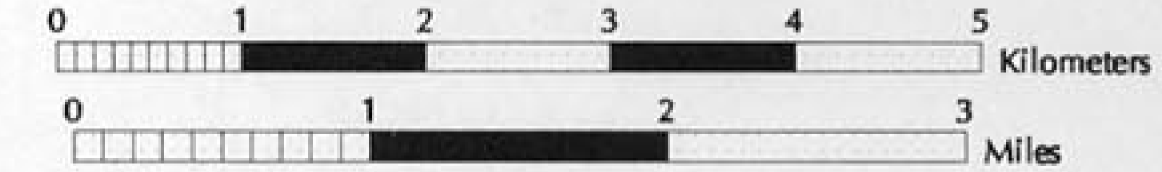
Plate 6



Slope Stability Hazards

- Slope Stability Hazard of 0 - 3
- Slope Stability Hazard of 4 - 6
- Slope Stability Hazard of 7 - 9
- Slope Stability Hazard of 10
- Butter Creek Watershed Boundary

Mapscale 1:63,360



Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 04, 1994 Sources: U.S.D.A. Forest Service

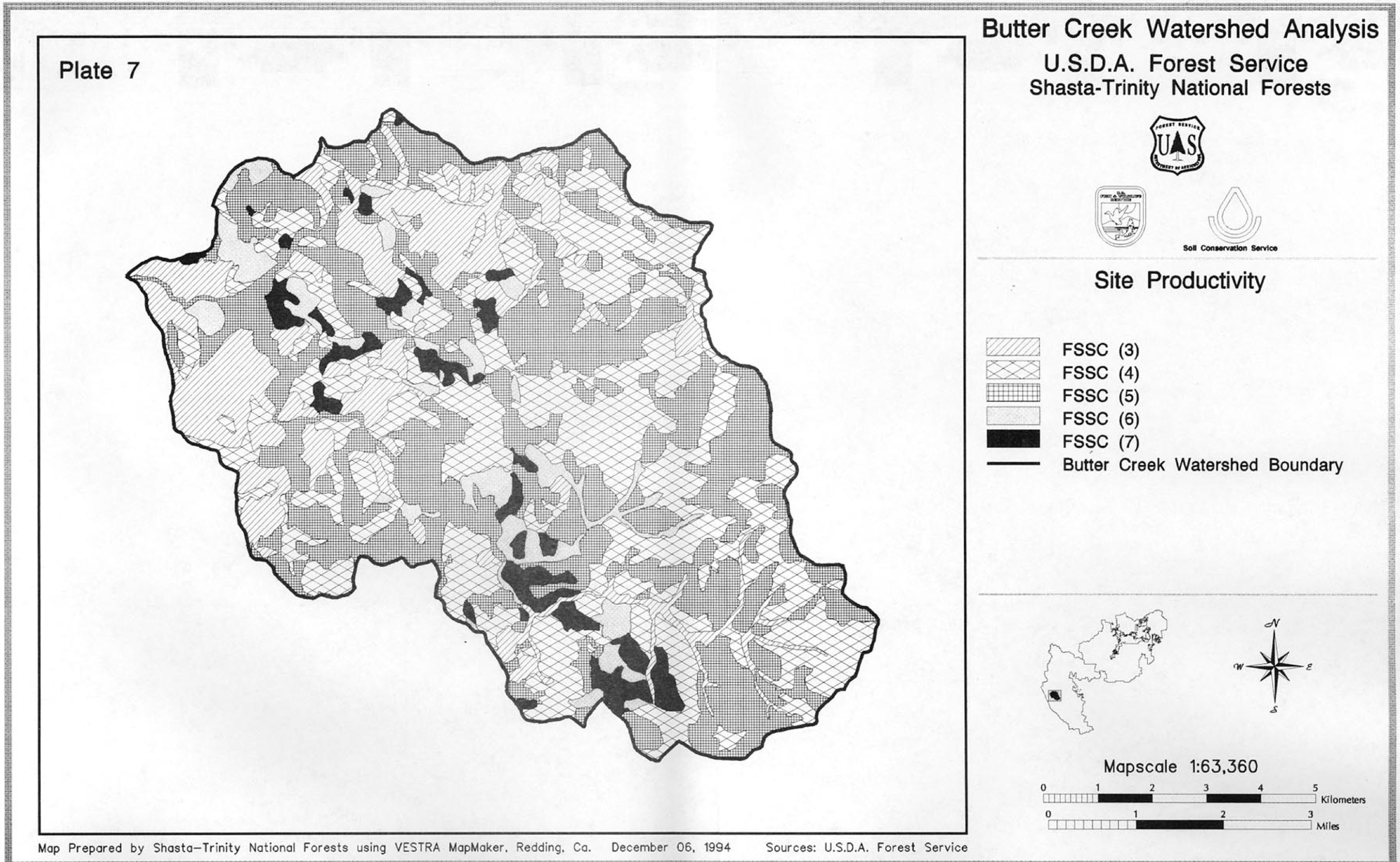
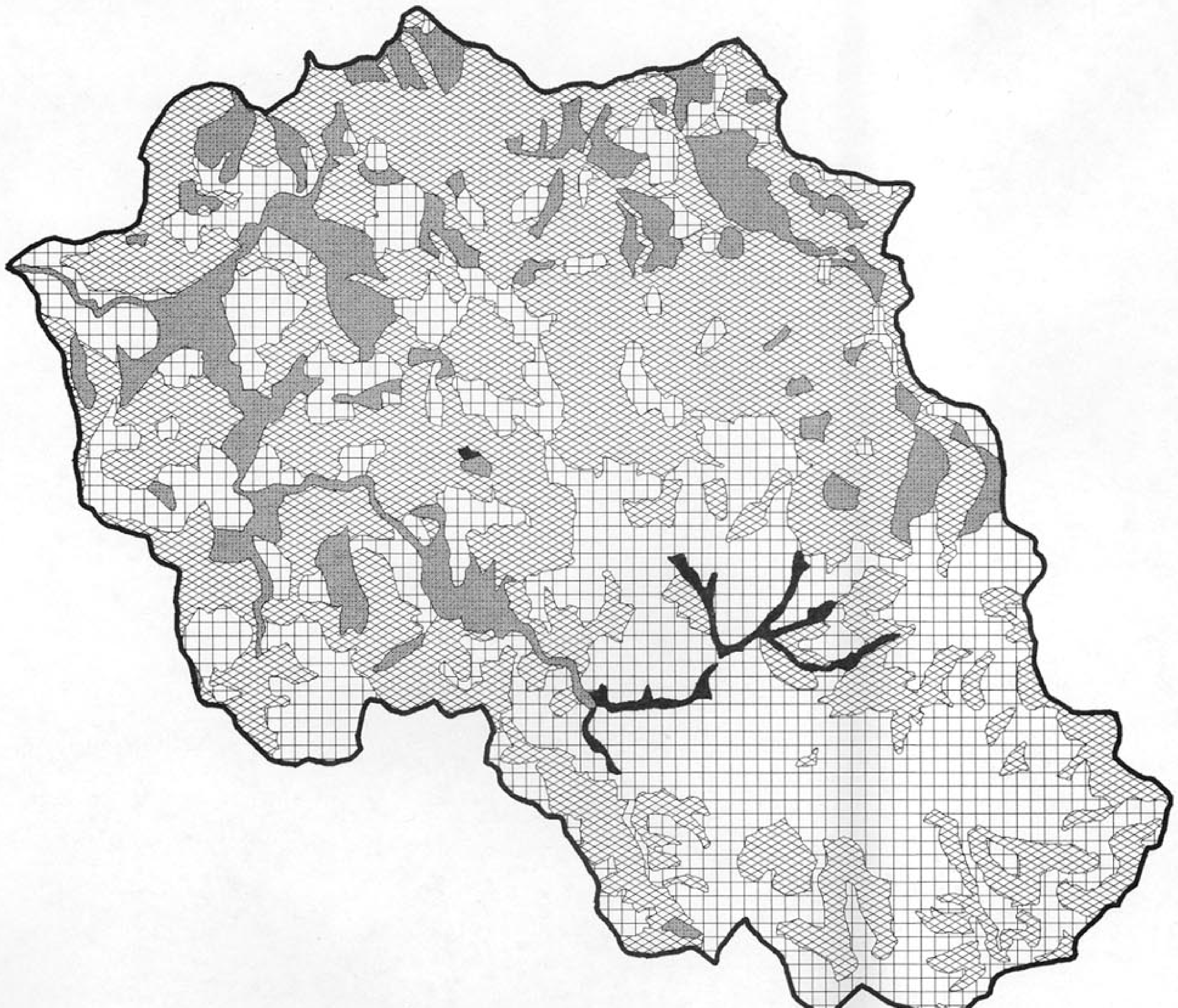


Plate 7
Butter Creek Watershed Analysis
U.S.D.A. Forest Service
Shasta-Trinity National Forests
Soil Conservation Service
Site Productivity
FSSC (3)
FSSC (4)
FSSC (5)
FSSC (6)
FSSC (7)
Butter Creek Watershed Boundary
N
W
E
S
Mapscale 1:63,360
0 1 2 3 4 5 Kilometers
0 1 2 3 Miles
Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994
Sources: U.S.D.A. Forest Service

Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Plate 8



Soil Conservation Service

Surface Erosion Hazards

- Low Erosion Hazard
- Moderate Erosion Hazard
- High Erosion Hazard
- Very High Erosion Hazard
- Butter Creek Watershed Boundary

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 04, 1994 Sources: U.S.D.A. Forest Service

Plate 9

Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

Stream Map - Flow Regime

Intermittent and Ephemeral Streams
Perennial Streams
Butter Creek Watershed Boundary

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers
0 1 2 3 Miles

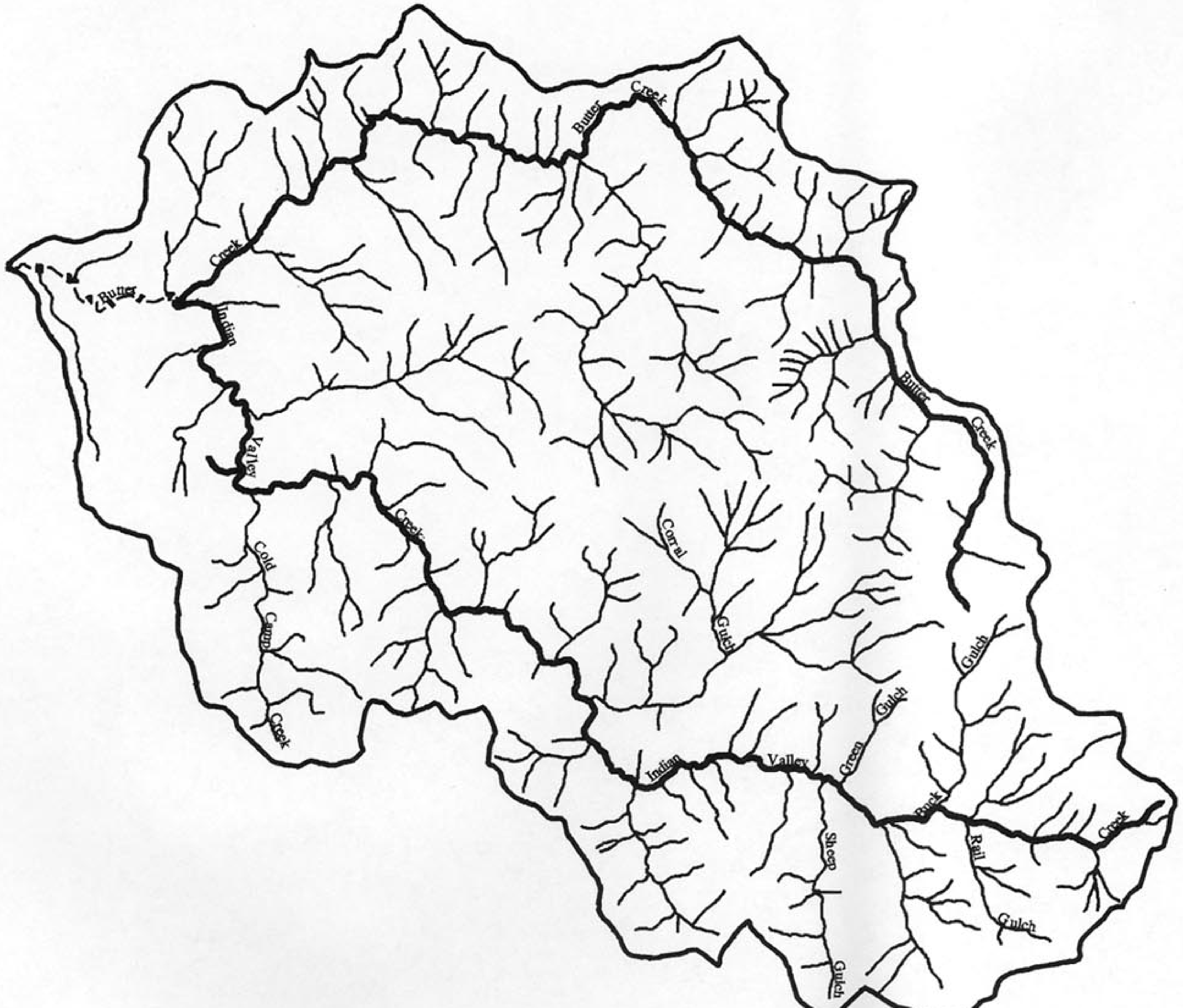
Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994 Sources: U.S.D.A. Forest Service

Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

Plate 10



Fish Distribution

- Anadromous and Resident Fish
- Resident Fish
- None
- Butter Creek Watershed Boundary

N W E S

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 08, 1994 Sources: U.S.D.A. Forest Service

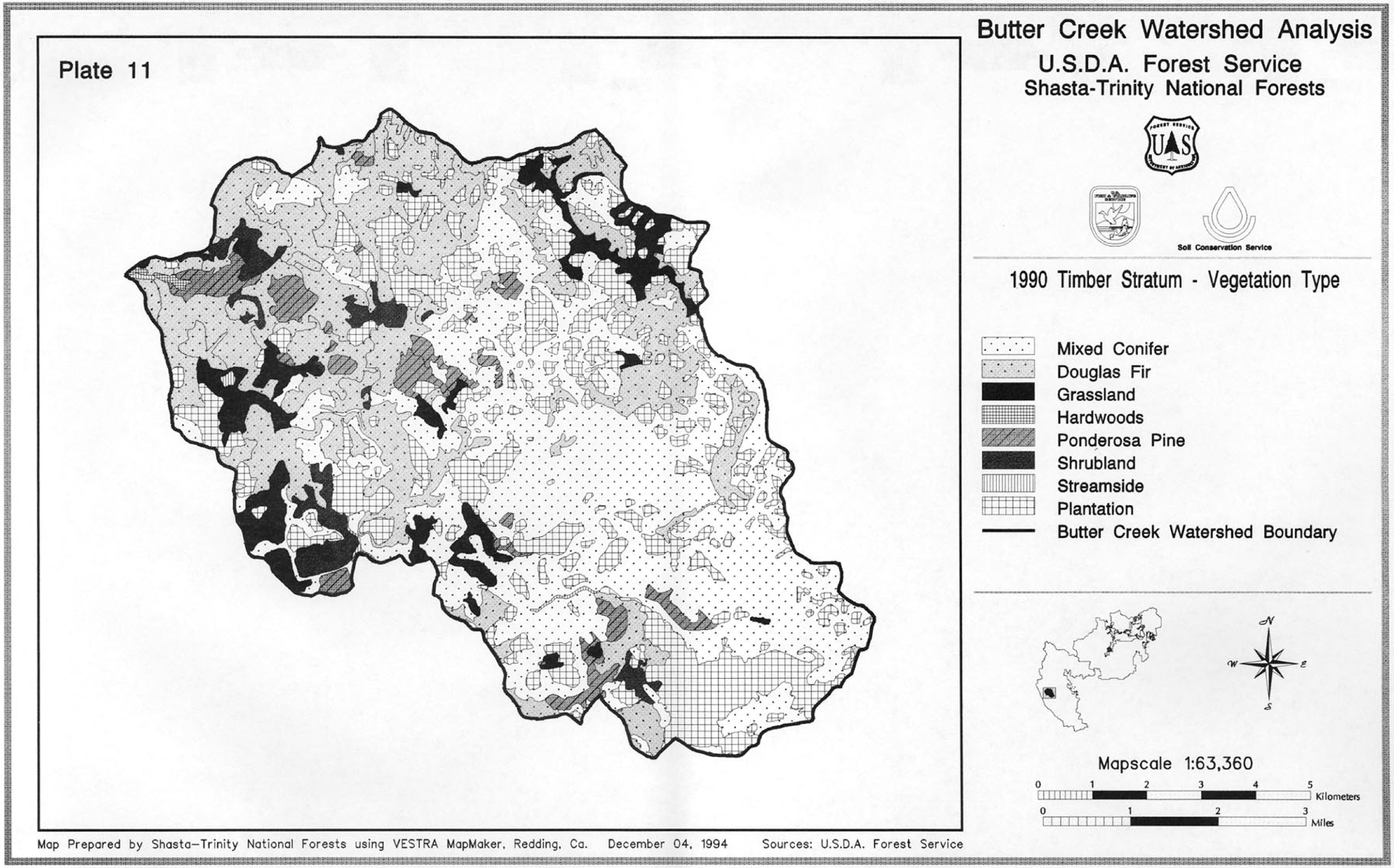
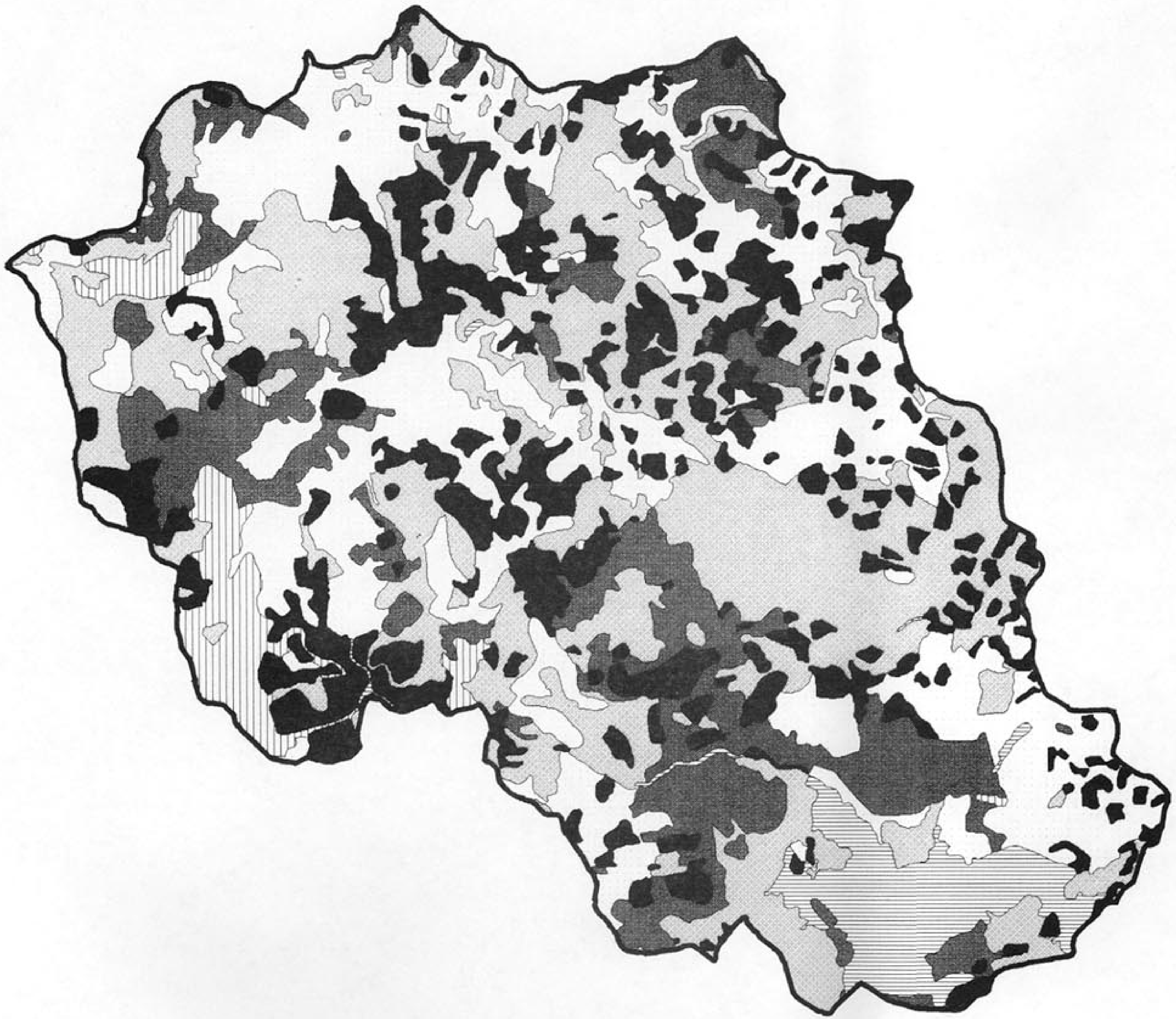


Plate 11
Butter Creek Watershed Analysis
U.S.D.A. Forest Service
Shasta-Trinity National Forests
Soil Conservation Service
1990 Timber Stratum - Vegetation Type
Mixed Conifer
Douglas Fir
Grassland
Hardwoods
Ponderosa Pine
Shrubland
Streamside
Plantation
Butter Creek Watershed Boundary
N
W
E
S
Mapscale 1:63,360
0 1 2 3 4 5 Kilometers
0 1 2 3 Miles
Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 04, 1994
Sources: U.S.D.A. Forest Service

Plate 12



Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

1990 Ecological Seral Stages

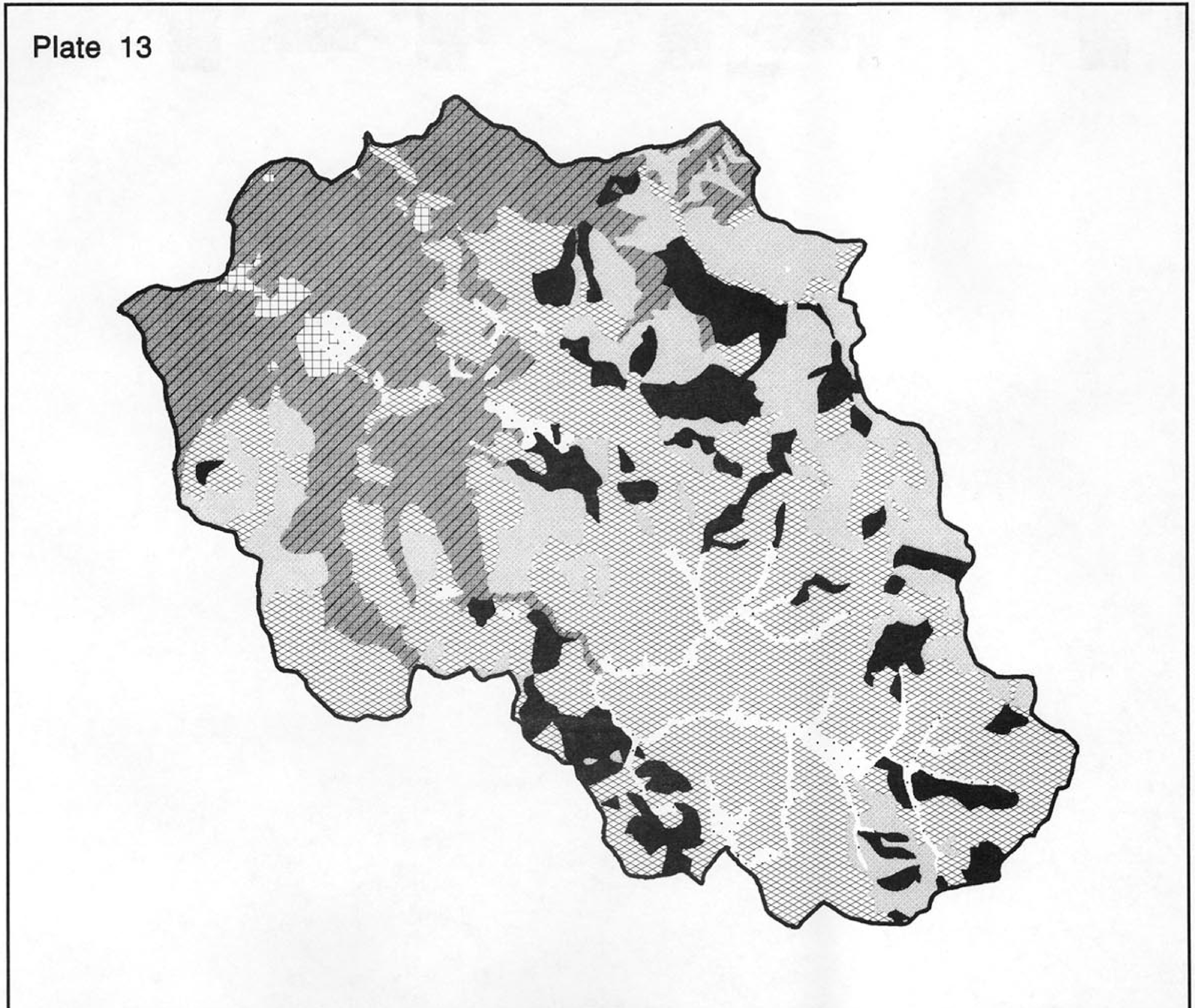
- Old Growth/Late Mature
- Mid Mature
- Early Mature
- Immature/Sapling - Seedling
- Shrub
- Herb
- Butter Creek Watershed Boundary

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994 Sources: U.S.D.A. Forest Service



Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

Potential Natural Community Series

- White Fir
- Jeffrey Pine Group
- Mixed Conifer
- Mixed Conifer/Canyon Live Oak
- Douglas Fir
- Gray Pine/Canyon Live Oak
- Butter Creek Watershed Boundary

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994 Sources: U.S.D.A. Forest Service

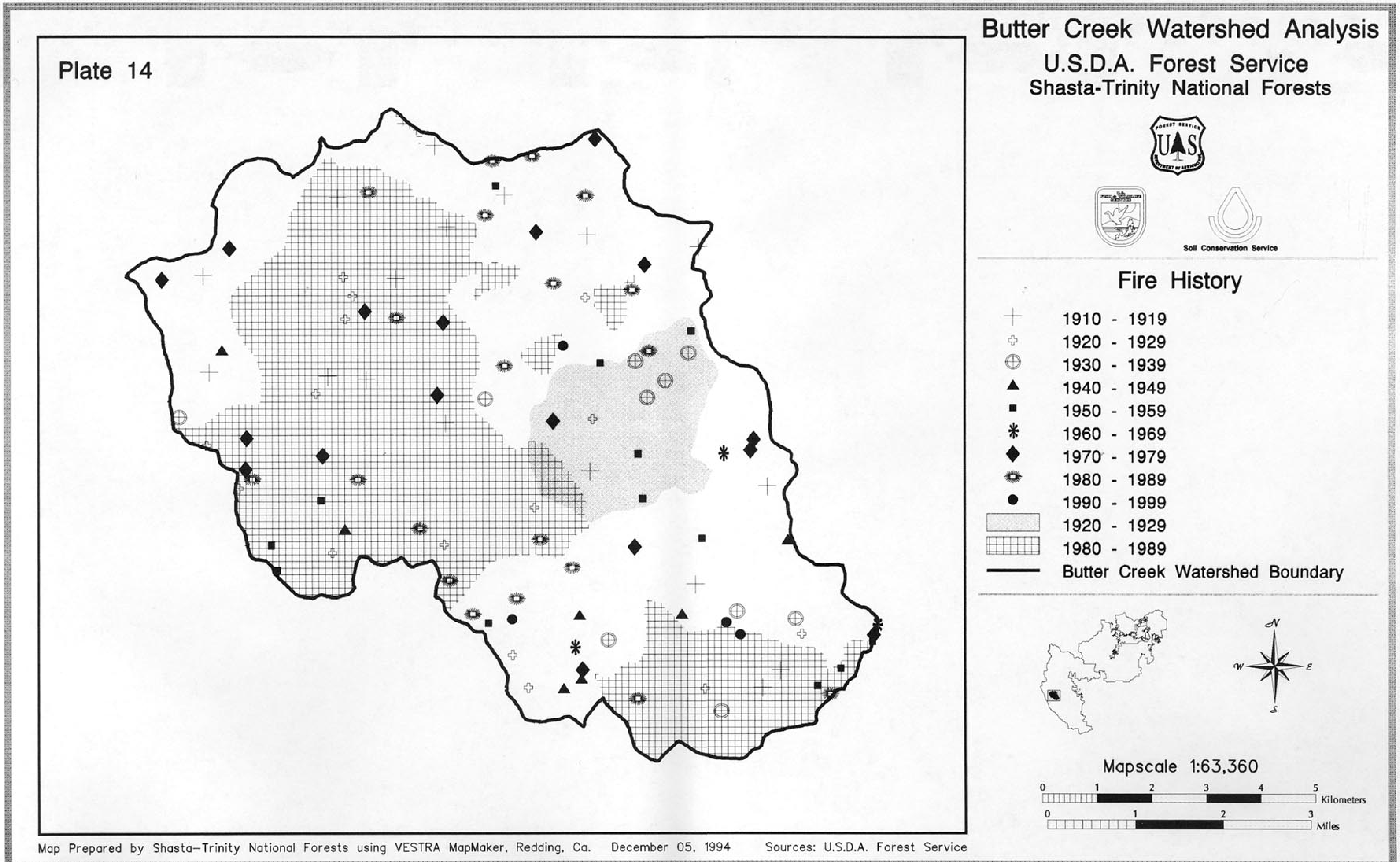
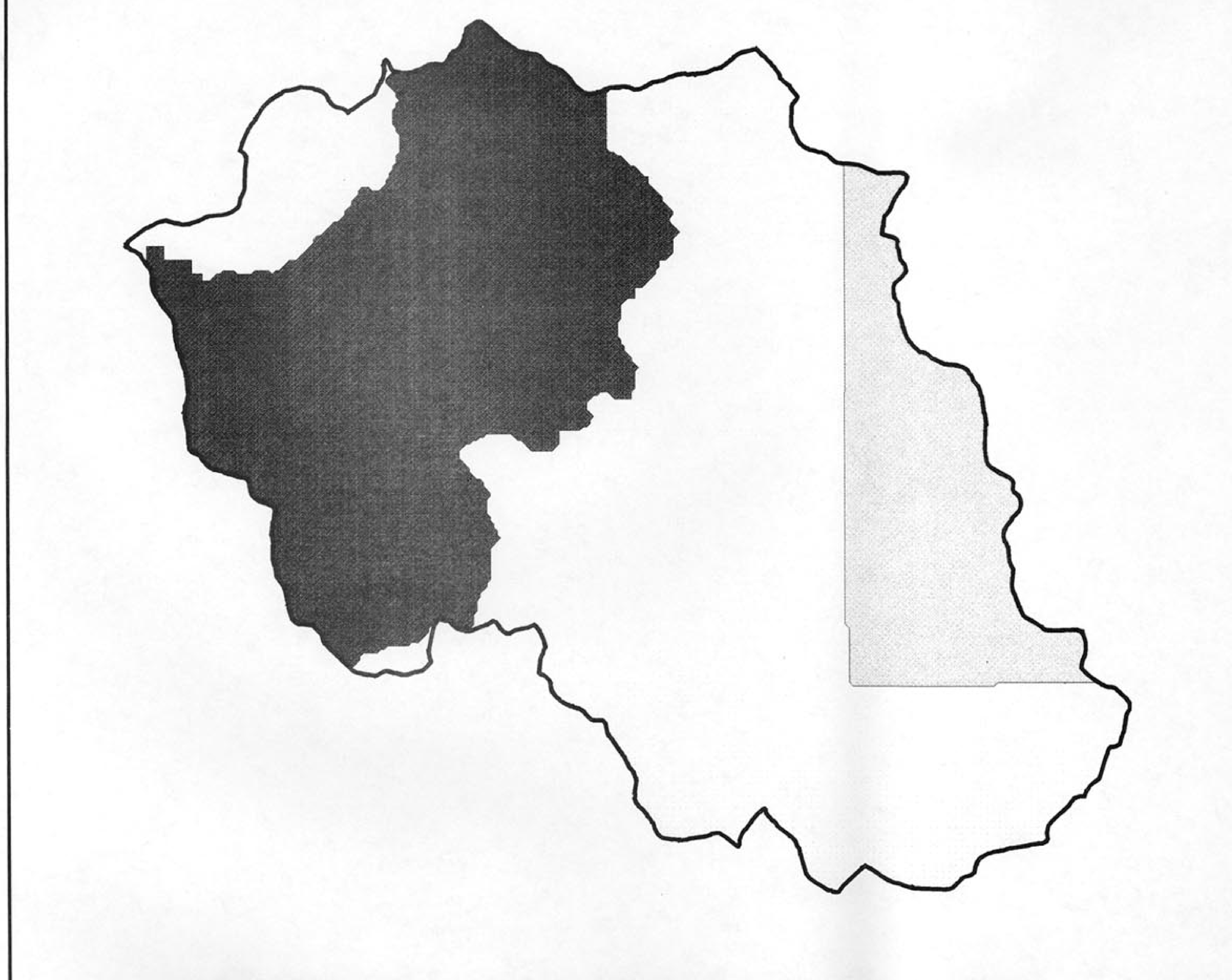


Plate 14
Butter Creek Watershed Analysis
U.S.D.A. Forest Service
Shasta-Trinity National Forests
Soil Conservation Service
Fire History
1910 - 1919
1920 - 1929
1930 - 1939
1940 - 1949
1950 - 1959
1960 - 1969
1970 - 1979
1980 - 1989
1990 - 1999
1920 - 1929
1980 - 1989
Butter Creek Watershed Boundary
N
W
E
S
Mapscale 1:63,360
0 1 2 3 4 5 Kilometers
0 1 2 3 Miles
Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994
Sources: U.S.D.A. Forest Service

Plate 15



Butter Creek Watershed Analysis

U.S.D.A. Forest Service

Shasta-Trinity National Forests

Soil Conservation Service

Late Successional Reserve and Critical Habitat Unit

- Late Successional Reserve RC330
- Critical Habitat Unit CA-35
- Butter Creek Watershed Boundary

N W E S

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

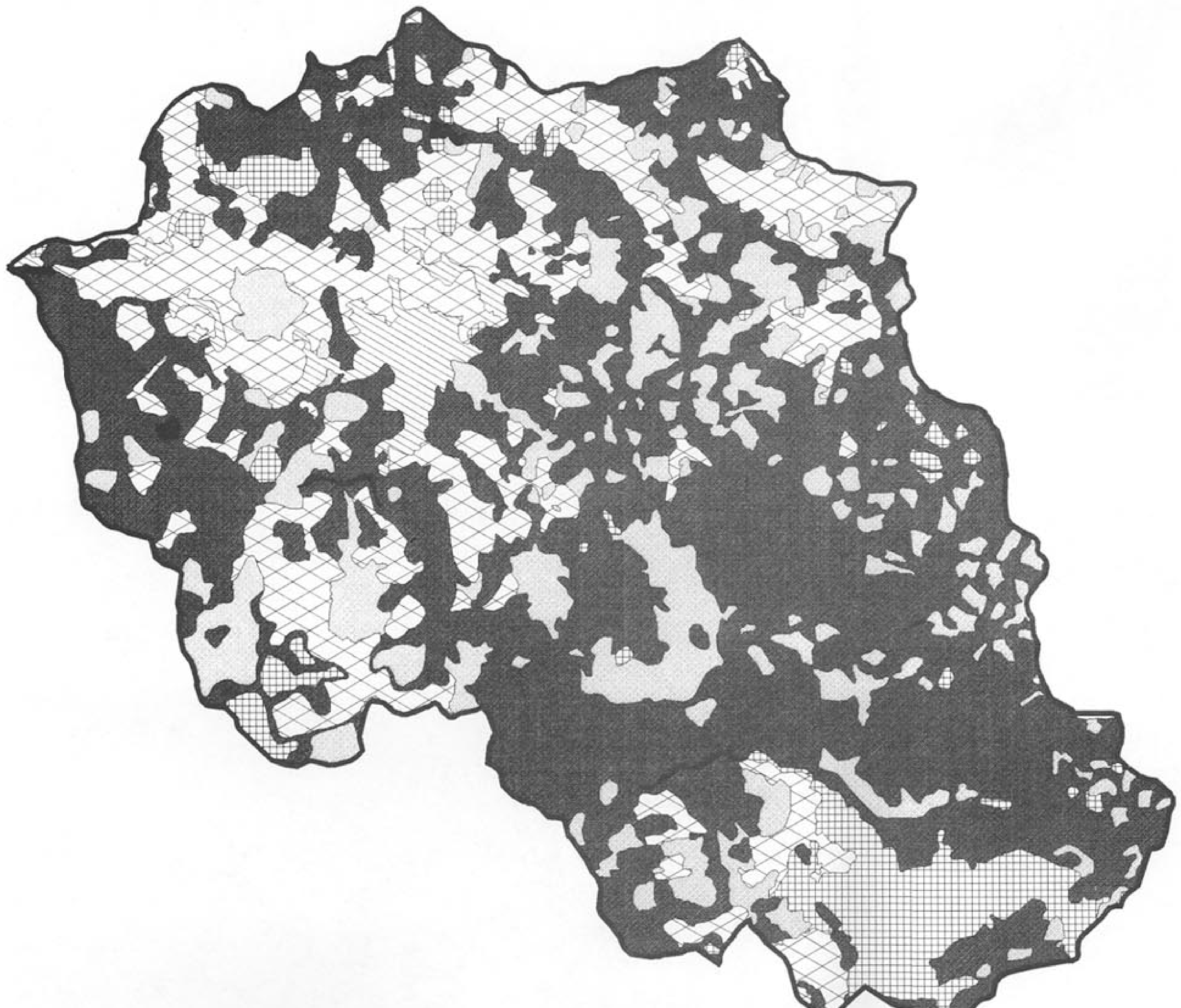
Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994 Sources: U.S.D.A. Forest Service

Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

Plate 16



1990 Wildlife Habitat Relations

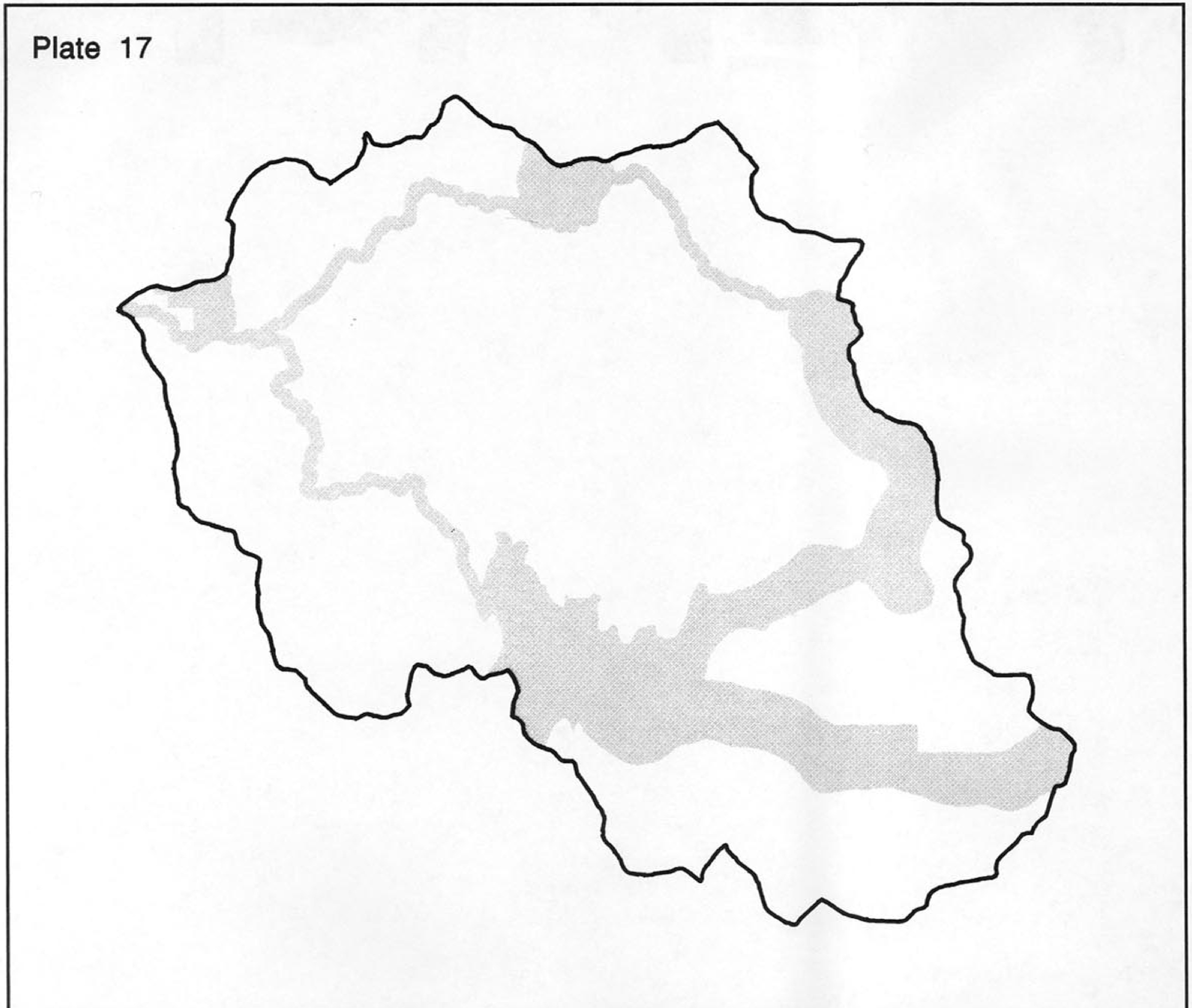
- Riparian / Aquatic Habitat Type (MRI)
- Open Habitat Types (PGS, MCP, MCH)
- Douglas Fir & Mixed Conifer Forest Habitat Types (KMC, DFR)
- Pine Forest Habitat Types (JPN, PPN)
- Hardwood Habitat Type (MHW)
- Hardwood Conifer Habitat Type (MHC)
- Butter Creek Watershed Boundary

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service



Butter Creek Watershed Analysis

U.S.D.A. Forest Service

Shasta-Trinity National Forests

Soil Conservation Service

Wildlife Corridors

Wildlife Corridors

Butter Creek Watershed Boundary

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service

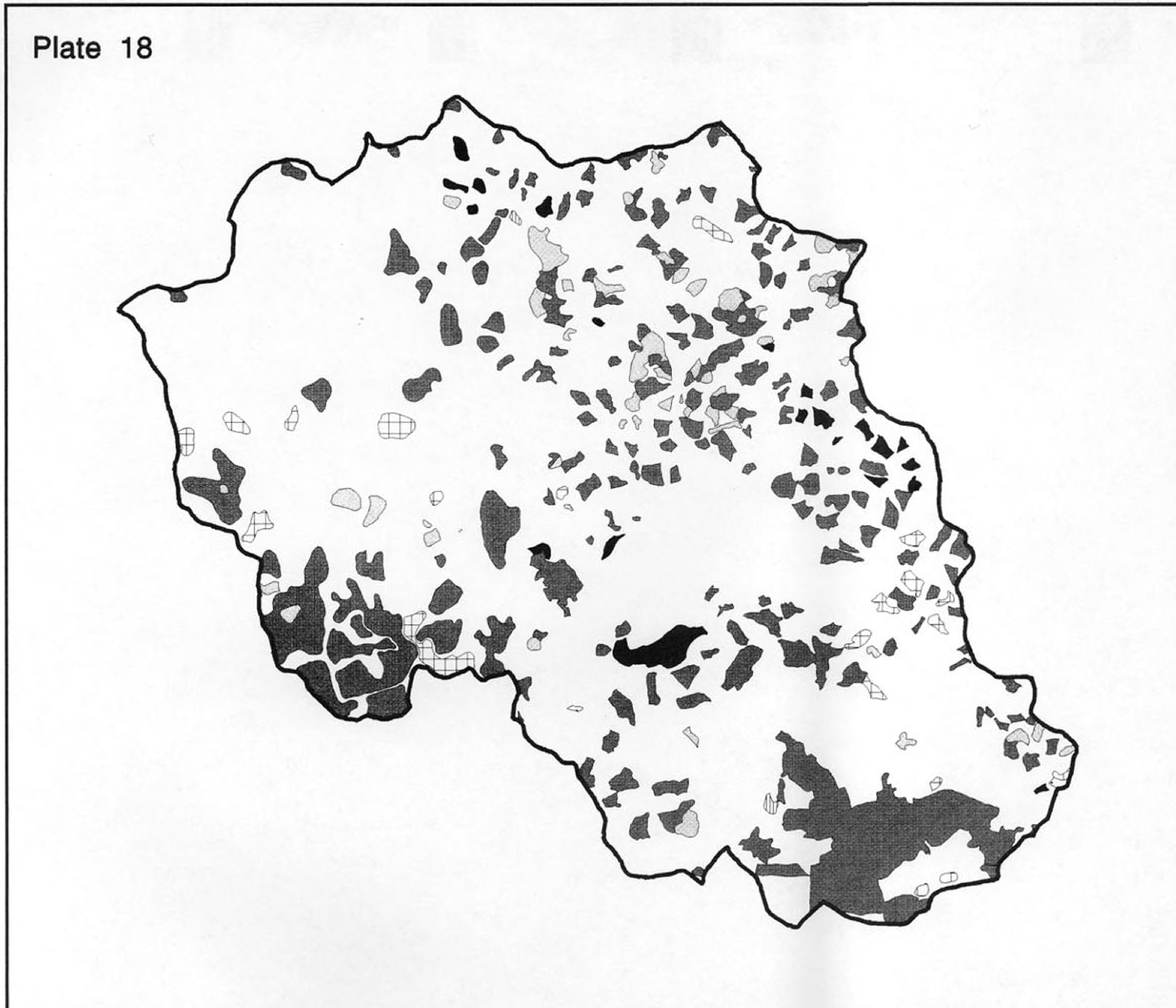
Butter Creek Watershed Analysis

U.S.D.A. Forest Service

Shasta-Trinity National Forests

Soil Conservation Service

Plate 18



Plantations By Decade

- 1960 - 1969
- 1970 - 1979
- 1980 - 1989
- 1990 - 1994
- Mixed Conifer Non-Stocked
- Unknown
- Butter Creek Watershed Boundary

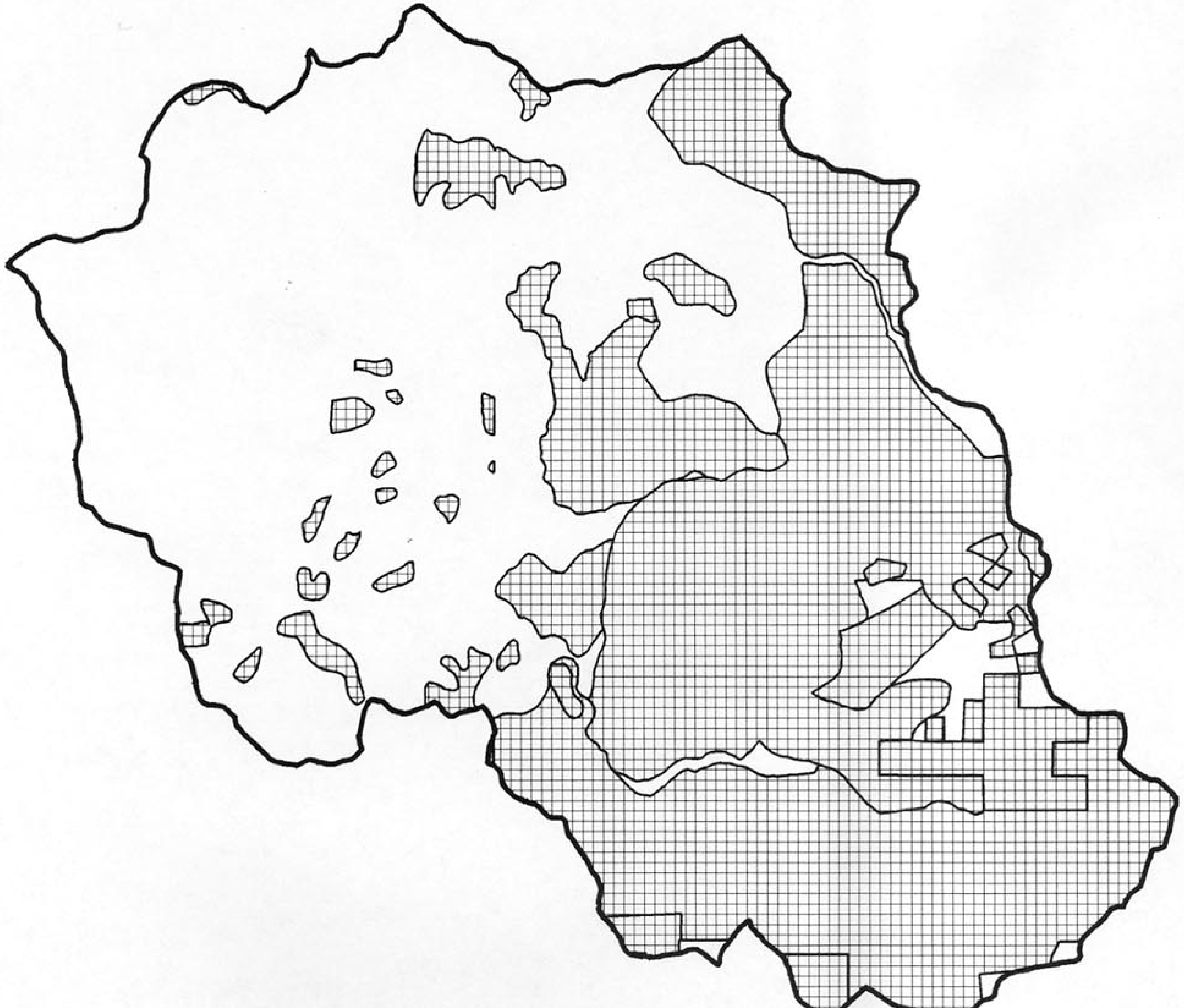
Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994 Sources: U.S.D.A. Forest Service

Plate 19



Butter Creek Watershed Analysis

U.S.D.A. Forest Service

Shasta-Trinity National Forests

Soil Conservation Service

Selective Harvests Units

(grid pattern)	Selective Harvest Units
(heavy line)	Butter Creek Watershed Boundary

N W E S

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

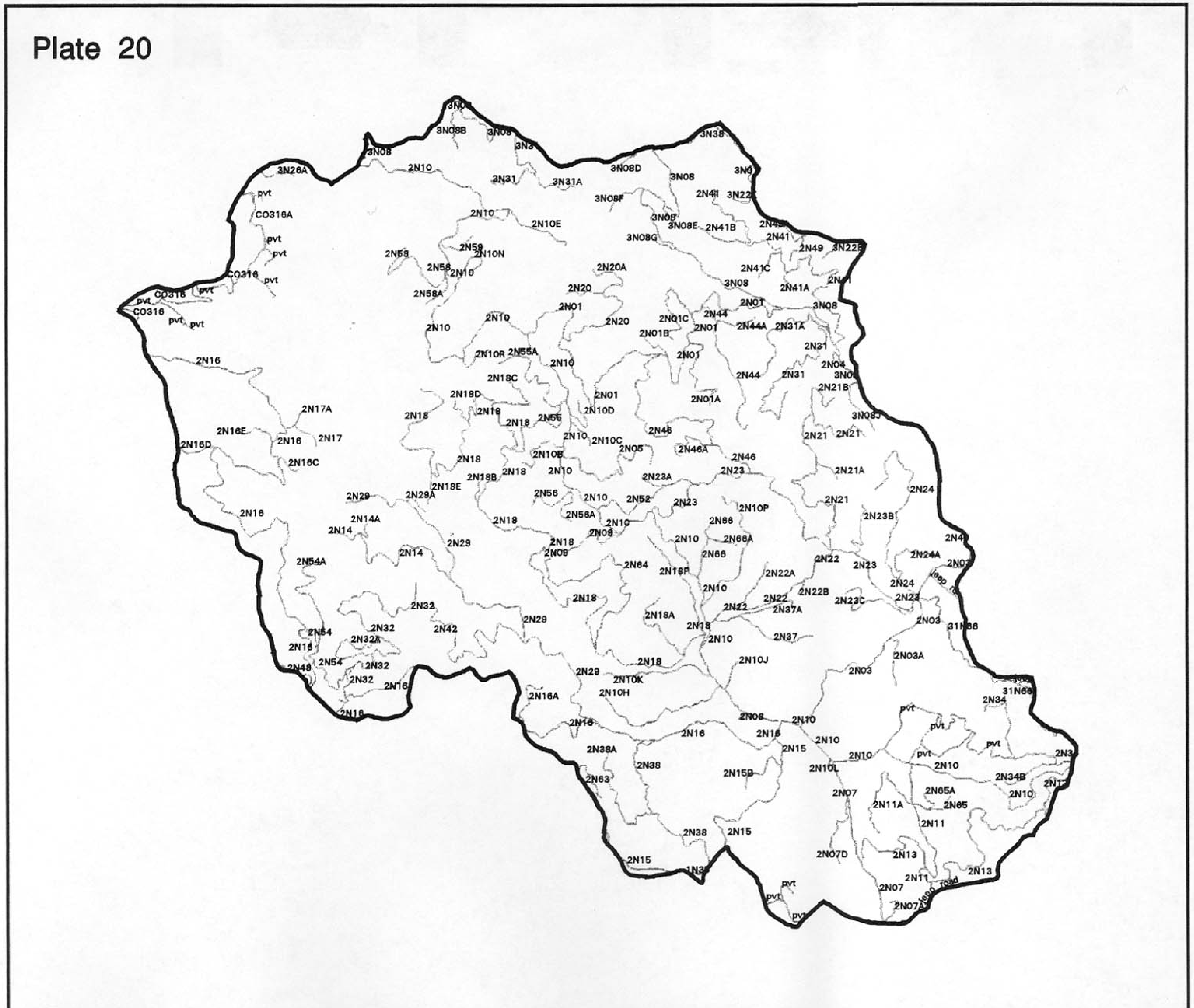
Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service

Butter Creek Watershed Analysis

U.S.D.A. Forest Service

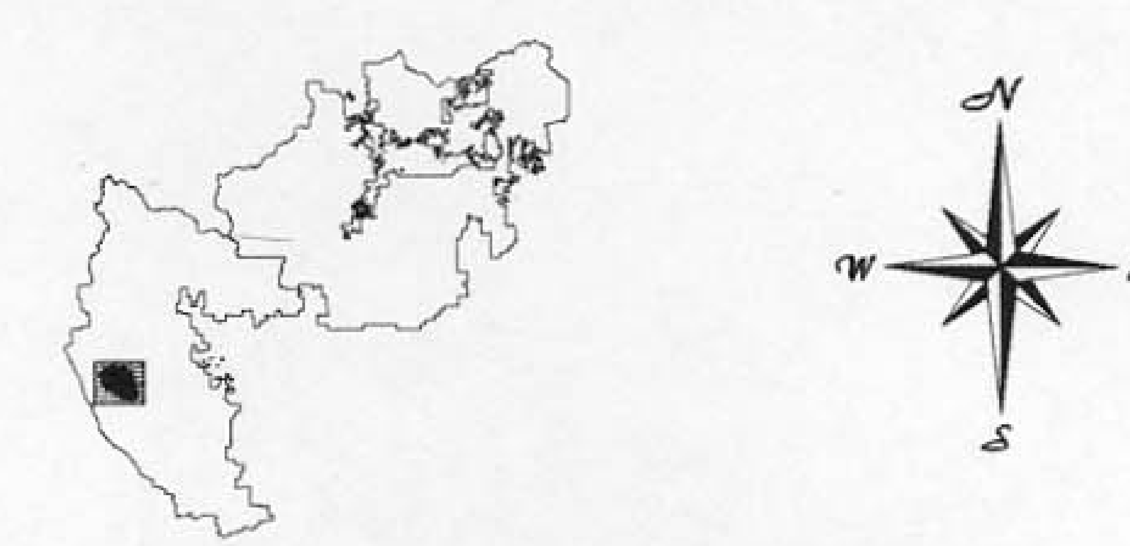
Shasta-Trinity National Forests

Plate 20



Road System

- Roads
- Butter Creek Watershed Boundary



Mapscale 1:63,360

0	1	2	3	4	5	Kilometers
0	1	2	3			Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service

CHAPTER II
Natural Range of Variability and Disturbance Regimes

This chapter of the Butter Creek Ecosystem Story describes the distribution, type and relative importance of environmental processes. Included is a description of the landscape and the mechanisms by which environmental changes have occurred over time. Land use activities which have generated change are examined for magnitude and trend.

Although forest land managers cannot reproduce naturally evolved ecosystems, the best strategy to sustainable, diverse and resilient ecosystems is to maintain the essential ecological elements, components, structures and processes. This may be achieved by managing within the natural ranges of variability for those essential or key ecological elements that reflect ecosystem function and integrity. This "coarse filter" approach assumes that if the key ecological elements are within the range of characteristics that they have adapted to over evolutionary time, then those conditions will sustain the ecosystem as a whole (USDA FS, 1994e).

The terms Range of Variability, Natural Variability, Historic Variability and Range of Variability are being used extensively and interchangeably amongst ecosystem managers. They essentially boil down to the following: The spectrum of conditions possible in ecosystem composition, structure and function considering both temporal and spatial factors.

The strategy of this Watershed Analysis is to first determine the natural range and then assess current status of the key elements. From these, recommendations are provided for restoration where current conditions are not within natural ranges and maintenance where they are. Since natural disturbance regimes are the most important causal agents in variability of characteristics of key ecological elements, an understanding of their timing, spatial patterns and magnitude is essential to the analysis.

This chapter describes natural disturbance regimes operating in the Butter Creek watershed and ranges of variability for key elements through time, from the formation of the Klamath Mountains to the present. The reliability, applicability and precision of the information to Butter Creek increases in the time periods nearest to the present. The Native American Age provides a glimpse of natural ranges that reflect low levels of human caused disturbance in a climatic regime similar to that of today.

The historic conditions, natural ranges of key ecosystem elements and discussions of disturbance regimes described in this chapter, set the stage for potential and desired future conditions and trends as discussed in the next chapter.

Four different time-frames were evaluated and are discussed in this chapter. These include the Geologic Age (400 million years before present to 10,000 years before present), the Native American Age (10,000 years ago to 1840), the European Settlement Age (1840 to 1950) and the Modern Age (1950 to 1994).

The Geologic Age was described in order to define the major landscape-forming physiographic and geologic features, and help give a perspective on how this landscape relates to others in the region. The Native American Age is meant to define the times when Native Americans settled the region and serves as a benchmark for the biological aspects of the watershed. The third period of European Settlement is an age when the landscape, flora and fauna began to change due to a transition out of the practices the Native Americans and early settlers used and the onset of practices employed for more extensive resource utilization. The Modern Age marks the period following World War II when the timber industry grew in Trinity County and wholesale land management activities commenced, present social values were developed, and public and agency expectations for resource management were debated.

THE GEOLOGIC AGE 400 million to 10,000 Years Before Present

The Klamath Mountain geologic province consists predominantly of marine arc-related volcanic and sedimentary rocks of Paleozoic and Mesozoic ages (Figure 3). The province is the product of tectonic accretion of fragments of oceanic crust and island arcs to the North American continent. Paleozoic rocks of the Eastern Klamath region, which are approximately 400 million years old, formed a nucleus against which other tectonic slices later accreted. The nucleus was a long-standing island arc, built on a dominantly ultramafic, oceanic crustal base which had intermittent volcanic and plutonic activity ranging from early Paleozoic into the Jurassic (400 to 140 million years before present [mypb]). The other belts, including the Central Metamorphic, Western Paleozoic and Triassic and Western Jurassic were swept against the Eastern Belt only during Jurassic time (160 to 140 mybp) (Irwin, 1985, Wright and Wyld, 1994). Following this period, the Coast Ranges began to develop through very similar processes, with the Eastern Belt of the Coast Ranges accreting to the Klamath Mountains in early Cretaceous times (135 mybp) (Blake et al, 1985).

During the Paleocene Epoch (60 mybp), the Klamath Mountains were sufficiently high to shed sediment to adjacent basins, and to block transport of sediment from the interior of the continent to the Pacific Coast. By the middle of the Eocene Epoch (45 mybp), topography had been reduced by erosional processes to a relatively subdued landscape. This condition allowed rivers to cut across the province from the east, and transport sediment to the Pacific basins of Oregon and California (Aalto, 1992). The lack of relief allowed Pacific storms to move into the interior. Fossil evidence suggests that from 50 to 30 million years ago the region was covered with temperate rainforest. The rainforest consisted of tree ferns, palms, cycads and large-leaved evergreen dicots. This combination of species indicates that the climate was similar to that of present day southeastern Mexico, characterized by heavy rainfall during the warm season and dry, frost-free winters.

During the Oligocene Epoch (30 mybp), rapid uplift occurred. During the early Miocene Epoch (20 mybp), much of the topographic relief was again reduced by erosion, creating a gentle landscape (Aalto, 1992).

The present forests of the Klamath Mountains and Coast Ranges are derived from a richer, ancestral flora that covered the Great Basin and Columbia Plateau 20 million years ago. These forests were exceptionally diverse in species composition. They consisted of ancient relatives of present day species; white fir, Port Orford cedar, ponderosa pine, madrone, tan oak, canyon and interior live oaks and many other broad-leaved deciduous sclerophyllous plants. In addition, species relegated to subalpine forests today were common. These included red fir, Brewer's spruce, western white pine, quaking aspen, mountain ash and mountain hemlock (Raven and Axelrod, 1978). During this time of mild temperatures and summer rainfall these species that are considered subalpine today were regular members of a rich mixed forest. The current diversity of the local flora is in part due to the survival of these relict species from the Tertiary Period. The uplift of the Coast Ranges provided protection from the more extreme continental climates that developed over the interior. These species have persisted owing to the sheltered, hospitable climate.

Most mesic mixed conifer, sclerophyllic vegetation and subalpine forests shifted coastward during the middle Tertiary period as a general cooling and drying trend accelerated. These communities displaced the more mesic mixed deciduous forests that had retreated earlier from the interior towards the coast where the low evaporation and mild temperatures compensated for low precipitation. Many species disappeared as summer rainfall gradually decreased during this time period.

From the middle of the Miocene to early Pleistocene Epochs (15 to 1.5 mybp), topographic relief in the Klamath Mountains was low. Rapid uplift began in the early to middle Pleistocene, and has continued through the Holocene, elevating the Klamath Mountains to their present elevation (Aalto, 1992).

In the early Pleistocene, the Klamath and Trinity Rivers flowed across a landscape of low relief with broad valley floors and a meandering river system.

It probably resembled a modern day low to moderate relief coastal plain. When this landscape was rapidly uplifted in the middle Pleistocene, the rivers cut deeply into the valley floors. As downcutting progressed, erosional and depositional terraces were left stranded on valley walls hundreds to several thousands of feet above modern day river elevations. A classic early study by Diller (1902) described this succession of erosional surfaces which exist above the highest river gravels, with the oldest of these surfaces occupying the modern mountain crests. He referred to this surface as the Klamath peneplain. The uplands of the Butter Creek watershed represents this peneplain. A cooler, wetter climate evolved with this uplift and the plant communities shifted again towards a more deciduous flora.

Alpine glaciation was a significant geomorphic process in the Klamath Mountains during the late Pleistocene. Although glacial features do not occur within the Butter Creek watershed, other areas within the Klamath Mountains, including the Trinity Alps and Trinity Divide were extensively glaciated. More locally, Black Rock Mountain, in the headwaters of the South Fork of the Trinity and the highest portions of South Fork Mountain, including Chinquapin Butte, were glaciated. Therefore, the South Fork Trinity had a much greater streamflow regime, transported significant sediment loads and left large stream terraces, as the river continued to downcut in response to Klamath Mountain uplift.

Mass wasting is the dominant geomorphic process which has operated within the Quaternary, in the Klamath Mountains. Many mass wasting features developed in the Pleistocene in response to continued uplift of the Klamath Mountains, channel incision and steep sideslopes, and the wetter climate associated with the Pleistocene. The wetter climate contributed to more rapid weathering of rocks, and contributed to elevated groundwater and pore water pressures, which also influence mass wasting. Contributing to landslide development and activation were seismic events which occurred throughout the Pleistocene, as the Klamath Mountains continued to be uplifted. The intensive groundshaking of weak, deeply weathered materials, having high pore water pressures, no doubt played a significant role in landslide activation, especially for the features which are several thousand acres in size. Because of these conditions, landslide activity was probably great in the Pleistocene, with a significant portion of the mass wasting features periodically active. In following, sediment production from the Butter Creek watershed was tremendous, as the slopes were failing and delivering sediment to the streams and the stream channel network was rapidly incising itself into the relict peneplain.

The range of geologic processes that acted on the Klamath Province during this time period significantly affected the rates of soil development. Uplifting, down-cutting, mass wasting, depositional processes and variations in chemical dissolution rates all created unique environments which affected rates of soil formation. Periods of rapid uplift and mass wasting likely resulted in a significant mixing of soil and rock. A broad range of geomorphic surfaces likely characterized the topography of Butter Creek. Periods of down-cutting triggered mass wasting and surface erosion processes on presumably deep, well weathered soil types. The action of gravity and physically-based weathering processes were dominant factors affecting soil development during periods of seismic and mass-wasting activity.

During periods of quiescence, such as during the Miocene to early Pleistocene, soils found on relict peneplains would have been affected more by in-situ, chemical dissolution and weathering processes. Warm and moist climate regimes, with its lush flora and fauna, would have enhanced soil development, leading to deeply weathered, heavily oxidized, very fine-textured soil types. Cooler periods, on the other hand, might have been reflected by relatively slow soil formation rates and physically-based weathering processes.

Soil characteristics of the upland portions of the watershed do not seem to fit what might be expected given the above-described processes of soil formation. The topography, recent climate trends and parent materials of this area would suggest fairly rapid rates of soil formation, as explained above. The soils here, however, do not completely reflect this trend. It could be hypothesized that the soils occupying this area are younger than the geomorphic surface on which they are developing. This could be linked to large-scale seismic activity and mass-wasting that produced sizable amounts of sediment during the Pleistocene.

The dramatically alternating climatic changes of the Pleistocene epoch increased the diversity of wildlife species. During times of glaciation northern species moved south into lower elevation areas in California. Between these periods when the ice melted and temperatures warmed, species moved northward. Along with the configuration of the mountain ranges these freezing and warming periods caused populations to be separated then joined and separated again. Thus they developed rapid genetic variations which account for the rich and varied fauna of today (Jameson and Peeters, 1988).

THE NATIVE AMERICAN AGE 10,000 Years Before Present to 1840

Prehistoric/Historic Values and Uses

This period of time is geologically referred to as the Holocene. Evidence from archeological investigations suggest early occupation of the Butter Creek watershed area occurred approximately 10,000 YBP. Paleoenvironmental data indicates that between 10,000 YBP to 2800 YBP the temperature was warmer in the North Coast Ranges and Klamath Mountains. Alpine glaciers on South Fork Mountain and Black Rock Mountain receded, and streamflows in the South Fork of the Trinity were reduced. During this time it is believed resources were more abundant and diverse. Early occupation of this area is represented by artifact assemblages characterized by wide stem projectile points, small serrated bifaces, flake tools, milling slabs and edge flaked spalls (Hildebrandt & Hayes, 1984).

Starting around 3000 YBP the climate cooled significantly. This cooling period is thought to have lasted a thousand years. This period is referred to as the "Little Ice Age". During this time it appears upland resources decreased in abundance and diversity. At this same time the productivity of anadromous fish runs improved. Settle- ments in this area were probably located in areas where oaks were present in association with fish runs. At this time it appears use of the Butter Creek Watershed became limited to short term task activities carried out by small groups. Artifact assemblages representing this time include large corner notched, side notched, contracting stemmed and serrated leaf shaped projectile points, formed flaked tools, small non-serrated bifaces, manos and pestles (Hildebrandt & Hayes, 1984).

Many wildlife species that we are familiar with today were present at this time. Species that formed large herds (elk and deer) or were far roaming (wolf and grizzly bear) were in much greater numbers due to large expanses of habitat that was unencumbered by fences, settlements, or the mosaic of land use practices of the Europeans who were to follow. Other species that proliferated in the human altered environments are more common today than during this period (coyote). Native Americans observed how natural fire improved forage for many wildlife species that they depended on. They continued the practice by setting fires to ensure healthy herds of deer and elk.

Between 1494 to 1820 AD it is suggested that the climate and upland habitat was similar to what it is today. During this time it appears that semi-sedentary settlements occurred which indicated social-political complexity where production and exchange was occurring. The artifact assemblage representing this time would include small barbed corner-notched projectile point, mortars, pestles and clam disk beads used as money (Fredrickson, 1974).

Explorations across the inland boundaries of California territory began in 1826, although trappers may have crossed the northern frontier before that time (Bancroft, 1866). The first recorded crossing of northern California was that of Jedediah Smith in April of 1828. Smith and his party of men crossed the divide to the "Hay Fork" of the Trinity River, reaching it at Wildwood. They followed Hayfork Creek down to the South Fork of the Trinity River continuing on to the Klamath River. Jedediah recorded little of his impressions of the valley other than, "The river to which I [Jedediah Smith] had given the name Smiths [South Fork of the Trinity River] was 40 yards wide with a strong current and wide sandbars. Its course was north northwest," (Owens, 1965). He made no mention of Butter Creek or any of the other South Fork of the Trinity River tributaries.

According to ethnographers, the Nor-El-Muk Wintu occupied the Butter Creek watershed (Powers, 1878, DuBois, 1935, Merriam, 1962). The Wintu depended upon salmon for a substantial percentage of their food intake. Steelhead, suckers, trout, freshwater shellfish and eel were utilized. The Nor-El-Muk were proficient fishermen who depended heavily on seasonal runs of salmon and other aquatic resources. Fall runs of king salmon as well as silver salmon and steelhead trout made their way up the South Fork of the Trinity River. Periodic blocking of this stream and/or its tributaries by large slides may have occurred, but it is probably safe to assume that during most years the fish runs were abundant and fluctuations probably only moderate in severity, meaning that minimum fish runs in poor years were not less that about 1/2 maximum availability during good years (Jensen, 1979).

One of the most important fishing devices was the fish weir. Weirs were built across streams to impede the progress of the fish and thus concentrate their numbers and make them easier to catch. Although seines and set gill nets were seldom used, the efficiency of the weirs perhaps made extensive use of seines unnecessary, although dip nets were known to have been used in certain circumstances. The Wintu also constructed salmon houses, effective underwater entrapments similar to weirs. Issac Cox (1858) recorded his observations of how the local Indians harvested the plentiful salmon in Hyampom Valley: "The fish were usually speared in the riffles of the river and creeks. Nets were used for trout. A special set of conical shaped basket-like nets were also used to catch salmon and steelhead. Another method of catching fish was that of suffocating them by dumping sacks of a certain type weed into the water. The powdered weed would become lodged in the fish's gills causing it to suffocate." With large fish catches the Wintu became experts at preserving fish by drying, smoking and grinding into a powder.

The most important plant food for the Wintu was acorns, with acorns from the black oak being preferred. Manzanita berries were made into flour and consumed as a soup and cider. Various berries, wild fruits, bulbs, tubers, grasses, seeds and nuts were also eaten. The Wintu hunted deer, brown bear, ducks, geese, squirrels, rabbits and other small animals. Deer hunting was particularly important and occurred both on an individual as well as communal basis. When hunted individually the deer would be stalked using deer antlers as a decoy. When several men were employed in stalking a deer, the one whose arrow first grazed the animal was considered to be the owner of the carcass, even though it may not have been his arrow which killed the animal. Communal deer hunts were usually initiated by enterprising persons (DuBois, 1935). The individual would state a specific duration for the hunt, usually two or three days. Then the individuals would gather in an area where deer had been recently spotted and the hunt would proceed by means of driving the deer into a pit or snare through brush-lined passageway (Krober, 1925). A communal hunt might also involve a large drive in which women and children chased deer into a canyon at the mouth of which men stationed with bows and arrows would be waiting.

In addition to deer, brown bear were hunted during the fall months when the animals were heaviest and moved slowly. Several methods of hunting were utilized, including killing the animals within their own dens, smoking the animals to death while they were sleeping and utilizing several hunters and dogs to run the bears down, tire them and then kill them with arrows or short thrusting spears. A variety of ceremonial actions usually accompanied and followed successful as well as unsuccessful bear hunts (Krober, 1925).

Trails were particularly important to the Wintu. Places along these routes held special meaning such as the sites of a legendary event or the home of mythological beings (Masson, 1966). Indian trails were often used by early day trappers and explorers. Some of these trails evolved into wagon roads and highways.

Religious and ceremonial sites were also important to the Wintu. Many places had religious significance including mountains, knolls, caves, rocks, rivers, water falls and other natural features. These area were believed to be inhabited by spirits, each of which had its own significance and code of conduct. Although most of these sites are currently indistinguishable from other behaviorally unmodified areas, some areas were modified through minor rock realignments and or etching of petroglyphs.

Natural forest fires occurring prior to the 1840s burned freely. Fires were typically ignited by lightning, and would often burn for months. Such fires were of a creeping type, burning at mostly low intensity on the forest floor, though extreme fire weather and occasional pockets of heavy fuels would accommodate periods of more intense burning. Fires would self-extinguish when the supply of fuel was exhausted or they were doused by rain or snowfall.

The Wintu utilized fire to manage and conserve their resources (Demetrocopoulou, 1944). They burnt to control shrubs, promote growth of seed producing plants, mushrooms, herbs, bulbs and to enhance forage for deer and other game (Baumhoff, 1978). Acorn groves were burnt for growth, production and for easier acorn collection. It has also been suggested that burning of acorn groves was utilized as a form of pest management. Grassy areas were burnt regularly to prevent encroachment by surrounding vegetation.

These areas were also burnt for grasshopper harvesting. Grasshoppers were obtained by encircling a grassy area. People sang and danced as they drove the grasshoppers into the center of the grassy area. The grass in the center was set afire with wormwood torches. After the blaze had subsided the grasshoppers were gathered (DuBois, 1935). Burning was also conducted to clear and fertilize patches of ground for sowing tobacco and to promote growth of materials used in making baskets (Baumhoff, 1978). Burning provided new tender young shoots for a desirable basket material which was easier to work and weave. Plant species that were burnt for utilization as basket material in this area included redbud, mock orange, hazel nut, choke cherry and gray willow (Oral Histories, 1994).

In most areas the forest was very open with large conifer and hardwood trees. Fires also maintained this condition which permitted grasses to grow on the forest floor as well as in larger openings. In the 1800s it was possible for a person astride a horse to bend down and scoop up a handful of grass seeds with ease. Native Americans gathered grass seeds to eat. The varieties of grasses that they gathered are no longer present (Oral Histories, 1994).

Fire Regimes

It is believed that fires were important in maintaining the heterogeneity of vegetation mosaics across the landscape. Localized fire history for the area combined with research findings in adjacent areas suggest a pattern of vegetative arrangement for this landscape. Wills (1991) hypothesized that the pre-settlement landscape was probably exceptionally patchy, containing a complex mosaic of age, size and structure. Stand conditions were likely more open on upper slopes (above 3100 feet), particularly on steep terrain and southerly aspects. Stand conditions in the lower portions of the slope (below 3100 feet) and on north aspects would have been less open, with more structural diversity, particularly on productive sites often associated with dormant landslides.

Fire return intervals in the vicinity of the Trinity Divide of the Klamath Mountains in the pre-1840 period, ranged from 7 to 50 years depending on the site. The average pre-1840 fire return interval was 17.1 years for all sites. Evidence indicates that these fires were most likely late season burns, probably late summer through early fall (Skinner, personal communications, 1994).

It is widely accepted that the contemporary fire regime contrasts sharply from regimes occurring in this region prior to European settlement. However, knowledge of actual ecosystem conditions prior to settlement is incomplete, and a historic perspective is necessary for assessing ecosystem trends that have occurred following the advent of the National Forest System.

The following narratives describe the vegetation types as they are believed to have been during this period and their related fire characteristics:

Mixed Conifer Forest - Mixed conifer forests were probably different in terms of structure, species composition and pattern. Overall, stands were more open than they are today, with few being as dense and multi-storied. The relatively denser stands within the landscape were likely to have developed on north-facing slopes, in riparian areas and areas of deep, productive soils. The more open stands occurred on south-facing slopes. White fir would have occurred less as a component of mixed conifer stands and would have been confined more to upper elevations. Douglas-fir would have been a co-dominant primarily at lower elevation and on northerly aspects, with ponderosa pine being more of a significant component throughout the mixed conifer stands. Past fire return intervals averaged from 8 to 20 years. The range of return intervals occurred on the order of 5 to 50 years. Fires were frequent and of low to moderate intensity.

Ponderosa Pine Forest - Pre-settlement westside, low elevation, ponderosa pine stands, were shaped by a fire regime of frequent, low intensity fires. Studies indicate that the historic return intervals ranged from 5 to 15 years (Martin, 1981).

Douglas-Fir Forest - The natural fire regime in Douglas-fir forests varies from frequent, low intensity surface fire to moderate severity fires of mixed intensity. Douglas-fir forests have differing fire regimes because of variability in length of fire season, climate, fuel accumulation rates and understory composition. Preliminary data (Skinner, 1991) indicate a fire free interval on the Mt. Shasta Ranger District of 15 to 25 years. It is likely that considerable variation in frequency and severity of fires existed within drainages due to the topographic variation and micro-climatic differences in the northwestern portion of California.

Montane Shrub Communities - The occurrence of shrub communities is largely determined by site capability, and probably has not changed significantly since just prior to European settlement. Under historic fire regimes, these communities were maintained in a more vigorous condition than what exists today. Post-fire response of most of the species in the landscape is either through vigorous root crown sprouting or germination of stored seedbanks. These communities burned on a regular and frequent basis.

Live Oak Stands - There were probably more pure stands of live oak with less encroachment of conifer species under historic fire regimes. Stands were sparsely stocked with a minimal understory. These communities probably burned more often and hotter than forested communities.

Geology

During the Holocene there was a significant climatic shift from the colder wetter sub-arctic like climate to a Mediterranean climate. This contributed to significant changes in the physical and biological processes within the Klamath Mountains. Stream runoff was reduced due to lower precipitation. It is also likely that regional and local groundwater tables receded, and some wetlands and ponds dried up. One of the major driving forces in mass wasting was reduced because of the reduction in groundwater. Many of the mass wasting features which developed and were active in the Pleistocene became dormant during the Holocene. Nearly 60 percent of the surface of the Klamath Mountains is covered by mass wasting features, the majority of which developed in the Pleistocene. During the Holocene, a minor percentage of mass wasting features remained periodically active. In the Butter Creek watershed, it is likely that the Maddox Lake slump-earthflow has been intermittently active in the Holocene. It extends from the watershed divide, in the southwest portion of the watershed, to lower Indian Valley Creek, a distance of approximately 7,000 feet. It is 5,000 feet in width. Maddox Lake, a partially filled slump pond, lies in the middle of the slump-earthflow, and is approximately 14 acres in size.

Soils Resource

The shift in climate also had a significant effect on soil processes and soil-vegetation relationships affecting soil development. Broader ranges in seasonal mean temperatures likely accelerated physical, biological and chemical weathering processes. Evapotranspiration rates were elevated by the shift in climate. Reductions in precipitation, however, likely slowed soil formation. Diminished groundwater significantly limited the chemical denudation of parent materials, as compared to earlier periods.

Vegetation of this period had a significant impact on soil formation and productivity in the watershed. Open stands of conifers, commonly maintained through the use of fire by Native Americans, meant more radiant energy reaching the ground. Warmer soils and open stands favored grass and shrub understories that tended to cycle nutrients, organic matter and water more rapidly than closed, mixed conifer and white fir types. Oak woodlands were favored on some drier landscape positions as both an overstory and understory component of stands, and this vegetation type would cycle nutrients (particularly base nutrients) more readily than conifer types.

Disturbance regimes within this time frame are considered the basis for the historic range of variability of the soil resource. Disturbances during this time frame could be related to natural erosion processes during floods, mass wasting and natural and manipulated fire regimes by Native Americans. None of these disturbance regimes, however, are expected to have halted the natural progression of soil development, nor do they reflect conditions that could have led to negative or non-sustaining impacts to the soil resource.

In the context of natural ranges of variability, soil development is, on balance, a soil-building process. For most forest soils, soils are deepened by physical and chemical processes acting on the deeper C and R horizons, and somewhat also by upslope inputs of organic and inorganic debris. Depending on a soil's geomorphic position (and other factors), the mass balance of upslope inputs to what leaves the site (outputs) can be positive or negative. Headwall areas, for example, might have a negative mass balance of inputs to outputs; in other words, they would tend to be a source for soil-building processes downslope.

Alexander (1988) suggests a range of approximately 0.15 to 0.9 tons per acre per year of soil formation for soils of the 48 contiguous states. Soil loss tolerances, or that amount of soil that could be annually exported yet not impede the natural processes of soil formation, would necessarily fall at or below that range for a given soil type. Alexander (1988) cautions that soil loss tolerances be postulated within the context of type of parent rock: soil loss tolerances for shale-derived soils would perhaps be higher, while shallow to moderately deep soils derived from plutonic rocks would be significantly lower.

Hydrology

During the time period when the Native Americans were inhabiting the area, the natural hydrologic processes were probably little affected. Vegetation manipulation with the use of fire was the most influential as it relates to the seasonal flow of water through the watershed. Regular fires encouraged the growth of grass, oaks and pine trees while discouraging the growth of fir trees. Therefore, less water was evapotranspired, which resulted in a summer flow regime having more water, and greater extent of perennial streams compared to the present.

Many of the upland, low gradient channels were formed in broad floodplains. These channels were stabilized primarily by vegetative roots and woody material. Although these upland channels had characteristics of being narrow and deep they did not meander as much as the definitive Rosgen “E” channel due to being formed in valley bottoms steeper than what is typical for “E” channel formation. However these channels maintained their stability during the Native American age due to the lack of disturbance. Channel conditions in the steeper gradient portions of the watershed were virtually unaffected by human factors during the age of the Native Americans.

The amount of erosion resulting from the influence of Native American habitation can only be speculated. Since there was no extensive ground-disturbing agricultural activity, the greatest possible impact would result from burning the forest. Depending on the burning conditions and post fire climatic conditions there could have been some short-lived erosion of soil. However with the likely variation of conditions it would be safe to assume that there was an undetectable amount of surface erosion during this age.

Sediment movement would have been within the range of natural variability due to the low level and extent of unnatural disturbances. The most conspicuous sediment transport in the stream system would have resulted from large landslides, such as the Maddox Lake slump-earthflow. These influxes of sediment were most likely spread out over relatively long periods of time, having only short-lived influences on the aquatic environment. Compared to the previous time period, sediment was in fact far reduced.

Riparian conditions and stream temperature conditions were mostly influenced by periodic flood events and landsliding. These processes were little influenced by the Native Americans and their use of fire.

Vegetation

The plant species that contribute to the distinct vegetation of northern California come from diverse sources and at different times during the Cenozoic period (Axelrod, 1977). The major regional differences in California forests emerged 8000 to 4000 years ago during the Xerothermic. The spreading warm, dry (montane Mediterranean) climate reduced the southern extent of madrone, tan oak, Douglas-fir and yew (Axelrod, 1967). As temperature contrasts increased from the coast to the interior, the surviving vegetation zones were segregated into communities of more local distribution and lower diversity.

In northern California pure forests of ponderosa pine, Jeffrey pine and Douglas-fir have developed on the edges of the mixed conifer forests. These forest types occupy new environments (Raven and Axelrod, 1978). In the past, moister phases of the Pleistocene, the mixed forests were richer in composition and more continuous in nature.

As has been previously described, the effects of underburning by Native American Indians in the Butter Creek watershed may have been quite widespread. This burning may have led to open stands of pine and Douglas-fir with a low diversity and cover of shrubs and a diverse and abundant layer of forbs and grasses. However, there is only anecdotal information to support this theory (Oral Interviews, 1994).

EUROPEAN SETTLEMENT AGE 1840 to 1950

Historic Values and Uses

After Jedediah Smith's brief exploration of Hayfork Creek and the lower South Fork of the Trinity River in 1828, hunters, trappers and traders found their way into these isolated valleys over the next 20 years. During the 1830s and early 1840s the foreign populations in California remained small. Fur trappers, exploring expeditions and some early settlers were among the few who traveled into these areas. It wasn't until the discovery of gold and the expansion of mining that a more widespread contact occurred. By 1849-1850 a number of non-Indian settlements were being established in Wintu territory.

European settlement accelerated dramatically in the 1850s because of the discovery of gold in the region. The non-Indians who populated Wintu territory in search of gold represented a variety of ethnic backgrounds which included American, French, German, Portuguese, Asian and Polynesian people. These groups formed a dynamic cultural mix with which the Wintu sometimes mingled and sometimes clashed. At times widespread personal battles occurred between the Wintu and these groups. Sometimes treaties were negotiated, relationships created and even marriages occurred (Theodoratus, 1981).

As one of the places most remote and difficult to penetrate of all the California mining areas, the Hayfork region was not settled until 1849-1950, and then only by a small number of miners. Some of the early miners included men like A. C. Philpot, Samuel Good and probably W. Dobbins, although he is listed in the census as a farmer by 1860 (U.S. Census, 1860-1900). All these men lived and worked in the Salt Creek, Dobbins Gulch area and had creeks or gulches named after them. During the entire early period, Hayfork township made up only a very small, although increasing, percentage of the population of Trinity County, growing from only 4.1 percent in 1860 to 11.6 percent in 1900 (U.S. Census, 1860-1900).

After the discovery of gold, the land was valued primarily for its mineral wealth. Only after the placers became exhausted did the majority of men look to farming, horticulture and ranching as a means for making a living. There were exceptions; some men saw that by farming and supplying the miners with some of their needs, they could perhaps make as good a living as by engaging in the more difficult and uncongenial work of mining. The mules and horses used for transportation needed hay, and the miners provided a market for grain, vegetables, fruit, dairy and meat products. By the end of the 1853, nearly all the flat land in this area that was suited for cultivation was occupied. Much of this land had been cleared, fenced and seeded for crops of hay and grain. With this settlement came the destruction of the Native American economy.

Some of the early ranches within the Hayfork area in the 1850s were the Big Creek Ranch, R. B. Wells place, Dockery Ranch, Drinkwater Ranch, B.M. George Ranch and Dobbin Ranch. John Carr spoke of Hayfork Valley as the granary of the county and the supplier of hay for Weaverville (Carr, 1891). According to Carr, the discovery of Hayfork Valley was a result of the reprisal raid on the Trinity Indians by the Weaverville population when one of their citizens was murdered. A complete Native American village was wiped out in what is known as the Bridge Gulch massacre where 153 Indians were killed.

Although by the late 1840s, Trinity County was buzzing with mining activities and developing agricultural interests, Hyampom Valley remained virtually isolated and off the main track of development. According to Cox (1858), "Hiapum was settled 12th of January, 1855, by Hank Young" and he found the place occupied by only a remnant of Indians, as the frequent visits of the hunters and herders had induced the majority to withdraw". Access into the valley was by trail only. Some accounts called Hyampom "The Land of Many Trails."

One account verifies just how good hunting and fishing conditions were in this valley area during those early settlement years: "Tom McKay went hunting up the South Fork Mountain. After seeing many bucks he finally chose to shoot five large, well-fed bucks. After killing and dressing these animals, he came off the mountain. He crossed the river near Butter Creek and noticed it filled with salmon. He speared eleven fish and was on his way home. In just two days he caught a large portion of his winter supply of meat" (Owens, 1965). Deer populations decreased as decades progressed.

Across the region agricultural settlements impeded communal hunts, limited access to hunting grounds and acorn groves. Farm animals destroyed native crops of grasses and acorns. Mining operations silted rivers and streams, which in turn destroyed local fishing grounds. During this time many Native Americans were being rounded up and sent to reservations or were massacred, especially the males. At the same time numerous young and single white men were arriving in this area which resulted in a significant number of marriages between these white men and young Native American women. According to the U.S. Census of 1860 nearly half of the married couples living in the Hayfork area were white male-Indian female couples (10 of 21) (U.S. Census, 1860).

In the 1860s, additional farming families came into the Hayfork and Hyampom Valleys. One of these was the William O. Vaughn family. Most of the good farm land was already taken, and the Vaughns turned to cattle and dairy ranching in the Butter Creek-Indian Valley area, which was not well suited for agricultural crops because of its short growing season. The Vaughns lived in Indian Valley, apparently near Vaughn Spring, and ran cattle at Corral Gulch in Indian Valley. The Vaughns pastured their horses for years at Butter Creek Meadows. Cattle ranching in those days involved running cattle in the meadows and forest during the spring, summer and early fall, then driving the cattle to lower elevations in the Sacramento Valley for winter range. In the spring the cattle would be driven back and the cycle repeated (Oral Histories, 1994).

The Vaughns also produced butter and buttermilk, which was packed out and sent on to the mines. The Vaughns remained in the Indian Valley area until the late 1880s when William, the family patriarch, moved to Oregon. His son remained in the area and established a ranch at the mouth of Philpot Creek. Vaughn and other ranchers sometimes hired Native Americans to work their ranches as farm or day laborers (Oral Histories, 1980). By the turn of the century many Native Americans had become employed as woodcutters, farm laborers and ranch hands.

The region remained sparsely settled and remote for much of these early years. "The length of the South Fork is one hundred miles, and, as stated above, is hardly anything but a vast canyon, carrying, however, apparently as large a body of water as the Trinity River itself. From Hyampum to its source no settlement as yet is enlivening its banks; no prospecting done, except three or four miles up, where from "color" to one bit is found. As this river as yet has not, therefore, been explored to any extent, its resources are of course not known." (Cox, 1858).

Forty-five years later, a local newspaper account spoke more of the valley's wondrous beauty: "On the west side of the valley rises the ponderous mass of the South Fork Range to a height of 5000 feet above the river; its slopes are covered with the most magnificent growth of timber in the county. Yellow and sugar pine seem to thrive there in abundance." (Searchlight, 1898).

In 1820 Cash Entry law and Cash Entry policy were established to promote land development and raise revenue. The policy was basically a public land disposal policy. The land could have agricultural, mineral or timber values. Any amount of land could be purchased, under this act, but had to be paid for in cash. The act did not require that there be development on the land, nor did it require that one lived on the land. If a person had filed a declaratory application for land under any of these land disposal laws prior to 1862, when the Homestead Act was passed, it would allow the applicant to be eligible to obtain 160 acres under the cash policy, and an additional 160 acres under the Homestead Act (Keeter, 1994).

The Homestead Act permitted any citizen to acquire 160 acres of land for a fee of $10. The only condition of the Homestead Act was that the occupant had to live on the property for five years and cultivate the land. Homestead laws after 1900 required that the land could not have any values for minerals, not be irrigable, that no merchantable timber be present and the land was to be used for personal use only. In 1873 the Timber Culture Act was signed into law. This act was designed to increase the supply of lumber. It gave an additional 160 acres of land to homesteaders who would plant one-fourth of the acreage to trees within four years. In 1878 The Timber and Stone Act was set. Under this Act individuals could apply for up to 160 acres of land at $2.50 per acre if they could prove the land unfit for agriculture and valuable only for timber and stone (Martin, 1981).

Eureka was a booming seaport during this period. It served as a center for supporting the expanding mining and agricultural communities within the western Klamath Mountains. Weather records from Eureka document that large floods occurred in 1862 and 1891. The 1862 flood was the largest of the two, causing significant damage throughout northwestern California. No records were found to indicate what effect the floods had within the South Fork Trinity watershed.

Even with the expanding presence of agricultural products, Hyampom Valley residents still maintained a dependency on the salmon. It was reported that, “Fish fries were a common social event in spring. In those days, there were no restrictions on methods of catching salmon. The people would spear fish late into the night. As the men caught the fish, the women cooked them. The fish which couldn’t be eaten that night were either smoked or canned. Besides catching fish, a great time was had by all at these night barbeques.” (Owens, 1965).

“Fish were an important part of the settler’s diet. The salmon and steelhead were much more numerous than we can imagine today. During the salmon runs, everyone would spear enough salmon for his own use. There were no legal restrictions upon the number of fish taken or the methods of harvest. The largest fish remembered taken weighed 52 pounds. Once caught, the fish were usually canned or smoked Indian fashion.” (Owens, 1965).

Another account provides more evidence, although not numerical, of the large anadromous fish runs at Hyampom Valley. “Crossing the river in spring and fall was dangerous not because of the high water and strong current, but because of the many hundreds of salmon and steelhead. They would be so numerous that often the fish would bump into the horse’s legs, causing the animal to panic. The salmon also digs holes for their spawn, sometimes two or three [feet] deep. This often caused the horse to stumble and spill its rider. Although not clearly documented, there was apparently loss of human life in some instances where a horse dumped its rider.” (Owens, 1965).

How long the anadromous runs to the South Fork of the Trinity River basin were maintained in this manner is not documented. Watershed conditions in the basin, although beginning to be compromised in a few settled areas, and significantly affected adjacent to and downstream from hydraulically mined areas on the Trinity River, probably remained relatively pristine for at least another 90 years. We also must assume that salmon and steelhead continued to thrive in abundance even though large numbers were harvested as a key food source, since little had occurred to change the productivity of the fish habitat. The only real change was that white European settlers replaced the local Native Americans as the chief harvesters of salmon and steelhead.

Although the fisheries remained relatively unaffected by humans during this period, wildlife were being impacted. Early in this period, grizzly bears were abundant throughout California. Because of the threat they posed to humans and livestock, they were eradicated. The last grizzly bear was shot shortly after the turn of the century. It is unclear how abundant wolves were in the Butter Creek watershed. It is likely that wolves were hunted within the area while at least passing through to other areas. The Bureau of Biological Survey paid trappers and hunters to eliminate wolves from cattle ranches in the early 1900s (Jameson and Peeters, 1988). Elk were known to graze in the watershed during this time. Upon European settlement, elk were killed for meat and because they competed with domestic livestock for range. The last known elk of this time period in Trinity county was reportedly killed near Butter Creek in 1871 (Knowles, 1937).

With the development of communities came the need for lumber. In mining communities miners felled their own timber and cut boards with adzes and broadaxes. Homesteaders utilized timber in order to construct homes, barns, sheds and fences. Sawmills were established which produced large quantities of lumber. When these first sawmills were in operation, there was no legal manner in which lumber was acquired. Trees were cut from public land without permit or fee. It soon became evident that laws were needed to protect the forest. The Trinity Forest Reserve was created by proclamation of President Theodore Roosevelt on April 26, l905. During the time that the Trinity Forest Reserve was established mining, ranching and grazing were the primary industries in this area although a few small sawmills were cutting timber from private lands (Jones, 1970). In 1907 the term forest reserves was changed to national forest. The objective of the name change was to emphasize that the resources of the reserves were open for use as long at it was compatible with the preservation and perpetuation of resources such as wood, water, forage, wildlife and recreation.

The period between 1900 and 1925 witnessed America's last and greatest rush for free land (LaLande, 1979). More land was claimed during this time than in the entire previous history of the Homestead Act. Timber lands as well as agricultural lands were purchased or claimed under the various laws to settle the West. The Butter Creek region saw two land claims under the provisions of the Homestead Act during this time. The first was patented by William J. Henry on September 18, 1911. It consisted of 160 acres of the western segments of Section 5 and 8 T.2N., R.7E., north of Butter Creek which is still private today. The Henrys did not live on the homestead for very long and sold out to Reuben Box and Bruce Viles. The other homestead in the area during this period was the Grel Ranch. It was claimed by Peter Grel in August 1922 and was composed of 110.67 acres in Section 7 T.2N., R.7E., and Section 12, T.2N., R,.6E.. Grel applied for water rights on Butter Creek to divert water for irrigation in November, 1916, in order to raise fruit, alfalfa and hogs (Water Notices, License No. 559, Permit No. 276). The private property that is located in T.2N., R.8E. was acquired under the Timber and Stone Act.

Hayfork and Hyampom were two of the seven original ranger districts in the Trinity National Forest. Hayfork's first headquarters was in Peanut where James William Patton was the first District Ranger. William X. Garrett was the first District Ranger for the Hyampom District. The district office was located in Hyampom. The Forest Service carried out the basic work of managing the land as well as they could given the limitations of access, communication and human resources. They also began the construction of the infrastructure needed to be able to manage the land efficiently. These rangers surveyed boundaries of the forest, posted boundary signs and fought fires (Trinity, 1963).

Natural wildfires have historically played a significant role in shaping the composition and structure of vegetation and the physical and biological processes within western forests. However, during the beginning of the century, Forest Service managers agreed that wildfires were causing detrimental effects to forest resources, especially timber and watershed conditions. Fire exclusion began in 1906 when burning by Native American Indians to encourage preferred growth forms of basketry materials and to benefit game, and by ranchers to increase forage, were outlawed. Systematic and organized fire suppression was then implemented.

Effective fire suppression tactics, strategies and technologies evolved over time. The first organized fire fighting activities occurred in 1906, but it is likely that pre-1940 fire suppression efforts were focused on those fires which threatened property or people; remote fires were probably not effectively controlled. Increased funding supported larger fire prevention, detection and suppression forces with more advanced equipment and personnel training. Increasingly, fires were contained before reaching significant size. After World War I, the Forest Service received surplus war equipment in the form of staff cars and Dodge trucks which were mostly used for fire control purposes. Following World War II, fire suppression became effective due to new technologies and better access to remote areas (Wills, 1991).

In addition to fire control, early District Rangers also examined homestead entries and mining claims to insure compliance with laws. They established a permit system to cut down numbers of cattle which grazed within the forest. In 1915 it was reported that approximately 10,000 head of cattle and horses and 19,000 sheep and goats grazed the forest (Martin, 1981).

During this time a network of fire lookouts and fire guard stations were developed, including Indian Valley Guard Station and Limedyke Lookout. These administrative sites needed to be connected by telephone since that was the only technological means available to communicate with others at remote sites. Therefore, an extensive system of phone lines were constructed within the area, connecting the district offices at Peanut and Hyampom with remote sites such as Limedyke Lookout and Indian Valley Guard Station.

Van Norden (1912), a consulting engineer, explored the South Fork Trinity River watershed for the purpose of evaluating the potential for dam sites for hydroelectric projects. Van Norden felt that a damsite located "...about 1.6 miles below the outlet of Hyampom Valley, where the South Fork has an elevation approximately 1,180 ft. above sea level...is by far the most logical and preferable for a power development." The proposed dam site was not developed for hydroelectric power and the South Fork of the Trinity River remains today as northern California's longest undammed river system.

Between 1914-1918 there was an increase in mining of strategic minerals in this area while the output for gold decreased during this time, continuing until 1929. During the depression in the 1930s many unemployed people moved into this area trying to mine enough gold to buy food to eat and keep themselves off welfare.

After World War I, the construction of a network of roads became a priority. It was in the early 1920s that highways from Hayfork to Hyampom and into the Forest Glen and South Fork of the Trinity areas were developed. Up until the late 1920s the only access into the Butter Creek watershed was horseback or walking. There were numerous trails into the area, some of which still exist today. In the late 1920s a road was built into Indian Valley to access the Forest Service station for fire protection. In the late 1930s and early 1940s additional roads were constructed to provide access to the private property to the east of Indian Valley.

The Federal agencies and programs were not the only institutions bringing change to the area. Dennis Rourke had a mill in Hayfork and William X. Garrett had one in Hyampom, but they were small and did not last into the Depression. Although the main aspect of the 1905-1940 period was laying the basis for a modern economy, there was a significant carry over of frontier activities from before. The two main frontier activities, which were prominent during this time, were continued mining and homesteading on land which was too marginal to be settled before, but with hard work and development could support at least one person. These marginal homesteads frequently had to develop flumes to get an adequate water supply for agriculture.

A 1930 Allotment Report for Indian Valley, written by Hayfork District Ranger Harry Everest, documented range conditions and makes recommendations for managing the allotment. The allotment at that time contained Butter Creek, Indian Valley Creek, Plummer Creek, Jim's Creek and Naufus Creek watersheds. As stated in his report: "Prior to the creation of this Forest, this range was heavily overgrazed by both cattle and horses from the Hayfork and Sacramento valleys. Since the creation of the Forest, the numbers have been decreased gradually until 1926 to the present date there have been a very noticeable reduction due to lack of demand and as a result, the feed is returning to its climax type." He also noted that "as a whole the allotment is understocked (with cattle), but due to early overgrazing, it will be the policy to keep understocked in order that it may recover. The stringer meadows along all of the streams are heavily overgrazed while the balance of the allotment is under utilized. Very serious erosion is found along Indian Valley Creek for about 5 miles in length. This has lowered the water table from 6 to 10 feet throughout this portion and as a result the adjacent meadows have suffered heavily." The report indicates that he recommends that grazing on the allotment should not exceed 230 head of cattle (Everest, 1930).

In 1933, Theodore Roosevelt created the Civilian Conservation Corps (CCC) in order to put unemployed young men to work and to conserve National Forests. Five camps of 200 men each were set up in the Trinity Forest, a very large number of young men in a county whose population stood at only 2809 in 1930. The CCC crews built bridges, fought forest fires, installed telephones lines, built roads and trails, planted trees, developed recreational facilities and constructed Forest Service administration sites. In June of 1942 Congress voted against further appropriations for the CCC.

The economic boom that brought the United States out of the great depression of the 1930s was stimulated by production for World War II. During the first stage of the war, 1939 to 1941, British war orders provided the demand which began to lift an economy that had been sputtering since the late 1920s. After the U.S. entry into the war in December 1941, the boom was fueled by the frantic demand for goods of all kinds to fight the war. Trinity County and the Hayfork area felt this demand for production and goods directly in the form of chromite mining and most importantly in lumber (Baker, 1981).

Minor deposits of chromite and other strategic minerals occur in ultramafic rocks within the Rattlesnake Creek terrane in small veins called kidneys throughout the Butter Creek area. Most of this chromite was mined, either with hand tools or caterpillar tractors, during World War II and again in the 1950s during the Korean conflict, when a premium price was offered by the government for strategic minerals. Several of these mines were located in the Butter and Indian Valley Creek areas. In addition, small scale mining for strategic minerals was so extensive that an informant stated that there probably wasn't a ridge that these miners weren't on throughout all the Indian Valley country (Oral Histories, 1980).

At the end of the Depression and the beginning of World War II, the Hayfork area saw another significant change; the establishment of a system of roads by the Forest Service, state and local governments. However, the road network was inadequate to effectively allow for significant land management activities. The expansion of the timber industry at this time was limited by transportation difficulties in Trinity County. It wasn't until after World War II that the timber industry attained a sound economic position in this area (Cleppen, 1971). However, in the decade between 1940 and 1950 the timber industry expanded rapidly. The percentage of employment in lumber and wood products increased in that decade from 2 to 36 percent.

Within the Butter Creek watershed, logging started in the late 1940s mainly from short spur roads off of the Indian Valley road and on the private property. Grazing and fire protection activities also continued during this time period, although were of a lesser magnitude than the logging.

Selective harvest occurred within subwatersheds in the uplands. Buck Gulch, Corral Gulch, Cow Gulch, Friend Mtn. Creek, Headwaters Creek, middle Butter Watershed, Sheep Creek, South Butter Creek, upper Butter Creek and upper Indian Valley Creek all had some selective harvest activities during the period (**Table 13**). At the end

Table 13	**ACRES of PLANTATIONS**					
Subwatershed	**Watershed Size**	**1960s**	**1970s**	**1980s**	**1990s**	**Totals**
Buck Gulch	584	7	30	34		**71**
Butter Ck.	2,320	79		194	45	**318**
Canyon Unit	1,619	56	80	254		**390**
Cold Camp Ck.	1,069	21	0	593		**614**
Confluence	476			10		**10**
Corral Gulch	2,097		20	196	105	**321**
Cow Gulch	378	1		27		**28**
First Butter Ck.	513			59		**59**
First IV Ck.	1,020		38	75		**113**
Friend Mtn. Ck.	663	23		116		**139**
Headwaters Ck.	584	24	10	101	4	**139**
Indian Valley Ck.	1,207	3	51	115		**169**
Long Ck.	306		19	21		**40**
Middle Butter Unit	1,673	110	22	310	3	**445**
Middle IV Unit	1,541	9	3	211	20	**243**
North Ck.	575			15		**15**
Rail Gulch	397		7	197	0	**204**
Seven Road Ck.	638		7	491		**498**
Sheep Ck.	518			159		**159**
South Butter Ck.	2,055	135	2	358	3	**498**
Upper Butter Ck.	1,857	9	28	312	75	**424**
Upper IV Ck.	1,400	12	2	174		**188**
Totals	**23,490**	**489**	**319**	**4,022**	**255**	**5,085**

of the 1940s, over 2300 acres had been selectively harvested and 17 miles of road existed within the watershed. A retrospective cumulative watershed effects analysis indicates that both Cow Gulch and upper Butter watersheds were heavily disturbed by timber harvest and roading during this period (**Table 14**).

The non-native pathogen *Cronartium ribicola*, the cause of white pine blister rust entered the watershed in the 1930s. It was first identified on the West Coast near Vancouver, British Columbia, where it was introduced on infected nursery stock brought over from Europe.

Frequent low-to-moderate intensity fire is historically one of the most important ecological processes in the Klamath Province. Recent data from the Happy Camp Ranger District on the Klamath National Forest indicate fire return intervals from 7-35 years, with most sites having a return interval of 10-17 years in Douglas-fir and mixed Douglas-fir and ponderosa pine stands. This is supported by findings from the Siskiyou Mountains in southern Oregon (Agee, 1991).

The character of the forest and the effect of fire on ecosystems was most significant during the early settlement and modern time periods. Deliberate burning of vegetation by Native American Indians declined in the early 1900s and was followed by accidental or intentional fires ignited by early settlers. The fires caused by the European settlers differed in periodicity and seasonality from fires set by Native American Indians. Free-burning lightning fires occurred until after the turn of the century. Logging activities left large quantities of untreated slash, and the machinery used in logging systems in the latter half of the 19th century often started fires. Fires set to clear land and roads often escaped. Fires ignited by cattlemen and shepherds to improve grazing conditions were also prevalent during this period. The devastation caused by these fires incited conservationists to impose an organized system of fire suppression and the restriction on use of fire in the forest environment.

Increased settlement of Europeans brought many cattle as well as the introduction of non-native

Table 14	**TOTAL ERA PERCENT by SUBWATERSHED and DECADE**						
Subwatershed	**Watershed Size**	**1940s % ERA**	**1950s % ERA**	**1960s % ERA**	**1970s % ERA**	**1980s % ERA**	**1990s % ERA**
Buck Gulch	584	1.0	4.1	8.2	5.9	6.6	6.3
Butter Creek	2,320			3.9	2.6	5.1	5.4
Canyon Unit	1,619			4.4	4.6	8.8	8.3
Cold Camp Ck.	1,069			3.5	2.5	18.7	15.3
Confluence	476			3.5	3.5	4.0	3.8
Corral Gulch	2,097	0.4	7.1	12.1	8.2	8.5	8.7
Cow Gulch	378	9.3	7.8	14.6	10.0	9.6	8.4
First Butter Ck.	513			1.1	1.0	4.0	3.3
First IV Ck.	1,020			4.3	4.6	6.3	6.0
Friend Mtn Ck.	663	1.8	1.4	13.9	7.9	11.1	9.6
Headwaters Ck.	584	1.0	0.8	16.5	10.6	13.5	12.4
Indian Valley Ck.	1,207			1.6	2.8	5.2	4.9
Long Ck.	306			0.6	2.4	3.8	3.8
Middle Butter Unit	1,673	0.4	1.6	10.3	5.5	11.1	10.3
Middle IV Unit	1,541		1.5	9.2	4.2	7.5	7.0
North Ck.	575			2.5	2.2	2.9	2.7
Rail Gulch	397			14.6	7.7	19.2	15.8
Seven Road Ck.	638			13.0	6.2	24.3	19.2
Sheep Ck.	518	3.0	2.5	12.0	4.1	10.9	8.7
South Butter Ck.	2,055		2.0	9.9	5.8	10.3	9.5
Upper Butter Ck.	1,857	11.1	10.1	13.3	10.0	11.8	11.1
Upper IV Ck.	1,400	1.9	2.2	9.9	5.9	7.7	6.5
Totals	**23,490**	**29.9**	**41.1**	**182.9**	**118.2**	**210.9**	**187.0**

grasses. Overgrazing, elimination of traditional uses of fire by Native American Indians along with increased fire suppression, and the introduction of foreign grass species dramatically altered the structure and composition of the grass and hardwood tree communities.

The forests of the early portion of this age were probably less dense with a more patchy look than those of today. A matrix of fairly open, large sized mixed conifer and Douglas-fir forest was interspersed with small patches of young forest, shrubs or grassland. The shrub component of older forests was sparse, consisting of manzanita and ceanothus. The regeneration layer was comprised of ponderosa pine and white fir.

A Timber Survey from 1941 has photographic evidence of the openness of some stands, but also the effects of the reduction of burning (USDA FS, 1942). The establishment of an understory of more shade tolerant species can be seen. White fir was considered a minor species, comprising less than 6 percent of the stands, found only on north and east aspects at the higher elevations. Ponderosa and sugar pine are more important components of the forest than they are today (23 and 13 percent of the stand respectively). Although a dense shrub layer is obvious in many of the photographs, 60 percent of the area was rated as light presence of shrubs. A well developed regeneration layer is also obvious in many of the photographs.

The Physical and Aquatic Environment

A set of 1944 black and white aerial photographs, having a scale of 1:30,000 (1 inch = 1/2 mile), gives us a brief but somewhat fuzzy perspective on what geomorphic processes were occurring in this period. The Maddox Lake slump-earthflow was active during this period, and several local inner gorge slides were active in lower Indian Valley Creek. Several revegetated debris slide features in lower Indian Valley Creek were probably active around the turn of the century, perhaps triggered by the 1862 or 1891 floods. All of the active landslides appear to be naturally occurring. The Maddox Lake slide occupies over 800 acres of land. The remaining active slides, which are visible on the photos occupy approximately an additional 15 acres. All of the active slides are developed in the serpentine melange portion of the Rattlesnake Creek terrane, within the deeply incised, steep-sided canyon of lower Indian Valley Creek. Several active debris slides are evident along the South Fork of the Trinity River in the vicinity of Butter Creek. They are all on the outside meander of relatively sharp bends in the river, and lie within the primary valley inner gorge.

There were significant impacts on the soil resource in the Butter Creek watershed during this period. As documented by Everest (1930), the introduction of cattle grazing to the relatively gentle terrain of Indian Valley resulted in a change in vegetation towards annual grasses, reduction in ground-cover and damage to riparian areas and vegetation. The loss of vegetative cover as a result of intensive grazing caused soil compaction in heavily grazed portions of the watershed. Increased compaction and poor ground cover may have resulted in significant surface erosion losses. Recovery from compaction impacts on most soils may take decades without intervention. Soil erosion impacts include the invasion of damaged areas by non-native grasses, more annual grass species and shrubs.

The exclusion of fire from this fire-maintained regime has resulted in a more closed, multi-story stand structure with increased demands for available water. This shift in stand structure has undoubtedly altered, to some degree, the hydraulics of the soil resource by reducing the volumes of water passing through the soil profile as interflow. It is unclear how this change has affected the soil environment in terms of function or productivity; the impacts on overall hydrologic functioning of the watershed, however, can be speculated to be significant.

A shift away from the generally more open forest of the pre-European settlement period may have had an impact on the cycling of organic matter and nutrients. First, changes in stand structure and a movement towards more late-successional stand composition shaded the earth and reduced the ground cover percentage occupied by grasses. This succession has altered the rapidity in which organic matter is processed in the soil environment, as grassy biomass with its extremely fine root mass and rapid die-off each season decays readily in a Mediterranean climate. The exclusion of fire has changed forest floor nutrient cycling by altering the distribution of woody biomass across the forest floor, and temporarily changing the rejuvenating effects of mineral nutrient release following historically more frequent understory burning.

The stream flow regime was also influenced by both the change in the fire regime and the results of grazing. Due to a the change in fire regimes, there was a shift in the water balance as more incoming rainfall was lost back to the atmosphere through interception and evapotranspiration by the greater number of coniferous trees. Therefore, the groundwater table was lowered regionally, and there is presently less groundwater available for springs, and the perennial stream network is less extensive.

Grazing of domestic livestock in the meadows and riparian areas of the west has had a well documented impact to the stability of low gradient, vegetation controlled stream channels. As described by Everest (1930) cattle grazing affected the stream flow regime by destabilizing the upland low gradient stream channels which resulted in channel destabilization and downcutting. These channel adjustments occurred quickly at first, with downcutting occurring within just a few years. Subsequent bank erosion as streams tried to redevelop their floodplains took a few more years or decades, before the channels assumed a relatively stable configuration. The downcutting also resulted in a lowering of local water tables in the upland meadows and valley bottoms. Downcutting also allowed for quicker delivery of water during stormflows, and therefore, less water retained in the watershed. The overall result of these grazing impacts is less surface water in the upland area during the low flow months.

The extent of erosion from roads during this period was probably minor, as the road system was limited and built on stable ground. Surface erosion caused by grazing animals could have been significant if severe overgrazing exposed extensive areas of soil. This has not been documented, however, and considering the small amount of potential forage in the watershed, unlikely to have occurred. The more significant influence of livestock grazing on stream sediment occurred due to changes in channel condition related to overgrazing in the riparian areas.

Water temperatures were elevated in the upland channels. Channel adjustments following downcutting events result in shallower, wider channels that are more exposed to direct solar radiation. Riparian shade was also likely reduced by the effects of grazing or lowering of the water table. There was, however, less water retained in the upland stream channels and more bedload sediment. This resulted in intergravel flow in some streams. Temperature of this intergravel water is much cooler than water flowing in the open exposed channels. Downstream water temperatures were not affected during this time period. Water temperature of the South Fork Trinity River was probably not affected by water temperature increases in the headwaters of Butter Creek due to the effects of volume dilution (Brown and Kugler, 1970).

Channel condition for the steeper, bedrock controlled channels were most likely not affected by grazing or fire control. A possible reaction of downstream channel stability might have occurred if a sudden influx of sediment coming from a destabilized upland channel resulted in an accelerated undercutting of a landslide feature. Although the components of this scenario exist in the Butter Creek watershed, there is no evidence to suggest that it actually occurred.

Historical evidence dating back to the turn of the 20th century, although limited, suggests that both chinook and coho salmon utilized Butter Creek. Although undoubtedly present in the South Fork Trinity River, early narrators failed to document the occurrence of steelhead trout in Butter Creek.

Records on file with the State of California Department of Fish and Game reveal that from 1938 until the 1960s eastern brook trout were planted in the upper reaches of the stream. California Department of Fish and Game records indicate that one rainbow trout planting occurred in 1947.

The Terrestrial and Riparian Systems

Forests which exhibit the most marked effects from pre-European settlement conditions to today are most likely the more productive mixed conifer forests in the lower to mid-elevations. The composition, structure and successional sequence of some communities changed due to the introduction of non-native plant and animal species during this time period (Jimerson et al, 1994). These are related mostly to past human caused disturbances including mining, timber harvest, cattle and sheep grazing. Burning to increase forage, and mining along with its associated logging for mine timbers and building materials had the most significant impacts.

Vegetative Conditions - 1944

The vegetative characteristics of interest for interpretation of range of natural variability of the Butter Creek watershed include seral stage distribution, plant community composition and structure, and vegetation density. These characteristics were interpreted with the use of 1944 black and white aerial photography at a scale of roughly 1:30,000. Polygons were delineated based on seral stage and overstory composition, size and density. Timber type, size class and density were interpreted for each polygon using the criteria used for the current draft Land Management Plan (USDA FS, 1993b). Wildlife habitat characteristics (type, size and density) were interpreted based on Mayer and Laudenslayer, (1988). Seral stage was interpreted using the regional guidelines for the Ecological Unit Inventory (USDA Forest Service, 1994b). Results of these analyses are displayed in **Tables 15** through **18**.

Fire suppression and the cessation of Native American Indian burning may have had some influence on the overall vegetation structure, making it more dense with fewer immature patches than might otherwise have been the case. However, it is likely that this relative proportion of seral stage distribution represents a typical pattern within the natural range of variability.

The landscape, as interpreted from the 1944 aerial photographs, was comprised of large patches of old and mature stands interspersed with smaller disjunct patches of young trees, shrubs and herbaceous communities (**Plate 21**). In 1944 old and later mature forest together made up 55 percent of the watershed; mid-mature forest covered 32 percent of the landscape and the remaining 13 percent was under early successional vegetation (**Table 15**). This was a landscape dominated by a matrix of mature forest. It was possible to travel across the watershed in most any direction in continuous corridors of mature vegetation.

In 1944, the forests for the most part were dominated by either mixed conifer (54 percent of the watershed) or Douglas-fir (41 percent of the watershed) (**Table 16, Plate 22**). There was a smattering of other vegetation types, but all occupied less than two percent of the land. These included ponderosa pine and Jeffrey pine forest, grasslands, shrublands and hardwood forest. The Douglas-fir forest occupied the western portion of the watershed encompassing both lower Butter Creek and lower Indian Valley Creek. There are two large patches of Douglas-fir forest in the eastern portion of the watershed, one in the upper Butter Creek and the other in the Cow Gulch subwatershed. Mixed conifer forest is found almost exclusively as a nearly contiguous matrix to the east of First Indian Valley Creek and the Indian Valley Canyon unit (the uplands portion of the watershed). The less common vegetation types are found as small patches scattered about the matrix of either Douglas-fir or mixed conifer.

The density of forested stands was coded based on timber stratum density codes from the Draft

Table 15 — 1944 ECOLOGICAL SERAL STAGE DISTRIBUTION

Seral Stage	Percent of Watershed	Acres	Number of Patches	Max Patch Size
Old Forest	9.6	2,245	19	720
Late Mature	45.3	10,657	80	1,258
Mid Mature	31.6	7,426	182	704
Early Mature	12.3	2,881	115	158
Very Early Mature	0.1	30	2	26
Shrub	0.7	159	25	43
Herb	0.4	92	13	23
Totals	**100**	**23,490**	**436**	

Table 16 — 1944 TIMBER STRATUM-VEGETATION TYPE

Vegetation Type	Percent of Watershed	Acres	Number of Patches
Douglas-fir	41	9,649	181
Jeffrey Pine	2	518	25
Ponderosa Pine	2	411	7
Mixed conifer	52	12,293	159
Hardwoods	2	354	24
Montane shrubs	1	168	28
Herbs			
Grass	0.003	78	11
Streamside			
Plantations			
Cultivated			

Forest LMP (Shasta-Trinity N.F., 1993). Sparse density is that less than 20 percent canopy cover, poor density 20-39 percent cover, normal density 40-69 percent cover and good greater than 70 percent cover. The timber density distribution for forested stands in 1944 was 5 percent in sparse, 12 percent in poor, 34 percent in normal and 45 percent in good (**Table 17**). Four percent of the watershed was in non-forest vegetation. The distribution of density was very patchy in the lower Butter Creek portion of the watershed, particularly along the south-facing slopes above Butter Creek (**Plate 23**). The majority of the watershed was large patches of normal and good (dense) forest interspersed with small and medium sized (100-200 acre) patches of poorly stocked forest.

Table 17	**1944 TIMBER STRATUM-DENSITY**		
Timber Density	**Percent of Watershed**	**Acres**	**Number of Patches**
Sparse	5	1,194	86
Poor	12	2,857	93
Normal	34	7,991	104
Good	45	10,605	85
Non-Forest/ Plantation	4	843	68
Totals	**100**	**23,490**	**436**

A majority of the poorly and sparsely stocked area was in the northwest portion of the watershed in Butter Creek, North Creek, Confluence Unit and First Butter Creek subwatersheds. This appears to have been the result of wildfires in the early 1900s. In addition, part of the area around upper Indian Valley Creek and upper Butter Creek was poorly stocked. This is probably due to the grazing activity centered around upper Indian Valley Creek.

The size of the vegetation in 1944 was also coded with the size classes used for the timber stratums from the Draft LMP. These are coded based on crown size as follows:

1 0-5 feet in diameter

2 6-12 feet in diameter

3 13-24 feet in diameter

4 25-40 feet in diameter

5 > 40 feet in diameter

6 Two storied stand with one layer in the 1 or 2 size class

The distribution of stratum size classes in 1944 is .01 percent in class 1, 1 percent in class 2, 26 percent in class 3, 27 percent in class 4, 37 percent in class 5 and 5 percent in class 6 (**Table 18**).

Table 18	**1944 TIMBER STRATUM - SIZE CLASS**		
Timber Size Class	**Percent of Watershed**	**Acres**	**Number of Patches**
0-5		30	2
6-12	1	198	13
13-24	26	6,127	209
25-40	27	6,420	81
40+	37	8,692	60
2 Layered	5	1,180	7
Non Forest	4	843	68
Totals	**100**	**23,490**	**440**

The small portion of the watershed in small forest (size classes 1 and 2) occurred as small patches scattered throughout the western side (**Plate 24**). They coincide with the low density patches on the south-facing slopes above lower Butter Creek. This supports the finding of fire studies in the Klamath province that large, catastrophic fires were historically quite rare (Agee, 1991). The watershed is characterized by large contiguous areas of large sized trees (greater than 24 inches DBH).

Using the Wildlife Habitat Relationships (WHR) types to describe habitat conditions, forest stands with Douglas-fir dominated the watershed (**Table 12**). Eighty percent of the habitat was in the Klamath Mixed Conifer and Douglas-Fir WHR types. Less then 4 percent was in the drier pine habitat. Jeffrey pine type made up 2.5 percent and ponderosa pine type was rare at less than 1 percent. About 20 percent was covered with oak hardwood habitat (Montane Hardwood-Conifer and Montane Hardwood WHR types)

The Douglas-fir and Klamath Mixed Conifer WHR types existed in good interior forest conditions with multi-layered stands of large diameter trees. Almost 80 percent of the average tree size was at 24 inches or greater. There were no ponderosa pine type plantations. All of the ponderosa pine type stands were at the 6 to 24 inch diameter class. The hardwood types existed in a dense canopy closure and large diameter size. This likely reflected wide canopy trees that produce large acorn crops. These forests provided good thermal cover and food sources for wildlife.

The most significant habitat changes from the land use practices of this time were loss of wet meadows and riparian areas. Indian Valley had been the site of a large wet meadow. Native Americans named the area after the sound of the sandhill crane (Oral Histories, 1994), a shallow wetland species no longer found in the watershed. Only a remnant of the formerly large wet meadow at Butter Creek Meadows remains today. There are no other accounts of specific wetland or riparian species that once inhabited the area but additional changes can be assumed from statewide trends in species like the willow flycatcher that had once been a common summer resident of healthy riparian systems. Changes in the use and control of fire, as well as other land use patterns such as livestock grazing, have reduced the quantity of native grasses and oaks with subsequent reductions in the population capability of wildlife dependant on these resources.

Fire History

With the prohibition of burning by ranchers and Native American Indians on National Forest lands during the middle of this era came an increase in fuels. Vegetation both dead and alive became more abundant and thus potential for fire starts and large fires increased.

There were 19 fires recorded for the period 1910 to 1919 (**Table 11**). Mostly lightning caused, they burned a total of 28 acres. The majority of the fires occurred in the northern portions of Butter Creek, the Confluence Unit and Rail Gulch.

The period 1920-1929 saw 16 fires in the watershed, including a very large fire of approximately 1900 acres in Corral Gulch, upper Butter Creek and the southern portion of South Butter Creek. The remainder of the small lightning strikes were on the ridges at the western edge of the watershed, First Butter Creek and scattered elsewhere throughout the watershed.

The number of recorded fires for the 1930s and 1940s dropped off to 10 and 7 respectively. Total acres burned for these decades was 1 acre or less. Two of the fires in the 1930s were human caused, the rest were caused by lightning. Nearly half of the fires were in upper Butter Creek. Most of the rest of the fires were in the area of upper Indian Valley including Buck and Cow Gulches. The fires in the 1940s centered around upper Indian Valley and Friend Mountain Creek. All of these were lightning caused.

THE MODERN AGE
1950 to 1994

Introduction

This age is marked by the return of people from the European and Asiatic theaters of war which bolstered industrial innovation and developmental pursuits. It was a time when the nation desired to forget the many years of war, its tragic losses, and the deprivation of domestic goods. Big business interests responded by turning their attention from the products of war to the products of peace and pleasure. Our nation was on the cutting edge, it was moving fast, and everyone caught the spirit of working hard, of getting ahead and enjoying new life styles with money to spend. It was a time to rebuild our nation and we had everything in our favor; humanpower, motivation, natural resources and money to do it. Expectations ran high and natural resources were developed and utilized at an increased rate to benefit a growing nation.

Benchmarks of this age included an increase in the number of homes and demand for other wood products, more and better access roads, increased reliance on inexpensive hydroelectric power, intensive commercial harvesting of fish, expanded cattle ranching and an overwhelming demand for more and better recreational activities. National Forests emerged with the focus of multiple-use management. Industry looked for the National Forests to provide high levels of timber production, more rangeland, and a more diverse spectrum of recreational opportunities.

Road construction, timber harvesting, fire suppression and recreation were the significant disturbance agents during this period. Grazing impacts lessened as forage became limiting and regulations tighter.

At the commencement of this age, inventory efforts were rudimentary and very functional in nature. For instance, fish surveys denoted only the presence or absence of a particular fish species from a basin or watershed. Obvious problems associated with the degradation of the streams and lakes were noted, but many minds still embraced the concept of “biological resiliency” with respect to our plant and animal species. Few thought that diminishing “pockets” of habitat would affect the abundance of a species.

During this entire time frame, fire suppression continued to be a dominant part of wildland management. With fire suppression came a growing risk of stand replacing catastrophic fires which severely degrade watershed conditions, wildlife and fisheries habitat and other forest resources, and threatens local communities and infrastructure.

Disturbance Events

The 1950s

Since the main commodity resource of Trinity County in modern times is timber, it is natural that the main economic activity would be centered around logging and sawmilling. Road building, timber cruising, fire suppression, timber improvements and related activities of private timber owners, the USDA Forest Service and other governmental agencies supported a lumber boom during World War II and thereafter. A mill even existed for a time at the mouth of Philpot Creek on the west side of Salt Creek (Oral Histories, 1980), south of Hayfork. By 1950 there were eleven logging or sawmill operations in the Hayfork and Hyampom valleys, all of them using trucks to bring logs onto the mill sites (The Timberman, 1950). Today, only one mill is in operation.

This lumber boom was reflected in the population figures for the township encompassing the Hayfork-Hyampom region. In 1940 the area was home to 739 people (18.6 percent of the population of Trinity County), making it the third largest township in population. By 1950 the population had increased by 137.8 percent to 1754, 34.5 percent of the county’s total population and the most populous township in the county (U.S. Census 1970).

Road construction and timber harvest accelerated within the South Fork of the Trinity River watershed. Large privately owned tracts on the eastern slopes of South Fork Mountain, across from the mouth of Butter Creek, were intensively roaded and logged in the mid-50s. Large portions of Hitchcock, Cold Springs, Johnson and Pelletreau Creek watersheds were intensively harvested. Sensitive lands such as inner gorges and other landslide prone areas were logged with tractors. Road density was high. Collector roads were spaced approximately 1000 feet apart and there were extensive local roads and skid trail networks. Stream crossings were often rather primitive. Cull logs were placed in creeks and fill pushed over them. Skid trails and landings were often located within swales, ephemeral and intermittent drainages. There were a few streamside buffers around perennial channels.

Timber harvest and road construction within the Butter Creek watershed also accelerated in the late 1950s. Extensive selective harvest occurred on private lands within the watershed. Selective harvesting was also on the rise on National Forests lands within the uplands portion of the watershed. The first tractor yarded patch clearcuts were harvested in the northern portion of the watershed on National Forest lands. Perennial channels were generally buffered from logging but intermittent channels and especially ephemeral channels were usually not. At the end of the 1950s, an additional 1900 acres had been selectively harvested, in addition to some re-entry into the previously managed areas (**Table 13**).

Approximately 55 miles of road were constructed in the watershed, north from Indian Valley and east from Hayfork. The majority of the roads constructed in this period were the main haul routes and are still in use today. Other more primitive roads were built in stream channels and on ridge tops and have gradually deteriorated to the extent that they are not usable.

Records indicate that 15.9 million board feet (MMBF) of timber was harvested from National Forest lands within the watershed in 1957. Analysis indicates that although timber harvest and road construction activities accelerated within the watershed, they were relatively dispersed. Cow Gulch and upper Butter subwatersheds were only moderately impacted.

Aerial photographs were used to chronicle changes in geomorphic processes and harvest activities during this time. Aerial photographs taken in 1960 were utilized to evaluate geomorphic processes and rates of change. In terms of mass wasting activity, there was no substantial change from 1944 to 1960. The Maddox Lake slump-earthflow remained active, as did the inner gorge debris slides in lower Indian Valley Creek.

There were 13 lightning caused fires during the 1950s. They burned a total of 71.7 acres. Corral Gulch, Cold Camp Creek, Headwaters Creek and upper Butter Creek were the sites of most of these fires.

The 1960s

There were three significant disturbances types in the 1960s: accelerated road construction, timber harvest and the 1964 flood event.

Timber Harvest

Significant timber harvest activity occurred during the period from 1960 to 1970. An extensive road network was established throughout the watershed. Intensive selective logging utilizing tractors occurred within the uplands. Clearcutting with tractors and intensive site preparation occurred on the steeper lands within the uplands. Cable harvest methods were implemented to a small degree in the canyonlands. Approximately 70 miles of road were constructed to the north and west of Indian Valley, connecting into the Hyampom area. Approximately 90 percent of all the roads in the Butter Creek watershed were constructed by 1970, mostly for the purposes of logging.

Over 7400 acres were selectively harvested and 320 acres of land clearcut during this period—nearly one-third of the watershed (**Table 13**). Although records are incomplete, at least 70.2 MMBF of timber was harvested between 1960 and 1964 within the watershed. An additional 101.9 MMBF of timber was harvested from the watershed between 1965 and 1969. Although all of the 15.7 MMBF of timber harvested within the 1950s decade was harvested in one year, 1957, the average annual timber output from the watershed was 1.6 MMBF in the 1950s. During the 1960s, that average grew to over 17 MMBF per year, a full magnitude of change.

The construction of roads and skid trails from timber harvesting and recreation activities has had an impact on the soil resource within the Butter Creek watershed. Roads and skid trails compact soils so that vegetation has difficulty in re-establishing itself on these surfaces. The road and skid surfaces become less permeable to water, increasing the amount of water that runs off and intensifying the energy and ability of the water to cause erosion. Roads and skid trails also tend to intercept, concentrate and discharge runoff towards areas previously unaffected by surface water flows. This phenomenon causes gullies or surface sheet and rill erosion to occur on site or downslope, degrading the long-term productivity of the soil resource.

The interception of water at the cutslope of roads or by skid trails also disrupts the natural flow of water through the soil. This subsurface flow is an important contributor to the retention and slow transmission of water through the watershed. Any interruption of this natural hydrologic cycle is a disruption to a basic function of the soil resource and can have negative (although unmeasurable) consequences on on-site and downslope resources.

The dominant impacts of timber harvest operations on the soil resource during this period were to increase the extent of compacted soil, the removal or redistribution of large quantities of forest biomass and vegetation cover and the alteration of the hydraulic and hydrologic functions of the soil resource.

Timber operations during this time took two forms: partial cutting and clearcutting. Often, areas that were partially cut were cleared a few years later to replace the understocked site with a new crop of trees. Two disturbances on the same piece of ground in a relatively short time period likely exacerbated the impacts on the soil resource, in particular soil compaction. Soil compaction has been shown to increase bulk densities up to 37 percent on certain sites after 20 tractor trips (Froehlich et al., 1983). Recovery from soil compaction may take decades in fine-textured soils (Hatchell et al, 1970).

The compaction of forest soils can lead to a number of potential consequences of varying significance, including: increased overland flows (leading to soil erosion on-site or downslope), alteration of soil porosity, inhibition of root penetration into the soil environment, reduction in water available for plant uptake, alteration of the vegetative communities and by reducing the overall productivity of a site's soil resource. The extensive network of skid trails, temporary roads and jeep roads developed in portions of Indian Valley Creek during this time period, coupled with the extensive harvesting and plantation establishment in the watershed as a whole, has undoubtedly led to localized compaction problems.

Timber harvesting has also had an effect on the distribution of forest biomass in the watershed. Organic cycling processes have been altered in harvesting units by changing the distribution of forest litter size classes and by modifying temperature and moisture regimes. Losses in soil organic matter through biomass removal have negative ramifications for long-term soil productivity and soil porosity. Documentation of this effect, however, has been limited to computer modeling and a few site studies (Powers, 1990).

It is likely that surface erosion may have became a significant erosional process during this period. Timber operations that reduce forest litter and organic matter on the soil surface, and remove the protective function of a forest canopy, can lead to accelerated soil erosion and sediment yield from hillsides. Following timber harvest, particularly clearcutting, site preparation activities often disturb the topsoil and expose the less productive subsoil layers. This can lead to poor site regeneration and the invasion of the site by undesirable species, which then are eradicated by additional soil disturbing activities. Compaction by logging equipment and broadcast burning can also accelerate soil erosion within harvest units.

Timber harvesting and road building during this period had impacts to the riparian areas of the smallest ephemeral and intermittent streams. Although most streams and small wetlands received protection from direct ground disturbing impacts there were indirect impacts to these areas. Vegetation and habitats of small riparian areas were affected by the removal of overstory shade and cover. Increases in solar radiation altered the composition of vegetation, from riparian to upland species, increased surface evaporation and decreased humidity levels. The result has been a significant alteration in the structure, composition and functioning of riparian areas that were impacted by clearcutting.

Cumulative watershed effects can result from intensive land management activities and catastrophic events. The effect of management activities on storm runoff, erosion and channel modification can be significant. The cumulative effects analysis indicates that many watersheds were intensively impacted from timber harvest and road construction during this period, prominently including Corral Gulch, Cow Gulch, Friend Mtn. Creek, Headwaters Creek, middle Butter Creek, Rail Gulch, Seven Road Creek, Sheep Creek and upper Butter Creek, all located within the uplands (**Table 14**).

The 1964 Flood

Nature sometimes gently nudges our awareness to impending environmental doom while at other times she wallops us into an absolute state of disbelief by resorting to more graphic and catastrophic means. Such was the case in the South Fork of the Trinity River basin where environmental stochasticity ran rampant in 1964. A significant event occurred: The Flood.

The following narrative from Helley and LaMarche (1973) describes the storms and subsequent flood of 1964. "Heavy rainfall began on December 18, 1964, caused by a storm system which approached the California coast at more northerly latitudes than usual. The storm of December 18 to 20 brought snow and lower temperatures to higher altitudes and latitudes of the region. This early cold storm set dangerous antecedent conditions by freezing soil moisture and storing storm runoff in the snowpack. After December 20 succeeding storm tracks moved progressively southward, and storm systems intensified as they approached the coastal areas of northern California. These new storms struck the coast at nearly right angles to the orientation of the mountain ranges, thus producing high rainfall. Higher temperatures associated with the new storms raised freezing levels to more than 10,000 feet and caused high precipitation, all in the form of rain. Rates in excess of 8 inches in 24 hours were common throughout the north coast, although there was wide variation. Precipitation totals for the 5 day period of December 19 to 24 exceeded 20 inches in many places but ranged from a low of 10 to a high of more than 30 inches."

"With the favorable antecedent conditions, high soil moisture and a thick snowpack, the warm torrential rain of December 19 to 23 quickly brought north coast streams to bankfull stage. Exactly 9 years earlier, most of these same streams had flooded to cause a then unprecedented disaster. However, the floods of December 1964 were generally more intense; in many areas of both northern California and southern Oregon peak stages not only exceeded those of 1955, but were equal to or greater than the almost-legendary floods of 1861-62. Throughout the region, landslides were activated, and vast volumes of sediment were mobilized. In a three day period, beginning December 22, 1964, the Eel River discharged 116 million tons of suspended sediment. Only 94 million tons were discharged in the previous 8 years" (Helley and LaMarche, 1973).

Watershed Effects - The effects of the flood in the South Fork of the Trinity River watershed are evident on the 1970 aerial photos. Wholesale landsliding occurred on South Fork Mountain, especially where intensive timber harvest had occurred. Hitchcock, Cold Springs, Johnson and Pelletreau Creeks, all had severe landslide damage. Throughout the upper managed portions of these watersheds stream crossing failures occurred and triggered a "domino" string of crossing failures down the channel. As additional crossings failed downstream, the slides became debris flows or torrents, which scoured the disturbed inner gorges causing secondary failures which extended upslope. Huge pulses of sediment and debris reached the South Fork which contributed to its load. The combination of high flood flows and accelerated sediment supply from the debris torrents off of South Fork Mountain, elevated the flow of the river, allowing it to scour adjacent inner gorge sideslopes. The souring triggered many large debris slides along the river, which further contributed to the large sediment load. Flood terraces are still evident along the South Fork of the Trinity and at the lower reaches of major tributaries. Some lie over 20 feet above the present floodplain.

In the Butter Creek watershed, the effects of the 1964 flood were far less spectacular. However, two large debris slides were triggered in lower Butter Creek, probably due to peak streamflows scouring the inner gorge sideslopes. Two debris slides of 3 acres each were activated in the inner gorge of Butter Creek, at the confluence of Indian Valley Creek. In addition, the toe zone of the Maddox Lake slump-earthflow became highly active and significant movement occurred. An earthflow at the confluence of Indian Valley and Butter Creeks was activated. A section of inner gorge upstream of the Maddox Lake slump-earthflow actively failed through debris sliding.

Finally, a translational slide within a small watershed located southwest of the Butter Creek-South Fork Trinity River confluence became active. The toe zone failed and it torrented down the stream channel and ultimately down county road 316. It is very difficult to distinguish road cut failures on aerial photos of this period, but several were apparent on the 2N16 road, as it crosses steep slopes along lower Butter Creek. The total area of new landslides triggered by the flood is approximately 80 acres within the Butter Creek watershed.

Except for the road failures, all of the slides activated during the 1964 flood, within the Butter Creek watershed, appeared to be triggered by floodflows. No landsliding was observed within clearcuts or selectively harvested areas on the photos. All of the slope failures occurred adjacent to the larger perennial channels within the lower canyonlands of Butter Creek and Indian Valley Creek. The slides occurred within the serpentine melange portion of the Rattlesnake Creek terrane, and within the Galice Formation. Other than the Maddox Lake and Confluence slump-earthflows, all large failures occurred within valley inner gorges.

Flood terraces in the lower watershed suggest that debris flows resulted from pulses of landslide material entering the stream system during the storm event. It appears that the torrents initiated downstream of the Maddox Lake slump-earthflow and confluence earthflow. These torrents impacted the lower portions of Butter Creek, removing riparian vegetation through scouring. Large volumes of sediment were deposited in the lower gradient reaches of the watershed. This resulted in a shallower, wider channel, having less shade than before the flood. The result was an increase in water temperature for several years until the channel worked down through the aggraded sediment, become narrower, and riparian vegetation reestablished. Thirty years later the alders growing along lower Butter Creek are maturing, but still do not provide the closed canopy cover over the stream that existed prior to the flood.

Channel conditions were moderately affected by the management of the watershed, but more severely affected by the flood of 1964. Prior to 1964 the early road building and harvesting practices of the 1950s often impacted the upland ephemeral and intermittent stream channels. Road fills constricted stream channels and thus crossings were not large enough to handle the waters of a flood event like the 1964 flood. That the effect of the 1964 flood event on channel conditions was exacerbated by management impacts is in evidence across the managed portion of the watershed. After thirty years the channels have restabilized themselves in a new channel form.

Not all channels were affected by the flood in the same way. The low gradient channels in the upland portion of the watershed were already downcutting from earlier grazing impacts. Indian Valley Creek near the guard station shows signs of terraces developed after an earlier downcutting event. It is likely that the channel had downcut as a result of the loss of riparian vegetation from grazing, and then was further destabilized by the 1964 flood event which started a new episode of downcutting and adjustment. Moderate gradient channels (2-4 percent) in the upland area were more impacted by management impacts and the 1964 flood event. These channels were relatively stable in their natural range of variability prior to 1950. Management impacts began destabilizing sections of stream channel where management activities were directly applied. Major destabilization occurred in these channels in response to the 1964 flood as the impacts were carried downstream via bank cutting and aggradation and upstream via headcutting. Following the flood event the channels have undergone a gradual recovery to a stable condition.

The conditions of the steep gradient (>10 percent) channels in the canyonlands portion of the watershed were less impacted by the flood effects due to their natural stability. Although landslides were triggered by the flood adjacent to the steep channels, the channel form and function has remained the same. Except for local small debris jams the channels are bedrock controlled steep cascade type channels that function as water and sediment conduits from the uplands to the South Fork Trinity River. Except for the infilling of pools with large boulders as the result of landslides, the channels lower in the watershed have maintained their general form and function. A short (400 ft.) section of lower Butter Creek, between the county road 316 bridge and the South Fork Trinity River has been mechanically altered by the reconstruction of the bridge following the flood.

Riparian conditions in the Butter Creek watershed were considerably altered by management practices and the 1964 flood event. Prior to 1950 only the upland riparian areas affected by grazing were outside the natural range of variability. Early harvesting and road building practices of the 50s and 60s had local impacts to riparian vegetation, mostly adjacent to the moderate gradient upland channels. The 1964 flood had direct impacts to the riparian vegetation by scouring and downcutting the riparian areas, sweeping the vegetation downstream. In downstream low gradient areas, riparian zones were buried with aggraded sediment.

The additive influence of existing roads and harvest units on the flood effects is not known. It is likely that roading and harvest levels had some influence on peak flows, but the extent is unknown and is probably not significant given the magnitude of the storm and flood event.

Fisheries Effects - Processes that may jeopardize the continued existence of a species are characterized as deterministic, stochastic and genetic. Risks associated with chance events are called stochastic processes. "Stochastic processes generally are grouped into two categories, demographic and environmental, depending on their origin. Environmental stochasticity is the name properly applied to a periodic environmental variation and often applied loosely to the resulting population fluctuations. Environmental stochasticity includes chronic and catastrophic fluctuations of high amplitude (Shaffer, 1987; Shaffer, 1991). Population variations in survival and birth rates can be attributed to normal variability in such characteristics as temperature and stream flow or, low frequency, extreme events such as flood, drought, fire storms and debris torrents" (Rieman et al., 1993).

"Historically, stochastic processes may have posed little threat to most local and regional salmonid populations. However, with the loss of habitat, many populations have declined dramatically in size and have been restricted to marginal or highly variable habitats, thus increasing the risk from stochastic factors. Habitat change can influence not only the amount of environmental variation, but also the sensitivity of a population to that variation. Populations in complex habitats should be more stable than populations in simple or restricted habitats because they have more refuges from extreme events and greater capacity to buffer the effects of environmental change" (Schlosser, 1982; Saunders et al., 1990; Sedell et al., 1990; Schlosser, 1991).

The physical and biological effects of erosion and subsequent sediment yield from logged lands during the 1964 flood have been severe and long-lived. This flood, more than any other single event, has been identified as a triggering mechanism that resulted in the dramatic loss of fish habitat and fish populations in tributaries and the lower main stem of the South Fork Trinity River. Cumulative watershed effects, including channel aggradation, widening, bank undercutting and general channel instability resulted during the 1964 flood.

"The large contribution of sediment filled pools and reduced critical holding areas for spring chinook and summer steelhead. Suitable rearing habitat for all species of juvenile salmonids was also severely reduced (CDWR, 1982)." Effects of this sediment still linger in the system today. Fisheries have not recovered from these effects, even though some of the tributaries in relatively stable watersheds have regained much of the original channel characteristics. Many lower South Fork tributaries and the lower main stem of the river are still heavily aggraded, and continue to display highly mobile beds and impacted riparian zones. A comprehensive survey, conducted by the California Department of Fish and Game prior to the flood, estimated a return adult run to the South Fork of 11,604 spring-run chinook and 3,337 fall-run chinook. In 1974, 30 spring-run chinook were reported in the upper reaches of the South Fork, a 99 percent decrease.

There were only three fires recorded for this period. One fire was lightning caused and the others caused by humans. The fires burned a total of 16.2 acres. They occurred in upper Butter Creek, upper Indian Valley Creek and on the ridge of Headwaters Creek.

The 1970s

Although legislative actions, such as the National Forest Management Act and the Endangered Species Act emerged in this decade, for the most part environmental astuteness remained relatively dormant until the mid-1970s. By then, some sensitive plant and animal populations had declined drastically or in some cases were eternally lost through natural or human induced catastrophes. It became impossible to balance multiple resource demands with dwindling and finite resources. Imbalances became more evident and the continued loss or diminishment of plant and animal populations became accepted as indicators of an overly stressed environment. Polarized reactions surfaced. Fortunately, at this point, public consciousness and the need to become enlightened about the conflicts between intensive commodity production versus environmental loss or degradation crystalized. The public desired to know more about the disappearance of our nation's natural resources and whether it was too late to save or conservatively manage what remained. 1994)

By the 1970s, the majority of the Butter Creek watershed had been roaded. Only 20 miles of new roads were constructed in the period. Little selective harvesting occurred, but 319 acres of land were clearcut and reforested. Records indicate that 55.7 MMBF of timber was harvested from National Forest lands within the watershed during this period. Compared to the previous period, the average annual timber harvest volume of 5.6 MMBF was reduced nearly 70 percent.

Analysis indicates that there was a reduction in Equivalent Road Acres in this period primarily due to the reduced levels of harvesting, which allowed for some degree of recovery (**Table 14**). Cow Gulch, Headwaters and upper Butter are the only watersheds which appeared to continue to have significant levels of disturbance during this period.

In the 1970s, one reconnaissance survey (USDA FS, 1972a) was conducted in the Butter Creek watershed to document the extent of the fisheries resources in the system. Surveyors reported, "The lower section is probably a significant spawning and nursery area for steelhead. The upper and middle sections are productive for trout, but the fishery is limited by low summer flows which cause the stream to become intermittent.

In the same year, Forest Service biologists documented an investigation of Indian Valley Creek and found it to be "a productive 10 mile long stream in which stream-resident rainbow trout is the only species of fish. In its upper three miles the stream meanders through the broad, sparsely wooded Indian Valley basin. The creek here is open and intermittent but has abundant spawning gravel and is highly productive of fish and other aquatic life. As it descends from the Indian Valley basin through a boulder-filled gorge the stream picks up water and encounters more shade; the abundant trout here no doubt survive the dry summers better than those in the upper section. At the mouth of Cold Camp Creek the first of many fish-blocking high falls is encountered; the last ones cascade some 150 feet over a limestone outcropping where Indian Valley and Butter Creeks join" (USDA FS, 1972b).

Four years later, Forest Service biologists again surveyed Indian Valley Creek and reported, "[The] stream is intermittent along its entire length. [The] middle section consists predominantly of pools in a dry channel. [The] lower section [consists] of pools and cascades. Fish habitat is extremely limited in late summer... [However], rainbow trout were present in all sections surveyed. Populations were dense in Indian Valley pools (50 fish/100 feet of water) east of Road 2N29 and light west of road crossing (2N29). These fish ranged in size from 1 to 6 inches, with an average of 3 inches. Propagation appeared to be good as many young were seen and spawning habitat was in good condition and supply" (USDA FS, 1976).

Current observations indicate that mature sugar pine trees in the 10-20 inch dbh range are presently showing signs of white pine blister rust infection that appears to have occurred in the 1970s. Many have dead tops and in more extreme situations, trees have died. Clearcutting during the 1950s and 1960s resulted in an increase in the vector *Ribes* spp. and therefore the potential for an increase in the rust population. There was what has been termed a "wave year" of infection in much of California in 1976. Environmental conditions were apparently excellent for the buildup of rust on *Ribes* spp. and for subsequent infection of sugar pine.

During this time there were 17 fires in the watershed. Of these, ten were lightning caused and the rest human caused. This is the highest number of human caused fires for any decade on record. Some of these fires may be attributed to the intensive timber harvest activities in the watershed during this time. The fires were spread somewhat evenly across the watershed, occurring in almost every subwatershed.

The 1980s

In the 1980s, silviculture and timber harvesting remained the economic mainstays of the area, with cattle grazing and recreational activities of lesser importance. With the popularity of the back-to-the-land philosophy, Trinity County encountered a population increase during this decade. The Hayfork and Hyampom areas saw an interesting influx of people having diverse cultural and social values.

In the early 1980s, land management activities within the Butter Creek watershed continued to consist primarily of timber harvesting. There was minor road construction during the period, as the transportation network was well established by this time. Nearly 37 MMBF of timber was harvested from 1980 to 1987 within the Butter Creek watershed, for an average annual timber production of 4.5 MMBF, which was similar to the previous decade.

A stream survey indicated that Butter Creek was a "small perennial stream with wide shallow, rubble-bottom riffles and many point bars; shows extensive deposits of new sand and coarse gravel. Rainbow trout were common in the lower and middle reaches, but were absent from upstream of [barrier] B3, a bedrock falls 5 feet high. Trout averaged about 25 per 100 feet of stream and 4 inches in length. Spawning areas were in fair condition. Riffles contained about 20 percent gravel suitable for spawning and contained only a trace of sand. No fry were seen, perhaps because they had not emerged yet" (USDA FS, 1980).

A later survey in the vicinity of the Indian Valley Guard station documented that: "The stream becomes intermittent at low flow. This intermittent condition limits fish habitat severely. The banks are severely eroded and are failing almost entirely. Stream diversity is minimal; dominated by slight riffle-runs. Pools are few and for the most part small. The larger pools only have water during the summer months. There is a considerable amount of fine material in the stream bed. Sand, gravel and some rubble and rock dominate. Spawning gravels are in very poor condition and heavily impacted by sand and silt, about 50 percent. Riparian vegetation is almost non-existent. Shade canopy is estimated at 20 percent and is provided by conifers. Some bank revetment work has been completed in the immediate area of the guard station; much more is needed" (USDA FS, 1983).

There were 19 small lightning caused and one arson caused fire during the period of 1980 through 1986. The total area burned was 53 acres. These small fires occurred on small ridges along a northeast/southwest trending band through the center of the watershed. However, these fires pale in comparison to the most important event in the watershed during this decade; the fires of 1987.

The 1987 Fires

Twenty-three years after the ill effects of the 1964 flood event, the South Fork of the Trinity River basin was again besieged. Just as the basin was starting to approach a quarter-century of recovery, further travesty struck; this time in the form of wildfires sparked by thousands of dry lightning strikes from a severe weather system which moved across northern California in late August.

"These fires burned with varying intensity, however much of the existing ground cover was consumed, including large areas draining into the mainstem Trinity River (34,000 acres) and the South Fork Trinity River (58,000 acres). Significant natural resources were either damaged or destroyed by the fires including watersheds and their riparian vegetation which afford the water quality and habitats necessary to rear salmon, steelhead and trout" (Irizarry et al., 1987).

The Butter Creek Watershed was impacted by parts of three separate fires; the 1,000 acre Trinity Fire, the 3,440 acre Friendly Fire and the 11,900 acre Cold Fire. As with most fire events, fire intensities varied from low to extreme. Fuel loadings, types and moistures, topography and aspect determined specific fire effects. The smoke inversion layer, which developed on the third day of the fires, and the dense road network in the area were the major factors that limited the size of the fire. District fuel inventory records, predating the 1987 fires indicate that fuel loadings in the area ranged from less than 25 tons-per-acre to more than 100 tons-per-acre.

Fire Effects - The 1987 fires had a pronounced effect on this watershed. Nearly one-third of the watershed was burned by the Cold and Friendly fires. Subwatersheds which were severely impacted include Rail Gulch, the headwaters of Indian Valley Creek, Cold Camp Creek and Corral Gulch.

Burn intensity varied significantly within each of the areas. All of the burn areas are a complex mosaic of burn intensities. It is estimated that approximately 15 percent of the burn areas were of high intensity, with perhaps 35 percent moderate and 50 percent light.

Areas considered to have burned "hot" are characterized as having total duff consumption, consumption of organic material within the soil surface, large areas of white ash, burned out roots and soil crusting beneath white ash. In these hot burn areas, tree canopies were generally either consumed or badly scorched. Downed logs are common in these areas due to snags burning at their base and falling following the fires. Needle cast was very heavy in the scorched areas. Moderately burned areas are characterized as having only limited areas of white ash, with a partially consumed duff layer and little soil crusting. In these moderately burned areas the canopies were generally not consumed, but a great deal of needle scorch occurred, especially on the lower tree limbs. Significant needle cast also occurred in some of these areas due to the scorch. Many down logs are evident in these areas also. Light burn areas were most common within the fire complexes. These areas are characterized by spotty duff consumption, usually only where there were heavy fuel concentrations. Soil crusting was limited to scattered root burnouts. In the lightly burned areas, needle scorch occurred only on some of the lower limbs, and some needle cast is evident (Haskins and Zustak, 1987).

Where stream channels were severely burned, significant changes resulted. Riparian vegetation, which serves to stabilize stream banks and floodplain deposits while also providing shade, was destroyed. Large organic material such as large logs and intertwined limbs completely burned out of some stream channels. These large organic debris jams serve to stabilize stream channels through damming sediment and forming local knickpoints or base levels. These natural jams do wash out under natural conditions, as the organic material decomposes and large storm flows scour and stress them. However, they generally fail at different time periods since in a natural system the material is of different ages, and therefore in different stages of decomposition. When the debris jams burned out, all the sediment that was backed up behind them was unconfined and unstable, and few jams were left to catch and stabilize the sediment when it mobilizes.

In steep gradient channels in the lower sub-watersheds, there was a potential for debris torrents occurring in response to large storm events. Following the fires, typically a debris torrent initiates from a debris avalanche entering a stream channel and scouring and entraining more material as it flows down channel. The sediment is generally deposited when a significant obstruction is encountered or there is a change in channel gradient. Debris torrents can also contribute to secondary effects such as inner gorge mass wasting. Debris torrents lead to extensive stream channel degradation and recovery can take many years.

In moderate and low gradient stream channels affected by fires, sediment is entrained by the streamflow, transported and then deposited in a more gradual manner. However, in alluvial channels, this can contribute to channel migration through lateral scour and progressive bank failure.

Fire can have many effects on soils including hydrophobicity, crusting and loss of structure due to the volatilization of the organic material within the soil surface. These effects can lead to increased surface erosion, particularly where the soils are highly erodible and the litter layer and other cover has been consumed.

Fires can also have major effects on hydrology, including increased groundwater and therefore, larger baseflows and increased storm peakflows. Groundwater levels increase due to tree mortality and decreased evapotranspiration. Therefore, summer flows can be greater following fires. Due to soil changes and loss of the litter layer, infiltration can be reduced and overland flow increased, thus contributing to greater peak streamflows. Depending on burn intensity and resulting site conditions, peak streamflow increases can be great. In addition, the potential for affecting large changes in snow hydrology is quite possible due to the size of the openings, and their influence on snow accumulation and melt rates, especially in the transient snow zone.

Fires can also have an effect on mass wasting processes. The two variables affected by fires which contribute to slope instability are tree mortality leading to loss of root support and increases in groundwater. Shallow seated mass wasting features such as small translational slides and debris slides rely on the shear strength from the intertwined root network for stability. In addition, root support is critical in certain zones of larger landslide complexes, often limiting seasonal slide movement to relatively low rates, due to the roots interlocking laterally and providing some shear strength. Loss of root support on some of these landslide features can result in increased instability over the a 5 to 7 year period as the root masses decompose and lose their strength (Ziemer, 1981). Increased groundwater levels is probably not as significant in contributing to mass wasting, except perhaps for some inner gorges where large areas above it were denuded of vegetation, or for features which were highly unstable prior to fires.

The fires increased the natural sensitivities of the watershed to cumulative watershed effects, primarily due to the widespread burnout and subsequent loss of organic material in stream channels within the upland subwatersheds. “Our assessment indicates that the risk of initiating cumulative watershed effects basin-wide is not considered great. However, we acknowledge that the South Fork Trinity River watershed continues to have timber harvest, fire and salvage related problems, where specific watersheds are approaching their individual TOC [threshold of concern]. These watersheds include the East Fork of the South Fork Trinity River, upper South Fork Trinity River, Rattlesnake Creek, Hidden Valley, Butter [Creek], upper Hayfork Creek, Gulch, and Hyampom. These watersheds need to be managed with more emphasis on the prevention of cumulative watershed effects. Analyses performed for proposed management activities should carefully address the potential for cumulative watershed effects, and consider implementation of special management practices and mitigation measures in order to minimize the potential for additional impacts. It also must be recognized that some watersheds are already at a relatively high level of risk and that proposed levels of timber harvest will need to be modified, based on project level analyses. It is important that natural recovery is not offset by additional [management] impacts” (Haskins and Irizarry, 1988).

The effects of the fire on the upper Indian Valley portion of the watershed were less intense. The drought following the fires kept flow in the tributaries at a minimum, despite the loss of evapotranspiration due to removal of the forest. The small channels have had some recovery of shade by riparian vegetation, especially the sprouting woody vegetation adjacent to the stream channels. There were no perennial channels with active channel widths greater than two feet that had extensive shade removed by the 1987 fires in upper Indian Valley Creek.

Burned-Area Emergency Rehabilitation

In response to the potential for significant watershed and fisheries degradation due to the fires, watershed protection measures were prescribed and implemented by interdisciplinary teams shortly after the fires were controlled. Two rehabilitation programs were implemented: burned-area emergency rehabilitation and suppression damage rehabilitation. Suppression damage rehabilitation was implemented to prevent water quality degradation related to disturbances caused by fire suppression activities (primarily constructed firelines). Measures such as waterbarring, mulching, seeding, cleaning debris out of stream channels, and constructing vehicle barriers were commonly employed.

The objective of burned-area emergency rehabilitation is to preserve site productivity through the prevention of surface erosion, maintain control of water and water quality, and to prevent the threat to life and property. Measures prescribed for all the burned areas generally were concentrated on areas which burned hot, highly erodible areas, stream channels which either burned out or were below badly burned areas, in watersheds where the water was domestically utilized, and in watersheds which had large acreages affected by the fires. Restoration measures included aerial seeding of annual grasses, construction of straw bale check dams in ephemeral and small intermittent stream channels, rock and log check dams in some larger intermittent and perennial channels, contour falling of small trees, mulching, hydro-seeding, rocking of roads through highly erodible areas and stream channel cleanout. Monitoring indicates that these practices were generally successful (Miles et al., 1989).

Salvage Harvest

Salvage logging occurred within portions of the burned areas due to widespread tree mortality. The objective of the salvage operation was to harvest many of the dead or dying trees in a manner which would not cause further environ-mental degradation. The intention was also to leave as many green trees as possible within salvage harvest units. However, most of the initial survivors later died. Harvested areas were refor-ested with Douglas-fir, ponderosa pines and Jeffrey pines, in order to restock the commercial forest lands, but also to help the sites hydrologi-cally recover, and to provide for wildlife habitat. Funds generated from the salvage harvest were used for watershed improvement, under the Knutson-Vandenberg Act.

The potential effect of the salvage harvesting is quite similar to a green timber sale, however, due to the additional fire caused effects, many of the watersheds were in very poor condition. Salvage harvesting and related road construction and site preparation, although thoroughly mitigated, may contribute to an aggravation of direct and cumula-tive effects related to the fires. Effects can include surface erosion, increased mass wasting and stream channel degradation contributing to water quality and fisheries habitat degradation.

To help avoid direct and cumulative effects and to mitigate some of the effects of the fires, special Best Management Practices were applied. These measures included special Streamside Manage-ment Zone Objectives, and strict guidelines for highly erodible areas, highly unstable areas, destabilized stream channels and for watersheds believed to be at a high risk for negative cumula-tive watershed effects. Due to the extent of salvage operations in several of the subwater-sheds, skid trails were tilled and site preparation kept to a minimal following salvage operations.

Effects of Fire and Salvage Activities

The impacts to the soil resource can be tied directly to soil erosion following these fires and the impacts from salvage logging following the fires. A study by Miles et al. (1992) focused on post-fire soil erosion losses from a portion of the Butter Creek watershed in 1987-1988. Limited data suggested a strong correlation between first-year soil erosion loss and parent material from zero-order watersheds with slopes less than 30 percent in burned units. Granitic soils had a mean accel-erated soil loss of 75.6 cubic feet per acre per year while soils derived from ultramafic, volcanic or metasedimentary rocks had a range of 1.0 to 10.3 cubic feet per acre of accelerated soil loss (mean value was 2.4 cubic feet per acre).

Accelerated soil erosion rates for non-granitic soil types presented by Miles et al. (1992) fell within the range of soil formation rates presented by Alexander (1988). Thus the range of natural (undisturbed) erosion rates in ultramafic, volcanic or metasedimentary rocks would be less than the range in rates of soil formation for these rock types. This would confirm that soil erosion from gentle slopes following fire would not likely be falling outside the natural range of variability of soil erosion processes on this geomorphic position. One must recall, however, that this study evalu-ated first-year erosion losses under one specific disturbance regime; second year soil erosion losses may be greater due to the decay of fine root mass that holds the soil matrix together the first year (Miles, 1994).

Additional consideration must be given to the fact that soil erosion from slopes greater than 30 percent were not evaluated by Miles et al. (1992). Soil erosion rates in the watershed are directly related to slope steepness, while soil formation rates would tend to be attenuated by increased slope for the dominant geology. Thus, soil erosion rates for slopes over 30 percent in Butter Creek could easily have exceeded the rates of soil loss tolerance on steep slopes, and thus are very likely to have fallen outside the natural range of variability.

No landsliding of consequence has occurred as a result of the fires and salvage activities in the Butter Creek watershed. This is probably due to the lack of large storm events during the period and the relatively low landslide hazard level of the areas which burned within the watershed.

In the 1980s, due primarily to the fires of 1987, road construction and acres of clearcut harvest increased greatly. Approximately 13 miles of road were constructed and over 5,085 acres of land salvaged and planted, 2,700 of which is attributed to the 1987 fires. From 1988 to 1989, 33.9 MMBF of timber was salvage harvested from the burned areas within the watershed. This averaged 17 MMBF per year, similar to the timber harvest averages of the 1960s. A total of 70 MMBF was harvested for the entire decade, for a decade average of 7 MMBF per year.

Cumulative watershed effects analysis indicates that Cold Camp Creek, Friend Mtn. Creek, Headwaters, middle Butter, Rail Gulch, Seven Road and upper Butter were significantly affected by the fires and salvage activities. Although recovering, these watersheds remain impacted and vulnerable to future storm and human caused effects.

The 1990s

Since the completion of the salvage operation in 1990 only a few small salvage sales have taken place in the watershed. The only other management activities have been tree planting and the normal silvicultural management of existing plantations. Stocking surveys indicate that the areas planted in 1988 through 1991 are relatively well stocked. Most of the burned areas are revegetated and ground cover is improving.

At the peak of road construction in 1970 there were over 165 miles of road within the Butter Creek watershed. Through time, roads have been reconstructed or relocated. Some early roads have been decommissioned or abandoned. Today there are 159 miles of system roads in the watershed.

There were four small fires in the watershed between 1990 and the present. Two were ignited by lightning and the others by escaped campfires. The total area burned was less than one acre. Two of the fires were in the same area as the Friend Fire of 1987.

Analysis - 1950 to 1990

Physical Environment

Fieldwork and study of aerial photography from 1980 and 1990 indicate that the slides triggered by the 1964 flood remain somewhat active today. Natural revegetation is occurring within the torrented channels on South Fork Mountain. However, intense storm events continue to reactivate recovering inner gorge landslides on South Fork Mountain. Fully 30 years after the flood, these sites continue to be persistent sources of sediment for the South Fork of the Trinity River. The same is true for the landslides in Butter Creek. They are gradually revegetating, but are reactivated by intense storms. Butter Creek and lower Indian Valley Creeks continue to scour the toes of these recently active slides during periods of high flow, triggering activation and pulses of sediment to the stream system. The two debris slides which were triggered in 1964 failed in 1983 during an intense storm event (McCaslin, 1994). Other than reactivation of old slides, no new landslides have occurred within the Butter Creek watershed over the period analyzed.

The stream flow regime of Butter Creek and its tributaries has been altered by the disturbance events in the last 44 years of land management. Roads and other compacted areas have contributed to more surface runoff from rainstorm events. Runoff from roads, skid trails and log landings has been observed during rainfall events. Roads constructed with an inslope and inboard ditch draining to existing streams are common in Butter Creek. Where the road, skid trail, or other compacted area results in surface runoff that reaches a natural stream system, the result is an expansion of the surface runoff network, increasing the area’s drainage density. More stream channels mean more efficient runoff and a faster “time to peak” response in the channels to rainstorm events. The ultimate result is an increase in peak flows with the resultant increase in channel and sideslope erosion and destabilization.

Sediment delivery outside the historic range of variability was initially instigated by early grazing practices. Since 1950, however, grazing has had much less impact than the disturbances of roads and soil compaction related to timber harvesting. Observations indicate that road, and to some extent, skid trail runoff delivers a continuous supply of sediment to the stream systems of the Butter Creek watershed. High flows usually carry this sediment load through the steep reaches of the channel system and out of the watershed. As high flows recede, some fine sediments settle in the low gradient stretch of anadromous fish habitat in lower Butter Creek. Particle size distribution analysis of six randomly selected spawning gravel sites has found an average fine sediment portion of 37.4 percent (fines 3.35 mm or less) (USDA FS, 1990). This level of fine sediment was higher than other streams monitored at the same time, both managed and unmanaged. Gravel quality is a limiting factor for many aquatic species, except those which are sediment tolerant. Surveys have also noted very large boulders filling bedrock pools. This reduces the pool usefulness as anadromous fish habitat. These boulders are believed to be present in the system due to large landslide events. The boulders are too large to be transported out of the pools with the channel's flow regime, but will be gradually broken down and transported out of the system. However, they will likely be replaced by future landslide material.

Water temperatures in the Butter Creek tributaries have been less affected by management practices from 1950 to date than they were by early grazing practices and the 1964 flood event. Lack of riparian shade over some small perennial streams resulted in elevated stream temperatures until regrowth took place. Riparian vegetation recovery on small streams was relatively rapid, probably taking no more than a decade. Larger streams were buffered from clearcutting and not generally impacted with thermal pollution except in those areas devastated by the 1964 flood event.

Long term effects of the flood on riparian areas include the loss of habitat due to erosion of stream banks. The resultant recovery of vegetation and habitat has been very slow in places. In the low gradient channels of the upland area downcutting in the alluvial channels has resulted in a lowering of the ground water table in adjacent riparian areas. The change in ground water regime has resulted in a change in vegetation from riparian species to upland species. This results in changing habitat conditions for fish and wildlife species. Where channels have restabilized, such as below the guard station on upper Indian Valley Creek, the riparian vegetation has also restabilized. In the lower reaches of Butter Creek, riparian areas have been altered by aggradation and subsequent downcutting of the channel. As a result flood terraces were formed in places, providing habitats differing from pre-flood conditions. Revegetation has occurred and continues to mature in this portion of the watershed.

Riparian areas which were severely burned in the 1987 fires have resprouted and recovered subsequent to the fires. Rehabilitation efforts following the fire have added stability to channels and riparian zones. Willow cuttings planted to enhance natural recovery are surviving. Structures utilizing straw bales no longer exist, but sediment stored behind most of them has subsequently been stabilized by vegetation. A few selected riparian zones were also planted with conifers to provide for long term coarse woody debris, riparian shade and diversity.

Fisheries

With the vast destruction of anadromous fish habitat within the mainstem South Fork Trinity River by the flood event of 1964 came the expected and drastic decline in population numbers. The California Department of Fish and Game estimated that there were 11,604 spring chinook and 3,500 summer steelhead adults in the entire South Fork Trinity River basin in 1964.

Since 1988, both species have been counted annually between Hyampom Valley and the East Fork of the South Fork of the Trinity River (**Table 19**). Although the numbers of spring chinook adults observed during snorkel counts remained dismally low between 1988 and 1991 ranging from 6 to 82 adults, the population responses in 1992 (107) and 1993 (284) were more hopeful. For the entire South Fork Trinity River basin, DFG biologists reported an upward trend in run size estimates for spring chinook: 232 fish in 1991; 324 fish in 1992; and 698 fish in 1993 (Dean, 1994).

With respect to summer steelhead, the number of adults observed within the same index section reflected similarly poor population levels even through 1993 ranging from 5 to 66 adults. Owing to low population numbers, DFG biologists did not estimate population size. Summer steelhead have not rebounded from their population lows, but are still managing an annual existence in the basin.

Table 19	FISH COUNT of SPRING-RUN CHINOOK and SUMMER STEELHEAD			
Year	**Species**		**Hyampom Valley to Rattlesnake Creek**	**Rattlesnake Creek to East Fork**
1979	Spring-Run Chinook	*1/	189	23
1982	Spring-Run Chinook	*2/	118	47
1984	Spring-Run Chinook	*3/		
1985	Spring-Run Chinook	*4/		15
1986	Spring-Run Chinook	*5/	62 (Partial)	121
1987	Spring-Run Chinook	*6/		
1988	Spring-Run Chinook	*7/	36	19
1989	Spring-Run Chinook		3	3
1990	Spring-Run Chinook		35	47
1991	Spring-Run Chinook	*8/	20	30
1992	Spring-Run Chinook	*9/	92	15
1993	Spring-Run Chinook	*10/	208	76
1994	Spring-Run Chinook	*11/	214	5
1979	Summer Steelhead	*1/	1	1
1982	Summer Steelhead		20	6
1984	Summer Steelhead	*3/		
1985	Summer Steelhead	*4/		3
1986	Summer Steelhead	*5/	16 (Partial)	57
1987	Summer Steelhead	*6/		
1988	Summer Steelhead		25	5
1989	Summer Steelhead		24	13
1990	Summer Steelhead		30	36
1991	Summer Steelhead	*8/	3	2
1992	Summer Steelhead	*9/	7	6
1993	Summer Steelhead	*10/	16	7
1994	Summer Steelhead	*11/	7	6
	* For explanation of footnotes, see Appendix A			

Factors limiting the population size of summer steelhead, even with improving habitat conditions in the upper South Fork Trinity River basin, still remain unresolved.

Shreds of evidence attest to the historic presence of chinook and coho salmon in Butter Creek. Such is not the case today. Winter steelhead appear as the predominant anadromous fish in its lower streamcourse. Summer steelhead have been observed near the confluence of Butter Creek with the South Fork Trinity River, but spawner use remains largely undocumented owing chiefly to poor access and high winter discharge rates which impair observation conditions during the spawning period.

In 1990, fisheries personnel from the Hayfork Ranger District conducted a stream and fish "habitat typing" survey on Butter Creek (USDA FS, 1993). The reach of stream surveyed was limited to the portion accessible to anadromous salmonids (the lowermost 1.6 miles). Habitat unit identification was based on a stream habitat classification system developed by Bisson et al. (1981) and modified by McCain et al. (1990) for northern California streams. Stream channel stability was also evaluated.

Young-of-the-year (Age 0+) steelhead juveniles were observed and measured (0.256) fish per square meter in Butter Creek at a density that rivalled some of the most pristine tributaries to the Trinity River (Brock, 1994). The range of variability (NRV) for juvenile steelhead densities when compared with those from 17 Shasta-Trinity National Forests streams within the South Fork Trinity River basin ranged from 0.002 fish per square meter (fsm) to 0.807 fsm. The NRV for 3 other Trinity River Basin streams ranged from 0.141 fsm to 0.364 fsm. The average Age 0+ juvenile steelhead density from Butter Creek ranked third highest of the 20 streams sampled. This average density suggests that the available habitat for steelhead (approximately 12,500 sq. meters or 0.4 percent of the total stream substrate area) may be fully utilized by spawning adults and is of reasonably accommodating quality (Brock, 1994).

Age 1+ juvenile steelhead densities in Butter Creek averaged 0.015 fsm. (USDA FS, 1993). The range of variability for Age 1+ juvenile steelhead densities when compared with those from 17 Shasta-Trinity National Forest streams within the South Fork Trinity River basin was from 0.003 fsm to 0.067 fsm. The range of variability for 3 other Trinity River Basin streams ranged from 0.055 fsm to 0.080 fsm. The average Age 1+ juvenile steelhead density from Butter Creek ranked 12th of the 20 streams sampled.

Age 2+ juvenile steelhead densities in Butter Creek averaged 0.010 fsm. (USDA FS, 1993). The range of variability for Age 2+ juvenile steelhead densities when compared with those from 11 Shasta-Trinity National Forest streams within the South Fork Trinity River basin was from 0.003 fsm to 0.074 fsm. The range of variability for 3 other Trinity River Basin streams ranged from 0.009 fsm to 0.018 fsm. The average Age 2+ juvenile steelhead density from Butter Creek ranked 14th of the 20 streams sampled.

Densities of Age 1+ and 2+ juvenile steelhead in Butter Creek matched results of other tributaries in the South Fork Trinity River basin that began with many less Age 0+ steelhead. Water temperatures in Butter Creek were never measured above 65 degrees F. indicating that other habitat variables are apparently limiting for steelhead beyond Age 0+. A relative lack of pools and cover in conjunction with high water velocities in winter, associated with the steep gradient (2.5 to 7.5 percent) may be the reasons why older steelhead juveniles do not hold and rear in large numbers within lower Butter Creek. Additionally, existing cover is provided primarily by large rocks, and woody material is rare (Brock, 1994).

Much of the sediment deposited in the anadromous reach by the 1964 storm event has been transported out of the streamcourse such that the present channel profile elevations may be approaching those levels occurring prior to the flood. This is indicated by flood terraces now observed many feet above the present water level. However, it is possible that coarser material, such as the boulder and rubble substrate observed to be dominating the majority of the channel bed today, was largely introduced from landslides during the 1964 event. This material may have filled pools that were once present and historically more accommodating for salmon species. Higgins et al. (1993) supported this concept stating, "Changes in Butter Creek's channel, such as diminished pool frequency and depth, stream armoring with larger cobbles and small boulders, or flushing of smaller gravels suitable for spawning may have reduced the ability of the stream to support salmon species." Brock (1994) surveyed Butter Creek and acknowledged Higgins conclusions stating, "Only a protracted time period allowing for physical breakdown and removal of this large material will permit the fish habitat of Butter Creek to be conducive for salmon once again without intensive instream manipulation which indeed may not be cost effective. The degree of embeddedness in pool tail crests was 40 percent which is due to the large volumes of fine-grained sediment delivered from the watershed. This is seen as a chronic problem."

Butter Creek was again habitat typed by USDA fisheries personnel in the spring of 1993 (USDA FS, 1994c). Waterflows were much higher than normal for this spring survey period rather than the lower than normal flows encountered prior to the survey period in the fall of 1990. Therefore, a very large difference in water volume was evident. The only habitat measurement that changed beyond surveyor variability was the degree of cover: 21 percent in 1990 versus 45 percent in 1993. This difference was attributed entirely to the additional whitewater cover associated with the much larger flow levels. It is at least interesting to note that juvenile steelhead densities for all three age classes were greater in 1993 than 1990, with Age 0+ densities increasing to 0.333 fish per square meter. Additional measurements during a fall season will be required for meaningful comparisons. Adult steelhead redd counts conducted by California Department of Fish and Game have dropped dramatically from 44 in 1990 to less than 15 redds in every year since and including the spring of 1994 (Brock, 1994).

Biologists investigating habitat improvement opportunities in lower Butter Creek in late June of 1994 reported that the overall abundance of newly-hatched steelhead is extremely impressive and not at all consistent with a scarcity of spawning gravels and a complete absence of "good" quality spawning gravels (Higgins, 1994).

Ten miles of resident trout habitat above the anadromous fish barrier were surveyed in 1993 as well, including both Butter Creek and Indian Valley Creek. Pools were frequent, but cover area and complexity were still below desirable levels. It is noteworthy that no brook trout were observed despite the planting performed decades earlier (Brock, 1994).

Vegetation Patterns

It is the goal of a landscape ecological analysis to characterize current and potential vegetation structure and distribution patterns with respect to their influence on the flows of ecosystem elements through the landscape. The primary sources of information underlying such analysis are historic patterns of vegetation, including characteristic disturbance regimes and natural ranges of variability, which shed light on possible determinants of present vegetation patterns and their likely rates of development.

Recent management activities such as timber harvest, road building and recreation have had a significant impact on seral stage distribution, patch sizes and amount of edge (Jimerson and Hoover, 1991). Historical data upon which to base landscape scaled comparisons of past and present vegetation structure and distribution patterns for Butter Creek watershed are scarce.

The comparisons made here are based on Geographic Information System data sets drawn from interpretation of aerial photographs taken in 1944 and 1990, extensive ground surveying, and an Ecological Unit Inventory conducted in 1992. The aerial photographs from 1944 are of good quality, and it is evident that there has been a marked shift in vegetation pattern during this nearly 50 year time period. Judgments about past vegetation structure and distribution must be made with the caveat that they are based on references from a single point in time in the historic period. The 1944 period was many years after the 1906 prohibition of burning in the area had taken effect, and active fire suppression was undertaken.

There are several methods of vegetation classification in use. The vegetation classification methods used for these analyses include the LMP timber stratum classification, wildlife habitat relations classification and an ecological seral stage classification. As one might expect, the results of these analyses in terms of vegetative patterns and trends through time are similar.

Land Management Plan Timber Stratum Analysis

Current vegetation patterns based on Land Management Plan (LMP) timber stratum types in the Butter Creek Watershed tend toward fragmentation. Patterns show a movement from mixed conifer and Douglas-fir dominated communities to ponderosa pine. This is due to the fact that ponderosa pine is the most common species used for clearcut reforestation. The matrix, or most abundant and connected vegetation type, is mixed conifer forest (CX), which covers over one-third or 8661 acres of the landscape. Douglas-fir and Douglas-fir mixed forest is the second most prominent category with 7679 acres, making up nearly one-third of the vegetation in the watershed. Eleven other vegetation types have been distinguished in Butter Creek. Of these, the most extensive type is land in plantations which has been clearcut or salvage logged after a fire (UX), making up over 5018 acres, over 20 percent of the landscape. Much of this fragmentation has occurred in the mixed conifer and Douglas-fir forested areas. Ponderosa pine was planted exclusively in clearcut harvested sites previous to 1980. After that time, Douglas-fir was added to the species mix. This reforestation practice is leading towards stands of low species diversity, away from mixed species types to those of one or two dominant species. The remaining area has a patchy distribution of vegetation communities due to slope, aspect, soils and fire effects (**Table 9, Plate 11**).

There has been a reduction in the amount of mixed conifer and Douglas-fir forest from 1944 to 1990 (**Tables 16** and **9, Plates 11** and **22**). It amounts to a reduction of about one-third of the mixed conifer forest and about one-fifth of the Douglas-fir forest. Most of this can be attributed equally to timber harvest and the 1987 wildfires. These areas are now in plantations of ponderosa pine and Douglas-fir. The number of patches of these major forest types for 1990 and 1944 are comparable. However, this might be a result of the smaller acreage in the types in 1990. For a comparable number of acres in 1990, it can be surmised that there would be from 20 to 30 percent more patches in 1990.

The amounts of the other vegetation types in the watershed are comparable for the two time periods. However, the distribution is one of more, but smaller, patches in 1990.

The timber density distribution for forested stands in 1990 was 7 percent in sparse, 21 percent in poor, 36 percent in normal and 11 percent in good (**Table 20**). One quarter of the watershed (25

Table 20	**1990 TIMBER STRATUM-DENSITY**		
Timber Density	**Percent of Watershed**	**Acres**	**Number of Patches**
Sparse	7	1,736	49
Poor	21	4,838	164
Normal	36	8,443	124
Good	11	2,482	49
Non-Forest/ Plantation	25	5,991	344
Totals	**100**	**23,490**	**730**

percent) is in plantations or non-timber vegetation types. Twenty one percent of the watershed is in plantations, with 4 percent being in grasslands or shrublands. About 12 percent of the plantations are the result of reforestation following the 1987 wildfires. The normally stocked forest occurs as a large matrix mostly in the eastern portion of the watershed (Indian Valley Uplands). It is fragmented by plantations and larger patches of poorly stocked stands (**Plate 25**). The most dense forest occurs in a large patch in the Long Creek, Confluence Unit and Indian Valley subwatersheds.

The most notable difference in forest density from 1944 to 1990 is in the “good” class. Forty five percent of the watershed was densely stocked in 1944 (**Table 17**) and only 11 percent in 1990. This indicates that many of the best stocked stands were clearcut harvested or burned in 1987. These stands are now classified as normal to poor stocking class, and are in plantations or partially harvested stands. About half of the area burned in 1987 was in the good stocking class in 1944. There was a nine percent gain in watershed acreage in the poorly stocked class.

The distribution of stratum size classes in 1990 is 22 percent in class 1, 12 percent in class 2, 31 percent in class 3, 20 percent in class 4 and 10 percent in class 5 (**Table 21**). The largest patches

Table 21	**1990 TIMBER STRATUM-SIZE CLASS**			
Timber Size Class	**Percent of Watershed**	**Acres**	**Number of Patches**	**Max Patch Size**
0-5	22	5,280	346	717
6-12	12	2,864	417	774
13-24	31	7,319	156	348
25-40	20	4,716	106	460
40+	10	2,233	49	428
Non Forest	5	1,078	26	
Totals	**100**	**23,490**	**1,100**	

of the large sized stands are concentrated in the western portion of the watershed, in the First Indian Valley Creek, Long Creek, Confluence Unit and Indian Valley subwatersheds (**Plate 26**). The largest patches of the smaller size classes are in the area of the 1987 fires. The pattern is one of many small patches throughout the watershed.

This differs from the 1944 pattern of several large patches, which are locally fragmented by very small patches (**Table 18**). The striking difference in the two time periods is that 22 percent of the landscape was in the 0-5 inch class (Class 1) in 1990 versus .01 percent in 1944. There is also an increase in the pole-sized stands (Class 2) from one percent in 1944 to 12 percent in 1990. The acreages in the middle size classes appear to be stable. The percent of the watershed in the largest size class has dropped from 37 percent of the watershed to 10 percent.

Ecological Seral Stage Analysis

Fire is the most important natural disturbance regime affecting vegetation in the Butter Creek watershed. Through the early use of fire by the Native Americans to the later exclusion and suppression of fire by the Forest Service, humans have influenced vegetation patterns in the Butter Creek watershed to some degree for many centuries. Perhaps the most significant result of human influence has been its disruption of natural ranges of variability in the fire regime. There is evidence of Native American Indian use of fire in the pre-European settlement period that suggests locally shorter intervals in burning than would occur without human intervention. From the early part of the century, the situation reversed with fire suppression including prohibition of Native American Indian burning and localized active fire fighting, reducing fire frequency to much longer intervals than would be expected to occur naturally. Livestock grazing was probably significant in maintaining park-like vegetation in parts of the watershed, especially near Indian Valley during the early part of the century.

Selective timber harvests in the 1950s and 1960s led to road construction and logging related disturbance which escalated significantly in the area in the late 1970s and 1980s. The major fires and subsequent salvage and reforestation efforts in the Butter Creek watershed resulted in large areas composed of early successional vegetation. These events of the recent past have significantly altered the vegetation composition in the landscape.

These factors surely have contributed to the vegetation patterns we see in Butter Creek today, yet it is difficult to quantify their influence without detailed study beyond the scope of this analysis. The discussion here is based primarily on GIS based comparisons drawn from good quality aerial photographs available for 1944 and for 1990, and on extensive vegetation surveys and Ecosystem Unit Inventory in Butter Creek in 1992 (**Tables 10** and **15, Plates 12** and **21**).

By 1990, the seral stage proportions from 1944 had nearly reversed. The mid stages in succession remained constant at 31 percent while old and late succession forest declined to 27 percent and early stages increased to a total of 42 percent. Thus overall the landscape has shifted from vegetation patterns in which late mature and old growth forest were the dominant type to one in which early succession stage vegetation resulting from fire and human activities predominate.

Of key importance for landscape analysis is identifying the dominant vegetation matrix and the distribution and relative connectivity of vegetation patches in the landscape. Both the distribution of vegetation communities and of seral stages is important.

Seven seral stages (phases in vegetation community development) have been delineated in the Butter Creek watershed. These are: stages dominated by herbs and shrubs, and very early mature, early mature, mid-mature, late mature and old growth forest. **Tables 10** and **15** list values for seral stage distribution in 1944 and 1990.

Vegetation patterns have changed significantly during the last 50 years largely due to human management including fire suppression, grazing, road construction and timber harvest. The matrix, or dominant seral stage in which the other stages are embedded as patches, is one measure of landscape character. In 1944, the matrix was late mature forest. By 1990, the dominant seral stage had dropped back a class in maturity with the matrix in mid-mature vegetation.

The overall connectivity in the matrix has been reduced and general fragmentation has increased. In 1944 it was possible to cross the watershed in either north/south or east/west directions in either later mature and old growth forest, or in mid-mature forest. Today no seral stage presents a continuous corridor across the landscape (**Plates 12** and **21**).

A further sign of fragmentation in Butter Creek watershed is the 60 percent increase in the number of vegetation patches from 436 in 1944 to 730 in 1990. At the same time the maximum patch size for older successional stages was reduced from 720 acres to 308 acres for old growth and 1258 acres to 460 acres for late mature vegetation respectively. The size of early succession stage patches increased by roughly a factor of 10. There has been a 50 percent decrease in the percentage of the watershed under old growth and late mature successional stages and a near tripling in area under early stages.

One goal of this analysis has been to understand the range of natural variability in vegetation patterns over time. The relative proportion of seral stage distribution in a landscape with low or no human intervention is indicative of the natural disturbance patterns and rates of change which drive vegetation structure and composition. In order to get a general impression of the proportion of vegetation in a given stage of development, it is useful to group the seral stages into early, mid- and late-successional classes and compare them (**Plates 21** and **27**).

In 1944 old and later mature forest together made up 55 percent of the watershed; mid-mature forest covered 32 percent of the landscape, and the remaining 13 percent was under early successional vegetation. This was a landscape dominated by mature vegetation.

By 1990, 27 percent of the watershed was in old and late mature forest, 45 percent in mid-mature stage and 28 percent in early successional stages. However, 29 percent of the early seral stage vegetation is in the 1987 burn area and is the result of catastrophic fire rather than timber harvest.

Plant Species of Concern

The sensitive plant Niles' madia is found on highly serpentinized soils. This special habitat is maintained by fire, which opens up the shrub layer and provides both nutrients and light for the madia. Although the amount and distribution of suitable ultramafic soil determines the upper limit of habitat potentially available for Niles' madia in the Butter Creek watershed, the fire regime strongly influences the amount of habitat actually available for colonization by the annual madia in any given year. With exclusion of fire from the ecosystem, not only is the absolute quantity of habitat decreased, but the available microsites become more isolated from each other and colonization of new sites is less likely.

Many obligate fire followers are annuals which quickly colonize burned sites when all the competing vegetation has burned up. The other rare serpentine endemic plants which occur in the watershed are less likely to be fire or disturbance dependent, since they are perennial species and occur on very rocky sites which are heavily serpentinized. The presence of high concentrations of serpentine rock limits competing vegetation severely, and there is little competing vegetation. Over geologic time, these sites will also be overtaken with other species in natural succession; fire on these sites would help to hold succession in check. However, the process of succession on these sites is likely to be very slow. Historical mining in the area during World War II and the Korean Conflict may have severely altered some of these sites. This could explain the disjunct nature of some populations and the occurrence of suitable habitat which is presently unoccupied by these plants.

Lady's-slipper orchids are dependent upon late-seral stable environments for viability, and may have been negatively affected by timber harvest activities. They have been identified in the ROD as old-growth associates declining throughout their range in North America (USDA FS, USDI BLM 1994b). These plants may have benefitted from the historical fire regime, ie., low-intensity fall fires in the understory which remove competing vegetation in these plants' habitat, while leaving shade-producing, fire-resistant conifers intact.

Similarly, the watch list species redwood lily is also adapted to fire in its chaparral or forest habitat and requires fire for regeneration. Many native bulbs in the lily family benefit from low-intensity fall burning. These species were much more widespread prior to the modern fire-suppression era; their associated oak woodland habitats were kept healthy and productive by Native Americans who utilized acorns and bulbs for food (Anderson, 1993). Returning fire to the biotic environment would likely bring an increase in botanical diversity to the watershed. Grazing has been identified as a threat to the redwood lily (Skinner and Pavlik, 1994). Plant species diversity has certainly declined from the Indian Valley region of the watershed, with the loss of the large meadow system which occurred there prior to the introduction of grazing livestock.

Fungi, lichens and bryophytes identified as old-growth associates in the ROD (USDA FS, USDI BLM, 1994b) are not presently monitored, and little information is known about their occurrence, distribution, ecology, or reasons for rarity.

Wildlife Habitat Conditions

Significant habitat changes during this period include the shift from older forests with contiguous multi-layered stands to patches of younger single layered forests with moderate canopy closure (**Plates 16** and **28**). As previously described, large expanses of late seral forests with small openings were replaced by a mosaic of seral stages. Connectivity of like habitat across the landscape decreased while fragmentation of habitat increased. Average patch size also increased dramatically during this period. Overall, old growth habitat patches decreased in size. The primary cause of the reduction in late seral and old growth habitat are timber harvest and fire salvage. With the loss of later seral stages and the replacement of these to younger smaller trees, there will be less recruitment of large diameter snags and down logs necessary for species such as black bear, fisher and pileated woodpecker. In addition, this habitat and subsequent fragmentation loss of interior forest habitat negatively affects species such as the northern spotted owl and goshawk.

Twenty-one percent of the watershed has been converted from habitats dominated by Douglas-fir (WHR type) (**Tables 12** and **22**). There has been a decrease of 3,300 acres in Klamath Mixed Conifer (WHR type) and 1690 acres of Douglas-fir. In addition, WHR Ponderosa Pine and WHR Mixed Chaparral types have increased by 2,990 and 1,100 acres respectively between 1944 and 1990. This is due to reforestation of harvested and fire areas with ponderosa pine or a mix of ponderosa pine and Douglas-fir. Some areas are now in the WHR Mixed Chaparral type because it is an early seral stage of forested types in burned areas. The Jeffrey pine habitat has remained about the same as during the European settlement era.

There has been a loss of large diameter trees and also recruitment of large diameter snag and down logs. Between 1944 and 1990, there has been a reduction of 11,170 acres (79 percent) of WHR size class 5 and 6 (>24 inch DBH) coniferous forests. Ponderosa pine habitat shifted from 100 percent in the 6 to 24 dbh category to 90 percent in the seedlings and sapling category. Primary and secondary cavity nesters and denners, such as the white-headed woodpecker and western bluebird, may have likely been effected by this reduction in stand size. Eighteen percent of the bird species found on the forest use cavities for nesting.

The quantity of oak hardwood habitat within the watershed remains about the same compared 1944. However, there has been a reduction in large sized oaks. Consequently, acorn production has been reduced. Acorns are an important food item to wildlife (acorn woodpecker, deer and bear) and Native Americans. This reduction is due to

Table 22	1944 WILDLIFE HABITAT RELATIONS (WHR) TYPES		
WHR Types	**WHR**	**Acres**	**Percent of Watershed**
Fresh Emergent Wetland	FEW	12	0.1
Mixed Chaparrel	MCH	0	0
Wet Meadow	WTM	3	
Perennial Grassland	PGS	66	0.3
Montane Riparian	MRI	88	0.4
Montane Chaparrel	MCP	178	0.8
Montane Hardwood	MHW	355	1.5
Montane Hardwood-Conifer	MHC	4,274	18.2
Klamath Mixed Conifer	KMC	11,762	50.1
Douglas-Fir	DFR	5,947	25.3
Jeffrey Pine	JPN	598	2.5
Ponderosa Pine	PPN	197	0.8

fire exclusion, timber harvest, firewood cutting, thinning practices and replanting practices that favored conifers while excluding oak.

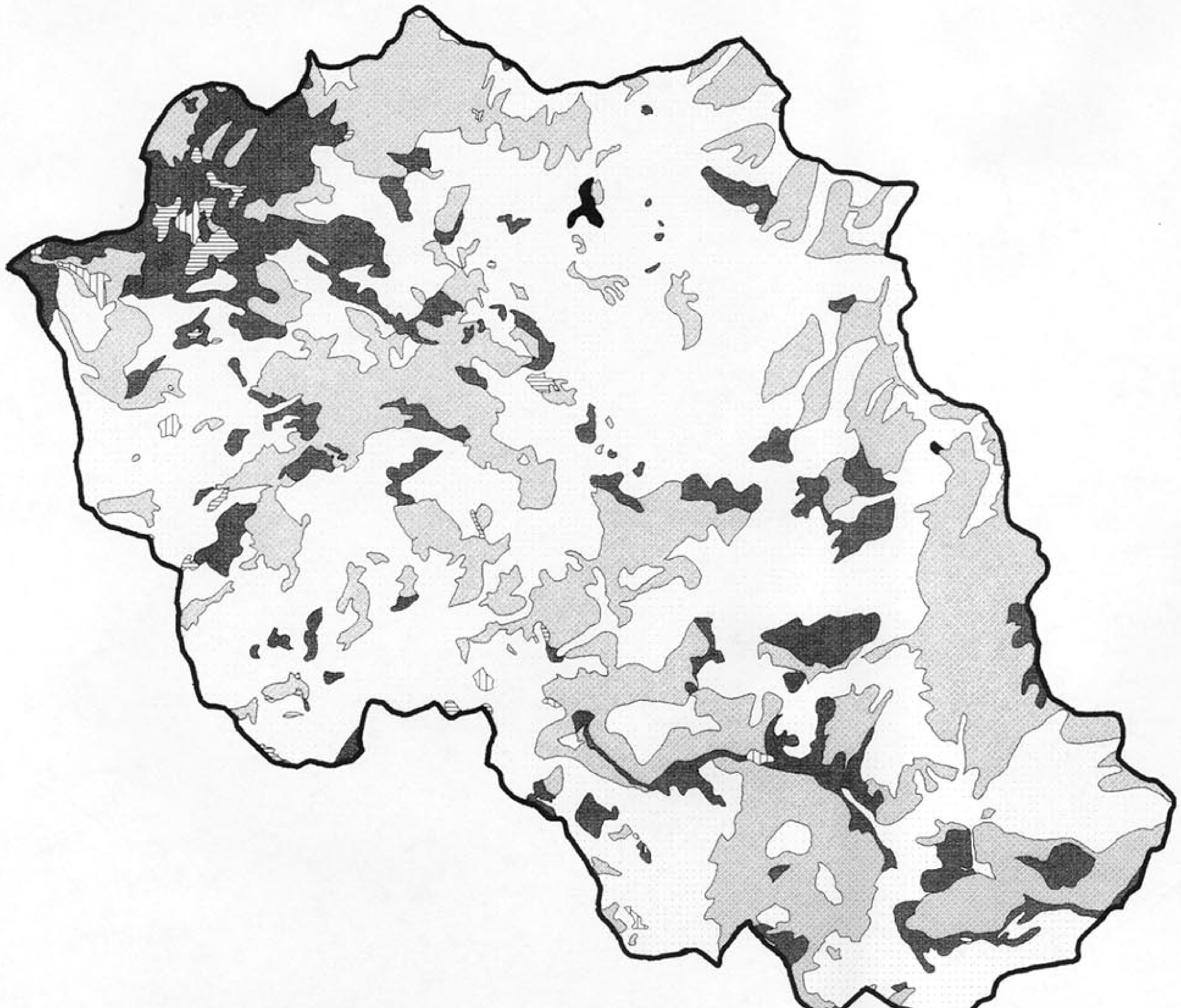
The lack of fire in the ecosystem has caused grasslands and mixed chaparral to become decadent, and increased fuel loadings and stocking densities in forested stands to occasional unhealthy levels. These habitats could be managed with prescribed burning and appropriate silvicultural prescriptions to enhance forage potential and stand longevity.

In recent years there has been only one recorded sighting of porcupine on the district to the east of the watershed (Sightings Record, 1994). Most District personnel indicate rarely seeing porcupines for the last 10 years or more. It appears that their numbers have severely declined in the watershed.

A number of wildlife species are present now that were absent in the past. With the reduction in connectivity and subsequent increase in fragmentation, habitat conditions have declined for species associated with late seral, old growth and large undisturbed habitats. The reduction in anadromous fish runs in the South Fork River may have led to unsuitable foraging conditions for the bald eagle. Exclusion of Native American burning practices and the consequential loss of historic acorn crop levels may have effected habitat quality for species such as acorn woodpecker, band-tailed pigeon, peregrine falcon, deer and bear. Increases in the amount of edge habitat from these disturbances has created habitat for parasitic and highly competitive species such as the brown-headed cowbird and European starling.

The range of the brown-headed cowbird expanded with human agricultural activities and the change in forest structure. They lay their eggs in the nests of other birds and their young are raised by host parents at the expense of the other nestlings. They are most common in riparian areas and have been linked with the decline of the willow flycatcher. European starling was introduced into the eastern United States at the turn of the century and had become common in northern California by the 1950s (Harris 1991). These birds aggressively compete with native cavity nesting birds such as bluebirds, nuthatches, swallows and wrens for nest holes and may be affecting population potential for the native species. The Virginia opossum was introduced to California at the turn of the century and has also expanded with human settlements.

Plate 21



Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

1944 Ecological Seral Stages

- Old Growth/Late Mature
- Mid Mature
- Early Mature
- Immature/Sapling - Seedling
- Shrub
- Herb
- Butter Creek Watershed Boundary

Mapscale 1:63,360

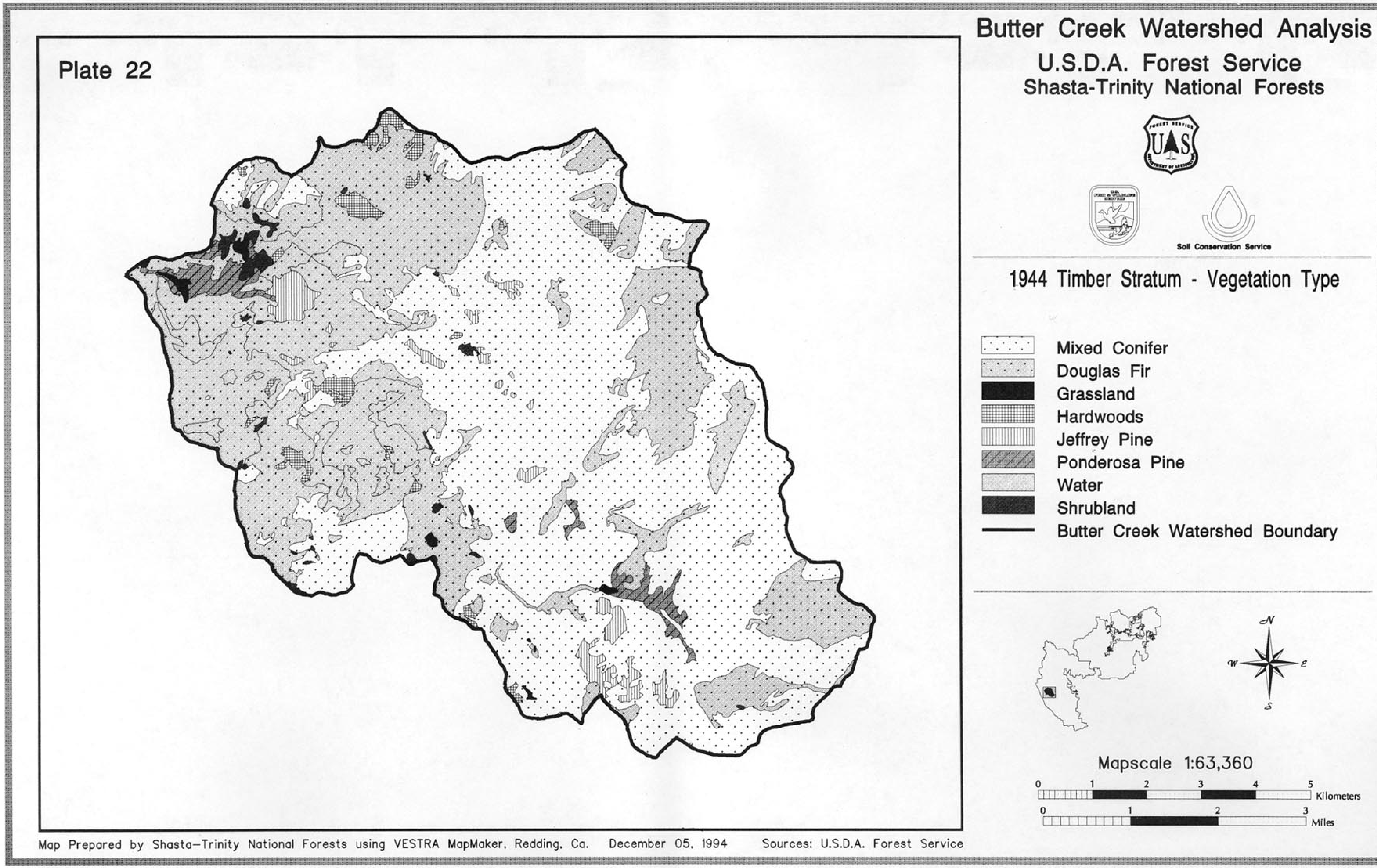
0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta—Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994 Sources: U.S.D.A. Forest Service

Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests



Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994 Sources: U.S.D.A. Forest Service

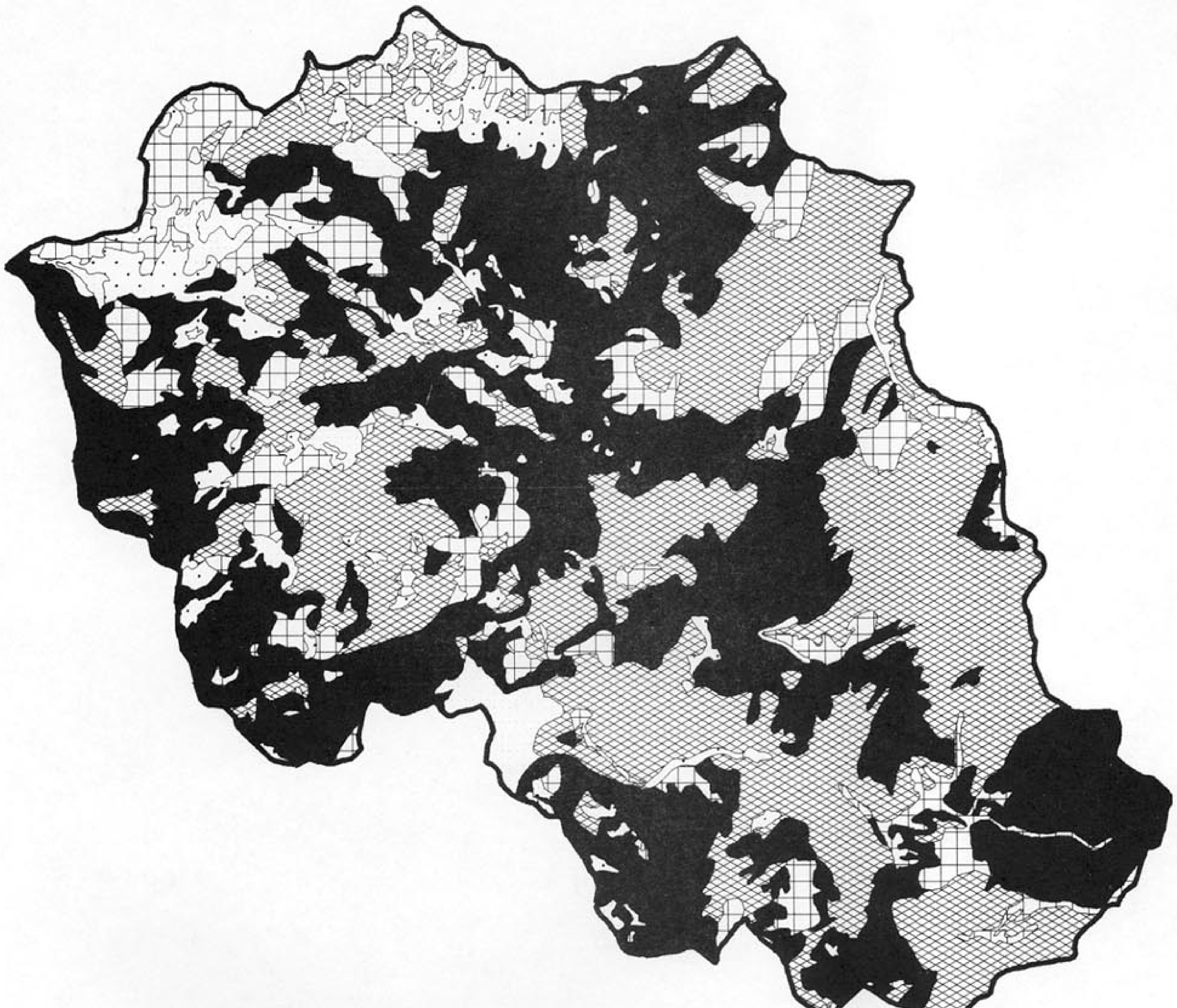
Butter Creek Watershed Analysis

U.S.D.A. Forest Service

Shasta-Trinity National Forests

Soil Conservation Service

Plate 23



1944 Timber Stratum - Density

- Percent Crown Cover > 70
- Percent Crown Cover 40 - 69
- Percent Crown Cover 20 - 39
- Percent Crown Cover < 20
- Plantation or Non-Forest
- Butter Creek Watershed Boundary

N W E S

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

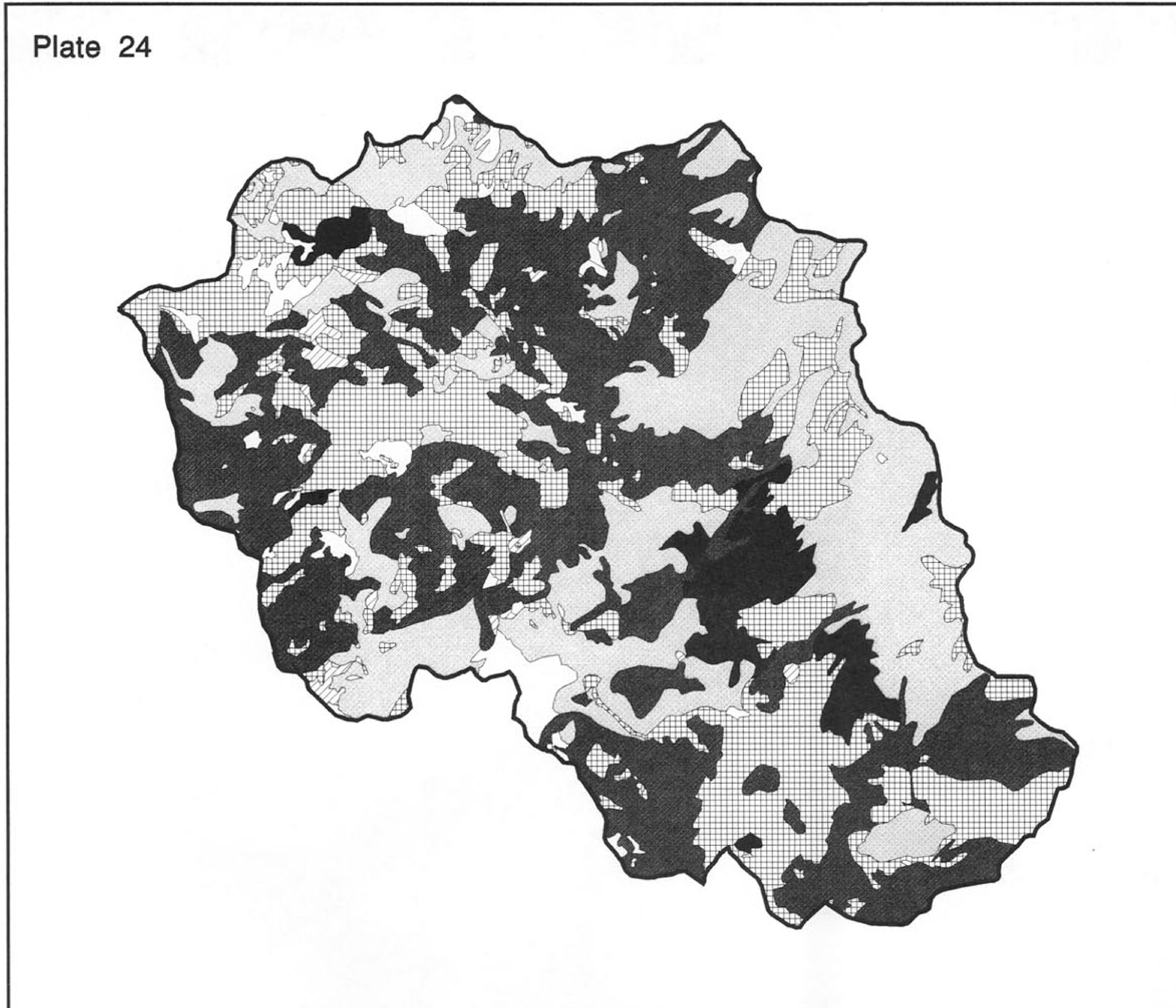
0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 05, 1994 Sources: U.S.D.A. Forest Service

Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Plate 24



Soil Conservation Service

1944 Timber Stratum - Size Class

- Crown Diameter 0 - 5 Feet
- Crown Diameter 6 - 12 Feet
- Crown Diameter 13 - 24 Feet
- Crown Diameter 25 - 40 Feet
- Crown Diameter > 40 Feet
- Crown Diameter Two-Storied
- Plantation or Non-Forest
- Butter Creek Watershed Boundary

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

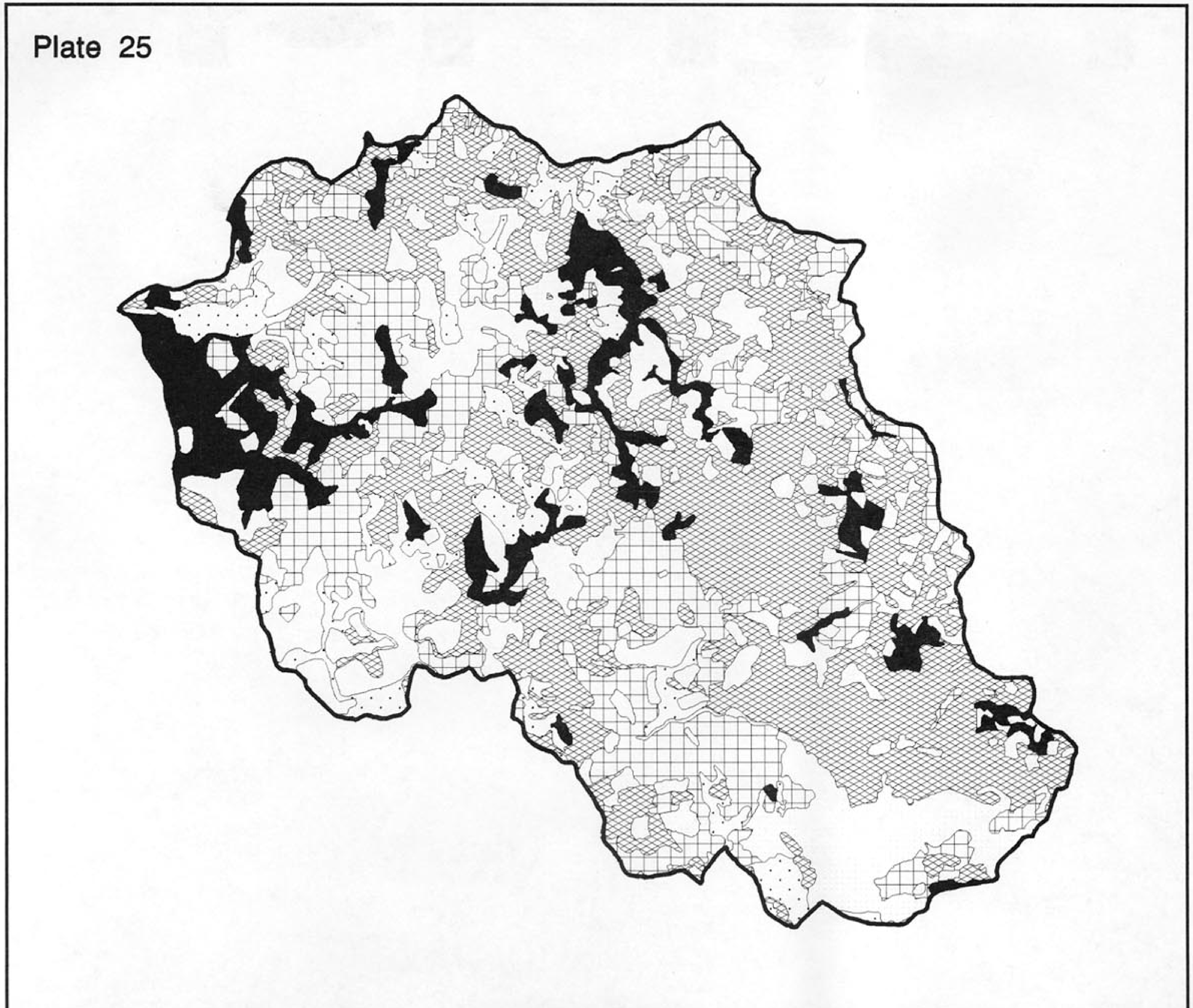
Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service

Butter Creek Watershed Analysis

U.S.D.A. Forest Service

Shasta-Trinity National Forests

Plate 25



Soil Conservation Service

1990 Timber Stratum - Density

- Percent Crown Cover > 70
- Percent Crown Cover 40 - 69
- Percent Crown Cover 20 - 39
- Percent Crown Cover < 20
- Plantation or Non-Forest
- Butter Creek Watershed Boundary

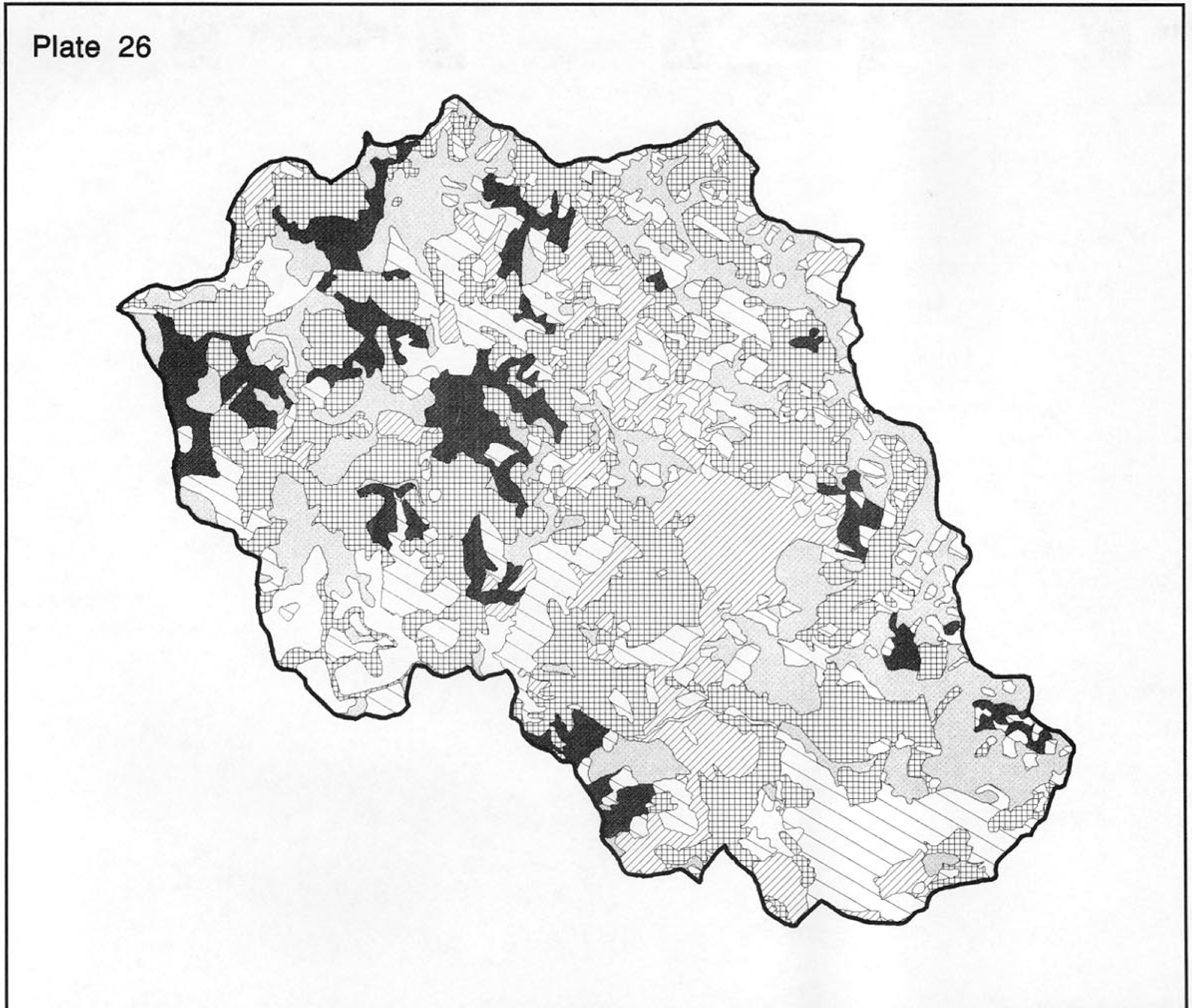
N W E S

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service



Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

1990 Timber Stratum - Size Class

- Crown Diameter 0 - 5 Feet
- Crown Diameter 6 - 12 Feet
- Crown Diameter 13 - 24 Feet
- Crown Diameter 25 - 40 Feet
- Crown Diameter > 40 Feet
- Plantation or Non-Forest
- Butter Creek Watershed Boundary

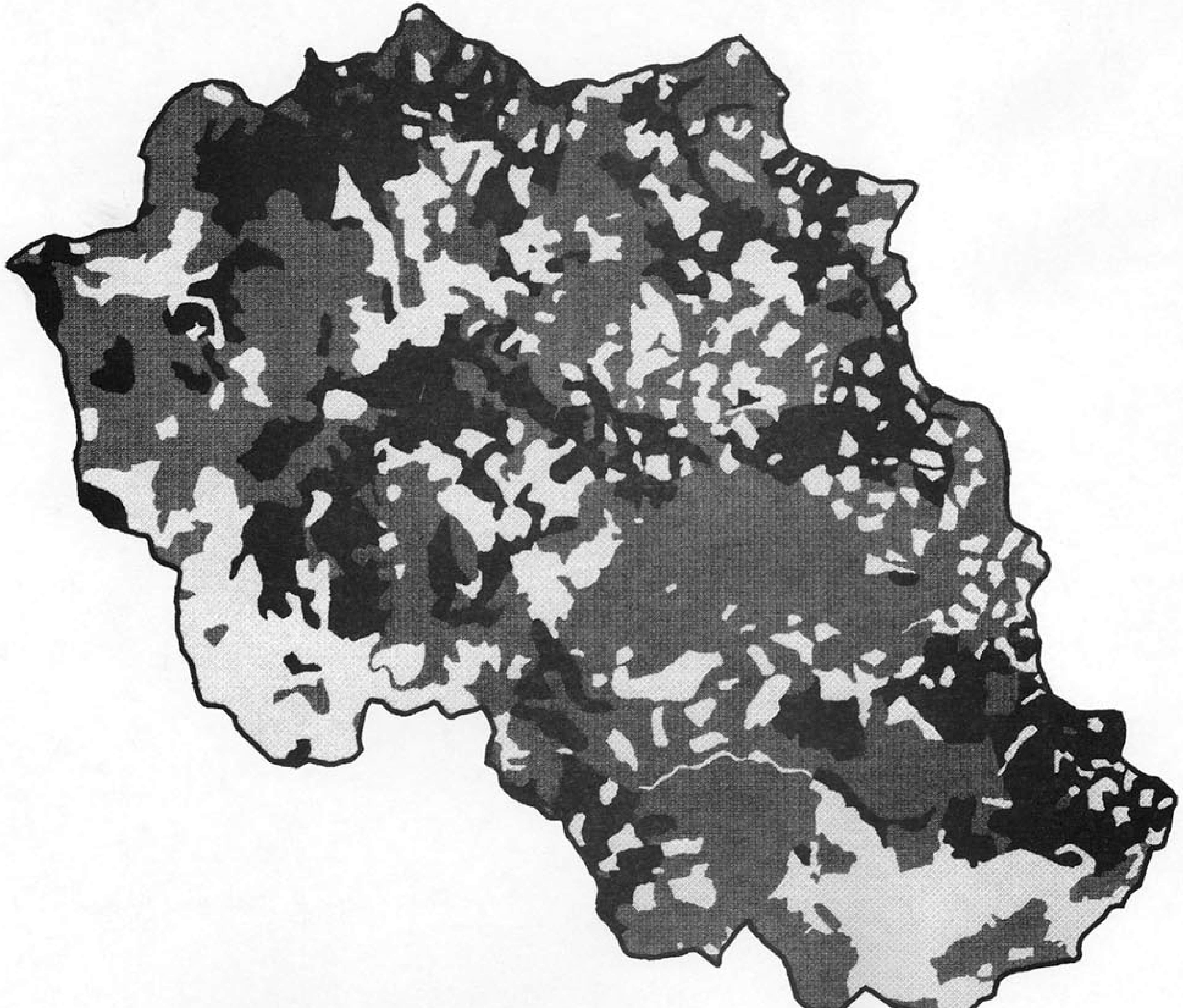
Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service

Plate 27



Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

1990 Grouped Seral Stage Map

- Late Seral
- Mid Seral
- Early Seral
- Butter Creek Watershed Boundary

N W E S

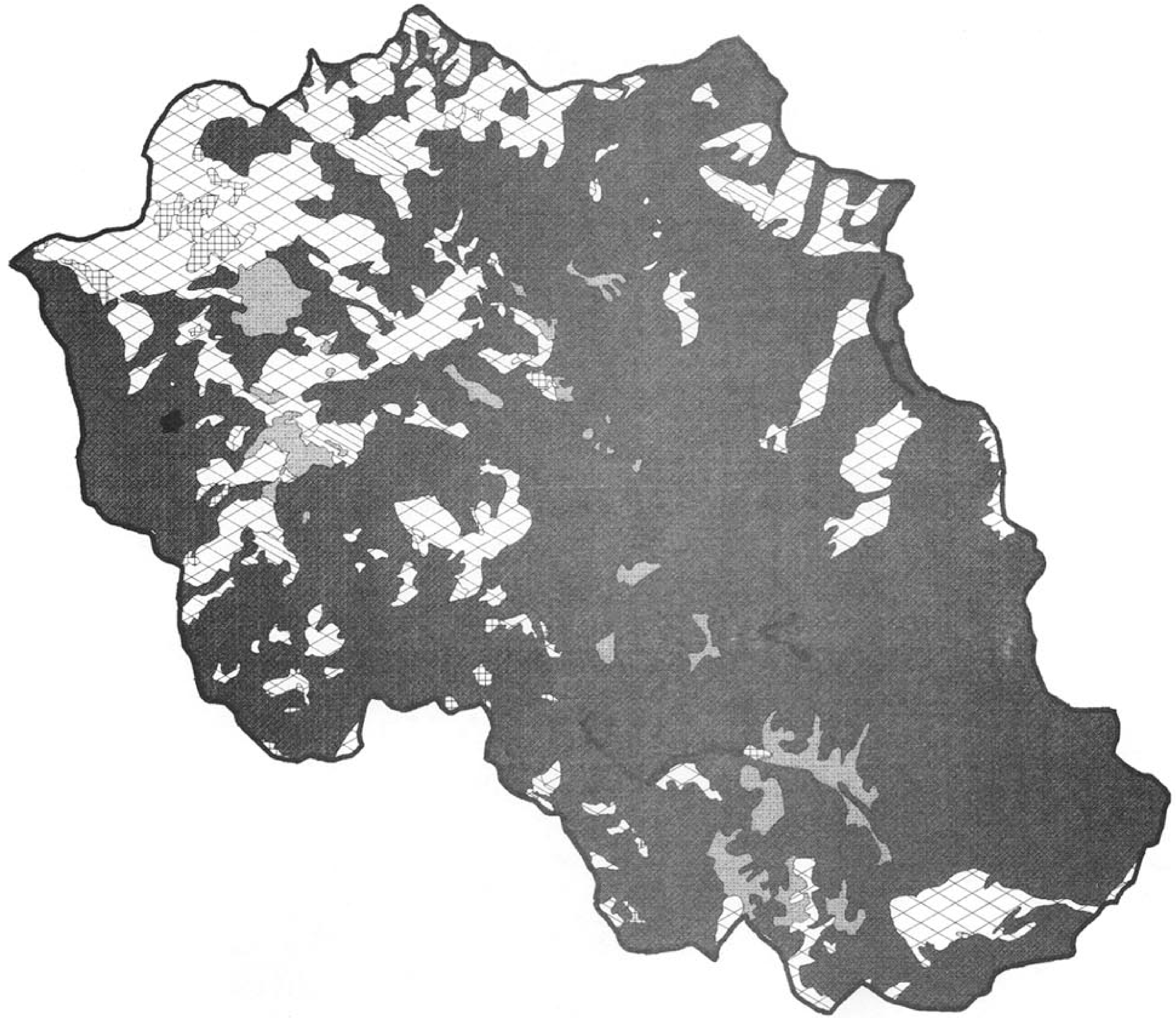
Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service

Plate 28



Butter Creek Watershed Analysis

U.S.D.A. Forest Service
Shasta-Trinity National Forests

Soil Conservation Service

1944 Wildlife Habitat Relations

- Riparian / Aquatic Habitat Types (LAC, MRI)
- Open Habitat Types (PGS, MCP, WTM)
- Douglas Fir & Mixed Conifer Forest Habitat Types (KMC, DFR)
- Pine Forest Habitat Types (JPN, PPN)
- Hardwood Habitat Type (MHW)
- Hardwood Conifer Habitat Type (MHC)
- Butter Creek Watershed Boundary

Mapscale 1:63,360

0 1 2 3 4 5 Kilometers

0 1 2 3 Miles

Map Prepared by Shasta–Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service

CHAPTER III
Desired Future Conditions

This chapter is written in three parts: the first part is a description of beneficial uses and values, including present condition in relationship to associated values and uses; the second part is a listing of Desired Future Conditions; the third part is a narrative description of the anticipated future conditions and trends.

Beneficial Uses

Fish Species Present in the South Fork Trinity River Basin

Three fish assemblages were defined in order to facilitate the development of the draft Forest Land and Resource Management Plan for the Shasta-Trinity National Forests. The three assemblages were the anadromous fish assemblage, the inland coldwater fish assemblage and the inland warm-water fish assemblage. Only the first two assemblages are identified as beneficial users of the South Fork Trinity River basin. The latter assemblage does not occur in the basin.

Each assemblage was further divided into distinctive subsets:

Anadromous Fish Assemblage

- Anadromous Commercial/Recreational Sportfish
  - Coho (*Oncorhynchus kisutch*)
  - Fall-Run Chinook (*Oncorhynchus tshawytscha*)
  - Spring-Run Chinook (*Oncorhynchus tshawytscha*)
  - Winter-Run Steelhead (*Oncorhynchus mykiss gairdneri*)
- Anadromous Threatened, Endangered and Sensitive Sportfish
  - Spring-Run [Summer] Steelhead (*Oncorhynchus mykiss gairdneri*)
- Anadromous Nongame Fish
  - Sea-Run Pacific Lamprey (*Lampetra tridentata tridentata*)

Inland Coldwater Fish Assemblage

- Inland Coldwater Sportfish
  - Resident Rainbow Trout (*Oncorhynchus mykiss gairdneri*)
- Inland Threatened, Endangered and Sensitive Sportfish
  - [NONE IDENTIFIED FOR THE SOUTH FORK TRINITY RIVER BASIN]
- Inland Coldwater Nongame Fish
  - Klamath Smallscale Sucker (*Catostomus rimiculus*)
  - Klamath Speckled Dace (*Rhinichthys osculus klamathensis*)

Domestic Water Uses

Domestic water use within Butter Creek is limited to the occupied portions of the watershed, in the uplands of Indian Valley and near the confluence of Butter Creek and the South Fork Trinity River. There is also an appropriated water right for irrigation purposes located on Butter Creek. These uses are relatively small and have little influence on minimum flows within the watershed.

Desired Future Conditions

These Desired Future Conditions describe the conditions that management activities, policy and public involvement will help achieve. There are three different Desired Future Conditions in this chapter. The first is the draft Forest Plan (USDA Forest Service, 1993b) Desired Future Condition. This DFC applies to a much larger area than Butter Creek, and is also relatively general. The second DFC is one that the public helped us develop in the public meetings and open houses. They provided input on the statement: “I would like a Butter Creek that....”. This input was revised and a Desired Future Condition was constructed by a small committee comprised of local residents from Trinity County. The third DFC is one that the Watershed Analysis team developed which is the most specific of the three.

Land Management Plan Desired Future Condition

The following DFC is for Management Area 19, Indian Valley/Rattlesnake Management Area. It extends from lower Hayfork Creek to south of Forest Glen. It is located primarily on the east side of the South Fork of the Trinity River.

Nineteen percent of the 124,356 acres in this management area are allocated to Adaptive Management Area (AMA), 24 percent to Matrix (Key Watershed), 9 percent to Administratively Withdrawn Areas and 48 percent to Late-Successional Reserves and Riparian Reserves.

Nearly half of this MA is allocated to Late-Successional Reserves and Unroaded Recreation (South Fork Trinity Wild And Scenic River). The character of the portion of the river which is designated wild and scenic is primitive and undeveloped, retaining a natural setting with only minor subtle modifications. Visitor use of the area continues to be occasional. Typical recreational activities within the area include hiking, cross-country skiing, horseback riding, hunting, camping and sight-seeing.

The western portion of this MA is identified as tier 1 Key Watershed. Activities have been implemented since the mid-1990s to restore and protect watershed health and water quality, particularly for anadromous fish habitat. Within Key Watersheds, watershed conditions are improved through watershed restoration activities including riparian improvement projects, road maintenance, fish habitat improvement and road obliteration. Forest health is maintained and fire risk reduced through vegetative manipulation and underburning.

The South Fork of the Trinity River, Hayfork, Butter, Rusch, Bear Wallow, Little Bear Wallow, Plummer, Rattlesnake and Smoky Creeks are capable of supporting sustainable anadromous fish populations. Cumulative watershed effects have been reduced through management activities such as road obliteration and restoration.

Late-Successional Reserves are located along the South Fork Trinity River on generally high site capability lands. The landscape of the Late-Successional Reserve appears natural with much of the area in late-successional forest vegetation. Large areas burned by wildfires during the 1980s are reestablished with early seral stage vegetation including young sapling to pole sized conifers and hardwood trees where stands were replanted. Where the forest was not replanted in the South Fork Released Roadless Area, the forest appears as scattered older residual trees with understory shrubs and occasional scattered young conifer and hardwood seedlings and sapling size trees. Late-successional forest stands are managed to maintain health and diversity components through the use of prescribed fire and thinning from below. Dead and dying trees and snags are at considerably higher levels than within the AMA/Matrix. Many patches of dead trees and snags 10 acres or less are scattered across the landscape. Younger to mature forest stands are managed to replace older dead and dying stands as they no longer are suitable for Old-Growth ecosystem dependent organisms. Late-successional stands contain large numbers of old-growth trees. These older stands are structurally diverse often being multiple-storied.

Suitable AMA/Matrix lands are managed on a sustained yield basis with stands ranging generally from 5 to 40 acres in size. Forest stands range from tree seedling to mature forests, while maintaining some structural diversity. Fifteen percent of all stands, when regenerated, are retained and managed to maintain or produce dispersed pockets of late-successional forests across the landscape. Regenerated stands or artificially created openings appear more natural in appearance than past stands due to the retention of larger trees and snags.

Forest stand densities are managed at levels to maintain and enhance growth and yield to improve and protect forest health and vigor recognizing the natural role of fire, insects and disease and other components that have a key role in the ecosystem. Stand understories appear more open with less ingrowth particularly in stands on sites where wild fire plays a key role in stand development consistent with higher level direction. The actual target stand densities depend upon stand species, site quality, stand age and stand objectives (i.e., stand densities are maintained at lower levels to grow larger old trees within Late-Successional Reserves).

As a by-product of ecosystem management, it is expected that suitable lands will yield approximately 72 million boardfeet per decade of commercial wood fiber including biomass from this MA.

AMA/Matrix lands are further disaggregated into three management prescriptions with more specific emphasis and direction. They are: Management Prescription III, Roaded Recreation—about 29 percent; Management Prescription VI, Wildlife Habitat Management—about 2 percent; and Management Prescription VIII, Commercial Wood Products Emphasis—about 69 percent of AMA/Matrix land.

Management Prescription III areas are located around high use recreation areas and travel corridors, primarily areas along the Hayfork Creek Road #301 and Highway Route 36. Management activities are evident but subordinate to the viewer within this area.

Management Prescription VI areas emphasize habitat management for early and mid-level seral stage dependent species, such as black bear, deer and gray squirrel. Forest stands in wildlife emphasis areas are managed to maintain lower tree stocking levels and greater amounts of understory cover/forage ratios. The landscape within this area contains openings of early seral stage plants and trees to open mature stands often containing multiple understory layers of trees and shrubs. This prescription area includes many areas of hardwood types and chaparral.

Management Prescription VIII areas emphasize optimum timber growth and yield. Commercial Wood Products Emphasis provide the highest level of outputs of the AMA/Matrix lands, although yields from these lands are lower than biological potential. The forest is more single storied, with in-growth and understory vegetation treatment to enhance timber stand growth and yield, improve forest stand health and provide protection from stand destroying wildfires.

Riparian areas are reserve zones applied along both sides of rivers, streams, lakes and wetlands. Riparian areas appear as unmanaged fingers and corridors dissecting about 2/5 of the AMA/Matrix lands, but not as evident within other land allocations such as Late-Successional Reserves.

Desired Future Conditions Developed with the Public

Following is the integrated DFC for Butter Creek:

Ecosystem Function

Healthy, balanced, sustainable forest managed as a whole for diversity, and for the enhancement and restoration of fish and wildlife habitat, biological corridors, vegetation, soil and water quality. Develop ecological standards for maintenance and utilization of resources in areas of early to late-successional habitat. Provide for a healthy watershed managed for stability, control of siltation and protection of anadromous and native fish habitat. Provide alternatives to the use of chemical pesticides. There may be some biological, mechanical or manual controls that are appropriate to use. There are some members that disagree with the prohibition against use of pesticides.

Forest Ecosystem Management

Utilization of up-to-date geographical information systems (GIS), accessible to the public. Research and utilize historical information regarding the past natural and Native American use of the area. Develop procedures allowing for community participation and review. Seek and obtain funding to achieve ecosystem management plan goals.

Develop an ecosystem plan capable of producing a variety of forest products and managed mineral and grazing opportunities. Enhance forest resources by managing timber harvest to encourage growth, diversity, sustainable timber production and utilization of salvage materials.

Use modern silvicultural methods and reforestation techniques to achieve an all age, multi-story, fire-resistant forest. Provide alternatives to clearcutting. It is understood that there may be instances such as fire or insect kill where a certain amount of clearcutting may be necessary to restore the forest to a healthy condition or for research.

Encourage research, experimental methods, small logging operations, utilization of resources without waste and fuel load reduction. Make forest resources available for traditional native products. Conduct ongoing monitoring of total process.

Ecosystem Protection

Reduce fuel loads, and maintain adequate access for fire protection. Create and maintain natural fuels reduction buffers to aid in control of future catastrophic fires. Research introduction of fire as a management tool and to maintain fire dependent species. Establish standards for methods of prevention and control of destructive insects, diseases and invasive plants.

Ecosystem Amenities

Protect historical and natural features. Provide recreational opportunities for camping, fishing and wildlife viewing, accessible for diverse users. Include access to falls, lakes and caves. Trails should be constructed, signed, maintained and managed to avoid overuse; specific trails should be created to provide use for a variety of different recreational purposes (i.e., hiking, biking, equestrian).

Ecosystem Restoration and Rehabilitation

Restore biological diversity in the forest, watershed and wetlands. Replant and improve timber stands in older clearcuts and burn areas; salvage and thin for fuel reduction. Rehabilitate watersheds, fisheries and provide habitat for wildlife. Improve and restore range lands. Maintain, stabilize or close roads to minimize stream sedimentation.

Human Considerations

Provide for local involvement and education. Manage for long term ecological benefit and economic stability. Incorporate historical and Native American values and techniques. Promote mutual trust of public and agency involvement on resource management. Respect the rights of private property owners and the public and develop a process which allows for consideration of their values.

Economic Considerations

Provide economic base for local communities utilizing diverse forest products while improving the forest. Develop and support local industry by giving preference to local contractors and workers, including young people, for forest jobs. Encourage new industry to process forest derived products locally. Develop a program which utilizes the funding and revenues generated from this project for restoration and rehabilitation of the Butter Creek management area.

Watershed Analysis Team Desired Future Conditions

Following are somewhat functional, but more detailed desired future condition statements that the Watershed Analysis team formulated, consistent with the FEMAT (1994), Federal Agency Guide for Pilot Watershed Analysis:

Geology

Naturally occurring landslides are recognized and the risk of activation through natural processes is lowered; watershed and habitat restoration plans recognize the potential influence of these naturally occurring slides and integrates these factors into project design and success expectations.

Landslide hazard is known and well integrated into all land management and restoration activity plans and designs in order to avoid triggering landslides through management activities.

Soils

Management activities are consistent with Soil Quality Standards so their physical and biological potential is realized, given the soils position on the landscape and within the natural range of variability.

The natural progression of hillside soil formation is only temporarily impaired by management activities such as vegetation management and fire suppression.

Soil disturbing activities are dispersed in space and time such that the unavoidable effects of contemporary ecosystem management on soil productivity, soil biology and the physical and hydrologic functions of soil are minimal and temporary.

Water Resources

Water quality parameters are within the natural watershed dynamics for the Butter Creek watershed when it has reached its physical and biological potential under ecosystem management.

Stream channel conditions are within the range of natural watershed dynamics for the Butter Creek watershed given its controlling landscape factors and the effects of ecosystem management.

Management activities are sufficiently distributed in time and space that they do not cumulatively contribute to water quality degradation, channel instability or degradation of beneficial uses within the natural range of watershed dynamics.

Fisheries

Populations are at or near full species diversity potential at all life stages for steelhead.

Habitat conditions (quality/quantity) are adequate to provide optimum carrying capacity for steelhead.

Population is at or near full species diversity potential at all life stages for resident rainbow trout.

Habitat conditions (quality/quantity) are adequate to provide optimum carrying capacity for resident rainbow trout.

Landscape Diversity

Plant communities, their seral stages and other landscape element distribution patterns are within the natural range of variability and thus are fully functioning.

Plant Species of Concern

Sensitive plant populations, including watch list species, are stable and increasing in size and distribution. Suitable habitats are intact and are managed to provide recruitment opportunities. Botanical diversity is enhanced by ecologically based land management.

Noxious and environmental pest plant populations are controlled and do not present a threat to native plant diversity.

Old-growth associated plant populations are healthy and viable, and are not threatened or declining.

Wildlife

Populations are at or near full species diversity potential and recovery of Threatened, Endangered and Sensitive species is promoted through using the best available information on their habitat needs.

The Late-Successional Reserve is maintained in late seral coniferous forest conditions by protecting older stands and allowing or managing younger stands to reach late seral conditions.

Dispersal habitat for northern spotted owls and species associated with late seral and old-growth forests are provided for within the watershed.

Biological corridors link the watershed to other watersheds and provide for wildlife dispersal and security.

Fire Regimes

Restoration of a fire regime which will result in vegetative patterns and structures that are more consistent with historical ranges of variability.

The desired residue profiles are based on fire hazard and fire behavior characteristics.

Reduction of hazard to reduce susceptibility to large stand replacement fires.

Protection of late seral stands and treatment of older plantations for recruitment into mature stand structure.

Meet air quality regulations for Class II airshed.

Traditional Native American Human Values

Relationships are developed which promote identification, protection, restoration and interpretation of heritage resources.

There is an active relationship with Native American Indians, working together to identify traditional land use patterns, develop and enhance sources for traditional materials, and provide for other traditional land uses.

Contemporary Human Values

Management activities promote forest health, involve the community, provide jobs locally, insure fire protection, develop recreational opportunities and utilize educational opportunities. Management activities integrate Native American management techniques.

Transportation

Provide a Transportation System that will help facilitate the management of the ecosystem on a long term basis with the least impact on the ecosystem.

Forest Products

Provide economic base for local communities utilizing diverse forest products harvested in an ecologically sustainable manner, which leads to improved conditions. Encourage new industry to process forest derived products locally.

Link management of healthy forests in the Butter Creek watershed to the income needs of local people.

Increase integration of special forest products and ecosystem management

Recreation

Provide recreational opportunities for camping, fishing and wildlife viewing, accessible for diverse users. Include access to falls, lakes and caves. Construct, maintain and place signs at trails, set some aside for different users (i.e., hiking, biking, equestrian), and manage to avoid overuse of areas.

Grazing

Grazing allotments within the Butter Creek watershed are managed to sustain viable numbers of animals while minimizing impacts to Riparian Reserves, and other environmentally sensitive areas.

A Vision of the Future - 1994 to the Future

The bridge between what the watershed looks like now (Chapters I and II) and its Desired Future Condition is the basis for the third part of this chapter: A narrative description of future conditions and trends. In the narrative are described conditions and trends already in place which are leading toward the Desired Future Conditions and strategies which could be employed to achieve them, where current conditions and trends do not appear to be in harmony with the Desired Future Conditions.

Following is a general scenario which will provide the framework for this section. It is meant to be a broad vision of what will occur within the Butter Creek watershed, based on existing land allocations, the President's Plan, legal mandates, regulations and the public's views. The management goal for Butter Creek is simply a healthy ecosystem in terms of function and resiliency. Specifically, since Butter Creek is a Key Watershed and contains Late-Successional Reserves and Critical Habitat Units, Butter Creek will be managed as a refugia for at-risk stocks of fish, old-growth habitat and dependent species, ecosystem health and function, Threatened, Endangered and Sensitive species and sustainable and ecologically compatible commodity outputs. To achieve these goals, watershed restoration will be a focused activity, with the intent of restoring Riparian Reserves, reducing sediment and restoring aquatic, riparian and terrestrial habitats. Fire hazards will be reduced through thinning and prescribed burning. This will help prevent stand replacing fires and protect private property, Late-Successional and Riparian Reserves. Vegetation will be silviculturally managed to provide habitat and maintain forest health. State-of-the-art silvicultural and harvest methods will be utilized where appropriate, to meet multiple resource needs, which will provide commodity outputs. Where sediment production can be reduced, roads which are no longer needed will be closed or obliterated and the remaining road system will be upgraded and properly maintained. Recreation and grazing will be managed to reduce impacts and heritage resources will be protected. The public will be partners in managing the watershed.

Geology

As discussed in Chapter II, several landslides have been highly active within the Butter Creek watershed for hundreds and perhaps thousands of years, while others were triggered by the 1964 flood event. It is likely that the Maddox Lake slump-earthflow, located within the Indian Valley subwatershed, will continue to actively move. The toe zone, where significant movement occurred in 1964, remains active and is the largest contributor of sediment to lower Indian Valley Creek. Two plantations and approximately 5,000 feet of roads are located on the lower, more hazardous portion of the slide. These disturbances may continue to contribute to the activity of this slump-earthflow.

When the next 50 year storm event hits the watershed, it is likely that additional slides will be triggered. As discussed in Chapter II, when the 1964 flood event hit the watershed, landslide features were activated, for the most part in the steeper canyonlands. There were far fewer roads and harvest units at that time. It is likely that the present level of roads and harvest units could contribute to accelerated slope failure indirectly by intercepting surface water and delivering it to a landslide prone area. Areas other than the Maddox Lake slump-earthflow are susceptible to future failures. A plantation located across the canyon from the Maddox Lake slump-earthflow also resides on a very hazardous landslide feature. It too could contribute to accelerated slope movement. In addition, there are seven additional plantations and over 1500 feet of road located within or directly adjacent to areas believed to have high landslide hazards scattered around the watershed. These could fail in the event of a significant storm event.

The highest landslide hazard areas are for the most part identified. They are located within the Late-Successional and Riparian Reserves, therefore, future ground disturbing activities will probably be limited to those treatments needed to reduce fire hazards and lower the risk of stand replacing fires. It is therefore less likely that future land management activities will significantly contribute to slope failures. Site analysis will be required to analyze specific landslide hazards, beyond the level done for this analysis, for all proposed ground disturbing activities. Restoration activities should help reduce ongoing failures through practices such as revegetation of portions of active slides, correcting artificial drainage problems and in limited cases slope stabilization.

Given the seismic history of the watershed, overprinted on top of the landslide hazards, management activities and recently burned areas, it is likely that a large seismic event occurring within the next 25 years could have a significant effect on slope stability, sediment delivery and beneficial uses. The timing of the event relative to wet climate cycles is no doubt significant. Seismic events are a significant land disturbance agent within this area. However, the recurrence interval of a major seismic event is not known.

Soils Resource

Soil erosion from roads, skidtrails, landings and hillslopes within the watershed are prevalent but rather non-specific in nature. Chronic, small volumes of soil erosion and sediment yield from a wide variety of source locations cumulatively contribute to a degraded stream channel condition and an impacted soil resource. Future trends suggest that cumulative watershed effects of surface erosion and sedimentation will continue to be a concern in the Butter Creek Watershed for the next 25 years, particularly during large magnitude storms and rain-on-snow events. This trend will steadily decline in severity as sites continue to recover from soil compaction, bare areas are revegetated, road maintenance is improved, plantations mature and unstable areas are identified and managed appropriately.

Soil compaction should decrease over the next 50 years, except on the permanent road and trail network within the watershed, especially if restoration focuses on tilling skid trails and decommissioning roads. Management activities in the next 50 years will still likely result in soil compaction, but on balance, the rate of recovery should exceed the rate of new impacts to the area.

Soil erosion risk associated with catastrophic fire will continue to be a concern over the next half-century. Fuels build-up over such a large percentage of the watershed combined with steady or increasing use by the public will still place significant portions of the watershed at risk for episodic fires followed by periodic large-scale storm events. However, risk should be reduced through accelerated fuels management.

By reducing fuel levels through thinning of understory vegetation, over-drafting of water from the soil profile by dense stands of understory should be reduced. It should also assist in restoring temperature and moisture regimes to a level more consistent with pre-1840 conditions.

Hydrology

Hydrologic conditions and those resources affected by water in the Butter Creek watershed will continue to change into the future as adjustments are made to either natural events or human related management practices. Rain will continue to fall and water will continue to flow from the watershed to the South Fork Trinity River and beyond no matter what actions are or are not applied. Adjustments to past natural and human disturbances are still being made in a mostly predictable manner. The potential impacts of human actions under the current direction for management of the area will most likely have a stabilizing influence on the watershed conditions. Current management direction is focused on stabilization of stream channels, reduction of sediment inputs and fuels reduction. Impacts of future natural events, such as floods, wildfire, insect attack, windstorm, etc. will most likely have a greater impact on watershed conditions than any foreseeable human activity initiated in the future. Some existing conditions, however, will need to be assessed and modified to eliminate their potential exacerbation of natural events.

Overall flow regimes in the Butter Creek watershed would be expected to return to pre-1950 levels of variability if vegetation is allowed to recover, road and skid trail runoff is greatly reduced, and wildfires are suppressed in a manner similar to the past several decades. A pre-European settlement flow regime could be approached, but not attained, with the addition of a fuels reduction program and a prescribed burning program designed to imitate Native American burning practices. If a transportation network is maintained within the watershed to manage the fire regime and the other resources, there will always be an influence on the flow regime that will differ from pre-1840 conditions. For the flow regime to recover to the point of being within the pre-1950 or pre-1840 range of variability, roads and skid trails that have the most influence on peak flow delivery will have to be obliterated or otherwise removed from their influence.

Sediment routing through the watershed will continue to function in a range of variability affected by past disturbances for several years into the future. Sediment outputs to the South Fork Trinity River can be reduced with stabilization of sediment sources related to management activities. Reducing runoff from unsurfaced roads will reduce the quantity of fine sediment movement through the stream system. The particle size distribution of streambed material in the low gradient channels in the upland area of the watershed will likely become more coarse as the fine sediment sources are reduced.

In addition, the cumulative area of recent harvest units, skid trails and roads could have an influence on erosion, sediment transport and on peak streamflows, especially in regards to snow accumulation and accelerated melt during rain on snow events. This is especially true for the subwatersheds described in Chapter I and II as being at risk due to high disturbance from the 1987 fires and salvage. These will remain vulnerable for another ten to twenty years, as the channels naturally recover, large woody material is recruited into the systems, areas revegetate, a duff layer accumulates and the slopes hydrologically recover.

With restoration and recovery, cumulative impacts will decline over a thirty to fifty year period. As a result there will be a gradual recovery of flow regimes and a subsequent reduction in the rate of accelerated landsliding. Landsliding activity is expected to continue, however, because of the long term nature of the process and the natural flood flow frequency. Engineered stabilization of presently active landslides as a restoration measure is impractical for most situations in the watershed. These areas will continue to contribute large quantities of all sediment sizes to the lower section of Butter Creek.

Water temperatures are expected to be reduced in the next 50 years through restoration of stream channels and riparian shade, and due to natural recovery as present riparian vegetation is allowed to mature. The most dramatic improvements are possible in the low gradient channels in the upland areas where additional riparian cover can be encouraged and the wide shallow channels are restored to deeper narrower channels. Riparian shade in the lower section of Butter Creek can also be expected to increase as the vegetation becomes mature. The result will be a slight drop in water temperature in this section as the shade increases. The decrease in temperature in the lower stream reach will not be as significant as in the headwater streams because of the large volume of cooler groundwater entering the stream system as it progresses downstream.

Channel conditions will improve within the next 50 years with stabilization efforts and implementation of Riparian Reserve Standards and Guidelines. Reducing peak flows and sediment sources through restoration efforts will reduce impacts to the channels and allow for natural stabilization as streams adjust to more natural conditions. The greatest opportunity for channel work exists in the lower gradient channels of the upland area. Although the original channels had developed into meandering vegetation and woody debris controlled systems it will not be possible to reestablish such conditions through restoration efforts. The channels are adjusting to a stable condition which is less sinuous and more bedrock controlled. The stream channels can be stabilized with more diversity for fish and wildlife habitat by strategically placing more coarse woody material and planting woody riparian vegetation. The result would be a more diverse stream environment that is stable within the natural range of variability.

Without restoration, but with the implementation of the riparian guidelines, the stream channels in Butter Creek Watershed would eventually reach a period of recover commensurate with the current conditions of stream flow and channel geomorphology. The channels in the upland area would not regain their narrow, deep, meandering nature, but would regain stability in another form. The new channel form would be more bedrock controlled, have a wide shallow shape, and include an adequate flood plain for peak flow events. Eventually, over several decades, coarse woody debris would begin to build up and become a more important component in channel formation and stability.

Restoration efforts in the lower portion of Butter Creek just above the confluence with the South Fork Trinity River could help to stabilize this section and enhance fish habitat. Habitat improvements could be provided in this lower section of Butter Creek if carefully planned to withstand expected flood flow events. Placing improvement structures in a stream the size of Butter Creek is very risky unless the flood flows are used for the design. Continued stabilization of the channel can be expected here naturally, but little development of diverse fish habitat will occur within the next fifty years without human intervention.

Fisheries

Watersheds that once produced surpluses of harvestable salmon have undergone such an extensive variety of land changes, both natural and human-induced, through the decades, that they may no longer be able to produce the large historical numbers of wild salmon and steelhead that abounded in their waters. But, the opportunity to build self-sustaining populations of wild salmon and steelhead, although dampened by the loss of critical downriver habitats, has not been lost. Salmon and steelhead are amazing pools of biological resiliency. They can be knocked down to low population levels, but if their habitat has not undergone severe environmental alteration they can rebound. Populations may not be as great as before, but definitely large enough to perpetuate their species. It is evident that although the upland areas of many of these watersheds have never been nor can no longer serve as major fish producers, they can certainly achieve, and with careful management, sustain appropriate levels of productivity. Such is the case for the South Fork of the Trinity River basin and many of its key anadromous fish tributaries, such as the Butter Creek watershed.

Over time, barring any immediate catastrophic event, the spring chinook of the mainstem South Fork of the Trinity River should regain its prominence as the most important salmon species in the basin. Given the gradual healing process of the mainstem South Fork of the Trinity River and the hopeful stabilization of its South Fork Mountain tributaries above Hyampom Valley from the 1964 flood event, it is anticipated that improved spawning conditions in the mainstem South Fork of the Trinity River will result in larger numbers of spring chinook being produced above that which has been observed or estimated in the late 1980s and early 1990s.

It remains uncertain as to how the summer steelhead populations will respond to better summer-holding conditions in the mainstem South Fork of the Trinity River as sediments are flushed from the system. It is reasonable to expect that with progressive watershed restoration efforts, tributaries utilized by summer steelhead will again provide better spawning conditions for adults and better rearing habitat for their resulting progeny. It is anticipated that watershed restoration will generate a positive response in the summer steelhead population, but the consistently small numbers of adults observed in the upper South Fork of the Trinity River basin during the late 1980s and early 1990s leaves room for concern and obvious conjecture.

Rieman et al. (1993) appraised the relative risk of extinction for local populations of salmonids with respect to six population characteristics. These included temporal variability in recruitment or survival, population size, growth and survival, isolation, replication and synchrony. These population characteristics have been applied to the summer steelhead of the South Fork of the Trinity River basin in order to portray a better picture as to this population's possible risk of extinction.

The South Fork of the Trinity River summer steelhead population is a small, self-sustaining population and may be reproductively isolated from those summer steelhead populations in the New River and North Fork Trinity River watersheds although all three drainages are geographically located in the Trinity River basin with their common point of convergence being the main stem Trinity River. No hatchery influence is present in the South Fork of the Trinity River basin for summer steelhead since the hatchery program does not rear summer steelhead juveniles. This population was directly subjected to the flood event of 1964 and indirectly to the wildfires of 1987. Currently, impairment of its holding and spawning habitat continues from annual pulses of naturally-released sediment. Cumulatively, disruption of its habitat has resulted in a clear declining trend in population size. As such, the South Fork of the Trinity River summer steelhead population still remains in jeopardy with a high to extreme risk of extinction with continued environmental stress.

Lower Butter Creek will continue to serve as a high quality producer of steelhead juveniles with habitat producing capabilities being compromised only by mass-wasting features that may logically be untreatable. As pool-filling boulders physically break down and are removed by streamflow, lower Butter Creek substrate spawning conditions for chinook salmon will improve near and immediately upstream of the mouth of Butter Creek.

It is anticipated that an active watershed restoration program in upper Butter Creek coupled with natural or man-enhanced stream channel and riparian habitat recovery will enhance the water quality of Butter and Indian Valley Creeks as well as the lower anadromous fish section of Butter Creek. A restored watershed with stabilized stream channels and streambanks vibrant with flourishing riparian vegetation will give rise to better living conditions for the resident rainbow trout of the upper Butter Creek watershed. It is anticipated that resident rainbow trout populations will increase to higher sustainable levels.

Vegetation

Future conditions and trends for landscape wide vegetation patterns allows the development of a seral stage and vegetation distribution pattern analogous in structure and function to the vegetation pattern maintained under natural processes. Where natural processes are not functioning properly or at acceptable rates, management activities may be used that mimic the ecological function of fire and the other natural processes in the landscape. Biological diversity will be enhanced to historic levels, while sustainable levels of a diverse array of products for human consumption may be removed from the watershed. In the short term, there may be an emphasis on moving towards a balanced successional stage scenario and on enhancing connectivity throughout the watershed and linkages to adjacent watersheds.

Ecosystem health is reflected in resilience to stresses and large-scale disturbances and in the ability to adapt to evolving conditions. One of the factors in resiliency is biological diversity. Diversity of communities in composition and structure on the landscape, species composition in the community and genes within the species are key to resiliency and the ability to adapt. The current conditions of loss of key unique habitats, such as riparian and wetlands, fragmentation of interior habitat and loss of genetic and species diversity in plantations, will continue to inhibit ecosystem resiliency. However, given the management emphasis of the future, these conditions are more likely to improve.

Wildlife

During the public involvement process for the Butter Creek Ecosystem Management project a number of other species were brought up as being of interest. Members of the general public and of the Nor-el-muk Wintu are interested in seeing the diversity of wildlife that existed here before European settlement. Due to the loss of large wet meadows, which cannot be restored under current conditions, it is not possible to bring back species like the sandhill crane and others that used these wetlands. Other species such as the grizzly bear and wolf are too great a threat to humans and livestock to re-introduce.

Given those exceptions, there are opportunities to enhance the habitat, and therefore, population levels of other species. Like the fisher and marten, wolverine use late seral forests having scattered openings, riparian areas and downed logs. Porcupine populations may increase on their own with a program to educate people on their role in the ecosystem. Deer and black bear will benefit from maintenance of wildlife travel corridors, reduced road density, a diversity of habitats, high quality forage and down logs. Mountain lions are another species of interest. Current evidence indicates that they are doing quite well in northern California and on the Hayfork Ranger District. An increase in chaparral habitat and an adequate prey base of deer are perhaps partially responsible for this. There was also a concern regarding the damage that beaver can do in terms of flooding and stream bank erosion. Before livestock grazing destabilized and enlarged the stream channels in the Butter Creek watershed, the activities of beavers played a role in maintaining and creating valuable wetlands. With the current conditions of lowered water tables and widened stream channels, beaver dams will interfere with channel restoration efforts, so re-introduction is inappropriate.

Transportation

In the future, there will be an expanded Road Closure Plan which will provide adequate access for all users in the area. Earthen mounds and gates will be used to limit access on roads which are closed. Many roads will be obliterated in order to reduce erosion, sedimentation or conflicts with other resources such as wildlife, or where their location is having a detrimental effect on Riparian Reserves, which cannot be mitigated.

The transportation system needed in this area will depend on the guidelines and project descriptions from the ecosystem management level plans and from broader Forest or Province scale land management plans. Current direction indicates that there will be no net increase in road mileage in Key Watersheds. In fact, it is anticipated that the transportation system will be reduced through closure and decommissioning. In its reduced state it should be adequate to manage the ecosystem. Short spur roads may have to be added from time to time to fully meet the management needs of this area.

Human Values

In the future, heritage resources will be inventoried and evaluated for significance. Historic properties will be protected and restoration projects will be implemented where sites are impacted from erosion, looting, vandalism, grazing and dispersed recreational use. A monitoring plan will be developed and sites monitored on a regular basis. Interpretive sites will be established and utilized as an educational tool to provide information and to raise the awareness of the public regarding the prehistory and history of the area.

Continuing research will be conducted to answer currently unresolvable questions. Additional research will be conducted to develop an understanding of how human values and needs affect biological and physical systems and how these systems affect human societies. The results of this research will establish a basis from which ecosystem management may more effectively sustain both human needs and healthy ecosystems.

Stronger working relationships will be established between the USDA Forest Service and local Native American groups. These relationships will foster better understanding of and continued traditional land use in this area. This includes the enhancement, availability and sustainability of traditional resource materials. Management practices will ensure the continued access to sites traditionally used by Native Americans.

Management activities promote healthy, productive, resilient and sustainable ecosystems, including flora, fauna, soil and water resources. A diversity of human values and benefits are provided. Human dimensions are incorporated on an equal footing with biological and physical elements in ecosystem planning. The local community is actively involved in providing comments and participating, to the extent legally allowable, in planning projects, policies, programs and management. Projects are designed to encourage local employment.

Management activities promote healthy ecosystems, involve the community, provide jobs locally, insure fire protection, develop recreational opportunities and utilize educational opportunities. Management activities integrate Native American management techniques.

Fuels Management

A diverse program of fuels management will be implemented with the goal of reducing existing fuel loads, reducing ladder fuels and developing and maintaining an appropriate system of natural fuels reduction buffers to facilitate control of unwanted wildfires. Silvicultural tools will be used in plantations and mature forests to achieve a balance of standing and down woody material, which minimizes ground disturbance, meets soil quality standards and wildlife requirements. Negative effects to Riparian Reserves are minimized with the use of management practices which reduce disturbance and minimize risk of damage.

Forest Products and Commodities

Timber Harvest

Since Butter Creek is within the upper South Fork of the Trinity River Key Watershed, timber production will not be an emphasized resource management program. However, silvicultural practices will be utilized, in an ecologically sound manner, to meet some of the goals for the watershed. Restoration of Riparian Reserves, wildlife corridor management, fuels reduction, maintenance of Late-Successional Reserves, maintenance of forest health and increased species diversity are some of the emphasis programs within the Butter Creek watershed which may require the use of silvicultural tools. It is anticipated that wood products such as chips, small diameter logs and sawlogs will be produced, in a sustainable manner, from the watershed.

Special Forest Products

A wide variety of specialized forest products will be available for harvest by small local businesses. Florals, pine cones, medicinal plants, mushrooms, boughs, Christmas trees and other miscellaneous forest products will be managed and harvested in an environmentally sensitive manner. Harvesting will be focused in areas where vegetation management treatments are prescribed, thus assuring efficiency and lower impacts. Harvesting will be monitored and practices modified as necessary.

Livestock Grazing

With the use of modern range management practices, such as dispersed water sites and salt licks and attentive animal management, the negative impacts of grazing will be reduced. Riparian forage will be increased through planting, however, grazing impacts within the Riparian Reserves are minimized through fencing sensitive areas and herd management. When it is apparent that use is causing an adverse affect, cattle are physically moved to another area and are further monitored. Updates to Allotment Management Plans, performed in an interdisciplinary manner, in an ecosystem management context, will assist in minimizing the adverse effects of grazing in the watershed.

CHAPTER IV
Interpretation, Key Findings and Management Recommendations

The first objective of this chapter is to identify Key Findings and Recommendations of the Watershed Analysis. These findings have already been presented in the previous chapters, however highlighted are the key outcomes of this analysis. A second objective is to identify areas of concern and to make recommendations for site analysis, project initiation, locations needing treatment and monitoring activities. The final objective of the chapter is to document non-resolvable key questions.

Integrated Summary of Recommendations

The intent of this section of the analysis is to integrate the recommendations made in this chapter and to define specifically what and where practices, analyses and activities should occur. This section is meant to be the primary recommendations of the team. The recommendations are organized in terms of the significant issues which emerged from the analysis. They are arranged in no particular order, nor is there meant to be any implication of prioritization. Recommendations which are not contained in this section are also important but are considered to need less emphasis at this time. Recommended monitoring practices are listed at the end of each issue-driven recommendation subsection. **Tables 23** through **30** summarize recommendations for each significant issue.

Transportation Planning

Recommendation A: A Transportation Plan should be developed for the entire watershed. The plan needs to 1) define the road system needed to access and manage the watershed, given all public, resource and administrative needs, 2) identify the maintenance needs over time for that system, 3) identify traffic regulation and seasonal closures necessary to protect the transportation system from roadbed damage and provide for resource protection, 4) identify measures necessary to maintain or improve stream crossings and 5) identify surface stabilization needs to control erosion and allow for seasonal use.

Location: The entire watershed, perhaps extending well outside of the watershed for specific analyses such as defining the minimum transportation system needed.

Recommendation B: Roads located in highly unstable areas, now considered a part of the Riparian Reserve, should be individually analyzed for opportunities for closure, obliteration, restoration or remediation, depending on the potential for the road to contribute to slope instability and subsequent degradation of water quality.

Location: Unstable areas within the Indian Valley Canyon Unit, Indian Valley Creek, middle Indian Valley Unit and North Creek subwatersheds, identified by inventories, and field verified.

Recommendation C: Reduce road density, with the objective of having road densities of less than 2.5 miles of road per square mile of land area within the entire watershed. Use the Transportation Plan, existing road density on a subwatershed basis and location within Riparian Reserves as criteria for prioritizing road closure, obliteration or surface stabilization.

Location: As displayed in **Table 8**, nearly all subwatersheds exceed the recommended road density. However, initially focus on the following subwatersheds which either have a high road density or are highly disturbed and at risk of having cumulative watershed effects: Seven Road, Headwaters, Rail Gulch, Cow Gulch, middle Butter Unit, upper Butter Creek and Cold Camp Creek.

Recommendation D: Culverts and low water crossings need to be evaluated for maintenance needs, replacement needs due to size or not providing for fish passage, or risk to the conditions within the Riparian Reserves. Following evaluation, develop a plan for maintenance needs.

Location: Throughout the watershed.

Monitoring Recommendations: Periodic review of the Transportation Plan and update as needed, field review critical sites following high streamflow events to evaluate how the designs worked, monitor areas affected by roads through surveys and evaluate wildlife population response to road closures.

prescribed fire and natural fuels reduction to reduce fire risk. This prescription may also improve forest health conditions and wildlife habitat. An analysis which contributed to this recommendation is contained in **Appendix G**.

Location: This practice should be performed throughout the watershed in Late-Successional Reserves, northern spotted owl activity centers, critical habitat units, within the wildlife corridor system and in younger stands with high fuel loading levels, as determined by further analysis. Thinning residual stands within the Riparian Reserves is not appropriate without further analysis.

Table 23	**TRANSPORTATION SYSTEM RECOMMENDATIONS**	
ISSUE	**PROPOSED ACTION**	**PRIORITY AREAS**
A - Transportation system needs are undefined.	Complete a Transportation Plan including: Define minimum road system . needed Maintenance needs Traffic regulation Stream crossing needs Surface stabilization needs	Watershed-wide.
B - Roads located within unstable areas.	Analyze roads located within highly unstable areas for opportunity for closure, obliteration, restoration or remediation.	Unstable areas within Indian Valley Canyon Unit, Indian Valley Creek, Middle Indian Valley Unit, and North Creek subwatersheds.
C - High road density.	Reduce road density through road closure and obliteration.	Seven Road, Headwaters, Rail Gulch, Cow Gulch, Middle Butter Unit, Upper Butter Creek, and Cold Camp Creek subwatersheds.
D - Stream crossings at risk of failure from high streamflows.	Evaluate all stream crossings for maintenance or replacement needs.	Watershed-wide.

Fuels

Recommendation E: In order to retain late seral stands, protect and enhance connectivity of corridors and reduce the risk and extent of catastrophic fires, forest fuels need to be reduced. The risk of catastrophic fire is high due to dense vegetative cover and high fuel accumulations, the result of fire suppression and recent drought. Ecologically sensitive thinning, pruning and slash chipping or other disposal practices may be used along with

Recommendation F: Fire safe practices and fuels reduction programs need to be practiced on National Forest lands around private land inholdings and Limedyke lookout. Natural fuels reduction buffers around private lands are necessary to protect life and property adjacent to National Forest administered lands and lower the risk of human caused fires spreading from private lands. Fuels specialists should work with local residents to increase awareness of the need to reduce fuel levels and fire hazards on their own lands. An analysis which contributed to this recommendation is contained in **Appendix G**.

Location: Around and within all private lands in the watershed and around Limedyke lookout.

duff layer through transects, evaluation of residual fuel levels following treatments and evaluation of fire effects to residual vegetation and wildlife habitat and populations.

Table 24	FUELS RECOMMENDATIONS	
ISSUE	**PROPOSED ACTION**	**PRIORITY AREAS**
E - High forest fuels levels.	Thinning, pruning, slash chipping and prescribed fire.	Throughout the watershed, but prioritized within LSR, owl activity centers, Critical Habitat Units, wildlife corridor system, and in stands with high fuel levels.
F - Fire hazards on and adjacent to private property and Forest Service facilities.	Perform intensive fuels reduction and promote fire-safe practices.	Limedyke lookout and private lands within the watershed.
G - Fuels reduction within Riparian Reserves.	Prescribe light fires only to reduce fine fuels, reduce large fuels through manual or low impact means.	Upland Riparian Reserves.
H - Fire hazards adjacent to roads.	Establish and maintain a fuel break buffer along main travel routes.	Along roads 2N10, 3N08, and county road 316.

Recommendation G: Prescribed fire is only appropriate within Riparian Reserves when it is used under a prescription to reduce only fine fuels. Larger fuels can only be reduced by manual or low impact mechanical means. Prior to large fuels reduction, down woody material levels and needs must be locally assessed. Spring burning in the Riparian Reserves is not recommended due to the potential effects on riparian dependent wildlife breeding cycles.

Location: Riparian Reserves within the upland portion of the watershed.

Recommendation H: The potential risk of human caused fire starts along major transportation corridors may be reduced by establishing and maintaining a natural fuels reduction buffer along main travel routes.

Location: Along the entire length of forest roads 2N10 and 3N08 and county road 316 within and adjacent to the watershed. Other roads should also be considered for this treatment, but these three are considered the highest priority.

Monitoring Recommendations: Implementation and effectiveness monitoring through the use of photo points, vegetation plots, evaluation of

Forest Health

Recommendation I: It is recommended that ponderosa and Jeffrey pine stands be thinned to reduce the probability of successful bark beetle group kill. Older stands would be thinned, while younger stands could be managed through a combination of thinning and underburning. These treatments may be integrated with fuels and fire reduction activities to achieve mutual benefits.

Location: Nine PP3N and PP3G timber stratum pine stands in the Indian Valley Uplands. Approximately 50 plantations in the Indian Valley Uplands and 6 plantations in the Butter Creek Canyonlands planted prior to 1975.

Recommendation J: Thin overstocked stands to restore vigor and prevent mortality. Most mature stands in the watershed are beyond the natural range of variability in carrying capacity due to fire suppression and the subsequent encroachment of a shade tolerant understory. This has led to conditions of low vigor and resiliency to stressors and excessive mortality. An analysis which contributed to this recommendation is contained in **Appendix G**.

Location: Throughout the watershed, but in particular in areas of high value for wildlife and fisheries and most at risk. These include Late-Successional Reserves, northern spotted owl activity centers, Critical Habitat Units and within the wildlife corridor system.

Monitoring Recommendations: Implementation and effectiveness monitoring through the use of photo points and vegetation plots.

Table 25	FOREST HEALTH RECOMMENDATIONS	
ISSUE	**PROPOSED ACTION**	**PRIORITY AREAS**
I - Potential for bark beetle group kill.	Thin older ponderosa and jeffrey pine stands. Thin and underburn younger stands.	Nine PP3N and PP3G timber stratum stands in upper Indian Valley, 50 plantations in upper Indian Valley and 6 plantations in Butter Creek canyonlands.
J - Overstocking contributing to drought induced mortality.	Reduce basal area within overstocked stands through thinning.	Across the watershed but initially focus on LSR, owl activity centers, Critical Habitat Units and within wildlife corridor system.

Sediment and Peak Streamflow Reduction

Recommendation K: For alluvial channels within the uplands, the following practices should be performed to help restore the riparian system: For first and second order stream channels, grade stabilization for unstable channels and revegetation of riparian areas. For third order channels, implement projects which will help the channels to return to a form which is stable within the existing landscape, including grade stabilization, bank stabilization and revegetation of riparian areas. Where riparian planting is performed, cattle grazing should be temporarily eliminated and carefully controlled thereafter.

Location: Within all subwatersheds in the upland area, but initial efforts focused on subwater-sheds within the burned area which have high levels of disturbance and are at risk of cumu-lative watershed effects, including Seven Road Creek, Rail Gulch, Cold Camp Creek, Headwaters Creek and local areas within Indian Valley and upper Butter Creek sub-watersheds.

Recommendation L: Compacted areas, including skid trails and landings, which are contributing increased surface runoff and sediment to the fluvial system should be ripped to break up the compaction, mulched with wood chips or straw and the area revegetated with native plant species appropriate for the site and objective. Where surface runoff cannot be eliminated, utilize water bars to disperse runoff. This practice can be performed in conjunction with plantation thinning, with wood chips derived from thinning utilized as mulch.

Location: Within all subwatersheds in the upland area, but initial efforts focused on subwater-sheds within the 1987 burned area which have high levels of disturbance and are at risk of cumulative watershed effects, including Seven Road Creek, Rail Gulch, Cold Camp Creek, Headwaters Creek and local areas within Indian Valley and upper Butter Creek sub-watersheds.

Monitoring Recommendations: For restoration of first, second and third order channels monitor-ing will focus on implementation of the resto-ration work and long term effectiveness of the practice to achieve its intended goal. Channel stabilization efforts will be monitored by establishing channel cross-sections and longitudinal profiles and remeasuring them over a five to ten year period to determine their effectiveness. As another example, revegetated riparian areas will be monitored for revegetation success compared to control sites. For upslope treatments designed to reduce erosion and sedimentation, monitoring will be conducted to determine on-site treat-ment implementation and effectiveness, as well as off-site effects as measured in stream channels. Parameters most sensitive to the individual landscape will be selected for monitoring. These could include cross-sections, residual pool depth, stream bed composition or sediment depth in pools.

down woody material. An analysis which contributed to this recommendation is contained in **Appendix G**.

Table 26	SEDIMENT AND PEAK STREAMFLOW REDUCTION RECOMMENDATIONS	
ISSUE	**PROPOSED ACTION**	**PRIORITY AREAS**
K - Unstable stream channels within the upland area.	Grade stabilization, bank stabilization and riparian planting, and grazing control.	Seven Road Creek, Rail Gulch, Cold Camp Creek, Headwaters Creek, and local areas within upper Indian Valley and upper Butter Creek subwatersheds.
L - Risk of cumulative watershed effects.	Rip and mulch skid trails and landings and revegetate with native plant species.	Seven Road Creek, Rail Gulch, Cold Camp Creek, Headwaters Creek, and local areas within upper Indian Valley and upper Butter Creek subwatersheds.

Late Seral Wildlife Habitat

Recommendation M: Minimize habitat damage and loss within Late-Successional Reserves by attacking new fire starts and attempting to limit the size of catastrophic fires. Utilize minimum impact suppression methods.

Location: Within the Late-Successional Reserve, Critical Habitat Unit and northern spotted owl home range.

Recommendation N: Promote the maintenance of sufficient late seral coniferous forests to promote recovery of old growth dependent species, including the northern spotted owl. Manage these forests for the long term maintenance of these stand characteristics through reducing fuels around and within these stands, thinning young plantations to promote more rapid growth to achieve these characteristics, planting understocked areas and maintaining adequate levels of snags and

Location: Within and adjacent to the Late-Successional Reserve, wildlife corridor and Critical Habitat Unit.

Monitoring Recommendations: Monitor northern spotted owl populations as well as other old growth dependent indicator species.

Social and Economic Considerations

Recommendation O: All projects identified and analyzed through the NEPA process should be evaluated for their potential to provide meaningful local jobs and contribute to the economic stability of local communities. Projects should be designed to have multi-year funding to allow for employment stability and capitalization of needed equipment. Provide multi-season work by mixing projects together in one contract.

Location: Throughout the watershed.

Table 27	LATE SERAL WILDLIFE HABITAT RECOMMENDATIONS	
ISSUE	**PROPOSED ACTION**	**PRIORITY AREAS**
M - Risk of stand replacing fires within Late Successional Reserves and Critical Habitat Units.	Attack fire starts and attempt to limit size of fires while minimizing impacts of fire suppression efforts.	Within and adjacent to LSR, Critical Habitat Unit, and owl activity centers.
N - Maintenance of late seral coniferous forests for recovery of old growth dependent species.	Reduce fuels, thin plantations, plant understocked areas and maintain snags and down woody material.	Within and adjacent to LSR, Critical Habitat Unit, and owl activity centers.

Recommendation P: Continue to work with the local public in planning and implementing a wide variety of projects, in an ecologically sound manner, through Watershed Analysis and Ecosystem Management planning which provides a variety of outputs. Outputs should range from traditional commodities such as saw logs and chips, to special forest products, increased quality of recreation, a larger and healthier anadromous and resident fisheries, better maintained roads, lowered fire risk and increased levels of receipts to the county government.

Location: Throughout the watershed.

Recommendation Q: Develop a plan to evaluate the existing impacts to historic properties from vandalism, dispersed recreation, erosion from road drainage and surface disturbance from road construction, administrative use, timber harvest and grazing. Use the plan to prioritize restoration and protection of the sites.

Location: Throughout the watershed.

Recommendation R: Evaluate at the project level, ways to reduce the impacts of high density dispersed recreation within and adjacent to Riparian Reserves. Specific options include excluding all camping within 100 feet of stream channels and wetlands, or off-set use of riparian areas through developing camp sites in non-sensitive areas. Rehabilitate sites which are heavily impacted by ripping roads and replanting riparian and other native vegetation appropriate for the site. Work with local interests to accomplish this goal, recognizing that historic and traditional use of these areas is important to various groups. Use signing and other methods to share with the public the need for these measures.

Location: Upper Indian Valley and upper Butter Creek subwatersheds.

Monitoring Recommendations: For the historic properties a wide variety of monitoring measures are appropriate, including photo points, surveys and site visits to ensure that restoration and protection measures are working effectively. For recommendation P, visit the sites during high use periods to monitor use patterns. Use photo points to measure effectiveness of restoration activities.

Table 28	**SOCIAL AND ECONOMIC CONSIDERATIONS RECOMMENDATIONS**	
ISSUE	**PROPOSED ACTION**	**PRIORITY AREAS**
O - Local economic stability.	Design projects for multi-year funding to allow for employment stability and capitilization of equipment. Provide for multi-season work by having mixed project packages.	Watershed-wide.
P - Partnerships with the public and expected outputs.	Continue public involvement with Watershed Analysis and Ecosystem Management planning, which will promote a variety of commodity and amenity outputs.	Throughout the Shasta-Trinity National Forests.
Q - Damage to historic properties.	Develop a plan to evaluate impacts to sites from vandalism, recreation, erosion, roads, administrative use, vegetation management and grazing.	Watershed-wide.
R - Dispersed recreation conflicts within the Riparian Reserves.	Reduce the effects of dispersed recreation within the Riparian Reserves. Rehabiliate impacted sites.	Upper Indian Valley and upper Butter Creek subwatersheds.

Riparian Restoration

Recommendation S: Evaluate the amount of down woody material and crown closure within Riparian Reserves at the site level. If appropriate, prescribe means to rehabilitate or enhance the Riparian Reserves through methods such as thinning and recruitment of large woody material.

Location: Within the upland areas of the watershed.

Recommendation T: At the site level, evaluate all water drafting sites and water holes for potential negative effects to Riparian Reserves. Evaluate measures such as storage out of channel, piping to non-sensitive sites and fencing as measures to help alleviate existing impacts.

Location: Evaluate all sites in the watershed, but rehabilitate Cold Camp Spring and Maddox Lake sites first.

Recommendation U: Restore wetlands, including artificially created ones, to increase their function as wildlife habitat. Restoration may entail the following: Road and access closure, elimination of developments which remove water, burning wet meadows to rejuvenate the vegetation and halt conifer encroachment, correction of erosion problems and/or fencing out cattle.

Location: Throughout the watershed.

Recommendation V: Restore the channel and riparian area of upper Indian Valley Creek. Restoration activities could include major modification of the channel, a mix of channel improvements and fish habitat improvements, revegetation and diversification of existing riparian habitats with native plants, or no action to allow natural recovery over a longer period of time. Action alternatives could be done piecemeal over an extended period, each piece contributing to the long term goal. All alternatives would be done in concert with management of grazing and recreational use of the riparian areas (see Recommendation R and W).

Table 29	RIPARIAN RESTORATION RECOMMENDATIONS	
ISSUE	**PROPOSED ACTION**	**PRIORITY AREAS**
S - Inadequate large woody material and vegetative cover within Riparian Reserves.	Survey the Riparian Reserves for those elements and if appropriate, prescribe restoration activities.	Within the upland areas of the watershed.
T - Conflict between water drafting and wetland quality.	Evaluate all water drafting sites and evaluate measures, such as storage out of channel, piping to less sensitive areas and fencing.	Watershed-wide.
U - Wetlands Degradation.	Restore wetlands through road closure, elimination of developments which remove water, prescribed burning, correct erosion problems and grazing control.	Watershed-wide.
V - Stream Channel Instability.	Restore channel and riparian areas through modification of channel forms, fish habitat improvements and revegetation.	Upper Indian Valley Creek and upper Butter Creek
W - Grazing impacts.	Minimize impacts to Riparian Reserves from grazing. Evaluate these recommendations in NEPA context and update Allotment Plan.	Upper Indian Valley, Cold Camp Creek and Seven Road subwatersheds.
X - High water temperatures.	Increase riparian shading through revegetation.	Lower Butter Creek along anadromous reach.

Location: Upper Indian Valley Creek and upper Butter Creek.

Recommendation W: We recommend further evaluation of allotment management through Watershed Analysis methods and incorporate results through amendment to this analysis. Evaluate means to minimize impacts to Riparian Reserves due to grazing. These recommendations would be evaluated in a NEPA context, in the Allotment Plan for the Indian Valley allotment.

Location: Upper Indian Valley, Cold Camp Creek and Seven Road subwatersheds.

Recommendation X: There is a need to increase riparian vegetation along the lower Butter Creek area. We recommend planting within the Riparian Reserve to provide shade which will contribute to cooler water temperatures.

Location: Lower Butter Creek

Monitoring Recommendations: For Recommendations S and T, restoration of wetlands and upper Indian Valley Creek, a comprehensive monitoring plan should be developed for each to evaluate the effectiveness of the treatments that are eventually implemented, even the "no action" alternative. Photo points would be an especially effective means to visually portray changes in channel stability and riparian recovery. More objective monitoring will be needed to evaluate the degree of change in the wetlands, the channel and riparian areas. Effectiveness monitoring of riparian planting for provision of stream shade (Recommendation U) will be both direct and indirect. Stream shade measurements taken at the sites treated will be monitored for changes in canopy cover. Indirect changes will be monitored by collecting stream temperatures data in Butter Creek upstream and downstream of the treatments over an extended period.

Fish and Wildlife Habitat Restoration

Recommendation Y: The most efficient way to reduce fine-grained sediment in the anadromous section of lower Butter Creek is to control sediment sources in the upstream watershed area. These recommended prac-

Table 30	FISH AND WILDLIFE HABITAT RESTORATION RECOMMENDATIONS	
ISSUE	**PROPOSED ACTION**	**PRIORITY AREAS**
Y - Fine-grained sediment impacting anadromous spawning gravels.	Reduce fine-grained sediment by controlling sediment sources in the upper watershed. Same as issues A, B, C, D, K and L.	Watershed-wide.
Z - Habitat improvement.	Evaluate habitat improvement proposals and develop funding sources for evaluation and projects on private lands.	Anadromous reach of lower Butter Creek.
AA - Active landslides affecting anadromous habitat.	Do not perform or support the mechanical remedial stabilization of active debris slides at this time. Biostabilization, using riparian planting, is an acceptable option.	Lower Butter Creek.
BB - Habitat connectivity across the landscape.	Establish a corridor system within the watershed with preference for mid and late seral habitats.	Within the designated wildlife corridor throughout the watershed.
CC - Loss of Douglas-fir and Klamath mixed conifer WHR vegetation types.	Plant species which mimic natural communities and thin plantations which are predominately ponderosa pine to favor the production of mixed species stands.	Watershed-wide.

tices to reduce sediment are described in recommendations A, B, C, D, K and L.

Location: Throughout the watershed.

Recommendation Z: There is an opportunity to perform fish habitat improvement in the lower 400 foot stretch of Butter Creek. This section of channel is located on private land, but we recommend detailed evaluation on the feasability and benefits of realignment of the channel and revegetating the new channel banks based on geomorphic principles. Funding sources would have to be explored to contract this work.

Location: Lower Butter Creek.

Recommendation AA: We should not perform or support the mechanical stabilization of active debris slides in the lower Butter Creek subwatershed at this time. However, biostabilization utilizing riparian planting is supportable due to its low cost and potential benefits. These slides may also be located on privately owned lands so funding sources would also have to be explored.

Location: Lower Butter Creek.

Recommendation BB: It is advisable to manage vegetation for a greater degree of connectivity in the landscape through the use of corridors, to support flows of various species of wildlife, such as dispersal habitat for juvenile northern spotted owls, with preferences for mid-and late seral habitats. These corridors should seek to encompass riparian zones and to connect the Butter Creek watershed with the surrounding landscape by working to conserve existing late successional vegetation and fill gaps in connectivity between late successional patches. This strategy would indicate immediate attention to reducing the potential for catastrophic fire due to overly dense vegetation and fuel ladders when they occur in these late successional patches. Ecologically sensitive thinning from below and other fuels reduction measures for forest health should be emphasized here.

Location: In the designated wildlife corridor throughout the watershed.

Recommendation CC: The trend toward a loss of Douglas-fir and Klamath mixed conifer Wildlife Habitat Relationships habitat types should be reversed by planting species that mimic natural communities and thinning plantations which are predominantly ponderosa pine, to favor the survival of naturally regenerated species.

Location: Throughout the watershed.

Monitoring Recommendations: None identified.

Key Findings and Recommendations

General Planning

Forest Health

Key Findings

1. The Butter Creek watershed contains mature pine stands which are very susceptible to *Dendroctonus* beetle attack, such as the stands around the Indian Valley Guard Station. It also contains several hundred acres of older pine plantations which have trees of the age, size and density to be susceptible to group kills by *Dendroctonus* bark beetles.

2. Current observations indicate that mature sugar pine trees in the 10-20 inch DBH range are now showing signs of blister rust infection that appears to have occurred in the 1970s. Many have dead tops and in more extreme situations, trees have died. Resistance to successful infection has been identified in sugar pine, but no resistant trees have currently been identified in this watershed or the breeding zone it is in. The incidence of the resistant gene is low in this area, less than one percent.

Recommendations

1. In areas where the sudden death of a group of pines with the resulting accumulation of fuel is unacceptable, the risk of mortality can be lowered by thinning. Thinning pine stands will reduce the probability of a successful *Dendroctonus* group kill by both increasing the amount of soil moisture available to each leave tree, as well as by increasing the spacing between leave trees to the outer limits of effectiveness of the

aggregating pheromone. The only reliable and effective method to thin existing stands of thick-barked mature pines is to mechanically cut some trees. Prescribed fire can be used to open up some very young pine stands, or to maintain an open condition in an older pine stand after it has been thinned.

2. Locating resistant parent trees and out planting resistant stock are critical to maintenance of sugar pine near historical levels in the Butter Creek watershed. Other management activities such as pruning and localized *Ribes* removal may be used in stands where only non-resistant sugar pine are available and it is desired to recruit sugar pine as a part of the future overstory. Although sugar pine will not disappear from the watershed, without some actions to protect it and promote regeneration of resistant trees its demographics will change as immature trees will not be available to move into mature and older age classes.

Fire Suppression

Key Findings

1. Catastrophic fires have increased in number and size in the watershed over the last fifty years. Catastrophic fires are events that are generally large in size, severe in their impacts and threaten lives and property. There is a relationship between fire exclusion that has increased fire behavior characteristics of forest fuels and resistance to control experienced by suppression forces. In addition, the influx of new residents and communities into fire environments has increased the hazard and risk associated with catastrophic fire. The accumulation of fuel and fuel structures optimal for fire spread and high intensity impacts are trending upwards.

2. Drought and increased tree mortality caused by various agents have led to large fire events. Large fire events occurred in 1987. Large wildfires that cause severe damage to property and forest resources are becoming extremely expensive to suppress and cause millions of dollars in damages annually.

3. The rural/wildland intermix poses new challenges to fire fighting agencies who must protect life and property at the expense of wildland forests and woodlands. Fire engines, aircraft and fire crews are being used to save structures, while forest fires become larger and more expensive to fight. Many communities have become at risk to large damaging fires. Recent losses of homes and out-buildings to wildfires has become alarming. Conditions of wildlands as a result of fire exclusion, past stand management practices and drought will only produce additional losses in the future.

4. Fire exclusion will and has resulted in the alteration of the natural fire regime. The fire regime now has shifted to one of long interval, high severity fires. This shift can be attributed to longer periods of fuel accumulation and the accompanying increase in severity when fires finally do occur. Williams et al. (1993) have identified six trends in short interval, fire adapted ecosystems associated with continued exclusion of fire and inadequate fuels treatment:

   a. A change from relatively low damage, stand-maintenance fires to more severe, stand replacement fires.

   b. Conversion from fire-resistant species to fire-intolerant species having less resistance to fire disturbances.

   c. Less controllable and more costly wildfires.

   d. A growing threat to wildland/urban interface.

   e. Increased danger to firefighters.

   f. Increased potential for high particulate matter emissions.

Recommendations

1. Application of fire safe practices around residential and community sites and active fuel management programs will continue to provide the greatest protection against catastrophic fire. There will continue to be pressure on firefighting agencies to protect residential areas at the expense of forest resources.

2. Work with local communities and Butter Creek residents to increase awareness and

to reduce fuel levels and fire hazards adjacent to their dwellings.

3. Fire will strongly influence vegetative patterns across the watershed. It is recommended that the Hayfork Ranger District complete a Fire Hazard and Risk Assessment which will characterize the wildfire potential across the watershed using consistent methodology to describe hazard. This assessment can indicate areas of concern to focus further attention on fuels reduction. This can be of value when planning priority areas for further review and possible treatment.

4. In the short-term, fire suppression strategies must continue to stress rapid suppression within the watershed. Reducing fuels over the next decade will hopefully allow for revising suppression strategies and permit the re-introduction and/or controlled suppression of fires in this landscape.

Special Forest Products

Key Findings

1. Permits on the Hayfork District, which includes Butter Creek, granted collecting rights for pine cones, mushrooms, beargrass, ferns, seedlings, manzanita, dogwood, prince's pine, boughs, florals, yarrow and other miscellaneous products.

2. In the Klamath Mountains, 250 plants currently yield products with a market value. Some of these, such as yarrow, pine cones and lichens are already being gathered in the Butter Creek watershed. Demand for permits for product gathering is increasing.

3. Existing guidelines on the Hayfork Ranger District are largely drawn from experience and policy on other districts and forests. A self monitoring process is currently used to keep track of general harvest locations and will begin to yield more specific information regarding harvest impacts as monitoring continues. In addition, several local special forest products gatherers are working with the USDA FS to develop specific monitoring regimes for several valued crops, such as prince's pine. There is a need to develop an overall plan for Special Forest Products monitoring on the Forest beginning with a focus on sustainable harvest methods and volumes for products already in demand.

Recommendations

1. Harvesting of Special Forest Products is highly likely to increase in volume and in diversity of products gathered. This raises concern about the sustainability of the resource given the harvest methods employed and volumes gathered. In some cases, such as careless mushrooming, overharvest can soon threaten a species' distribution. Standards and guidelines should be developed pro-actively. The current policy is piecemeal; as local people apply for permits for a new product, networks are searched for information and guidance in extending permits. Sometimes, they find guidelines for harvesting the species of interest in a climatically different bioregion, where the plants may be either more or less abundant and more or less likely to recover from suggested harvest rates.

   Sustainable harvest rates are not only species specific, they can be micro-habitat specific. For potentially sensitive plants, ecological guidelines for sustainable harvesting may need to be researched and set on a bioregional zone, in some cases, on a watershed by watershed basis. At the same time, for more abundant products, a standardization of fees for permits across forest jurisdictional lines within bioregions would be appropriate. Including economic botanical surveying in future watershed analysis projects and to develop approaches to gathering information for special forest products with existing information.

2. Areas where vegetation management treatments are planned should be identified as collecting areas prior to treatment to maximize the benefits to special forest products in these areas.

Landscape Diversity and Vegetation Patterns

Key Findings

1. Overall, the vegetation in the Butter Creek watershed is more fragmented and at a less mature stage of development than would be

expected within the natural range of variability. When successional stages are classed in early, mid-and late stages of maturity, early stages of succession dominate. Forest plantations are the second most dominant vegetation community classification.

2. While the evidence is still somewhat limited, the historic pattern of vegetation would have been a highly connected matrix of mixed conifer with Douglas-fir forest being the largest single patch type in the matrix. Hardwoods and other specialized communities were distributed based on microsite conditions determined by soils, hydrologic regime, aspect and slope.

3. Fire would have historically kept the seral stage distribution at roughly 20 percent early, 30 percent mid-and 50 percent late succession stages. The 1944 photos represent a somewhat greater than average proportion of late succession (55 percent) after 40 years of some degree of fire suppression. The 1990 period represents early succession dominance beyond the natural range of variability after the recent decades of intensive timber harvest and the 1987 fires.

4. The current lack of connectivity and predominance of vegetation in early stages of succession, have major implications for wildlife, hydrologic regime, erosion and other ecological relationships as discussed throughout this document.

5. For hydrologic relations, less mature vegetation may indicate less interception and infiltration of precipitation and faster run-off leading to a loss of water retained and cycled through the watershed. At the same time, the reduction in biomass would be likely to result in a reduction in transpiration as well. The relative importance of each effect on hydrology would be a subject for future research. Certainly the reduction in ground cover and increased surface flows of water during storm events combined with the extensive road network that has been developed since the 1960s would be expected to led to greater rates of soil erosion than prevailed in the past. Here again, a reduction of the proportion of area in very early and early stages of vegetation development would likely reduce these types of disturbance.

Recommendations

1. In the future, to gain a better understanding of patterns of variability in this landscape, a fire history study and increases in archaeological surveying would be useful to shed light on natural ranges of variability of vegetative patterns for the prehistoric period.

2. It will be advisable to manage vegetation for a greater degree of connectivity in the landscape, through the use of corridors, to support flows of various species of wildlife with preferences for mid-and late succession forest throughout the watershed. These corridors should seek to encompass riparian zones and to connect the Butter Creek watershed with the surrounding landscape by working to conserve existing late succession vegetation and fill gaps in connectivity between late succession patches. This strategy would indicate immediate attention to reducing the potential for catastrophic fire due to dense vegetation and fuel ladders when they occur in these late succession patches. Ecologically sensitive thinning from below and other fuels reduction measures for forest health should be focused here. The connectivity of mid-successional forest is currently more adequate than that of later stages and should be maintained and slowly increased by allowing gaps to fill in over time.

Biological Diversity

Key Finding

1. There are several plant communities found in the Butter Creek watershed that are not very extensive, but contribute to the overall diversity of the landscape. These include the white oak communities near the mouth of Butter Creek, the Oregon ash and other wetland communities at Maddox Lake and dry meadows throughout the watershed.

Recommendation

1. Protect rare communities from additional human-caused disturbance. Consider the ecological significance of these rare communities in project and landscape planning and design restoration projects where appropri-

ate, especially where encroachment of conifers and non-native species in wet and dry meadows is occurring.

Late-Successional Reserves and Riparian Reserves (wildlife)

Key Findings

1. There is the potential for loss of threatened or endangered species habitat to catastrophic fire and suppression activities.
2. There is the potential to harass threatened or endangered species during fire suppression activities.

Recommendation

1. Minimize habitat damage and loss by aggressively attacking new fire starts and attempt to limit the size of all fires. Assign Resource Advisors familiar with the area immediately to all fires within LSRs and Riparian Reserves. Utilize minimum impact suppression methods by: Maintaining as much down woody material left in place as possible; by avoiding the felling of snags (unless safety conditions warrant otherwise); by avoiding the felling of standing vegetation (unless safety conditions warrant otherwise). Rapidly extinguish smoldering coarse woody and duff. Consult the ROD for other fire suppression standards and guidelines.
2. Attempt to avoid or limit loud and continuous noise (i.e., chainsaw, bulldozer, helicopter work) within approximately 1/4 mile of spotted owl activity centers. Prohibit loud and continuous noise within the peregrine falcon disturbance zone.

Historic and Prehistoric Human Values

Key Findings

1. Analysis indicates that the Butter Creek watershed was utilized for habitation in both prehistoric and historic times. It appears that the analysis area was used primarily on a temporary basis for short-term habitation. Native Americans spent their winter months along major streams where they utilized salmonid fisheries and stored plant foods. It has been suggested that year-round habitation occurred along some portions of major streams. Historic settlement patterns appear to have been in areas located adjacent to rivers or year-round water sources where the landform was relatively flat to gently sloping.
2. Analysis indicates that the configuration and total net acreage of the private landholdings has not changed significantly since the early 1900s. However, many parcels have been subdivided into smaller units ranging from 2.5 to 60 acres each. Therefore, the number of landowners has increased over time. One parcel, the Vaughn Ranch, was abandoned in 1880. It was never re-occupied, therefore is now included in the National Forest system.
3. Analysis indicates that heritage resources are being impacted by vandalism, dispersed recreation, erosion from non-system roads and road drainage, surface disturbance from road construction, administrative use and grazing. Past logging activities have also impacted heritage resources.
4. Analysis indicates that recreational use, private ownership/habitation, grazing, ranching and traditional Native American resource utilization are expected to continue into the future.

Recommendations

1. Additional research needs to be conducted in order to determine which prehistoric and historic resources are significant.
2. A plan needs to be developed to monitor impacts to historic properties.
3. Restoration measures need to be implemented on historic properties that are being impacted.

Contemporary Human Values

Key Findings

1. Analysis indicates that the social contexts associated with the Butter Creek watershed include logging, millwork, grazing, ranching, Forest Service administrative practices, recreation, local business, Native American use of resources, private ownership and habitation.
2. Hayfork is a classic example of a small community with a timber-dependent

economy. In addition to occupations directly associated with logging and sawmilling, secondary occupations dealing with recreation and government industries make significant contributions to the local economy. Other income is derived from farming, ranching, local business providing goods and services and cottage industries.

3. A growing sector of the population includes retirees and business people from large population centers that maintain a secondary residence in preparation for retirement. These individuals have moved to this area for the rural environment including a lower cost of living, more recreational opportunities and a slower pace of life.

4. Many Native Americans still maintain traditional values and practices. In many instances, they are concerned with management activities that may impact traditional land use. Many derive their income from the production and utilization of forest commodities.

5. Trinity County also has one of the highest unemployment rates in California, as well as one of the largest welfare programs in the state on a per capita basis with more than 1,900 citizens on public assistance. Reduced timber harvests have resulted in a reduction in jobs and income throughout the community's economy. Local businesses, government and many other sources of employment have all been affected. Educational and road maintenance needs have been adversely affected by reduced timber receipt dollars.

6. The local community expects ecosystem management to result in a healthy forest environment that will continue to provide employment in the future. They also value the watershed for its many recreational and educational opportunities. They envision a management approach that includes them in the decision-making process. Protection from the effects of devastating wildfires is also of paramount interest.

Recommendations

1. Continue to work with the local public in planning and implementing a wide variety of projects, in an ecologically sound manner, through Watershed Analysis and Ecosystem Management planning which provides a variety of outputs. Outputs could range from traditional commodities such as saw logs and chips, to special forest products, increased quality of recreation, a larger and healthier anadromous and resident fishery, better maintained roads and increased levels of receipts to the county government.

2. All projects identified and analyzed through the NEPA process should be evaluated for their potential to provide meaningful local jobs and contribute to the economic stability of local communities. Projects should be designed to have multi-year funding to allow for employment stability and capitalization of needed equipment. Provide multi-season work by mixing projects together in one contract.

Riparian Reserves

Key Findings

1. Three general riparian systems have been identified within the Butter Creek watershed, based on their physical characteristics: 1) upland alluvial channels, 2) steep canyonland inner gorge bedrock confined channels, and 3) moderate gradient bedrock confined channels. Each of these systems has different vegetation communities, fluvial processes, sediment delivery processes and riparian functions.

   The upland alluvial channels are characterized by dry sideslopes and mixed conifer plant associations, with an overstory of Jeffrey pine, ponderosa pine, incense cedar and some Douglas-fir. The overstory streamside vegetation can also be classified as mixed conifer. The flow regime of individual streams affects the composition of the understory vegetation. In a continuum from the driest ephemerals to the wettest perennial stream (Indian Valley Creek) the understory streamside vegetation ranges from herbaceous vegetation, such as grasses and rushes on the dry sites to a high cover of shrubs such as willow, gooseberry and Oregon grape along with herbs on mesic sites, to willow and herbs with no overstory on the wettest sites.

The vegetation of the steep canyonland inner gorge and moderate gradient bedrock confined channels indicates moister conditions than those of the upland alluvial channels, including the steepest slopes. In contrast to the upland alluvial channels, shrubs are found along ephemeral streams.

Elevation and stream flow regime control vegetative composition. Overstory vegetation varies along an elevation gradient from 1700 to 4600 feet. Douglas-fir dominates in the lower elevations and grades into white fir at the higher elevations. Sideslope overstory vegetation is normally Douglas-fir, canyon live oak and some ponderosa pine between 1700 to 4460 feet. From 3150 to 4460 feet, the overstory vegetation composition is white fir, Douglas-fir, canyon live oak and ponderosa pine.

Sideslope steepness and channel incision affects the amount of solar radiation the vegetation is exposed to. In general, deeper and steeper sideslopes are more protected from solar radiation and have greater relative humidity surrounding the riparian area. White fir plant associations tend to dominate under these conditions, and those populations often extend to a lower elevation, especially when the stream is perennial or intermittent. Moderate gradient drainages with shallow, less steep sideslopes are less protected from solar radiation and have lower relative humidity. Under these conditions, Douglas-fir tends to dominate, especially when on ephemeral streams.

a. Key factors in the upland alluvial systems are:

- ❑ The role large woody material plays in promoting channel stability and aquatic habitat diversity.
- ❑ The sensitivity of channel margins.
- ❑ The role of riparian vegetation, such as willows for bank stability and wildlife habitat.
- ❑ The relatively open nature of the vegetation structure.

Sediment delivery in the uplands is dominated by surface erosion from roads and the burned areas and unstable stream banks.

Grazing impacts are concentrated within wetlands and in certain areas adjacent to and within Indian Valley Creek.

Concentrated recreation, primarily during deer hunting season, has resulted in a lack of large woody material within the Riparian Reserve, soil compaction and direct effects to the water resource.

The 1987 fires burned predominantly within the upland areas and resulted in the death of much of the riparian vegetation within Friend Mountain Creek, Sheep Creek, Seven Road Creek, Rail Gulch and Cold Camp Creek.

b. Canyonland inner gorge, bedrock confined channels.

Key factors in this channel type are:

- ❑ The prominent source of sediment for these channel types are adjacent inner gorge landslides and upslope deep-seated landslides. Sediment is also delivered from the upstream upland alluvial channels.
- ❑ Due to channel gradient, much of the sediment delivered from the upland channels is routed through these channels.
- ❑ Channels have relatively diverse habitats with many reaches full of boulder lag from upslope landslides.
- ❑ Large woody material does not control channel gradient but local jams do store several cubic yards of material.
- ❑ Due to poor human access and steep slopes, snags and downed wood are in abundance adjacent to these channel types.
- ❑ Roads have less of an influence on these channels primarily due to slope steepness limiting the location of roads adjacent to these stream types.

- Due to the vegetation communities and lack of human access, there is more cover and the corridors are more effective than those in the upland areas.

c. Moderate Gradient Bedrock Confined Channels

This channel type is found in lower Butter Creek, and corresponds to the anadromous reach of Butter Creek. It lies below the falls, and there is a distinct gradient change from the upslope confined channel. It is still bounded by inner gorges.

Key factors for this channel type are:

- Due to the change in slope gradient, this is a depositional reach. Sediment from the 1964 flood was deposited within this reach, burying riparian vegetation. The channel was widened and made more shallow as well.
- Sediment sources are primarily from upstream, but there are several active or recently active inner gorge debris slides which deliver sediment directly to the channel.
- Gravel imbeddedness is 40 percent while the percent fines is 37 percent. Both of these values are relatively high and indicate that spawning habitat is generally poor.
- Pools appear to have been infilled by boulder lag from upstream or adjacent landslides, primarily related to the 1964 flood. Streamflow is insufficient to move this large material from the pools.
- Large woody material is deficient along this channel type, perhaps a function of the streamflow regime in the lower watershed.
- Snags and down woody material adjacent to the channel are adequate in this reach due to poor human access.
- The lowermost reach of Butter Creek lacks diversity because the channel has been artificially straightened below the county road bridge.

2. There are many more intermittent streams in the watershed than have been mapped. An example comparing field mapping of the actual extent of the intermittent stream network to what was mapped on the USGS 7 1/2 minute quadrangle yielded the following: A 30 percent increase in drainage density in the Buck Gulch subwatershed, a 38 percent increase in drainage density in the Headwaters Creek subwatershed and a 102 percent increase in drainage density in the Seven Road subwatershed.

3. Dispersed recreation is impacting several areas within the watershed, such as upper Indian Valley and Butter Creek Meadows. Recreation use has eliminated large woody material, snags and components of the understory vegetation community. Vehicular access to the Riparian Reserves has caused compaction, exposed soil and damaged channel margins.

4. Grazing is concentrated within several areas of the Riparian Reserve, such as upper Indian Valley and in the vicinity of Cold Camp Springs. Extensive use of these areas has led to impacts to riparian vegetation, bank trampling and water quality impacts.

Recommendations

1. The team recommends that the interim Riparian Reserves consist of the following, which shall be finalized at the site analysis level. The affects of these reserve boundaries will be analyzed through the NEPA process. Our recommendations are consistent with the Record of Decision for the President’s Plan, but refine the boundaries based on local conditions. A site potential tree height is defined in the ROD as “the average maximum height of the tallest dominant trees (200 years or older) for a given site class.” Calculation of site potential tree height should be made at the site analysis level. For analysis purposes, it is modeled as 150 feet. **Plate 29** is a map of the interim Riparian Reserves.

   Fish-bearing streams - We recommend that the Riparian Reserves consist of the stream and the area on either side of the stream extending from the edges of the active stream channel to:

- the top of the inner gorge,
- or to the outer edges of the 100-year floodplain,
- or to the outer edges of the riparian vegetation,
- or to a distance equal to the height of two site potential trees or 300 feet slope distance, whichever is greatest.

Permanently flowing nonfish-bearing streams - The Riparian Reserves should consist of the stream and the area on either side of the stream extending from the edges of the active stream channel to:

- the top of the inner gorge,
- or to the outer edges of the 100-year floodplain,
- or to the outer edges of the riparian vegetation,
- or to a distance equal to the height of one site potential tree or 150 feet slope distance, whichever is greatest.

Wetlands greater than 1 acre - The Riparian Reserves should consist of the wetland and the area to:

- the outer edges of the riparian vegetation,
- or to the extent of seasonally saturated soil,
- or to the extent of unstable or potentially unstable areas,
- or to a distance equal to the height of one site-potential tree,
- or 150 feet slope distance from the outer edge of the wetland whichever is greatest.

Natural Ponds - We recommend that the Riparian Reserves consist of the body of water and the area to:

- the outer edges of the riparian vegetation,
- or to the extent of seasonally saturated soil,
- or to the extent of unstable and potentially unstable areas,
- or to a distance equal to the height of two site potential trees,
- or 300 feet slope distance, whichever is greatest.

Seasonally flowing or intermittent streams, wetlands less than 1 acre and unstable and potentially unstable areas - The Riparian Reserves should include the following:

- All mass wasting features having a slope stability hazard of greater than seven, as mapped in the Ecological Unit Inventory, and described in Chapter I. This includes all valley inner gorges. These unstable and potentially unstable areas should be field verified and boundaries refined at the site analysis level, and additional areas added if warranted.

  Extend from the edges of the stream channel or wetland to a distance equal to the height of one site-potential tree, or 100 feet slope distance, whichever is greatest.

Intermittent streams are defined in the ROD as "any nonpermanent flowing drainage features having a definable channel and evidence of annual scour and deposition. This includes what are sometimes referred to as ephemeral streams if they meet these two physical criteria".

Analysis of the hydrography layer of the Cartographic Feature Files in GIS, which were edited to include obvious ephemeral streams, indicates that the approximate acres of Riparian Reserve within the Butter Creek Watershed are displayed in **Table 31**

As detailed earlier, field mapping of the actual intermittent stream locations and extent indicated that channel length will increase from 30 to 102 percent. Therefore, it is expected that the Riparian Reserves for Butter Creek are in actuality closer to 8,000 acres, or 33 percent of the watershed.

Table 31	ACRES OF RIPARIAN RESERVES
	Acres
Fish-bearing streams	1,724
Non fish-bearing streams	580
Intermittent streams	2,633
Unstable or potentially unstable lands	1,068
Wet areas and ponds	25
Total	**6,030**

2. There is a need for field verification of Riparian Reserves at the site analysis level. There are far more stream channels in the watershed than are mapped on the USGS quadrangle sheets. Intermittent streams must be identified at the site level during project implementation and the Riparian Reserves increased accordingly.

3. Consider the influence of road drainage when defining intermittent streams. Studies indicate that road drainage sometimes is concentrated in swales, which upslope from the road do not have evidence of annual flow, however, downslope of the road do show evidence of annual scour and deposition. Within the watershed, there are examples of how road drainage related flow can destabilize these swales. These are not riparian systems and in fact the road drainage should be corrected to prevent ongoing or future problems. However, if riparian plant communities have developed at these sites, assess the potential riparian values which may exist, realizing that there may be some value locally, and that these areas need to be maintained.

4. Specific interim Riparian Reserve widths may need to be expanded due to presence of specific plant or wildlife populations which may be found during site analysis, such as the presence of the western pond turtle.

5. During site analysis, consider specific corridor needs and how they are presently functioning. The Riparian Reserves may require expansion to compensate for locally poor corridor conditions.

6. Prescribed fire is only appropriate within Riparian Reserves when it is used under a prescription to reduce only fine fuels. At this point in time, larger fuels should be reduced within the Riparian Reserves only by manual, low impact means. The only exception would be fuels reduction/thinning in plantations which lie within the reserves. Spring burning within the Riparian Reserves is not recommended due to the potential effects on riparian dependent wildlife breeding.

7. Salvage harvesting should be prohibited within the Riparian Reserves due to the role of down large woody material for stream channel function and wildlife needs in the upland areas, and the generally deficient levels of snags and down woody material.

8. If the interim Riparian Reserve does not meet standards for down woody material and crown closure, evaluate for rehabilitation or enhancement during site analysis.

9. Focus Riparian Reserve restoration to upland alluvial channels within the 1987 burn areas and selected reaches adjacent to the lower moderate gradient bedrock confined anadromous reaches of lower Butter Creek.

10. Design Riparian Reserves at the site level adjacent to specific floodplains and along the upland alluvial channels to extend into the upslope area. Areas such as Butter Creek Meadow are very diverse and additional Riparian Reserve width is warranted.

11. At the site level, evaluate all roads within, crossing or directly affecting Riparian Reserves for closure, decommissioning, relocation or remediation.

12. At the site analysis level, evaluate all water drafting sites for potential negative effects to Riparian Reserves. Evaluate measures such as storage out-of-channel, piping to non-sensitive sites and fencing, which can help minimize impacts to the areas.

13. Through NEPA analysis, evaluate allotment plans to direct management to minimize impacts to Riparian Reserves, specifically in upper Indian Valley and Cold Camp Spring.

14. At the site level, evaluate ways to reduce the impacts of high density dispersed recreation within and adjacent to the Riparian Reserves of Indian Valley.

15. Be consistent with the ROD when performing fire suppression. One goal of fire suppression is to limit the negative effects of wildfire in Riparian Reserves. To avoid other impacts to Riparian Reserves:

    a) Do not locate incident bases, roads, camps, helibases, staging areas and helispots inside Riparian Reserve boundaries.

    b) Avoid applying chemical retardant, foam, or other additives, **if at all possible**, to surface waters in streams, springs, seeps, or any other wet area. Avoidance is the preferred alternative. Safety concerns override this prescription.

    c) When cutting line avoid Riparian Reserves. If necessary, avoid cutting line through any vegetation such as shrubs or trees adjacent to any wet or dry water course. Do not cut or dislodge any wood within a wet or dry water course. Safety concerns override this prescription.

    d) Due to the extremely low water levels during the fire season, in-stream drafting from existing water holes should be avoided. Water can be obtained from the South Fork Trinity River or lower Hayfork Creek. Need to confer with hydrology resource specialist prior drafting. Obviously, safety concerns override this prescription.

    e) Report any fire suppression related disturbance within Riparian Reserves to the Planning Section for rehabilitation consideration and treatment. This includes hand lines as well as dozer lines.

    f) Burned area emergency rehabilitation efforts will use an ecosystems management approach, utilizing genetically local native plant materials, when available and appropriate, for surface stabilization.

Transportation Planning

Key Findings

1. Analysis indicates that some subwatersheds have a very high road density. The overall road density for the Butter Creek watershed is 4.33 miles per square mile. The range is from 1.18 to 7.3 mi/mi^2. **Table 8** is a listing of road densities for each subwatershed. A road density of 1.5 miles per square mile is considered high from a wildlife perspective (Brown, 1985). High road densities not only contribute to erosion and sedimentation, but also increase disturbance to wildlife, concentrate hunting pressure, facilitate illegal harvest, and decrease the effective use of habitats, especially wetlands and riparian areas. Furthermore, from a watershed perspective, equivalent road acre levels are very high in some of the subwatersheds, with roads contributing to the problem.

2. Analysis indicates that surface erosion from roads is contributing to the amount of fine-grained sediment which is being deposited in the lower anadromous reaches of Butter Creek. It is a cumulative effect rather than a site specific problem, and is one of three major sources of sediment.

3. Much of the transportation system within the watershed, including Forest Service and county roads, need maintenance. Some roads have insloped drainage systems, which left unmaintained can cause erosion.

4. The majority of the main haul roads constructed in the 1950s were designed for an inside ditch with cross-draining culverts placed approximately every 300 feet, depending on the grade of the road. The placement of these pipes did not always match the natural drainages and therefore, diverted surface runoff down exposed hillsides which sometimes caused gullies to form and sediment to enter streams.

5. Analysis indicates that 35.09 miles of road or 168 acres of the transportation system is within the interim Riparian Reserve. Most of the areas are stream crossings, however many roads are located parallel to streams in the upland area. The majority of these acres are related to essential roads, which cannot be easily decommissioned.

6. For the most part, roads have been located in areas without any significant slope stability problems. However, 3.97 miles of road

are located within areas having a slope stability hazard of greater than seven.

7. A field survey found 142 culverts within the Butter Creek watershed, of which 94 to 115 did not meet the 100 year flow requirement outlined in Standards and Guideline RF-4, on page C-33 of the ROD (USDA and USDI, 1994). Eight culverts which did not meet the 100 year flow need to be replaced to allow fish passage, defined by Standard and Guideline RF-6. One culvert which met the 100 year flow also needs to be replaced to allow fish passage.

8. The majority of culverts are no longer at grade at the outlet, therefore are “shotgun” culverts. They have created their own energy dissipators through erosion. In some cases maintenance was needed to cut down shrubs and alders which were growing across culvert inlets. No analysis was performed regarding the risk that these culverts posed to the Riparian Reserve, as defined by the ROD. However, replacement costs were estimated to be over $8,000 per mile of road, or 1.2 million dollars for the watershed.

9. The transportation system was also surveyed for surface type. Over 66 percent of the system within the Butter Creek watershed is native surfaced, nearly 30 percent has aggregate surface, 1.9 percent is asphalt surfaced and 1.7 percent is chip sealed.

Recommendations

1. Be consistent with Road Management Standards and Guidelines on pages C-32 and 33, in the ROD.

2. A transportation plan needs to be developed for the watershed which considers decreasing road density because of the problems noted in the key findings. As defined on page C-33 of the ROD: “This plan shall include provisions for the following activities:

   a. inspections and maintenance during storm events.

   b. inspections and maintenance after storm events.

   c. road operation and maintenance, giving high priority to identifying and correcting road drainage problems that contribute to degraded riparian resources.

   d. traffic regulation during wet periods to prevent damage to riparian resources.

   e. establish the purpose of each road by developing the Road Management Objective.”

   Priorities for the above activities should be defined. A “minimum system” needs to be identified and maintenance prescribed and budgeted for. A part of this plan includes recommendations for seasonal closure, year-round closure and decommissioning. In addition, the plan needs to evaluate the condition of stream crossings and surface stabilization needs at the site level for reduction of fine-grained sediment. This plan would serve as a key tool for the watershed restoration program, and will greatly aid in the identification of potential projects and in setting priorities.

3. Roads which are located within highly unstable areas should be individually analyzed and closure, obliteration, restoration or remediation be considered, depending on the potential of the road to contribute to slope instability and water quality degradation.

4. Through road closure or obliteration, road density should be managed to be less than 2.5 miles per square mile. Use road density as a prioritization criteria for road closure and obliteration. Give a high priority to decreasing access to wetlands, Riparian Reserves, LSR, Critical Habitat Unit, northern spotted owl home range and wildlife corridors.

5. Jeep trails and temporary roads which are presently being used need to be closed or obliterated unless they are determined to be needed as system roads. If they are needed as system roads they should be evaluated for maintenance needs, assigned a maintenance class and evaluated for the need to be upgraded to meet standards.

6. Evaluate the need for surfacing based on evidence of erosion, and location of the road relative to Riparian Reserves since much of the road system in the watershed is unsur-faced.

7. Evaluate culvert size and condition within the watershed. As stated on page C-33 of the ROD: "New culverts, bridges and other stream crossings shall be constructed and existing culverts, bridges and other stream crossings determined to pose a substantial risk to riparian conditions will be improved, to accommodate at least the 100 year flood, including associated bedload and debris. Priority for upgrading will be based on the potential impact and the ecological value of the riparian resources affected. Crossings will be constructed and maintained to prevent diversion of streamflow out of the channel and down the road in the event of crossing failure."

8. Since Butter Creek is within the South Fork Key Watershed, the ROD directs on page C-7 to "Reduce existing road system and nonsystem road mileage. If funding is insufficient to implement reductions, there will be no net increase in the amount of roads in Key Watersheds."

9. Evaluate low water crossings to assess if road closure, culvert installation or other measures are warranted to prevent stream channel or water quality degradation.

10. Through the Resource Conservation District and Natural Resources Conservation Service, evaluate roads and stream crossings on private lands within the watershed. Work with private landowners to identify sources of funding to help correct identified problems.

11. At the site level, perform a risk assessment for culverts at the major stream crossing to see if they pose a significant risk to the Riparian Reserve, as defined by the ROD.

12. Evaluate shotgun culverts and repair them based on their potential effects on Riparian Reserves.

13. Evaluate the nine culverts identified as not providing fish passage for replacement, based on fish presence and potential impacts to Riparian Reserves.

Cumulative Watershed Effects

Key Findings

1. Quantity of water, in the form of large flood events and annual peak flows, has an influence on the water quality, in the form of sediment loads. Large runoff events have triggered and reactivated landslides along Butter Creek and Indian Valley Creek contributing large quantities of sediment to the downstream system. Because of steep stream gradients, Butter Creek and its tributaries are able to transport the majority of all but the largest sediment produced by large flood events out of the watershed and into the South Fork Trinity River. However, large volumes of sediment were deposited in the lower gradient anadromous reach during the 1964 flood event.

2. Under annual and bankfull peak flow events the stream system seems to be sediment-rich in the fine-size component. Although Butter Creek is a high energy stream system, it is not flushing out all fine sediment in the anadromous, lower gradient stream reach. As peak flows recede the fine sediment load, contributed from the watershed upstream, drops out and becomes a rather large component of the stream bed material. There is also a high percentage of cobble and boulder-size material in the anadromous section of Butter Creek, but a low percentage of the gravel size component.

3. The potential for management induced peak flow increases was assessed three different ways. First, the Equivalent Roaded Area (ERA) method was utilized to evaluate levels of harvesting and road related disturbances for each subwatershed as key contributors to increases in peak flows. **Table 6**, in Chapter I, shows existing ERA levels for each of the subwatersheds. The highest ERA levels are 19.2 percent in the Seven Road subwatershed, 15.8 percent in Rail Gulch, 15.3 percent in Cold Camp Creek and 12.4 percent in Headwaters Creek. All of these high ERA levels are related to the 1987 fire and salvage activities.

Table 7, in Chapter I, documents the acres of plantations for each subwatershed. There are over 5,000 acres of plantations within the Butter Creek watershed, which is nearly 20 percent of the area. Similar to the ERA analysis, subwatersheds with the greatest area in plantations include Seven Road Creek (78.1 percent), Cold Camp Creek (57.4 percent), Rail Gulch (51.4 percent) and Sheep Creek (30.1 percent).

The watershed is well roaded, with over 159 miles of road present. As shown in **Table 8**, in Chapter I, road densities range from a low of 1.2 miles per square mile in the Long Creek subwatershed, to 7.3 miles per square mile in the Headwaters subwatershed. Other subwatersheds having high road densities include Rail Gulch (6.8), Cow Gulch, (6.1), Cold Camp Creek (5.4) and middle Butter unit (5.3). The average road density is roughly 4.3 miles of road per square mile. The majority of upland watersheds are heavily roaded, while the canyonlands are not.

Each of these methods indicate that Seven Road, Rail Gulch and Cold Camp subwatersheds are at greatest risk for peak flow increases and potential cumulative effects.

4. Another analysis evaluated the sediment sources within the Butter Creek watershed. Since the present condition of lower Butter Creek includes a high proportion of fine sediment, it is evident that there is a considerable source of fine sediment upstream. Sources of the fine sediment are threefold: 1) The Maddox Lake and Confluence slump-earthflows; 2) a variety of smaller point sources such as small slides, unvegetated erodible soils and unstable channel banks in the uplands, and 3) non-point sources associated with roads and the 1987 burned areas.

The earthflows are developed within the serpentine melange and therefore have a very large clay and silt component due to the highly sheared nature of that bedrock unit. Both of these features are active and deliver sediment directly into lower Indian Valley Creek and lower Butter Creek. Periodically, the features become quite active and deliver large amounts of sediment to the system. In addition, there are many smaller landslide features which deliver several cubic yards to several hundred cubic yards periodically to the stream system. These mass wasting features are located throughout the canyon-lands and lower Butter Creek. Secondary processes, such as surface erosion, also contribute sediment to the fluvial system from active or recently active mass wasting features.

Many alluvial stream channels in the uplands have been destabilized in the past and have not fully recovered to a stable condition. During large storm events, stream banks are scoured and channels reconfigured in the upper reaches and tributaries, providing above-background sediment to the system. There are also small scattered areas having soils of granodiorite parent material within the watershed that are considered highly erodible. These soils contribute accelerated sedimentation following surface disturbances.

As described previously, there are 159 miles of road within the watershed contributing to high road densities. The majority of the roads have native surfaces, and thus are not always resistant to surface erosion. Field observations indicate that road drainage is not well controlled in the watershed. There were many sections having rills and evidence of water running down long segments of road. County road 316 is insloped and generally carries water 400 to 600 feet before being cross-drained. Some sections are not draining according to design. Where this road surface drainage connects to the active stream system the runoff produced delivers its fine-grained sediment load downstream.

The fires of 1987 burned approximately 35 percent of the watershed. Large woody material was burned within intermittent stream channels. Large wood in these channels serve as grade control structures and sites of sediment storage. When the wood is burned out the channels become destabilized and large quantities of stored sediment are released downstream. In addition, many of the fire-killed trees were salvage harvested, causing further site disturbance. Subsequent watershed restoration efforts, reforestation and natural processes of revegetation and dead trees falling into the intermittent streams have helped the area move toward hydrologic recovery.

5. As described in Chapter I, the Shasta-Trinity National Forests have traditionally evaluated the sensitivity of watersheds as a function of slope steepness, mass wasting potential, surface erosion potential and peak flow characteristics. The following narratives will describe those qualities for the watershed:

   In general the distribution of the mass wasting hazards is a function of slope and material. By evaluating the spatial distribution of mass wasting hazards on a subwatershed basis, the general inherent sensitivity, or potential for sediment production can be ascertained and compared on a relative basis. **Figure 3**, in Chapter I, is a comparative histogram of the distribution of landslide hazards for each of the subwatersheds within Butter Creek. Subwatersheds at the left side of the figure have the greatest level of hazards, while the ones on the right have the lowest relative hazard.

   The moderate slopes of much of the watershed combined with the generally inherent low erodibility of the soils results in a surface erosion hazard of low or moderate for much of the watershed (**Figure 4**, Chapter I). High erosion hazards can be almost exclusively linked to slopes in excess of 65 percent, or as a secondary process of localized landsliding. High coarse gravel contents within the matrix of fine-grained, not-readily detachable clay soils also reduce the erosion hazard rating on some soil types occurring on moderately steep to steep surfaces.

   Figure 5, in Chapter I, shows the drainage densities for the subwatersheds of Butter Creek. Generally, most of the higher drainage density subwatersheds are located in the upland plateau portion of Butter Creek watershed and most of the low drainage density subwatersheds are located in the canyonlands portion. Drainage density may be an indication of the ability of a watershed to deliver water and its sediment to the stream system, although is only one of many such factors. It is influenced by the parent material, geomorphology and fluvial development of the watershed, to name but a few. It can be used to assess the sensitivity of the various sub-watersheds in the Butter Creek watershed.

   Initially, the utility of using these physical characteristics to evaluate the sensitivities of these subwatersheds was considered. After numerous discussions, it was decided that the best way to rank the watersheds, in terms of their sensitivity to peak flows and sediment, was on the basis of process. There are two different channel types, which we have previously described: Upland alluvial channels and canyonland bedrock confined channels. Each have different processes and factors which affect their stability and function.

   The upland channels were destabilized initially when significant riparian vegetation was removed as a result of over-grazing in the late 1800s. Many of these channels responded by downcutting and gullying headward. In the intervening years the channels adjusted, re-established floodplains, and again approached stability. Subsequent downcutting and adjustments were made in tributaries and in the main channels as other upland disturbances and the large runoff events of 1955 and 1964 occurred. Presently the upland channels are less sensitive to cumulative affect changes, primarily because they have eroded down to bedrock controls and have adjusted sufficiently to normal stormflows and sediment loads.

   The bedrock confined channels have not been directly affected by management disturbances. They are, however, the site of active mass wasting, triggered by peak flows undercutting toe zones of slides and inner gorge debris slides. The channels are stable, but the immediate side slopes remain sensitive to peak flow destabilization.

   As shown in **Table 6**, in Chapter I, the following watersheds are predominately alluvial channels: Buck Gulch, Cow Gulch, upper Butter Creek, middle Butter Unit, South Butter Creek, Corral Gulch, Headwaters Creek, Rail Gulch, Seven Road Creek, Sheep Creek, Friend Mtn. Creek and upper Indian Valley Creek. The remaining watersheds, including middle Indian Valley Unit, Cold Camp Creek, Indian Valley Canyon Unit, First Indian Valley Creek, First Butter Creek, Butter Creek, North Creek, Indian Valley Creek, Confluence Unit and Long Creek are considered to have bedrock confined channels.

6. The quality of water produced from the Butter Creek watershed is excellent during baseflow conditions. There are few human developments within the watershed that could produce associated pollutants such as pesticides, fertilizers, sewage, and industrial wastes, to name a few. There is a limited amount of cattle grazing and thus the potential for local, short duration bacterial pollution. Giardia populations are potentially present in all mountain streams of the area and can be expected to be in Butter Creek as well. Testing for alkalinity and total dissolved solids have shown no evidence of chemical pollutants (USDA FS, 1991). Measurements of pH have been consistent with pH measurements throughout the South Fork Trinity River system, in managed and unmanaged watersheds (USDA FS, 1991).

7. Monitoring of water temperature has been conducted throughout the South Fork Trinity River basin, including Butter Creek, at various times during the last several years. Some data was collected as early as the 1950s by the U.S. Geological Survey (USGS, 1971). A California Department of Fish and Game stream survey report recorded water temperatures of 59 degrees on September 10, 1952, and 63 degrees on September 16, 1952 (CDFG, 1952). These temperatures correspond to temperatures recorded for that time of year in recent years (USDA FS, 1990, 1991, 1994). Although it is generally believed that water temperatures have been elevated in the Butter Creek watershed due to removal of riparian vegetation, the monitoring program has not produced data to confirm this belief. Water temperatures appear to be consistent with other streams of similar size and elevation in the South Fork Trinity River watershed, whether disturbed or undisturbed.

Recommendations

1. An analysis was conducted to evaluate what level the threshold of concern (TOC) for each of the subwatersheds should be. The TOC value is based on the sensitivity of each subwater-shed; the higher the sensitivity to cumulative effects, the lower the TOC. Values of TOC used on the Forest range from 12 percent to 18 percent. Based on the sensitivity analysis, it is recommend that the subwatersheds of Butter Creek be assigned TOCs of 12 or 14 percent, as displayed in **Table 6**, Chapter I. Given the recovery evident in the burned area, it is not recommended that TOCs be lowered in the burned areas. It is also emphasized that if watersheds approach or exceed these TOCs, that further evaluation be performed, and approaches proposed for lowering disturbance levels. The TOC is meant to be a red flag indicator, not a value predictive of the onset of cumulative effects.

   Based on the above discussion, the following subwatersheds are considered to be approaching or exceeding their TOC. It is recommended that watershed restoration activities be focussed on these subwatersheds in the next several years: Cold Camp Creek, Headwaters Creek, Rail Gulch, Seven Road Creek and upper Butter Creek.

2. Restoration activities which will help reduce cumulative watershed effects include reducing the level of roads within the watershed through obliteration. Road closure, including restoration of stream crossings and ripping and revegetation of the road surface is also an effective way to help reduce runoff and sedimentation. Surface stabilization of roads which are to remain system roads is an effective practice in reducing erosion of fine-grained sediment. Other practices which will help reduce cumulative effects are the ripping and mulching of skid trails and landings, restoration of Riparian Reserves where they have been impacted by fires, and correction of road drainage problems, including water concentration and the control of water at stream crossings.

3. Ground disturbing activities from future activities, especially within the watersheds

listed above, should be minimized. There should be no net increase in ground disturbances within watersheds approaching or exceeding their TOC. Special management practices and BMPs should be prescribed.

Ecosystem Restoration

Aquatic Restoration

Watershed restoration throughout the Butter Creek watershed is a necessary action to achieve the Desired Future Conditions of the stream channels, riparian habitats and fisheries resources. The needs for these resources vary throughout the entire watershed, and therefore will be discussed by considering present conditions and causative factors.

Key Findings

1. Upper Indian Valley Creek has exhibited the greatest change from the Native American age to the present. The channel has been downcut and widened in a series of adjustments in response to several environmental disturbances, including grazing, roads, timber management, the combined effects of these disturbances and the 1964 flood event. These adjustments were translated to the tributaries of Indian Valley Creek.

2. The major change in channel form of Indian Valley Creek is a shift from a narrow, deep, meandering channel, controlled mainly by vegetation and woody material, to a less sinuous, broad, shallow channel, overladen with fine sediment in depositional reaches and bedrock controlled in steeper reaches. The stream offers little aquatic habitat in the dryer months of the year, primarily due to intergravel flow of the available water. Channel adjustments have progressed to the point where further downcutting and side cutting are generally unlikely. Once the upstream input of sediment drops off due to natural or induced stabilization efforts, the lower sections of the main channel will begin to reform flood plains and deepen their bankfull channel profiles.

3. Stream channels in small upland watersheds tributary to Indian Valley Creek are primarily First and second order channels, with relatively small segments of Third order channels. These third order channels are often dry during the late summer and are all classified as non fish-bearing streams. The main channels of the streams directly tributary to Indian Valley Creek were downcut when Indian Valley Creek experienced its stages of destabilization and downcutting. Attempts have been made over several years to stabilize the most severely eroding and downcutting portions of Indian Valley Creek and its tributaries. Currently the most actively adjusting channels are in the Headwaters subwatershed where downcutting and side-cutting continue to occur.

4. Potential changes in channel condition are most likely to be negative in the tributaries of Indian Valley Creek and, most particularly, in the channels of the Headwaters subwatershed where downcutting is still occurring. The rest of Indian Valley Creek and its tributaries are stabilizing and are beginning to settle into a channel form which is natural for the landscape.

5. Large woody material likely played a larger role in the streams of this area in the past, however little large woody material is present today. Large woody material has the potential to control stream channel structure and diversify fish habitat in the streams in the uplands area.

6. Within the four subwatersheds (Corral Gulch, upper Butter Creek, South Butter Creek and middle Butter Unit) comprising the upland portion of Butter Creek watershed proper, channel gradients are generally moderate, with the higher order streams having grades of two to four percent. The channels have downcut in places and stabilized themselves over the years into moderately confined, but stable stream channels, having characteristics of Rosgen type B channels (Rosgen, 1994). First and second order channels have been impacted the most by initial harvesting practices in the 1950s and 1960s. The 1964 flood and 1987 fire disturbances had some effect in these

drainages, but only to a moderate degree relative to other areas. Channel sensitivity is most pronounced in a portion of the upper Butter Creek subwatershed due to the presence of highly erodible soils and in the lower reaches of Corral Gulch due to channel aggradation.

7. First and second order channels of the canyonlands area are generally steep, bedrock controlled channels typical of Rosgen type A channels (Rosgen, 1994). These channels have experienced fewer direct impacts from past harvesting and roading due to the steepness of the terrain with the subsequent difficulty of placing site disturbing equipment within the Riparian Reserves of these channels. Sediment is routed quickly through these high energy channels. Bank stability is dependent more on adjacent slope stability than the influence of channel migration. However, slope stability has historically been affected by peak flow events eroding toe zones of slides and triggering activity. Confined bedrock controlled channels are the norm. Woody debris has some function for sediment storage and stability in the short term, but the steeper low order channels are more functional as woody debris conduits, delivering wood to downstream channels.

8. Third and fourth order channels of the canyonlands area include the major channels of Indian Valley Creek and Butter Creek upstream of their confluence. These reaches are high discharge, steep gradient channels that are well developed in their landscapes. Bedrock and boulders control these very stable channels that have not changed significantly despite upstream channel changes. Although the channels themselves are stable, the sideslopes of the higher order channels of the canyonlands area are characteristically very unstable (see discussion under Geology, Chapter I).

9. The only anadromous fish habitat stream in the watershed is in the relatively short , 1 1/2 mile reach of Butter Creek between the confluence of Butter and Indian Valley Creeks and the confluence with the South Fork Trinity River. This reach is characterized by moderate to low gradients (less than four percent), high volumes of storm runoff and sediment load and active instability of the inner gorge sideslopes.

10. The channel is stable in its landscape, being predominantly a Rosgen type “B” channel. It has been modified by large runoff events and influxes of sediment from local and upstream landslides. Since it is of a lower gradient than its upstream tributaries, it is a reach of temporary sediment storage. Flood deposit terraces are present that show evidence of multiple event historic depositions and subsequent downcutting to the original bed surface.

11. Streambed composition of this reach is a result of the sediment delivery dynamics of the upstream watershed. The large size class of the streambed has been influenced by the most recent landslide activity (1964 to present). Large boulders have infilled some bedrock pools and are likely to be immobile during a normal range of future flood flow events. Large quantities of fine sediments (<3.5mm) are supplied by the chronic sources already described. These can be expected to be flushed out of the bed over time if the sources are stabilized.

12. Sediment deposited in this lower reach from the 1964 flood event has been reworked and transported out of the watershed to the extent that the original channel profile elevations may be approaching those levels occurring prior to the flood. This is indicated by flood terraces now observed many feet above the water level. It is possible that coarser material, such as the boulder and rubble substrate observed to be dominating the majority of the channel bed today, was largely introduced from landslides during the 1964 flood. This material may be filling pools that were once present and historically more accommodating for salmon species now absent. Only a protracted time period allowing for much physical reduction and transport of this large material will permit the fish habitat of Butter Creek to be conducive for salmon once again without intensive instream manipulation which indeed may not be cost effective.

13. It appears that some channelization work was conducted in the lower 400 feet of Butter Creek which resulted in a relatively artificial channel lacking habitat diversity and acting as a deterrent to easy fish access.

14. There is a scarcity of riparian vegetation for stream channel shade, cover and large woody recruitment along lower Butter Creek.

15. Grazing in the watersheds of the Upland Area has occurred since early settlement of the area in the 1800s. The initial grazing impacts were the most severe due to over-utilization of riparian vegetation and the impact of herding animals. Impacts to the streams included a reduction in riparian vegetation, compaction of soil, bank sloughing and the loss of channel stability. Present levels of grazing on National Forest lands are relatively light and are not contributing to significant channel degradation. If grazing continues at its present level, it is likely that there will be a gradual degradation of environmental conditions in the intensive use area, and suppression and effects to riparian vegetation and habitats. Stock grazing on the private land in Indian Valley has had more recent impacts and is more locally intense, resulting in continued compaction, erosion and sedimentation.

16. Indian Valley has the most intense recreational use of any area in the Butter Creek watershed. Concentration of hunter camps along Indian Valley Creek upstream of the Guard Station has had a negative influence on riparian vegetation and down woody material. Vehicular intrusion has led to soil compaction and bank erosion within the Riparian Reserves. Potential changes due to recreational use in the Indian Valley area will be very similar to those described for grazing.

17. Road densities in the Butter Creek watershed average 4.7 miles/mile^2, the high being 7.3 and the low 1.8 (see **Table 8**). Many roads are located within Riparian Reserves in the upland portion of the Butter Creek Watershed and contribute fine sediment directly to streams from storm runoff. Although a sediment budget was not conducted for this analysis, it appears from current knowledge of the watershed that roads are a chronic and major contributor of fine sediment to the stream system which is impacting anadromous fish habitat.

18. Roads throughout the watershed contribute to surface runoff following rainstorms. Where the road drainage system discharges directly to the stream channel system the runoff influences the flow regime by increasing peak stream flows. Stream crossings have the potential for culvert plugging and road fill failure.

19. The canyonlands area contains the bulk of the identified unstable areas in the Butter Creek Watershed. Roads can be of particular concern when they cross into unstable terrain (see discussion of roads and unstable areas). Roads have not been a major problem in the unstable areas in the past, but remain a maintenance problem and a potential trigger to mass wasting events.

20. All upland channels have been affected by some form of timber harvest practice; the intense salvage operations of 1988, green tree timber sales on private land, selective harvesting and patch clear cutting on National Forest land. Almost all of the harvesting was done with tractors utilizing skid trail systems. These skid trails have compacted the soil and in some places resulted in direct runoff and sediment delivery to streams.

21. The 1987 fires had significant impact on the upper portions of Cold Camp Creek, the north facing tributaries of upper Indian Valley Creek and the Indian Valley Canyon Unit. Very high fire intensities burned through the Riparian Reserves and affected channel stability. Restoration efforts following the fire provided some mitigation.

22. The canyonlands area contains the largest areal extent of unmanaged land in the Butter Creek watershed. Management has been lacking due to the extreme ruggedness of the area and, to some extent, the lack of timber values. Some of the lower order, undisturbed channels may be useful as models of refugia to use for restoration efforts of disturbed streams in similar settings.

23. Habitat typing surveys in 1990 and 1993 found winter steelhead as the dominant

anadromous fish species in lower Butter Creek. Surveyors did not observe spring Chinook adults or coho salmon juveniles in lower Butter Creek.

24. Summer steelhead adults were observed in the holding pool near the confluence of the South Fork of the Trinity River and Butter Creek. As such, Butter Creek may serve as a spawning stream for summer steelhead.

25. Young-of-the-year (Age 0+) steelhead juveniles were observed and measured in Butter Creek at a density that rivalled some of the least disturbed tributaries to the Trinity River. This average Age 0+ steelhead juvenile density suggests that the available habitat for steelhead (approximately 12,500 sq. meters or 0.4 percent of the total stream substrate area) may be fully utilized by spawning adults and is of reasonably accommodating quality.

26. No biological factors have been found that account for the apparent disproportionate reduction of Age 1+ and 2+ steelhead juveniles in relation to Age 0+ production. Butter Creek is a high energy stream with high flushing capabilities. Given the lack of pools, older aged steelhead juveniles would find it exceedingly difficulty to maintain a foot-hold during high flows in winter. We ascertain that the older aged steelhead are flushed from Butter Creek and forced downstream into the South Fork Trinity River to rear in its deeper pools.

27. Densities of Age 1+ and 2+ juvenile steelhead in Butter Creek matched results of other tributaries in the South Fork basin that began with many less Age 0+ steelhead. Because water temperatures in Butter Creek were never measured above 65 degrees F., other habitat variables are apparently limiting for steelhead beyond Age 0+. A relative lack of pools and cover in conjunction with high water velocities in winter associated with the steep gradient [2.5 to 7.5 percent] may be the reasons why older steelhead juveniles do not hold and rear in large numbers within lower Butter Creek. Additionally, existing cover was provided primarily by large rock substrate with large woody material seldom found in the lower anadromous reach.

Recommendations

1. The most effective channel stabilization techniques that could be applied to the first and second order channels include grade stabilization and revegetation. Only those channels showing indications of instability need to be treated with grade stabilizers. Third order channels should be treated to return them to a natural form which is stable for their landscape. This may involve grade stabilization, bank stabilization and revegetation of their riparian areas. Revegetation is progressing naturally, although past use of willow cuttings have proven effective in accelerating revegetation. Restoration of species diversity is another possible objective. Control of cattle grazing will have to be a component of any restoration effort utilizing vegetation planting. Expected benefits include stream channels that are stable in their landform and are capable of delivering a natural level of sediment load downstream.

2. In the third and fourth-order sections of upper Indian Valley Creek there are several optional courses of action that could be taken for restoration of the channel and riparian area. No action will allow for natural stabilization, however, change will be gradual. Restoration activities could include major modification of the channel to produce a channel which is stable in its geomorphic environment, or a mix of channel improvements and fish habitat improvements which are physically and environmentally appropriate. Habitat improvements could include the use of logs and/or large boulders to produce pools and low flow habitat. Restoration could be done piecemeal over an extended period, each piece contributing to the long term whole. Revegetation of the riparian areas along Indian Valley Creek would be an appropriate technique for bank stabilization. The practice would also increase plant abundance and diversity, and improve riparian habitat. The primary benefit of doing restoration practices within the main channel of Indian Valley Creek would be the stabilization of the most highly disturbed channel in the Butter Creek watershed. There would also be related benefits to aquatic and riparian habitats and populations. The area

would be more aesthetically pleasing and have an increased value for recreation.

3. The third and fourth order channels in the four subwatersheds comprising upper Butter Creek have generally stabilized in their environments naturally, and require stabilization efforts in only a few places. Introduction of large woody material and boulder weirs would produce more diversity of habitat for aquatic species. These improvements would be most beneficial in the main channel of Butter Creek in the middle and upper Butter Creek watersheds. Benefits would be directed toward the diversity of aquatic habitat while maintaining or enhancing channel stability.

4. Compacted skid trails in tractor harvested areas, which are contributing sediment to the stream channels, should be a high priority for restoration. The most severely compacted areas can be ripped to break up the compaction, mulched with wood chips or straw and the area revegetated. Where surface runoff cannot be eliminated, water bars can be utilized to disperse the runoff and prevent it from directly entering a stream system.

5. As discussed under Transportation Planning, a Transportation Plan should evaluate road needs, crossing conditions and evaluate how to reduce road densities and road generated sediment.

6. Transportation planning should consider relocation of roads necessary for management in order to remove them from unstable areas. Removing the threat of mass failures due to present road locations in unstable areas should be the highest priority project for watershed restoration. Maintenance of proper drainage should be a high priority of the road maintenance program in Butter Creek.

7. Fine sediment contributed by the road system should be reduced by decommissioning, closure, or surface stabilization practices. This is especially true for roads which lie within the Riparian Reserves.

8. In the Riparian Reserves section of this chapter a recommendation was made to evaluate ways to reduce recreational impacts to Indian Valley Creek and riparian areas. Consideration should be given to excluding all camping within 100 feet on either side of any perennial stream. One strategy would be to offset use through developing a system of centralized camps in designated non-sensitive or non-critical riparian or upland areas. Restoration of the impacts of recreational use along Indian Valley Creek are best handled with the use of techniques that change the use patterns, which will allow for successful revegetation. Decompaction may also be desirable in some of the more severely affected areas. Benefits will be a healthier riparian zone and a more desirable recreational environment. Methods for restricting vehicular access, as described in the Riparian Reserves section of this chapter, should be considered.

9. Watershed restoration measures need to be applied across the major part of the basin and allowed to achieve stabilization before attempts are made to manipulate or improve fish habitat, particularly for resident rainbow trout.

10. The first 400 foot reach of Butter Creek, upstream of the South Fork Trinity River, should be realigned and riparian vegetation replanted, based on geomorphic principles. This task will restore a more natural stream channel that will benefit spawning salmon. Considerations that need to be taken into account for such a project include: The area is subject to future inundation with sediments deposited from upstream landslide events. The gradient, bankfull flow depth, confinement of sideslopes and historic bedload movement suggest that a step-pool configuration, rather than a meandering pool-riffle configuration is more likely to fit the landscape. The cost-benefit of doing temporary improvements that would be obliterated by future large runoff events may be greater than the cost-benefit of installing structures capable of surviving a large runoff event. This lower reach is located on private lands, however, the Forest Service should support Trinity River Restoration Program efforts to work on this channel reach.

11. Riparian vegetation should be restored through planting within the Riparian Reserve to potentially contribute to cooler water temperatures where current vegetative

shade can be improved. While temperature problems in Butter Creek are not critical, any improvement in this sub-basin would help buffer high stream temperatures in the South Fork Trinity River. In addition, plantings would eventually be a source of large woody material. The highest priority area for this treatment is along the anadromous fish habitat section of lower Butter Creek.

12. Do not attempt any restoration work in the third and fourth order channels in the canyon-lands area. These channels are high gradient, high discharge and high energy channels that quickly adjust to any changes. “Improvements” in these channels would be costly and not likely to survive high flow events.

13. In-channel improvements for channel stability are not required in the anadromous fish habitat section of lower Butter Creek as the channel quickly adjusts to any changes and is stable in its landscape.

14. Mechanical or remedial stabilization of active slides adjacent to the channel in the anadromous reach is not recommended at this time. Analysis indicates that within the Butter Creek watershed, these are not major sources of sediment. They do occasionally fail during large storm events, however, compared to the other chronic sources of sediment in the basin, these slides are not major contributors. Presently it is more important to invest resources to reduce fine sediment production in the upper watershed, before expending a large amount of funds attempting to mechanically stabilize slides in the lower watershed. In addition to the active slides in lower Butter Creek, there are highly hazardous slopes within the inner gorge which appear at a high natural risk of failure. These hazardous slopes are extensive and mechanical treatment is again not economically feasible. However, bio-stabilization of the active slides, utilizing riparian and other vegetative planting as appropriate, can be supported at this time due to its low cost and potential benefits.

15. Biological enhancement for salmon production is not recommended at this time. Butter Creek is one of the best Age 0+ steelhead nursery streams in the basin. Improvement of pool-rearing habitat through instream improvement efforts would undoubtedly be a bonus for the older aged steelhead juveniles, but needs to be undertaken only after very careful scrutiny. Currently, the stream is harmoniously producing annual bumper crops of Age 0+ steelhead and should be allowed to cycle as naturally as possible.

16. Evaluate the opportunity to develop an interactive habitat restoration and fish recovery program with California Department of Fish and Game and the communities of Hayfork and Hyampom for the Butter Creek watershed, including both the anadromous and resident fish segments.

Future Trends With and Without Restoration

1. Fine sediment produced from roads and compacted ground in the upland areas will continue at a slowly diminishing rate if no restoration efforts are performed. There is a potential for increased sedimentation from these areas if road maintenance levels are reduced, or if a large storm were to produce significant surface runoff. If restoration efforts are effectively implemented, the amount of fine sediment delivered downstream would be decreased in proportion to the level of restoration efforts. Fine sediment would continue to be produced from remaining roads, but at a much lower rate. The potential for large sediment inputs from large storm events would also be reduced with implementation of the restoration work.

2. Restoration of the low gradient stream channels in the upland area will expedite the natural adjustment of the channels that have been destabilized in the past. Restoration would include grade stabilization, bank stabilization and revegetation of riparian areas. Without these efforts the channels will eventually stabilize themselves, however, sediment delivery would be greater for a longer period of time. In addition, the channels would be more sensitive to large storm events with a greater potential to further destabilize. Riparian areas would not recover as quickly, nor have the diversity of vegetation and habitat that could be provided with restoration efforts.

3. The main channel of upper Indian Valley Creek will become more stable over time without restoration efforts being made. There will continue to be channel and bank adjustments until the channels have adjusted to their new grade and the sediment load from upstream comes into equilibrium with the stream power of the channels. The gabion dam located downstream of the guard station will eventually give way, resulting in another round of downcutting and channel bank adjustment as the stream works its way down through the sediment deposits stored upstream of the dam. The main channel will be bedrock and grade controlled for many years before significant amounts of large woody material becomes entrained in the system again. Habitat for fish and other aquatic organisms will continue to be limited, especially in the low flow months of the year.

4. Restoration efforts could transform Indian Valley Creek into a productive stable channel with abundant habitat for aquatic and riparian dependent species. The effort could be conducted over a several year period. Another alternative would be to select the most promising reaches for restoration and let the lower potential reaches adjust naturally. Overall, the main channel of upper Indian Valley Creek offers the best opportunity to conduct meaningful stream restoration work in all of the Butter Creek watershed. Although it is not an anadromous fish habitat reach, it does offer an excellent opportunity to increase fish habitat and populations of resident fish. Restoration efforts would also contribute to providing high quality water to the anadromous section of Butter Creek.

5. Without restoration of the areas affected by intensive recreational use within upper Indian Valley, the area will continue to slowly degrade as more compaction occurs and more riparian vegetation is lost. With restoration and cooperative efforts with the recreation users, the riparian areas can be improved from its current condition. Full recovery of the riparian area to a state with less human impacts cannot be expected to occur, as long as the area continues to be a popular recreational destination. In fact, if unmanaged conditions will worsen.

6. With a careful evaluation of the potential effects of roads and skid trails in the highly erodible areas of upper Butter Creek sub-watershed, present conditions can be mitigated and future detrimental effects can be avoided. Although the road drainage and stream channel conditions will eventually stabilize themselves, the potential for significant erosion and sedimentation from these areas is greater without restoration efforts to compensate for the watershed’s sensitivity.

7. Third and fourth order channels will continue to stabilize themselves within their landscape with or without restoration efforts. Sediment size distribution in the stream beds will tend toward the finer sizes if sources from roads and compacted areas are not treated through restoration efforts.

8. With environmentally appropriate construction of structures from boulder and large woody material within the higher order channels of the four subwatersheds in upper Butter Creek, there will be an increase in aquatic habitat diversity. These structures will be most successful if they are synchronized with upland treatment to reduce sediment inputs from roads and compacted areas. Without these restoration efforts the streams will take decades or centuries to reach a significant level of stability and diversity.

9. Restoration of stream channels and sediment sources are more limited in the canyonlands than other areas due to the relatively lower level of past disturbances and the difficulty of influencing the natural processes occurring in this steep portion of the watershed. Natural processes of water and sediment transport are dominant here, as well as the sideslope landslide processes. It can be expected then, that future trends in the canyonlands will be largely the result of natural processes, with a smaller potential to influence water quality and stream stability than in the other areas. Localized exceptions to this are the existing roads that have the potential to contribute to landslide activation.

10. The quantity of sediment introduced into the stream network will be influenced the most

by restoration of roads in the Riparian Reserves, especially the unstable areas. Without restoration or prioritized maintenance of these roads, surface runoff will continue to contribute sediment to the stream system and the potential exists for triggering of landslides.

11. As with the other areas, treatment of the sediment sources produced from roads and compacted areas will reduce the total sediment load of Butter Creek. Identification of undersized culverts or other drainage problems, followed by treatment, will prevent future fill failures. Without restoration, sediment produced from roads will remain constant, with the likely influx of large amounts of sediment from fill failures when very large storm runoff events occur.

12. Restoration implementation in the headwater areas will have much more influence on some properties of the stream channel in lower Butter Creek. With reduction of sediment produced upstream, the stream bed composition should shift away from the fine grained material size. If upstream restoration is not done there will be no change in the size distribution of the spawning gravels in the anadromous reach of Butter Creek.

13. Planting of riparian vegetation in several reaches along lower Butter Creek will provide more shade to the water and protect it from temperature increases. The decrease in water temperature due to the restoration effort in this area, however, will be too small to be measurable. Without restoration as prescribed, water temperatures will remain static or gradually cool as riparian vegetation recovers naturally throughout the watershed.

Recommended Strategies For Restoration

1. Prioritize watershed restoration based on the results of the cumulative watershed effects analysis, documented in this chapter. It is important to begin restoration efforts in these high risk subwatersheds, before taking on restoration efforts in other portions of the watershed.

2. Conduct a Watershed Improvement Needs (WIN) inventory for the watershed. It should emphasize the location of sediment sources, accelerated surface runoff and unstable stream channels.

3. Criteria for evaluating effectiveness should include criteria for the following factors:

   - ❑ Runoff reduction,
   - ❑ Erosion reduction,
   - ❑ Reduction of sediment delivered to streams,
   - ❑ Reduction of time-to-peak runoff events,
   - ❑ Provide benefit to physical and biological function of Riparian Reserves and
   - ❑ Result in a move toward stream channel stability.

4. The time frames for implementing restoration efforts will depend on restoration priorities and a logical sequence of implementation to achieve the highest benefit. Funding and administration constraints will also have an effect on the timing of restoration. The first priority for watershed restoration is the treatment of the road system, which supplies large quantities of fine sediment. Secondly, roads which cross unstable areas should be treated in an appropriate manner, to avoid the triggering of landslides. Next, the disturbances within Riparian Reserves that contribute to peak flow increases and direct delivery of fine sediments should be treated. The sequence of this work should start in high priority subwatersheds in the upland area and move downstream. Stream channels still susceptible to destabilization and delivery of eroded streambank material to the system are next on the priority list. The sequence of treatment should start with the most unstable and potentially large contributors of sediment and work to the smaller sources. Likewise, the channels in the upland areas should be treated before moving downstream. Finally, all other sediment sources outside the Riparian Reserves should be stabilized starting from the most severe and working from the upland end of the watershed first.

5. Monitoring of the restoration program should include implementation, effectiveness and trend monitoring methodologies. Implementation monitoring should be done at the time

of restoration work and should be highly interactive with the process to insure restoration prescriptions are delivered to the ground as intended. Effectiveness monitoring should be done at the project level to determine if the restoration efforts were effective and if further work is needed. Trend monitoring should be conducted in the larger streams to monitor indicators of stream channel stability, habitat quality, habitat quantity, and in some cases, populations of interest. Trend monitoring should be as simple as possible to reduce cost of a necessarily long-term monitoring effort. Further details of monitoring efforts are to be found in the Monitoring section of this chapter.

Terrestrial Wildlife Habitat Restoration

Key Findings

1. Fragmentation and the loss of interior forest conditions has occurred in the Butter Creek watershed. There are nine Wildlife Habitat Relations (WHR) terrestrial habitat types in the watershed: Klamath Mixed Conifer, Douglas-Fir, Jeffrey Pine, Ponderosa Pine, Montane Hardwood-Conifer, Montane Hardwood, Montane Chaparral, Mixed Chaparral and Perennial Grassland. The Ponderosa Pine WHR type, which is a drier, more open growing type, has replaced much of the Douglas-Fir type in recent history. Specifically, there has been a decrease of 3300 acres of Klamath Mixed Conifer and 1690 acres of Douglas-Fir. There has been an increase of 2990 acres of Ponderosa Pine and 1,100 acres of WHR Mixed Chaparral types between 1944 and 1990. **Tables 10** and **15** display the current and historic seral stage distribution. Timber harvest, fires, fire salvage and reforestation are the primary causes for this shift in structural diversity. Prior to 1980, harvested areas were typically replanted to ponderosa pine or a mix of ponderosa and Jeffrey pine. Some areas have remained in the WHR Mixed Chaparral type due to fire frequency, difficulties in regeneration, or the youthfulness of plantations.

2. Another result of timber harvest and fires in the Indian Valley and upland areas has been a loss large diameter trees, and resultant snags and down logs. Between 1944 and 1990, there has been a loss of 11,170 acres (79 percent) of WHR size class 5 and 6 (>24 inch DBH) coniferous forests. Dispersal habitat for the northern spotted owl and species associated with late seral and old-growth forests is currently below desired levels. Snag densities vary greatly in the watershed.

3. There has been a reduction in large diameter oaks and consequently acorn production. The reduction is due to fire exclusion, timber harvest and reforestation practices that favored conifers while excluding oak. Harvesting of fuelwood has also impacted the distribution of oaks.

4. Grasslands and Mixed Chaparral have become decadent. These habitats are not currently being managed with prescribed burning to enhance forage potential.

5. There has been an initial review of streamside WHR tree canopy closure along the upper reaches of Butter Creek and Indian Valley Creek. Data analysis needs to be done to determine wildlife travel corridor widths needs along Indian Valley Creek and Butter Creek. Specifically, stands having 40 percent or greater overstory crown closure were mapped to measure possible corridor widths. Again this closure does not provide for all species nor perhaps for all the various needs of even one species. However, it does provide at least adequate dispersal for many species including bear and deer, and some Threatened, Endangered and Sensitive species such as the northern spotted owl, northern goshawk and Pacific fisher. Corridors, in addition to Riparian Reserves, would benefit the western pond turtle. The turtle needs meadows for nesting and woodlands for hibernation. The corridor widths to be reviewed are 300 feet, 1/8 mile, 1/4 mile, 1/2 mile and 1 mile on each side of the stream. To select widths to emphasize as wildlife corridors, an in-depth review of the data set is needed.

6. Beaver and porcupine populations have declined. The principal reason appears to be past trapping and eradication efforts. Porcupine is important from a biological diversity standpoint and as a source of quills for Native American basket weaving. Beaver

are important for wetland creation and maintenance. However, due to existing degraded channel conditions, re-introduction of beaver into the watershed may be detrimental to watershed restoration.

7. Suitable habitat for the northern spotted owl has been significantly reduced by wildfires and timber harvest. Four northern spotted owl pairs currently reside within the watershed, primarily in the canyonlands. Two pairs are within Late-Successional Reserves (LSR). There are 8115 acres of LSRs within the watershed much of which is in the canyonlands. More than 47 percent (3824 acres) is suitable owl nesting habitat. There are 3020 acres of USFWS designated Critical Habitat for the northern spotted owl within Buck and Cow Gulch. An estimated 43 percent (1291 acres) is suitable nesting habitat.

8. There has been a significant reduction in recruitment and potential recruitment for large diameter snags especially in the upland areas. This is due to the reduction of large trees through timber harvests, including salvage logging. A number of wildlife species require large diameter snags for a variety of life functions and larger snags remain functional longer. Overall, snag densities vary greatly depending on the location within the watershed.

Recommendations

1. Maintain sufficient late seral/large size class coniferous forests to promote recovery of spotted owls and provide for other species associated with this habitat. Manage forests for the long term maintenance of suitable spotted owl habitat within the Late-Successional Reserve and Critical Habitat Unit. Depending on site specific conditions, maintenance goals would be to:
    - ❑ reduce fuels around or within these areas.
    - ❑ thin young plantations to promote late seral conditions.
    - ❑ plant understocked areas.
    - ❑ maintain and restore adequate levels of snags and down woody material.

2. Enhance dispersal conditions for northern spotted owls:
    - ❑ thin stands to promote more rapid growth to achieve “11-40” characteristics.
    - ❑ manage stands which presently meet dispersal characteristics to maintain those qualities.

3. Perform a LSR management assessment in consideration of the goal to protect and enhance conditions of late successional and old growth forest ecosystems, consistent with direction in the ROD (USDA Forest Service and USDI Bureau of Land Management, 1994b). The assessment should include:
    - ❑ an inventory of vegetative conditions.
    - ❑ a history of change among the vegetation conditions.
    - ❑ list of associated species.
    - ❑ a history of land practices.
    - ❑ current land practices.
    - ❑ a fire management plan.
    - ❑ criteria for selecting treatments for restoration and enhancement.
    - ❑ identification of best treatment areas.
    - ❑ an implementation schedule.
    - ❑ monitoring and evaluation plans.

    Review the ROD for other procedures and standards for activities and protection measures. For instance, although thinning is appropriate for young stands to enhance conditions for late seral species, all silvicultural treatments require review by the Regional Ecosystem Office in Portland. An initial LSR assessment can be found in **Appendix F**.

4. Reverse the trend toward loss of Douglas-fir and Klamath mixed conifer by:
    - ❑ plant species that mimic natural communities.
    - ❑ thin ponderosa pine plantations to favor the natural regeneration of Douglas-fir and mixed conifer species.

- prevent forest types from converting to chaparral or canyon live oak by using appropriate silvicultural and fuels reduction techniques.

5. Enhance black oak acorn production, especially within 2 miles of peregrine eyries, at shaded fuelbreaks, and in cooperation with Native American acorn production needs. Recommended techniques are:
   - plant oaks.
   - use silvicultural techniques to increase crown size.
   - retain oaks in plantations.
   - underburn to decrease insect damage.
6. Implement wildlife corridor treatments that will maintain and restore the canopy closure to 40 percent or greater. This may involve tree planting, thinning to promote overstory development of plantations and fuels reduction in areas that have a high potential for fire loss.
7. Minimize new road construction within the corridors since this opens the canopy and can interrupt wildlife movements due to increased disturbance. Likewise, reduce road densities where possible.
8. Designate home ranges around goshawk nest stands to protect them from disturbance or habitat alterations that would reduce the likelihood of successful nesting.
9. Locate, protect and manage all known sites for those species of concern according to the Survey and Manage Table C-3 on the ROD.
10. Conduct surveys and gather information on USFWS candidate species when proposing projects in the watershed.
11. Wood duck boxes have been installed at many wetland sites. This can significantly increase the potential of a site being used by wood ducks and provide for increased population levels. A yearly review of these boxes for use and productivity should be conducted. Nest box maintenance is recommended.
12. Snag density changes rapidly because of tree mortality, snags falling down and loss from salvage operations. Monitor the density of soft and hard snags. Broadly map the distribution of snags to identify areas that are currently deficit of snags in the larger diameter classes and hard snags. Recruit where needed.
13. Review the cover provided within corridors at intervals that would be reflective of changes in tree growth or fire occurrence. Monitor and manage for wider corridors, where cover is lacking. If there is an event such as fire that has created gaps in the corridor, widening of the corridor may be needed to permit wildlife passage as close to the water source as possible and away from road disturbance. If cover is dense in the corridor, reduction in corridor width may be warranted.
14. Evaluate grassland and chaparral habitat types to maintain habitat diversity. Areas can be maintained in a variety of seral stages through the use of prescribed fire to provide quality cover and forage for associated wildlife species.
15. Closely follow efforts to reintroduce elk into the Trinity Alps Wilderness. Information from this effort may determine if it would be feasible to reintroduce elk in the Butter Creek watershed. It is also possible that elk introduced in the Trinity alps may migrate southward to the Hayfork District and benefit from some habitat provisions here.
16. Collect baseline information on Category 1 and 2 species listed by the U.S. Fish and Wildlife Service, and monitor existing sites and populations of these species.

Fuels Treatments

Key Findings

1. Most recent fuel treatments have been used to treat logging debris. The focus of fuel management practices will be directed toward sustainability of ecosystem structure and function and returning forest communities to historic conditions. Fuel treatments provide protection and fire safety for private lands and adjacent communities.
2. Prescribed burning has some elements of risk. Burning of forest fuels is subject to weather changes and local wind conditions not easily predicted. Prescribed fires from

time to time escape controls threatening forest resources and adjacent communities.

3. Fire exclusion has caused abnormally high fuel levels to develop. Fuel loads within the watershed are relatively high, ranging from 25 to over 100 tons per acre.

4. Butter Creek is located in a County classified as non-attainment for various pollutant categories. Restrictions have been placed upon the timing and amount of prescribed burning. Smoke was a common element in the natural and Native American environment especially during the late summer and early fall periods. However, smoke is less acceptable in forest areas today. Smoke creates nuisances where it lies over roads, residences, communities and wilderness areas.

Recommendations

1. Prescribed burning will be very difficult in many areas due to extremely high fuel levels and the need to avoid burning within Riparian Reserves. Methods other than broadcast burning may be necessary, such as multiple low to moderate burn intensity entries, vegetation thinning or mechanical treatment of vegetation and down woody fuels. Prescription windows may be very narrow considering air quality guidelines, existing fire hazard conditions and adverse weather patterns.

2. The best modeling and predictive information should be used to carefully plan prescribed burns. Use mechanical or hand methods where appropriate to reduce fuel levels if prescribed burning is unavailable as a management tool. Plan prescribed burns to minimize smoke, particularly in sensitive airsheds. Work with enforcement agencies. Promote a prescribed fire awareness campaign with local community groups.

3. Produce an Integrated Vegetation Management Plan which takes into account the Desired Future Conditions for the Riparian Reserves, Late-Successional Reserves, Critical Habitat Unit, wildlife corridor and Matrix lands. This plan should prescribe treatments, schedule treatments and prioritize areas for treatment for residual stands and plantations. **Appendix G** contains an initial Integrated Vegetation Management Plan.

Future Trends With and Without Restoration:

Without a reduction in the hazardous fuel levels throughout the watershed, the risk of catastrophic fire events will remain high. The danger of loss of life and property will become even more extreme over time. There will also be a loss of ecosystem stability and health.

If fuels levels are reduced and a systematic plan for maintaining low fuels levels is put in place, fire risk and hazard may be reduced to reasonable levels. The potential for achieving the Desired Future Conditions for this landscape will be much greater with these treatments.

Wetlands Wildlife Habitat Restoration

Key findings

1. Most of the wetlands (including fresh emergent wetlands, wet meadows and springs) throughout the watershed have been negatively impacted by one or more of the following: Road construction, grazing, timber harvesting and erosion of adjacent channels (Bardolf, 1993). Some sites have had their hydrologic characteristics altered to provide water sources for fire suppression, livestock and road watering. Road building has occasionally created a wetland site by altering surface water flow or surfacing an underground spring.

2. There has been a significant loss of the quantity, quality and size of wetlands in the watershed. Some of the loss is due to vegetation succession related to fire suppression, which allowed for the intrusion of vegetation into the wet areas which through increased evapotranspiration, contributed to lowering the local groundwater table, and reduction in the wetland. The principal impacts, though, are due to channel downcutting and straightening which caused lowered water tables, dried adjacent wetlands, eliminated the natural overbank flooding and decreased the meandering nature of streams adjacent to wetlands.

3. Due to the loss of wetlands, there has been a loss of wildlife species dependent on wetlands. It is important to enhance and maintain the remaining wetlands so they will provide habitat for western pond turtles, wood ducks and many other species.

Recommendations

1. Restore wetlands, including artificially created ones, to increase their function as wildlife habitat. Restoration may entail the following: Road and access closure, elimination of developments that remove water, burning wet meadows to rejuvenate the vegetation and reduce conifer encroachment, correction of erosion problems, fencing out cattle and channel stabilization.

Biological Diversity

Key Findings

1. Little is known of the autecology or response to management of most of the sensitive plants on the forest. The special serpentine habitat occupied by Nile's madia is maintained by fire, which opens up the shrub layer and provides both nutrients and light for the madia. Although the amount and distribution of suitable ultramafic soil determines the upper limit of habitat potentially available for Niles' madia in the Butter Creek watershed, the fire regime strongly influences the amount of habitat actually available for colonization by the madia in any given year. Without fire, not only is the absolute quantity of habitat decreased, but the available microsites become more isolated from each other, making colonization of new sites less likely.
2. Yellow star thistle has colonized much of the private pasture land within the lower Butter Creek subwatershed and is common along county road 316 in that vicinity. The county road is the primary vector for the spread of yellow star thistle in the watershed.

Recommendations

1. Complete a species management guide for the Forest listed sensitive plants in the watershed. Consider baseline monitoring and controlled burning of Nile's madia populations in the watershed.
2. Contact county agricultural commissioners or the Agricultural Research Service concerning the use of one of the biological control agents being tested in the region that interfere with the successful reproduction of the yellow star thistle. Investigate the possibility of instituting a field release of weevils or start an eradication partnership with private landowners.

Monitoring

The purpose of this section is to provide the information specific to the Butter Creek watershed that will be needed to design appropriate monitoring strategies for future uses. Monitoring may be needed to document implementation of management practices, to determine the environmental effects of those practices, to validate the effectiveness of certain practices, or to identify and track long term environmental trends. This monitoring section is divided into resource areas where monitoring is thought to be of most importance in Butter Creek. For each resource consideration was given to the following monitoring related topics:

- ❑ Resources and impacts of most concern
- ❑ Conditions most susceptible to environmental change
- ❑ Types of changes likely to occur
- ❑ Locations most susceptible to environmental change
- ❑ Driving variables or indicators most closely associated with the changes of concern
- ❑ Data needs for better understanding processes and ecosystems in the watershed

Streams and Water Quality

Resources of concern involving streams are best divided into first and second order streams and higher order channels (third, fourth and fifth). For the low order channels the impacts of most concern are to: Channel bed stability (aggradation or degradation), large woody material and bank stability. For the higher order channels with perennial flows resources of concern also include aquatic life (flora and fauna), and the stream's flow regimes, including peak and base flows. See the Fish Habitat and Population discussion for stream habitat related resources and impacts associated with fish bearing streams.

Water quality issues and impacts of most concern are largely related to water temperature and sediment. The State of California has a numerical turbidity standard, but turbidity associated with immediate impacts of disturbance activities does not adequately address monitoring needs in the Butter Creek watershed. Other parameters that do not address the impacts to water quality in Butter Creek include: Dissolved oxygen, pH, conductivity, total dissolved solids, nutrients, pesticides and other chemicals. Introduced chemicals, such as fertilizers and pesticides are not used on National Forest lands, and are not known to be used on private land within Butter Creek. The other physical parameters mentioned have been monitored in the past and are not sensitive to changes induced by management practices to the point where they become useful to address impacts.

Low gradient firstand second order channels in the upland portion of Butter Creek watershed are the channels most susceptible to destabilization and the most responsive to restoration efforts. Other streams sensitive to change include those segments downstream of road crossings, unstable side slopes and compacted areas related to forest management activities. Lower gradient channels (<4 percent) with large woody material incorporated as grade controls are also susceptible to change induced by a consuming wildfire. In perennial streams some forms of aquatic life are sensitive to change, such as macroinvertibrates in the stream bed. Third and fourth order channels are susceptible to cumulative impacts brought on by changes in the flow regime during storm runoff events. In a similar manner rain-on-snow events can result in channel changes due to a change in the flow regime caused by past clear cutting.

Water temperature in streams is most affected by antecedent groundwater temperature and exposure to solar radiation. The amount of riparian vegetation providing shade to the water's surface is the condition most susceptible to environmental change of water temperature. Any condition where fine sediments can be directly delivered to the stream channel system will be of interest for monitoring. Changes can be include an increase in sedimentation due to road surface runoff, culvert failures and mass wasting.

Changes in the stream channels that would be most likely occur, and therefore be of interest to monitor, include changes to the stream bed, changes to the flow regime and changes of habitat quality for aquatic lifeforms. The shape of the stream bed is susceptible to change, including bankfull width and depth. Longitudinally the channel bed can show a change in residual pool depth (in some situations gradient can change, but rarely). With regard to bedload sediment, the depth of sediment in pools can change and the distribution of sediment size can also change.

The quantity of water at any point in a stream channel can change as a result of changes occurring in the upstream watershed. Another flow related pattern that is susceptible to change is the timing of runoff relative to precipitation events (time-to-peak or hydrograph lag time).

Water quality changes that are most likely to occur include water temperature, suspended sediment and bacterial contamination. Other potential sources are accidental spills of hazardous materials. The most likely scenario would be a spill of diesel fuel or gasoline following a vehicle accident.

Generally the upland portion of the Butter Creek watershed and the anadromous fish reach of lower Butter Creek are the two locations most susceptible to change in the stream system. The steep gradient channels of the canyonlands portion of the watershed are a much less suitable location to detect changes which are likely to occur.

In the uplands, the second, third and smaller fourth order channels are the best locations for detecting changes in stream channel cross-section, longitudinal profile (residual pool depth), depth of sediment in pools, bedload size composition and flow regime type parameters. Water quality parameters most susceptible to change are also likely to be evident in the smaller upland streams. Water chemistry and bacterialogical changes are most likely to be found close to their source, no matter what the position in the watershed.

The anadromous reach would be a good location to look for changes in residual pool depth, sediment in pools and stream bed composition. For long term monitoring efforts, the lower section would be the place to follow water temperature trends.

A more thorough discussion of monitoring that can be applied to all watersheds in general is given in "Monitoring Guidelines to Evaluate Effects of Forestry Activities on Streams in the Pacific Northwest and Alaska", (MacDonald, et al, 1991).

Of the variables previously mentioned for monitoring streams and water quality, the most cost effective are: Water temperature, cross-sections, residual pool depth, stream bed composition and to a limited degree, sediment depth in pools. These parameters can usually produce enough meaningful data with a limited amount of expense to collect, analyze and interpret.

As for time frames for response, the water quality parameters give the most immediate feedback of response to effects brought on in the watershed. Physical changes in the stream channel are brought about and can be measured only after a high runoff producing rainstorm or snowmelt event has occurred after the change inducing event.

Reliability of monitoring results depends on many conditions. The variability of the parameter being measured, the opportunity to account for all the variables, amplitude of the changes occurring and the capability of the monitoring technique to measure the parameter in question. Are all factors which need to be accounted for in all monitoring schemes.

Data needs for long term watershed analysis purposes are focused on two qualities of the stream environment; water temperature and sediment. The need for temperature information is to show long term trends. Temperature monitoring in Butter Creek watershed should be linked to a broader monitoring program throughout the Trinity River Basin for the purpose of understanding processes involved that control water temperature in the larger ecosystem.

Future data needs for sediment movement in Butter Creek would involve acquiring enough information to develop a sediment budget for the watershed. This effort should be a part of a larger effort to link sediment supply to sources in the South Fork Trinity River. Other long term trend monitoring should be done to look for trends in stream bed sediment size distribution, depth of sediment in pools and residual pool depths along a longitudinal profile.

Stream channel stability in low gradient, meandering systems should be monitored by remote sensing and/or photo points established at key locations. Analysis of visual changes could be made every few years, after major runoff events and over a several decade lapse of time.

Fish Habitat and Populations

The greatest concern and challenge facing fisheries is the restoration of the resident fish habitat for rainbow trout in Butter and Indian Valley creeks. However, before major in-stream restoration work occurs, watershed restoration needs to be well underway, particularly sediment reduction from the vast road network in the watershed. Resident fish habitat may not display full recovery within the first decade after watershed restoration, but rather may be delayed as much as two perhaps three decades as the Butter Creek systems adjusts and stabilizes from watershed restoration treatments.

The process of physical breakdown and removal of the landslide lag deposits from pools may take years to achieve naturally in lower Butter Creek. As such, current spawning and rearing habitat conditions will prevail over the next 20 to 30 years before observable gains are made in the natural creation of spawning habitat suitable for spring Chinook salmon.

Summer steelhead has been identified as perhaps the anadromous fish stock at the highest risk of extinction in the South Fork Trinity River basin . A variety of biological and physical factors appear to be working cumulatively to constrain population expansion. One key factor that remains undetermined from the overall basin perspective is to identify which streams are important to this fish population for spawning and rearing. Unfortunately, the population is so small and the basin so large that detailed observations may be very time consuming and expensive.

As discussed by MacDonald et al (1991), "Quantitative monitoring of fish populations, although of critical importance for fisheries management, often is of limited or uncertain value for water quality monitoring. The limited value of fish for monitoring stems from their mobility, multi-year life span, ecological role and the numerous extraneous factors that can effect their population. High mobility means that it is difficult to obtain an accurate population estimate and this limits the likelihood of detecting a statistically significant change. Given the numerous factors affecting fish populations and our knowledge of the habitat requirements of many of the most important fish species, it often will be most cost effective to directly monitor selected habitat parameters and then to assume that these will affect fish populations."

As identified above, stream channels are most susceptible to environmental change and thus affect the quality, quantity and condition of the fish habitat and associated riparian areas within or adjacent to those stream channels. A decrease in road related sediment input, an increase in the recruitment of large woody material, an increase in riparian shade canopy, and a focused approached to in-stream habitat improvement work will commence the rehabilitation process of stream channels and their fish habitats in the Butter Creek watershed.

Restoration of the resident fish habitat in the Butter Creek watershed should stimulate better rainbow trout productivity. Gains in habitat improvement in the upper watershed will benefit the downstream anadromous fish habitat. However, biological factors may constrain summer steelhead production while physical factors may continue to restrain salmon productivity.

Changes most likely to occur in stream channels to the benefit of fish species include the formation of pools, reduced sediment in spawning gravels and pools, stabilization of faltering streambanks, better functioning of processes between the aquatic and riparian zones, and reduced high water temperatures through improvement of riparian shade canopy.

Besides the physical habitat parameters mentioned above, three biological variables associated with changes of concern are rainbow trout (adult and juvenile) densities, juvenile steelhead densities and adult salmon counts.

Lower Butter Creek should be added to a rotational snorkeling population survey (yet to be developed), similar to the long-term electrofishing index streams program. This program will assess juvenile steelhead densities six to ten major anadromous fish streams tributary to the South Fork Trinity River basin, i.e. Eltapom Creek, Plummer Creek, Smoky Creek, Madden Creek, the East Fork of the South Fork Trinity River and the main stem South Fork Trinity River above the East Fork of the South Fork Trinity River confluence. To facilitate this process it is recommended that volunteer resources from schools and the communities of Hayfork and Hyampom be mobilized for these assessments under the guidance of a professional fisheries biologist(s).

A full comprehensive survey of resident rainbow trout distribution has not been completed for the upper Butter Creek watershed. Information on hand attests to the presence of resident rainbow trout in Indian Valley Creek. Only sketchy information is available for the lateral tributaries to the main stem channel. Resident rainbow trout may use intermittent streamcourses for spawning that will later dry out as the summer progresses. Past surveys and searches have not concentrated on these smaller streamcourses, but rather on the mainstem channels and usually only after high flows have moderated and safer access is permitted. Therefore, we recommend that a comprehensive survey for resident trout be performed.

Habitat typing surveys should be performed in lower Butter Creek every five years to (1) determine the level of improvement in fish habitat quality, quantity, and condition for anadromous and resident fish habitat, (2) document the response of juvenile steelhead and resident rainbow trout production to watershed restoration efforts, and (3) document the use, if any, of lower Butter Creek by Chinook salmon.

Vegetation

The rare plant communities found in the watershed, serpentine barrens and remnant old-growth patches are the areas that may be most affected by environmental change. Riparian communities of the higher order, lower gradient streams are most susceptible to disturbance in the form of vegetation removal, particularly when adjacent to areas with high fuel levels. Plant cover, size of rare plant populations and fuel levels are the elements of concern.

The changes most likely to occur are those precipitated by catastrophic fire. These include loss of vegetative cover, soil loss, loss of large woody material, duff layer and damage caused by suppression activities. There may be a need to do some population counts in specific areas in the watershed. This should be determined at the site analysis level.

Wildlife Habitat and Populations

Past survey and monitoring efforts within the watershed have focused on the presence and reproductive success of some Threatened and

Endangered species. Most TES species are dependent or highly associated with late successional forests or riparian habitat. Monitoring of animal populations within the watershed is part of a large scale effort to assess species viability. Most of the late-successional species and some of the riparian species should be monitored on a province-wide or larger scale to provide adequate viability information. These species are bald eagle, peregrine falcon, northern spotted owl, northern goshawk and Pacific fisher. Riparian species with small ranges can be monitored on a local scale, especially for site planning. These species are northwestern pond turtle, Del Norte salamander, south- ern torrent salamander, yellow legged frog, red legged frog, tailed frog, Cascades frog and willow flycatcher. TES species locations are centralized in the GIS data base.

Corridor cover is lacking in particular areas of Indian Valley and the uplands. Further in-depth analysis of the WHR tree canopy closure corridor map and report (GIS product) is warranted for general area management and for site specific planning.

Monitor late successional species as part of the larger, province-scale effort as needed. Local considerations may be:

> Map and field verify 100 acre zones for northern spotted owl activity centers. Monitor known northern spotted owl activity centers to determine site specific factors that enhance or reduce nesting success. Conduct surveys for northern spotted owl as appropriate for specific project consultation.
>
> In the Trinity Forest, baseline information is lacking for the northern goshawk, a Sensitive species. Currently very little is known about population levels or habitat quality in the watershed. Conduct a comprehensive survey to determine the locations of nesting goshawks.
>
> Continue research into historical presence of american pine marten in the watershed through interviews with local residents and documentations of early trappers. Conduct surveys for marten in marginal and suitable habitat.

Monitor wide-ranging riparian and aquatic related species as part of the larger scale effort as needed.

> Conduct surveys to determine presence or absence of bald eagle nesting territories and potential nesting locations along the South Fork Trinity River. Once the above survey has been done return to monitor active or potential nesting territories.
>
> Conduct surveys for fisher to estimate population levels and locate denning areas.

Monitor small ranging riparian and aquatic related species in the watershed as needed for viability and site protection. Considerations may be:

> Use the District 1993 Wetland Inventory, with additional ground work, to establish site restoration needs. Monitor pond turtle habitat to determine limiting factors and reproductive success. If basking sites are limiting, review their availability and provide basking logs/surfaces where current levels are inadequate.
>
> Baseline information is desired for willow flycatcher, a Sensitive species. Survey for willow flycatchers after mapping out potential habitats.
>
> Baseline information is needed for amphibious Sensitive species. Del Norte salamander, southern torrent salamander and tailed frog are known to be in the Trinity Forest. Surveys for these vulnerable species is warranted for viability and site protection.

Conduct baseline inventory on Category 1 and 2 species listed by the USFWS, and monitor known populations.

Fuels

Monitoring needs for fuels management include the following:

- ❑ Fuels inventories, before and after treatments
- ❑ Effects of prescribed fire treatments
- ❑ Computer modeling for fire and fuels
- ❑ Moisture measuring instruments/protocol for vegetation
- ❑ Transects to evaluate impacts to duff and vegetation both prior and after treatment.

Unresolvable Key Questions

Some of the Key Questions identified by the Watershed Analysis team were not answered for a variety of reasons. This section will identify which key questions were not answered, why they were not answered and recommendations will be made concerning the value of resolving specific key questions.

1. **How much sediment is delivered from slides in the Butter Creek watershed to the stream system.**

   No quantitative evaluation was made concerning sediment delivery from the active slides in Butter Creek. It was determined that nearly every active or recently active slide in the watershed lies adjacent to a drainage, therefore, delivery rates would be relatively high. The primary sediment producing landslides were identified. Although it was determined that active landslides were the chief source of sediment in the watershed, landslide activity is much lower than in other watersheds in the South Fork of the Trinity basin.

   There would be value in answering this key question in the scheme of a sediment budget for the watershed. However, the answer to this question is not essential for planning restoration activities in the watershed.

2. **Are there any known impacts of current harvest levels on special forest products on the resources harvested (increases or decreases in yields due to harvest, effects on other species or ecosystem functions)?**

   There is no existing data available to address this question specifically for special forest products, though in general the fire suppression practices leading up to the 1987 fires will have affected the intensity of the fires and resulting distribution of vegetation. In particular early succession vegetation has increased, which would mean an increase in meadow, shrub and shrubby habitat types. Yarrow, for example is more plentiful than it would have been before the fires. There will have been a commensurate reduction in potential crop species found in mid-to late succession habitat.

3. **What were historic patterns of harvesting of special forest products in the area?**

   This is an area for further research on land use practices of Native American Indians and of early European settlers. Qualitative evidence for Native American Indian gathering of acorns, beargrass and other plants in the areas is available, but there has not been a study attempting to quantify their impact.

4. **What is the natural range of variability of landscape patterns, seral stages, patch sizes and juxtaposition?**

   In order to adequately determine natural ranges of variability for landscape patterns, additional information and analyses are necessary. Information such as an extensive fire history study is necessary, as well as more in-depth information regarding current stand age and age of origin. A geographic based analysis of seral stage distributions through time would be extremely helpful in analyzing patterns at any time period. The 1944 aerial photography was used to reflect natural ranges as there was little evidence of human caused disturbance. However, it is acknowledged that there had been 30 years of fire exclusion at this time. The aerial photographic interpretations were verified with the use of interviews and historical records.

5. **What are the current, historical and potential population levels of TES species?**

   Current species population levels have been addressed by analyzing population survey data and suitable habitat availability. Historic population levels and potential levels can only be postulated. Species depending on late successional habitat, such as the spotted owl and northern goshawk, may have more abundant prior to the timber harvest programs of the last 40 years. For most of the TES species, we do not have facts on historic levels. Historical and potential population levels would have to be based on habitat models. Modeling was not done for this analysis. This information is useful but not essential to develop population goals for species recovery. Additional surveys for TES, as recommended above, will provide the current population level information.

6. **What is the current and historical wildlife species diversity?**

Similar to TES species population levels, current species diversity can be addressed by modeling data on suitable habitat and habitat elements. Historic information on vegetation and old sightings were used to indicate species presence. Species depending on late seral communities may have been more abundant prior to timber harvest programs of the last 40 years. Species such as the northern spotted owl and the fisher may have been more widely distributed previously, however with the current levels of fragmentation across the landscape, free movement of these species may now be constrained.

Species associated with early seral stage communities such as deer and coyotes may now be more locally abundant than in the past. Large scale disturbances such as wildfires may have provided these species increased forage opportunities at irregular intervals, unlike the recent more regular levels of early seral communities and the subsequent forage capacity available today.

7. **Are there problems associated with the current species diversity?**

Wildlife species diversity present on the landscape today differs from historic diversity. The extirpation of some species such as the grizzly bear, gray wolf and sandhill crane may represent a shift in the types of fauna present historically in the absence of frequent human disturbance. Species immigrating into the watershed from other areas, such as the Virginia opossum, may be replacing diversity lost with the settlement of the area. In general many scientists consider non-native species as problems because of there ability to successfully compete with native species.

8. **What is the current and historical distribution of habitat and habitat elements? Are there habitat deficiencies?**

Habitat deficiencies for species associated with late seral and old-growth communities are present on the landscape today. Capacity for some species to travel through fragmented areas may be limited with the current conditions and the juxtaposition of suitable habitat.

Based on 1944 vegetation data and historic accounts by settlers and Native Americans in the area, habitat for some species of TES is limited in the watershed. Historic abundance of salmon in Butter Creek may have provided a more consistent forage base for bald eagles and grizzly bears.

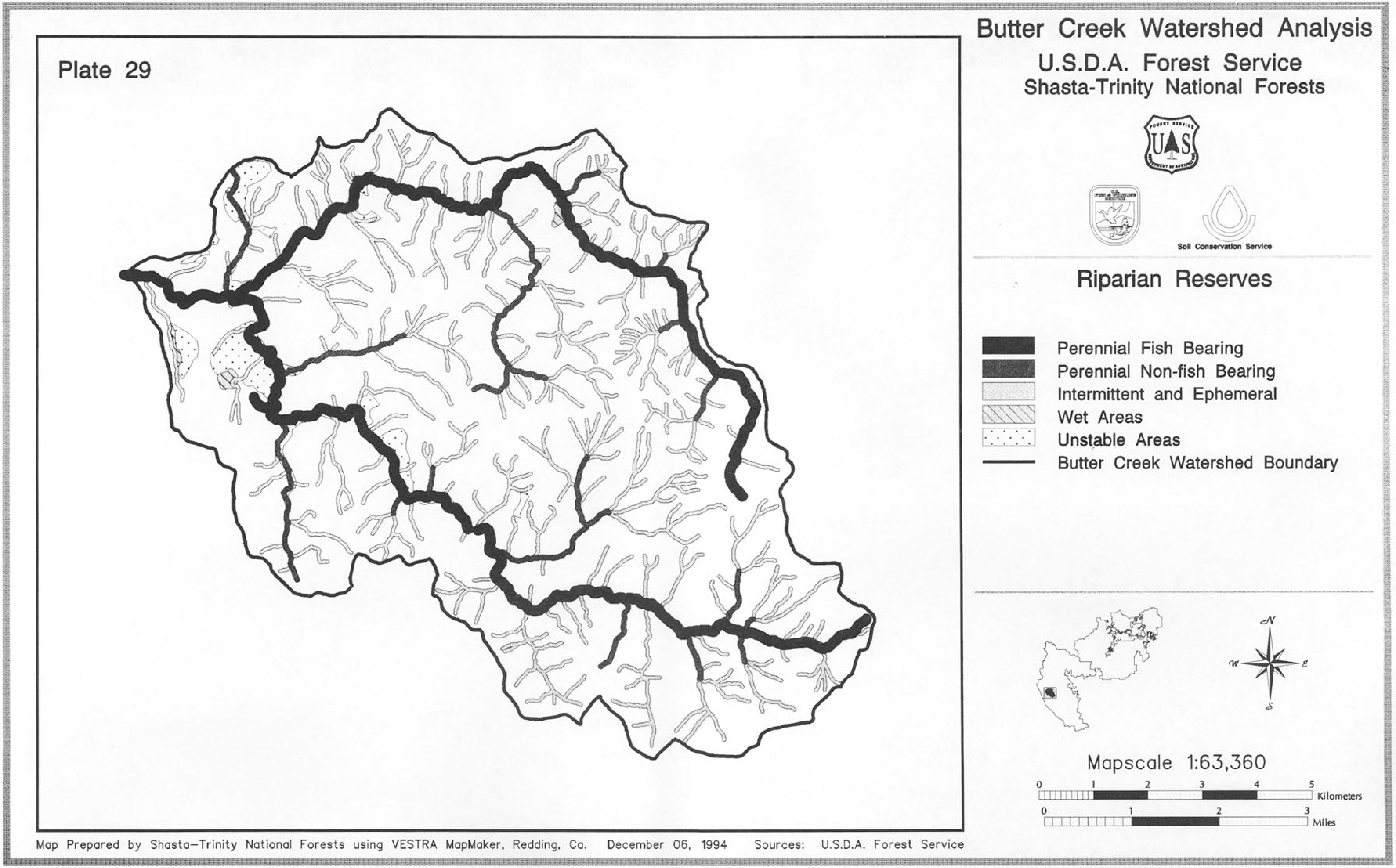


Plate 29
Butter Creek Watershed Analysis
U.S.D.A. Forest Service
Shasta-Trinity National Forests
Soil Conservation Service
Riparian Reserves
Perennial Fish Bearing
Perennial Non-fish Bearing
Intermittent and Ephemeral
Wet Areas
Unstable Areas
Butter Creek Watershed Boundary
N
W
E
S
Mapscale 1:63,360
0 1 2 3 4 5 Kilometers
0 1 2 3 Miles
Map Prepared by Shasta-Trinity National Forests using VESTRA MapMaker, Redding, Ca. December 06, 1994 Sources: U.S.D.A. Forest Service

BIBLIOGRAPHY

Aalto, K.R., 1992, Late Cenozoic Sediment Provenance and Tectonic Evolution of northernmost California: Pacific Cell Friends of the Pleistocene Guidebook for the field Trip to Northern Coastal California, June 5-7, 1992, pp 73-89.

Agee J.K., 1989, Wildfire in the Pacific West: a brief history and its implications for the future: In Proceedings of the symposium on fire and watershed management, USDA Forest Service Tech. Report PSW-109, pp. 11-16.

Agee, J.K., 1991, Fire History along an Elevational Gradient in the Siskiyou Mountains, Oregon: Northwest Science, vol 65, no. 4, pp 188-199.

Agee, J.K., 1991b, Fire Ecology of Pacific Northwest Forests, Island Press, Washington, D.C., 493 pp.

Agee, J.K., 1993, "Fire and Weather Disturbances in Terrestrial Ecosystems of the Eastern Cascades": Eastside Forest Ecosystem Health Assessment Volume III. Assessment, Compiler, Paul F. Hessburg. Portland, OR: USDA Forest Service, Pacific Northwest Region and Research Station.

Alexander, E.B., 1985, Rates of Soil Formation from Bedrock or Consolidated Sediments: Phys. Geography. Vol. 142:25-42)

Alexander, E.B., 1988, Rates of Soil Formation: Implications for Soil-Loss Tolerance: Phys. Geography 145(1)

Anderson, K., 1993. The Mountains Smell like Fire. Fremontia. 21(4):15-20; 1993.

Atzet, T. and D.L. Wheeler, 1982, Historical and Ecological Perspectives on Fire Activity in the Klamath Geological Province of the Rogue River and Siskiyou National Forests: USDA Forest Service, Pacific Northwest Region. R6-Range-102: 16 p.

Axelrod, D.I., 1967, Geologic History of the California insular flora, In: Philbrick, R.N., (ed), Proceedings of the symposium on the biology of the California islands: pp. 267-315, Santa Barbara, CA, Santa Barbara Botanic Gardens.

Axelrod, D.I., 1988, Outline history of California vegetation, In: Terrestrial vegetation of California. Barbour, M.G. and J. Major (Eds.). Wiley-Interscience Publishers, pp 139-194

Baker, S. and Shoup L., 1981, Archaeological Reconnaissance of the Salty Dob, Butter Meadows and Butter Caves Compartments: Hayfork Ranger District, Shasta-Trinity National Forests. pp 1-26

Bancroft, H.H., 1866, History of California, Vol. I-VII: The History Company, San Francisco.

Barbour, M.G. and Major, J., 1988, Terrestrial vegetation of California: California Native Plant Society, Special Publication No. 9, Sacramento, CA. 1030 p.

Bardolf, J., 1993, Hayfork District Wetland Inventory, Trinity River Restoration Program: USDA Forest Service internal report, 30 p.

Barrett, J.G., 1966, Climate of Trinity County: USDA Soil Conservation Service, Redding, CA.

Baumhoff, M., 1978, Handbook of North American Indians: vol 8, California; Smithsonian Institution, Washington, DC. p 23.

Bisson, P.A., Nielsen, J.L., Palmason, R.A., and Grove, L.E., 1981, A System of Naming Habitat Types in Small Streams with Examples of Habitat Utilization by Salmonids During Low Streamflows; In: N.B. Armantrout ed. Acquisition and Utilization of Aquatic Habitat Inventory Information: Proceedings of a symposium, October 28-30, Portland, Oregon. Hagen Publishing Co., Billings, Montana. pp 62-73.

Biswell, H.H., 1973, Fire ecology in ponderosa pine-grassland; Tall Timbers Fire Ecology conference, 12:69-96

Blake, M.C. Jr., Jayco, A.S., and McLaughlin, R.J., 1985, Tectonostratigraphic terranes of the northern Coast Ranges, California: in D.G. Howell, ed., Tectonostratigraphic Terranes of the Circum-Pacific Region: Circum-Pacific council for energy and mineral resources, Houston, Texas, p 159-171.

Bonnicksen, T.M., Stone, E.C., 1982, Managing vegetation within U.S. national parks: A policy Analysis. Environ. Manage. 6:101-2, 109-22.

Brock, W., 1994, Summary of Stream and Fisheries Surveys in the Butter Creek System: USDI Fish and Wildlife Service, Trinity River Restoration Field Office, Weaverville, CA (unpublished). 2 p.

Brown, G.W., and Kygier, 1970, Effects of Clear-cutting on Stream Temperature: Water Resources Research 6(4):1131-1140.

Brown, R.E., 1985, eds, Management of Wildlife and Fish Habitats in Forests of Western Oregon and Washington: vol. 1:11, USDA Forest Service Tech. Pub, PNW; 332 pp.

California Department of Fish and Game (DFG), 1952, Butter Creek Stream Survey of 1952: Unpublished by Millard Coots. Shasta-Trinity National Forests. Supervisor's Office, Fisheries Survey Files.

California Department of Water Resources (CDWR), 1982, South Fork of the Trinity River Salmonid Enhancement Studies: CDWR, Northern District, Red Bluff, CA. 175 p.

Carr, J., 1891, Pioneer Days in California: Historical and Personal Sketches: Times Publishing Company, Eureka.

Childs, S., 1981, The Nature of Skeletal Soils in Steep Terrain. In: S.D. Hobbs and O.T. Helgerson, Reforestation of Skeletal Soils: Proc., Workshop Forest Research Laboratory, Oregon State University, Corvallis, OR.

Christensen, N.L., 1991, "Variable fire regimes on complex landscapes: ecological consequences, Policy implications, and management strategies: in: Proceedings of an International Symposium: Fire and the Environment: Ecological and Cultural Perspectives, Nodvin, Steven C.; Waldrop A., eds. USDA Forest Service, Gen. Tech. Rep. SE-69. Ashville NC. pp. ix-xiii

Christner, J.; Harr, R.D., 1982, Peak streamflow from the transient snow zone, western Cascades, Oregon, In" Proceedings, 56th Western Snow Conference: Colorado State Univ. Press, Ft. Collins. pp. 27-38.

Cleppen, H., 1971, Professional Forestry in the United States: Resources for the Future, Inc.; Washington DC.

Cox, I., 1858, Annals of Trinity County: Commercial Book and Job Steam Printing Establishment. Chapter 11.

Cox, I., 1940, The Annals Of Trinity County. [reprint] preface by Caroline Wenzel, Introd. by Owen C. Coy, the First California County History by George D. Lyman, Annotator's Foreword by James W. Bartlett: University of Oregon, Eugene (first published 1858).

Crumpton, P.L., 1994, personal communication, USDA Forest Service, Shasta-Trinity National Forests, SO.

Crumpton, P.L., and Dias, H., 1994, Guilds from Modified Wildlife Habitat Relationships Model of the Shasta-Trinity National Forest: USDA Forest Service internal report. 30 p.

Dean, M., 1994, Fisheries Biologist, California Department of Fish and Game, Weaverville, CA., Personnel communication with Richard Irizarry, Shasta-Trinity National Forests, SO.

Diller, J.S., 1902, Topographic Development of the Klamath Mountains: Bulletin of the U.S. Geological Survey; no.196, 69 p.

Dillon, R., 1975, Siskiyou Trail: The Hudson's Bay Company Route to California: McGraw-Hill, New York.

DuBois, C., 1935, Wintu Ethnography. University of California Publications In American Archaeology and Ethnology: 28(5):279-403.

Everest, H., 1930, District 7 Grazing Assessment: USDA Forest Service, Hayfork Ranger District, Trinity National Forest; in-house report.

FEMAT, 1993, Forest Ecosystem Management: An Ecological, Economic and Social Assessment: Forest Ecosystem Management Assessment Team; V-20 p.

FEMAT, 1994, A Federal Agency Guide for Pilot Watershed Analysis: Forest Ecosystem Management Assessment Team; 200 p.

Frederickson, D. A., 1974, Cultural Diversity in Early Central California: A View from the North Coast Ranges: Journal of California Anthropology 1:41-53.

Froehlich, H.A., Robbins, R.W., Miles, D.W.R., and Lyons J.K., 1983, Monitoring Recovery of Compacted Skid Trails in Central Idaho. Soil Monitoring Project Report on the Payette National Forest and Boise Cascade Lands, contract 43-0256-2-543. Oregon State University

FSH 2090, USDA Forest Service Handbook; Ecological Unit Inventories

Griffen, J.R. and Muick, P.C., 1990, California Oaks: Past and Present, In: Year of the Oak: Fremontia July 1990. 9 p.

Hall, F.C., 1976, Fire and vegetation in the Blue Mountains: Implications for land managers. Tall Timbers Fire Ecology conference proceedings; 15:155-170.

Harr, R.D., 1986, Effects of clearcutting on rain-on-snow runoff in western Oregon: A new look at old studies: Water Resources Research 22(7): 1095-1100.

Harris, S.W., 1991, Northwestern California Birds: A guide to the status, distribution, and habitats of the birds of Del Norte, Humboldt, Trinity, northern Mendocino, and western Siskiyou counties, California: Humboldt State University Press. 257 p.

Haskins, D.M., 1986, A Management Model for Evaluating Cumulative Watershed Effects: California Watershed Management Conference, Report No. 11. Callaham and DeVries eds. 125 p.

Haskins, D.M., and Irizarry, R., 1988, A Holistic Appraisal of Cumulative Watershed Effects on Watershed Condition and Fisheries, South Fork Trinity River, Northwestern California: USDA Forest Service, Shasta-Trinity National Forests internal report, 40 p.

Haskins, D.M., and Chatoian, J.M., 1993, Geology Data Standards for Ecological Unit Inventories for the Pacific Southwest Region: USDA Forest Service, R5 Technical Paper 05-008; 56 p.

Haskins, D.M., and Zustak, J., 1987, The Direct and Cumulative Effects of the 1987 Fires and Projected Impacts of Salvage Harvesting on Watershed and Fisheries: USDA Forest Service, Shasta-Trinity National Forests in house report, 30 p.

Hatchell, G.E., Ralston, C.W., and Foil, R.R., 1970, Soil Disturbance in Logging: Journal of Forestry 68:772-775.

Helley, E.J., and LaMarche, V.C.Jr. 1973, Historic Flood Information for Northern California Streams from Geological and Botanical Evidence: U.S. Geological Survey Professional Paper 485-E, 16 p.

Higgins, P., Fuller D., and Dobush, S. 1992a, Stocks of Salmon, Steelhead and Cutthroat Trout of Northern California at Risk of Extinction: Humboldt Chapter, American Fisheries Society, Arcata, California.

Higgins, P., Fuller, D., and Dobush, S., 1992b, Executive Summary of Factors in Northern California Threatening Stocks with Extinction: Humboldt Chapter, American Fisheries Society, Arcata, California.

Higgins P., Hagans, D., and Weaver, W., 1993, Action Plan for Restoration of the South Fork Trinity River Watershed and Its Fisheries: Pacific Watershed Associates, Arcata, California, under contract with USDI Fish and Wildlife Service, Trinity River Basin Field Office, Weaverville, CA.

Higgins, P., 1994, Butter Creek Stream Survey, Draft, Report No. 1., 6-16-94.

Hildebrandt, W.R. and Hayes, J.F., 1984, Archaeological Investigations on South Fork Mountain, Six Rivers and Shasta-Trinity National Forests: Submitted to USDA Forest Service, Contract No. 53-9A47-3-27, Six Rivers National Forest, Eureka, California.

Irizarry, R., Barnes, J., Matousek, G., and Mills, T., 1985, Model Steelhead Stream Demonstration Project (MSSDP) Plan: USDA Forest Service, California Trout Inc., and California Department of Fish and Game. 110 p.

Irizarry, R., Zustak, J., Carrier, D., and Coop, K., 1987, Trinity River Basin Fisheries Habitat Fire Rehabilitation Plan. Shasta-Trinity National Forests. Supervisor's Office, Fisheries Survey Files.

Irwin, W.P., 1972, Terranes of the western Paleozoic and Triassic belt in the southern Klamath Mountains, California: Geol Survey Research, USGS Prof. Paper 800C, p. C-103 - C-111.

Irwin, W.P., 1981, Tectonic accretion of the Klamath Mountains, in W.G. Ernst, ed., The Geotectonic Development of California: Rubey v.1, Englewood Cliffs, NJ, Prentice-Hall, Inc p 29-49.

Irwin, W.P., 1985, Age and tectonics of plutonic belts in accreted terranes of the Klamath Mountains, California and Oregon, in D.G. Howell, ed., Tectonostratigraphic Terranes of the Circum-Pacific Region: Circum-Pacific council for energy and mineral resources, Houston, Texas, p 187-199.

Jaegel, R., USDA Forest Service, Implementation Officer, Hayfork Ranger District, Shasta-Trinity National Forests, personal communication with Don Haskins, Forest Geologist, Shasta-Trinity National Forests.

Jameson, E.W. Jr. and Peters H.J., 1988, California Mammals: Univ. Calif. Press, Berkeley, 404 p.

Jenny, H., 1941, Factors of Soil Formation, A System of Quantitative Pedology: McGraw-Hill 281 pages.

Jenny, H., 1981, The Soil Resource - Origin and Behavior: In Ecological Studies. Vol. 37, 377 pages.

Jensen, P.M., and Farber, A., 1979, Archaeological reconnaissance of the Silver, Maddox and Rattlesnake parcels: Report prepared for, U.S. Department of Agriculture, Forest Service, Shasta-Trinity National Forests, Redding, California.

Jimerson, T., Schmitt, G. and Mary E. Flores. 1994. Draft R5 Ecosystem Management Guidebook, Appendices pp. I-C-8-24.

Jimerson, T.M., Hoover, L.D., 1991, Old-growth forest fragmentation: changes in amount, patch size and edge as a result of logging. Symposium on biodiversity of northwestern California, (eds) Harris, R.R., Erman, D.C., and Kerner, H.M., Wildland Resources Center, Div. of Agriculture and Natural Resources, University of California, Berkeley, CA. pp. 168-174.

Jones, A.G., 1970, History of Trinity County Public Lands Classification: Term paper written for Local History 94A class, Shasta College; on file with Trinity County Historical Society.

Keane, R. E., Arno, S.F., and Brown, J.K., 1990, Simulating Cumulative fire effects in ponderosa pine/Douglas-fir forests: Ecology, 71: 189-203.

Keeley, J. 1982, Distribution of lightening and man-caused wildfires in California: In Proceedings of the symposium on dynamics and management of Mediterranean-type ecosystems, June 22-26, San Diego, California, Gen.Tech. Rep. PSW-58, Berkeley CA. Conrad, C., W.C.Tech coord. PSW Range and Experiment Station, Forest Service, USDA, pp. 431-437.

Kilgore, B.M., 1981, Fire in ecosystem distribution and structure: western forests and scrublands, in: Proceedings of the Conference Fire Regimes and Ecosystem properties. Mooney H.A.: Bonicksen, T.M.; Christensen, N.L.; Lotan, J.E.; and Reiners, W.A. (Tech Coords.). USDA Forest Service, Gen. Tech. Rep. WO-26 Washington D.C. pp. 58-89

Knight, D. H., 1987, Parasites, lightning, and the vegetation mosaic in wilderness landscapes, in: Landscape Heterogeneity and Disturbance, Monica Goigel Turner (ed.): Springer-Verlag, New York, p. 59-83

Knopp, C., 1994, Watershed Staff Officer, USDA Forest Service, Lake Tahoe Basin Management Unit, Personal communication with Richard Irizarry, Shasta Trinity National Forests, SO.

Knowles, L., 1937, Last bull elk killed in Trinity County by Chief Tewitty: Trinity Journal, Sept 16, 1937.

Krober, A., 1925, Handbook of the Indians of California: U.S. Bureau of American Ethnology, Bulletin 78 (reprinted 1976), Dover Publications, New York.

Kruckeberg, A.R., 1969. Soil Diversity and the Distribution of Plants, with Examples from Western North America. Madrono, 20:129-153.

LaLande, J. M., 1979, Medford Corporation: A history of an Oregon Logging and Lumber Company: Medford, Oregon: Klocker Printing Company.

LaPena, F. R., 1978, Wintu: In Handbook of North American Indians, volume 8, California, edited by Robert F. Heizer: Smithsonian Institution, Washington, D.C., pp. 324-340.

Listle, T., 1994. USDA Forest Service Pacific Southwest Research Station, Redwood Sciences Lab, Arcata, Fluvial Geomorphologist; Personnel Communication with Richard Irizarry, Shasta Trinty National Forests, SO.

MacDonald, L.H., Smart, A.W., and Wissmar, R.C., 1991, Monitoring guidelines to evaluate effects of forestry activities on streams in the Pacific Northwest and Alaska: EPA 910/9-91-001, EPA, Seattle Wa. 166 p.

Madrone, S., 1994, Butter Creek Stream Survey: Draft, Report No. 2., 6-16-94.

Martin, I.B., Hodder, D.T., and Whitaker, C., 1981, Overview Of The Cultural Historic Resources of Euro-American and Other Immigrant Groups in the Shasta-Trinity National Forests: USDA Forest Service, in-house publication.

Martin, R.E., 1982, Fire history and its role in succession, In Means, J.E., (ed), Forest succession and stand development in the northwest: Corvallis Forest Research Lab., Oregon State University, pp. 92-99.

Martin, R.E. and Saspis, D.B., 1991, Fires as Agents of Biodiversity - Pyrodiversity Promotes Biodiversity: Proceedings of the Symposium on Biodiversity of Northwestern California. R.R. Harris and D.C. Erman, editors. Div. of Agric. and Nat. Res. Univ. of California, Berkeley.

Mason, H.L., 1946. The Edaphic Factor in Narrow Endemism. II. The Geographic Occurrence of Plants of Highly Restricted Patterns of Distribution. Madrono, 8:241-257.

Masson, M., 1966, A Bag of Bones; The Wintu Myths of a Trinity River Indian: Naturegraph, Oakland.

Mayer, K.E. and Laudenslayer, W.F., 1988, A Guide to Wildlife Habitats of California. Calif. Dept. of Forestry and Fire. 166 p.

McCain, M.E., Fuller, D., Decker, L., and Overton, K., 1990, Stream Habitat Classification and Inventory Procedures for Northern California: Fish Habitat Relationship Series, No. 1, prepared for the USDA Forest Service Region 5, Six Rivers National Forest, Eureka, CA.

McCaslin, L., 1994, private land owner in lower Butter Creek, personal communication with Don Haskins, Shasta-Trinity National Forests, SO.

McKelvey, K.S., and Johnson, J.D., 1993, Historical perspectives on forests of the Sierra Nevada and the Transverse Ranges of Southern California: forest conditions at the turn of the century. In: the California spotted owl: a technical assessment of its current status. USDA Forest service Pacific Southwest Research Station Gen. Tech. Report PSW-GTR-133, pp. 225-246.

Merriam, C.H., 1962, Studies of California Indians: Edited by the staff of the Department of Anthropology of the University of California. University of California Press, Berkeley.

Miles, S.R., Haskins, D.M., and Ranken, D.W., 1989, Emergency Burn Rehabilitation: Cost, Risk and Effectiveness, in Proceedings of the Symposium on Fire and Watershed Management; Berg, N.H. editor, General Technical Report PSW-109, USDA Forest Service, Pacific Southwest Experiment Station, P 97-102.

Miles, S., Haskins, D.M., and Lukacic, C.T., 1992, Erosion Monitoring and its Implications for Timber Management, in Proceedings of the Conference on Decomposed Granitic Soils: Problems and Solutions. p. 92-97.

Miles, S., 1994, USDA Forest Service, Shasta-Trinity National Forests, SO, Personal Communication with Jim Komar, USDA Natural Resources Conservation Service, Weaverville Field Office.

Minnich, R.A., Barbour, M.G., Burk, J.H., and Sosa-Ramirez, J., 1993, Californian Conifer Forests Under Unmanaged Fire Regimes in the Sierra San Pedro Matir, Baja California, Mexico: J.Biogeography (submitted).

Morgan, D., 1953, Jedediah Smith and the Opening of the West: University of Nebraska Press, Lincoln, Nebraska.

Mutch, R.W., Arno, S.F., Brown, J.K., Carlson, C.E., Orrmat, R.D., Peterson, J.L., 1993, Forest Health in the Blue Mountains: a management strategy for fire-adapted ecosystems: Gen. Tech. Rep. PNW-GTR-310. Portland, OR: USDA Forest Service, Pacific Northwest Research Station. 14 p.

Norgren, J., Wicherski, B., and Parsons, A., 1990, Order II Soil Resource Inventory, Oak Ridge and Indian Valley Areas, USDA Forest Service, Shasta-Trinity National Forests, Hayfork Ranger District.

Oral Histories, 1980, Mr. Howard Crews, Hayfork, Mr. Ray Patton, Hayfork; Hayfork Ranger District files.

Oral Histories, 1994, Mr. Charles Bramlet, Hayfork, Mrs. Edith Garrett, Hyampom, Mr. and Mrs. George Maker, Anderson, CA, Mr. and Mrs. Ralph Patton, Hayfork, Mr. Ray Patton, Hayfork, Mr. John Rourke, Hayfork; Hayfork Ranger District files.

Owens, B., 1965, Hyampom: Its History and Development: Reference Book NonCir R979.414. Trinity County Library, Weaverville, California.

Parsons, D.J., and DeBenedetti, S.H., 1979, Impact of fire suppression on a mixed-conifer forest: For. Ecol. Manage. 2:21:33.

Parsons, D.J., Graber, J.K., Agee, J.K., van Wagtendonk, J.W., 1986, Natural fire in National Parks; Environmental Management 10:21-24.

Pearson, T.D., Lamberti, H.W., Lamberti, L.I., and Lamberti, G.A., 1992, Influence of Habitat Complexity on Resistance to Flooding and Resilience of Stream Assemblages: Transactions of the American Fisheries Society 121:427-436.

Powers, R. F., 1990, Do Timber Management Practices Degrade Long-term Productivity? What We Know, and What We Need To Know: in: Proceedings, 11th Annual Forest Vegetation Management Conference, Nov. 7-9, Sacramento, CA, p. 87-106

Powers, S., 1978, Tribes of California: University of California Press, Berkeley and Los Angeles. (Originally published 1877.)

Pyne, S.J., 1982, Fire in America: A cultural history of wildland and rural fire. Princeton, NJ: Princeton Univ. Press.

Raven, P.H. and Axelrod, D.I., 1978, Origin and relationships of the California flora: University of California Publications in Botany 72:1-134.

Rieman, B., Lee, D., McIntyre, J., Overton, K., and Thurow,R., 1993, Consideration of Extinction Risks for Salmonids: Fish Habitat Relationships, USDA Forest Service Technical Bulletin, Number 14. pp 12.

Rosgen, D.L., 1994(in press), A classification of natural rivers: Submitted to Catena. Catena, Elseiver Publications, Amsterdam.

Rothermel, R. C., 1983, How to predict the spread and intensity of forest and range fires: Gen. Tech. Rep. INT-143. Ogden, UT: USDA Forest Service, Intermountain Forest and Range Experiment Station. 161 p.

Rothermel, R. C., 1991, Predicting behavior and size of crown fires in the Northern Rocky Mountains: Res. Pap. INT-438. Ogden, UT:USDA Forest Service, Intermountain Forest and Range Experiment Station. 46 p.

Saunders, H.R., Hobbs, R.J., and Margules, C.R., 1990, Biological Consequences of Ecosystem Fragmentation: A Review: Conservation Biology 5:18-32.

Sawyer, J.O.; Thornburgh, D.A., 1977, Montane and subalpine vegetation of the Klamath Mountains: In: Barbour, M.G.; Major, J., eds. Terrestrial vegetation of California. New York: John Wiley and Sons, Inc.; 699-732.

Sawyer, J.O., Thornburgh, J.A., and Griffin, J.R., 1977, Mixed evergreen forest: In: Barbour, M.G.; Major, J., eds. Terrestrial vegetation of California. New York: John Wiley and Sons, Inc.; 359-381.

Schlosser, J.J., 1982, Trophic Structure Reproductive Success and Growth Rate of Fishes in Natural and Modified Headwater Streams: Canadian Journal of Fisheries and Aquatic Sciences 39:968-978.

Schlosser, J.J., 1991, Stream Fish Ecology: A Landscape Perspective: Bioscience 41:704-712.

Searchlight, The Record, 1898, Special Issue: "Northern California Mining Edition": Redding CA.

Sedell, J.R., Reeves, G.H., Hauer, F.R., Sanford, J.A., and Hawkins, C.P., 1990, Role of Refugia in Recovery from Disturbances: Modern Fragmented and Disconnected River Systems: Environmental Management 14:711-724.

Shaffer, M.L., 1987, Minimum Viable Populations; Coping with Uncertainty: in M.E. Soule, ed.: Viable Populations for Conservation: Cambridge University Press, Cambridge, England, pp 69-86.

Shaffer, M.L., 1991, Population Viability Analysis: in Decker,D.J., Krasny, M.E., Goff, G.R., Smith, C.R., and Gross, D.W., eds.: Challenges in the Conservation of Biological Resources: Westview Press, Boulder, Colorado, USA.

Skinner, N., 1991, Fire considerations letter: USDA Forest Service, Shasta-Trinity National Forests, Mt. Shasta Ranger District.

Skinner, N., 1994, personal communications, with Garland, A., Shasta-Trinity National Forests, SO.

Skinner, M. and B. Pavlik, 1994. California Native Plant Society's Inventory of Rare and Endangered Vascular Plants of California. Sacramento, Calif.

Starosolszky, O., 1987, Applied Surface Hydrology. Water Resources Publications. p. 6.

Stebbins, G.L. and J. Major, 1965. Endemism and Speciation in the California Flora. Ecol. Mono. 35(1):1-35.

Steffes, W., 1994, on-file information concerning analysis of culverts within the Butter Creek watershed, Shasta-Trinity National Forests, engineering group, SO.

Steinbrenner, E.C. 1979, Forest Soil Productivity Relationships: in P.E. Heilman et al., eds.: Forest Soils of the Douglas-fir region: Washington State University, Pullman, WA.

Swetnam, T.W., 1993, Fire history and climate change in giant sequoia groves: Science. 262:885-889

Taylor, A.H., and Skinner, C.N., In Preparation, Fire history and fire regimes in the Klamath Mountains, California

Theodoratus, D., 1981, Native American Cultural Overview: Shasta-Trinity National Forest Contract #53-9a28-9-2957.

Thomas, J.W., 1994, Cover Letter on Special Forest Products Strategic Plan: USDA Forest Service, June, 1994

Thomas, J.W., 1993, Forest Ecosystem Management: An Ecological, Economic and Social Assessment; Report of the Forest Ecosystem Management Assessment Team; USDA Forest Service, USDI Fish and Wildlife Service, USDC National Marine Fisheries Service, USDI National Park Service, USDI Bureau of Land Management, and EPA, July, 1993.

Timberman, The, 1950, Directory of Western North America; Forest Products Industry, Portland, Oregon.

Timossi, I., 1993, California Wildlife Habitat Relationships Microcomputer Database, Version 5.0: Calif. Dept. Fish and Game. 4 diskettes.

Trinity County, 1993, Annual planning information for Trinity County, County publication.

U.S. Census, 1970, Department of Commerce, vol. I, part 6:33

USDA Forest Service and USDI Bureau of Land Management, 1994a, FSEIS on Management of Habitat for Late-Successional Old-Growth Forest Related Species within the Range of the Northern Spotted Owl; 2 volumes.

USDA Forest Service and USDI Bureau of Land Management, 1994b, Record of Decision for Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl; April

USDA Forest Service, 1942, Timber Survey Report Tule Creek Project, Trinity National Forest, CA.: Pacific Southwest Region, San Francisco, CA., 27 pages.

USDA Forest Service, 1972a, Butter Creek Stream Survey. Shasta-Trinity National Forests, Supervisor's Office, Fisheries Survey Files.

USDA Forest Service, 1972b, Indian Valley Creek Stream Survey. Shasta-Trinity National Forests. Supervisor's Office, Fisheries Survey Files.

USDA Forest Service, 1976a, Indian Valley Creek Stream Survey. Shasta-Trinity National Forests. Supervisor's Office, Fisheries Survey Files.

USDA Forest Service, 1976b, South Fork Trinity River Stream Survey. Shasta-Trinity National Forests. Supervisor's Office, Fisheries Survey Files.

USDA Forest Service, 1979, South Fork Trinity River Stream Survey. Shasta-Trinity National Forests. Supervisor's Office, Fisheries Survey Files.

USDA Forest Service, 1980, Butter Creek Stream Survey. Shasta-Trinity National Forests. Supervisor's Office, Fisheries Survey Files.

USDA Forest Service, 1983, Indian Valley Creek Stream Survey near the Indian Valley Guard Station. Shasta-Trinity National Forests. Supervisor's Office, Fisheries Survey Files.

USDA Forest Service, 1990, South Fork Trinity River Watershed and Fisheries Monitoring Program, 1990 Progress Report. USDA Forest Service, Shasta-Trinity National Forests, Redding, CA. p. 191.

USDA Forest Service, 1991, Annual Progress Report for South Fork Trinity River Watershed and Fisheries Monitoring Program. USDA Forest Service, Shasta-Trinity National Forests, Redding CA. 49 p. plus App.

USDA Forest Service, 1992a, FEIS for the South Fork Trinity River Wild and Scenic River Plan, Shasta-Trinity National Forests

USDA Forest Service, 1992b, Old Growth Inventory, Trinity National Forest: Oracle Database.

USDA Forest Service, 1993a, Butter Creek Stream Habitat Survey of 1990, Shasta-Trinity National Forests: Supervisor's Office, Fisheries Survey Files.

USDA Forest Service, 1993b, Draft Land and Resource Management Plan. Shasta-Trinity National Forests.

USDA Forest Service, 1993d, Fire related considerations and strategies in support of ecosystem management. Fire and Aviation Management, Washington Office. Washington, D.C.

USDA Forest Service, 1994a, Unpublished data from 1992 and 1993 monitoring program: USDA Forest Service, Shasta-Trinity National Forests, Redding, CA.

USDA Forest Service, 1994b, ORACLE Ecological Unit Inventory Database, Version 2.01 Documentation Package: Pacific Southwest Region, San Francisco, CA., 125 pp.

USDA Forest Service, 1994c, Butter Creek Stream Habitat Survey of 1993: Unpublished (rough draft). Shasta-Trinity National Forests. Hayfork Ranger District, Fisheries Survey Files.

USDA Forest Service, 1994d, Special Forest Products Strategic Plan.

USDA Forest Service, 1994e, Draft Region 5 Ecosystem Management Guidebook, Volume 1: Pacific Southwest Region, San Francisco, CA.

USDA Forest Service, 1994f, Draft Region 5 Ecosystem Management Guidebook, Volume 3: Pacific Southwest Region, San Francisso, CA.

USDA Forest Service, 1994g, Random Wildlife Sightings Records: USDA Forest Service, Hayfork Ranger District, internal records.

USDA Forest Service, 1994i, Relationship of watershed analysis to land management planning, project planning and ecosystem management, Mattson, P., in Watershed Analysis Notes, No. 1, September 16, 1994, R6.

USDA Forest Service, 1994j, Draft Environmental Impact Statement for the management of land within the range of the California Spotted Owl; Region 5, Forest Service.

USDA Forest Service, 1994k, Preliminary Watershed Restoration Assessment,

Upper South Fork Trinity River, Shasta-Trinity National Forests; prepared by Trinity County Local Interagency Interdisciplinary Team to support FY94 watershed restoration program, Jan 31, 1994.

USDA Soil Conservation Service, 1975, Soil Taxonomy: USDA Handbook AH-436, 754 pages.

USDA Soil Conservation Service, 1987b, Weaverville Area Soil Survey: Draft, Davis,CA.

USGS, 1971, California Streamflow Characteristics Volume 1, including the Pacific Slope Basins.

Van Norden, R.W., 1912, Report on An Hydro-Electric Power Project. South Fork Trinity River, California: Reference Book TK 1081 V217, State of California Natural Resources Library, Sacramento, California. pp 48.

van Wagtendonk, J.W., 1985, Fire suppression effects on fuels and succession in short-fire-interval wilderness ecosystems: In: J.E. Lotan, B.M. Kilgore, W.C. Fischer, and R.W. Mutch(eds.), Proceedings of symposium and workshop on wilderness fire, USDA Forest Service, Intermountain Forest and Range Experiment Station, Gen. Tech. Rep. INT-182, Ogden, UT. pp 119-126.

Varnes, D.J., 1984, Landslide hazard zonation: a review of principles and practices: United Nations Educational Scientific and Cultural Organization, Paris, France, 63 pp.

VTN Environmental Sciences, 1979, Fish and Wildlife Management Options. Trinity River Basin, Northwestern California: prepared for the USDI Bureau of Reclamation, Mid-Pacific Region, Sacramento, California.

Wallace, R.E., 1990, The San Andreas Fault System, California: U.S. Geological Survey Professional Paper 1515; 283 p.

Water Notices, Licence no. 559, Permit no. 276; Trinity County, Weaverville, CA

Weatherspoon, C.P. and Skinner, C.N., 1994, In Draft. An Assessment of Factors Associated with Damage from the 1987 Wildfires in Northern California. In Progress. USDA Forest Service, PSW Res. Stn., Redding, CA.

Williams, G.W. 1993. References on the American Indian use of fire in ecosystems. Draft white paper, USDA Forest Service, Pacific Northwest Region.

Williams, J.T. and Rothermel, R.C., 1992, Fire dynamics in Northern Rocky Mountain Stand Types. USDA Forest Service. Res. Note INT-405. 4 p.

Wills, R. D., 1991, Fire History and Stand Development of Douglas-fir/Hardwood Forests in Northern California. Master of Science Thesis

Wills, R.D., and Stuart, J.D., Fire history and stand development of a Douglas-fir/hardwood forest in northern California; Northwest Science, 68, 205-212.

Wright, H.A. and Bailey, A.W., 1982. Fire Ecology in United States and Southern Canada.

Wright, J.E, and Wyld, S.J., 1994, The Rattlesnake Creek terrane, Klamath Mountains, California: An early Mesozoic volcanic arc and its basement of tectonically disrupted oceanic crust: Geological Society of America Bull., v. 106, p. 1033-1056.

Ziemer, R.R., 1981, Roots and the Stability of Forested Slopes: in: Davies, T.R.H., and Pearce, A.J., eds.: Erosion and Sediment Transport in Pacific Rim Steeplands: Proceedings Christchurch Symposium 25-31, January 1981, Christchurch, New Zealand, International Assn. Hydrological Sciences Pub. 132, IAHS, Wallingford, UK.

Zinke, P., and Colwell, R., 1963, Forest-Soil Relationships in North America: a paper presented at the Second North American Forest Soils Conference, Oregon State University, 1963.

GLOSSARY

Abiotic - The non-living material components of the environment such as air, rocks, soil, plant litter, and water.

Accelerated Erosion and Sediment Yield - The increase in erosion and sediment yield above natural levels as caused by human activities.

Aggradation - The upbuilding performed by a stream in order to establish or maintain uniformity of grade or slope.

Alluvial - Deposited by a stream or running water.

Aquatic Ecosystem - A water based ecosystem (see ecosystem). An interacting system of water with aquatic organisms (plants and animals).

Anadromous - Fish that swim from the ocean up streams to spawn.

Beneficial Uses - The range of items directly associated with the flow and distribution of water through a watershed. The uses of the waters of the state that may be protected against quality degradation, including but not necessarily limited to domestic, municipal, agricultural, and industrial supply; power generation; recreation; esthetic enjoyment; navigation; and preservation and enhancement of fish, wildlife, and other aquatic resources of preserves.

Best Management Practice (BMP) - A practice or a combination of practices, that is determined by a State (or designated area-wide planning agency) after problem assessment, examination of alternative practices, and appropriate public participation to be the most effective, practicable (including technological, economic, and institutional considerations) means of preventing or reducing the amount of pollution generated by nonpoint sources to a level compatible with water quality goals.

Biodiversity - see Biological Diversity

Biological Diversity - The variety of life and its processes, including the variety in genes, species, ecosystems, and the ecological processes that connect everything in ecosystems.

Biomass - The total mass (weight, volume) of living organisms in a biological system. The above-ground portions of shrubs and trees, excluding material that meets commercial sawlog specifications.

Biome - A major portion of the living environment of a particular region characterized by its distinctive vegetation and maintained by local conditions of climate.

Bioregion - A system of related, interconnected ecosystems.

Biota - All the species of plants and animals occurring within an area or region.

Biotic - All the plants and animals and their life processes within the planning area.

Biotic Community - Any assemblage of populations living in a prescribed area or physical habitat: an aggregate of organisms which form a distinct ecological unit.

Candidate Species - A species of plant or animal being considered for listing as a federally endangered or threatened species.

Catastrophic event - A large-scale, high-intensity natural disturbance that occurs infrequently.

Cemented (embedded) - Under general stream dynamics, fine sediment gets trapped in the interstitial spaces between rocks, especially on spawning sites or riffles. Natural, seasonal flushing flows cleanse trapped fines from the riffle areas allowing little accumulation. However, either a natural or man-made event may add such an excessive amount of fine sediment that natural flows cannot flush the fines from the riffles. Overtime the riffles “harden” or become cemented thereby making them unsuitable for spawning.

Channel (streamcourse) - An open outlet either naturally or artificially created which periodically or continuously contains moving water, or which forms a connecting link between two bodies of water. River, creek, run, branch, anabranch, and tributary are some of the terms used to describe natural channels. Natural channels may be single or braided.

Climax Community - The final or stable biotic community in a successional series which is self-perpetuating and in dynamic equilibrium with the physical habitat.

Colluvium - Any loose and incoherent mass of soil material and/or rock fragments deposited by rainwash, sheetwash, or slow continuous down-slope creep, usually collecting at the base of gentle slopes or hillsides.

Community - An aggregation of living organisms having mutual relationships among themselves and to their environment.

Corridor - Route that permits the movement of species from one Ecoregion, Province, landscape or ecosystem to another.

Corridor, Landscape - The landscape elements that connect similar patches through a dissimilar matrix or aggregation of patches.

Crown Scarp - The outward-facing scarp, bordering the upper portion of a landslide.

Cumulative Effects Analysis - An analysis of the effects on the environment which results from the incremental impact of a proposed action when added to other past, present, and reasonable foreseeable future actions, regardless of what agency or person undertakes such other actions.

Cumulative Watershed Analysis - An analysis of Cumulative Watershed Effects, described below.

Cumulative Watershed Effects - Impacts occurring away from the site of primary development which are transmitted through the fluvial system. The impacts occur through both increases in peak stream flows and through increased sediment levels. The effects generally are concentrated within stream channels which can lead to bank undercutting, channel aggradation, degradation and inner gorge mass wasting.

Debris Torrents - A mass wasting process which results from a debris slide or avalanche entering and flowing down a steep gradient stream channel. As the mass entrains more water, it scours and transports large quantities of organic material and sediment. This material is generally deposited as the channel gradient decreased or a significant obstruction is met. Torrents generally contribute to secondary mass wasting along the margins of the scoured channel.

Debris Slide/Avalanche - A mass wasting process characterized by a relatively shallow failure plane, which generally corresponds to the soil/bedrock interface. The distinction between an avalanche and a slide is that a slide moves slower, and retains more of a coherent slide mass. An avalanche generally fails rapidly, with the slide mass disaggregating, and sometimes flowing, depending on the water content.

Desired Future Condition - Objectives for physical and biological conditions within the watershed. They may be expressed in terms of current conditions, ecosystem potential, or social expectations. They describe the conditions that are to be achieved and are phrased in the present tense.

Diorite - A plutonic rock intermediate in composition between acidic and basic.

Disturbance - A discrete event, either natural or human induced, that causes a change in the existing condition of an ecological system.

Diversity - The distribution and abundance of plant and animal species and communities in an area.

Dormant Mass Wasting Feature - A landform which can be defined as originating through mass wasting. There are different degrees of dormancy, from a feature which has been active less than 50 years ago, to one which has been dormant for over one thousand years.

Drainage Area - The drainage area of a stream at a specified location is that area, measured in a horizontal plane, which is enclosed by a drainage divide.

Ecological Unit - A mapped landscape unit designed to meet management objectives, comprised of one or more ecological types.

Ecological Classification - A multifactor approach to categorizing and delineating, at different levels of resolution, areas of land and water having similar characteristic combinations of the physical environment (such as climate, geomorphic processes, geology, soil, and hydrologic function), biological communities (such as plants, animals, microorganisms, and potential natural communities), and the human dimension (such as social, economic, cultural, and infrastructure).

Ecological Processes - see Ecosystem Functions

Ecology - The science of the interrelationships between organisms and their environments.

Ecoregion - A continuous geographic area in which the environmental complex, produced by climate, topography, and soil, is sufficiently uniform to develop characteristics of potential major vegetation communities.

Ecosystem - The complex of a community of organisms and its environment functioning as an ecological unit in nature.

Ecosystem Functions - The major processes of ecosystems that regulate or influence the structure, composition and pattern. These include nutrient cycles, energy flows, trophic levels (food chains), diversity patterns in time/space development and evolution, cybernetics (control), hydrologic cycles and weathering processes.

Ecosystem Processes - see Ecosystem Functions.

Ecosystem Management - Using an ecological approach to achieve the multiple-use management of national forests and grasslands by blending the needs of people and environmental values in such a way that national forests and grasslands represent diverse, healthy, productive, and sustainable ecosystems. The careful and skillful use of ecological, economic, social, and managerial principles in managing ecosystems to produce, restore, or sustain ecosystem integrity and desired conditions, uses, products, values, and services over the long-term.

Ecosystem Sustainability - The ability to sustain diversity, productivity, resilience to stress, health, renewability, and/or yields of desired values, resource uses, products, or services from an ecosystem while maintaining the integrity of the ecosystem over time.

Ecotone - A transition between two or more biotic communities.

Ecotype - A locally adapted population of a species which has a distinctive limit of tolerance to environmental factors: a genetically uniform population of a species resulting from natural selection by the special conditions of a particular habitat.

Edaphic - Resulting from or influenced by factors inherent in the soil or other substrate.

Endangered Species - A species which is in danger of extinction.

Endemic - Restricted to a specified region, locality, or attribute of the environment.

Environment - The complex of climatic, soil and biotic factors that act upon an organism or ecological community and ultimately determine its form and survival.

Environmental Change - A shift in the rate or timing of a physical process or a shift in state of physical or biotic character.

Erosion - The group of processes whereby earthy or rock material is worn away, loosened or dissolved and removed from any part of the earth's surface. It includes the processes of weathering, solution, corrasion, and transportation. Erosion is often classified by: the eroding agent (wind, water, wave, or raindrop erosion); the appearance of the erosion (sheet, rill, or gully erosion); the location of the erosional activity (surface, or shoreline); and/or by the material being eroded (soil erosion or beach erosion).

Erosion Hazard Rating - A relative (not absolute) rating of the potential for soil loss due to sheet and rill erosion from a specific site. Commonly used to address erosion response expected from a given land management activity. Ratings are the result of a cumulative analysis of the following factors: soil, topography, climate, and vegetative and protective cover.

Eyrie - A raptor's cliff nest, such as a peregrine falcon.

Exotic Species - Non-native species which occur in a given area as the result of deliberate or accidental introduction of the species from a foreign country.

Fault Zone - A fault that is expressed as a zone of numerous small fractures.

Fauna - All animals, including birds, mammals, amphibians, reptiles, fish and invertebrates (clams, insects, etc.).

Fragmentation - Breaking up of contiguous areas into progressively smaller patches of increasing degrees of isolation.

Fuel Loading - The amount of combustible material present per unit of area, usually expressed in tons per acre.

Fuels - Any material capable of sustaining or carrying a forest fire, usually natural material, both live and dead.

Gap Analysis - Process to determine distribution and status of biological diversity and assess adequacy of existing management areas to protect biological diversity.

Geologic Province - Any large area or region considered as a whole, all parts of which are characterized by similar features or by a history differing significantly from that of adjacent areas.

Guild - A group of species that have similar habitat requirements. Can also be known as an assemblage.

Habitat Type - The collective land area in which one vegetation type is dominant or will come to be dominant as succession advances.

Habitat Connections - A network of habitat patches linked by areas of like habitat. The linkages connect habitat areas within the watershed to each other and to areas outside the watershed. These connections include riparian areas, mid-slopes, and ridges.

Home Range - The geographic area within which an animal travels to carry out its activities.

Impact - A negative environmental change. The value judgement of "negative" is generally construed to mean that conditions or processes are moving away from desired states.

Inpool Cover - Cover for fish within pools provided by undercut banks, submerged vegetation, and submerged objects. Examples include logs, rocks, floating woody material, water depth, and water turbulence.

Integrated Resource Management - The simultaneous consideration of ecological, physical, economic, and social aspects of lands, waters, and resources in developing and carrying out multiple-use, sustained-yield management.

Island Arc - A chain of islands rising from the deep-sea floor and near to the continents.

Issue - Refers to a topic, a subject, a category, or a value which is registered by a person as something in which they have a high level of interest. Used synonymously with the term "concern". Identification of issues can occur through formal solicitation, content analysis of publication and periodicals, or informal communications.

Jurassic - A period of geologic time covering the span of time between 190 to 135 million years ago.

Key Questions - Questions that Watershed Analysis attempts to answer. These are the interdisciplinary team's expectations for the analysis.

Landscape - The mixture of topographic, vegetative, and biologic attributes within an area. An area composed of interacting and interconnected patterns of habitats, that are repeated because of the geology, land forms, soils, climate, biota, and human influences throughout the area. Landscape structure is formed by patches, connections, and the matrix. Landscape function is based on disturbance events, successional development of landscape structure, and flows of energy and nutrients through the structure of the landscape.

Landscape Connectivity - The spatial contiguity within the landscape. A measure of how easy or difficult it is for organisms to move through the landscape without crossing habitat barriers.

Landscape Ecology - The study of spatial and temporal interactions and exchanges across heterogeneous landscapes, the influences of spatial heterogeneity on biotic and abiotic process, and the management of spatial heterogeneity.

Landscape Unit - A continuous geographic area with fairly consistent landform and vegetation communities.

Lentic - A still water aquatic system as in pond or lake.

Linkage - Route that permits movement of individual plant (by dispersal) and animals from a Landscape Unit and/or habitat type to another similar Landscape Unit and/or habitat type.

Lithology - The description of rocks on the basis of such characteristics as color, mineralogy, and grain size.

Lotic - A running water aquatic system as in a stream or river.

Mass wasting - A general term for the dislodgement and downslope transport of soil and rock material under the direct application of gravitational body stresses. In contrast to other erosional processes, the debris removed by mass wasting is not carried within, on or under any other medium. Mass wasting includes many processes, including relatively slow displacement, such as creep, or rapid movement such as rock falls, debris avalanches, or debris torrents.

Melange - A mappable body of rock characterized by the inclusion of fragments and blocks of all sizes, both exotic and native, embedded in a fragmented and generally sheared matrix of more tractable material.

Microsite - A rock outcrop, snag, seep, stream pool, and other environmental features small in scale but unique in character.

Monitoring - To watch, observe, or check, especially for a specific purpose, such as to keep track of, regulate, or control.

Natural Range of Variability- The spectrum of conditions possible in ecosystem composition, structure, and function considering both temporal and spatial factors.

Obligate - Restricted to one particular attribute of habitat or life cycle.

Peak Streamflows - The highest level of streamflow in response to a rainstorm or period of snow melt.

Peridotite - A coarse grained, ultramafic plutonic rock composed chiefly of olivine.

Phyllite - A metamorphosed rock, intermediate in grade between slate and mica schist.

Physical Process - The rate and timing of the interaction of biotic and abiotic ecosystem components.

Plant Association - A potential natural plant community of definite floristic composition and uniform appearance. The lowest level of potential natural community classification.

Population - A group of individuals of a species living in a certain area. They have a common ancestry and are much more likely to mate with one another than with individuals from another area.

Potential Natural Community - The biotic community that would be established if all successional sequences of its ecosystem were completed without additional human-caused disturbances under present environmental conditions. Grazing by native fauna, natural disturbances such as drought, floods, wildfire, insects, and disease, are inherent in the development of potential natural communities which may include naturalized non-native species.

Plutonic - Igneous rocks formed at great depth.

Pool Frequency - The number (occurrence) of pools or a certain size pool within a general or selected stream reach.

Proposed Species - Any species that is proposed in the Federal Register to be listed as threatened or endangered.

Province - A continuous geographic area wherein species composition, both plant and animal, is more homogeneous than between adjacent areas.

Range of Variability (Natural Variability, Historic Variability) - The spectrum of conditions possible in ecosystem composition, structure, and function considering both temporal and spatial factors.

Rehabilitation - Returning of land to productivity in conformity with a prior land use plan, including a stable ecological state that does not contribute substantially to environmental deterioration and is consistent with surrounding aesthetic values.

Resilience - The ability of an ecosystem to maintain diversity, integrity and ecological processes following disturbance.

Restoration - The process of restoring site conditions as they were before a land disturbance.

Riparian Ecosystem - Ecosystems transitional between terrestrial and aquatic ecosystems. Streams, lakes, wet areas and adjacent vegetation communities and their associated soils which have free water at or near the surface.

Riparian Reserve - The area which encompasses streams, lakes, and wetlands and is designed to protect aquatic and riparian functions and values. The Riparian Reserve is a function of site characteristics, physical processes linked to the area, and the type and timing of activity proposed.

River Basin - An area, defined by physical boundaries, in which all surface water flows to a common point. River basins are associated with large river systems and are typically 1000s of square miles in size.

River Basin Analysis - The collection and organization of aquatic and fisheries issues and processes or condition, at a scale greater than watershed analysis.

Schist - A strongly foliated rock, formed by metamorphism, that can be readily split into thin flakes or slabs due to the well developed parallelism of the minerals present.

Sediment - Fragmental material that originates from weathering of rocks and is transported by, suspended in, or deposited by water or air or is accumulated in beds by other natural agencies.

Sensitive Species - A species not formally listed as endangered or threatened, but thought, by a Regional Forester in the USDA Forest Service, , to be at risk.

Seral - A biotic community which is a developmental, transitory stage in an ecologic succession.

Seral Stage - A biological community viewed as a single developmental or transitional stage in an ecological succession.

Serpentine - A rock high in iron-magnesium content. Commonly green, greenish yellow, or greenish gray and often veined or spotted with green and white.

Shear Zone - A tabular zone of rock that has been crushed and brecciated by many parallel fractures due to shear strain.

Site - An area described or defined by its biotic, climatic, and soil condition as related to its capacity to produce vegetation; an area sufficiently uniform in biotic, climatic, and soil conditions to produce a particular climax vegetation.

Soil Map Units - Groupings of soils that are too intricately mixed to be mapped discretely at the scale of soils survey mapping being conducted.

Soil Series - Soils of discrete, relative uniform and repeatable character.

Spawning Sites - Gravelled areas within a stream system having the appropriate attributes, i.e., dissolved oxygen, water depth, water velocity, water temperature, substrate composition, and cover that are selected as suitable for spawning by adult fish.

Species Richness - A component of community species diversity that is expressed by simple ratios between total number of species and importance values (such as numbers, biomass, productivity)

Stochastic - Random or uncertain variation.

Stratification - The delineation of areas within a watershed which will respond relatively uniformly to a given process or set of conditions.

Stream Order - A method of numbering streams as part of a drainage basin network. The smallest unbranched mapped tributary is called first order, the stream receiving the tributary is called second order, and so on. It is usually necessary to specify the scale of the map used. A first-order stream on a l:62,500 map, may be a third-order stream on a 1:12,000 map. Tributaries which have no branches are designated as of the first order, streams which receives only first-order tributaries are of the second order, larger branches which receive only first-order and second-order tributaries are designated third order, and so on, the main stream being always of the highest order.

Streamside Management Zone - A designated zone along streams and wetlands which acts as an effective filter and absorptive zone for sediment; maintains shade; protects aquatic and terrestrial riparian habitat; protects channel and streambanks; and keeps the floodplain surface in a resistant, undisturbed condition to limit erosion by floodflows.

Succession - An orderly process of biotic community development that involves changes in species, structure and community processes with time. It is reasonably directional and therefore, predictable.

Sustainability - The ability to sustain diversity, productivity, resilience to stress, health, renewability, and/or yields of desired values, resource uses, products, or services from an ecosystem while maintaining the integrity of the ecosystem over time.

Tectonic - Regional assembling of structural features or the forces involved there in, by crustal dynamics of the earth's surface.

Terrestrial - Living primarily on land rather than in water.

Terrestrial Ecosystem - An interacting system of soil, geology, topography with plant and animal communities.

Threatened Species - A species which is likely to become an endangered species.

Threshold of Concern (TOC) - Used in cumulative watershed effects analyses to describe the point (in terms of percent equivalent road area) where the risk of watershed degradation is significant if mitigation measures are not employed.

Transient Snow Zone - The area between 2,500 and 5,000 feet elevation subject to rain-on-snow events during winter months.

Translational-Rotational Landslides - This type of mass wasting feature is characterized as having a planar failure surface which generally parallels the ground surface (translational), or a failure surface which is circular about an imaginary axis located above the ground surface (rotational). In practice, there is a gradation between the two features; different portions of a landslide complex can either be translational or rotational in character. These types of features generally have low to moderate movement rates.

Ultramafic - Said of an igneous rock having a silica content lower than that of a basic rock.

Underburning - The prescribed use of fire beneath a forest canopy.

Valley Inner Gorge - A zone with slopes adjacent to stream channels, having slope gradients greater than 65%, which are separated from the upslope area by a distinctive break in slope. Valley inner gorges are formed by mass wasting and therefore are noted for their instability.

Viability - The likelihood of continued existence in an area for some specified period of time.

Watershed - A region or area bounded peripherally by a water parting feature and draining ultimately to a particular watercourse or body of water. There are many watersheds within a river basin. Watershed areas range from 20 to 200 square miles in size.

Watershed Analysis - Development and documentation of a scientifically based understanding of the processes and interactions occurring within a watershed in order to make more sound management decisions.

Watershed Product - Terrestrial ecosystem components that move in the fluvial system: water, sediment, chemicals, organic debris, and heat.

Weir - An obstruction placed across a stream thereby causing the water to pass through a particular opening.

Wetland - An area at least periodically wet or flooded: an area where the water table stands at or above the land surface.

APPENDIX A
Inventories Utilized in Analysis

An Ecological Unit Inventory (EUI) served as one of the core inventories for the Watershed Analysis. Ecological Unit Inventory is a national program with direction from the Washington Office ECOMAP group. This group has been active for three years with its focus being a national hierarchical system of ecological units and mapping at the broader levels of the hierarchy (USDA Forest Service, 1994h). It is an interagency effort with major participating agencies being the USDA Soil Conservation Service, USDI Bureau of Land Management, USDI Fish and Wildlife Service, state agencies and The Nature Conservancy. The Shasta-Trinity National Forests have been involved in this effort from the beginning.

The EUI is an integrated mapping and data collection effort designed to classify, map and document ecological types, the basic national planning land unit (USDA, FS, FSH 2090). The goal of this inventory is to provide land managers with map and data elements that accurately merge land and vegetation into logical units with interpretations, mapping, and modeling capabilities suitable for landscape level analysis.

Geomorphology, bedrock geology, soils and potential natural vegetation communities are mapped by specialists. Existing vegetation is mapped as a separate map layer since boundaries are management defined and may not generally conform to land and vegetation controlled boundaries. The polygon data collected conforms to National and Regional USDA Forest Service standards. Resource data for both the existing vegetation and ecological type layers are entered into a relational data base and linked to the digital maps, in an ARC/INFO environment. Relationships between the layers are analyzed by querying the data base, and maps may be plotted to display the results. Version 2.01 Ecological Unit Inventory Data Dictionary (USDA FS, 1994b) lists and defines all of the attributes which may be collected as a part of the inventory, and used for analysis.

The EUI is most useful in evaluating capability, current conditions, modeling and predicting future trends. These are all necessary to adequately address Desired Future Conditions, watershed conditions, ecosystem resilience and to provide the scientific basis for recommendations within the context of Watershed Analysis. Important questions such as slope stability hazard, site productivity, seral stage distribution, fire risk and hazard, wildlife habitat relationships, and restoration recommendations can be addressed with EUI maps and data.

Aerial photography was another important tool used in the analysis. Photography taken in the years 1944, 1960, 1970, 1980 and 1990 was used for many types of analysis, including vegetation, wildlife habitat, geomorphic processes, and management activities.

The California Wildlife Habitat Relationships (WHR) database (Timossi, 1993) was used, along with many supporting references, to create wildlife guilds for the Forest and the watershed. Modeling tools were developed using this WHR database, along with the Avesbase database, for further biological analysis such as micro-habitat elements, habitat trend index, and risk ranks. A Guide to Wildlife Habitat of California was used to link EUI data to wildlife habitat conditions. Sightings atlases at the Hayfork and Supervisor's offices, along with observations records from other agencies and organizations, were incorporated into a GIS map format for easy access. The Hayfork Wetland Inventory (Bardolf, 1993) was used to identify and describe small lentic and lotic systems.

Personal interviews and historic records were the basis for many of the characterizations of the watershed. Information was obtained from the Trinity County library, personal interviews and archived documents, including the Hayfork District Timber Atlas, and Stand Record Cards.

The Transportation Information System inventory was linked to an updated road system map in a GIS environment using ARC/INFO software. It provided the team with information about surface type and maintenance levels.

In order to complete the fisheries portion of the Butter Creek Watershed Analysis, documented survey information collected between 1952 and 1994 was reviewed and analyzed. The surveys in general were classified as (1) habitat improvement or analysis, (2) habitat typing, (3) population and (4) stream assessment. For a chronology of the surveys, see Chapter II, **Table 19**.

The following synopsis of fisheries surveys has been grouped to track the progression of fisheries inventories from the 1950s to the 1990s:

(1) Initial fisheries surveys (1952-1980) in the South Fork Trinity River basin focused primarily on an ocular assessment of fish habitat with a secondary focus on the presence or absence of a particular fish species within a stream.

(2) In 1979, the first count of spring chinook and summer steelhead spawners within their holding habitat was conducted by foot from Raspberry Gulch downstream to the confluence of the South Fork Trinity River with the main stem Trinity River.

(3) The habitat surveys or analyses conducted between 1981 and 1988 concentrated on assessing the extent of habitat loss and possible restoration measures predominantly in the South Fork Trinity River basin, with one assessment in Indian Valley Creek.

(4) Four population counts (two completed, one nearly completed, and one only partially completed) were made by Shasta-Trinity personnel between 1982 and 1986 by snorkelling for spring chinook and summer steelhead spawners within the main stem South Fork Trinity River, in the more focused area between Hyampom Valley and the confluence with the East Fork South Fork Trinity River. Both species were then counted annually (1988-1990) in this same river area initially by the Forest Service and then by California Department of Fish and Game personnel.

(5) Commencing in 1988, the Forest Service conducted habitat typing surveys in the Trinity River basin. These surveys were predominantly funded by the Trinity River Restoration Program. USFS personnel surveyed the main stem South Fork Trinity River during 1988 and 1989; Butter Creek was surveyed during 1990 and 1993 (unpublished).

(6) In 1991 and thru 1994, DFG biologists continued the annual spring-run spawner counts, but extended their counts to the entire main stem South Fork Trinity River, including the area snorkelled by USFS personnel in previous years.

(7) In 1993, Pacific Watershed Associates published their comprehensive analyses of the current watershed, fish habitat, and fish population conditions in the South Fork Trinity River basin.

(8) In 1994, cursory surveys were made of the anadromous fish section in lower Butter Creek to assess habitat conditions and scope opportunities for instream and riparian habitat restoration.

A summary table of fish population figures is included in Chapter II, **Table 19**.

The digital hydrography layer from the Cartographic Feature File was updated to include obvious ephemeral drainages, which were digitized. The layer was attributed for range of anadromy, flow regime, stream order and riparian plant community. A subwatershed layer which subdivided the Butter Creek watershed into 22 subwatersheds was digitized.

A stream channel condition survey was conducted in 1993 to inventory channel conditions in selected stream reaches throughout the watershed. Information was collected on channel type, using the Rosgen classification (Rosgen, 1994), channel gradient, channel stability, stream shade, and other extensive evaluations.

A Watershed Improvement Needs Inventory (WINI) was conducted in the watershed in 1991-92. Results were compiled in an unpublished report and filed within the R-5 WIN computer data base. This inventory was used to determine the type of restoration work needed in different portions of the watershed.

A botanical survey was completed for the watershed during the 1993 field season. All suitable habitat was surveyed for sensitive and endemic plant populations. Each of the potential habitat areas surveyed was mapped, along with known populations. Six new populations of sensitive plant species were discovered. An analysis of potential effects of disturbance was completed.

Observation counts for spring-run chinook and spring run (summer) steelhead between Hyampom Valley and the East Fork of the South Fork, South Fork Trinity River, California. 1979-1993, are found in Chapter II, **Table 19**.

The following footnotes describe the individual fish counts by year, which are refered to in Chapter II, **Table 19**.

1/ The 1979 information was collected during a foot survey. Snorkeling surveys were employeed during the following years. The 1979 fish count for both species was revised by R.A. Irizarry on 4/17/93 when discrepancies in data information were pointed out by Eric Gerstung of Sacramento DFG.

2/ The 1982 fish count for spring-run chinook was revised by R.A. Irizarry on 4/17/93 when discrepancies in data information were pointed out by Eric Gerstung of Sacramento DFG.

3/ Owing to an increase in marijuana control operations in the South Fork Trinity River and concerns for non-enforcement Forest Service personnel in the area, the 1984 snorkeling survey was not permitted.

4/ In June 1985, Forest Service stream surveyors conducted a foot survey between Frisbee and Cable creeks and counted 20 adult summer steelhead. In October 1985, Eric Gerstung, CDF&G, conducted a foot survey between Silver Creek and Rough Gulch and counted 15 adult chinook salmon, 7 jack salmon, and 3 adult summer steelhead.

5/ Owing to time and manpower constraints, the 1986 snorkeling survey was not extended below Klondike Mine.

6/ A series of lightning caused wildfires burned from August 30, 1987 into October, 1987 across major portions of the former South Fork Roadless Area. As a result, the snorkeling survey of 1987 was cancelled because all available fisheries personnel were dedicated to fish habitat and watershed rehabilitation efforts during and after the fires.

7/ The 1988 fish count for spring-run chinook was revised by R.A. Irizarry on 4/17/93 when discrepancies in data information were pointed out by Eric Gerstung of Sacramento DFG.

8/ Only personnel from the State of California Department of Fish and Game conducted the South Fork adult counts in 1991. The 1991 fish count for summer steelhead was revised by R.A. Irizarry on 4/19/93 in discussion with Mike Dean, Weaverville DFG, when discrepancies in data information were pointed out by Eric Gerstung of Sacramento DFG.

9/ Personnel from the State of California Department of Fish and Game conducted the South Fork adult counts in 1992 with assistance from Forest Service District fish biologists. The 1992 fish count for both species was revised by R.A. Irizarry on 4/19/93 in discussion with Mike Dean, Weaverville DFG, when discrepancies in data information were pointed out by Eric Gerstung of Sacramento DFG. The corrected information as provided by Mike Dean comes from the August, 1992 snorkeling survey not the July, 1992 snorkeling survey as previously recorded.

10/ Personnel from the State of California Department of Fish and Game conducted the South Fork adult counts in 1993.

11/ Personnel from the State of California Department of Fish and Game conducted the South Fork adult counts in 1994.

APPENDIX B
Descriptions of Riparian Vegetation Communities

The following descriptions should be considered a first apprroximation of a riparian classification for the Butter Creek Watershed. The actual species composition of each community is probably far more diverse than described here. Any mapping done with these descriptions shoud be done carefully taking into account landform, stream flow regime as well as species abundance and cover.

Group 1. Group 1 consists of riparian plant communities found around Indian Valley Creek and tributaries down to and including Corral Gulch. The overstory of these communities is usually comprised of Jeffrey pine and/or ponderosa pine, Douglas-fir and incense cedar. The shrub and herbaceous species composition varies according to available soil moisture.

1) Mixed conifer/herb

This community is located along ephemeral drainages. The mixed conifer/herb community rarely has more than a trace of shrub cover, the most common being whitethorn. The herb layer is composed of species such as *Juncus balticus*, western fescue and other grasses.

2) Mixed conifer/willow/herb

This community is found along intermittent streams. Shrub cover of the mixed conifer/willow/herb community is composed of willow, snowberry and gooseberry. Shrubs are not abundant, but occur in overstory gaps. Shrub cover is usually no greater than 10 to 20 percent. The herbaceous layer consists of *Juncus balticus*, western fescue and other grasses. The difference between the mixed conifer/willow/herb and mixed conifer/herb is the presence of the mesic site shrubs listed above, indicating that these channels stay moist throughout most of the year.

3) Mixed conifer/willow-shrub/herb

This community is primarily located along the perennial streams of Indian Valley and Corral Creeks. The community is characterized by dense shrub cover, usually greater than 25 percent, within and along the banks of the stream channels. Herbs are abundant and diverse during the late spring and early summer. The herb layer consists of California fescue, blue bunch wheatgrass, sedges, *Juncus balticus*, mints and a variety of other species. Full species lists are available. The difference between the mixed conifer/willow-shrub/herb community and the mixed conifer/willow/herb is greater shrub cover and diversity of the mixed conifer/willow-shrub/herb type. Along the perennial streams, the shrub composition usually consists of willow, snowberry, gooseberry, rose and Oregon grape. When it occurs on intermittent streams the shrub layer is primarily comprised of willow, snowberry and gooseberry.

4) Willow/herb

There are a few areas along the perennial Indian Valley Creek where the channel is wide and the banks high. Within these areas the riparian vegetation is constrained to the channel and is composed of willow and a few moisture indicating herbs such as mints.

5) Mixed conifer/shrub/California fescue

This community is located along ephemeral and some intermittent streams on the sideslopes of Friend Mountain. Soil moisture retention is greater along these channels than along other ephemeral and inter- mittent channels in the Indian Valley Creek drainage. The shrub layer is more diverse and is composed of willow, snowberry, whitethorn, coffeeberry and gooseberry. The herbaceous layer is characterized by *Juncus balticus*, California fescue and other grasses.

Group 2. Riparian plant communities along drainages with sideslopes of moderate to steep terrain. These communities can have an overstory dominated by either Douglas-fir or white fir.

6) Douglas-fir/shrub

This plant community is found along ephemeral streams between 1900 and 4600 feet in elevation. The overstory consists of Douglas-fir, canyon live oak, ponderosa pine and madrone. Other species found in the overstory include a few white fir in the upper elevations and black or Oregon white oak in the lower elevations. The shrub layer consists of serviceberry, elderberry and gooseberry at all elevations in the watershed. A few shrub species are affected by elevation. Honeysuckle and poison oak can be found in the lower elevations and California hazel is part of the shrub composition at the higher elevations. Bracken fern, swordfern and California fescue are the most common of the many the herbaceous species found in this community.

7) Douglas-fir-big leaf maple/shrub

This community is usually found between 1770 and 4200 feet in elevation along intermittent and perennial streams. Overstory species include Douglas-fir and other conifers, big leaf maple and occasionally canyon live oak. The shrub layer consists of species listed for the Douglas-fir/shrub type, with the addition of California hazel, Oregon grape, and dogwood. Herbaceous species associated with this community also include those of the Douglas-fir/shrub community as well as the abundant moisture indicating herbs such as inside-out flower, horsetails and giant chain fern. With further investigation, this community may be combined with the Douglas-fir-big leaf maple-pacific yew/shrub community.

8) Douglas-fir-big leaf maple-alder/shrub

This type is usually found along wide segments of perennial streams such as Butter Creek from 1700 to 3100 feet in elevation. The overstory consists of Douglas-fir, big leaf maple, alder and other conifers. The shrub and herbaceous layers consists of the same species found in the Douglas-fir-big leaf maple/shrub community with the addition of colt's foot, cow parsnip, ranger's buttons, fairybells, twisted stalk, heuchera and other creekside plants.

9) Douglas-fir-big leaf maple-pacific yew/shrub

This community is found along moist intermittent or perennial streams between 2100 and 4140 feet in elevation. This community occurs along streams too narrow to support alder and high enough in elevation and with seasonally moist enough soils to support pacific yew. The overstory consists of Douglas-fir, pacific yew and other conifers, as well as big leaf maple and occasionally canyon live oak. The shrub and herbaceous layers are similar to the Douglas-fir-big leaf maple/shrub community.

10) Douglas fir-big leaf maple-alder-pacific yew/shrub

This plant community is found between 2100 and 3600 feet in elevation along intermittent and perennial streams with wide channels. The species composition is similar to the Douglas-fir-big leaf maple-pacific yew/shrub community except for the inclusion of alder. It seems odd to see pacific yew, a shade tolerant tree, growing alongside alder, a shade intolerant tree. Perhaps pacific yew can adapt to moderately sunny conditions as long as there is a ready supply of water.

11) White fir/shrub

This community is usually located within ephemeral channels between 3600 to 4600 feet. The overstory is composed of white fir, Douglas-fir, canyon live oak and some ponderosa pine. In an old growth forest situation, the shade tolerant white fir would probably dominate. The shrub layer is composed of California hazel, pinemat manzanita, Oregon grape, spiraea, serviceberry, snowberry, gooseberry and various species of berry. Swordfern, bracken fern, California fescue and other grasses and forbs may be present.

12) White fir-big leaf maple-pacific yew/shrub

This community is found along intermittent and perennial streams between 3150 and 4070 feet in elevation. The overstory is similar to the white fir/shrub type except for the inclusion of big leaf maple and pacific yew. This community marks the upper elevation limit of big leaf maple in this watershed. The shrub layer is similar to the white fir/shrub type except for the inclusion of burning bush. The herbaceous layer consists of horsetails, wild ginger, bracken fern, maiden hair fern, fairybells, twisted stalk and bedstraw.

13) White fir-pacific yew/willow/herb

This community is found along intermittent or perennial streams with moist sideslopes in the higher elevations of the watershed, 4070 to 4600 feet. It is frequently found below sideslopes dominated by giant chinquapin. The overstory layer is similar to the white fir-big leaf maple-pacific yew/shrub community except for the exclusion of big leaf maple. Giant chinquapin may also be part of the composition. Tree cover is usually high in the undisturbed stands as pacific yew is tolerant to shade. The shrub composition of this community is similar to the white fir-big leaf maple-pacific yew/shrub type, with the addition of willow. Huckleberry oak is sometimes found along the banks above this community.

APPENDIX C - Current Wildlife Diversity by Habitat type and Guild

	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
AMPHIBIANS																															
Northwestern Salamander		2			2		2				1	1			x																
Pacific Giant Salamander	2	2					1					1		x			x														
Olympic Salamander												1	x																		
Rough-Skinned Newt	2	2			2		1					2			x																
Ensatina	2	2		2	2	2	2		2								x														
Black Salamander		2					1										x														
Tailed Frog		2		2	2		1							x									x							*	
Western Toad												1			x																
Pacific Treefrog										2	1				x								x								
Red-Legged Frog												1			x								x						*		
Foothill Yellow-Legged Frog												1		x															*		
Bullfrog											1	1			x																
REPTILES																															
Northwestern Pond Turtle											1	1			x					x									*		*
Western Fence Lizard	2			2	2			1	1											x											
Sagebrush Lizard			2					1								x															
Western Skink								2	2	2											x										
Western Whiptail									1													x									
Southern Alligator Lizard									1													x									
Northern Alligator Lizard	2	2			2	2		1												x											
Rubber Boa							1										x														
Ringneck Snake									2								x			x											

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
REPTILES (cont.)																															
Sharp-Tailed Snake									2								x														
Racer								2	2	2											x										
Gopher Snake									2	2											x										
Common Kingsnake									2	2							x														
Common Garter Snake									2	2	1												x								
Western Terrestrial Garter S.		2					1				1												x								
Western Aquatic Garter Snake									2		1	2			x								x								
Western Rattlesnake				2					1																x						
BIRDS																															
Pied-Billed Grebe											1	2			x																
Eared Grebe											1				x																
Great Blue Heron				2			1				1	2			x				x												
Green-Backed Heron											2	2			x								x								
Wood Duck							1				2	2			x									x							
Mallard										2	1	2			x																
Northern Pintail										2	1				x																
Ring-Necked Duck											1				x																
Lesser Scaup										1	1	2			x																
Hooded Merganser												2	x																		
Common Merganser							1				2	1	x											x							
Ruddy Duck											1				x																
Turkey Vulture	2	2	2	2		2	2	2	2	2										x						x					
Osprey	2	2	2	2	2		2				1	1	x											x							

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
BIRDS (cont.)																															
Bald Eagle	2	2										1	x											x			*				
Sharp-Shinned Hawk	2	2		2	2	2	1																x								
Cooper's Hawk					2	2	1											x													
Northern Goshawk	2		2	2	2	2	2												x										*		*
Red-Tailed Hawk	2	2	2	2	2	2	1			2											x										
Golden Eagle	2		2	2	2	2	2	2	2	2										x				x		x					
American Kestrel	2			2	2	2	2			1											x										
Merlin										2													x								
American Peregrine Falcon							1			2	2	1											x			x	*				
Blue Grouse	1	1	2																x												
Ruffed Grouse	2				2		1										x						x								
California Quail								2	2											x											
Mountain Quail	2		2	2	2	2	2													x											
American Coot											1	1			x																
Killdeer										2	2	1									x										
Spotted Sandpiper												1	x																		
Common Snipe											1										x										
Band-Tailed Pigeon	2				2	2	1											x													
Mourning Dove				2	2	2	1			2											x		x								
Common Barn Owl				2	2	2	2	2	2	2											x										
Flammulated Owl	2	2	2	2	2	2	2																	x							
Western Screech Owl					2	2	2													x				x							
Great Horned Owl	2			2	2	2	2													x											
Northern Pygmy Owl	2	2		2	2	2	2																	x							

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
BIRDS (cont.)																															
Northern Spotted Owl	2	2		2	2	2	2												x					x				*			
Northern Saw-Whet Owl	2	2		2	2	2	2																	x							
Common Nighthawk	1	2	2	2	1			2		2	2	2								x											
Common Poorwill									2											x											
Vaux's Swift		1																		x				x							
Anna's Hummingbird	2							2	1													x									
Calliope Hummingbird				2	2		1	2			2									x											
Rufous Hummingbird	2	2	2	2	2	2	1		2											x			x								
Belted Kingfisher							1					2	x										x								
Lewis' Woodpecker	2		2	2	2	2	2																	x							
Acorn Woodpecker				2	1	1	2											x						x							
Red-Breasted Sapsucker	2	2	2		2	2	1																x	x							
Downy Woodpecker							1																	x							
Hairy Woodpecker	2		1	2	2	2	2											x	x					x							
White-Headed Woodpecker	2		2	2	2														x					x							
Northern Flicker	2			2	2	2	2																	x							
Pileated Woodpecker	2	2	2	2	2														x					x							
Olive-Sided Flycatcher	2	2	2		2														x												
Western Wood-Pewee	2		2	2	2	2	1																x								
Hammond's Flycatcher	2	2	2	2	2														x												
Dusky Flycatcher	2		2	2	2		2	2														x									
Western Flycatcher		2		2	2	2	1																x								
Black Phoebe							1			2	1	2											x								
Ash-Throated Flycatcher									2													x		x							

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
BIRDS (cont.)																															
Western Kingbird					2	2															x										
Purple Martin							1				2	2											x	x							
Tree Swallow							1			2	2	2											x	x							
Violet-Green Swallow	2			2	2	2	1			2	1												x	x							
N. Rough-Winged Swallow				2	2	2	1			2	1	2									x					x					
Cliff Swallow				2			1			2	2	1	x													x					
Barn Swallow				2				2	2	2	2	2									x					x					
Steller's Jay	2	2	2	2	2														x												
Scrub Jay								2										x													
Common Raven	2	2	2	2	2	2	2	2	2											x											
Mountain Chickadee	2		2	2															x					x							
Chestnut-Backed Chickadee		1					2												x					x							
Plain Titmous				2	2	1												x						x							
Bushtit					2	2	2		2													x									
Red-Breasted Nuthatch	2	2	2	2															x					x							
White-Breasted Nuthatch	2	2	2	2	1	1	2											x						x							
Brown Creeper	2	2	2	2	2														x												
Rock Wren					2	2		2	2	2										x					x						
Bewick's Wren							1	2	2													x									
House Wren							1		2														x								
Winter Wren	2				2		2																x								
American Dipper							2					1		x																	
Golden-Crowned Kinglet	2	2		2	2														x												
Ruby-Crowned Kinglet	2			2																		x									

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
BIRDS (cont.)																															
Blue-Gray Knatcatcher									1													x									
Western Bluebird					2	2	2													x				x							
Mountain Bluebird	2			2			2			2														x							
Townsend's Solitaire	2		1	2		2																x									
Swainson's Thrush							1																x								
Hermit Thrush	2	2	2		2	2	2																x								
American Robin	2	2	2	2	2	2	2														x										
Varied Thrush		1		2	2														x												
Wrentit								1	1							x															
Water Pipet										1						x					x										
Cedar Waxwing		2					2		2													x									
European Starling										1	1										x			x							
Solitary Vireo			2	2	2	2	2												x												
Hutton's Vireo					2	2	2											x													
Warbling Vireo					2	2	1											x													
Orange-Crowned Warbler									2													x									
Nashville Warbler	1			2	2	2	1	1														x									
Yellow Warbler	2			2			1	2															x								
Yellow-Rumped Warbler	2	2	2	2	2		2															x									
Black-Throated Gray Warbler				1	1	1																x									
Townsend's Warbler		1																	x												
Hermit Warbler	1	1	2	2	1														x												
Macgillivray's Warbler		1					1																x								
Common Yellowthroat							1			2	1												x								

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

BIRDS (cont.)	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
Wilson's Warbler							1																x								
Yellow-Breasted Chat							1																x								
Western Tanager	2		2	2	2	2	2															x									
Black-Headed Grosbeak					2	2	1																x								
Lazuli Bunting							1		2													x									
Green-Tailed Towhee	2			2	2	2		1								x															
Rufous-Sided Towhee								2	2													x									
Brown Towhee									1							x															
Chipping Sparrow	2			2	2	2														x											
Grasshopper Sparrow										1											x										
Fox Sparrow	2		2		2	2	2	2														x									
Song Sparrow							1				1									x											
Golden-Crowned Sparrow		2																		x											
Dark-Eyed Junco	2	2	2	2	2	2	2													x											
Red-Winged Blackbird										2	1												x								
Western Meadowlark		2								1											x										
Brewer's Blackbird					2	2	2			2	2	2								x											
Brown-Headed Cowbird							2			2	2												x								
Northern Oriole					2	2	2																x								
Purple Finch	1	2			1	2	2															x									
Cassin's Finch	2																				x										
House Finch					2	2	2	2	2	2										x											
Red Crossbill	2	1		2															x												
Pine Siskin		1																		x											

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
BIRDS (cont.)																															
Lesser Goldfinch					2	2	2	2	2	2										x											
American Goldfinch							2		2	2										x											
Evening Grosbeak	1																		x												
MAMMALS																															
Virginia Opossum							2	2	2		2												x								
Water Shrew							1					2											x								
Trowbridge's Shrew	2	1		1	1		2												x												
Shrew-Mole	1	1				2	1				2						x														
Broad-Footed Mole							2			1											x										
Little Brown Myotis	2	2	2	2	2	2	2	2				2								x						x					
Yuma Myotis	2			2	2	2	1	2	2	2		1								x						x					
Long-Legged Myotis	2	2	2	2																x						x					
Fringed Myotis					2	2	2																			x					
Long-Legged Myotis	2		2	2	2	2	1													x						x					
California Myotis	2				2	2	2	2	2																	x					
Silver-Haired Bat	2	2	2	2			2												x												
Big Brown Bat	2				2	2	2	2												x						x					
Hoary Bat	2	2		2	2	2	2												x												
Townsend's Big-Eared Bat	2	2	2	2	2	2	2			2		2														x			*		
Brush Rabbit	2	2			2		2	2	2											x											
Snowshoe Hare							1													x											
Black-Tailed Hare	2			2		2			2	2										x											
Mountain Beaver							1																x								

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

	WHR Types by Trend Index												Guilds														Fed. Status				
	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
MAMMALS (cont.)																															
Allen's Chipmunk	2		2	2																		x									
Sonoma Chipmunk	2		2	2	2	2	2	2	2							x															
California Ground Squirrel	2		2	2	2	2		2	2	1																					
Western Gray Squirrel					2	2												x			x			x							
Douglas' Squirrel	2	2	2	2	2														x					x							
Northern Flying Squirrel	2	2	2	2	2		2												x					x							
Botta's Pocket Gopher	2	2		2	2	2	2	2	2	1																					
California Kangaroo Rat									1											x	x										
Beaver							1					1	x										x								
Western Harvest Mouse							2														x										
Deer Mouse	2		2	2	2	2	2	2	2								x														
Brush Mouse	2	2	2		2	2	2	2	2																						
Pinyon Mouse		2		1	2	2	2	2									x														
Dusky-Footed Woodrat	2	2		2		2		2	2													x									
Bushy-Tailed Woodrat		2	2			2																			x						
Western Red-Backed Vole	2	2	2		2		2												x												
California Vole							2														x										
Creeping Vole	2	2			2		2			1										x											
Muskrat							2				1	2	x																		
Porcupine	2	2		2																x											
Coyote	2	2	2	2	2	2	2	2	2											x											
Gray Fox	2	2	2		2	2		1	1							x															
Black Bear	2	1	2	2	2	2	2												x	x											
Ringtail		2			2		2	1	1													x									

1 = Highly Associated Index
2 = Generalist Index

Explaination of Trend Index is on the last page of this appendix

APPENDIX C (continued)

	WHR Types by Trend Index												Guilds														Fed. Status				
MAMMALS (cont.)	Klamath Mixed Conifer	Douglas-Fir	Jeffrey Pine	Ponderosa Pine	Montane Hardwood-Conifer	Montane Hardwood	Montane Riparian	Montane Chaparral	Mixed Chaparral	Perennial Grassland	Fresh Emergent Wetland	Riverine	General Aquatic	Fast Aquatic	Slow Aquatic	Chaparral	Dead and Down Wood	Hardwood	Late Seral Forest	General Open Habitat	Grass and Meadow	Shrub	Riparian	Snag/Cavity	Talus and Rock	Cliff and Cave	Endangered	Threatened	Catagory 2	Recommended for Catagory 2	USFS Region 5 Sensitive
Racoon	2	2	2	2	2	2	1																x								
Pacific Fisher	2	2	2	2	2		2												x										*		*
Marten	1	2	2		2		1			2									x												*
Ermine	2	2	2	2	2	2	1													x											
Long-Tailed Weasel	2	2	2	2	2	2	2										x														
Mink											2	2											x								
Western Spotted Skunk	2	2	2	2	2	2	1	2	2													x									
Striped Skunk	2	2	2	2	2	2	2	2	2											x											
River Otter											1	2	x										x								
Mountain Lion	2	2	2	2	2	2	1	1	1											x											
Bobcat							2	2	2											x											
Mule Deer	2	2	2	2	2	2	2	2	2							x				x											

Habitat Trend Index

Some species are highly associated with certain habitat types. Other species can use a variety of habitat. The highly associated species can be used for analysis or monitoring because their population would be more effected by habitat changes. Species that use a variety of habitats are labeled generalists. The generalists would not be suitable for monitoring habitat types change, but could be tied to habitat elements such as snags or fish for prey. The indexes are as follows:

1 = Highly Associated Index
2 = Generalist Index

Appendix D - Acres of Wildlife Habitat Relationship Types

Standards *for* Size Class

WHR	DBH
1	<1"
2	
3	6"-11"
4	11"-24"
5	>24"
6	>24" Multi-Layered

Standards *for Canopy* Closure

WHR Canopy Closure

S	10-24%
P	25-39%
M	40-59%
D	60-100%

Klamath Mixed Conifer

Size Class (1990)	S	P	M	D	Total	Size Class (1944)	S	P	M	D	Total	Change
1	54				54	1					0	54
2	105	99	650	11	865	2				3	3	862
3		69	2465	667	3201	3	3	4	158	213	378	2823
4		199	1301	1612	3112	4		32	135	2306	2473	639
5				584	584	5	22	148	191	5619	5980	-5396
6			5	636	641	6				2928	2928	-2287
Total	159	367	4421	3510	8457	Total	25	184	484	11069	11762	-3305

Douglas-Fir

Size Class (1990)	S	P	M	D	Total	Size Class (1944)	S	P	M	D	Total	Change
1					0	1					0	0
2	11	37	180	182	410	2				26	26	384
3			260	144	404	3				231	231	173
4		10	716	971	1697	4	1		85	469	555	1142
5			376	1225	1601	5			13	3295	3308	-1707
6				146	146	6				1827	1827	-1681
Total	11	47	1532	2668	4258	Total	1	0	98	5848	5947	-1689

Jeffrey Pine

Size Class (1990)	S	P	M	D	Total	Size Class (1944)	S	P	M	D	Total	Change
1					0	1					0	0
2	8	8		76	92	2					0	92
3	2	196	87		285	3	18	147	53		218	67
4		97	167		264	4	15	22	271		308	-44
5					0	5	11	12	49		72	-72
6					0	6					0	0
Total	10	301	254	76	641	Total	44	181	373	0	598	43

Ponderosa Pine

Size Class (1990)	S	P	M	D	Total	Size Class (1944)	S	P	M	D	Total	Change
1	68				68	1					0	68
2	71	978	1210	551	2810	2					0	2810
3	3	13	286	11	313	3			15	158	173	140
4					0	4		24			24	-24
5					0	5					0	0
6					0	6					0	0
Total	142	991	1496	562	3191	Total	0	24	15	158	197	2994

Montane Hardwood Conifer

Size Class (1990)	S	P	M	D	Total	Size Class (1944)	S	P	M	D	Total	Change
1		3	10		13	1					0	13
2	164	307	1365	180	2016	2			10	136	146	1870
3		88	562	299	949	3		103	317	759	1179	-230
4		84	569	810	1463	4	14	88	346	1822	2270	-807
5			42	204	246	5	13	5	76	383	477	-231
6					0	6				202	202	-202
Total	164	482	2548	1493	4687	Total	27	196	749	3302	4274	413

Montane Hardwood

Size Class (1990)	S	P	M	D	Total	Size Class (1944)	S	P	M	D	Total	Change
1					0	1					0	0
2	50		240		290	2			50		50	240
3				10	10	3	10	11	7	90	118	-108
4				31	31	4	27	6	13	141	187	-156
5			197	60	257	5					0	257
6					0	6					0	0
Total	50	0	437	101	588	Total	37	17	70	231	355	233

Montane Riparian

Size Class (1990)	S	P	M	D	Total	Size Class (1944)	S	P	M	D	Total	Change
1					0	1					0	0
2			45		45	2					0	45
3			10		10	3		27			27	-17
4					0	4		17		44	61	-61
					0	5					0	0
6			16		16	6					0	16
Total	0	0	71	0	71	Total	0	44	0	44	88	-17

Appendix D - Acres of Wildlife Habitat Relationship Types (continuted)

Standards for Size Class

WHR	WHR Size Class	Crown Decadence
1	Seedling Shrub	Seedlings/Sprouts <3 years
2	Young Shrub	None
3	Mature Shrub	1 - 25%
4	Decadent Shrub	>25%

	1990						1944						
	Size Class	S	P	M	D	Total	Size Class	S	P	M	D	Total	Change
Montane Chaparral	1					0	1					0	0
	2					0	2		2	9	43	54	-54
	3	94	1			95	3		6	85	6	97	-2
	4					0	4	3			22	25	-25
	Total	94	1	0	0	95	Total	3	8	94	71	176	-81

	1990						1944						
	Size Class	S	P	M	D	Total	Size Class	S	P	M	D	Total	Change
Mixed Chaparral	1					0	1					0	0
	2		26	920		946	2					0	946
	3					0	3					0	0
	4			30	129	159	4					0	159
	Total	0	26	950	129	1105	Total	0	0	0	0	0	1105

Standards for Height Class

WHR	WHR Height Class	Plant Height at Maturity
1	Short Herb	<12"
2	Tall Herb	>12"

	1990						1944						
	Size Class	S	P	M	D	Total	Size Class	S	P	M	D	Total	Change
Perennial Grassland	1					0	1			1	21	22	-22
	2			207	191	398	2				44	44	354
	Total	0	0	207	191	398	Total	0	0	1	65	66	332

APPENDIX E
Threatened, Endangered and Sensitive Species Analysis

This appendix contains answers to questions posed in Appendix C, page C7-12, "Endangered Species Act and Other Species Considerations", contained in the June 13, 1994 letter on "FY 1994-96 Watershed Analysis Guidelines", signed by Regional Forester Ronald Stewart.

Northern Spotted Owl

1. Are spotted owl activity centers located within the watershed? Yes

   a. If so, how many and in what ROD land allocations are they located?

      There are 4 owl activity centers within the Butter Creek watershed. Two (#630 and 631) are centered within a Late Successional Reserve (LSR)-RC 330, while the other two (637 and 638) are located in the matrix. One is within a half mile of the LSR, thus the western portion of its .7 mile territory circle and its 1.3 mile home range circle is within the LSR.

   b. Which of these are currently above "take" thresholds and which are below?

      At the .7 mile radius level, 2 of the 4 territories are above the incidental take threshold. Two territories have greater than 500 acres and two have less than 500 acres for suitable habitat. At the home range 1.3 mile radius level, all 4 owl pairs have less than 1336 acres required to preclude incidental take allowance.

Suitable Habitat

Owl#	.7 circle	1.3 circle
630	175 acres	1135 acres
631	540 acres*	1010 acres
637	570 acres*	860 acres
638	370 acres	555 acres

* incidental take allowance not needed.

   c. When were the activity centers located?

Owl#	year located
630	1986
631	1989
637	1991
638	1989

   d. Describe the reproductive history.

Owl#	pair verified	young verified
630	1886, 1989	*
631	1989	*
637	1991, 1993	1991
638	1989	*

* reproduction not verified

2. Has a 100 acre core area been designated around each activity center located in matrix lands?

   Yes, the 100 acre cores have been delineated for owls #638 and 637.

3. How many acres of nesting, roosting, and foraging (NRF) habitat are there in the watershed?

   Only nesting and roosting habitat has been defined and tracked for the Forest. This NR habitat is known as suitable owl habitat. There are 8135 acres of suitable owl habitat in the watershed.

   a. What percentage of the watershed is this?

      Suitable habitat exists over 35 percent of the watershed. In addition, another 57 percent of the watershed is forested and capable of becoming suitable habitat. Thus, 92% of the watershed is either currently suitable or capable of becoming suitable in the future.

b. Which of these stands have been surveyed to protocol? (2 years)

Within about 75 percent of the watershed, surveys have been performed to protocol for calling routes, SOHAs, timber sales, and ecosystem management areas from 1989 to 1994.

Surveys areas	Years
Butter Creek ecosystem areas A & B	1993 and 1994
Jim's Friend proposed timber sale	1990, 1991 and 1992
Indian Valley proposed timber sale	1991 and 1992
Canyon proposed timber sale	1991
Plufus proposed timber sale	1991
Snow Fire proposed timber sale	1989 and 1990
CinnBear proposed timber sale	1989 and 1990
Indian Valley Calling Route	1989 and 1990
Grassy Flat SOHA	1989 and 1990
Butter Caves SOHA	1989

c. Which were not?

About 25 percent of the watershed (lower portions of Butter and Indian Valley Creeks and Maddox Lake vicinity) has not been surveyed for spotted owls. This area is the northwestern section of the watershed. The unsurveyed area partially includes the LSR and home range circles for two owl pairs.

4. What is the amount of nesting, rearing and foraging habitat in each ROD land allocation within the watershed?

Only nesting and roosting habitat has been defined and tracked for the Forest. This NR habitat is known as suitable owl habitat. Most of the 8135 acres of suitable habitat occurs within the LSR and matrix ROD land allocation.

Suitable Habitat (NR)

ROD Alloc	Acres
LSR	3824
Matrix	3436
AMA	545
PVT	330

5. Does any portion of the watershed contain LSRs?

Yes, a 8115 acre portion of LSR RC330 lies within the watershed.

a. What percent of the total watershed is this?

The LSR area totals 8115 acres, or 35 percent of the watershed.

b. What are the current totals of NRF habitat and capable habitat in the LSR?

Suitable habitat within the LSR is 3824 acres (47 percent of LSR). In addition, the capable forested habitat is 3729 acres (46 percent of the LSR). Acres of suitable habitat plus acres of capable forested habitat total 93 percent of the LSR.

6. What is the amount of dispersal habitat (11-40 and above) in each ROD land allocation within the watershed?

Including LSR lands and suitable habitat, there are 9353 acres that provide adequate dispersal habitat within the watershed. Dispersal habitat is present over 40 percent of the watershed and makes up 71 percent of the capable forested acreage.

Dispersal Habitat

ROD Alloc	Acres
LSR	4080
Matrix	4355
AMA	555
PVT	363

7. Is the distance between LSRs (those over 10,000 acres) greater than 4 miles? Yes

   a. If so, then what is the amount of dispersal habitat on Federal lands for all 1/4 townships between the LSRs? (50/11/40)

      There are 2,910 acres of adequate dispersal habitat outside of the LSR within the Federal lands of the watershed. Outside the LSR and private lands, there are 13,095 acres for forests that are capable of becoming dispersal habitat. The current dispersal habitat is 32 percent of these forested lands. A rough estimate of 2000 acres of Riparian Reserves can be added to the current dispersal acreage. Thus, 4910 acres or 37 percent of the area provides dispersal.

      Most of the 1/4 townships adjacent to the LSR currently provide or almost provide adequate dispersal habitat (44-76 percent cover). The two 1/4 townships within the CHU almost provide adequate dispersal habitat at 40-46 percent cover.

      The acreage and percentage figures below reflect the detailed analysis of the 1/4 townships inside the watershed, outside the LSR, and excluding private lands.

1/4 Township #s		Total Area Acre Available	Capable Acre	Dispersal Acre	Percent by Total	Percent of Capable Acreage
140137	03.ON07EC	25	24	16	64	67
140138	03.ON07ED	187	174	21	11	12
140147	02.ON06EA*	0	0	0		
140148	02.ON07EB	902	745	566	63	76
140149	02.ON07EA	3,454	3,443	1,538	45	45
140150	02.ON08EB	1,011	944	378	37	40
140159	02.ON07EC	183	172	16	9	9
140160	02.ON07ED	4,991	4,782	1,128	24	24
140161	02.ON08EC	2,846	2,359	1,091	38	46
140171	01.ON07EA	213	187	52	24	28
140172	01.ON08EB	633	265	43	7	16

* No Federal Lands outside of LSR

   b. What percent of the total Federal lands in these 1/4 townships is this?

      Approximately 95 percent of the Butter Creek watershed is National Forest System lands.

   c. How much (percent and total) of the dispersal habitat is in Riparian Reserves, Administratively Withdrawn (which provide long-term protection), Congressionally Reserved, 100 acre cores, and smaller (<10,000 acres) LSRs?

      About 41 percent of the watershed, or 9630 acres, are Riparian Reserves. Two hundred acres, or <1 percent, will become 100 acre owl cores. A wildlife travel corridor has been designated to be managed to increase cover, including dispersal habitat. The corridor includes Riparian Reserves and also expands to about a 1/2 mile band where cover is currently lacking. This wide band will be emphasized for cover treatments.

   d. Is this total greater than 50 percent?

      No, but managing the wildlife corridor would increase the total percentage to over 50%.

   e. Describe, if present, the natural barriers to dispersal.

      The burn areas will likely be avoided by dispersing owls. Corridors for wildlife are planned to be established. Within the corridors, tree growth, structure, and canopy closure will be managed for to improve dispersal habitat.

   f. Is connectivity, or dispersal habitat, sufficient to allow movement?

      Connectivity is sufficient from the watershed down to South Fork Trinity River corridor, and across the river into the remainder of the LSR.

8. How much critical habitat has been designated within the watershed?

Within the Butter Creek watershed, 3020 acres are located within Critical Habitat Unit CA-35.

a. How much of this total overlaps with LSRs?

The CHU does not overlap with the LSR.

b. For areas that do not overlap, how much is currently NRF habitat?

The suitable habitat (NR) outside of the LSR is 4311 acres. Within the CHU, there are 1291 acres of suitable habitat (43 percent of the CHU).

And how much is capable?

Within the CHU, there are 2,926 acres of forested land that are capable of becoming suitable NR habitat at a later time.

c. How many activity centers are located in this non-overlap area of CHU?

Two, #637 and 638.

d. How many territories are currently above "take"? How many below? (use acres established by FWS for .7 and 1.3 mile radius).

At the .7 mile radius level, 1 of the 2 territories are above the incidental take threshold. One territories has greater than 500 acres and the other has less than 500 acres of suitable habitat. At the home range 1.3 mile radius level, the 2 owl pairs have less than 1336 acres required to preclude incidental take allowance.

Suitable NR Habitat for 2 Owl Pairs

Owl#	.7 circle	1.3 circle
637	570 acres	860 acres
638	370 acres	555 acres

e. What role does this non-overlap critical habitat play in this watershed in relation to the reasons for the designation of the CHU?

The critical habitat was previously established as an overlay for connectivity of fisher management areas. Then it became a CHU to provide dispersal habitat. With the ROD allocation network, this area is no longer required for late successional species viability.

Bald Eagle

1. Are occupied bald eagle activity areas (nesting, foraging, winter roosts, or concentration areas) located within the watershed?

No. There is an eagle pair that nests about 9 miles away. It forages outside of the watershed along the South Fork Trinity river. There is neither enough of a food base or foraging view points in the 1.5 mile of anadromous reach of Butter Creek to support an eagle pair and young.

a. If so, what type? n/a

b. How many? n/a

c. What ROD land allocations are they located? n/a

d. Describe reproductive history based on monitoring data. n/a

e. Has a final site-specific protection/management assessment been developed for each site? n/a

f. Does this watershed analysis corroborate the findings of the management assessment? n/a

2. Has an assessment been made as to whether there are potential bald eagle activity areas (nesting, foraging, winter roosts, or concentration areas) located within the watershed?

Yes, the watershed analysis evaluated fish populations, stream habitat and eagle sighting records. It confirmed that the fisheries is not a sufficient food base in either the resident trout streams or in the 1.5 mile of anadromous reach of Butter Creek to support an eagle pair and young.

a. If so, what type? n/a

b. How many? n/a

c. What ROD land allocations are they located? n/a

d. Have these areas been surveyed to protocol to determine they are unoccupied? n/a

3. Describe historical bald eagle occurrence and nesting within the watershed.

   There is no known historic occurrence or nesting in the watershed.

4. What is the status of the watershed as it relates to the Recovery Plan? (target territories, including beyond watershed boundaries)

   a. Does the watershed and the surrounding area meet objectives of the Recovery Plan?

      Yes. The watershed is in Zone 23 (California/Oregon Coast) of the Pacific States Recovery Plan. The main threats previously listed for this zone are shooting, logging, human disturbance, and loss of anadromous fish. The proposed management direction is to restore anadromous fish populations and increase the nesting population. This zone is rated at the 75 percent occupancy level according to the California Department of Fish and Game update of September 7, 1994. The Forest currently exceeds the target nesting pair levels recommended in the February 7, 1985 memo regarding population levels for Pacific states recovery goals.

   b. If not, then are there capable eagle activity areas located within the watershed?

      No, there are no capable activity areas since there is not an adequate fisheries food base. Even if salmon recovery efforts are successful, the watershed may only serve as a complementary foraging area to the larger South Fork Trinity River.

   c. If capable activity areas are present, what type are they? n/a

      1) How many? n/a

      2) What ROD land allocations are they located? n/a

   d. What type of project or enhancement could develop sites into potential or occupied sites?

      Most of the watershed contains resident trout streams. Only 1.5 miles of anadromous streams are in Butter Creek. Restoration goals for the watershed will contribute to increase habitat quality for trout and salmon in the future. The watershed may only serve as a complementary foraging area to the larger South Fork Trinity River.

5. If present, describe significant habitat within the watershed that is not under Federal ownership.

   Private lands do not have significant habitat for the eagle.

Amphibians

1. Have any amphibian inventories been done on a project or watershed level?

   A wetland inventory has been performed for the Hayfork Ranger District. Wildlife sightings have been recorded. For example, western pond turtles were located at several ponds. During fish habitat and snorkel surveys, incidental frog sightings were recorded.

   a. What species does the literature suggest may be present?

      The home range of the following frogs and salamanders extends into the watershed:

      northwestern salamander
      Pacific giant salamander
      southern torrent salamander
      rough-skinned newt
      ensatina
      black salamander
      western toad
      tailed frog
      Pacific tree frog
      northern red-legged frog
      foothill yellow-legged frog
      bullfrog

2. Are sensitive species and ROD Table C-3 species present or based on best information, is there a possibility they can occur in the watershed?

   None of the Table C-3 salamanders are suspected to occur in the watershed or vicinity. The northern red-legged frog and foothill yellow-legged frog are listed or may become listed as Sensitive species. There are two observations of the foothill yellow-legged frog in the watershed. This frog has been observed in several reaches along the South Fork Trinity River. There is no confirmation of the northern red-legged frog's presence in or near the vicinity of the watershed.

3. Have intensive or extensive inventories been conducted in adjoining drainages/sub-watersheds?

   The observations of the foothill yellow-legged frogs were done during stream surveys in Butter Creek by the Pat Higgins, Pacific Watershed Associates.

   a. If so, can those inventories be extrapolated to this watershed?

      Yes, this frog occurs within the watershed.

4. Are endemic species known to occur in the general geographic region?

   No, they are not known to occur in the vicinity

5. Are exotic species known or suspected to be in the watershed? (e.g., bullfrogs)

   Bullfrog populations are a possibility since there are observations on the Trinity Forest.

Peregrine Falcon

1. Are any cliffs located within the watershed? (rock wall >50 feet)

   Yes, there is one cliff area.

2. Are any cliffs present that are historic (pre-1975) or traditional (post-1975) peregrine eyries?

   There are no historic cliff eyries. There is one traditional eyrie known as the Butter Creek Caves territory.

3. For past projects near historic cliffs, have mitigation measures for habitat been considered? n/a

   a. At these historic cliffs, have surveys to protocol been accomplished for at least 2 years prior to the activities? n/a

4. For traditional cliffs, have surveys/monitoring been conducted to determine nest site occupancy and reproductive status?

   The following table documents historical surveys:

Survey Yr	**Results**
1979	no sightings
1983	no sightings
1984	no sightings
1986	no sightings (ledge enhancement occurred)
1987	no sightings
1988	no sightings
1990	pair seen, along with 1 other adult, one chick which perished on the nest
1991	results unknown
1992	pair with one young
1993	results unknown
1994	female seen incubating

   b. Has a draft or final site mgt plan been created?

      The Butter Creek Peregrine Falcon Management Plan was approved in January 1991.

      1) Is this plan based on site specific and PNW sub-population nesting ecology?

         The plan is based on U.S. Fish and Wildlife Service and Forest Service recommendations and the Pacific Coast Recovery Plan. It has a 450 acre primary zone and a 850 acre secondary zone.

5. Have the cliffs located been rated or monitored for falcon potential or presence?

   n/a

6. If cliffs are un-rated, have surveys been accomplished to protocol?

   n/a

7. Describe site habitat variables within a 3 mile radius of historic and traditional nest sites. (cliff parent material, distance to water/riparian, vegetative habitat, seral stages, human activities)

   The Butter Creek eyrie cliff is composed of weathered, highly fractured, limestone.

Butter Creek and its Riparian Reserve is within 1/2 mile of the site. The South Fork Trinity River is 3 miles away. The habitat is a mosaic of riparian areas and forested habitat that has 8,135 acres of suitable spotted owl habitat.

Gray Wolf

Not applicable. Species not in the State or province.

Grizzly Bear

Not applicable. Species not in the State or province.

Marbled Murrelet (Zone 1 & 2)

Not applicable. The watershed is beyond the Zone 2 boundary.

APPENDIX F
Late Successional Reserve Assessment

This working document is a Late Successional Reserve (LSR) Assessment for the Butter Creek Watershed portion of LSR RC330 (South Fork Trinity Mountain). This LSR assessment will address the steps outlined on page C-11 of the ROD. This LSR assessment will use the Butter Creek Watershed Analysis (BWA) data and results that are currently available to meet the ROD standards, guidelines, goals and objectives for Late Successional Reserves.

Introduction

This Late Successional Reserve (LSR) Assessment for the Butter Creek Watershed portion of LSR RC330 (South Fork Trinity Mountain) will follow ROD standards and guidelines and Regional Ecosystem Office (REO) advice (Tony Sisto, LSR group). Initial project specific assessments will go through REO approval procedures using this LSR assessment as a baseline (Tony Sisto, LSR group).

ROD Attachment A includes the Standards and Guidelines (S&G) for the management of habitat for late successional (LS) and old growth (OG) forest related species. LSR S&G begin on ROD page C-9. The objectives are to manage LSRs to protect and enhance conditions of LS and OG forest ecosystems, which serve as habitat for LS and OG related species, including the northern spotted owl (ROD page C-11). LSRs are designed to maintain a functional, interacting LS and OG forest ecosystem (ROD page C-11).

This LSR assessment will address the steps outlined on page C-11 of the ROD. This LSR assessment will use the Butter Creek Watershed Analysis (BWA) data and results that are currently available.

General LSR Assessment Steps

The LSR in the South Fork Trinity area, RC330, is a 'mapped' LSR. The total area is over 83,000 acres, most of which is on the Shasta-Trinity National Forest (80,695 acres). It was designed to incorporate the South Fork Trinity River Key Watershed and ecological significant forests (identified by the Scientific Panel) to the extent possible (ROD page C-9 and BWA Introduction).

LSR management assessments should generally include and describe these items within the reserve (ROD page C-11):

Step 1a) an inventory of vegetative conditions and

1b) a history of change among the vegetation conditions.

Step 2a) list of associated species and

2b) information on species locations

Step 3a) a history of land uses and

3b) current land uses.

Step 4) a fire management plan.

Step 5) criteria for developing appropriate treatments (restoration, protection and enhancement).

Step 6) identification of specific areas for treatments.

Step 7) a proposed implementation schedule tiered to larger scale plans.

Step 8) proposed monitoring and evaluation components to evaluate if future activities are carried out as intended (implementation monitoring) and achieve desired results (effectiveness monitoring).

General Project Level Assessments

Initial project specific assessments will go through REO approval procedures using this LSR assessment as a baseline (Tony Sisto, LSR group). For initial project assessment within the LSR, Ranger Districts should follow procedures where needed beyond this LSR assessment: (ROD page 57)

- ❑ Projects and activities within LSR (restoration, recreation, safety projects, thinning, salvage, etc.) may proceed in FY94-96 using initial LSR assessments done at a level of detail sufficient to assess whether activities are consistent with objectives of the LSRs.

- Non-silvicultural projects and activities are addressed by LSR standards and guidelines in Attachment A (ROD Standards and Guidelines).
- The environmental effects of this initial implementation of these activities should vary little from those displayed in the Final SEIS because silvicultural activities must demonstrate benefit to LSR habitat conditions and these activities are subject to review by the REO and approval by RIEC.

Butter Creek - LSR RC 330 Assessment Steps

The Butter Creek LSR assessment is a companion process with other assessment and analysis processes that are occurring concurrently:

Butter Creek Watershed Analysis including recommendations and monitoring plan in Chapter 4 and Appendix G "Integrated Vegetation Management Plan". BWA is the parent document to this appendix.

Butter Creek Ecosystem Management Plan: a project level plan which includes priority activities based on landscape level design with the public.

Butter Creek Environmental Assessment: analysis of the potential effects of proposed activities within the watershed).

The Butter Creek watershed includes a 8115 acre portion of the LSR RC330. It is located in a Tier 1 Key Watershed. The LSR goal is to manage the LSR to protect and enhance conditions of LS and OG forest ecosystems, which serve as habitat for LS and OG related species, including the northern spotted owl. The key question for this assessment is: How is the LSR functioning currently for NSO and other LS/OG species and how should it be functioning for future needs including matrix owls immigration into the LSR?

To address this key question, the following are assessment steps and their data for the Butter Creek portion of the LSR RC330:

Step 1a) An inventory of vegetative conditions and

1b) a history of change among the vegetation conditions.

Assessment - To compare current and historic vegetation conditions, the years 1990 and 1944 are used, respectively. Ecological Unit Inventory (EUI) data, collected in 1990, classified vegetation into wildlife habitat relationship (WHR) types, WHR size classes, and WHR canopy closures. Aerial photos from 1944 were interpreted into these same WHR classes.

The forested vegetation within the Butter Creek watershed has changed significantly during this century. About one-fourth of the LSR has become fragmented since 1944 and is not functioning as interior forest habitat — 24 percent of the Douglas-fir and mixed conifer WHR types present in 1944 have converted to Pine, Hardwood types, or openings. Specifically, Douglas-Fir (DFR) decreased by 13 percent, Klamath Mixed Conifer (KMC) decreased by 11 percent, while Jeffrey Pine (JPN) and Ponderosa Pine (PPN) increased by 9 percent, montane hardwood conifer (MHC) increased by 8 percent, Montane Hardwood (MHW) increased by 3 percent, and Perennial Grasslands increased by 2 percent. The PPN type was not found in the LSR during the 1944 photo interpretation. Being new to the area, the PPN type currently exists only in small diameter classes.

KMC and DFR types still represent the majority of the conifer types, although the structure has changed. We use WHR size class 4, 5, and 6 (11" to 24"+ dbh) and WHR canopy closure M and D (40-100 percent) for suitable owl nesting habitat and as an indicator of functioning LS or OG conditions. Size 4M is only used within the home range (1.3 mile circle) of an owl activity center. Size 4M beyond pairs home range is consider part of dispersal habitat.

Currently, almost half, or 47 percent of the LSR is functioning as suitable nesting habitat for northern spotted owl. Of the other 53 percent in the LSR, 50 percent is in early seral stage forests or hardwood forests and 3 percent (265 acres) are open grassland and shrubland habitats. Therefore half of the LSR may have capability to function as LS/OG habitat with protection and treatment.

The LSR has 3327 acres of Riparian Reserves. These riparian areas are mostly in bedrock confined channels and have been affected by human disturbance to a slight degree. Specific WHR riparian habitat types have not been characterized in the watershed. Within steep gradient channels, downed logs do not remain in the streams.

Step 2a) List of associated species.

Assessment - Almost half, or 47 percent, of the LSR functions as LS/OG for associated species. Two pair of northern spotted owls currently nest in the LSR. To create a valid list of associated LS and OG species for the Shasta-Trinity National Forests, we reviewed the SAT report LS/OG spp - Appendix 5-D Short List Terrestrial Vertebrates (OG category called "Classic old growth"). We compared it to our local (Regional, Province and Forest) data, models, and guilds which analyzed the function of habitat elements and special needs, such as snags and aquatic conditions. **Table F-1** reflects the species most associated with LS/OG conditions.

Table F-1. Species likely occuring in the Butter Creek Watershed that are highly associated with late seral and old growth habitat (from SAT terrestrial vertebrates "Short List", Appendix 5-D).

Legend:

OCCUR - Are there recorded observations this species in the watershed?

ENDEM - Is this species endemic to the range of the Northern spotted owl?

FOREST SUCCESSIONAL STAGE - Based on the Primary breeding, foraging, and resting habitat needs in Appendix 5-D, Part 1.

Young = Grass/forb and Shrub/sapling stages

Mid = Pole stage

Late = Mature and Old Growth (OG) stages

non brdr = breeding habitat not required; species does not breed on this Forest

OLD GROWTH STRUCTURAL STAGE - For species using the OG stage, which structural stages are used, from Appendix 5-D, Part 1.

Sparse = Canopy; <= 25 percent

Comp = Young growth with legacies

Class.OG = Classic old growth

WHR-GUILD - Indicates the species guild association for Shasta-Trinity National Forest, based on WHR habitat needs and Elemental requirements.

Late - Late seral stage habitats

Snag - Snag important for nesting or foraging

Open - Open habitats, meadows, grassland, seral 1

Cliff - Cliffs/Caves important for nesting

Aquatic - uses fast or slow moving aquatic habitats

Riparian - Associated with streamside vegetation

Hardwood - Hardwood forests important

Shrub - Open shrubby habitats, seral 2a, 3a

Dead/Down - Utilizes Dead/down woody material

Table F-1. Species likely occuring in the Butter Creek Watershed that are highly associated with late seral and old growth habitat (from SAT terrestrial vertebrates "Short List", Appendix 5-D).

SAT Table 5-D		STNF	From SAT table 5-D		STNF Guild
Wildlife Species	**Occur**	**Endemic**	**Forest Successional Stage**	**Old Growth Structural Stage**	**WHR-Guild**
Species associated with late seral habitat on the Shasta-Trinity					
Brown Creeper			Late	Sparse, Class	Late
Chestnut-backed Chickadee			Mid & Late	All	Late/Snag
Douglas Squirrel			Young - Late	All	Late/Snag
Golden-crowned Kinglet			Mid & Late	Sparse	Late
Hammond's Flycatcher			Late	Class	Late
Hermit Warbler			Young & Late	Sparse	Late
Hoary Bat			Young & Late	All	Late
Marten			Late	Class	Late
Northern Flying Squirrel			Late	Sparse, Class	Late/Snag
Northern Goshawk	4	X	Late	Sparse, Class	Late
Northern Spotted Owl	20	X	Late: OG	Sparse, Class	Late/Snag
Pacific Fisher	6		Late	Sparse, Class	Late
Pileated Woodpecker			Late: OG	Class	Late/Snag
Red-breasted Nuthatch			Late	Sparse, Class	Late/Snag
Red Crossbill			Late	Sparse	Late
Silver-haired Bat			Open & Late	All	Late
Varied Thrush			Shrub & Late	Sparse	Late
Western Red-backed Vole		X	Late	All	Late
White-headed Woodpecker			Late: OG	Class	Late/Snag
Bald Eagle	SF Riv		Late: OG	Sparse, Class	Late/Snag

Step 2b) Information on species locations.

Assessment - Tables of species observations follow. Surveys for goshawks and other LS/OG species have been infrequent.

Legend for these tables:

Occurrences for species listed on page 5

YR VER - Year status verified

REP VER - Year reproduction status

L.A. - Land Allocation, LSR, AMA, AWA, MTX (Matrix)

DIST - Distance occurrence is located from Butter Ck. LSR

DIR - Direction occurrence is located from Butter Ck.

Table F-2. Goshawk Occurrences (within 12 miles of the LSR)

The LSR functions as habitat for goshawk, although nesting pairs have not been observed. In general, the Trinity Forest with its steep terrain has only been infrequently surveyed for this species.

FS#	TWN	RNG	SEC	QTR	QQ	STAT	YR VER	REP VER	L.A.	DIST(m)	DIR
402	4N	8E	19	SW		0	1991	1991	AMA	10	NNE
403	4N	7E	20	NE	SW	S			AMA	10	N
605	31N	12W	29	SW	NW	P	1986	1986	AMA	8.8	ESE
606	2N	8E	9	NW	NW	S	1988	1988	AMA	4.9	E

Table F-3. Spotted Owl Activity centers within BWA LSR and those capable of immigrating to this LSR. They are grouped into 0-6.0 miles and over 6.0 miles from Butter Ck. WA LSR, then sorted by L.A. and distance.

Two spotted owl activity centers are within the LSR. Of those pairs capable of immigrating to this LSR, fourteen pairs are outside the LSR and in the Matrix or Adaptive Management area.

FS #	TWN	RNG	SEC	QTR	QQ	STAT	YR VER	REP VER	L.A.	DIST(m)	DIR
630	2N	7E	9	NW	SE	P	1989		LSR		
631	2N	7E	16	NE	SW	P	1989		LSR		
635	2N	8E	8	NE	NE	P	1992		AMA	3.5	E
636	2N	8E	17	SE	NE	P	1990		AMA	4.0	ESE
614	3N	8E	32	SW	SW	P	1989	1989	AMA	3.5	ENE
615	3N	6E	28	NE	SW	P	1992		AMA	6.0	NW
733	31N	12W	18	NW	NW	P	1993		AMA	6.0	E
638	2N	7E	2	NW	SE	P	1989		MTX	0.5	NE
634	2N	7E	33	SE	SE	P	1992		MTX	2.0	S
637	2N	8E	30	SE	NE	P	1993	1991	MTX	4.8	SE
730	31N	12W	6	SE	SW	P	1992	1991	AMA	6.8	E
734	31N	12W	7	SE	NW	P	1992	1991	AMA	6.8	E
616	3N	6E	21	SW	NW	P	1992	1990	AMA	7.0	NW
732	31N	12W	31	SW	NW	P	1993		AMA	7.8	SE
617	3N	6E	9	SW	SE	P	1990		AMA	9.0	NW

Table F-4. Pacific Fisher Occurrences Within Butter Creek WA

ARABIS	TW	RNG	SEC	QTR	QQ	DATE
363	2N	7E	7			1969
364	2N	7E	8			1967
334	2N	7E	18			1985
372	2N	7E	10	SW		
336	2N	8E	33			1977
316	31N	12W	28			

Step 3a) A history of land uses and 3b) current land uses.

Assessment - In the portion of the LSR within the Butter Creek watershed, there are 4 complete subwatersheds along with portions of 5 subwatersheds. There are approximately 41.6 miles of roads currently within the LSR. The average road density is high with 3.5 miles of road for each square mile. The highest road density is about 5.4 miles per square mile in the Cold Camp Creek subwatershed. First Indian Valley Creek and South Butter Creek subwatershed are also very high and 4.8 miles per square mile.

Information on harvest acres (plantation and salvage) and large fire polygons is in progress.

Step 4) Fire management plan.

There is no specific fire management plan for this LSR or WA. A fuels reduction strategy is in progress for the watershed. In the mean time, fire management will follow **fire management standards and guidelines** from ROD S&G and draft Shasta-Trinity Forest Plan S&G for fire prevention, presupression, and supression.

a) ROD S&GS:

Fuelwood gathering: (C-16) Fuelwood gathering will be permitted only in existing cull decks, where green trees are marked by silviculturist to thin (consistent with standards and guidelines), to remove blowdown blocking roads, and in recently harvested timber sale units where down material will impede scheduled post-sale activities or pose an unacceptable risk of future large-scale disturbances. In all case these activities should comply with the standards and guidelines for salvage and silvicultural activities.

Fire Suppression and Prevention: (C-17) Each Late-Successional Reserve will be included in fire management planning as part of watershed analysis. Fuels management in Late-Successional Reserves will utilize minimum impact suppression methods in accordance with guidelines for reducing risks of large scale disturbances. Plans for wildfire suppression will emphasize maintaining late-successional habitat. During actual fire suppression activities, fire managers will consult with resource specialist (e.g., botanists, fisheries, and wildlife biologist, hydrologists) familiar with the area, these standards and guidelines, and their objectives, to assure that habitat damage is minimized. Until a fire management plan is completed for Late-Successional Reserves, suppress wildfire to avoid loss of habitat in order to maintain future management options.

In Late-Successional Reserves, a specific fire management plan will be prepared prior to any habitat manipulation activities. This plan, prepared during watershed analysis or as an element of province-level planning or a Late-Successional Reserve assessment, should specify how hazard reduction and other prescribed fire applications will meet the objectives of the Late-Successional Reserve. Until the plan is approved, all proposed activities will be subject to review by the Regional Ecosystem Office. The Regional Ecosystem Office may develop additional guidelines that would exempt some activities from review. In all Late-Successional Reserves, watershed analysis will provide information to determine the amount of coarse woody material to be retained when applying prescribe fire.

In Riparian and Late-Succession Reserves, the goal of wildfire suppression is to limit the size of all fires. When Watershed Analysis, Province-level planning, or a Late-Successional Reserve assessment are completed, some natural fires may be allowed to burn under prescribed conditions. Rapidly extinguishing smoldering coarse woody debris and duff should be considered to preserve these ecosystem elements.

Riparian Reserves: (C-35) Design fuel treatment and fire suppression strategies, practices, and activities to meet Aquatic Conservation Strategy objectives, and to minimize disturbance of riparian ground cover and vegetation. Strategies should recognize the role of fire in ecosystem function and identify those instances where fire suppression or fuels management activities could be damaging to long-term ecosystem.

Located incident bases, camps, helibases, staging areas, helispots and other centers for incident activities outside Riparian Reserves. If the only suitable location for such activities is within the Riparian Reserve, an exemption may be granted following review and recommendation by a resource advisor. The advisor will prescribe the location, use conditions, and rehabilitation requirements. Use an interdisciplinary team to predetermine suitable incident base and helibase locations.

Minimize delivery of chemical retardent, foam, or additives to surface waters. An exception may be warranted in situations where overriding immediate safety imperatives would cause more long-term damage.

Design prescribe burn projects and prescription to contribute to attainment of Aquatic Conservation Strategy objectives.

Immediately establish an emergency team to develop a rehabilitation treatment plan needed to attain Aquatic Conservation Strategy objective whenever Riparian Reserves are significantly damaged by wildfire or a prescribed fire burning outside prescribed parameters.

In Riparian Reserves, the goal of wildfire suppression is to limit the spread of all fires. When watershed and/or landscape analysis, or province-level plans are completed and approved, some natural fires may be allowed to burn under prescribed conditions. Rapidly extinguishing smoldering coarse woody debris and duff should be considered to preserve these ecosystem elements. In Riparian Reserves, water drafting sites would be located and managed to minimize adverse effects on riparian habitat and water quality, as consistent with Aquatic Conservation Strategy objectives.

b) Draft Shasta-Trinity National Forest Land and Resource Management Plan Chapter 4, S&G. (@1993 version)

dead/down material (page 12) Maintain unburned dead/down material in the quantity prescribed for each management prescription.

biomass (page 12)): Incorporate biomass opportunities into site-specific projects that would need user needs and other resource requirements, such as dead/down material for wildlife and ground cover for soil protection, and to reduce fuel loading to complement the natural fire regime.

Remove only biomass material that is in excess of the required to meet the standard for soil quality and wildlife diversity, and natural fire regimes.

chaparral (page 14): Assess shrublands for multi-resource management opportunities, and develop project plans for treatment. Selection of specific areas and the treatment methods used would be guided by the following criteria: 1) the effectiveness of producing multi-resource benefits through modification of the specific vegetation association; the cost effectiveness of the project; 3) the degree of fire protection provided by conversion; and the risk to watersheds.

facilities (page 15): Retain roads on the Forest transportation system which would be needed for future activities such as: timber management fire protection.

fire and fuels (page 15): Wildland fires would receive an appropriate suppression response which may range from confinement to control. Unless a different suppression response is authorized in this plan, or subsequent approved Plans, all suppression responses would have an objective of “control”.

All wildland fires, on or threatening private land protected by agreement with the State of California, would receive a “control” suppression response.

Activity fuels that remain after meeting wildlife, riparian, soil, and other environmental needs would be considered surplus and a potential fire hazard. The amount and method of disposal would be determined in the project environmental analysis and would be consistent with Regional fuels management guidelines.

To assist in determining the future fuels profile, USDA Technical Reports, Photo Series for Quantifying Forest Residuals, would be used to visualize desired conditions. These photo series are: PNW-

51, PNW-52, and PNW-95. They can be modified by 10 percent in any fuel size class and no more than 10 percent of the total.

Plan and implement fuel treatments emphasizing biomass utilization, firewood availability, wildlife requirements, air, soil and water quality maintenance, and reforestation needs.

Natural fuels would be treated in the following order of priority: (1) public safety; (2) high investment situations (structural improvements, powerlines, plantations, etc); (3) known high fire occurrence ares; and (4)coordinated resource benefits, i.e., ecosystem maintenance for natural fire regimes.

Consider fuelbreak construction investments when the following situations exist: (1) very high and extensive resource values are at risk: (2) they can be located near roads; (3) if maintenance can be accomplished with little or no special funding.

Design fire prevention efforts to minimize human-caused wildfires commensurate with the resource values-at-risk.

recreation (page 20): Prepare objectives and prescription for managing vegetation in and around developed recreation sites.

soil and water (page 22): Forest Soil Quality Standards, in relation to ground cover, soil organic matter, and soil porosity would be used to protect soil productivity.

timber stand improvement and forest health (page 24): Consider a full range of vegetation management methods to treat competing vegetation and ensure adequate seedling establishment and plantation growth. These practices may include mechanical, manual, prescribe fire, biological, and chemical methods as well as grazing.

prescription VII for LSR and TES (page 42): Treatment of fuels created by project activities would be determined during project planning.

Maintain dead/down material, hardwoods, and snags at naturally occurring levels.

Immediate fire suppression activities would take place for all incidents occurring within or adjacent to HCAs (now LSRs). The TES biologist or Forest Biologist would be contacted to aid in coordinating suppression activities.

Step 5) Criteria for developing appropriate treatments (restoration and protection.)

The key question for this assessment is: How is the LSR functioning currently for NSO and other LS/OG species and how should it be functioning for future needs (i.e. matrix owls immigration into the LSR)? Steps 1 - 3 assess this key question. General criteria are needed for treatments to restore the function of the LSR restoration and meet protection needs for species.

1. Activity is designed to maintain late-successional forest ecosystems. (ROD B-1)
2. Activity protects the LS forest ecosystem from loss due to large-scale fire, insect and disease epidemic. (ROD B-1)
3. Activity protects the LS forest ecosystem from major human impacts. (ROD B-1)
4. Activity maintains natural ecosystem processes such as gap dynamics, natural regeneration, pathogenic fungal activity, insect herbivory, and low-intensity fire. (ROD B-1) Low to moderate intensity disturbances are acceptable and considered natural processes (e.g. tens to hundreds of acres of fire; ROD B-4 and B-5).
5. Silvicultural activities in overstocked young plantations encourage growth to LS and OG characteristics. (ROD B-1 and B-6)
6. Silvicultural activities reduce the risk of the LSR from severe impacts resulting from large-scale disturbances and unacceptable loss of habitat (e.g. thinning, underburning, and mid-level canopy layer thinning to reduce crown fires). (ROD B-1, B-5 and B-7)
7. Activity maintains the major structural attributes of OG: live OG trees, snags, down logs on the forest floor and in the streams, multiple canopy layers, smaller understory trees, canopy gaps, and patchy understory. (ROD B-2)
8. Activity maintains desired characteristics such as multispecies and multilayered assemblages of trees; moderate to high accumulations of large logs and snags; moderate to high canopy closure; moderate to high numbers of trees with physical imperfections such as cavities, broken tops, and large deformed limbs; and moderate to high accumulations of fungi, lichens, and bryophytes. (ROD B-5)

9. Activity increases LS and OG habitat conditions: snags, down logs, large trees, canopy gaps that enable establishment of multiple tree layers and diverse species composition. (ROD B-5).

10. Activity decreases disturbance and harrassment potential, such as road closures that decrease road access.

11. Activity sustains viable forest species populations. (ROD B-5)

12. Activity encourages reproductive success of LS and OG wildlife species.

13. Activity does not harrass or disturb LS and OG wildlife species.

14. Activities in previously regenerated stands are managed to acquire late successional characteristics by thinning or managing the overstory to produce large trees and a variety of species in the overstory and understory; release advanced regeneration of conifers, hardwoods, or other plants; reduce risk from fire, or other environmental variables; underplanting and limiting understory vegetation control to begin development of multistory stands; killing trees to make snags and coarse woody debris; reforestation; and prescribed fire. (ROD B-6).

15. Activities in previously regenerated stands have prescriptions that vary within and among stands. (ROD B-6)

Step 6) Identification of specific areas for treatments.

Refer to Butter Creek WA Chapter 4 and its recommendation and Butter Creek EM and EA currently in progress.

Step 7) A proposed implementation schedule tiered to larger scale plans.

The Butter Creek environmental analysis process will implement the first phase of projects. This is currently in progress.

Step 8) Proposed monitoring and evaluation components to evaluate if future activities are carried out as intended (implementation monitoring) and achieve desired results (effectiveness monitoring).

The monitoring process in Butter Creek WA and in the "Interagency Framework for Monitoring the Presidents Forest Ecosystem Plan" will be used.

Literature Cited:

Crumpton, P.L. and H. Dias, 1994. Guilds from Modified Wildlife Habitat Relationships Model of the Shasta-Trinity National Forest. USDA Forest Service Internal Report.

Mayer, K.E. and W.F. Laudenslayer. 1988. A Guide to Wildlife Habitats of California. Calif. Dept of Forestry and Fire Protection.

Timossi, I. 1993. California Wildlife Habitat Relationships Microcomputer Database, Version 5.0. Calif. Dept Fish and Game. 4 diskettes.

USDA Forest Service. 1993 Draft Land and Resource Management Plan. Shasta-Trinity National Forest.

USDA Forest Service. 1993c. Spotted Owl Territory Summary Report for Shasta-Trinity National Forest. Internal Document.

USDA Forest Service. 1993b. Viability Assessments and Management Considerations for Species Associated with Late-successional and Old-growth Forests of the Pacific Northwest: The Report of the Scientific Analysis Team.

USDA Forest Service et al. 1994. Interagency Framework for Monitoring the President's Forest Ecosystem Plan.

USDA Forest Service et al. 1994b. Record of Decision for the Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl.

USDA Forest Service et al. 1994. Interagency Framework for Monitoring the President's Forest Ecosystem Plan.

USDA Forest Service et al. 1994b. Record of Decision for the Amendments to Forest Service and Bureau of Land Management Planning Documents within the Range of the Northern Spotted Owl.

USDA Forest Service. 1994c. Threatened, Endangered, and Sensitive Species Map and Database for the Shasta-Trinity National Forest. Internal Document.

Attachment A

Table 5. Species are more highly associated with other elements or habitat than LS/OG specifically.

List of species likely occurring in the Butter Creek Watershed and found on the SAT Terrestrial Vertebrates “Short List”, Appendix 5-D.

Table 1 Legend:

* - Species that are associated with younger seral stages for feeding or reproduction, or have a low risk rank.

OCCUR - Are there recorded observations this species in the watershed?

ENDEM - Is this species endemic to the range of the Northern spotted owl?

FOREST SUCCESSIONAL STAGE - Based on the Primary breeding, foraging, and resting habitat needs in Appendix 5-D, Part 1.

Young = Grass/forb and Shrub/sapling stages

Mid = Pole stage

Late = Mature and Old Growth (OG) stages

non brdr = breeding habitat not required; species does not breed on this Forest.

OLD GROWTH STRUCTURAL STAGE - For species using the OG stage, which structural stages are used, from Appendix 5-D, Part 1.

Sparse = Canopy; <= 25 percent

Comp = Young growth with legacies

Class.OG = Classic old growth

WHR-GUILD - Indicates the species guild association for Shasta-Trinity National Forest, based on WHR habitat needs and Elemental requirements.

Late - Late seral stage habitats

Snag - Snag important for nesting or foraging

Open - Open habitats, meadows, grassland, seral 1

Cliff - Cliffs/Caves important for nesting

Aquatic - uses fast or slow moving aquatic habitats

Riparian - Associated with streamside vegetation

Hardwood - Hardwood forests important

Shrub - Open shrubby habitats, seral 2a, 3a

Dead/Down - Utilizes Dead/down woody material

SAT table 5-D		STNF	From SAT table 5-D		STNF
Species	**Occur**	**Endemic**	**Forest Successional Stage**	**Old Growth Structural Stage**	**WHR-Guild**
Species associated with the snag component on the Shasta-Trinity					
Common Merganser			Late	Class.	Snag
Flammulated Owl			Young & Late	All	Snag
Northern Flicker*			Young & Late	Sparse,Class.	Snag
Northern Pygmy Owl			Late	Sparse,Class.	Snag
Red-breasted Sapsucker*			Mid - Late	Sparse(only S)	Snag
Vaux's Swift			Young & OG	All	Snag
Species associated with open habitat or cliff habitat on the Shasta-Trinity					
Yuma Myotis			Young & Late	Comp, Class.	Open/Cliff
Big Brown Bat*			Open & OG	Sparse, Class.	Open/Cliff
California Myotis*			Open & Late	All	Cliff
Long-legged Myotis*			Shrub - Late	Comp, Class.	Open/Cliff
Species associated with riparian habitat on the Shasta-Trinity					
Hermit Thrush*			Shrub - Late	Sparse	Riparian
Tailed Frog			Mid - Late	Comp, Class.	Riparian
Western Flycatcher			Late: OG	Sparse,Class.	Riparian
Winter Wren*			Shrub & Late	Comp, Class.	Riparian
Wilson's Warbler*			Shrub	none	Riparian
Wood Duck			Late	Classical	Ripar/Snag
Species associated with aquatic habitat on the Shasta-Trinity					
Hooded Merganser*			Late-non brdr	Classical	Aquatic
Northwestern Salamander		X	Young - Late	Comp, Class.	Aquatic
Olympic Salamander			Young - Late	none, Talus	Aquatic
Rough-skinned Newt		X	Young - Late	Comp, Class.	Aquatic
Species associated with hardwood habitat on the Shasta-Trinity					
Hairy Woodpecker			Late: OG	Sparse,Class.	Hrdwd/Late
Warbling Vireo			Late: OG	Sparse	Hardwood
White-breasted Nuthatch*			Late	Sparse,Class.	Hrdwd/Snag
Species associated with shrub component on the Shasta-Trinity					
Dusky-footed Woodrat*			Shrub - Late	All	Shrub
Species associated with dead/down component on the Shasta-Trinity					
Black Salamander*			Young - Late	All	D/D/Aquatc
Deer Mouse*			Young: Shrub	Sparse, Comp	Dead/down
Pacific Giant Salamander			Mid - Late	All	Dead/Down
Shrew-mole			Mid & Mature	Comp, Class.	Dead/Down

APPENDIX G
Integrated Vegetation Management Plan

The following plan is a first attempt to link the recommendations from watershed analysis to ecosystem management planning. These prescriptions and treatment priorities may be revised upon further review during the ecosystem management planning process.

Based on the analysis of current high forest fuel levels creating a fuel hazard, fire risk, forest health and vegetation restoration needs, a variety of vegetation management treatments have been developed. The treatments are designed to meet the needs identified through watershed analysis and are consistent with the Land Management Plan, President's Plan ROD Standards and Guidelines and Desired Future Conditions for all of the land allocations within the watershed. These include northern spotted owl nest activity centers, peregrine falcon core area, Late Successional Reserve (LSR), Critical Habitat Unit (CHU), Riparian Reserve, wildlife corridor and Matrix lands.

This is a long-term plan. The treatments will be implemented over the next five to ten years with scheduled maintenance thereafter.

General Recommendations Common to all Treatments

- Procedures and treatments will be implemented in such a manner as to minimize ground disturbance.
- Soil quality standards dealing with compaction, organic cover and large woody material will be maintained.
- Species and genetic diversity of residual stands will be maximized in all vegetation removal activities.
- Healthy sugar pine will only be removed when thinning to enhance sugar pine groves and superior trees (Treatment 4).
- Hardwoods, especially black oak, will be favored for release to provide mast for wildlife.
- Fuels inventories will be completed prior to fuels reduction treatments.

All vegetation manipulation treatments will be monitored for effectiveness and prescriptions adapted based on findings in a timely manner. In particular, the effects of silvicultural treatments on water quality, and fish and wildlife habitat and populations will be closely monitored. Cooperative research and monitoring opportunities will be sought with the Pacific Southwest Forest and Range Experiment Station labs.

All activities will comply with USFWS and Endangered Species Act requirements including limited operating season procedures. Activities will not occur during owl breeding season in or within one half mile of suitable owl habitat unless owl surveys confirm the absence of owls.

Interim Riparian Reserve - The only treatments recommended for the interim Riparian Reserves, including the unstable land component, is prescribed light underburning and plantation enhancement (Treatment 7).

Late Successional Reserve - All treatments in the LSR will be guided by and be consistent with the LSR Assessment.

Owl activity center (100 acre suitable habitat core) - There will be no treatment within the designated 100 acre core areas.

Vegetation Management Treatments

Prescriptions Common to All Treatments

Sugar Pine Grove Enhancement - Where groups of six to ten healthy or moderately white pine blister rust infected sugar pine occur, thinning will be used to reduce competition within the grove and within 50 feet of the grove. Trees will be tested for resistance to white pine blister rust. This prescription will be used where groups of sugar pine occur in thinning areas.

Black Oak Mast Enhancement - Where black oak occurs in fuels reduction and forest health treatment areas mast production will be enhanced by maintaining and thinning around all black oak over 13 inches DBH. The area under the crown and to a distance of 10 feet from the crown edge will be thinned. Basal areas of from 5 to 50 sq. ft./acre are recommended. Interplanting in plantations may be necessary to attain adequate numbers of black oak. Prescribed burning and pruning may also be used to encourage mast production.

Prescribed Underburning - Light ground fire will be used in concert with thinnings, natural fuels reduction buffers or other treatments to reduce quantities of ground fuels and slash less than 3 inches in diameter. Prescriptions that mimic natural fire characteristics will be used.

Fuels Reduction and Forest Health Treatments in Natural Forest Stands

These fuels reduction and forest health treatments are designed to address recommendations from the watershed analysis regarding vegetation management. The extent of the vegetation manipulation varies based on purpose and land allocation. Treatment 1, the fuels reduction buffer, will be used to reduce the hazard and risk of catastrophic fire and is the most intense of the three treatments. Treatment 2 is the standard forest health treatment, designed to reduce mortality and fire spread. It was necessary to modify Treatment 2 to maintain special habitat features required by late seral dependent species. This treatment (3) will be used in sensitive areas where wildlife values are high such as LSR, CHU, owl activity centers and wildlife corridor.

Treatment 1 - Natural Fuels Reduction Buffers

Prescription - This treatment is meant to produce a defensible fire zone primarily for resource protection. The treatment area will average between 100 and 300 feet in width, depending on terrain and vegetative conditions. The forest will be thinned to the extent that crowns do not overlap (approximately 30 feet spacing or 50 trees per acre remaining, or 40 percent of normal basal area). Enough crown cover will be retained to discourage accelerated growth of understory shrubs (between 50-70 percent canopy closure). Snags and understory trees identified as high risk fuel ladders will be removed. Four to ten of the largest diameter down logs per acre (longer than 10 feet in length) will be maintained. Approximately 10 tons per acre of down material will remain.

This prescription may also include prescribed burning to reduce fine ground fuels. However, the duff layer will be maintained to retard subsequent regeneration and enhance moisture retention. Periodic burning and thinning will be used to maintain this treatment.

Treatment Area - Around private land, administrative sites, and along major travel routes in the Matrix.

Treatment 2 - Forest Health and Fuels Reduction Thinning

Prescription - This treatment is designed to reduce the excessive stocking that has led to a lack of vigor and mortality, and to achieve fuels reduction goals. Stands will be thinned to 55 to 70 percent of normal basal area based on site and stand age or between 70 and 120 trees per acre. A canopy closure of 40-70 percent cover will be maintained. Species diversity will be maintained and surface disturbance will be minimized through designated skid trails, use of small equipment and minimum ground disturbing activities. Structural diversity will be achieved by a clumpy distribution of the residual trees and shrubs. Adequate hiding and foraging cover provided by shrubs and small trees will be maintained. Adequate numbers and sizes of snags and down wood necessary for wildlife habitat and nutrient and water cycling needs will be maintained. The black oak enhancement prescription will be used in concert with this prescription where black oak occurs. The sugar pine enhancement prescription will be used where groups of sugar pine occur.

Prescribed burning may be used to reduce fine ground fuels. Periodic burning and thinning will be used to maintain this treatment. Slash treatment will be accomplished through low ground disturbing methods such as lop and scatter and burn, hand pile and burn and limited machine piling using low impact equipment.

Treatment Area - Across the watershed in areas having high stocking and high fuels levels and especially in dense ponderosa pine forests susceptible to bark beetle attack and mortality due to overstocking. There are approximately 14 of these timber stratum stands of PP3N and PP3G.

Treatment 3 - Modified Forest Health and Fuels Reduction in Areas of Special Concern

Prescription - This treatment is a low intensity thinning treatment, meant to maximize resource protection and meet wildlife habitat goals. It is designed to allow fuels reduction and promote forest health while maintaining suitable northern spotted owl nesting habitat characteristics.

This treatment consists of thinning from below to a 20-40 foot spacing, maintaining all snags greater than 15 inches DBH and down wood greater than 10 inches at the large end, maintaining at least 70 percent canopy closure and a multi-storied canopy (minimum of two layers). Structural diversity will be achieved by a clumpy distribution of the residual trees and shrubs. Twenty to forty percent of the treatment area will be maintained in unthinned clumps. This treatment will be modified as necessary to be consistent with the LSR assessment. Low intensity prescribed burning may be used in concert with this treatment.

Treatment Area - First as buffers for northern spotted owl activity centers and other high value areas in the watershed. In the LSR, CHU, northern spotted owl territory and home range, peregrine falcon core area and wildlife corridor.

Treatment 4 - Superior Seed Tree Protection and Enhancement

Prescription - In order to protect superior seed trees selected for genetic improvement a natural fuels reduction buffer averaging 150 feet will be constructed and maintained. This will be a combination of treatments 1, 2 and 3 depending on the land allocations where the superior seed trees are located.

Treatment Area - Across the watershed where superior seed trees are located.

Plantation Treatments

Treatment 5 - Plantation Treatment in Natural Fuels Reduction Buffers

Prescription - When plantations occur in natural fuels reduction buffer treatment areas in the matrix they will be thinned to attain stocking levels of 50-100 trees per acre. Trees will be pruned as necessary to reduce fuel ladders and slash disposed off-site. Fuel levels will be reduced to approximately ten tons per acre. Shrub crowns will not be touching and dense shrub patches will be removed.

Treatment Area - Plantations within the natural fuels reduction buffer.

Treatment 6 - Plantation Thinning for Forest Health

Prescription - Older plantations will be thinned to 100-150 trees per acre to maximize growth and achieve adequate owl dispersal habitat. Some patches of trees will be left in clumps to assure structural diversity and provide for future snag recruitment. Non-pine species will be favored for retention. Black oak may be planted to achieve stocking levels that are within the historic range of variability. Slash will be treated off-site.

Treatment Area - There are more than 50 plantations established prior to 1975 that require thinning.

Treatment 7 - Plantation Enhancement and Restoration to Attain Old Forest Characteristics

Prescription - Thinning to approximately 100-150 trees per acre, interplanting and competition reduction treatments will be used to enhance plantation growth. This treatment will be used to ensure that owl dispersal habitat (11-40) can be achieved as quickly and effectively as possible and species diversity is maintained or enhanced. In addition, mortality and patchiness in plantations will be reduced.

Species other than ponderosa pine and Douglas-fir will be favored in thinning to enhance species diversity. Black oak and other hardwoods will not be removed. Means such as mulching or mechanical cutting will be used to reduce competition from shrubs, herbs and grasses. Skid trails will be ripped, mulched and planted or seeded with native species. Hand labor may be necessary in the Riparian Reserve, especially on unstable lands where mechanical disturbance may be particularly damaging and during limited operating season in and near suitable habitat. Black oak may be planted at levels in which it would occur in natural stands of the same potential natural plant community.

Treatment Area - This set of plantation prescriptions is especially important in the Riparian Reserve, LSR, CHU and wildlife corridor. This treatment can be used to maximize growth, vigor and related root strength on unstable lands.

Treatment Area Priorities

Treatment priorities were determined using an interdisciplinary process. Priorities were assigned based on risk of fire or accelerated mortality due to forest health conditions, fire or forest health hazard and resource value. Within each category the actual acres to be treated will be prioritized based on fuel levels, fire occurrence, stand density, forest health conditions, topography and stand age. Areas of high fuel accumulation, dense stands, stands with high levels of mortality or of low vigor, stands less than 120 years old and on less than 35 percent slope will be treated first. Areas adjacent to anchor points (areas of defensible low fuels) will be treated first.

For efficiency, lower priority projects may be combined with higher priority projects. This may enhance the economic benefits and allow activities to occur throughout the year. It is estimated that treatment of between 1000 and 1500 acres per year may be accomplished within the Butter Creek watershed over the next 5 to 10 years.

For the short term, fuels reduction buffers will be used to protect highly valuable or high risk areas. As fuels reduction progresses over the next decade in the watershed, risk will be lowered as protection will be derived from watershed-wide fuels reduction.

Prioritized Treatment Area List

Fuels Reduction Buffers for High Value and High Risk Areas

1. An average fuels reduction buffer of between 100 and 300 feet will be constructed around private land using intensive fuels reduction treatment (1) in Matrix lands and modified fuels treatment (3) in LSR, CHU and northern spotted owl territory (a .7 mile concentric circle around activity center) and home range (1.3 mile concentric circle around activity center).

   Treatment 5 will be used to reduce fuels and fire risk in plantations that occur in the buffer area. Treatment 7 will be used for plantations in the buffer with LSR, CHU and northern spotted owl territory and home range land allocations.

2. An average fuels reduction buffer of between 100 and 300 feet will be constructed south of Indian Valley Guard Station using natural fuels reduction buffer treatment (1). Treatment 7 will be used on plantations in the buffer for fuels reduction.

3. An average fuels reduction buffer of between 100 and 300 feet will be constructed around 100 acre owl activity centers and 100 acre peregrine falcon core area using modified fuels reduction treatment (3). Treatment 7 will be used to reduce fuels and fire risk in plantations that occur in the buffer area.

4. A fuels reduction buffer averaging 150 feet on each side of major transportation corridors (2N10, 3N08 and county road 316) will be constructed using fuels reduction buffer (Treatment 1) in Matrix, fuels reduction thinning (2) in the wildlife corridor outside of LSR and CHU and modified fuels reduction treatment (3) in the LSR, CHU and northern spotted owl territory and home range.

   Treatment 5 will be used to reduce fuels and fire risk in plantations that occur in the buffer area. Treatment 7 will be used for plantations in the buffer with LSR, CHU and northern spotted owl territory and home range land allocations.

Fuels Reduction and Forest Health Treatments

5. Fuels reduction and forest health thinning will be performed in the wildlife corridor. Treatment 2 will be used in the Matrix, and Treatment 3 in the LSR, CHU and northern spotted owl territories and home ranges.

6. Check for adequacy of buffers as reduced fuel zones and the need for additional fuel breaks. Construct additional fuel breaks along major ridges at south end of watershed and divide between Indian Valley Creek and Butter Creek as necessary. Treatments 1, 2 and 3 will be used depending on land allocation.

   Treatment 5 will be used to reduce fuels and fire risk in plantations that occur in the buffer area. Treatment 7 will be used for plantations in the buffer with LSR, CHU and northern spotted owl territory and home range land allocations.

7. Plantation enhancement treatment (7) in wildlife corridor and within northern spotted owl territory (.7 mile radius of owl activity center) to enhance the rate at which the plantations will provide adequate dispersal habitat (11-40).

8. Modified fuels reduction treatment (3) for suitable habitat within northern spotted owl territory (within .7 mile of owl nesting center).

9. Forest health thinning of dense ponderosa pine stands (Treatment 2) within northern spotted owl territory (.7 mile of owl nesting activity center).

10. Fuels reduction treatment (3) on remaining suitable northern spotted owl nesting habitat within the LSR and dispersal habitat in the CHU. Suitable nesting habitat is defined as wildlife habitat relations vegetation types DFR, PPN, JPN, MHC or KMC with size classes of 4, 5 or 6 and densities of D or M. In addition, any habitat that an owl pair is nesting in is considered suitable habitat, and will be treated.

11. Forest health thinning of dense ponderosa pine stands (Treatment 7) in the rest of the watershed except in the Riparian Reserve.

12. Forest health thinning of approximately 50 older plantations established before 1975 (Treatment 6) for forest health in the LSR, CHU and wildlife corridor first and then in the remainder of the watershed.

13. Modified forest health/fuels reduction thinning treatment (3) on the remaining acres (non-suitable habitat) within northern spotted owl home range (1.3 mi. radius of owl nesting activity center).

14. Plantation enhancement (Treatment 7) within northern spotted owl home range (1.3 mi. radius of owl nesting activity center).

15. Construct a fuels reduction buffer averaging 150 feet on each side of secondary transportation corridors (2N16, 2N01, 2N07 and 2N03) using intensive fuels reduction treatment (1) in Matrix, fuels reduction thinning (2) in the wildlife corridor and modified fuels reduction treatment (3) in the LSR, CHU and northern spotted owl territory and home range.

16. Fuels reduction and forest health treatments 2 and 3 in the remainder of the watershed as required.

17. Plantation enhancement (Treatment 7) in the rest of the watershed as required.