Watershed Management Strategy

Part I of the Deer Creek Watershed Management Plan

Prepared for the:

The Resources Agency, State of California
California State Water Resources Control Board
U.S. Fish and Wildlife Service

Prepared by:

Deer Creek Watershed Conservancy
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and the
Deer Creek Watershed Action Committee

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INTRODUCTION

The Deer Creek Watershed Management Strategy is comprised of those strategies and actions needed to meet our goals and resolve the present management issues for Deer Creek. Some of these strategies were identified by our Watershed Action Committee, the Habitat Restoration Group and from the following documents: Restoring Central Valley Streams: "A Plan for Action" (Calif. Dept. of Fish & Game – 1993), "Anadromous Fish Restoration Program" (U.S. Fish & Wildlife Service) and the "Ecosystem Restoration Program Plan" (CALFED).

Generally, the items discussed in this report are in relative prioritized order of importance for implementation over the next few years. We consider this strategy report to be an adaptive management document and planning guide that will not only continually reflect new resource management issues but also guide our implementation priorities.

This document will provide us with the framework for continued responsible stewardship through effective management practices. We look forward to working with our many stakeholders in order to provide the needed improvement measures necessary to protect and enhance one of the most beautiful wild rivers of California.

DEER CREEK WATERSHED MANAGEMENT

GOALS

1. Optimize use of public and private resources to develop, adopt and implement a management strategy for the Deer Creek watershed that will provide clear guidance for resource conservation and land-use for present and future generations.

2. Foster conservation, restoration and sound resource management in the Deer Creek watershed. Achieve long-term sustainability of watershed processes, natural resources, economic viability and preserve the cultural heritage and resources within the watershed.

3. Respect and protect private property rights and public resources.

4. Apply an ecosystem and multi-species approach to maintaining biodiversity and the conservation of native habitats in the Deer Creek watershed. Base management decisions on sustaining ecosystem functions in response to long-term changes and/or unexpected occurrences.

5. Protect and enhance the long-term productivity of the Deer Creek aquatic ecosystem with special consideration for spring-run chinook salmon, fall-run chinook salmon and steelhead populations and quality of their habitat.

6. Manage watershed lands so as to minimize unnatural rates of erosion and sedimentation.

7. Encourage good land stewardship practices through education, research and public outreach

8. Eliminate duplication of effort by agencies/organizations through improved communication and cooperation.

9. Develop a long-term monitoring program that provides continuous evaluation of key watershed conditions.

DEER CREEK
WATERSHED MANAGEMENT STRATEGY

1. STRATEGY: MAINTAIN STREAM FLOWS NECESSARY FOR UNIMPAIRED FISH PASSAGE FOR CHINOOK SALMON AND STEELHEAD.

Note: In order to protect the exceptional qualities of the watershed, legislation was initiated by the Deer Creek Watershed Conservancy (DCWC) in 1995 to preclude any **new** dams, diversions, impoundments or reservoirs on Deer Creek. This legislation (AB 1413) became law on July 22, 1995.

RECOMMENDATIONS:

1.A Proceed with the implementation of the Deer Creek Water Exchange Project in order to allow natural stream flows to remain in Deer Creek during critical fish migration periods.

Note: A water exchange project is being developed by a cooperative effort between Stanford Vina Irrigation Company, Deer Creek Irrigation District, California Dept. of Fish & Game and California Dept. of Water Resources whereby natural flows will be maintained in Deer Creek to aid fish passage during critical migration periods. Alternative water sources (ground water) will be developed to offset water needs for agriculture and allow an adequate flow for fish passage. Since 1989, Deer Creek diverters have voluntarily released necessary flow to provide upstream and downstream fish passage.

1.B Encourage California Department of Fish and Game to evaluate in-stream flow for adequate fish passage based upon accepted methodology.

1 C Support California Dept. Fish & Game in its efforts to maintain and monitor all fish ladders and screens at the water diversions to ensure maximum efficiency.

1.D Determine the need to upgrade existing ladders and screens by monitoring critical locations during low flow years to evaluate fish passage.

1 E Investigate opportunities to increase irrigation efficiency.

1.F Investigate opportunities for vegetation management to improve stream flows.

2. STRATEGY: MAINTAIN THE HIGH WATER QUALITY OF DEER CREEK.

Note: The California Dept. of Water Resources (DWR) has designed, and is currently conducting, an on-going water quality monitoring program on Deer Creek. This water quality monitoring program is being coordinated with other water quality data collection efforts performed by Lassen National Forest, Sierra Pacific Industries, Collins Pine Company and U. S. Geological Survey. Since May 1997, DWR has maintained continuous temperature and flow monitoring recorders at eight (8) stations throughout the watershed. Collins Pine Company has maintained 6 other monitoring stations in and around Deer Creek since 1995. For more information, please refer to the Existing Conditions Report.

RECOMMENDATIONS:

2.A Support long-term continuance of the Deer Creek Water Quality Monitoring Program that is being conducted by DWR.

1. Prepare an annual Deer Creek water quality monitoring report which includes results of the year's monitoring efforts and recommends any needed monitoring program changes.

2.B Develop a **Highway 32 Contingency Spill Plan** to not only plan an emergency response strategy for hazardous material spills, which could directly or indirectly contaminate Deer Creek, but to also develop highway safety measures to reduce the potential for such accidents.

1. Coordinate all efforts with the Forest Service, Caltrans and Calif. Dept. of Fish and Game.

2.C Utilizing the 1997 Meadowbrook Road Survey, solicit the participation from the Lassen National Forest, Collins Pine Company and Sierra Pacific Industries to aggressively treat known sediment sources. Solutions may include road closures, road repairs, watershed restoration, revegetation, etc.

1. Encourage road maintenance standards for minimum siltation on all public (Hwy. 32) and private dirt roads within the watershed.

3. STRATEGY: PROTECT ANADROMOUS FISH SPAWNING, REARING AND HOLDING HABITAT.

RECOMMENDATIONS:

Note: Before Shasta Dam, the fall-run did not enter the Sacramento River until after the rainy season began and transport water was available in the Sacramento River and its tributaries. Now, however, with year around high cold water flows, salmon are entering the river in mid-summer

3.A If temperature and flow changes are determined to have altered the migratory patterns of fall-run chinook salmon in the Sacramento River, evaluate what effects those changes have on fall-run migration in Deer Creek and the subsequent feasibility for enhancing fall-run populations

Note: It has been identified in "Restoring Central Valley Streams: A Plan for Action" (Calif. Dept. of Fish & Game - 1993) that "adequate spawning gravel occurs in lower Deer Creek for present population levels of fall- and late- fall-run salmon. However, gravel rehabilitation at selected sites could increase available spawning habitat."" The Anadromous Fish Restoration Plan" U.S.Fish and Wildlife Service (1995) claims that present levels of gravel are insufficient to meet the needs of future increases in fall-run populations.

Conversely, fluvial geomorphological studies of Deer Creek have concluded that because of Deer Creek's dynamics and its present configuation, any introduction of smaller spawning gravel for fall-run salmon habitat enhancement, would be washed out in future high water occurrences.

Fall-run spawning gravel has been an issue of concern for Deer Creek for several years and therefore warrants further study

3.B Determine spawning gravel quantity and quality for present fall-run salmon populations and for the eventuality of future increases in fall-run numbers.

1. Survey a detailed longitudinal profile of the channel through the alluvial reach (USGS gauge downstream) to provide information on the relation between channel conditions and the distribution of spawning gravel and other habitat.

3.C Evaluate potential impacts of adding additional spawning gravel and the likelihood for gravel sustainability.

Note: A consistent long-term monitoring program is esssential to effectively manage the salmonid populations of Deer Creek.

3.D Support and encourage an annual long-term adult and juvenile salmonid monitoring program to include fall-run, spring run and steelhead.

3.E Assist agencies in acquiring the needed funding to prevent any interruption in data collection to keep all applicable monitoring activities active.

3.F Determine relative fish abundance by reach and season to assess fish distribution and the effects of restoration projects or catastrophic events.

3.G Determine the status of steelhead trout in Deer Creek by conducting the following surveys: (a) spawning surveys during the months of January through March; (b) rearing habitat surveys; and, (c) outmigration survey of juveniles.

Note: Knowledge of outmigration timing of salmonids in Deer Creek is critical to on-going management efforts to ensure protection of juvenile salmon and steelhead emmigrating from Deer Creek and entering the Sacramento River and Delta.

3.H Monitor outmigrant timing of juvenile fall-run chinook salmon, spring-run chinook salmon and steelhead.

3.I Include efforts to tag outmigrating juvenile spring-run salmon.

3.J Determine the usage of Deer Creek by winter-run chinook salmon

1. Request Dr. Paul Maslin, California State University - Chico, to include Deer Creek in his evaluation studies on non-natal rearing in upper Sacramento River tributaries.

3.K In cooperation with the Forest Service, Sierra Pacific Industries and local game wardens, institute the **Deer Creek Spring-run Protection Program** and request that this program address the following:

1. Determine if and where poaching is a problem.
2. Ensure adequate game warden support and volunteer surveillance.
3. If necessary, discourage access to spring-run holding pools by closing access points during critical months.
4. Provide "Streamwatch" educational materials that instructs how to identify poachers and how and where to report violations.
5. Determine the need for more restrictive angling regulation
6. Provide interpretive signs educating the public about sensitive habitat.

7. Assure that future recreational areas are carefully planned to protect fish and their habitat (i.e. away from riparian zones).

Note: Dams, diversions, impoundments and consumptive uses are human impacts that everyone acknowledges as being significant limiting stressors to salmonid populations. However, the consequences from the introduction of exotic game species into salmonid spawning areas has received little attention as a contributor to the diminishing numbers of salmon and steelhead.

3.L Determine the adverse impacts to anadromous fish from non-native species and manage those impacts to insignificant proportions.

1. Consider allowing a targeted fishery for non-native species, if necessary.

3.M Determine if there is adequate habitat to support juvenile steelhead in the upper reaches of Deer Creek.

1. Evaluate impact from resident species.

3.N Determine if there is enough woody debris and organic input to provide the needed nutrients for ample insect populations.

3.O Determine the impact on spawning spring-run chinook salmon by bears and otters.

4. STRATEGY: PROTECT AND ENHANCE AQUATIC HABITAT AND STREAMBANK VEGETATION.

Note: It has been stated in" Restoring Central Valley Streams: A Plan For Action" (Calif. Dept. of Fish and Game) and "Ecosystem Restoration Program Plan" (CALFED) that "fish habitat, throughout the Deer Creek drainage, is generally of good quality." However, there are site-specific enhancement opportunities that the Deer Creek Watershed Conservancy will be pursuing.

RECOMMENDATIONS:

4.A Update the map of the existing riparian habitat in lower Deer Creek in order to identify site-specific riparian restoration projects.

1. Remove exotic species and replace with native species.

2. Plant native riparian trees along unvegetated stream banks where mature riparian forest vegetation will cast shade on the low flow channel.

Note: Under the direction of DCWC,the Dept. of Water Resources and Dr. Matt Kondolf, University of California, Berkeley are preparing a flood control feasibility plan to meet the needs of requirements identified by landowners. It is anticipated that this plan will be adopted into the Army Corps of Engineer's Challenge XXI Program.

4.B Prepare the **Deer Creek Flood Plan** to investigate the feasibility of restoring some natural channel processes, enhancing/restoring native vegetation and increasing the width of the riparian corridor.{i.e. set back levees}

4.C Work with willing landowners to create vegetated buffer zones between existing riparian habitat and cultivated and/or grazed lands.

4.D Allow woody debris accumulation in all areas of the creek to increase primary production, retention of spawning gravel and enhance aquatic habitat.(refer to Existing Conditions Report -- Fluvial Geomorphology).

1. Develop guidelines for preserving large woody debris in the stream channel unless it obstructs or redirects flood flows, or adversely impacts diversions or bridges.

2. Identify and propose potential improvements to bridges and diversions which would permit large woody debris to pass without damage.

4.E Inform landowners about the benefits of conservation easements.

5. STRATEGY: MANAGE RANGELAND FOR MULTIPLE RESOURCE PROTECTION AND ENHANCEMENT, INCLUDING FORAGE FOR LIVESTOCK , WILDLIFE AND PROPAGATION OF OAK WOODLANDS.

RECOMMENDATIONS:

5.A With the assistance from U.C. Davis Cooperative Fxtension's Rangeland Monitoring Program, encourage ranchers within the watershed to design grazing strategies and monitoring plans for their land.

1. Strategies should minimize pressure on riparian areas (e.g., implement seasonal and rotational grazing,consruct cross fencing of pastures, and where appropriate, control invasive non-native plant species, develop riparian exclusion zones and alternative water sources, etc.).

Note: DCWC is funding the creation of a historical GIS for the upper meadows region of Deer Creek and its tributaries. This mapping system will be prepared by DWR, with the cooperation of Lassen National Forest, Collins Pine Company and other landowners in order to analyze historical changes over time and assess restoration needs.

5.B Promote site-specific restoration projects in cooperation with Lassen National Forest, Collins Pine Company and other private landowners in the upper Deer Creek watershed.

1. Where appropriate, fence and plant native riparian vegetation along stream channels and add dead woody material, if determined to be advantageous.

5.C Develop a **Fire Management Plan** to establish an efficient, coordinated fire strategy to reduce fire fuel loads and to promote the use of fire as a tool to increase forage for cattle and wildlife, increase stream flow and to control detrimental vegetation.

5.D Protect and enhance summer and winter range deer habitat in the Deer Creek watershed.

1. Use fire as a tool for habitat enhancement.

2. Evaluate the effects of fire suppression on the watershed deer population.

3. Assess changes in habitat usage and population trends of the Lassen Deer herd following vegetation management practices implemented to increase forage and stream flow.

4. Determine the impacts of predation from cougars and bears on the watershed's deer herd.

5.E Protect and restore oak woodlands in the lower Deer Creek watershed.

1. Seek information from the Integrated Hardwood Range Management Program in order to assess oak woodland habitat conditions in the lower watershed.

2. Evaluate the effects of flood, fire and cattle grazing on oak woodlands in the watershed.

6. STRATEGY: MAINTAIN THE LOW DENSITY AGRICULTURALLY BASED LAND USES WITHIN THE WATERSHED.

RECOMMENDATIONS:

6.A Support low density zoning for the Deer Creek Watershed as depicted in the Tehama County General Plan.

6.B Request the Tehama County Board of Supervisors to adopt the Deer Creek Watershed Management Plan as a support tool for county planning.

6.C Promote the locally-based agricultural economy in order to protect the natural and cultural resources of Deer Creek.

6.D Promote, preserve and protect private property land holdings within the watershed and encourage acquisitions of public lands.

7. STRATEGY: PROMOTE GOOD LAND STEWARDSHIP THROUGH EDUCATION

RECOMMENDATIONS:

7.A Create a watershed education curriculum, "**CREEKSIDERS,**" for grades K-12 which emphasizes the best land use practices for sustaining healthy watersheds and teach the importance of timber harvesting, ranching and farming as major contributors to the preservation of open space and wild and scenic ecosystems.

7.B Coordinate hands-on watershed projects with local school districts (i.e., planting native species, building duck and bat nesting boxes and conducting on-stream studies of aquatic and terrestrial habitat).

7.C Educate landowners about resource issues that may impact private property and its management.

1. Implications of various evaluations, assessments and recommendations (i.e. native specie re-vegetation and riparian buffer zones).

7.D Maintain continuous outreach activities to promote this strategy report and seek appropriate implementation funds.

8. STRATEGY: CONTINUE DEER CREEK WATERSHED CONSERVANCY'S ROLE IN THE ON-GOING MANAGEMENT OF THE DEER CREEK WATERSHED.

RECOMMENDATIONS:

8.A Maintain a coordinated watershed management effort within the Deer Creek watershed.

8.B Implement the **Deer Creek Watershed Management Strategy**.

1. Develop an annual work program which outlines actions to be taken that will accomplish the implementation of targeted strategies.

2. Continually adapt/update the management strategies to include new issues and concerns that effect the watershed.

8.C Develop the **DEER CREEK ANNUAL REPORT**.

1. Publish water quality monitoring survey results.

2. Report adult and juvenile fish "real-time monitoring" results and long-term trends.

3. Describe completed projects and discuss proposed projects for the coming year.

8.D Host annual membership meetings to discuss watershed events and project implementation.

8.E Promote the concepts of **"CREEKSIDERS"** K-12 education program throughout California.

8.F Maintain out-reach with community members, local, state and federal agencies and conservation groups.

8.G Participate in cooperative efforts with local, state and federal agencies to promote local watershed stewardship programs.

Existing Conditions Report

Part II of the Deer Creek Watershed Management Plan

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Chapter 12.0 Recreational Resources in the Deer Creek Watershed

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Chapter 13.0 Archeological and Historical Resources

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Appendix A Soil Erodibility and Erosion Hazard in the Deer Creek Watershed

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Appendix B Preliminary Vascular Plant Checklist for the Deer Creek Watershed

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Appendix C Wildlife Species Observed or Predicted to Occur in the Deer Creek Watershed Project Site/Study Area

Lead Author: Dawn Reis, The Habitat Restoration Group

Appendix D Species Accounts for Special Status Species that are Known to Occur or have the Potential to Occur in the Deer Creek Watershed

Lead Author: Dawn Reis, The Habitat Restoration Group

Appendix E Fishing Experiences On Deer Creek

Lead Author: Jim Gaumer, Deer Creek Property Owner

1.0 INTRODUCTION

PURPOSE OF THIS REPORT

The purpose of the Existing Conditions Report is to provide an inventory of the physical, natural, and cultural resources of Deer Creek and a baseline for future investigations. Considering budget, time, and volunteer efforts, we hope that the authors have established a strong informational foundation upon which to develop and refine our understanding of the watershed.

Our long-term goal is that this report will provide the reader with an analysis of watershed conditions rather than just lists and maps of what is present. Thus, to the extent possible, the authors of each chapter have attempted to evaluate the condition of each resource in order to clarify our present level of understanding of the "health" of the watershed and specific resources within the watershed. Each year the conservancy will publish an annual report presenting new data that has been collected to further our understanding of the resources, any changers in natural occurrences that altered conditions, and projects that have been implemented which changed the present existing conditions.

COLLABORATIVE EFFORT

The Deer Creek Watershed Strategic Planning Process is the result of a public-private partnership which evolved out of the development of trust between watershed landowners, public agency personnel, and the environmental community with the realization that it is in everyone's interest to develop a consensus plan for the protection, management, and enhancement of the Deer Creek Watershed. Many individuals representing a wide variety of experience and expertise have contributed to the preparation of this document. DCWC members, consultants, University faculty, Federal, State and County agency employees, and volunteers from environmental organizations have worked together to gather and evaluate the material presented in this background report. Needless-to-say, without everyone's participation, it would not have been possible to assemble and organize so much information in so short of a period of time.

Under the stewardship of DCWC, staff members from The Habitat Restoration Group have prepared this Existing Conditions Report based on the text submitted by the lead authors of each of the chapters.

ORGANIZATION OF THE EXISTING CONDITIONS REPORT

With the exception of Chapter 2, each of the thirteen (13) additional chapters in this report deals with a particular physical, natural, or cultural resource. Chapter 2, prepared by Ken Cawley of Meadowbrook Conservation Associates, contains a general description of the topographic, climatic, geographic, and edaphic features of the watershed. This material is dealt with in more detail in later chapters but is also presented here to allow the reader who is only interested in a particular resource to gain a general understanding of the Deer Creek Watershed.

In Chapter 3, Land Use and Land management, a number of authors have come together to describe the current land uses and land management practices employed in the watershed. Dr. Donald Holtgrieve, Chairman of the Geography Department of CSU Chico, reviews the policies setforth in the Tehama County General Plan as they relate to land use in the Deer Creek Watershed and discusses the consistency of this planning process with the General Plan. Larry Branham of the Natural Resource Conservation Service, Linda Hughes with the Tehama County Resource Conservation District, Chris Leininger, Sue Knox, and Joan Hemsted of the DCWC, and Bill Travers of CSU Chico describe the rangeland resource and livestock grazing practices in the watershed. Also in this chapter is a discussion, by Steve Evans of Friends of the River, on Wilderness Management and other special management areas and a description of The Nature Conservancy's program to create conservation easements along lower Deer Creek written by Olen Zirkle of The Nature Conservancy.

Chapter 4 deals with the hydrology and water resources of the Deer Creek Watershed. Stacy Cepello of the California Department of Water Resources, Northern California Region, has provided the reader with an overview of the hydrologic processes in the Deer Creek Watershed. Dan Keppen, Director of the Tehama County Department of Public Works, has assembled historical information on prior flooding and flood control efforts.
Dr. Matt Kondolf and his students at the University of California, Berkeley, have performed a historical geomorphic analysis of lower Deer Creek in order to evaluate the fluvial-geomorphic processes affecting channel stability and aquatic habitat conditions. Chapter 5 evaluates several specific geomorphic subjects relevant to salmon habitat river management, such as spawning gravels (availability, quality, and mobility), fine sediment supply and deposition, effects of levees on channel processes, and the potential of Deer Creek to restore a more natural morphology.

In Chapter 6, Ken Cawley of Meadowbrook Conservation Associates describes the erodability of the soils in the watershed and studies which are underway to evaluate sediment sources and identify measures which can be implemented to control erosion problems. Appendix A, compiled by Mark Parsons and Linda Hughes of the Natural Resources Conservation Service, explains in more detail the methodology for evaluating soil erosion problems and presents a table rating the erodability of each soil unit mapped in the Deer Creek Watershed.

Chapter 7 addresses our current level of understanding of surface and groundwater quality in the Deer Creek Watershed. In Chapter 5, Frazier Sime of the Northern California District of the California Department of Water Resources (DWR), summarizes existing surface water quality data collected by DWR and identifies surface water quality monitoring programs which have been and/or are being undertaken by other public agencies. Dan Keppen, Director of the Tehama County Department of Public Works, describes our knowledge of ground water quality.

Chapter 8, Botanical Resources, prepared by Valerie Haley, Botanist with The Habitat Restoration Group, contains descriptions of the plant communities and their distribution in the Deer Creek Watershed. A table summarizes the status and occurrence of rare and endangered plant species and other plant species of special concern, which are known or suspected to occur in the watershed. Information is also provided on sensitive plant communities in the watershed and on invasive, exotic, non-native plant species that threaten the stability of the native plant communities. Appendix B contains a list of the plant species that were observed by Ms. Haley during the field surveys conducted in 1996 and 1997.

Dawn Reis, Wildlife Biologist with The Habitat Restoration Group, describes the wildlife resources in the Deer Creek Watershed in Chapter 9. Ms. Reis discusses the importance of each habitat type to various groups of wildlife species. The known and potential occurrence of Federal and State threatened and endangered wildlife species and California wildlife species of special concern is summarized in tabular form. Information is also presented on game animals and exotic animal species that may adversely affect native wildlife populations. Appendix C contains a list of wildlife species observed or predicted to occur in the Deer Creek Watershed. Appendix D presents additional information on the distribution and habitat requirements of special status wildlife species known or predicted to occur in the Deer Creek Watershed.

In Chapter 10, Dr. Stacy Li, Fisheries Ecologist with Aquatic Systems Research, describes the life history of the salmon and steelhead fishery in Deer Creek and discusses our present level of understanding of native fish populations in the watershed. Dr. Li describes current and prior investigations on salmonid populations in Deer Creek and summarizes the available data on aquatic habitat conditions in an attempt to evaluate our present level of understanding of the fishery resource.

Chapter 11 is intended to address Fire and Fire Management in the Deer Creek Watershed. Revised text for this chapter will be prepared during Phase II of the planning process. Topics discussed in this chapter include: Fire History, Fuel Loads and Fuel Management, Fire Hazard and Fire Hazard Reduction, Fire Ecology, and Fire Protection.

In Chapter 12, Steve Evans of Friends of the Rivers, describes the Recreational Resources of the upper and lower Deer Creek Watersheds. Steve discusses public access and the variety of recreational activities that are available on public lands in the watershed. Additionally, in Appendix E, Jim Gaumer of DCWC, a life-long fisherman on Deer Creek, describes the value of the recreational fishery through past experiences and a vision for what the future may hold.

Chapter 13 deals with Cultural and Historic Resources in the watershed and has been prepared by Eric Ritter of the Bureau of Land Management. Readers interested in the history of western man's activities in the watershed should refer to the Historical Conditions Background Report prepared by Bill Travers of CSU Chico, Sue Knox of DCWC, and others.

DATA SOURCES AND METHODOLOGY

The information included in this report has been assembled from a variety of sources. To a large extent, the authors have had to rely on data and descriptions of resource conditions contained in prior reports. This information has been reviewed and incorporated into this report with the appropriate citations of source materials. The field surveys that were conducted as a part of this investigation were designed to familiarize the lead authors with the range of resource conditions in the watershed so they would be in a position to evaluate the information obtained from the literature. No systematic inventories of species or habitat conditions were conducted as a part of this study. Recommendations will be made for such investigations as data deficiencies are identified.

In many cases, the information contained in the existing literature has been refined by the lead authors based on their knowledge of the resources of the Central Valley and the Sierra Nevada. Much of the new information contained in this report has been obtained from landowners with long-time familiarity with the watershed and agency personnel who are currently conducting field investigations and resource evaluations in the watershed. The involvement of these contributors and reviews is much appreciated.

OVERLAP WITH OTHER INVENTORIES AND ANALYSES

Lassen National Forest (LNF) personnel are currently preparing a Watershed Analysis for Mill, Deer, and Antelope Creek Watersheds. Although the collection of new baseline information is focused on lands within the Lassen National Forest, the study area for this watershed analysis includes the entire upper and middle Deer Creek Watershed down to the mouth of the canyon (i.e., USGS Gaging Station). Preliminary maps documenting the distribution of natural resources and events in the upper and middle watershed have been provided to the lead authors.

We wish to thanks the Forest Service personnel for their participation in the Deer Creek Watershed planning process and their cooperation in providing the lead authors with advanced draft copies of their chapters describing the resources in the watershed. The LNF Watershed Analysis is being prepared in accordance with the Federal Guide for Watershed Analysis entitled Ecosystem Analysis at the Watershed Scale.

Because there is a great deal of overlap between the Lassen National Forest Watershed Analysis and the Deer Creek Watershed Existing Conditions Report, both in terms of the land area studied and the resources being evaluated, it will be important to review and revise the information contained in this report after the LNF Watershed Analysis report is released.

RESOURCE MAPPING

There are numerous maps pertaining to the resources of the Deer Creek Watershed. The lead authors have attempted to list the sources of available mapped information at the end of each chapter. Stacy Cepello of the California Department of Water Resources assembled much of this information on existing mapped data. Unfortunately, much of the previously mapped information is difficult to use when evaluating resources distribution and conditions since it is: 1) incomplete for portions of the watershed; 2) presented in varying scales of resolution; 3) mapped according to differing classification systems; and 4) representative of differing levels of effort.

Funding for GIS mapping of resources in the Deer Creek Watershed was approved by The Resources Agency and signed by Governor Wilson in the 1997-98 budget; however, this was subsequent to the preparation of the draft text of the Existing Conditions Report. DWR has contracted with the CSU GIS Laboratory to prepare maps showing the distribution of resources and land uses in the Deer Creek Watershed. In the long run, the greatest benefit of this GIS mapping system covering the entire Deer Creek Watershed will be the ability to add new information and refine the resource maps through time. This will not only allow us to document changes in resource conditions, but to evaluate the success of our restoration efforts.

Normally, the writing of text for an existing conditions report and the mapping of resources proceed simultaneously. This enables the investigators to use the mapped information as one means of describing and evaluating the resources. Because the GIS maps had not been prepared at the time at which the fieldwork was conducted and when the chapters were written, the descriptions of the resources contained in each chapter are not keyed to the maps. After the GIS maps covering the entire watershed have been finalized, it will be important to have the authors of the chapters in this report review these maps and revise their text accordingly.

CSU Chico is also in the process of preparing a 1" - 400' base map for the lower Deer Creek channel and riparian corridor. This map will be useful for the future mapping of resource problem areas along Deer Creek between the mouth and the USGS Gaging Station. Presently, it has not been possible to evaluate the magnitude of various resource problems along the valley floor reaches since there has been no mapping of problem areas. After the base map is complete, it will be possible to map the locations of problem areas and potential restoration sites.


Highway 36
Los Molinos
Vina
Highway 99E

2.0 GENERAL DESCRIPTION OF THE WATERSHED

INTRODUCTION

The Deer Creek Watershed (Figure 2-1) is a southwest-northeast trending basin located at the southern end of the Cascade Range. The basin extends from its peak at Butt Mountain to its confluence with the Sacramento River near Vina, California. Overall basin size is approximately 229 square miles (146,617 acres).

The surface geology is almost entirely volcanic but nonetheless heterogeneous from the standpoint of erosion rates and productivity of soils derived from it. Geomorphically, the basin exhibits a spatial pattern common to neighboring watersheds: a flatter upper watershed area, with significant alluvial valley areas, connected to lowland areas via a steep and deeply incised middle section.

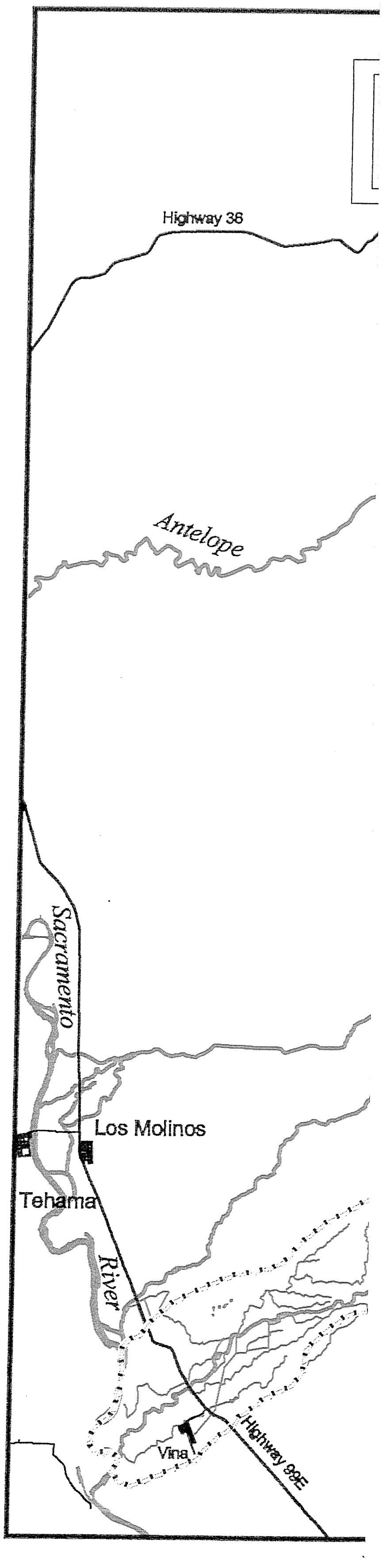
Vegetation ranges from irrigated agricultural at the lowest elevations, through foothill oak-pine types, to mixed conifer forest, and eventually sub-alpine fir forests at the very highest elevations.

TOPOGRAPHY

Topographically, the basin has three distinct areas that reflect its geologic history. The upper watershed, from the Lost Creek Plateau to the general vicinity of Slate Creek, is characterized by broad, low-gradient rhyolitic plateaus separated by large alluvial valleys (Childs Meadows and Deer Creek Meadows). This upper zone corresponds approximately with the extent of the rhyolitic layers. Below this zone is a steeper "canyon reach" typified by deep channel incision, steep inner gorge topography, and narrow ridges. Headwater areas of tributary channels show geomorphic evidence of recent debris flow/debris torrent mass movement features. The canyon reach extends below the lower boundary of the Ishi Wilderness to the site of the USGS Gaging Station. Below this zone lies a broad outwash plain. Here the flattening of the stream gradient and lack of confining canyon walls fosters the deposition of coarse sediment leading to the development of a large alluvial fan.

ELEVATION RANGES

Elevations in the basin range from 7,866 feet at the summit of Butt Mountain to 340 feet at the confluence with the Sacramento River. Figure 2-2 is a contour map of the Deer Creek Watershed. Figure 2-3 depicts the relationship between elevation and basin area (commonly referred to as a hyposometric curve). The percent of the basin in the various elevation zones has significant implications relative to the precipitation totals, snowpack accumulation, and vegetation types. For example, 40 percent of the basin lies above 4,000 feet, indicating a high potential for snowpack accumulation and spring snowmelt run-off.



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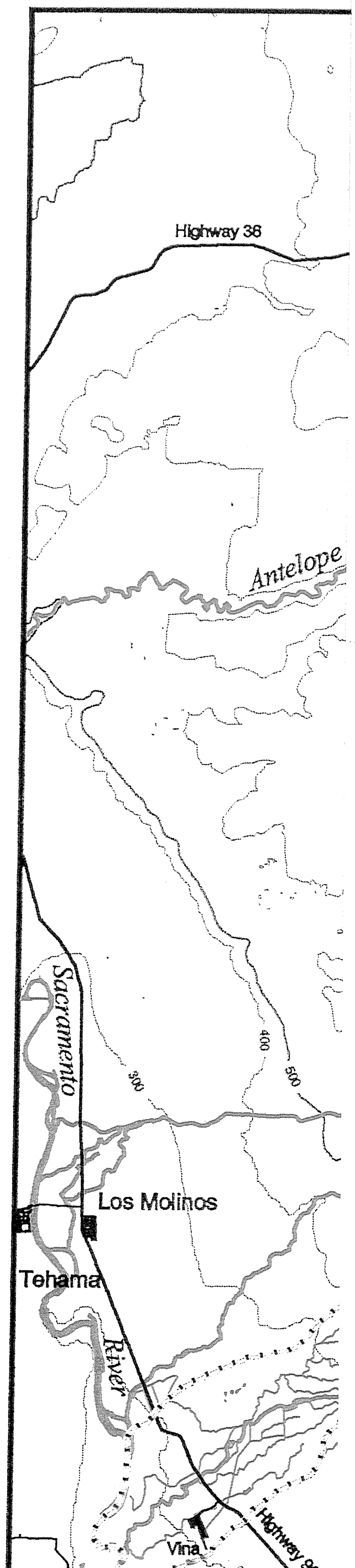

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300
500
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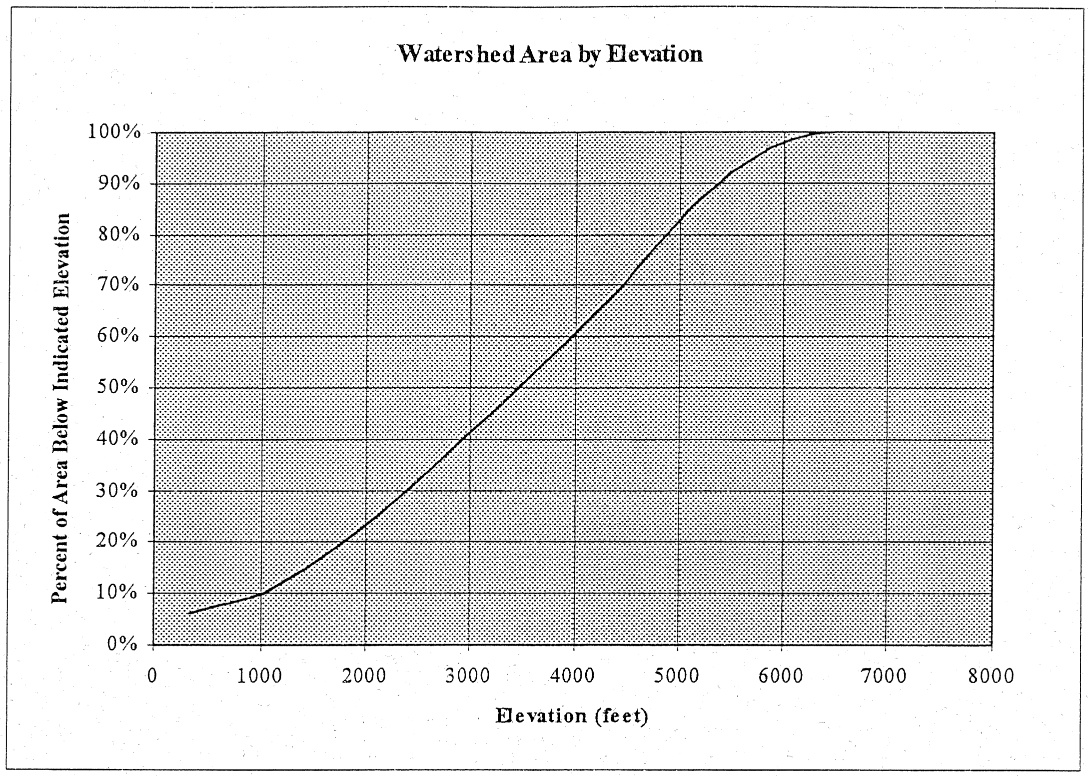
Tehama
River
Vina
Highway 99E

Figure 2-3. Watershed Area by Elevation



SLOPE GRADIENTS

Slope steepness is the dominant driving force behind hillslope erosion processes. Thus the average steepness of a watershed and the distribution of slope classes can reflect a watershed's overall erosional sensitivity. Figure 2-4 is a slope map of the Deer Creek Watershed upstream of the USGS Gaging Station. Although the Deer Creek Watershed contains some areas of extremely steep slopes, overall, slopes tend to be somewhat moderate compared to similarly situated watersheds. The average basin slope is only 25 percent. The large alluvial valleys and broad, flat plateaus tend to reduce the average slope for the watershed. The steepest slopes are associated with two geomorphic settings: 1) headwall areas in the upper reaches of tributary streams such as Cub Creek and Calf Creek and 2) canyon walls adjacent to the main channel in the most deeply incised reaches. Mass movement processes are primarily responsible for the steepness of slopes in both settings.

Figure 2-5 shows the distribution of slope classes by percent of watershed area. The reader will notice that slopes over 50 percent are actually very limited in extent. Beyond that, the distribution of slope classes is fairly even.

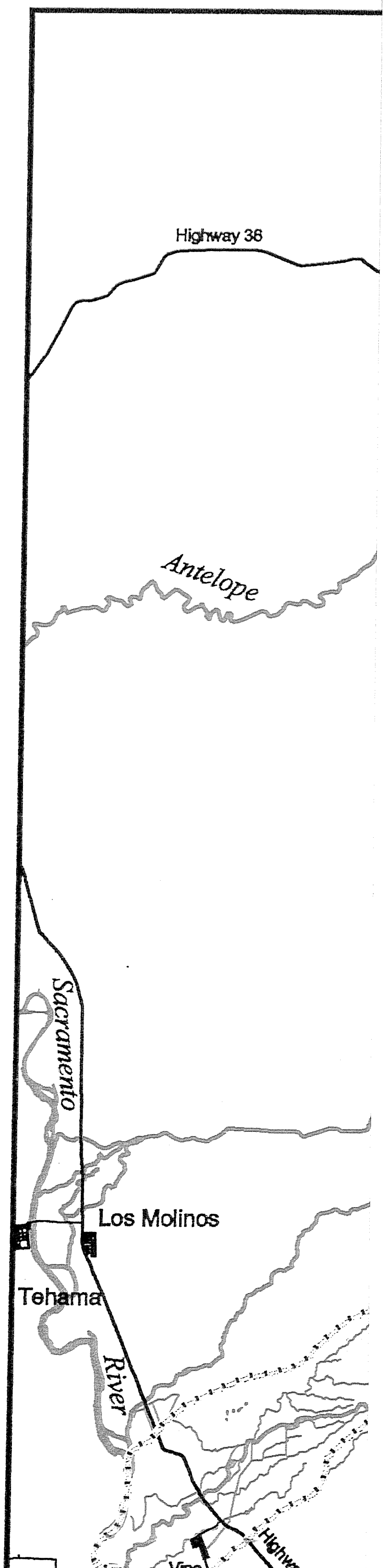

Highway 36
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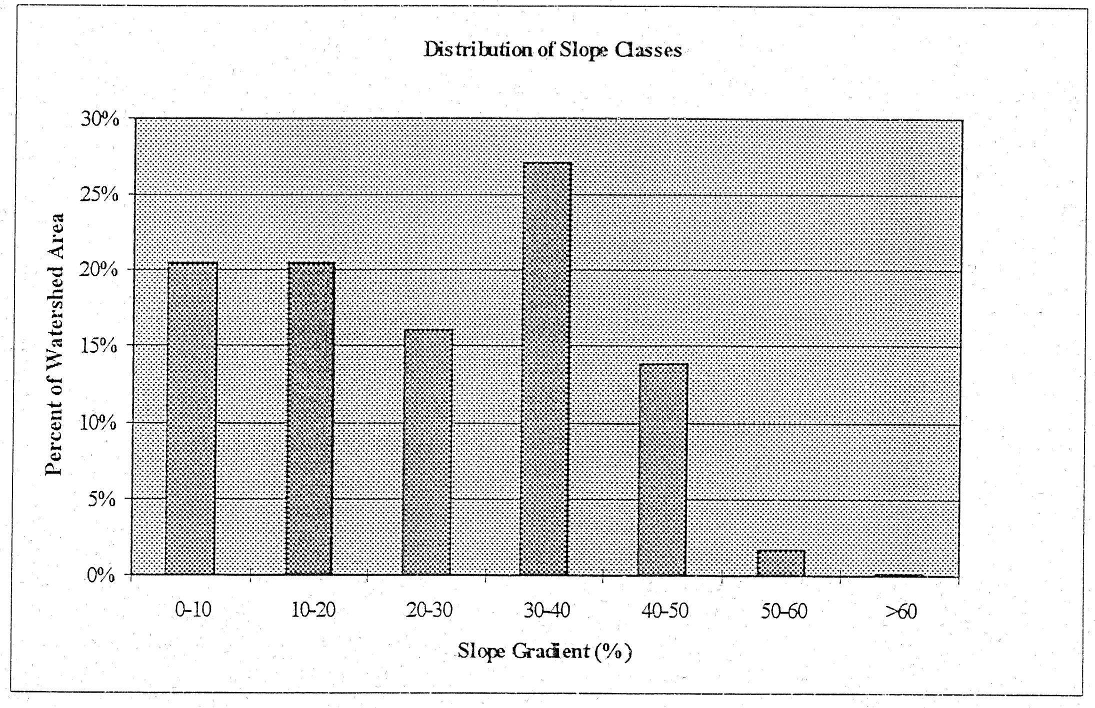
Figure 2-5. Distribution of Slope Classes



ASPECT

Aspect strongly influences vegetation patterns. Southern exposures often have sparse vegetative cover due to high heat and moisture stress. As result of reduced cover, fluvial erosion rates are often higher than on more densely vegetated north-facing slopes.

Because of the northeast-southwest trend of the basin itself, slopes flanking the main channel canyon tend to have aspects perpendicular to that trend, namely northwest and southeast. Flatter areas such as valleys and plateaus are little influenced by aspect. In the upper watershed, no one aspect is dominant. In the canyon reach, northwest and southeast aspects are most frequently encountered although all other aspects are well represented.

GEOLOGY

The Deer Creek Watershed is located within the southernmost extension of the Cascade Range. The Cascade Range is an active volcanic mountain range extending south from Washington and Oregon into California. The volcanic rocks of the Cascades are characterized by pyroclastic deposits and volcanic flows of basaltic, andesitic, and rhyolitic composition formed from volcanic activity of Quaternary and Tertiary age. These volcanic rocks locally overly Mesozoic and or Paleozoic metamorphic rocks of sedimentary and volcanic origin that are believed to be correlative with the Sierra Nevada metamorphic rocks to the southeast. On the west side of the southern Cascade Range, marine sedimentary rocks of Cretaceous age locally overly the metamorphic rocks.

Local Geology

The Deer Creek Watershed consists predominantly of the Tuscan formation of late Pliocene age. This formation is primarily comprised of basalt/andesite mudflows but also includes locally derived fluvial deposits, ash-flow and air fall tuffs, lava flows, and intrusions (Muffler and others, 1989). The Tuscan Formation deposits dip gently and thin toward the southwestern portions of the watershed. In the upper watershed, the Tuscan formation is overlain by voluminous flows of rhyolite which form the Mill Creek and Lost Creek Plateaus.

Cretaceous marine sedimentary rocks of the Chico Formation have relatively minor exposures located along the most deeply incised reaches of Deer Creek. The Mesozoic and/or Paleozoic basement metamorphic rocks are also only minorly exposed along a portion of Deer Creek near Polk Springs (Peterson and others, 1982).

Along the lower elevations at the western portions of the watersheds, the creek flows over the volcanic rocks of the Cascades onto the Quaternary sediments of the eastern Sacramento Valley.

GEOMORPHOLOGY

Deer Creek has a relatively long narrow watershed with moderate to steep slopes. The two major geomorphic processes in the watersheds are mass wasting and fluvial surface erosion. The primary mass wasting process appears to be debris flows that occur predominantly in colluvium-filled hillslope hollows. These are areas where the sediment supply is likely to be high and where run-off is concentrated. Flows are episodic and tend to be triggered by large, infrequent precipitation events. Rock falls that occur along steep and rocky parts of the watersheds where some of the volcanics have formed pinnacles and along rocky reaches of the creeks.

Fluvial erosion includes the processes of sheetwash, rill erosion, channel erosion, and soil creep. These processes are more ubiquitous than mass wasting processes. Some degree of surface erosion is apparent on most hillslopes in any given year. However, the severity of fluvial erosion is strongly linked to major rainfall/run-off events.

Glacial processes have shaped some of the landforms at higher elevations. Glacial deposits have been mapped at the headwaters of Deer Creek on Butt Mountain (Lydon, 1968). In general, the extent of glacial landscapes in Deer Creek is insignificantly small.

CLIMATE AND WEATHER

The following section, excerpted from the Sierra Nevada Ecosystem Project (SNEP) Executive Summary, describes long-term climatic changes and the current climatic setting pertinent to the Deer Creek Watershed.

Climate

Major climate change has occurred at millennial, decadal, and annual scales in the history of the Sierra Nevada. The regional climate developed from warm, wet, tropical conditions about 65 million years ago through a cycle of at least eight major glacial and interglacial periods of the last million years to the winter-wet, summer-dry pattern of the last 10,000 years. These climatic periods have greatly influenced vegetation, animals, and human populations; their effects are observable today and influence how people manage resources. For instance, two extensive droughts, each lasting 100 to 200 years, occurred within the last 1,200 years. During the cold phase of the Little Ice Age (about a.d. 1650-1850), glaciers in the Sierra Nevada advanced to positions they had not occupied since the end of the last major ice age over 10,000 years ago. The period of modern settlement in the Sierra Nevada (about the last 150 years), by contrast, has been relatively warm and wet, containing one of the wettest half-century intervals of the past 1,000 years. Many of the forests that stand today were established under different climates generally wetter ones from the present regimes (UC Davis 1996).

The current Sierran climate is dominated by a Mediterranean pattern of a cool, wet winter followed by a long hot and dry period in summer, with high yearly variability in temperature and precipitation. Precipitation increases and average temperature decreases with increase in elevation. The transition zone of rain to snow is an important determinant of vegetation types, stream dynamics, and human settlement (UC Davis 1996).

PRECIPITATION

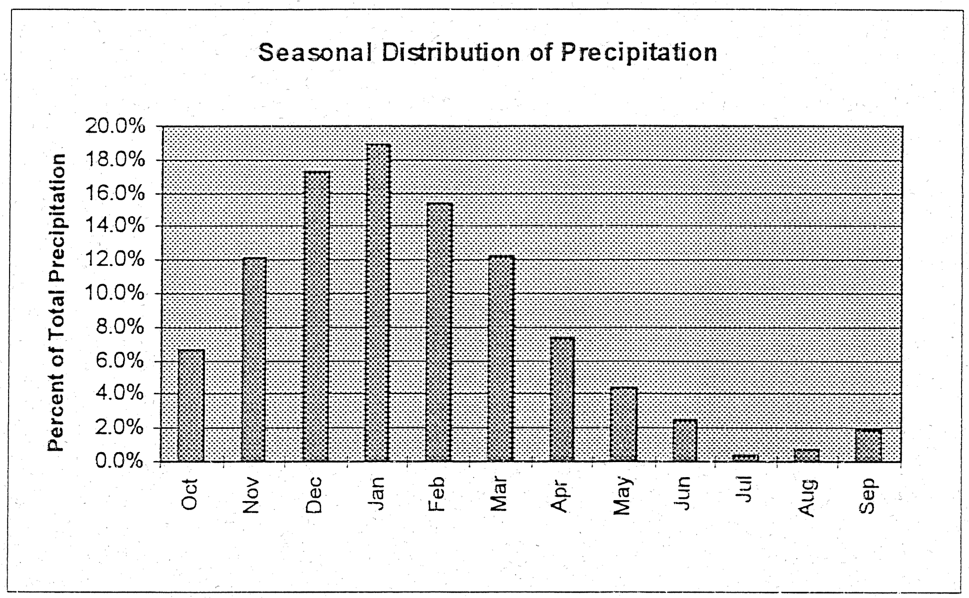
Current precipitation patterns were generated from three precipitation stations, none of which are located in the Deer Creek Watershed but are near enough to its periphery to reflect conditions within the watershed. The stations are Red Bluff, Mineral, and Chester.

Annual precipitation ranges from 21 inches at the valley floor to 51 inches in the upper watershed. The highest elevations may receive somewhat more. Like most west-slope watersheds, a strong orographic influence is evident along an eastward gradient, increasing to the crest of the range and then declining in an eastward direction. Annual average precipitation at Mineral, five miles west of Deer Creek at an elevation of 4,910, is 51.13 inches. By comparison, the town of Chester, approximately 13 miles east of Deer Creek at an elevation of 4,525, has an annual average of 31.92.

The seasonal distribution of precipitation is typical for the dry summer Mediterranean climatic regime. Seventy-six percent of the total annual average occurs in the five month period from

The seasonal distribution of precipitation is typical for the dry summer Mediterranean climatic regime. Seventy-six percent of the total annual average occurs in the five month period from November to March with the peak occurring in December and January. With the exception of isolated thunder storms, the period from mid-June to mid-September is virtually rain free. The seasonal distribution is shown below in Figure 2-6.

Figure 2-6. Seasonal Distribution of Precipitation



Snow

Snowpack information was summarized from snow course data from eight nearby sites. As was the case for precipitation data, none of the snow courses occur in the Deer Creek Watershed but are near enough to be considered representative of conditions in the watershed. The eight snow courses are shown below in Table 2-1.

Table 2-1. Snow Course Locations Used to Estimate Snow Conditions for Deer Creek

Snow Course	Aspect	Cover	Elevation (feet)
Chester Flat	Flat	Open Timber	4,600
Humbug	NE	Open Timber	4,850
Humbug2	n/s	not specified	4,850
Feather River Meadows	Flat	Open Timber	5,400
Stover Mountain	SW	Dense Timber	7,100
Mt Dyer2	NW	Open Timber	6,050
Mt Dyer1	NW	Dense Timber	7,100
Lower Lassen Peak	NW	Open Meadow	8,250

Snow accumulation reaches a peak in March with maximum average depths of 50 to 60 inches in the upper watershed. Typically, this corresponds to a peak snow water content of 20 to 25 inches in this same period. Snow accumulation below 3,500 feet in elevation is minimal. Above 5,500 feet, a snowpack less than 10 inches in depth can linger into June. April 1 snow water content varies between 3 inches at 4,000 feet to 30 inches at the highest elevations in the basin (above 7,000 feet).

GEOGRAPHIC FEATURES

Alluvial Valleys — Childs Meadows, Deer Creek Meadows, and Carter Meadows

The major alluvial valleys in the upper watershed are important features in the watershed. With the exception of Carter Meadows, they are primarily in private ownership. Livestock grazing and commercial/residential development are concentrated in these valleys. Channel erosion along these reaches is one of several significant sediment source areas in the watershed. Carter Meadows is of less economic significance but has a number of unique wetland ecological values.

Falls — Upper and Lower Deer Creek Falls

These falls are located in the canyon reach of the watershed and were historic barriers to migration of anadromous fish. Both falls now have fish ladders although the ladder on the Upper Falls is not operated to allow upstream migration of anadromous fish. The Upper Falls are located near Potato Patch Campground along Highway 32. The Lower Falls are located approximately one mile upstream of the confluence with Panther Creek.

Other Water Bodies — Wilson Lake

Wilson Lake is a shallow, naturally occurring lake situated in a volcanic depression near the watershed divide along County Road 769. There are no other natural lakes in the Deer Creek Watershed.

Mountain Peaks

Major peaks include Butt Mountain (7,866 feet), Colby Mountain (6,001 feet), Onion Butte (5,518 feet), Barkley Mountain (4,488 feet), and Flatiron Mountain (4,400 feet).

Roads and Highways

Several State Highways traverse the watershed. Highway 36 and Highway 32 access the upper watershed area. Highway 99 crosses the lower end of the watershed near the town of Vina. Ponderosa Way is a native surface forest road that crosses the watershed at the approximate boundary between the foothill zone and the forested upper watershed. Originally built as a depression-era public works project, the purpose of the road was to provide access and control points for fire suppression. An extensive network of roads totaling over 450 miles access the upper slopes for timber harvesting purposes.

Roadless Areas

Roadless areas occur in the Cub Creek sub-watershed, Polk Springs area, Butt Mountain area, and the Ishi Wilderness (Ishi A [designated wilderness area] and Ishi B).

Recreation Sites

The USDA Forest Service operates four campgrounds in the upper watershed. Potato Patch Campground, Elam Creek Campground, and Alder Creek Campground are located along Highway 32 below Deer Creek Meadows. The Gurnsey Creek Campground is located off Highway 36 near Childs Meadows. Dispersed recreation occurs throughout the upper watershed, especially during deer season. The Ishi Wilderness Area offers non-motorized, backcountry recreational opportunities, primarily hiking and primitive camping.

Tehama State Game Refuge

Officially designated as State Game Refuge 1-G, the boundary of the Tehama State Game Refuge begins at Round Valley Creek and follows the Deer Creek channel down to (and in conjunction with) the Ishi Wilderness Area. The Refuge encompasses all of the area north of Deer Creek and south west of Round Valley Creek down to the lower boundary of the Ishi Wilderness Area. (Note: State Game Refuge 1-G is not the same as the Tehama State Wildlife Area that occurs in the Antelope and Mill Creek Watersheds.

Quadrangle Maps

Figure 2-7 shows the thirteen (13) 7.5 Minute Quadrangle Maps that cover the Deer Creek Watershed.

STREAM REACHES

For discussion purposes, Deer Creek has been divided into the following stream reaches based on geographic features and changes in channel geomorphology. Table 2-2 summarizes the length of each reach, tributaries entering Deer Creek in each reach, and key geographic and man-made features. Table 2-3 compares the stream reaches used in this document with the stream reach boundaries used in prior reports.

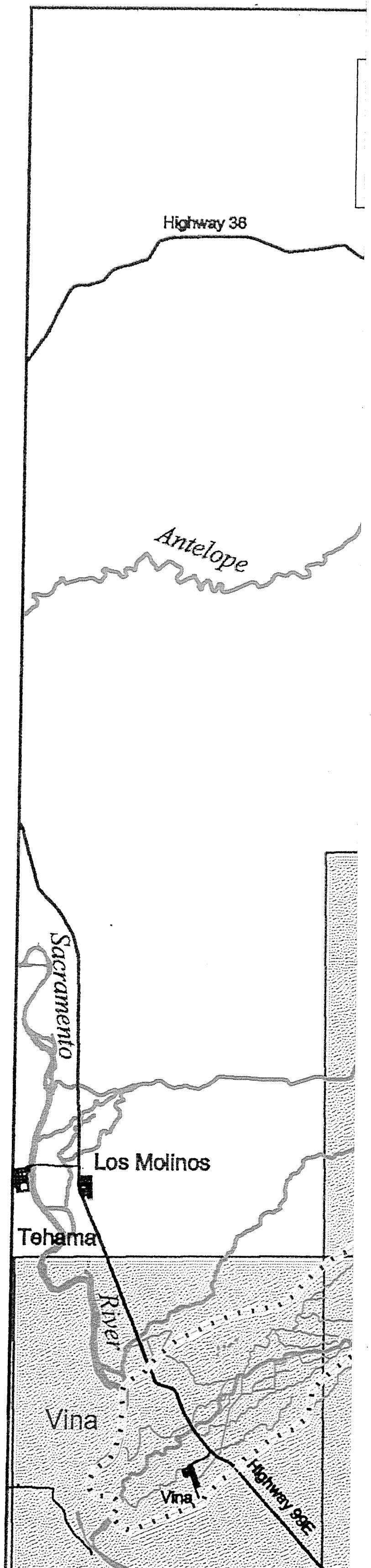

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Table 2-2. Deer Creek Stream Reaches

	Stream Reach	Length	Tributaries	Key Features
Upper Watershed	**Butt Mountain Reach** Headwaters down to Collins Pine Company Road 1110	2.25 miles 1.4 km		
Upper Watershed	**Deer Creek Meadows Reach** Collins Pine Company Road 1110 down to the confluence with Gurnsey Creek (i.e., North Fork Deer Creek)	4.0 miles 2.48 km	Lost Creek Carter Creek	Deer Creek Meadows
Upper Watershed / Middle Watershed "Canyon Reach"	**Highway 32 Reach** Gurnsey Creek (North Fork Deer Creek) down to the lowermost crossing of Highway 32	11.6 miles 7.19 km	Gurnsey Creek Alder Creek Elam Creek Slate Creek Round Valley Creek Cub Creek Forked Creek Rattlesnake Creek	Elam Campground Elam Creek Rest Area Alder Campground Upper Deer Creek Falls Potato Patch Campground
Middle Watershed "Canyon Reach"	**Upper Canyon Reach** Lowermost bridge crossing of Highway 32 downstream to Ponderosa Way	14.3 miles 8.87 km	Calf Creek Panther Creek Dead Horse Creek Rush Creek Calf Creek Ditch Creek Big Smoky Creek Bear Creek Beaver Creek	Lower Deer Creek Falls Transfer Road/Bridge
Middle Watershed "Canyon Reach"	**Lower Canyon Reach** Ponderosa Way downstream to DCID Dam	18.0 miles 11.16 km	Little Pine Creek Iron Creek Wildcat Creek Sulpher Creek Rock Creek	Ponderosa Way Ishi Wilderness Hobson Camp USGS Gaging Station DCID Dam
Lower Watershed	**Valley Floor Reach** DCID Dam downstream to Southern Pacific Railroad Crossing	9.5 miles 5.89 km		Cone-Kimball Diversion Delaney Slough Leininger Road Crossing Stanford-Vina Dam Highway 99 Town of Vina
Lower Watershed	**Mouth** Southern Pacific Railroad Crossing downstream to confluence to Sacramento River	2.1 miles 1.3 km		Abbey of New Clairvaux

Table 2-3. Comparison With Stream Reach Boundaries Used in Prior Reports

Sato & Moyle (1987)	Jones & Stokes (1994)	Habitat Restoration Group (1998)
Butt Mountain Collins Pine Company Road IIIV to just above the Lassen National Forest boundary line on Butt Mountain	**Butt Mountain Reach (Reach 1)** Headwaters down to Collins Pine Company Road 1110	**Butt Mountain Reach** Headwaters down to Collins Pine Company Road 1110
Deer Creek Meadows Inflow of the North Fork to the Collins Pine Company Road 1110	**Deer Creek Meadows Reach (Reach 2)** Collins Pine Company Road 1110 down to the confluence with Gurnsey Creek (i.e., North Fork Deer Creek)	**Deer Creek Meadows Reach** Collins Pine Company Road 1110 down to the confluence with Gurnsey Creek (i.e., North Fork Deer Creek)
Highway 32 Lowermost Highway 32 crossing to the inflow of the North Fork	**Highway 32 Reach (Reach 3)** Gurnsey Creek down to the lowermost crossing of Highway 32	**Highway 32 Reach** Gurnsey Creek down to the lowermost crossing of Highway 32
Upper Canyon Ponderosa Way to the lowermost bridge crossing of Highway 32	**Upper Canyon Reach (Reach 4)** Lowermost bridge crossing of Highway 32 downstream to Ponderosa Way	**Upper Canyon Reach** Lowermost bridge crossing of Highway 32 downstream to Ponderosa Way
Lower Canyon Leininger Road crossing to Ponderosa Way	**Lower Canyon Reach (Reach 5)** Ponderosa Way downstream to the Stanford-Vina Dam	**Lower Canyon Reach** Ponderosa Way downstream to DCID Dam
Area between SVID Dam and Leininger Road not studied		**Valley Floor Reach** DCID Dam downstream to Southern Pacific Railroad Crossing
Below Dam Southern Pacific Railroad Crossing upstream to the base of the Stanford-Vina Irrigation Dam	**Valley Floor Reach (Reach 6)** Stanford-Vina Dam downstream to the confluence with the Sacramento River	
Area between river mouth and Southern Pacific Railroad not included in study		**Mouth** Southern Pacific Railroad Crossing downstream to confluence to Sacramento River

Butt Mountain Reach

This reach extends from the headwaters of Deer Creek on Butt Mountain down to Collins Pine Company Road 1110.

Deer Creek Meadows Reach

This reach extends from Collins Pine Company Road 1110 to the confluence with Gurnsey Creek (North Fork Deer Creek). Lost Creek enters at the upper end and Gurnsey Creek at the lower end of the meadows.

Highway 32 Reach

This reach parallels Highway 32, extending from Gurnsey Creek downstream to the lowermost crossing of Highway 32. Upper Deer Creek Falls lies within this reach.

Upper Canyon Reach

This reach extends from the lowermost bridge crossing of Highway 32 downstream to Ponderosa Way. Lower Deer Creek Falls lies within the reach.

Lower Canyon Reach

This reach extends from Ponderosa Way downstream to the Deer Creek Irrigation District (DCID) Dam (approximately 1/3 mile downstream of the USGS Gaging Station).

Valley Floor Reach

This reach extends from the DCID Dam downstream to the railroad bridge. Highway 99 crosses Deer Creek upstream of the railroad bridge.

Mouth

The mouth reach extends from the railroad bridge to the confluence with the Sacramento River.

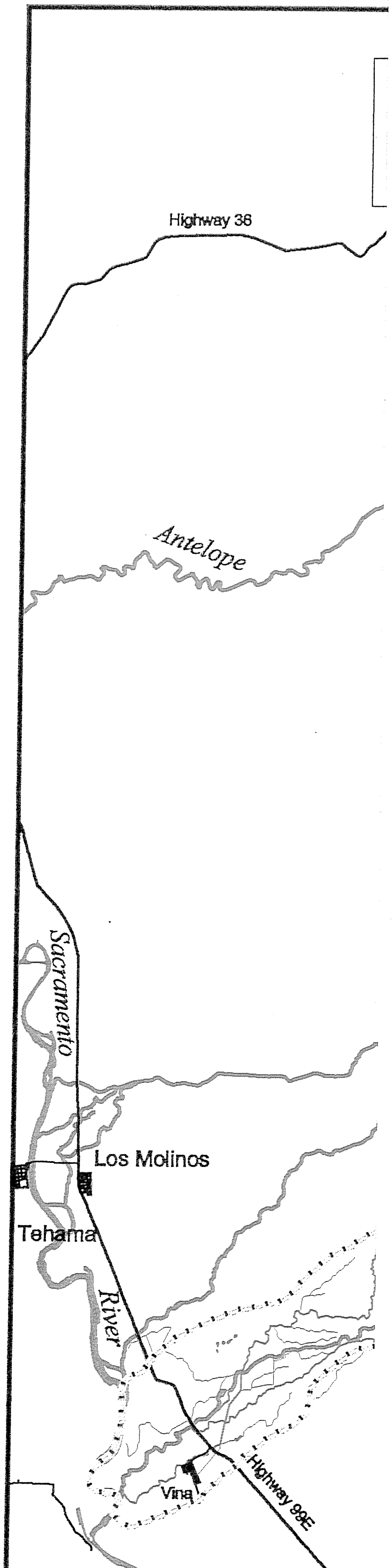
TRIBUTARIES AND SUB-WATERSHEDS

Figure 2-8 shows the tributary streams that enter Deer Creek. The Deer Creek Watershed upstream of the USGS Gaging Station can be conveniently divided into 13 different sub-watersheds (Figure 2-9). Table 2-4 shows the number of acres within each sub-watershed.

Table 2-4. Number of Acres in Each Sub-Watershed in the Deer Creek Watershed (Derived from GIS Mapping)

Label	Acres
Sub-Watersheds	
Calf Creek	7,004
Carter Creek	11,995
Cement Creek	10,916
Deer Creek Flat	13,927
Devils Kitchen	10,837
Gurnsey Creek	13,058
Iron Mountain	12,891
Lost Creek	13,277
Rattlesnake Creek	12,456
Round Valley	7,812
State Creek	6,535
Transfer	9,524
Windy Cut	3,086
Unclassified*	13,293
Total Acres	**146,611**

*Lower Deer Creek Watershed west of (downstream of) USGS Gaging Station.



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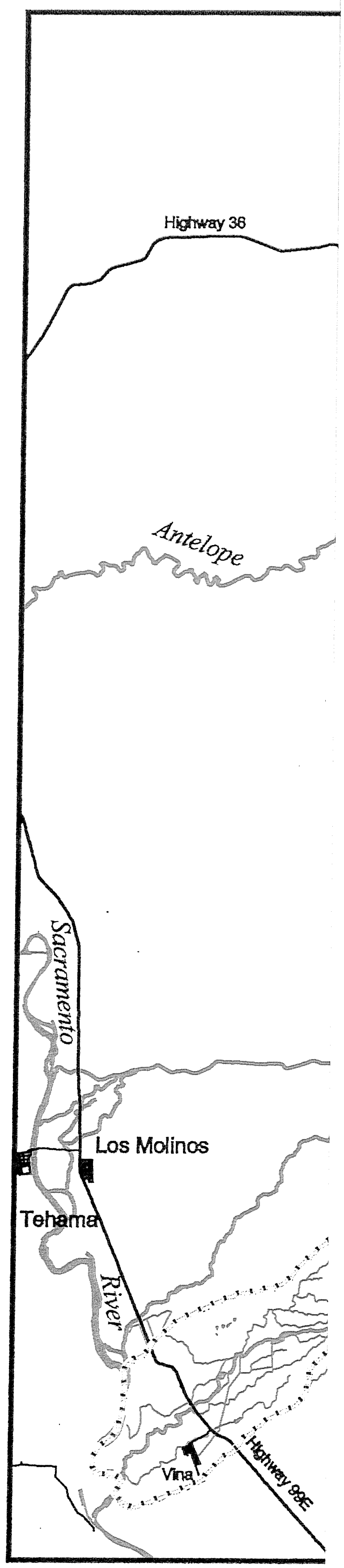

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AVAILABLE MAPPED INFORMATION

1. **Calwater**
   Source: California Department of Forestry (CDF)
   Coverage: Shows watershed and sub-watershed delineations for the State of California
   Scale: 1:24,000 (1" = 2,000')
   Units: Meters

2. **Watershed Boundary**
   Source: California Department of Water Resources, Northern District
   Coverage:
   Scale: 1:24,000 (1" = 2,000')
   Units: Meters
   (Note: No sub-basin linework)

3. **Deer Creek Watershed: Sub-watersheds**
   Source: Lassen National Forest (derived from CDF's Calwater coverage
   Coverage: Shows 13 sub-watersheds from headwaters down to USGS Gaging Station
   Scale: 1" = 2 miles (1" = 10,560')
   Units: Miles
   (Note: GIS file downloaded to DWR Northern District)

4. **Contours: 200' Interval**
   Source: Department of Water Resources, Northern District
   Coverage: Complete for USGS Quads Devil's Parade Ground, Butte Meadows, and part of Onion But?
   Scale: 1:24,000 (1" = 2,000')
   Units: Meters

5. **Contours: 40' Interval**
   Source: Collins Pine
   Coverage: Roughly 1/5 of entire watershed
   Scale: 1:24,000 (1" = 2,000')
   Units: Feet

6. **Creeks**
   Source: DWR
   Coverage:
   Scale: 1:100,000 (1" = 8,333')
   Units: Meters

7. **Intermittent and Perennial Streams**
Source: U.S. Forest Service, Lassen National Forest
Coverage: Shows ephemeral (dashed) and perennial (solid line) streams from headwaters down to USGS Gaging Station
Scale: 1:24,000 (1" = 2,000')
Units: Meters

8. **Creeks**
Source: Collins Pine
Coverage: Single line streams, Classes 1 to 4
Scale: 1:24,000 (1" = 2,000')
Units: Feet

9. **Water**
Source: Collins Pine
Coverage: Lakes, ponds, and double line streams for roughly 1/5 of the entire watershed
Scale: 1:24,000 (1" = 2,000')
Units: Feet

10. **Rainfall (Precipitation)**
Source: California Department of Forestry and Fire Protection
Coverage: Shows average annual precipitation based on point data
Scale: 1:250,000 (1" = 20,833')
Units:

11. Geology
Source: U.S. Geologic Survey (USGS)
Coverage: Geologic mapping
Scale: 1:100,000 (1" = 8,333')
Units:

12. Geology
Source: California Department of Water Resources, Northern District
Coverage: Geologic mapping from Geologic maps of California Westwood sheet
Scale: varies
Units:

13. **Surface Geology in the Deer Creek Study Area**
Source: Jones & Stokes Associates (1994). Derived from Lydon *et al.*, 1960.
Coverage: Two mile-wide corridor (one mile on either side of Deer Creek) from headwaters to confluence with Sacramento River
Scale: (.63" = 1 mile)
Units: Miles

14. **Soils**
Source: DWR (derived from 1967 Tehama County Soil Survey)
Coverage:
Scale: 1:62,500 (1" = 5,208')
Units:

15. **Soils (Rhyolitic)**
Source: Collins Pine
Coverage: Coverage differentiating between rhyolitic soils and non-rhyolitic soils
Scale: 1:24,000 (1" = 2,000')
Units: Feet

16. **Soils**
Source: Sierra Nevada Ecosystem Project (SNEP) and NRCS
Coverage: Broad classifications, derived from sample point data
Scale: 1:250,000 (1" = 20,833')
Units:

17. **Digital Elevation Model (DEM)**
Source: U.S. Geologic Survey (USGS)
Coverage:
Scale:
Units:
(Note: Can be obtained from CARA)

18. **Reach Files**
Source: Teale Data Center
Coverage:
Scale: 1:100,000 (1" = 8,333')
Units: Meters
(Note: Can be obtained from CARA)

19. **USGS Quadrangle Sheet**
Source: U.S. Geologic Survey (USGS)
Coverage: Deer Creek Watershed
Scale:
Units:

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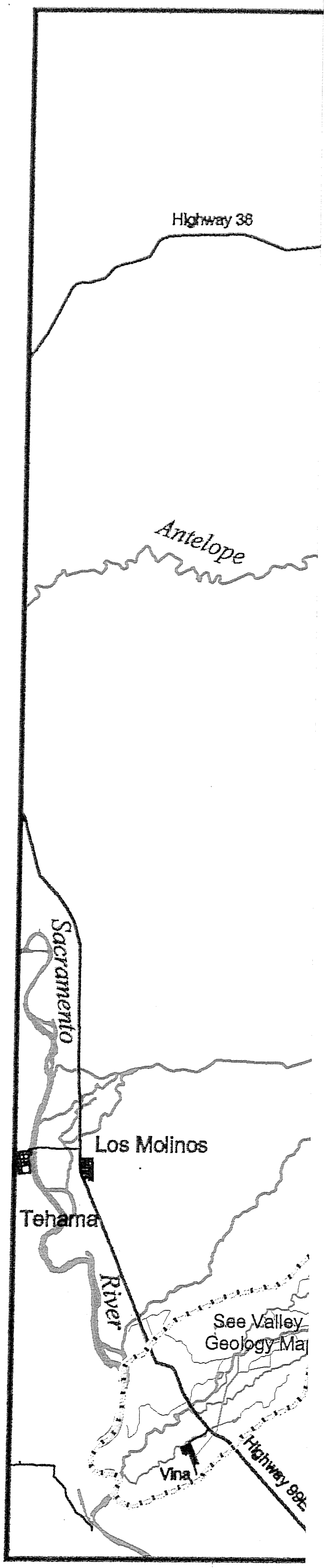

Highway 36
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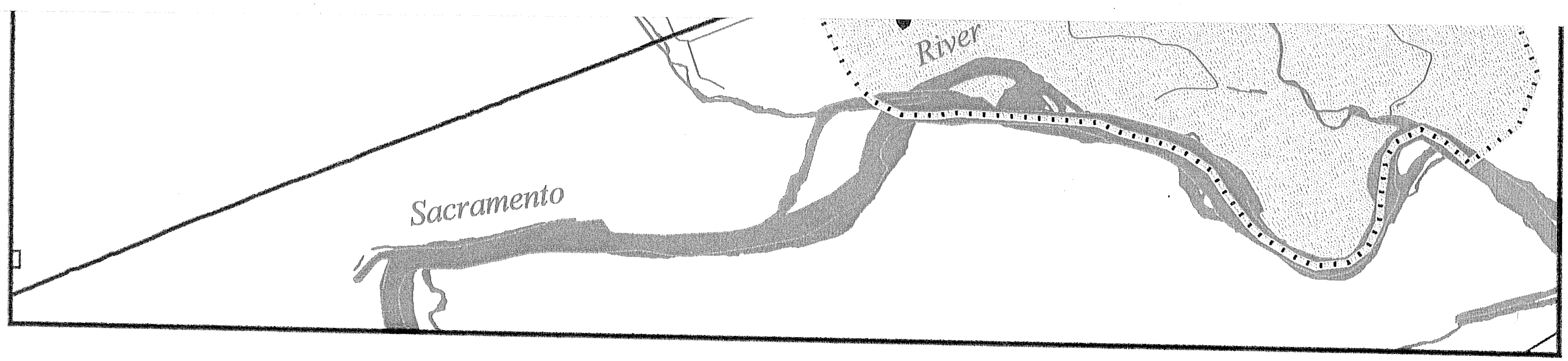
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River

3.0 LAND USE AND LAND MANAGEMENT

LAND OWNERSHIP

Land ownership in the Deer Creek Watershed consists of both public and private lands. Table 3-1 shows the number of acres that are in public and private ownership. Lassen National Forest is the predominant public owner.

Figure 3-1 shows the pattern of land ownership in the Deer Creek Watershed.

Table 3-1. Number of Acres for Each Type of Land Ownership in the Deer Creek Watershed (Derived From GIS Mapping)

Label	Acre
Ownership	
BLM	984
Lassen National Forest	65,701
Private	79,509
State Lands Commission	316
Total Acres	**146,510**

PUBLIC LAND USE POLICIES

Public Land Use and Management

Government owned land in the watershed amounts to 67,001 acres or 46 percent of the watershed area. This land use is located in the middle and upper sections of the watershed. This land experiences multiple uses and is managed by the United States Forest Service (USFS) and the Bureau of Land Management (BLM).

Lassen Land and Resource Management Plan

The Lassen Land and Resource Management Plan (LRMP) provides direction for planning and conducting resource management activities on National Forest land, including those public lands within the Deer Creek Watershed which are managed by the USFS. The USFS has the authority to dictate land use activities for the Forestlands that are consistent with the Forest Plan. The LRMP was formally adopted in 1993 after several years of gathering data and public input.

Preparation of Forest Plans is required by the Forest and Rangeland Renewable Resources Planning Act of 1974 (RPA), as amended by the National Forest Management Act of 1986 (NFMA), and the implementing regulations found in the Code of Federal Regulations (36 CFR 219, issued September 30, 1982).

As directed by NFMA, the Forest Plan will be revised at least every 15 years and ordinarily every 10 years. It may also be revised whenever the Forest Supervisors determines that the conditions or demands, including the RPA program, have changed sufficiently to affect goals or uses for the entire Forest. The Forest Supervisor will review conditions of the lands covered by the LLMP at least every 5 years.

Between Plan revisions, the Plan can be amended to reflect changing conditions. The Forest Supervisor can prepare and approve an amendment if the change is not significant. If the change is significant, the Forest Supervisor prepares the amendment for the Regional Forester's approval. Public notifications and adherence to NEPA procedures are required in either case.

Since the Lassen Land and Resource Plan was adopted there have been two amendments which impact the Deer Creek Watershed. The two amendments include the 1993 California Spotted Owl management policies and the 1995 PACFISH interim guidelines.

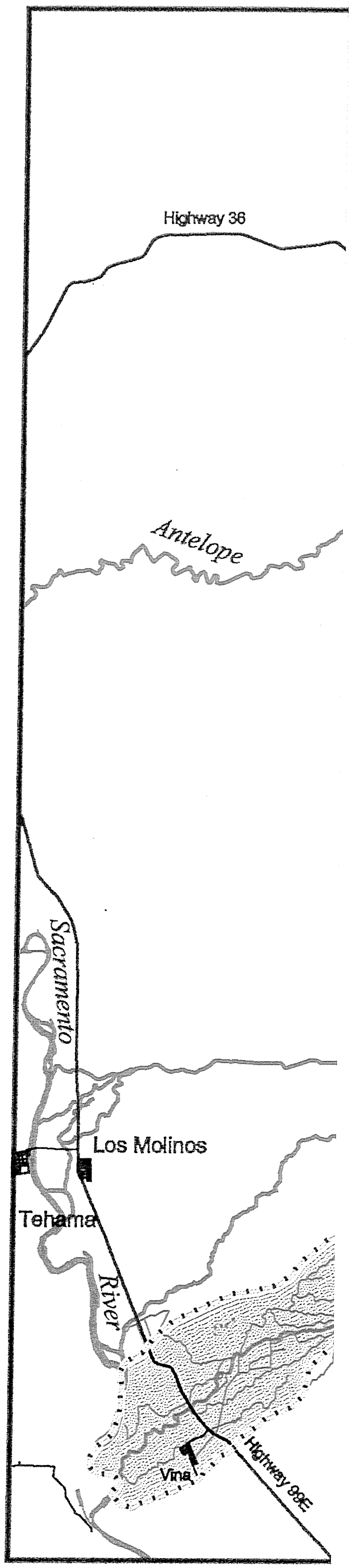
The USFS is still in the process of gathering data to make a final determination regarding long term management policies for both the California Spotted Owl and the anadromous species and their respective habitats. Both issues will be covered in a combined future amendment that will be subject to public review (Mill Creek Conservancy 1997).

Future Trends. Future issues and trends for management of public land in the Deer Creek Watershed include the following:

- Continued movement toward an ecosystem approach to the management of public lands. This includes assessment of existing and desired conditions in developing vegetation management prescriptions. For instance, managing stands to achieve a desired habitat characteristic and fire risk, rather than a timber volume objective.

- Greater emphasis on monitoring of activities and conditions to provide information necessary to adapt management strategies and prescriptions. Collecting monitoring data by efficient and effective means.

- Increased coordination with private landowners and agencies to accomplish watershed and other larger scale management objectives.



Highway 36
Antelope
Sacramento
Los Molinos
Tehama
River
Vina
Highway 99E

USFS Management Direction. The purpose of the Lassen Land and Resource Management Plan (LRMP) is described below:

1. Define the resources to be emphasized in different parts of the Forest.
2. Establish goals and objectives for commodities and services to be provided.
3. Prescribe standards, guidelines, and practices to achieve the goals and objectives.

This management direction provides the framework for interdisciplinary project-level planning.

Direction for management of National Forests comes from law, regulation, policy, and procedures. The many laws enacted by Congress for this purpose include, among others: the Organic Administration Act of 1897, the Multiple-Use Sustained-Yield Act of 1960, the Forest and Rangeland Renewable Resources Planning Act of 1974, and the National Forest Management Act of 1976. Regulations developed by the Secretary of Agriculture are found in the code of Federal Regulations (CFR). Policies developed by the agency are listed in the Forest Service Manual (FSM), and procedures developed by the agency are described in the Forest Service Handbooks (FSH).

The Forest will continue to be guided by these laws, regulations, and forest Service Manual policy and Handbook procedures. This forest Plan supplements, but does not replace, the direction from these sources. The Plan generally does not restate this direction, except where it is necessary to clarify treatment of an issue or concern.

There are three USFS Management Areas located in the Deer Creek Watershed.

1. Management Area 36 Upper Deer Creek.
2. Management Area 41 Middle Deer Creek.
3. Management Area 42 Lower Deer Creek.

The following section provides a description and standards and guidelines for each of the management areas in the Deer Creek Watershed.

USFS Management Area 36 - Upper Deer Creek

County:	Tehama
Ranger District:	Almanor
Acreage:	
National Forest	17,220
Other	29,390

Location. The Upper Deer Creek Management Area is a large, diverse area containing the headwaters and upper tributaries of Deer Creek. It lies midway between the towns of Mineral and Chester. Deer Creek Meadows is a prominent landmark at the confluence of Deer and Gurnsey Creeks. Except for continuous National Forest land in the south, the area is a primarily scattered National Forest parcel surrounded by private land.

Physical Environment. The diverse terrain includes rocky peaks, flat plateaus, and steep creek gorges. Elevations range from 4,000 to 7,866 feet at Butt Mountain. Precipitation is about 60 inches a year. The soils are moderately deep to deep, and are developing in andesite and rhyolite. The rhyolite soils are erodible and have lower productivity than other soils in the area.

Biological Environment. Forests consist of mixed conifers at the lower elevations and red fir at higher elevations. The highest points of Butt Mountain are sub-alpine. Fuel loads vary from light too heavy. Fires occur at a rate of about two per year. Well over half are from lightning, and nearly all are smaller than ten acres. Wilson Lake in the extreme north central portion is an important waterfowl area, supporting breeding Canada geese, mallards, cinnamon teal, and the uncommon ring-necked duck. Bald eagles are often seen at the lake and, in past years, osprey breeding has occurred. Both Gurnsey Creek and Deer Creek support popular put-and-take fisheries. Potential habitat could be provided to steelhead and spring-run Chinook salmon in tributary streams with the rehabilitation of the upper Deer Creek fish ladder. The area is summer range for the East Tehama deer herd. Marten spotted owls, and goshawks are also present. Major features of the Dutch Hill Mine established about 1880 still exist - the tunnel, flume, and ditch used to carry water from Wilson Lake to Feather River Meadows.

Management. Timber has been harvested throughout this area except on Butt Mountain. The area is within the Deer Creek and Soldier Meadows Range Allotments. Deer Creek Meadows is utilized as summer livestock range and has an undeveloped camping site. Gurnsey Creek Campground and Elam Campground are developed sites. Fishing and hiking are popular along Deer Creek, Gurnsey Creek, and Lost Creek.

Facilities. The northern portion of the management area lies within the Lassen Known Geothermal Resource Area, and other portions have been subject to geothermal lease application, but no leases have been issued. Highways 32 and 36 intersect near the center of the area. A segment of the Pacific Crest National Scenic Trail traverses the northeast corner of the Management Area. The Lassen Trail also crosses the area.

Further Planning Area. The area contains the northwestern half of the Butt Mountain further planning area.

USFS Standards and Guidelines for Upper Deer Creek

Cultural Resources

1. At recreation facilities, provide information on the cultural history of the area.
2. Interpret the Dutch Mill Mine ditch for visitor information.

Fish

1. Protect habitat and evaluated for enhancement opportunities for anadromous and resident fisheries along Deer Creek and its tributaries.
2. Pursue the opportunity with private landowners in Deer Creek Meadows to improve stream conditions through the management of livestock.

Lands

1. Acquire lands containing fish habitat and/or riparian areas.

Recreation

1. Maintain the potential of the Butt Mountain area for a downhill ski area development
2. Assess the need for snowmobile and cross-country skiing facilities.
3. Manage recreation use on acquired lands to protect riparian habitat and streamside management zones.

Sensitive Plants

1. Inventory for possible occurrences of short petalled campion (Silene invisa) and closed throat beard tongue (Penstemon personatus) in red fir stands.
2. Inventory for possible occurrences of Wilkin's harebell (Campanula wilkinsiana) at Deer Creek and other meadows.
3. Inventory for Cantelow's lewisia (Lewisia cantelowii) on wet rock faces.

Soils

1. Prohibit tractor logging on rhyolitic soils having slopes steeper than 35 percent.

Visual Resources

1. Meet partial retention visual quality objectives or higher along the Pacific Crest National Scenic Trail as shown on the Adopted Visual Quality Objective Map.
2. Meet a visual quality objective of Retention in the foreground of Highway 36.

3. Meet a visual quality objective of Partial Retention in the foreground of Wilson Lake.

Wild and Scenic Rivers

1. Preserve the "outstandingly remarkable" values of Deer Creek until congressional action on the proposed inclusion in the Wild and Scenic Rivers System, commensurate with recommended classifications.

Wildlife

1. Maintain or enhance potential bald eagle nesting habitat near Wilson Lake.
2. Control accesses and minimizes impacts to the area around Wilson Lake.
3. Maintain or enhance potential willow flycatcher habitat.

Table 3-2. USFS Prescription Allocation for Upper Deer Creek

Strategy	Prescription	Acres
A	Non-Timber Wildlife	200
D	Developed Recreation	40
E	Early Successional	100
F	Riparian/fish	600
K	Rocky/Sparse Timber	900
L	Late Successional	1,900
S	Special Areas	100
T	Timber	6,200
V	View/Timber	4,690
Z	Minimal Management	2,490
Total Acres		**17,220**

USFS Wildlife Habitat Allocation for Upper Deer Creek

Bald Eagle Territories	1
Spotted Owl Habitat Areas	2
Goshawk Territories	2

Other Emphasis Species. Deer (summer range), mallard, chinook salmon, steelhead trout, rainbow trout, willow flycatcher, marten.

Table 3-3. USFS Desired State for Diversity for Upper Deer Creek

Vegetation	Acres
Shrub	
Chaparral	0
Montane Shrub	10
Sagebrush	0
Conifer Forest	
Eastside Pine	0
Mixed Conifer	605
Red Fir	210

Table 3-4. USFS Range Allotment Strategies for Upper Deer Creek

Allotment	Strategy
Deer Creek (50%)	C
Soldier Meadows (20%)	C

USFS Management Area 41 - Middle Deer Creek

County: Butte
Ranger District: Almanor
Acreage
National Forest 16,570
Other 6,329

Location. The Middle Deer Creek Management Area is the portion of Deer Creek Canyon from Elam Campground downstream to the Forest boundary. Also included are the headwaters of Deer Creek's tributaries - Slate, Forked, and Rattlesnake Creeks. Deer Creek Canyon is the major feature. The southeast half is completely in National Forest ownership, while the northwest half is mostly private land.

Physical Environment. The terrain in the canyon is quite steep with many cliffs and bluffs. The uplands are also mountainous, but are less steep. At 6,000 feet, Colby Mountain on the southern boundary is the highest point. A forest Service lookout is located on the summit. The lowest point is 3,200 feet. Precipitation averages 30 inches a year. The moderately deep, rocky soil overlies volcanic rock.

Biological Environment. Forests are mainly comprised of mixed conifers. Red fir is present on the uplands near Colby and Upper Rattlesnake Creek, while oaks and other low elevation species are found from Alder Campground downstream to the area boundary. Fuel loads vary from light too heavy. While a few large fires burned in the past, none recently has exceeded ten acres. Fires average one per year and are started equally by humans and lightning. Much of the area north of Deer Creek is a wildlife refuge. Spotted owls have been found on the steep south side of Deer Creek. Black-tailed deer use the area as summer range or migrate through in spring and fall. Deer Creek supports a popular put-and-take trout fishery. It also supports runs of steelhead and a remnant population of spring-run Chinook salmon. This anadromous fishery has enhancement potential.

Management. Timber harvesting has occurred in the southern one-third of this area. The remaining National Forest land is either road less or isolated by private lands. The area is part of the Tehama, Deer Creek, and Butte Meadows Range Allotments. Alder Campground and Potato Patch Campground are popular sites along Highway 32. Very little dispersed camping occurs, except for hunter camping around Round Valley.

Special Areas. The area contains the Cub Creek Research Natural Area.

USFS Standards and Guidelines for Middle Deer Creek

Cultural Resources

1. At recreation facilities, provide information about the cultural history of the area.

Fish

1. Protect and maintain habitat conditions for anadromous fish.
2. Continue cooperative efforts with the California Department of Fish and Game, U.S. Fish and Wildlife Service, Department of Water Resources and U.C. Davis to monitor the in-river population of adult spring-run Chinook salmon.
3. Evaluate the distribution and abundance of anadromous fish and their habitat to determine the need for barrier modification at the fish ladder at Upper Deer Creek Falls.

Fire and Fuels

1. Use fire suppression strategies and tactics that least alter the landscape or disturb the land surface in the Cub Creek Research Natural Area.

Recreation

1. Restrict camping or other occupancy along Deer Creek parallel to Highway 32, other than at designated campgrounds.

Sensitive Plants

1. Inventory for possible occurrences of short petalled campion (Silene invisa) and closed-throated beard-tongue (Penstemon personatus) in red fir stands.

Visual Resources

1. Meet a visual quality objective of Retention in the foreground of Highway 32 and/or Deer Creek and Partial Retention middleground.

Water and Riparian Areas

1. Recommend denial of hydroelectric development that would cause damage to fisheries, water quality, or recreational values of Deer Creek or its perennial tributaries.

Wild and Scenic Rivers

1. Preserve the "outstandingly remarkable" values of Deer Creek until congressional action on the proposed inclusion in the Wild and Scenic Rivers System, commensurate with recommended classifications.

Table 3-5. USFS Prescription Allocation for Middle Deer Creek

Strategy	Prescription	Acres
A	Non-Timber Wildlife	200
D	Developed Recreation	10
E	Early Successional	100
F	Riparian/Fish	200
K	Rocky/Sparse Timber	210
L	Late Successional	3,300
S	Special Areas	5,700
T	Timber	3,350
V	View/Timber	3,500
Total Acres		**16,570**

USFS Wildlife Habitat Allocations for Middle Deer Creek

Spotted Owl Habitat Areas	3
Goshawk Territories	2

Other Emphasis Species. Pileated woodpecker, deer (summer range), Chinook salmon, steelhead trout, rainbow trout.

Table 3-6. USFS Desired State for Diversity for Middle Deer Creek

Vegetation	Acres
Shrub	
Chaparral	
Montane Shrub	195
Sagebrush	0
Conifer Forest	
Eastside Pine	0
Mixed Conifer	630
Red Fir	115

Table 3-7. USFS Range Allotment Strategies for Middle Deer Creek

Allotment	Strategy
Butte Meadows (25%)	C
Deer Creek (30%)	C
Tehama (15%)	C

USFS Management Area 42 - Lower Deer Creek

County: Butte
Ranger District: Almanor
Acreage:
National Forest 18,020
Other 16,636

Location. The Lower Deer Creek Management Area is located along the southwest boundary of the Almanor Ranger District. It contains the Deer Creek drainage from below Onion Butte downstream to Devil's Kitchen. Substantial sections of private land are in the south and east portions of the area. The chief features are its history and its anadromous fishery in Deer Creek canyon. The northwest boundary borders the Ishi Wilderness.

Physical Environment. The highest elevation is 4,038 feet at Cold Spring Hill, and the lowest is about 1,4000 near Sulphur Creek. The major terrain feature is the rugged Deer Creek canyon. Precipitation averages 30 inches a year. A shallow soil overlies volcanic rock.

Biological Environment. The area is typical "front" country - the western most forested slopes of the Sierra Nevada - with mixed conifer forest on the ridge tops, and oaks, chaparral, and grasslands at lower elevations. Fuel loads are light and consist mostly of fine materials. Many large fires historically occurred, and most of the area has burred at least once in the last 60 years. Average fire occurrence is about three fires every two years. Eighty percent are lightning-caused, and rarely do they burn more than 10 acres each, but the 131,000-acre Campbell Fire burned the western portion of this area in 1990. Golden eagles, prairie falcons, goshawks, and other raptors are present. Steelhead and spring-run Chinook salmon also occur as remnant runs in Deer Creek. Other wildlife present include: species associated with oak, grassland, chaparral, and riparian habitats. For subsistence, the Native Americans relied on acorns, and resident and anadromous fish.

Management. Because commercial timber is scarce, logging has been limited. However, many ranchers historically used the area for extensive livestock operations. There are approximately 21 operations by many ranchers. Approximately 21 head of horse's roam the area, remnants of domestic herds gone wild. The area is part of the Tehama and Campbell Mountain Range Allotments. Hikers, backpackers, and fishermen enjoy streams and trails in the area, particularly along Deer Creek at Transfer Bridge, Murphy's Trail, and Ponderosa Way.

Facilities. Access is limited to two roads in the eastern portion and Ponderosa Way in the west. Deer Creek has been the subject of applications for small hydroelectric facilities, but no leases have been issued.

Further Planning Area. This area includes part of the Ishi B further planning area.

Wild and Scenic. The area contains the middle segments of the proposed Deer Creek Wild and Scenic River.

USFS Standards and Guidelines for Lower Deer Creek

Cultural Resources

1. Protect archaeological sites by resource protection patrol or other methods.
2. Nominate the area used by Ishi and the Yahi Yana people as a National Register District.

Facilities

1. Develop an administrative site with temporary quarters in the vicinity of Devil's Kitchen for wilderness and recreation management.

Fish

1. Protect and maintain habitat conditions for anadromous fish.
2. Continue cooperative efforts with the California Department of Fish and Game, U.S. Fish and Wildlife Service, Department of Water Resources and U.C. Davis to monitor the in-river population of adult spring-run Chinook salmon.

Lands

1. Pursue the acquisition of private lands in areas highly suitable for peregrine falcons, and for cultural resource values.

Range

1. Complete the Wild Horse Territory Management Plan, and monitor management objectives.

Recreation

1. Develop a trailhead at Deer Creek for access into Ishi Wilderness.

Sensitive Plants

1. Inventory for possible occurrences of Butte County fritillary (Fritillaria eastwoodiae) in foothill woodland areas.
2. Inventory for Cantelow's lewisia (Lewisia cantelowii) on wet rocks faces.

Visual Resources

1. Recommend denial of hydroelectric development that would cause damage to fisheries, water quality, or recreational values of Deer Creek or its perennial tributaries.

Wild and Scenic Rivers

1. Preserve the "outstandingly remarkable" values of Deer Creek until congressional action on the proposed inclusion in the Wild and Scenic Rivers System, commensurate with recommended classifications.

Table 3-8. USFS Prescription Allocation for Lower Deer Creek

Strategy	Prescription	Acres
B	Range-Wildlife	700
E	Early Successional	100
F	Riparian/Fish	220
K	Rocky/Sparse Timber	2,800
M	Semi-Primitive Motorized	2,700
N	Semi-Primitive Non-Motorized	6,900
S	Special Areas	3,000
T	Timber	1,600
Total		**18,020**

USFS Wildlife Habitat Allocations for Lower Deer Creek

Goshawk Territories	2

Other Emphasis Species. Deer (winter range), gray squirrel, chinook salmon, steelhead trout.

Table 3-9. USFS Desired State for Diversity for Lower Deer Creek

Vegetation	Acres
Shrub	
Chaparral	0
Montane Shrub	195
Sagebrush	0
Conifer Forest	
Eastside Pine	0
Mixed Conifer	300
Red Fir	0

Table 3-10. USFS Range Allotment Strategies for Lower Deer Creek

Allotment	Strategy
Campbell Mountain (100%)	C
Tehama (15%)	C

Bureau of Land Management

The Redding Resource Management Plan (RMP) guides the Bureau of Land Management (BLM) in managing its public land and mineral reserve estate within the Redding Resource Area of northern California. Sections 102 and 202 of the Federal Land Policy and Management Act (FLPMA) require the Secretary of the Interior to develop land-use plans for all public land under the administration of the BLM.

The primary purpose of the RMP is to update and integrate BLM land use planning into a single comprehensive land use plan. The RMP is a 15-year strategy on where and how BLM will administer public lands under their jurisdiction within the Redding Resource Area. When fully implemented, the BLM public land ownership pattern will shift dramatically from more than 1,000 scattered parcels to less than twenty-five large aggregates of accessible and useful public lands. This will be accomplished principally through land exchanges with the private sector and some transfers of jurisdiction with other agencies and organizations.

BLM Planning Area. The Redding RMP covers a planning area which is identical to the Redding Resource Area. The planning area encompasses approximately 9,914,000 acres within the north central portion of California. BLM administered public lands total approximately 247,500 acres of roughly 2.5 percent of the surface of the area within the Redding Resource Area boundary. These public lands are generally scattered throughout the middle and to a lesser degree, lower elevations of the planning area. The over 1,000 individual parcels of BLM administered public land range in size from a fraction of an acre to over 8,000 acres.

The planning area encompasses all or portions of five counties including: Butte, Shasta, Siskiyou, Tehama, and Trinity. Approximately one half of the planning area is privately owned land predominately within the lower elevations or valleys. The public owned half of the resource area is dominated by the U.S. Forest Service, notably the Shasta, Trinity, Klamath and Lassen National Forests. The overwhelming majority of forest Service administered public lands are located within the upper elevations of the planning area.

BLM Planning Issues. Planning issues are the major concerns with the management of BLM administered public land within the Redding Resource Area. These issues drive the entire RMP process through all steps of the planning process since the land-use management alternatives, including the proposed action, are designed to address these planning issues. There are four planning issues that the BLM has defined which encompass the majority of concerns for management of BLM administered public lands. These issues include land tenure adjustment, recreation management, and access and forest management.

BLM Management Concerns. The BLM uses the RMP process to make other decisions to resolve management concerns. Many of these decisions are required through Supplemental Program Guidance (BLM Manual 1620) and California BLM State Director Guidance. A few decisions are made to address management situations especially applicable or unique to the planning area. These decisions or management concerns are treated within the context of the proposed action or as Resource Area-Wide Decisions.

Some of the more significant decisions include: designation of Areas of Critical Environmental Concern (ACEC); designation of Special Recreation Management Areas; determination of eligibility (and preliminary classification) for inclusion of specific streams in the National Wild and Scenic Rivers System; determination of Recreation Opportunity Spectrum settings to be maintained; and closure of areas to domestic livestock grazing.

BLM Monitoring and Implementation. BLM will monitor the RMP on an annual or as needed basis. The purpose of the monitoring plan is to track successful completion of the actions approved by the RMP and to identify necessary changes to the RMP. Minor changes in data not necessitating changes in land use allocations, restrictions or uses are documented in supporting records. Public involvement is not necessary to perform this plan maintenance. However, the BLM will be required to fully involve the public in any substantive modification of the RMP. Any change to land use allocations, restrictions or uses will be effected only through a formal plan amendment or revision prepared in conformance with BLM planning regulations found in Section 1610.4 of Title 43 of the code of Federal Regulations.

Management Area Decisions. The BLM recognizes that Deer Creek has tremendous biological importance due to the diversity and sensitivity of many species. The canyon contains nationally significant cultural resources in good to excellent condition. The creek also has regional recreational value. The Federal government has a long-term commitment to the unmodified majority of this important stream. Special management attention is necessary to protect the natural values, cultural resources, and adjoining wilderness values. Therefore, the BLM has designated all of the public land managed by the agency along Deer Creek west of the National Forest boundary as an Area of Critical Environmental Concern (ACEC).

The BLM's objectives for Ishi Management Area as described in the RMP for resource condition objectives, land use allocations, and management actions for Deer Creek are as follows.

Resource Condition Objectives.

1. Ensure long-term protection of raptors within the canyon.
2. Protect the scenic quality of the canyon.
3. Maintain and improve, if feasible, the fisheries habitat of Deer Creek.
4. Conserve the archaeological resources of the canyon.
5. Maintain the primitive recreation opportunities within the canyon.

Land Use Allocations.

1. Two hundred acres in Section 14, T. 25 N., R. 1 E. are designated as wilderness.
2. Manage the area as VRM Class 1.
3. Manage as Semi-Primitive Non-Motorized.
4. The area is closed to vehicles.
5. Offer public lands for mineral leasing with no surface occupancy.
6. The area is closed to livestock grazing.
7. Designated the area as an ACEC.
8. Mineral material disposals are not permitted.
9. Acquire available unimproved lands within the canyon.

Management Actions. Develop ACEC management plan for Deer Creek.

PRIVATE LAND USE POLICIES

The primary regulatory agency for private land use decision making in the Deer Creek Watershed is Tehama County, California. The policy making body for that agency is the Tehama County Board of Supervisors with input from the Tehama County Planning Commission. All discretionary decisions regarding land use, resource management, development approvals, environmental impact assessment and related matters must be considered by the Board of Supervisors in the context of the current Tehama County General Plan. The current General Plan was updated and adopted in 1983 in compliance with Government Code Section 65302.

General Plan

The General Plan presents a policy framework within which Tehama County reviews proposals for developing its resources. The policy statements contained in the plan must be brought about or implemented through a series of clear statements concerning the standards which must be met prior to development, and programs for financing, operating, and maintaining facilities that service existing and new development. California law provides local governments with a variety of ways to implement general plans. These implementation tools must, however be based upon the policies contained in the plan. Implementation measures most commonly used by the County include: zoning regulation, subdivision regulation, specific plans, capital improvements, building and housing codes, environmental impact procedures and citizen participation in decision making.

If the County supervisors were to adopt the anticipated Deer Creek Management Strategy, it would also become an implementation tool for County land use decision-making. Such an adoption would be the same as for Specific Plans or Area Plans that are authorized by Government Code Section 65450.

The County General Plan describes the existing pattern of development near the Deer Creek Watershed as follows:

> "South of Red Bluff along the Sacramento River Valley occur several small and relatively compact rural centers which, as the name implies, function to provide services to the predominantly rural agricultural lands surrounding them. The rural service centers of Dairyville, Proberta, Gerber, Richfield, and Vina have grown at a scale and to a size indicative of the predominately agricultural resource base that supports these communities (TCGP, III-61)."

The Deer Creek region in general is not expected to grow significantly in the future. The County General Plan predicted in 1983 that the County's total population would increase to 59,000 persons only one percent of which would be in the southeastern portion of the valley. In fact the County population in 1997 is estimated at 56,841 and new development in the watershed has been very minimal since 1983.

The predicted future of Vina was described in 1983 as follows:

> "In addition to lands designated as urban and suburban, two areas are designated rural residential small-lot. These are the rural service centers of Richfield and Vina. For the most part, these two areas will experience limited growth and in-fill and will continue to function as agricultural support centers for surrounding croplands (TCGP, III-71).
>
> For Vina, agricultural support commercial would be provided for in the vicinity of the intersection of Highway 99E and Vina Road. Additional commercial use on the eastside of Rowles Road between Fifth and Sixth Streets in Vina would complement the similar commercial activities now found in this area (III-82)."

Land Use

Land use maps provided by County Planning Director, George Robson, were used to calculate generalized land uses, in acres, in the Deer Creek area. However, the calculations were based on property lines rather than the physiographic boundary of the watershed and are therefore not precisely comparable to areas delineated by the Conservancy's Geographic Information system.

The maps identify 16,720 acres of grazing land, 5,440 acres of cropland, 14,720 acres of timberland, 26,880 acres of government owned land, mostly managed for multiple uses by the U.S. Forest Service, and 320 acres of land classified as natural habitat. The total area of 64,080 acres is divided by percentages as follows: 26 percent grazing land, 8.5 percent crop land, 23 percent timber land, 42 percent government managed and .5 percent natural habitat, located at the mouth of Deer Creek where it flows into the Sacramento River.

All of the above land uses are projected to remain in their present general plan classifications into the foreseeable future.

Table 3-11 identifies land uses and acreage based on the watershed boundaries delineated by the Conservancy's Geographic Information System Land Use Map. Figure 3-2 shows the land use within the Deer Creek Watershed and Figure 3-3 shows the land use within the valley portion of the watershed.

Table 3-11. Number of Acres for Each Type of Land Use in the Deer Creek Watershed (Derived From GIS Mapping)

Label	Acres
Land Use Categories	
Commercial	42
Field Crops	468
Grain and Hay Crop	563
Industrial	6
Open Space	6,620
Orchards	2,390
Pasture	1,743
Truck, Nursery and Berry Crop	46
Urban	49
Water Surface	157
BLM	955
Forestry	120,489
Grazing	11,583
Habitat Resources	1,387
Suburban	121
Total Acres	**146,619**

General Plan Objectives

The general plan also contains a large number of objectives that are intended to guide policy and project specific questions and issues that the Board of Supervisors may address. The County objectives that pertain to the Deer Creek Watershed are:

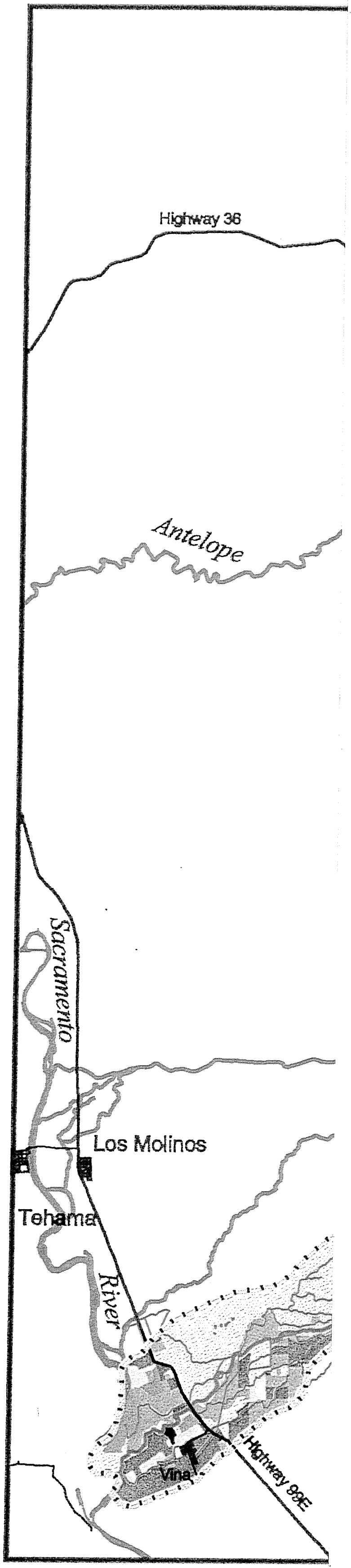
AG-1. Preservation of lands of viable agricultural capabilities according to soil characteristics, with consideration given to access, water, location, and other relevant factors.

AG-2. Protection of lands currently being used for agriculture, but which have marginal agricultural capability characteristics unless their need for non-agricultural use is demonstrated.

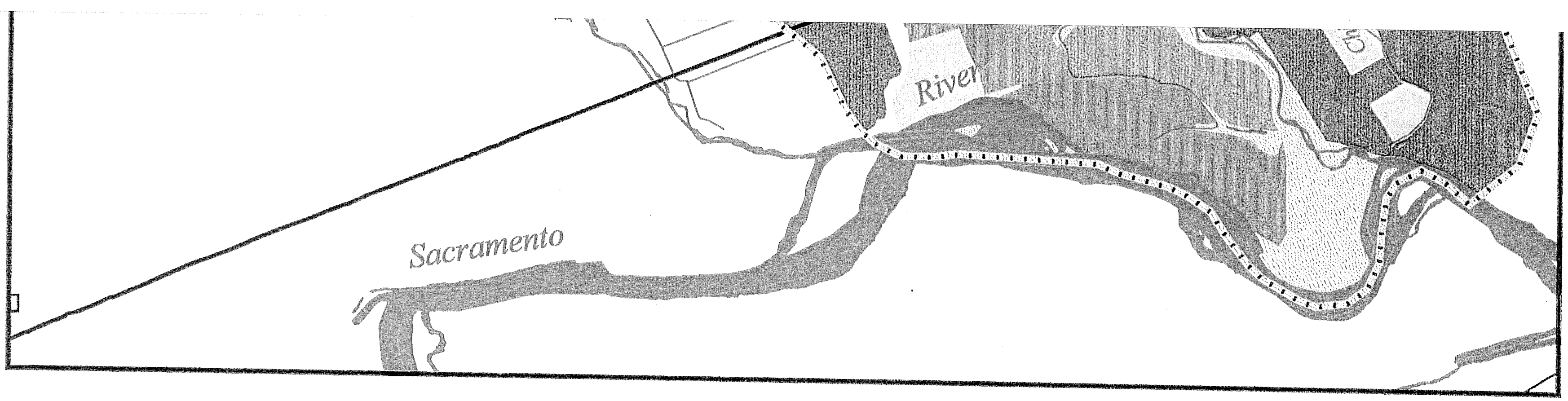
AG-3. Protections of agricultural lands, whenever possible, from non-agricultural development through separation by natural buffers and land use transition areas that mitigate or prevent land use conflicts.

AG-4. Protections of agricultural lands from development pressures and/or uses that will adversely impact and/or hinder existing and/or foreseeable agricultural operations.

AG-5. Recognition that preservation of agricultural lands emphasizes community understanding and acceptance of the agricultural practices utilized by agriculturists and ranchers.



Highway 36
Antelope
Sacramento
River
Los Molinos
Tehama
Vina
Highway 99E


Sacramento
River

T-1. Preservation of prime timber lands.

T-2. Protection of prime timber lands from adjacent development that has the potential to adversely impact timber growing and harvesting operations.

T-3. County recognition of the various timber management improvement and education programs as a means to improve timber yields and protects wildlife habitat and watershed lands.

W-1. Protection and conservation of water resources and supply systems.

W-2. Protect surface water quality and streamflows for water supply, recreation, and aquatic ecosystem maintenance.

W-4. Maintenance, to the extent feasible, of open space along the Sacramento Valley Groundwater Basin to assure continued recharge of groundwater resources.

W-7. Insure the high quality of groundwater by emphasizing programs that minimize erosion and prevent the intrusion of municipal and agricultural wastes into water supplies.

A-1. Preserve and protect the existing air quality of the County.

WR-1. Preserve environmentally sensitive and significant lands and water valuable for their plant and wildlife habitat, natural appearance and character.

WR-2. Afford, to the extent feasible, adequate protection to areas identified by the California Department of Fish and Game and the California Natural Diversity Data Base as critical riparian zones.

WR-3. Support and coordinate County plans with interjurisdictional programs for the proper management of riparian resources in the County.

NRR-1. Protection of resource lands for the continued benefit of agriculture, timber, grazing, recreation, wildlife habitat and quality of life.

NRR-2. Provide access to resource land areas when neither the integrity of the natural resource nor private property rights will be adversely affected.

HA-1. Preserve the historic and archaeological resources of the County for their scientific, educational, aesthetic and recreational values.

CO-1. Plan development within the County in a manner which will provide opportunities for current and future residents to enjoy small-scale, community oriented living environments that are similar to those currently found in the County. Encourage higher densities, where appropriate, to reduce agricultural land conversion demands.

CO-2. Protect private property rights and insure that an individual(s) action(s) do not adversely impact the health, safety, and welfare of the County's citizens.

CO-3. Promote a development pattern which, whenever possible, maximizes the use of existing public roads prior to constructing new roads.

CO-4. Encourage compact development and discourage linear development patterns.

CO-8. Accommodate growth in a manner that preserves the predominate rural lifestyle and unique qualities that make the County an attractive place to live and that recognizes that a rural lifestyle does not always necessitate the provision of the full complement of services normally found in urban communities.

CO-12. Accommodate urban growth and other non-agricultural development by utilizing, whenever possible, lands that do not have agricultural viability.

CO (SI-5)-c. The rural service centers of Richfield and Vina shall accommodate growth consistent with their agricultural support function and in a manner which preserves the agricultural resource value of lands surrounding these communities.

Policy Analysis

In summary, there are no portions of the County General Plan that are inconsistent with the anticipated draft Deer Creek Management Strategy and, in fact, the objectives stated above are very much consistent with the stated goals of the Strategy. Likewise, there are no goals, policies, objectives or implementation measures in the Deer Creek Watershed Management Plan that are inconsistent with the County General Plan. Therefore, there is no reason, based on consistency, for the Strategy not to be adopted as an element of the County General Plan or as an adopted specific plan.

Based on the above conclusions the following recommendations are should be considered by the WAC for inclusion in the Watershed Management Strategy:

1. The County Planning Commission and Board of Supervisors should adopt the Deer Creek Watershed Management Strategy as a County area plan.

2. The Deer Creek Watershed Management Strategy should be considered in the preparation of any future general plan amendments and in any land use decisions that affect lands within the watershed.

3. All of the land use and planning related information that has been collected in the preparation of the management strategy should be made available to the County Planning Department.

LIVESTOCK GRAZING AND RANGELAND MANAGEMENT

History of Livestock Grazing

The history of grazing in the Deer Creek Watershed starts as far back as 1840's. When Peter Lassen received approval of a land grant from the Mexican Government in 1844, he thought the open grassland of the valley was a promising range for cattle. There are accounts that parts of the watershed were not very productive. In 1848, Lassen took a group of immigrants to pioneer the Lassen Trail. When they arrived in the valley area, they stocked the range with cattle from the floor of the valley up into the hills, including the mountain area called Deer Creek Meadows. In 1861 and 1962, a severe drought claimed 30,000 head of cattle in Tehama County. Many ranchers were forced to make the decision to stock and graze sheep rather than risk buying cattle again. During this same time frame, ranchers began the practice of annual late-spring cattle and sheep drives. The mountain meadows, at higher elevations, provided summer forage. With the Southern Pacific Railroad being established in August of 1871, the viability of ranching, the transportation of cattle and sheep into and out of the area was enhanced. In 1881, Leland Stanford purchased enough land to establish the Stanford-Vina Ranch. In addition to crops and orchards, Stanford raised 2,000 hogs, 25,000 sheep, 600 horses, and 800 dairy cows. During World War I, the United States Government demanded ranchers to provide tons of meat for our fighting troops. As a result, a large amount of rangeland in the watershed was severely overgrazed. In the following years, the rangelands could not support the large number of cattle and sheep, and subsequently ranching operations could not survive. From 1920, the number of animal-unit-months (aum's) fluctuated yearly, reaching a peak in 1930 with 5742 aum's and a low of 317 aum's in 1940. The building of ponds for livestock and wildlife, prescribed burns used to re-establish good forage and higher groundwater tables, plus drift fences (which today are called "cross fences"), were then used for range improvements by the ranchers.

Current Livestock Grazing

How much of Deer Creek is grazed? Upper watershed, the Lassen National Forest; USFS administers grazing allotments throughout the Deer Creek basin. The allotments include Deer Creek, Childs Meadow, 1/2 Cone-Ward, Polk Springs, and Barkley Mountain. Since 1920, there has been an overall reduction in range use in all allotments in the Deer Creek Watershed (Lassen National Forest 1997 Draft Watershed Analysis). The lower watershed is primarily private land, which was divided in the 1920's into two irrigation systems: the Deer Creek Irrigation District and the Stanford-Vina Irrigation Company. Within these two systems, there are irrigated pastures that are grazed in the summer months. Winter grazing is primarily in the foothills and on the plains. These two areas are non-irrigated rangelands (C. Knox and S. Hanna, 1997).

What Kinds of Animals Graze in the Watershed? Currently, cattle are the dominant grazers. As written in the history section, sheep had once dominated livestock grazing until about the 1920's when the National Forest reduced allotment sized and permits were converted to cattle. Rangeland use in the Deer Creek basin has gone through changes in intensity since the 1920's. Most of the dramatic changes have occurred in the early period of record. In 1920, the Deer

Creek allotment supported 4,000 aum's, reaching a peak in 1930 with 5,742 aum's. By 1940, use in the Deer Creek allotment had crashed to 317 aum's. Since 1950, use in the Deer Creek allotment has stabilized at close to 2,000 aum's. On the irrigated pasture in the lower watershed, ranchers have been stocking at one animal unit per acre for the season. In general, the breed of livestock ranchers graze are Angus and Ilerford. These are commercial cow/calf operations. There are also purebred herds of Limosims, Brangus, Angus and Herfords raised in the watershed. On non-irrigated range in the foothills and plains, the stocking rate is approximately 10 to 12 acres per animal unit for the season, depending on rainfall. Other grazing animals that may impact the vegetation include the deer and wild horses.

It is estimated that in 1995, there were 29,500 deer in the East Tehama Deer Herd. This deer herd starts to migrate, as the weather drives them, through the Deer Creek Watershed from the "Narrows" (ridge between Mill and Deer Creeks) downstream into the valley (A. Brown, 1950's). Although there are no recent estimates on the population of the wild horses in the watershed, in 1986 there were 30 head of horses according to the U.S. Lassen National Forest Service Wild Horse Management Plan. These herds have been spotted in each season, throughout the years.

What types of grazing management systems/management is practiced? Ranchers usually graze cattle from about November 1 until around May 1, known as winter grazing. Then at that time they move to irrigated pastures, some on the valley floor and some to mountain pastures. Some ranchers move to the summer ranges as early as mid-March. During this season, most ranches operate rotational operations, using fencing, watering and salting to better utilize the range (J. And L. Pitter 1997). On non-irrigated range, operators usually rotate the herd in two to four week periods, depending on the growth of forage.

What are the range conditions and trends in the watershed? Condition and trend data were collected intermittently on National Forest allotments from 1957 to 1986. A variety of methods have been utilized to determine grazing capacity since 1992. Because of the intermittent nature of monitoring efforts from the National Forest allotments, a consistent record does not exist (Lassen National Forest 1997 Draft Watershed Analysis). For the lower watershed no data on condition or trend has been collected. However, it is speculated by the landowners that the soil and vegetation condition is fair, because ranchers always try to leave adequate amount of stubble before moving to the summer pastures (S. Knox 1997).

Of the data collected on National Forest allotments, there appears to be appreciable change in soil or vegetation condition between 1957 and 1986. Soil condition rates ranged from poor to good in 1957. All allotments that were still being monitored by 1986 and soil conditions rating of fair to good. Vegetation condition ratings ranged from very poor to good in 1957. By 1986, the allotments that were monitored rated from fair to good condition, yet only three of the original seven were still being evaluated. The only noticeable change occurred on the Cone-Ward allotment: the vegetation condition rating changed from very poor to fair between 1957-1986 (Lassen National Forest 1997 Draft Watershed Analysis).

Rangeland Management in Deer Creek Watershed

The projects summarized here are the projects that are known. There are landowners in the Deer Creek Watershed who implemented rangeland management practices on their own. A majority of the improvements for the rangeland has been fencing.

Riparian Fencing. The Deer Creek Watershed Conservancy, along with numerous private landowners along the creek, was funded to fence along the creek. A major portion of the lower segment of Deer Creek (from the Deer Creek diversion to the Sacramento River) has been fenced. The overall goal of the fence projects is to maintain a mature riparian community that will provide increased streambank stability as well as shade and cover for fish and wildlife. In 1994, a 1.5-mile long livestock exclusion fence was constructed on the west side of Gurnesey Creek from the Highway 32 crossing up to Highway 36 crossing. This was a cooperative project between the California Department of Fish and Game, Collins Pine Company, California Department of Forestry and Fire Protection, and the grazing lessee, Tucker Baccala. The purpose of the project is to allow riparian vegetation to become re-established on the streambank.

Cross Fencing. The practice of cross fencing has been used by ranchers to allow for proper grazing use. With cross fencing, many ranchers in the watershed are able to rotate the livestock to allow vegetation in pastures to recover from grazing pressures. It is unknown how many miles of cross fencing exist in the watershed.

Prescribed Burning. There has been an on-going prescribed burning program on the Vina Plains Ranch south of Deer Creek. The objective of the program is to reduce the amount of star thistle and medusa head vegetation species on the ranch. A more comprehensive plan to use prescribed burning is available from the Nature Conservancy. The Roney Land and Cattle Company (now owned by D. Garst) initiated a brush management program in 1979. The plan included yearly burns on different portions of the ranch (part of which is within the Deer Creek Watershed) on a rotational basis. The objective of the program was to increase the productivity of the range, improve deer habitat, increase water flows, and reduce the potential for a catastrophic fire.

Other Practices. During the 1950's, Resource Conservation Districts (RCD's) were established in the state of California, including Tehama County. The RCD is governed by an elected Board of Directors made up of landowners within their District. The Vina RCD, which contains the Deer Creek Watershed, was formed to assist landowners in planning, improving and protecting agriculture's basic soil and water resources. Through the years, these same landowners and ranchers have used various methods to allow for uniformity in grazing. Water and salt blocks are used to distribute livestock. Irrigated pastures have been seeded to improve forage production. The development of a conservation easement in lower Deer Creek is tentatively in progress. The intent of the conservation easement would be to protect and preserve the condition of the property, while allowing the easement area to be grazed under a Grazing Management Plan. Upgraded watering systems have been and are being continuously upgraded throughout the Deer Creek Watershed.

Issues and Concerns Relating to Grazing

The issue of how livestock grazing in the Deer Creek Watershed is impacting valuable resources has been acknowledged. The effects of grazing on riparian areas, soil health, water quality, and spread of invasive and non-native vegetation have been identified as being a concern for Deer Creek.

Riparian Areas. The riparian corridor of Deer Creek offers highly productive rangeland for cattle to graze. Currently there is no monitoring data of the range condition and trend in riparian areas of the creek. A more detailed study of this impact is needed.

Soil Health. On average, the soils of the rangeland in Deer Creek range from very productive to marginally productive in terms of forage production. The 1997 Draft Watershed Analysis for Lassen National Forest reports that the soil condition for Deer Creek shows the soil condition ratings ranged from poor to good in 1957. All allotments that were still being monitored by 1986 had soil condition ratings of fair to good. Data is lacking for impact to soil conditions in the lower and foothill portions of the watershed.

Water Quality. Water quality impacts form grazing may include increased nutrient levels or increased sedimentation. As summarized from Chapter 7 on Water Quality, the nutrient values measured were within an acceptable range and generally less than State and Federal drinking water and freshwater aquatic live Maximum Contaminant Level (MCL) standards. The Central Valley Regional Water Quality Control Board has reported that the mineral quality of Deer Creek is acceptable for all stated beneficial uses. Minor element concentrations are also primarily within established water quality standards. Grazing effects on water temperature in Deer Creek is not clear. There is a need to study the data collected from various groups over the years. Fecal coliform numbers at two stations downstream from grazing areas in Deer Creek Meadows area showed that total coliform values greater than 1,600 MPN/100mL. This exceeded the Regional Board Basin Plan Water Quality Objective for fecal coliforms in waters used for contact recreation. It is unclear whether grazing, recreational use or some other impact caused the reason for this reading.

Invasive, Non-Native Vegetation. In Chapter 8, Deer Creek vegetation is described. The presence of invasive, non-native vegetation in Deer Creek, largely, is a result of disturbance by human activities. In general, there are three factors that lead to the introduction of most introduced annual grasses in California. Those factors are historic overgrazing, climate, and grass seed contamination (L. Jolley 1997). With the arrival of settlers, California's grasslands changed dramatically. Annual grasses and forbs from the Mediterranean area where introduced both accidentally and intentionally. These species were shorter-lived and shallower-rooted than the perennial grass that they replaced. Grazing is a disturbance that has contributed to the increase in undesirable vegetation. Vegetation species (e.g., yellow starthistle, medusa head, ragweed, and cocklebursd) have been very aggressive throughout the rangelands in Deer Creek. The continued spread of these undesirable species constitutes a threat to current rangeland conditions.

Vegetation Descriptions of Range Sites of Deer Creek Watershed

A range site is a distinctive kind of rangeland that differs from other kinds of rangeland in its ability to produce a characteristic natural plant community. A range site is the product of all the environmental factors responsible for its development. Range site information can be interpreted as to the suitability of a site for a single use as grazing or for many other uses (e.g., wildlife habitat, recreation, natural beauty, watershed and open space). The plant community of a range site is not a precise assembly of species for which the proportions are the same from place to place or even in the same place from year to year. The initial description of a plant community should be considered as an approximation subject to modification as additional knowledge is gained. The nine (9) range sites in the Deer Creek Watershed are listed below and are shown on Figure 3-4.

Loamy

Vegetation. Characteristic species are annual grasses and forbs. Common grass species are barely, medusa head, ripgut brome, soft chess, and wild oats. Forb species include clover, plantain, star thistle, turkey mullein, and filaree.

Topography. This range site is characterized by old alluvium evolved from shale, sandstone, and soft siltstone. Nearly level on low terraces, the slopes vary from 1 to 8 percent. The elevations vary from 200 to 1000 feet. In Deer Creek Watershed, this range site occurs mostly on the low terraces of the Sacramento River, downstream from the Deer Creek Irrigation water take out. Although this area is designated as a range site, cultivated agriculture has occurred on a majority of this range site in the Deer Creek Watershed. This range site also occurs in the upper watershed in-between portions of "rockland," "rubble land," and rocky sandy loams of the Iron Mountain soil association.

Production. The estimated total annual production in a normal year is approximately 1,800 pounds air dry weight. This range site produces good grazing for livestock. This site is usually open with few trees and brush. This is a key site when grazed with other sites. Drinking water is scarce during summer and fall.

Soils. This range site is an association of soils that are nearly level to sloping and are well drained. These soils formed in alluvium, sedimentary, and metasedimentary rocks. The surface texture is loam and silt loam and is slightly to medium acid. The subsoil is clay to silt clay loam. Permeability is slow. Available water capacity and fertility are moderate. Soil map units that occur in this range site are in the loams and silt loams Columbia, Vina, Keefers, and Supan Associations.

Course Loamy

Vegetation. Characteristic species are annual grasses and forbs. Common grass species are soft chess wild oats, ripgut brome, medusa head, and Italian ryegrass. Forb species include brodiaea, annual clover, lupine, popcornflower, and filaree.

Topography. This range site is characterized by rounded hills and steep scarps and along active streams. The elevations are from 200 to 1,000 feet. Slopes vary from 0 to 50 percent, but mostly less than 20 percent. In the Deer Creek Watershed, this range site occurs entirely within the low terraces and is interspersed with the "Loamy" range site as described above.

Production. The estimated total annual production in a normal year is approximately 1,400 pounds of air dry weight. This site provides adequate forage for cattle and sheep, but the areas are usually small in size.

Soils. Soils that characterize this site are fine sandy loams, gravely fine sandy loams, shallow to deep. The available water holding capacity and fertility are low to moderate. Soil map units that occur in this range site are in fine sandy loams of the Columbia, Molinos, and Laniger soil association.

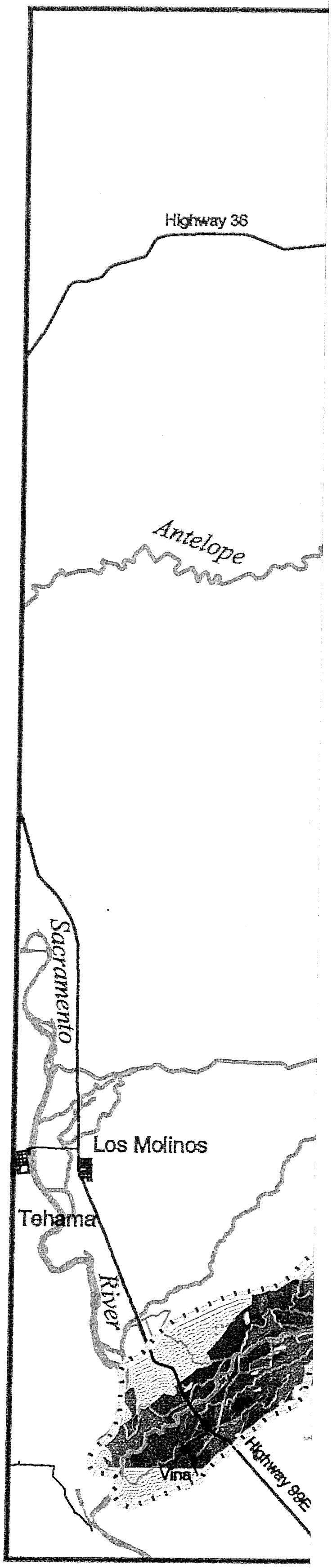
Shallow Stony Loam

Vegetation. Characteristic species are annual grasses and forbs. Common grass species are soft chess, medusahead, wildoats, annual ryegrass, barley, and foxtail fescue. Forb species include venegar weed, common spikeweed, and brodiaea.

Topography. This range site occurs on old alluvium washed from acres of volcanic rock. These soils are on terraces at elevations from 200 to 1,000 feet. Slopes may vary from 1 to 15 percent, but mostly below 10 percent. In the Deer Creek Watershed, this range site occurs only in a small portion. It is found along the terraces of Juniper Gulch and in two other places north of Deer Creek.

Production. The estimated total annual production in a normal year is approximately 400 pounds of air dry weight per acre. Forage production is low on this site and the forage dries up early in the spring. Stones on the surface may hinder livestock travel. Drinking water is usually scarce.

Soils. Soils that characterize this site are cobbly loams, very stony loams. The depth to an indurated hardpan is 10 to 20 inches. Available water holding capacity and fertility are low. The soil type that occurs in this range site is Inks cobbly loam.



Highway 36
Antelope
Sacramento
River
Los Molinos
Tehama
Vina
Highway 99E

Shallow Loamy

Vegetation. This plant community consists of annual grasses and forbs. Common grass species are foxtail fescue, soft chess, wild oats, medusahead, annual rye grass, barley, and red brome. Forb species include common spikeweed, brodiaea, vinegar weed, tarweed, popcorn flower, and wild onion.

Topography. This range site occurs on old alluvium washed from areas of volcanic rock. These soils are terraces at elevations from 200 to 1,000 feet. Slopes vary from 1 to 15 percent, but mostly below 10 percent. In the Deer Creek Watershed, this range site occurs mostly within the low terraced area downstream of the Deer Creek Irrigation take out. Within this area, it occurs near the boundaries of the watershed, away from the creek. In the upper watershed, it is associated with Toomes rocky loam soils.

Production. The estimated total annual production in a normal year is approximately 800 pounds of air dry weight per acre. Forage production is low on this site and the forage dries up early in the spring. Drinking water is usually scarce on this site.

Soils. The soils that characterize this site are cobbly loams, clay loams, stony loams, and loams. The depth to the indurated hardpan is 10 to 20 inches. Available water holding capacity and fertility are low. Soil map units that occur in this site are in the Toomes, and Tuscan soil series.

Very Stony Shallow Loam

Vegetation. This range site community consists of annual grasses and forbs. Some areas have a canopy of blue oak of 10 to 15 percent and also some shrubs. Common grass species are wildoats, soft chess, ripgut brome, foxtail fescue, medusahead, dogtail, and purple needlegrass. Forb species include brodiaea, common spikeweed, venegar weed, star thistle, turkey mullein, and lettuce. Wood species are blue oak, gray pine, coffeeberry, California juniper, California live oak, California buckeye and cennothus.

Topography. This range site occurs on nearly level to very steep slopes that formed in material from volcanic rock. The elevations are from 300 to 4,000 feet. The slopes vary from 1 to 50 percent, but mostly are below 30 percent. In the Deer Creek Watershed, this range site occurs entirely within the area from upstream of the Deer Creek Irrigation take-out to approximately Iron Mountain.

Production. The estimated total annual production in a normal year is approximately 500 pounds of air dry weight per acre. Livestock grazing on this site is difficult because of the very stony surface. Forage production is low and drinking water is scarce.

Soils. The soils that characterize this range site are very rocky and extremely rocky loams and silt loams. These soils are well drained. The available water capacity and fertility are low. Volcanic rocks cover 10 to 25 percent of the surface. The depth varies from 8 to 20 inches. The soils that occur in this range site are the Toomes very rocky loam soils.

Very Stony Very Shallow Loam

Vegetation. This range site community consists of 30 to 85 percent annual grasses and 10 to 15 percent annual forbs. Common grass species include: foxtail fescue, silverhair grass, and soft chess. Forbs species include: vinegar weed, and navarretia.

Topography. This range site occurs on nearly level to very steep, well drained soils that formed material from volcanic rock. Slopes range from 10 to 30 percent, but are mostly less than 20 percent. Elevations are from 300 to 4,000 feet. In the Deer Creek Watershed, this range site occurs upstream of the Deer Creek Irrigation take-out, mostly along the north watershed boundary. A significant amount of this range site occurs on the south foothill of Deer Creek, as it exits out of the canyon (uphill of the irrigation ditch).

Production. The estimated total annual production in a normal year is approximately 400 pounds of air dry weight per acre. This range site is very droughty and provides limited forage for only a short time. Stones interfere with livestock travel. Drinking water is scarce.

Soils. The soils that characterize this site are Toomes extremely rocky loam, a soil that is very shallow and occurs over hard andesite or basalt.

Clayey

Vegetation. This range site community consists of 25 to 80 percent annual grasses and 20 to 35 percent annual forbs. Common grass species are wild oats, soft chess, dogtail, ripgut brome, annual ryegrass, red brome, and foxtail fescue. Forbs species include annual clovers, filaree, brodiaea, lupine, and other forbs.

Topography. This range site occurs on rounded foothills at elevations from 500 to 2,000 feet. Slopes vary from 0 to 50 percent, but are mostly 10 to 30 percent. In the Dee Creek Watershed, this range site occurs in small portions mostly downstream of the Deer Creek Irrigation take-out on the low terrace soils. It also occurs in the upper watershed along Deer Creek near "Ishi Indian camp" and near "Aperson Cow Camp".

Production. The estimated total annual production in a normal year is approximately 2,000 pounds of air dry weight per acre. This range site provides good grazing for livestock. This site is usually open with few trees and no brush. This site should not be grazed when saturated with water. The few blue oaks occurring on this site should be protected to provide shade or livestock.

Soils. The soils that characterize this site are the Anita Clays and Berrendos clay. These soils are formed in material from sandstone and shale. This soil is well drained, permeability is slow, and the available water-holding capacity and fertility are moderate.

Stony Loam

Vegetation. This plant community consists of annual grasses and annual forbs. Common grass species are medusa head, ripgut brome, soft chess, and wild oats. Forb species include brodiaea, vinegar weed, and common spikeweed.

Topography. This site occurs on nearly level too gently sloping, well-drained soils formed in old alluvium. Elevations range from 200 to 1,000 feet. Slopes vary form 0 to 3 percent. In the Deer Creek Watershed, this range site occurs in small areas on the low terraces, downstream from the Deer Creek Irrigation take-out.

Production. The estimated total annual production in a normally year is approximately 1,000 pounds of air dry weight per acre. This site provides grazing for livestock during late winter and spring. Stones on the surface limit grazing in some areas. Drinking water is scarce in summer and fall months.

Soils. The soils that characterize this site are Los Robles clay loam, Los Robles loam, Keefers cobbly loam, and Keefers complex, channeled. These soils are moderately deep, slightly acid and the subsoil is very cobbly.

Stony Clay

Vegetation. This plant community consists of annual grasses and forbs. Major plant species include annual ryegrass, dogtail, foxtail fescue, red brome, ripgut brome, soft chess, and wild oats. Forb species include annual clovers, redstem filaree, brodiaea, and other forbs.

Topography. This site occurs on nearly level to moderately sloping imperfectly drained soils that formed in alluvium from volcanic rocks. The elevations were from 200 to 500 feet. The slopes vary from 1 percent to 30 percent. In the Deer Creek Watershed, this range site occurs only along Juniper Gulch and along the Deer Creek Irrigation Diversion, at the take-out.

Production. The estimated total annual production in a normal year is approximately 1,600 pounds of air dry weight per acre. Stones on the surface may hinder livestock movement in places. This site should not be grazed when wet.

Soils. The soils that characterize this site are Anity cobbly clay and moderately deep Anita cobbly clay. These soils are cobbly or stony clays. Drainage is imperfect, runoff is medium and permeability is very slow. Available water holding capacity and fertility are moderate. Seeps are common near the upper edge of the slopes.

Information Needs for Range Resources in Deer Creek Watershed

There is a need to determine the range condition and trend for rangeland outside the National Forest Service Boundary. This includes the foothill rangeland and on the irrigated pastures of lower watershed rangelands. This need can only be satisfied with the cooperation of private landowners. A monitoring program needs to be developed to determine current conditions and trends of the rangeland resources. The monitoring program should include a uniform strategy in which the data is to be collected and analyzed. The Deer Creek Watershed Conservancy plans on developing a Rangeland Monitoring Program in cooperation with CSU Chico, Tehama County Farm Advisor, UC Davis Erg Extension, the Vina RCD, and the Natural Resource Conservation Service. This upcoming plan will depend on available funding.

Rangeland Vegetation

The rangeland area of the Deer Creek Watershed is a vast mosaic of different vegetative communities. These communities may have distinct boundaries (e.g., riparian zones) or they may blend together with unclear boundaries (e.g., grasslands and oak woodlands).

Factors that control the distribution of these communities include: rainfall, temperature, elevation, slope, aspect, soils and geology. The interactions of these factors determine the makeup and complexity of the different communities.

The grassland community is located in a belt above the cropland and below the oak woodland and brush land area. This community consists of many different forbs and grasses both introduced, native, annual and perennial. This community has undergone much change over the last several hundred years with the introduction of alien annual herbaceous species from Europe. It is speculated that his community was once dominated by native perennial bunch grass species before the introduction of alien annuals. Currently these alien species make up the majority of this community. Typical species include wild oats, soft chess, filaree, ripgut brome, medusahead, and starthistle. This community is dynamic and very responsive to the climate, especially rainfall. The productivity of this community can be very high when climatic conditions are favorable or low during periods of drought.

The hardwood community is located below the coniferous forest and in some areas associated with brush lands. The dominant species associated with this community are the oaks, especially blue oak. Other oak species include interior live oak, scrub oak and black oak. The herbaceous understory vegetation has undergone changes similar to the grassland community. The oak and associated shrub component is relatively stable, with cyclic fluctuations occurring on a continual basis.

The productivity of this community in relation to livestock forage varies, and is related to canopy cover. Canopy cover up to 30 percent has little influence on forage production. As canopy levels increase forage production tends to decrease, and there is a shift to less desirable forage species. During periods of drought, however, the shade provided by the canopy has shown to be beneficial reducing soil moisture use and extending the green feed period. Hardwoods also have deep extensive root systems that can utilize nutrients deep within the soil profile, and recycle these nutrients to the soil surface making them available to shallow rooted forage plants.

The brush land community is located within the mid-portion of the watershed. This community may occur in thick dense stands or in more isolated discontinuous patches. Canopy levels may be high with little understory. Many of the species associated with this community are fire responsive and require fire to maintain their productivity. Typical species include buckbrush, several species of manzanita, toyon and coffeeberry.

The livestock forage value of the brush land is low. In old brush fields the herbaceous understory is very limited. The exception of this is after a fire. The nutrients tied up in the woody plants are released and available for use by herbaceous species. This level of productivity usually lasts for several years, until the brush is reestablished. Productivity can be increased by post fire seeding of desirable forage species into the burn area.

Vernal pools occur in the watershed where favorable soil and hydrologic conditions exist. Vernal pools provide unique habitat to many endemic species of flora and fauna. The actual vernal pools are small in total area, but occur in complexes with associated upland mound areas "micro-topography", creating a mound - intermound (depression area) association. The integrity of the vernal pools is dependent on this mound - intermound complex.

The livestock forage value of this community is similar to the upland grassland community. Productivity varies greatly and is affected greatly by the weather conditions during the growing season.

The riparian community is associated with active streams and tends to form corridors adjacent to the streams. The extent and diversity of this community is dependent on the moisture regime, soils and topography. This community, although small in total area, serves an important role within the watershed. It provides important wildlife habitat, both for upland species as well. As for fisheries, it stabilizes stream channels and provides a buffer between the uplands and the stream.

This community is diverse, with many different species of native trees and shrubs. In some areas introduced species have become established at the expense of the native plants, forming dense stands of single species monocultures, and reducing diversity.

Livestock forage production in the riparian community is high, but varies depending on overstory species and moisture regime.

The high-elevation mountain meadow community, although small in total area is a very important component of the grazing resource in the watershed. They provide significant livestock forage for summer grazing. In addition they are key wildlife areas as well as important to the overall function of the watershed, acting as buffers and filter areas during periods of high runoff.

Forage productivity and quality are high for this community. Typical species include red top, sedges, tufted hairgrass and clovers. The associated species are predominantly perennials.

Role of Fire. The occurrence of fire has been a major formative factor of the watershed. The nature of the climate (i.e., hot dry summers with convective summer storms) makes the area prone to fire. Because of this plant communities have evolved over time to co-exist with the natural fire regime.

Many shrub-dominated communities require fire to maintain health and vigor. Other communities have developed defenses that limit their susceptibility to fire.

One role of fire is the re-cycling of nutrients. The biological break down of nutrients from plant material is slow because of the climate. Fire creates a rapid turn over of these nutrients back to the soil in a form usable for plant growth.

Brush management either through prescribed burning or mechanical clearing is effective in increasing livestock forage. Additional benefits include increased water flow in springs and small drainages and improved wildlife habitat by increased diversity in species composition and multiple age classes of desirable browse species.

Wildlife. Wildlife use in the watershed is extensive. Many wildlife species occupy and utilize several different plant communities at different times of the year, while others may utilize and complete its entire life cycle in a single community. The wildlife population varies both in species and numbers through out the year. Some species are migratory, utilizing the area part of the year, while others are resident living in the area the entire year.

Livestock grazing and wildlife are compatible. They have coexisted for many years. Livestock in some cases can be used as a tool to improve wildlife habitat. Range improvement practices (e.g., water developments and brush management) also benefit wildlife. A grazing management plan can be developed that recognize wildlife needs and measures taken to address these needs.

Livestock Grazing. Livestock grazing has occurred in Tehama County and probably in the Deer Creek Watershed since the 1850's. Prior to that it is believed that large roving herds of herbivores occupied and used the area for many centuries.

Early livestock operations involved the free ranging of livestock over extensive area. The animals were allowed to move from area to area, continually moving to fresh forage.

Over time grazing areas became smaller. Livestock movement is now being controlled within individual ranch boundaries. When forage is adequately utilized the livestock are moved to high elevation grazing areas or irrigated pasture.

The Rangeland Resource

The production of forage varies from site to site within the watershed. Factors that can affect productivity are soils, slope, aspect, topography, past grazing use and precipitation. Precipitation is the greatest year to year variable affecting productivity.

Total precipitation is not as critical as the timing of rainfall events. Water use by forage plants is low during the winter when temperatures are low. In the spring, however, water use by plants begins to increase as the temperature increases and limited moisture can greatly reduce production.

Season of Use. The grazing season coincides with the growing season. Fall green up normally occurs in late October or November. Growth of forage plants during the winter is slow because of cold temperatures. The growth rate increases in late February or early March as temperatures increase and continues until the soil moisture is depleted usually in May.

Proper Grazing Use. Proper grazing use on land dominated by annual vegetation is determined by measuring the residual dry matter (RDM). This technique involves inventorying and weighing the amount of litter and residue on the soil surface, and is expressed as pounds per acre. This is done in the fall prior to the onset of the rainy season.

Standards on the amount of RDM required and desirable for a site are established. Factors (e.g., soil protection, species composition and seedling establishment) are used to determine RDM levels.

Determining proper grazing use for areas dominated by perennial grasses, shrubs and trees may involve using a different technique. Measuring the percent utilization of the current year's growth is typically used to determine use for these areas.

Improvement Practices. Improvement practices can be broken in to two general categories, structural and management. Structural practices include the on the ground measures which allow for the distribution and control of the livestock. These practices include fences, ponds, spring developments and handling facilities. Also included are practices that improve forage production (e.g., seeding, fertilization, and brush management). New advances in technology have created new opportunities for the use of some of these practices. High tensile electric fencing and solar water pumps are now available for use in many situations.

Management practices deal with the allocation of forage and techniques to increase forage production, encourage desirable forage species, while at the same time enhancing and protecting other associated resources. This is not an easy task. It requires knowledge of the land, plants and animals. Proper livestock distribution and uniform forage utilization are two ways to achieve this goal.

Current Needs

Baseline Data. The collection and evaluation of baseline existing conditions should be the considered for further analysis in the watershed. From this inventory the condition of the major resource concerns can be determined. This analysis should include the inventory of current range health and the location of existing structural range improvement practices. Soils and range site data could also be included.

From this further analysis specific issues and concerns can be addressed and evaluated to determine their condition and status.

Opportunities

There are many opportunities available to the watershed. They include management, education and financial related assistance available from various agencies and groups involved with the Deer Creek Watershed Conservancy. The extent and scope of this assistance should be based on identified needs determined by the Conservancy work group.

There is much potential to expand the knowledge base within the watershed. This can be achieved through workshops and seminars or field trips that relate to specific areas of interest or resource concerns. Examples of this would be range monitoring, riparian zone management, prescribed grazing management, holistic management and innovations in range improvements.

There are also several financial assistance programs available to implement and apply new concepts, technology and range improvement practices on the land. These include cost share and grant programs available from different agencies and organizations.

There is a large base of potential assistance available to the landowners of the Deer Creek Watershed. It will be important that a well thought out plan be developed both for the overall watershed and by individual landowners to utilize this assistance. Clearly defined goals and objectives will be the first step in developing these plans.

TIMBER PRODUCTION AND FOREST MANAGEMENT

Timberland in the watershed amounts to 14,720 acres or 23 percent of the area. All timberland land uses are located in the upper reaches of the Deer Creek Watershed (Holtgrieve 1997, Bickel 1997). The Collins Pine Company manages a significant portion of the headwaters of the Deer Creek basin.

In 1981, the County of Tehama produced 147,208 board feet valued at $24,374 (State Board of Equalization 1981). In 1995, Tehama County produced 82,028,000 board feet valued at $33,882,000 (Tehama County 1996).

Natural habitat land in the watershed amounts to 320 acres or 0.5 percent of the area. This land use is located at the confluence of Deer Creek and the Sacramento River (Holtgrieve 1997).

Most of the timberland in the watershed is located in the external boundaries of Lassen National Forest. Management prescriptions for lands managed by the Forest Service are specified in its Land and Resource Management Plan. All Lassen National Forest lands adjacent to Deer Creek are being managed according to either the "Special Areas Prescription" (Elam Creek Campground to Ishi Wilderness) or the "Wilderness" prescription (Ishi Wilderness). No timber harvesting is permitted within these prescription areas. The Wilderness prescription applies to a corridor approximately 2 miles wide (i.e., it coincides with the secondary study area). The Special Areas Prescription applies to a corridor approximately 1 mile wide. Except for a "Special Areas Prescription" that extends along Cub Creek, the remaining national forest lands within the study area is being managed according to prescriptions that include limited harvesting (U.S. Forest Service 1992c, Jones and Stokes 1994).

Much of the timberland consists of private inholdings within the external boundaries of Lassen National Forest. Timber harvesting on private land is regulated under the Z'Berg-Negedly Forest Practice Act and the California Forest Practice Rules pursuant to this act. These rules specify measures to ensure sustained production of timber, protection of soil and water from the effects of erosion, and protection of wildlife habitat. Sustained timber production is ensured by requiring that areas that receive clearcuts or other types of regeneration harvests be adequately reforested within 5 years of completion of harvest operations. Regulations to minimize soil erosion focus on design criteria for construction and maintenance of roads, skid roads, and landings (Jones and Stokes 1994).

Forest practice rules to protect water quality, stream channel structure, and riparian habitat focus on establishing watercourse and lake protection zones (WLPZs) adjacent to streams within which special operation restrictions apply. Because Deer Creek is a Class I water, WLPZs for timber harvesting along Deer Creek range in width from 75 feet to 150 feet, depending on the steepness of the adjacent terrain. Within WLPZs, harvesting operations must retain at least 50 percent of the overstory and understory canopies in a well distributed, multistoried stand configuration (Jones and Stokes 1994).

Private timberlands in Tehama County are eligible for enrollment under Timberland Production Zone (TPZ) contracts pursuant to the California Forest Taxation Reform Act. As with Williamson Act contracts, TPZ contracts restrict landowners' ability to convert lands to conflicting uses. Approximately 13,020 acres in the study area are enrolled under TPZ contracts; most of these lands are located near Deer Creek Meadows and the Ponderosa Way crossing (Table 3-12). Land under TPZ contracts within the study corridor account for approximately 5 percent of the total acreage under contract in Tehama County (California Department of Finance 1994, Jones and Stokes 1994).

Table 3-12. Deer Creek Land Ownership and Uses

Land Ownership and Use	Acres	Percent
Public Lands		
Lassen National Forest	30,740	46
Ishi Wilderness	9,820	15
U.S. Bureau of Land Management	990	1
Woodson Bridge State Recreation Area	130	0
Subtotal	**31,860**	**47**
Private Lands		
Timberland production zones	13,020	19
Agricultural land		
Grazing land/native vegetation	18,000	27
Alfalfa/row crops	820	1
Irrigated pasture	1,220	2
Orchards	1,100	2
Williamson Act lands	16,125	24
Urban development	360	1
Other private	1,060	2
Subtotal	**35,580**	**53**
TOTAL	**67,440**	**100**

Sources: U.S. Forest Service 1992; Tehama County Assessor's Office 1991, 1992; and California Department of Water Resources 1988.
Note: Ishi Wilderness acreage is included in the Lassen National Forest total acreage. Total does not include acreage under Williamson Act contract. This acreage is included as part of other grazing land/native vegetation, alfalfa/row crops, irrigated pasture and orchards.

AGRICULTURE, VITICULTURE AND ARBORICULTURE

This section covers cropland, grazing land, timberland, government land, and natural habitat. One of the problems in compiling this information is the lack of sub-County information. The Deer Creek Watershed is a regional area that is smaller than the County; however, there is a considerable amount of data for Tehama County. Estimates and assumptions are, therefore, necessary.

Agricultural lands include unimproved rangeland, irrigated pasture, alfalfa, and orchards. Most of the agricultural land is located on the lower one-third of the watershed, downstream of the Lassen National Forest boundary. Most of this area is private land used for livestock production (Jones and Stokes 1994).

Cropland in the watershed area amounts to 5,440 acres or 8.5 percent of the area. This land use is located in the lower third of the watershed near the town of Vina (Holtgrieve, 1997). The total gross value of Tehama County agriculture for 1995 was approximately $ 97,000,000 (Tehama

County, 1996). Orchard crops (e.g., almonds and walnuts) make up the majority of the agricultural value for Tehama County (Tehama County 1996).

Grazing land in the watershed amounts to 6,720 acres or 26 percent of the area. This land use is located in the middle of the watershed, above the town of Vina, but not far into the canyon (Holtgrieve 1997). The lower watershed includes approximately 1,220 acres of irrigated pasture. Most of this irrigated pasture occurs along the south side of the creek between the Cone-Kimball Diversion Dam and Highway 99 (California Department of Water Resources 1994). This acreage represents approximately 5 percent of the total irrigated pasture in Tehama County (Tehama County Department of Agriculture 1993). Irrigated pasture produced an average crop value of $77.50 per acre in 1993 (Tehama County Department of Agriculture 1994). The production value of irrigated pasture within the study area totaled $94,550 in 1993 (Jones and Stokes 1994). In 1981, the average value of one acre of irrigated pastureland in the Sacramento Valley was $2,000. In the same year, the value of non-irrigated pastureland in the Sacramento Valley was $1,000 (Security Pacific Bank 1981). In 1995 the total livestock value for Tehama County was $14,000,000 (Tehama County 1996), accounting for approximately 20 percent of the total agricultural value for Tehama County.

The following table (Table 3-13) indicates the agricultural uses/products of land within the Deer Creek Watershed boundaries. The watershed has been broken into two distinct areas according to the irrigation districts that serve the upper and lower watershed.

Table 3-13. Agricultural Uses/Products of Land within the Deer Creek Watershed Boundaries

Agricultural Use/Product	Deer Creek Irrigation District (acres)	Stanford Vina Irrigation District (acres)
Prunes	120	1,034
Walnuts	550	1,732
Almonds	500	-
Pasture	750	808
Cropland	90	1,037

As required by Section 2279 of the California Food and Agricultural Code, the following report represents the acreage, production, and value of agricultural crops produced in Tehama County in 1996.

The total gross value of Tehama County agriculture for 1996 was $114,977,000, an increase of 14.9 percent from revised 1995 figures. Higher yields, along with relatively good prices for most crops, gave many Tehama County growers a much needed respite from the damaging floods of the last two years. Orchard crops accounted for most of the increase in 1996. Larger almond acreage and yield added $2,000,000 onto the total value. Olives enjoyed an increase of 50 percent in total value due to larger yields and prices. Prune yield nearly doubled, which more than offset a drop in prices; total value increased from $17,615,000 in 1995 to $25,110,000 in 1996. Walnut yield was significantly lower, but higher prices resulted in a total value close to that of 1995.

The watershed includes approximately 18,000 acres of unimproved rangeland, or 2 percent of the total rangeland within Tehama County (Tehama County Department of Agriculture 1994). The average farm-gate value of livestock produced on Tehama County rangeland in 1993 was $7 per acre (Tehama County Department of Agriculture 1993). Rangeland produced livestock in the study area were worth a total of $126,000 in 1993 (Jones and Stokes 1994). Livestock values suffered in the mid-1990s from generally lower inventory and prices. Total value fell over 10 percent, from $14,057,200 in 1995 to $12,547,000 in 1996. Milk and dairy products continued their recent increase from a revised 1995 value of $8,604,500 to $10,755,000 in 1996.

Field crops had generally better yields and prices, rising from $7,523,700 in 1995 to $9,477,600 in 1996. Other crop categories showed little significant change from 1995 (letter, Mark D. Black, Department of Agriculture/Weights and Measures).

Alfalfa and row crops are also grown in the lower portion of the study area on the north and south sides of the creek below the Cone-Kimball Diversion Dam (California Department of Water Resources 1994). Assuming that most of this land is used for alfalfa production, lands within the study area accounted for approximately 8 percent of the total land planted to alfalfa in Tehama County (Tehama County Department of Agriculture 1993). The value of alfalfa raised within the study area totaled approximately $303,000 in 1993 (Jones and Stokes 1994).

Higher value orchard crops are also grown in the study area. These orchards are located on fertile soil downstream of the Cone-Kimball Diversion Dam (California Department of Water Resources 1994). Most of the orchards in the study corridor produce walnuts, prunes, and almonds. Orchards in the study corridor account for approximately 4 percent of the total walnut, prune, and almond acreage in the County. The total value produced by the orchards in the study area was approximately $2.3 million in 1993, making orchards the most valuable crops grown in the study area (Tehama County Department of Agriculture 1994, Jones and Stokes 1994).

A large portion of the private land in the study area is enrolled in agricultural preserves pursuant to the California Land Conservation (Williamson) Act. Enrollment of parcels under Williamson Act contracts restricts the ability of landowners to convert land to nonagricultural uses and thus increases the stability of the area's land use pattern. All study area lands under Williamson Act contract are located in the lower one-third of the study corridor between the Lassen National Forest boundary and the confluence with the Sacramento River (Table 3-12). Much of the land immediately adjacent to the creek is under contract. Most of the contract lands in the corridor are used for grazing. Approximately 2 percent of the total land in Tehama County under contract are located in the study area (California Department of Conservation 1993). Approximately 780 acres near the confluence with the Sacramento River are classified as prime (Tehama County Assessor's Office 1993, Jones and Stokes 1994).

The following is a brief account of those efforts, in Tehama County, which are being made to exclude or eradicate exotic pests and to best manage those which already exist, in a manner most conducive to the protection of our environment (Annual Crop Report, Tehama County, 1996).

Ten noxious weed pests of limited distribution at 20 sites were under eradication by both chemical and mechanical means (Annual Crop Report, Tehama County, 1996). The yellow starthistle continues to be one of the most invasive and noxious weeds in Tehama County. Three different bio-control agents have been released at 31 sites throughout the County. Increases in number and range of population have occurred in the last few years. In addition, bio-control agents have been established for the ash whitefly, Italian thistle, and puncturevine (Annual Crop Report, Tehama County, 1996).

Trapping for Medfly, Orientalf fruit fly, melon fly, Japanese beetle, and gypsy moth was carried out over the warm season with a total of 327 traps being deployed: no finds of these exotic pests were made in Tehama County (Annual Crop Report, Tehama County, 1996).

There were 20 registered organic growers in Tehama County in 1996, consisting of both local Farmer's Market producers and large-scale orchard and field crop growers (Annual Crop Report, Tehama County, 1996).

RESIDENTIAL DEVELOPMENT

Most residential and urban uses of the study area occur in the lower 4 miles. Residential, urban, and suburban land uses account for approximately 3,328 acres within the watershed. Most of the residential and urban uses occur at the small community of Vina between the Highway 99 crossing and the confluence with the Sacramento River. Home sites and recreation developments are located along Highway 36 near Deer Creek Meadows. Deer Creek does not flow through any major urban areas (Jones and Stokes 1994).

Based on Tehama County land use designations, Table 3-14 indicates the number of potential lots with one home on each. However, the calculations are based on property lines rather than the physiologic boundary of the watershed and are, therefore, not precisely comparable to the areas delineated by the Conservancy's Geographic Information System.

Table 3-14. Potential Lot-Splits

Land Use Designation	Total Acres	Minimum Acres for Split	Potential New Lots
Cropland	5,440	40	136.0
Grazing	16,720	160	104.5
Timber	14,720	160	92.0

Under the "worst case" scenario, the addition of 332 homes would increase the population of the area and would potentially create significant impacts on water quality, soil, erodibility, and demand for ground and surface water. Impacts on fish and wildlife could also be potentially significant. A complete environmental impact analysis would have to be conducted if this kind of parcel splitting process were to be approved as County policy.

HIGHWAYS AND ROADS

Several State Highways traverse the watershed. Highway 36 and Highway 32 access the upper watershed area. Highway 99 crosses the lower end of the watershed near the town of Vina. Ponderosa Way is a native surface forest road that crosses the watershed at the approximate boundary between the foothill zone and the forested upper watershed. Originally built as a depression-era public works project, the purpose of the road was to provide access and conrol points for fire suppression. An extensive network of roads totaling over 450 miles access the upper slopes for timber harvesting purposes.

Major changes to Routes 32, 36, and 99 are not planned for at least the next decade. Minor curve realignments and widening in those curves on Route 32 will be done within a year or two. A passing lane may be added on Route 32 from time-to-time. The Route 99 structure crossing Deer Creek is expected to be replaced in 1999 due to scour problems with the existing bridge. At that site, the property owner, in cooperation with Caltrans, restricted public access to Deer Creek to help prevent wheeled vehicles from damaging the creek bed or adjacent private property (Brockett, B.E. 1997).

Roadless areas occur in the Cub Creek tributary, Polk Springs area, and the Ishi Wilderness.

WATER RESOURCES DEVELOPMENT

Compared to most California watersheds, Deer Creek's water resources are relatively undeveloped. A Federally licensed 15 kilowatt hydroelectric project is located on one of the source springs of Deer Creek near Fire Mountain. The project (FERC Lic. #1992) is up for relicensing in 2010. Three significant irrigation diversion dams are located on lower Deer Creek in the Sacramento Valley. Flood control levees are located along the lower creek banks. But no large dams and reservoirs were established on Deer Creek, unlike most other large streams and rivers in California.

Nevertheless, Deer Creek has not escaped the past scrutiny of public and private dam builders. The California Water Plan included a series of reservoirs and diversions on Deer and Mill Creeks intended to provide local water supplies (DWR 1957). The plan included a relatively large reservoir site at Deer Creek Meadow and a smaller diversion dam and reservoir near Wilson Cove. A subsequent state analysis of potential hydroelectric development sites in California identified dam and diversion sites at Deer Creek Meadows, Wilson Cove, and Ishi Caves (DWR 1974). A national preliminary inventory of hydro resources listed six potential hydro sites on Deer Creek (USACE 1979). During the highly speculative small hydro boom of the early 1980's, at least three preliminary permits were filed with FERC to study potential hydro projects on Deer Creek (DWR 1981, 1982).

Poor economics probably played a key role in discouraging any major water supply or hydroelectric development of Deer Creek. In recognizing the potential of eventually loosing the free flowing character and outstanding values of the Deer Creek Watershed to water resource development, the California Legislature and the Governor approved a bill in 1995 that was initiated by DCWC. This bill prohibits State approval or permits to construct any new dams on Deer Creek from its source in the upper watershed to where the creek flows out of the foothills into the Sacramento Valley.

RECREATION USES/DEVELOPMENT

All publicly owned lands in the study area are open to the public for recreation uses (e.g., swimming, wading, picnicking, camping, hiking, and fishing). Hunting is permitted on all public lands except for land in State Wildlife Refuge 1G. This refuge was created in the 1930s to provide a wildlife migration corridor (Stone pers. comm). Off-road vehicle use is allowed on designated routes throughout Lassen National Forest, except for lands in the Ishi Wilderness. Additional information on recreation uses in the study area is presented in Chapter 2G, "Recreational Resources" (Jones and Stokes 1994).

Private lands are typically closed to the general public. The private landowners support recreational use by the families and friends.

WILDERNESS AND WILDERNESS MANAGEMENT

Deer Creek flows through the 41,000 acre Ishi Wilderness, which was established by Congress in 1984. In designating the Ishi Wilderness, Congress recognized the unique salmon fishery, wildlife habitat, cultural values, scenic quality, and cultural resources of the area. The Forest Service has been developing a Wilderness Implementation Plan to guide management activities and protect natural values of the Ishi Wilderness. The plan has not been released for public review by the latest scheduled completion date of June 1997 (USDA 1997).

A wilderness, in contrast with those areas where man and his own works dominate the landscape, is recognized as an area where the earth and its community of life are untrammeled by man, where man himself is a visitor who does not remain (Wilderness Society 1970). The most commonly recognized human use of wilderness is for primitive recreation. Motorized and mechanical vehicles are prohibited. No significant permanent structures are allowed. Grazing, hunting, and even mining are allowed, as long as these activities do not impact wilderness values. Wilderness areas are also considered important biotic reserves.

When Congress established the Ishi Wilderness in 1984, they instructed USFS to study for potential acreage to the wilderness 20,000 acres of adjacent roadless land in the Sulphur Creek sub-drainage of Deer Creek and in the Antelope Creek Watershed to the north of Mill Creek (the Ishi B roadless area). The Forest Service subsequently completed its study in 1992 and did not recommend the addition of the Ishi B area to the wilderness. However, most of the Ishi B area was allocated to semi-primitive recreation management by the agency (USDA 1992). The potential to add these lands to the Ishi Wilderness will be considered again when the forest plan is updated and revised.

The upper watershed encompasses other inventoried roadless areas that could be considered for future wilderness designation, including the 8,300 acre Butt Mountain roadless area, the 8,875 acre Cub Creek roadless area, and the 9,728 acre Polk Springs roadless area. None of the roadless areas were recommended by the Forest Service for wilderness designation in the forest plan, although most of the Polk Springs area was allocated to semi-primitive non-motorized recreation (USDA 1992). The remaining roadless lands were primarily allocated to various levels of timber management. Areas still retaining their roadless character may be reconsidered for potential wilderness status when the forest plan is updated and revised.

WILD AND SCENIC RIVER STATUS

The National Wild & Scenic Rivers Act requires federal agencies to consider the potential of adding rivers and streams flowing through federally managed public lands to the National Wild & Scenic Rivers System. Federal approval or permits for new dams are prohibited on designated National Wild & Scenic Rivers. Federal agencies are required to manage the public lands along a designated river corridor with an average width of 320 acres per mile to protect its free flowing character and it's outstanding values. Designated segments are also classified and managed as wild, scenic, or recreational according to the level of existing development.

The Forest Service studied Deer Creek for its National Wild & Scenic River potential as part of its forest planning process that began in 1979. The agency's conclusion was to recommend to Congress that thirty miles of Deer Creek from the Elam Creek campground to the western boundary of the Lassen National Forest be added to the National System (USDA 1992).

The outstanding values that make Deer Creek eligible for federal protection include its anadromous and catchable trout fishery, wildlife habitat, cultural values, and scenic values. Forest Service guidelines require the protection of the creek's free flowing character and outstanding values is required on an interim basis until Congress acts on the agency recommendation. If designated by Congress, protection of the creek's free flowing character and outstanding values will become a legislative mandate.

As part of its land and resource planning process, the Bureau of Land Management (BLM) studied lower Deer Creek for its Wild & Scenic potential. Despite limited public lands, 8.2 miles of Deer Creek west of the National Forest boundary were determined eligible for National Wild & Scenic River status by the BLM in recognition of the segment's outstanding visual quality and white-water recreation (USDI 1992). BLM guidelines require the agency to provide interim protection for these outstanding values on public lands until the agency completes its suitability study and makes a recommendation to Congress.

California has a Wild & Scenic Rivers System somewhat similar to the National System. In contrast to the National System, state Wild & Scenic status prohibits state approval or permits for new dams, but this state authority does not necessarily apply to federal dam projects. The protective designation also only applies to the first line of riparian vegetation.

In response to state legislation passed in 1993, the Resources Agency contracted with the consulting firm of Jones and Stokes to study the potential of adding Deer Creek to the California Wild & Scenic River System (Jones & Stokes 1994). Jones & Stokes found the creek to possess extraordinary fishery, recreational, scenic, cultural, scientific, ecological, and educational values and recommended its inclusion in the California System.

Local public concern over the state Wild & Scenic study and the potential for federal legislation implementing the Forest Service recommendation for National designation, contributed to the formation of the Deer Creek Watershed Conservancy and the initiation of a watershed management strategy process. This report is an initial component of that process. In response to this process, the Resources Secretary deferred action on the state Wild & Scenic recommendation pending completion of the strategy. Similarly, federal legislation to add Deer Creek to the National System was put on hold by the local Representative in Congress pending completion of a strategy that provides protection that is "functionally equivalent" to National designation. A major component of the watershed management strategy process has already been successfully completed by the Deer Creek Watershed Conservancy. Their first action was to draft and initiate legislation to preclude all future dams, reservoirs, diversions, and other water impoundment facilities on Deer Creek from the headwaters to the U.S. Geological Survey gauging station. This bill (AB1413) became law on July 22, 1995.

Proposed Wild and Scenic River Designation

Thirty-miles of the Deer Creek Watershed, from the Elam Creek campground to the western boundary of the Lassen National Forest, has been recommended for National Wild & Scenic River designation by the USFS. Two of the values that make Deer Creek eligible for Federal protection include outstanding visual quality along Highway 32 and downstream trails, as well as its catchable trout fishery upstream of Deer Creek Falls. A primary emphasis of the Wild & Scenic River recommendation is to protect the free flowing character and outstanding values of the creek and adjacent public lands.

Despite limited public lands, 8.2 miles of Deer Creek west of the National Forest boundary have been determined eligible for National Wild & Scenic River status by the BLM in recognition of the segments outstanding visual quality and white-water recreation. BLM guidelines require the agency to provide interim protection for these outstanding values on public lands until the agency completes its suitability study.

SPECIAL MANAGEMENT AREAS

As part of its land and resource planning and management process, the Forest Service considers establishment of special management areas to address specific resource needs in the Deer Creek Watershed.

The Cub Creek Research Natural Area (RNA) was established in the Deer Creek Watershed by the Forest Service in 1981. RNAs are set aside in perpetuity as baselines of natural ecological conditions. The Cub Creek RNA consists of 3,922 acres representing the mixed conifer timber type in the Cascade Range province. No logging is allowed in the area (USDA 1992).

A second RNA in the Deer Creek Watershed - the Graham Pinery - was considered for establishment in the Forest Service planning process. This nomination has since been withdrawn because most of the area burned in the 1990 Campbell fire. The Forest Service is now proposing to replace this area with a more suitable candidate, the Iron Mountain RNA, to represent the Pacific ponderosa pine timber type in the Cascade Range Province. Since both areas are already located in the Ishi Wilderness, the RNA prohibition against logging would be redundant.

Also as part of its planning process, the Forest Service considered designation of special interest areas (SIAs) which include unusual or outstanding botanical, aquatic, scenic, geologic, zoological, paleontological, cultural, or other unique characteristics that merit special attention and management. Approximately 14,108 acres of Deer Creek canyon from Elam Campground to Ponderosa Way qualified for SIA criteria based on outstanding geologic and scenic values, but the area was not designated in the forest plan (USDA 1992). Presumably, designation of Deer Creek canyon as an SIA could be reconsidered in the next forest plan update and revision.

As part of its land and resource planning and management process, the Bureau of Land Management (BLM) designated all of the public land managed by the agency along Deer Creek west of the National Forest boundary as an Area of Critical Environmental Concern (ACEC). ACEC designation is intended to provide special management to protect and prevent irreparable harm to important historic, cultural, or scenic values, fish and wildlife resources and other natural systems or processes. The Deer Creek ACEC is intended specifically to protect outstanding raptor habitat, important whitewater recreation opportunities, and cultural values. The BLM hopes to expand the existing 620 acre ACEC into an area encompassing up to 5,000 acres through land exchanges with willing private landowners (USDI 1992).

Another 1992 forest plan management allocation in the upper watershed is the Cub Creek Research Natural Area (RNA). The Cub Creek RNA was established to protect an outstanding example of mixed conifer forest in an undisturbed sub-watershed that is tributary to Deer Creek.

CONSERVATION EASEMENTS

Conservation easements are legal restrictions landowners voluntarily place on their property that permanently bind the actions of present and future owners of the property. Property ownership is a combination of privileges that allows a landowner to exercise certain rights. Being allowed to cut timber, explore for minerals, dig a ditch and build a house are all examples of a landowner's rights. A conservation easement restricts the landowner's ability to exercise some or all of these rights in order to preserve the natural features of the land, to protect the flora and fauna found on the land or otherwise to meet the conservation needs of the property.

The rights the owner relinquishes and those he or she retains are set forth in a legal document known as a "conservation easement." The easement is transferred to either a qualified conservation organization or a government agency. When the document is properly drawn, signed, and recorded on the land records, the property's current and future owners can no longer exercise the rights relinquished in the conservation easement. Each conservation easement must be specifically designed with a particular piece of property and its unique natural characteristics in mind. The specific rights retained by a landowner or restricted by an easement will vary with each property.

The Nature Conservancy is currently working with willing landowners to place conservation easements on property located within the riparian area of Deer Creek from the Forest Service boundary to the confluence with the Sacramento River. The purpose of these easements are to preserve, protect, enhance, and restore in perpetuity the conservation values of the property including significant habitat for fish, wildlife, and plants on the property. Where the easements involve ranching property, the conservation easement fosters ranching practices on the property that work in harmony with the protection and preservation of the conservation values of the property. Additionally the easements seek to retain the properties' predominantly agricultural condition by preserving and protecting in perpetuity its ranching and grazing values, character, and utility in a manner consistent with the conservation purposes of the conservation easement.

These easements can be acquired by The Nature Conservancy in many ways including donation, which may provide Federal and State income tax benefits, or outright purchase based on the fair market value of the property rights restricted.

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4.0 HYDROLOGY AND WATER RESOURCES

HYDROLOGIC SYSTEM

Hydrology is a geoscience that focuses on the land phase processes of the global hydrologic cycle; the movement of water on and under the land surface. The study of hydrology also includes the physical and chemical processes of water movement and considers the effects of the biological influences on the process. The science of hydrology is an essential basis for the practice of water-resource management. Hydrologic information for the Deer Creek basin includes rainfall, snowfall, and infiltration of precipitation, run-off, and the presence or absence of lakes and ponds within the watershed boundary. Deer Creek drains approximately 208 square miles with an average flow of 317 cubic feet per second (cfs) (Kondolf 1997).

Deer Creek originates just south of Lost Creek Meadows at an elevation of approximately 6,200 feet above mean sea level (MSL). As Deer Creek flows in a southwesterly direction, it is joined by Lost Creek in Upper Deer Creek Meadows; Lost Creek drains Wilson Lake. Gurnsey Creek also enters Deer Creek in Deer Creek Meadows. From these sub-alpine meadows the creek continues in a southwesterly direction into a deeply incised canyon.

The canyon portion of Deer Creek is mostly underlain by the Tuscan Formation of late Pliocene Age. This formation is comprised almost completely of ancient volcanic mudflows. The Tuscan Formation has been capped by "terrace deposits of the Pleistocene Red Bluff Formation" (Ely 1994). As Deer Creek flows through the deeply incised canyon, it continues on in a western direction towards the Sacramento Valley portion of the creek where the gradient flattens. The valley portion of Deer Creek has very rich soils created by deposition from Deer Creek and the Sacramento River.

Fresh water is found to a depth of 1,500 feet below MSL. Below this level, groundwater becomes brackish. The Tuscan Formation is the major water bearing aquifer in the northeastern portion of the Sacramento Valley. Groundwater recharges occur either through deep percolation of streamflow, precipitation, infiltration of agricultural run-off, or subsurface inflow from the Tuscan Formation. The inflow of water into the Sacramento Valley is facilitated by the flexure fractures in the Tuscan rocks created by the Chico Monocline (Ely 1994). In general, ground-water moves from east to west, toward the Sacramento River.

Rainfall

Due to California's Mediterranean climate (cool wet winters and warm dry summers), rainfall for Deer Creek is a seasonal event. Most of the precipitation occurs in the winter and spring months of the year. The mountainous areas of the watershed receive more precipitation than the valley portions. Mean annual precipitation ranges from 70 inches near Wilson Lake (5,272 feet MSL) to about 20 inches near the Sacramento River (175 feet MSL). Figures 4-1 and 4-2 show the average and average annual precipitation for the Deer Creek Watershed (map from CDF data.).

For Chester, California (4,525 feet MSL), precipitation records exist from 1911 to 1997 (Table 4-1). The precipitation measuring station at Mineral, California (4,960 feet MSL) has recorded precipitation data since 1927 (Table 4-2). For both stations, some gaps appear in the record. For the Sacramento Valley portion of the Deer Creek Watershed, the California DWR CIMIS Station at Gerber, California has records for precipitation from 1982 until the present. However, the information for the Gerber Station was not available at the time of preparation for this report.

Table 4-1. NOAA Chester Precipitation Station: Period of Record Water Years 1911 to 1996 (all measurements in inches)

Average	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Water Year
Year	1.90	3.89	5.29	5.90	5.07	4.23	2.18	1.45	0.84	0.25	0.27	0.72	32.00
Percent	6	12	17	18	16	13	7	5	3	<1	<1	2	100

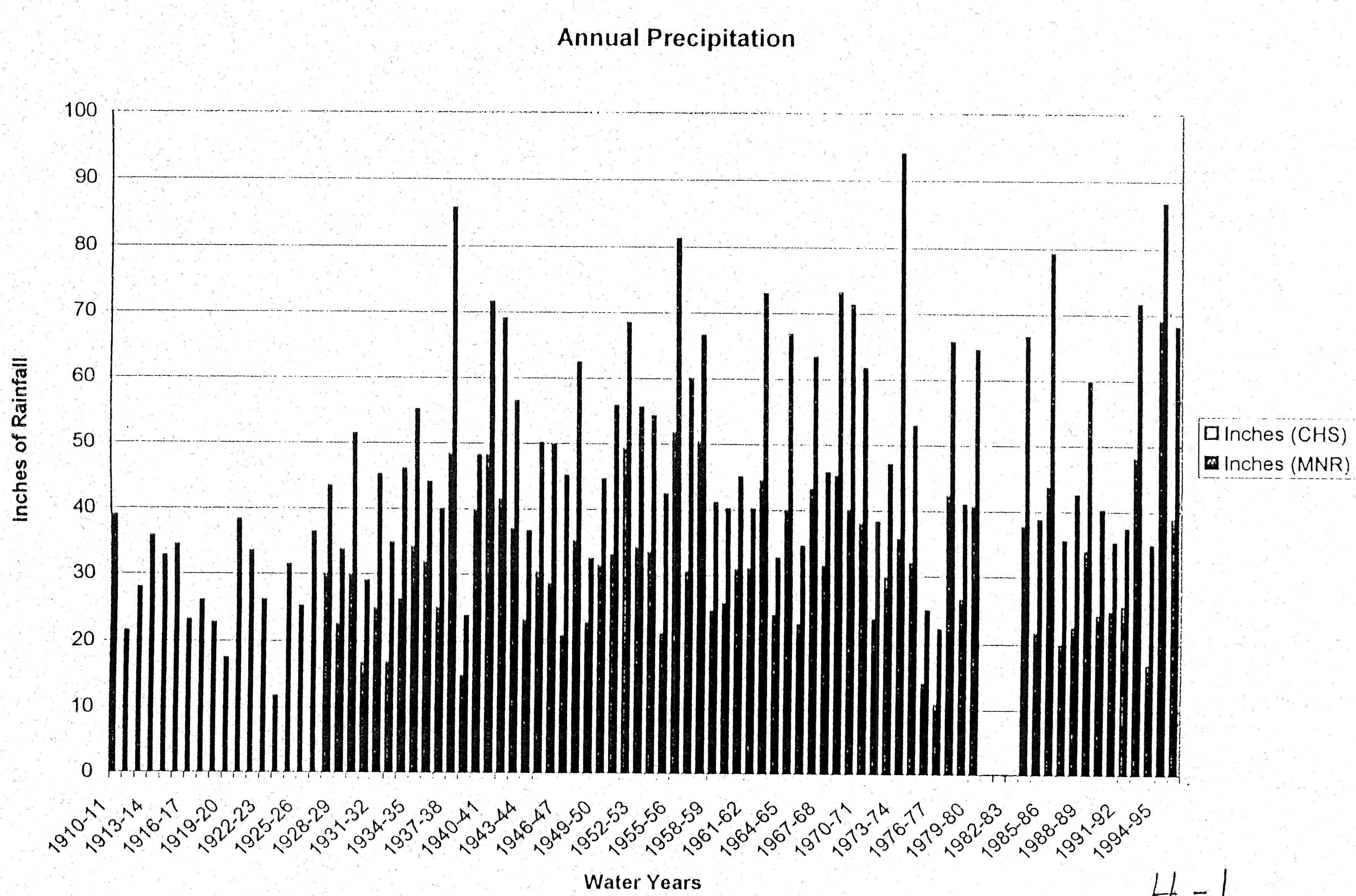
Table 4-2. DWR Mineral Precipitation Station: Period of Record Water Years 1927 to 1996 (all measurements in inches)

Average	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Water Year
Year	2.01	3.73	5.24	6.00	5.24	4.02	2.18	1.46	0.93	0.23	0.28	0.60	31.92
Percent	6	12	16	19	16	13	7	5	3	<1	<1	2	100

Infiltration

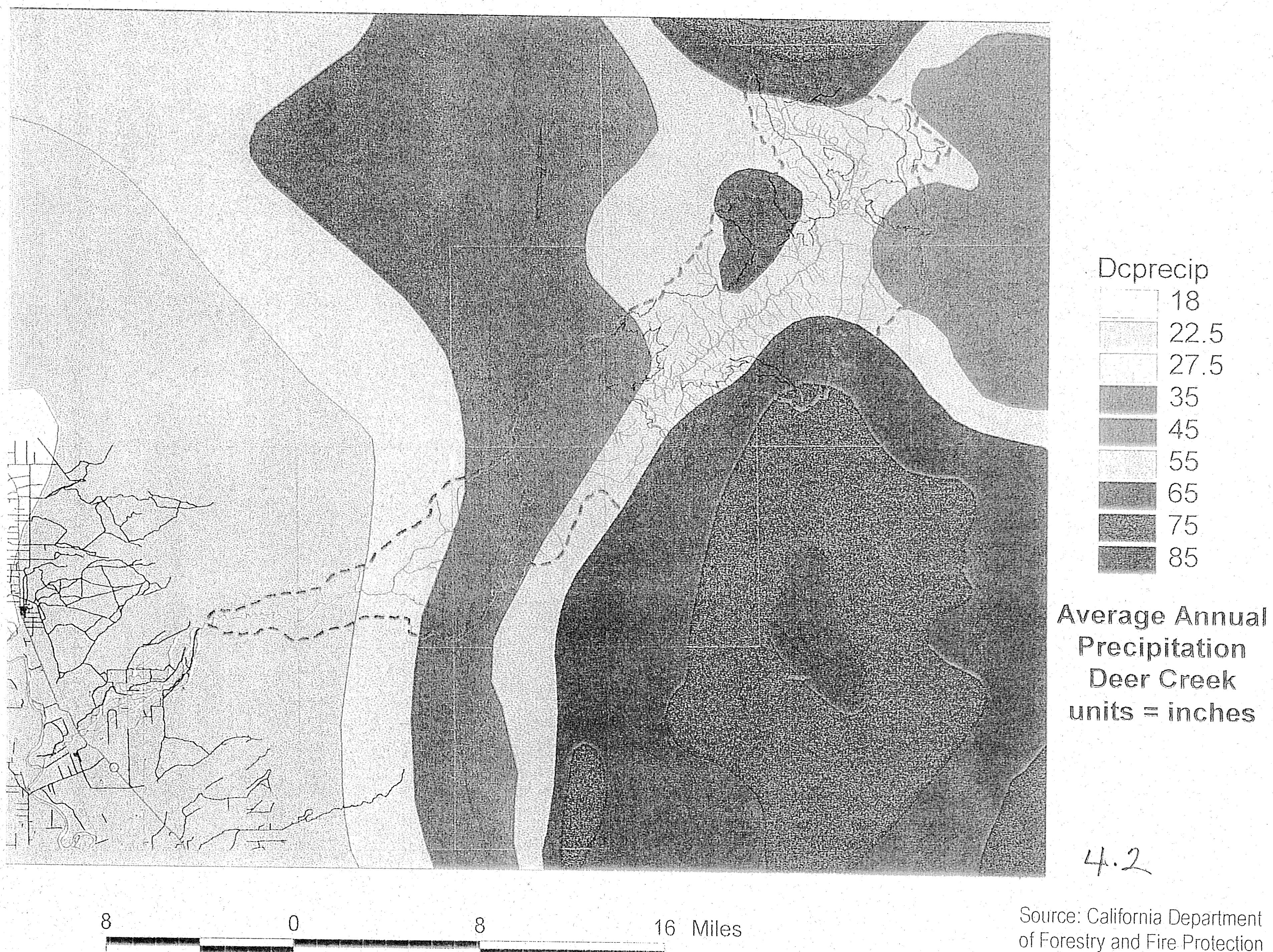
Infiltration is the process by which water arriving at the land surface enters the soil and percolates down through the soil to an impermeable geologic layer or an aquifer. Generally speaking, infiltration rates depend on the magnitude and duration of the rainfall event and the land cover characteristics. Individual soil characteristics and vegetative cover influence infiltration rates over the watershed area. The depth of the soil, the amount of soil saturation, and the distribution and type of vegetation represent factors in developing models that might predict run-off and infiltration rates.

Soil associations for the Deer Creek Watershed include: the Columbia-Vina Association, the Tuscan-Inks Association, the Jiggs-Lyonsville Association, the Toomes-Guenoc Association, and the Windy-Iron Mountain Association. The Toomes-Guenoc and Windy-Iron Mountain associations are both considered shallow soils (Tehama County Soil Survey 1967).



Annual Precipitation
Inches of Rainfall
100
90
80
70
60
50
40
30
20
10
0
1910-11
1913-14
1916-17
1919-20
1922-23
1925-26
1928-29
1931-32
1934-35
1937-38
1940-41
1943-44
1946-47
1949-50
1952-53
1955-56
1958-59
1961-62
1964-65
1967-68
1970-71
1973-74
1976-77
1979-80
1982-83
1985-86
1988-89
1991-92
1994-95
Water Years
Inches (CHS)
Inches (MNR)

4-1



Source: California Department
of Forestry and Fire Protection
Statewide Precipitation Data

Surface Water/Run-off

Stream gages are located at the Stanford-Vina Ranch Irrigation Company Diversion Dam near Vina, Polk Springs, and at a site below Slate Creek. Discharge was measured at Polk Springs from 1929 until 1932. The Slate Creek site recorded discharge from 1929 to 1932 and 1962 to 1970.

There is also a USGS Gage #11383500 in Deer Creek near Vina, California. The period of record for this gage is from October 1911 to September 1915 and March of 1920 to the current year. This gage is located approximately nine miles upstream of the confluence with the Sacramento River (see Figure 4-3). It is near the mouth of the canyon. For some periods of record, there exists only monthly discharge data. There are no storage reservoirs or large diversions upstream of this station. Extremes for the period of record are 23,800 cfs (December 10, 1937) as a maximum flow and 43 cfs as the minimum flow (December 13, 1932).

Table 4-3 lists some summary statistics for surface run-off based on data collected by the USGS Gage near Vina, California.

Table 4-3. Surface Water Run-off Statistics

Summary Statistics	Water Years 1912-1995	Date of Occurrence
Annual Mean	318 cfs	Water Years 1912 to 1995
High Annual Mean	700 cfs	Water Years 1912 to 1995
Low Annual Mean	86.2 cfs	Water Years 1912 to 1995
High Daily Mean	14,300 cfs	12/22/64
Low Daily Mean	52 cfs	8/25/31
Annual 7-day Minimum	53 cfs	8/21/31
Instantaneous Peak Flow	23,800 cfs	12/10/37
Peak Stage	19.2 feet	12/10/37
Average Annual Run-off	230,500 acre feet	Water Years 1912 to 1995
10 Percent Exceedence	675 cfs	Not Applicable
50 Percent Exceedence	144 cfs	Not Applicable
90 Percent Exceedence	78 cfs	Not Applicable

FLOOD HAZARD AND FLOOD CONTROL

Flood Control Improvements and Channelization

The lower reaches of Deer Creek have long been a flooding concern to local property owners and government officials. The publicly-maintained flood control improvements along Deer Creek represent some of the oldest such facilities in Tehama County. They are part of an U.S. Army Corps of Engineers (COE) project constructed during the early 1950's under the 1944 Flood

Control Act, that involved channel clearing, excavation, levee construction in two separate locations, and rock bank protection.

In addition to public flood control facilities, there are numerous examples of private facilities developed by local property owners located between the mouth of the canyon and the confluence of Deer Creek with the Sacramento River.

Authorization. The 1944 Flood Control Act (Public Law No. 534, Seventy-eighth Congress, Second Session, H.R. 4485) authorized construction of levees and channel enlargement of Deer Creek in accordance with recommendations contained in an interim report prepared by the COE. At the time of its completion, this project was considered to form an integral part of the Sacramento River Flood Control Project.

Location. The original Deer Creek Channel Improvement extends a distance of 7.4 miles from a point 0.7 miles above Delaney Slough to its junction with the Sacramento River.

Description of Project Works. The specific project works originally authorized by Congress included the following:

1. The cleared and excavated channel of Deer Creek extending from upstream of Delaney Slough downstream to the Sacramento River.

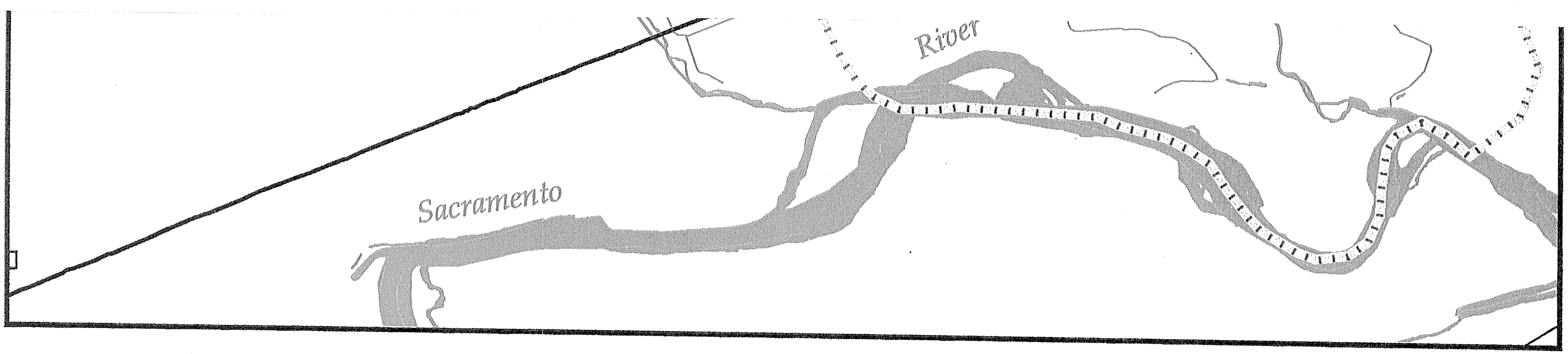
2. Levees on both banks of Deer Creek built along low-lying areas between Delaney Slough and the Sacramento River (see Figure 4-3).

3. Rock bank protection at various places between the Southern Pacific Railroad and the Sacramento River.

4. Levee along the left (south) bank of Deer Creek from Delany Slough upstream 0.7 miles to high ground (see Figure 4-3).

Protection Provided. The original project work was designed to protect the town of Vina and adjacent farm and pasture lands from a flood flow of 21,000 cfs. The original levee design provided for a freeboard of 3 feet during a flood flow of this magnitude.

Transfer and Acceptance of Project Work. The major portion of the Deer Creek levee and channel work was accepted by the County of Tehama in 1953. The left (south) bank levee of Deer Creek from Delany Slough upstream 0.7 miles was transferred to the jurisdiction of the State Reclamation Board in 1956.


Sacramento
River

Levee and Channel Maintenance Activities

In March 1957, the Sacramento District of the COE prepared an Operation and Maintenance Manual for the on-going maintenance of levees and channel improvements constructed along Deer Creek. Regulations regarding levee inspection, maintenance, and operation are found in paragraphs 4-02c, d, and e of this manual.

Since 1964, the Deer Creek levee system has been maintained by the County of Tehama and/or the Tehama County Flood Control and Water Conservation District. In recent years, routine maintenance has been guided by directives resulting from annual inspection reports generated by the DWR. Routine maintenance generally consists of vegetation control on the levees, access road repairs, minor repairs to bank protection features, and drain pipe cleaning.

Maintenance activities within the stream channel are based on Federal Flood Control Regulations paragraph 208.10 that require that any adverse conditions disclosed by inspection be remedied immediately.

Tehama County is responsible for maintenance of the levees and the Reclamation Board associated with the California DWR is responsible for maintaining channel capacity.

Deer Creek Sand and Gravel Removal Project. In 1984 the DWR began the Deer Creek Sand and Gravel Removal Project (Table 4-4). This project involved the removal of gravel from the creek and the modification of the creek bed itself. Unfortunately the first year implementation of this project created problems for the anadromous fish which spawn in Deer Creek. Starting in 1985, the project aimed to remove sands and gravel which impaired the flood capacity while mitigating for potential impacts to anadromous fish that spawn in lower Deer Creek. From 1985 until 1987, DWR's Northern District provided the planning and field inspection portion of the project.

Historic Flood Damage

Table 4-5 presents a summary of the damage which has occurred to the Deer Creek channel, banks, and levees as a result of flood flows and the repairs undertaken to restore the integrity of the flood control project.

Description of Other Flood Control Projects

Soske Ranch. Approximately 1/2 mile upstream of the south project levee east of Leininger Road is a rock groin originally constructed by the Tehama County Flood Control & Water Conservation District in 1970. This action was directed by the District Board of Directors after concern was raised by Mr. Joshua Soske, Jr., owner of the Soske Ranch.

Table 4-4. Deer Creek Sand and Gravel Removal Project

Year	Activities
1984	Project initiated. Approximately 60,000 cubic yards of bed material removed. This material was primarily stream gravel, removed from the immediate vicinity of Highway 99 to the Sacramento River. Material was then deposited in spoil areas along lower Deer Creek. The project resulted in significant negative impacts to salmon passage in lower Deer Creek in the fall of 1984.
1985	Phase II of this project began in the summer of 1985. The low flow channel in lower Deer Creek was re-excavated to alleviate the shallow, braided, low-flow conditions created by the prior removal of sediments. An eroding levee downstream of the Leininger Road Bridge was reinforced. Several permanent survey cross sections were established.
1986	Deer Creek experienced high flows during the month of February 1986. Phase III of the project was completed in the fall of 1986. This phase of the project focused on the area between Highway 99 and the Stanford-Vina Dam. A total of 45,000 cubic yards of material was removed from the main streambed. A rock weir was constructed downstream of the dam. Habitat improvement was done at the recommendation of the California DFG. The COE replaced a failed levee downstream of Leininger Road with a setback levee.
1987	Phase IV of the project, which was completed in the fall of 1987, concentrated on the area between the Stanford-Vina Dam and Leininger Road. A total of 30,000 cubic yards of material was excavated from this reach of stream. A substantial amount of material was removed from the gravel bar adjacent to the COE's newly constructed levee. At the request of DFG, several measures to keep salmon habitat intact were taken. An additional, 8,000 cubic yards of material was removed downstream.

Table 4-5. Summary of Flood Damage Occurring Within the Deer Creek Watershed

Date	Comments
December 1964	Major replacements and repairs undertaken. Left (south) Bank, 1,000 feet downstream of Highway 99E: 400 feet levee destroyed. Left Bank, downstream of Southern Pacific Railroad: 300 feet levee damage. Damage east of Leininger Road at two locations and at monastery. Called the "worst flood disaster in Tehama County History."[1]
February 1969	Erosion along right (north) bank, west of Leininger Road.
January 1970	Stanford-Vina Main Diversion Dam, Cone Dam, and Kimball Dam damaged by floodwaters.
September 1971	Flood Control Board funded repairs to Soske Ranch groin in Deer Creek.
January 1974	Damaged riprap on left (south) bank, downstream from the Southern Pacific Railroad. A 100 foot section of levee erosion and riprap loss 1/4 mile south of Red Bridge on left bank.
March 1983	Damage to private levees/streambank at Abbey of New Clairvaux, Rumiano, Ramsey, and Soske properties. A 700 foot breach, left (south) bank, west of Leininger Road. (Levee was set back 80 feet from the original alignment, per COE.) 100 foot erosion, left bank, east of Highway 99. A 350 foot breach, left bank, west of Highway 99. 300 foot erosion, right (north) bank, west of Red Bridge.
February 1986	Extensive damage between Leininger Road and Highway 99E. Site A: South Levee 1,500 feet downstream from Leininger Road - 800 lineal feet levee breached. Site B: East of Highway 99 bridge – 100 foot levee washout. Site C: 300 feet west of Highway 99E, 200 feet of levee washout. Site D: 1,800 feet west of Leininger Road, north Bank. 300 lineal feet of bank protection lost.
January 1997	Extensive damages between Leininger Road and Southern Pacific Railroad. Bank protection damaged upstream of Leininger Road, 1500 foot breach in south levee downstream of Leininger Road; 200 foot breach in bank opposite. 300 foot bank protection damage along north bank, immediately downstream from primary breach. Additional breaches immediately upstream and downstream of Highway 99E. 800 feet of the secondary levee overtopped west of Highway 99E. These flood damages cost the County of Tehama approximately $570,000,000.

[1] "Statement to California Water Commission by TCFCWCD", February 10, 1965.

This groin was placed to protect a section of private levee varying in height from 4 to 6 feet just south of the creek bank. No maintenance agreement was developed for this facility, save for a right-of-entry agreement that expired in 1979.

Rumiano Ranch. The Deer Creek frontage along this property has a long history of bank erosion problems. This ranch is located west of Highway 99E, on the north bank of Deer Creek, directly across from the monastery. Alternating sections of the north bank are armored with rock revetment. Since the erosion on this property does not affect the project levees or the rock bank protection on Deer Creek, DWR, and the Flood Control District are not required to stabilize the banks on this property.

Cobb Ranch. The Cobb Ranch participated in a cost-share with the Tehama County Flood Control and Water Conservation District in 1973 to fill and grade with cobbles approximately 500 lineal feet of eroding bank on Deer Creek. This site is located approximately 10 miles east of Vina, on the south side of Deer Creek, 600 feet upstream of the Central Valley Project pole line.

The Abbey of New Clairvaux. The abbey frontage on the south bank of Deer Creek has historically been subjected to considerable bank erosion. This erosion has been attributed to the buildup of sand and gravel in the main channel, which forces streamflow into the south bank, immediately downstream from where the stream begins to veer to the southwest. It appears that DWR addressed this problem in the 1960's and 1970's through channel clearance operations. One operation, conducted in 1966, cleared gravel bars and vegetation along 1,300 lineal feet of channel.

Flood Management Policy for the Deer Creek Basin

Presently, flood management policy for the Deer Creek Watershed is in the form of non-specific County and FEMA guidelines.

FEMA maps indicate a classification of Zone A for areas along Deer Creek in the lower watershed from about 2 miles northeast of the Stanford-Vina Irrigation Diversion Dam to the Sacramento River. FEMA defines Zone A as areas of 100-year flood, where base flood elevations and flood hazard factors have not been determined.

WATER RESOURCES DEVELOPMENT

The water in Deer Creek has been used by humans for millennia. During the nineteenth century, Deer Creek was utilized as a resource for the development of grazing, timber, and agricultural activities. Water from the creek was diverted for agriculture and other uses. This created hazards for the anadromous fish which use the creek to migrate upstream to their spawning grounds. In the first 20 years of this century, significant surface water diversions were installed in lower Deer Creek to divert 100 percent of the annual flow for agricultural and other uses.

SURFACE DIVERSIONS AND DIVERSION STRUCTURES

There are three major diversions on lower Deer Creek: the Stanford-Vina Ranch Diversion Dam (located in Section 1, T24N, R2W), the Cone-Kimball Diversion Dam (Section 33, T25N, R1W), and the Deer Creek Irrigation Company Dam (Section 23, T25N, R1W).

Two of these diversions supply water to the SVRIC; the Cone-Kimball Diversion Dam and the Stanford-Vina Ranch Diversion Dam. The Stanford-Vina Ranch Diversion Dam is the largest of these diversions, diverting water through two distribution canals to the north and south of the creek, respectively. The North Main Diversion Canal diverts approximately 20 cfs to the most northern part of the SVRIC service area. The South Main Diversion Canal diverts about 50 cfs. The SVRIC currently consists of about 4,417 acres of irrigated orchards, row crops, and irrigated pasture. Average diversion for Cone-Kimball is 5 cfs or 10 acre feet per day. This diversion serves 351 acres of pastureland north of Deer Creek and areas outside of the SVRIC service area.

The Deer Creek Irrigation District (DCID) provides water to 1,785 acres of primarily almond and walnut orchards. The average diversion for the Deer Creek Irrigation Company Dam is 29 cfs during the month of June.

The Deer Creek Watershed Conservancy initiated and authored the recently enacted legislation AB-1413. This bill was co-sponsored by then Assemblyman Byron Sher, Assemblyman Bernie Richter, and signed by Governor Pete Wilson in 1995. This legislation provides protection for Deer Creek to the extent that State approval or permits may be required for the construction of new dams. It is unclear whether State law would successfully prohibit the construction of a Federal water supply project on Deer Creek.

Surface Water Rights

The SVRIC was established around 1918 and was granted water rights by the State Water Commission to divert 15 cfs from Deer Creek for agricultural purposes. DCID was established around 1923. In 1923, the Tehama County Superior Court decreed 100 percent of the water in Deer Creek to be split between SVRIC and DCID at 65 percent and 35 percent, respectively. In 1926, changes were made to this original agreement which allowed for an additional 180 acres of riparian rights north of Deer Creek to be included in SVRIC's portion of the split. This made their portion of the water in the creek equivalent to 66.7 percent of the entire flow in Deer Creek, while DCID received 33.3 percent of the entire flow.

GROUNDWATER USE

From its point of origin high in Lassen National Forest, Deer Creek flows over volcanic rocks to where it emerges from a steep sided, dissected canyon and empties into the Sacramento Valley. On the valley floor, Deer Creek flows about 12 miles over andesitic gravels where it infiltrates and contributes to valley groundwater recharge. Groundwater resources include the Tuscan

Formation, a sequence of interbedded siltstones, lahars, sandstones, and conglomerates. Permeability is dependent on geologic layers. Many wells drilled within the area report large thicknesses of cobbles, which result in high groundwater yields.

No water level data or aquifer testing has been collected for this region. Groundwater supply has been estimated based on well driller's reports and land owner information. Estimates of groundwater supply also rely upon the capacity of known wells. Not every well within the region has been documented.

Within the area of the DCID and SVRIC, many farms pump groundwater during times of drought, low flows, and for scheduled irrigation needs. Capacity information on several wells was collected for a study which proposes using groundwater to supplement irrigation water to aid the fish in their spawning migration (Hartzell 1994). This study indicated that substantial quantities of groundwater may be available to be developed for this purpose.

The Tehama County Flood Control and Water Conservation District Coordinated AB 3030 Groundwater Management Plan (Modified Draft, 11/20/96) contains detailed information on the geologic structure and flow regime of groundwater basins within Tehama County.

This management plan, commonly referred to as AB 3030, is a relatively recent program granting local public agencies a legal framework to develop groundwater management programs in their communities. AB 3030 plans are voluntary and the details of each plan are left to the local agencies and communities. When AB 3030 was first adopted, it was hailed as a major step towards effective groundwater management. In some areas it has been the perfect tool to build consensus that will lead towards successful basin management. In other areas, lack of consensus has made implementation more difficult. Ultimately, a successful AB 3030 plan will, as any other groundwater management program will, turn on a technical understanding of the groundwater resource. The plan may also include a variety of management tools, including extensive basin monitoring and data collection efforts, pump charges, and restrictions on extraction when absolutely necessary" (AB 3030).

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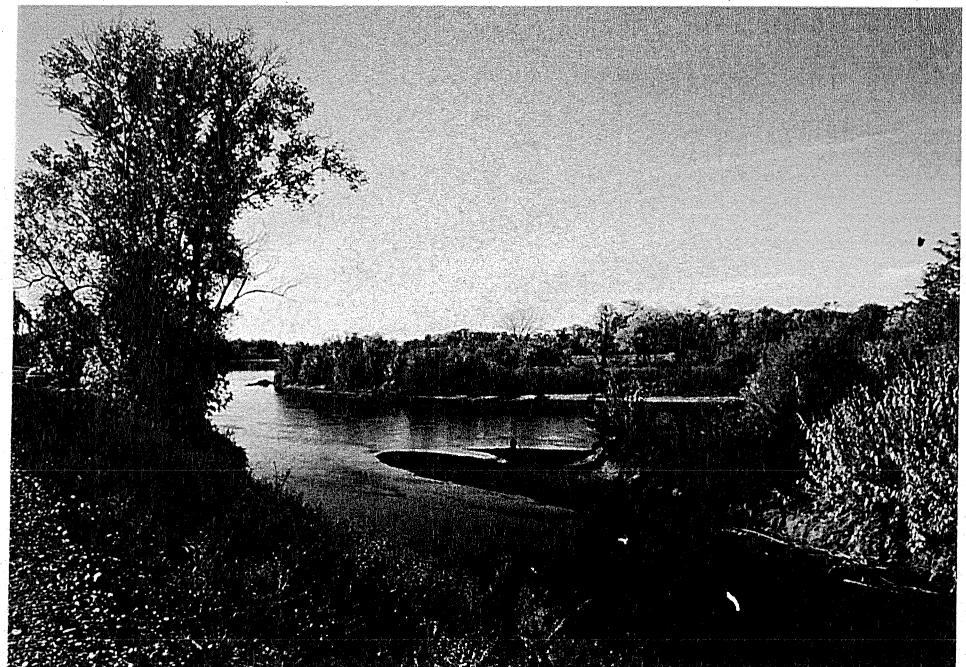


Photo 4-1. Confluence of Deer Creek and the Sacramento River (looking west from the south bank of Deer Creek). (Photo by J. Stanley, November 1996)

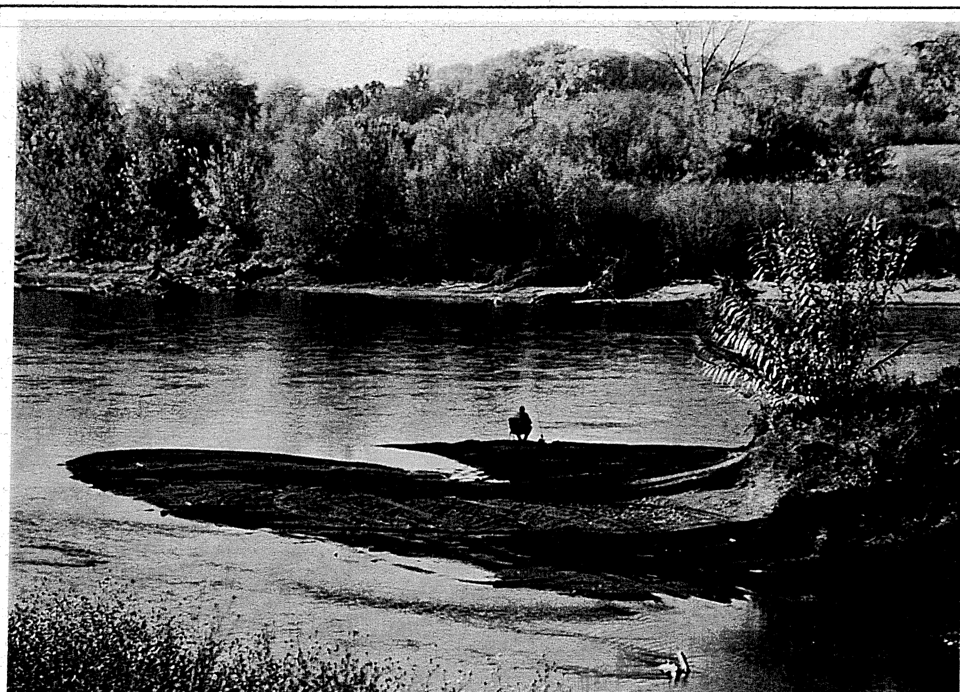


Photo 4-2. Fisherman seated at the mouth of Deer Creek (note vehicle tire tracks on gravel bar at river mouth). (Photo by J. Stanley, November 1996)

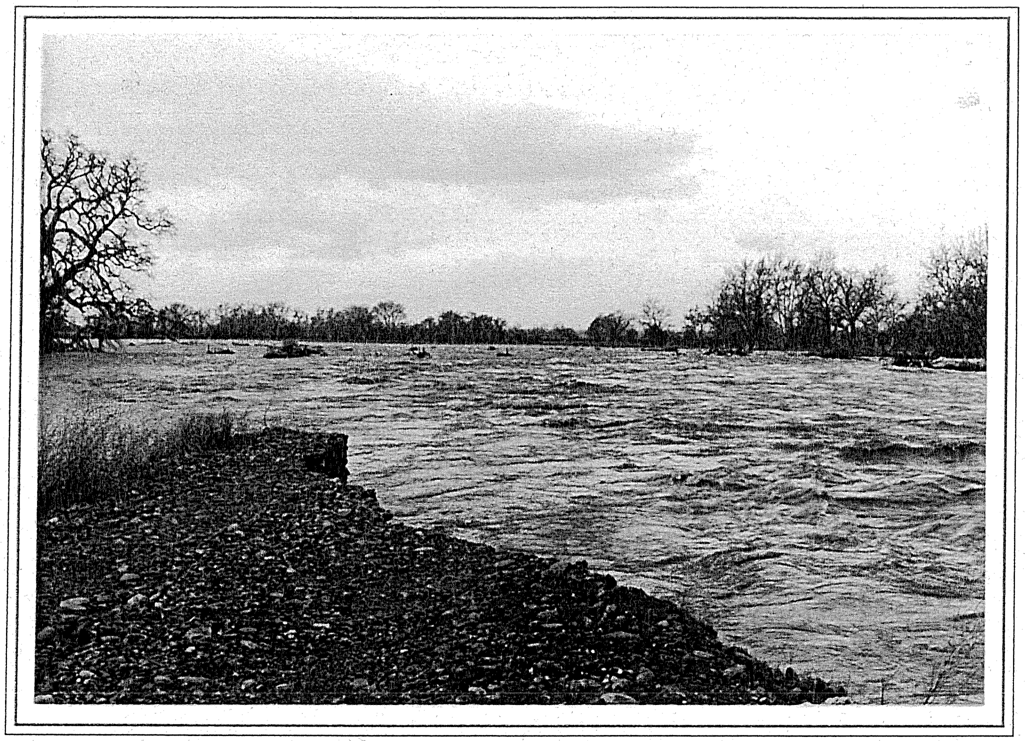


Photo 4-3. Flood waters of 1986 viewed from on top of south levee looking downstream across levee break. (Photo by S. Cepello, 1986)

Photo 4-4. Flooded pasture adjacent to Deer Creek. (Photo by S. Cepello, 1986)

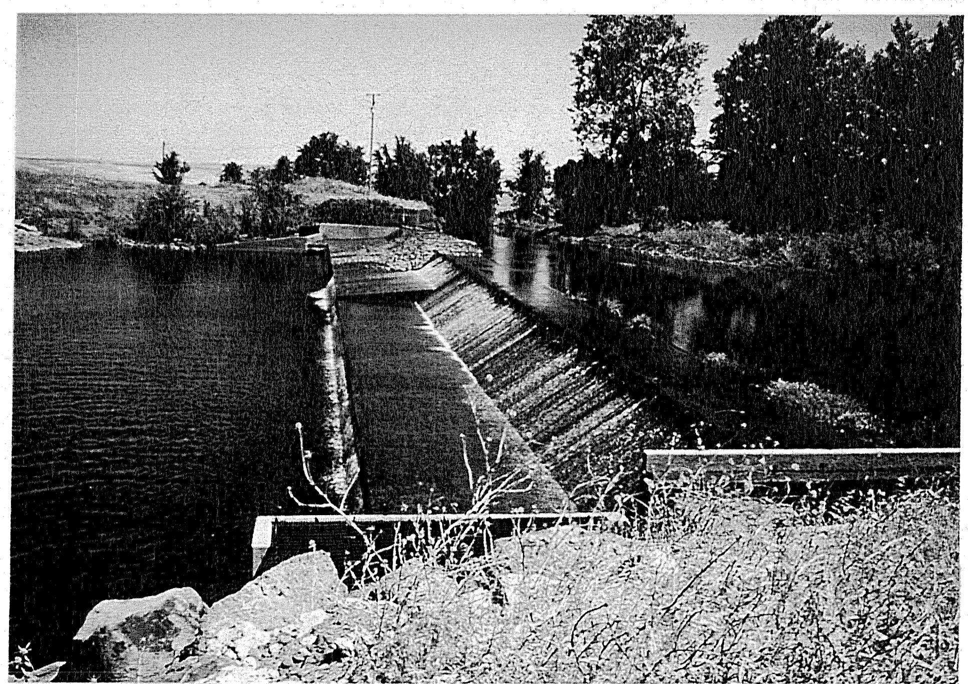


Photo 4-6. Stanford-Vina Ranch Irrigation Dam viewed from south bank of Deer Creek. Note fish ladders at both ends. (Photo by S. Cepello, 1987)

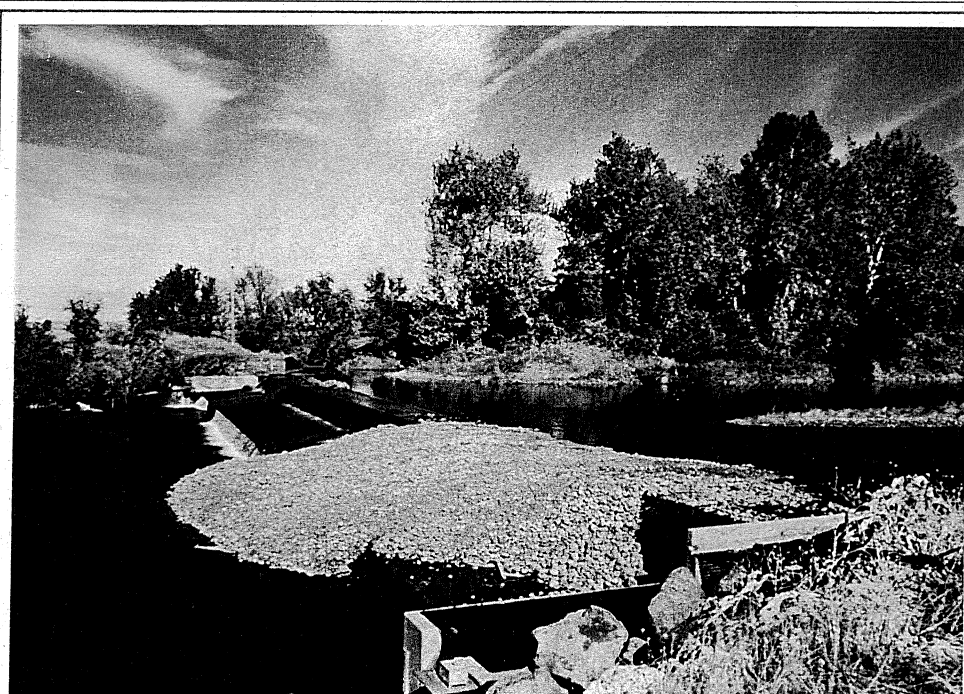


Photo 4-7. Gravel deposited on apron of Stanford-Vina Ranch Irrigation Dam. Looking north from south bank. (Photo by J. Stanley, November 1996)

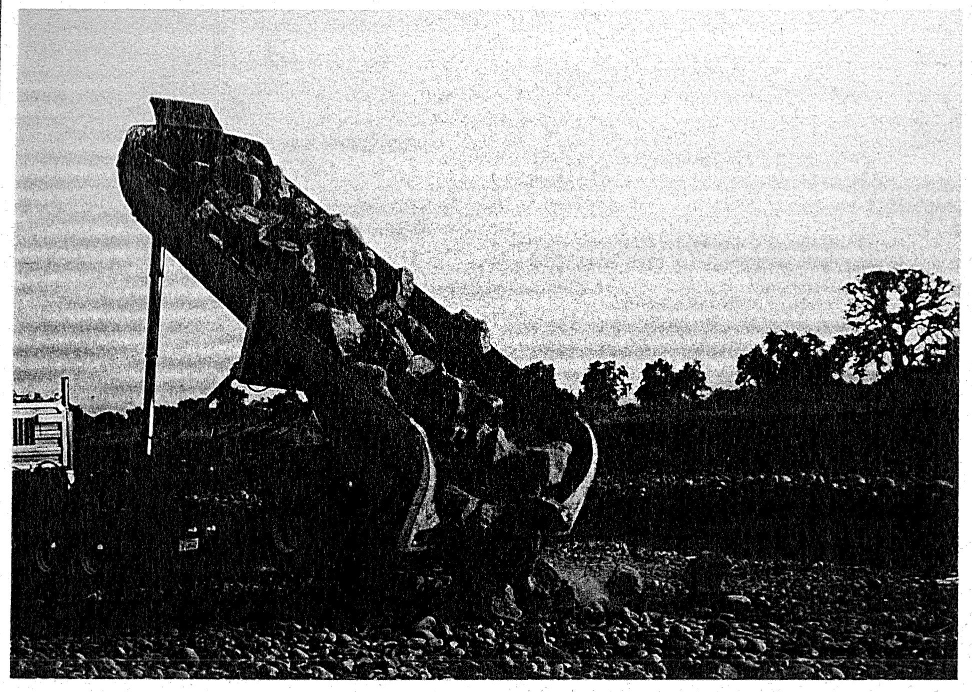


Photo 4-8. Construction of rock weir below the Stanford-Vina Ranch Dam to stabilize pool elevation for fish ladder operation. (Photo by S. Cepello, Summer 1987)

Photo 4-9. Completed and buried rock weir downstream of Stanford-Vina Ranch Dam. (Photo by S. Cepello, Summer 1987)

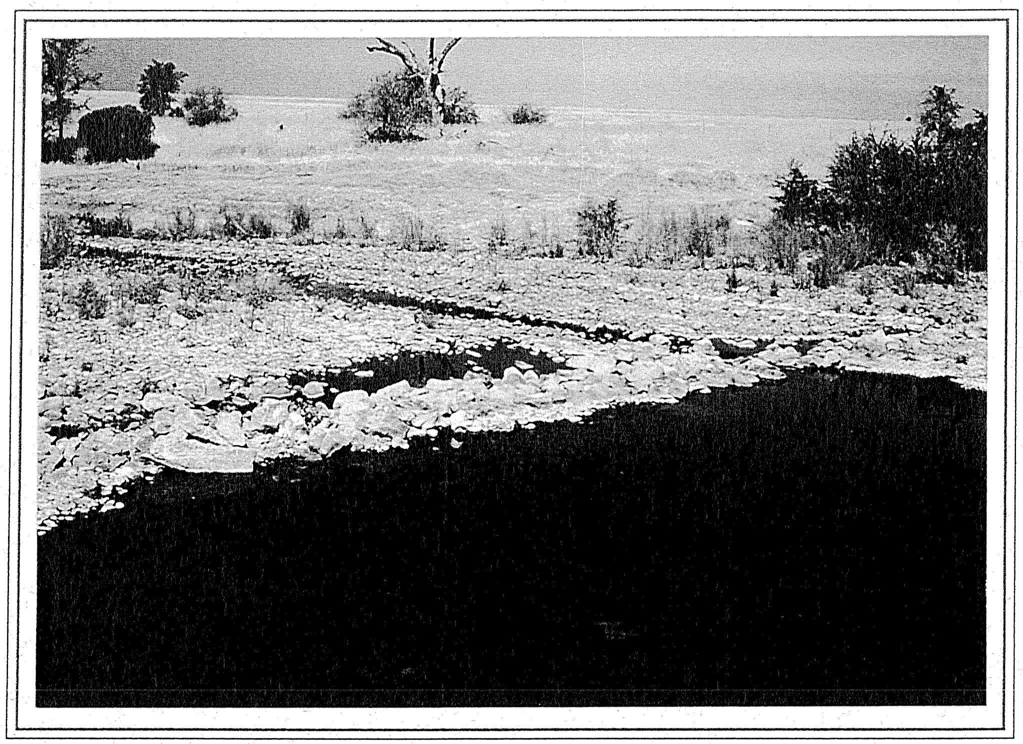


Photo 4-10. Rock weir below Stanford-Vina Ranch Dam still intact after major flows (large quarry rock was keyed in 10+ feet into the stream channel). (Photo by S. Cepello)

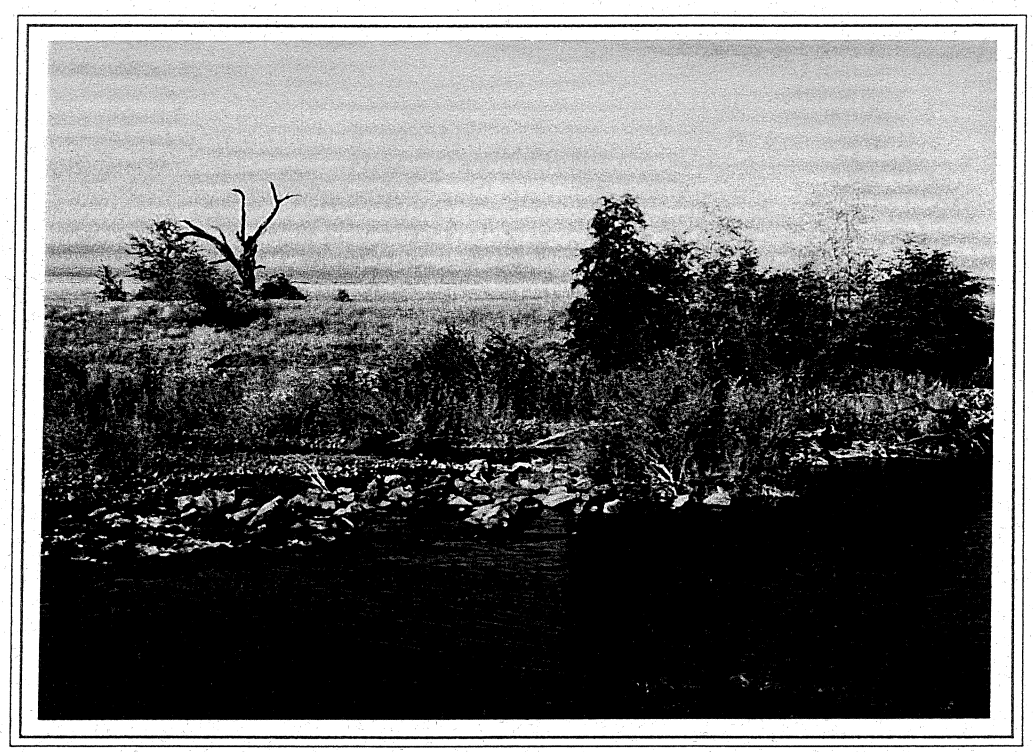


Photo 4-11. View of rock weir and pool below Stanford-Vina Dam, 10 years after construction. (Photo by J. Stanley, November 1996)

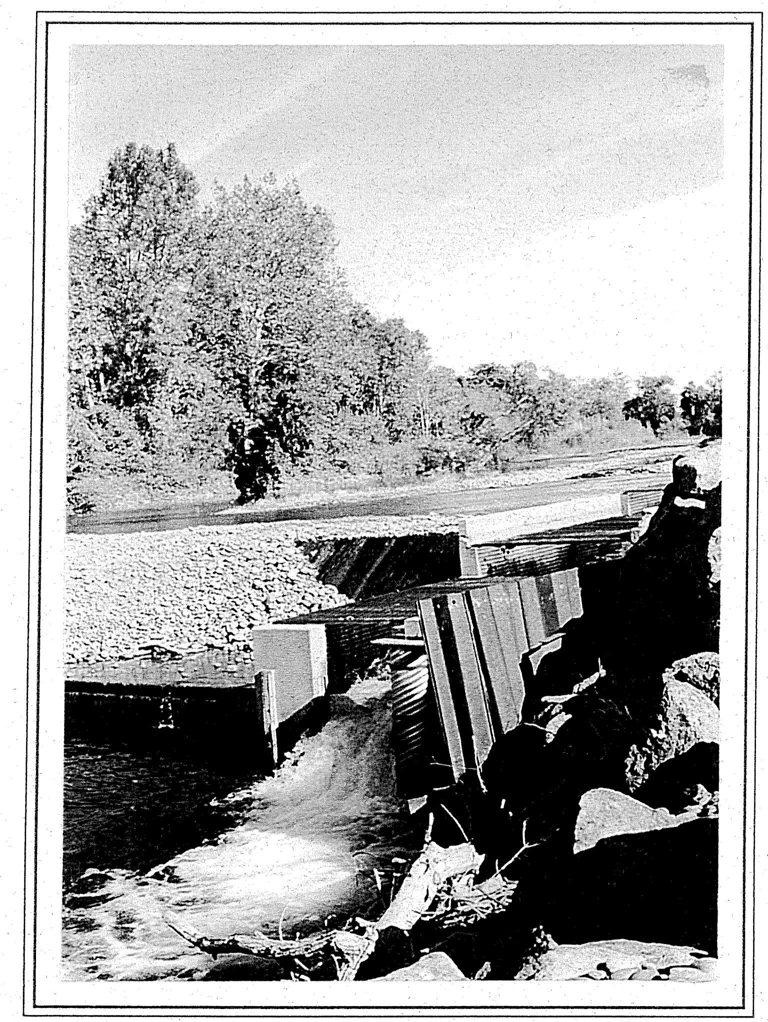


Photo 4-12. Entrance to fish ladder on south bank of Deer Creek at Stanford-Vina Ranch Diversion Dam. (Photo by Dana Bland, November 1996)

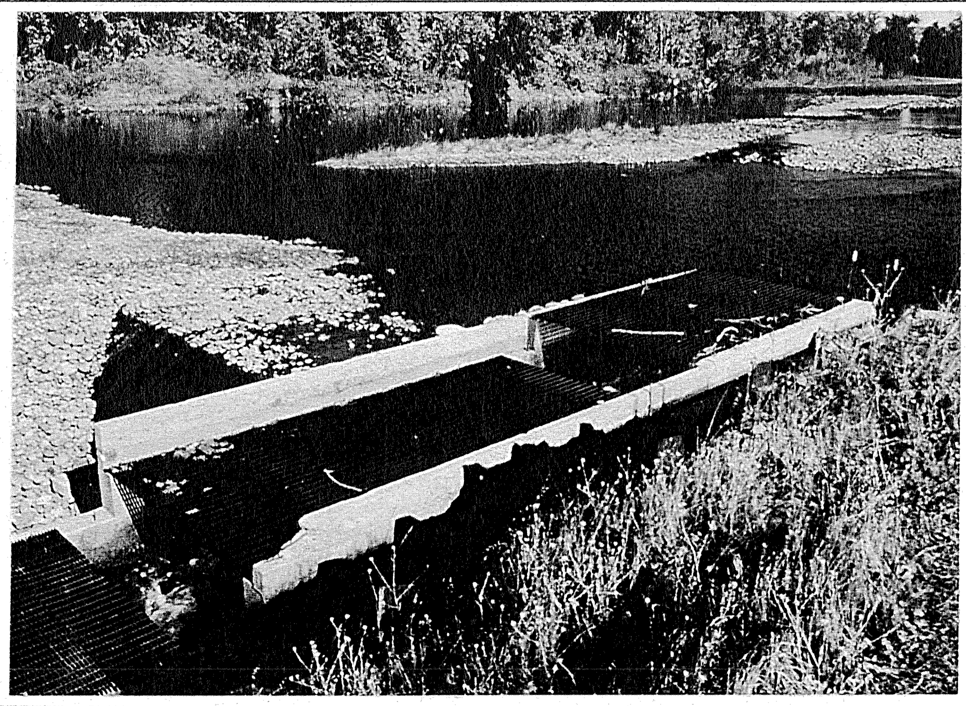


Photo 4-13. Fish ladder on south side of Stanford-Vina Irrigation Dam. (Photo by J. Stanley, November 1996)

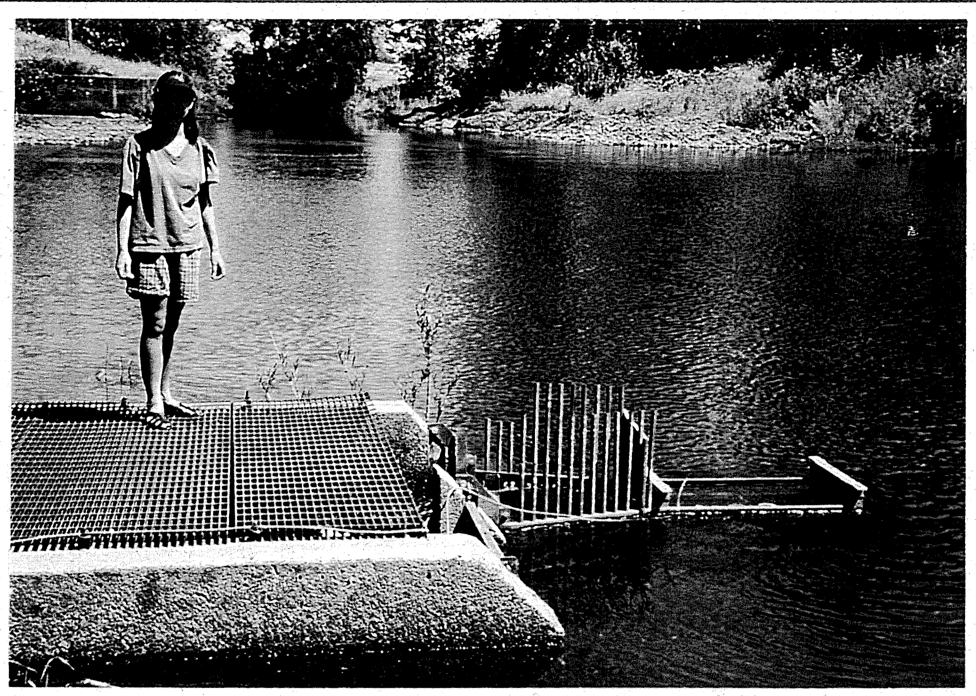


Photo 4-14. Electric fish counter in place at upper end of the south ladder-Stanford-Vina Ranch Irrigation Dam. (Photo by S. Cepello)

Photo 4-15. Fish screen at entrance to South Main Canal immediately upstream of the Stanford-Vina Ranch Dam. (Photo by S. Cepello)

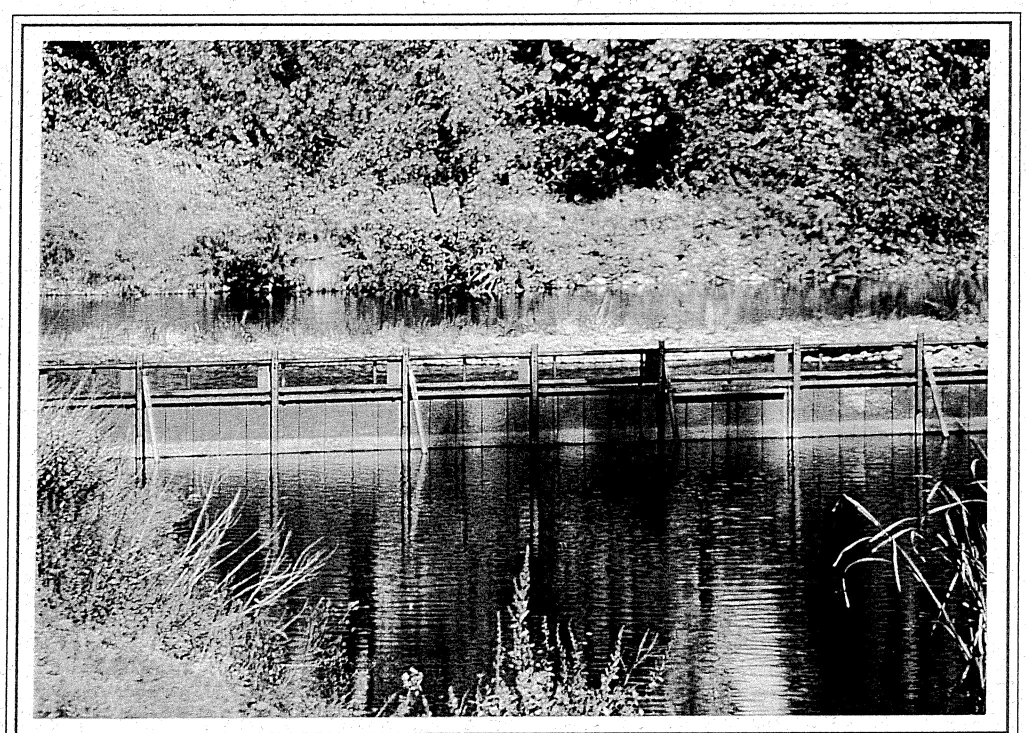


Photo 4-16. Fish screen across entrance to South Main Canal-Stanford-Vina Ranch Dam. (Photo by J. Stanley, November 1996)

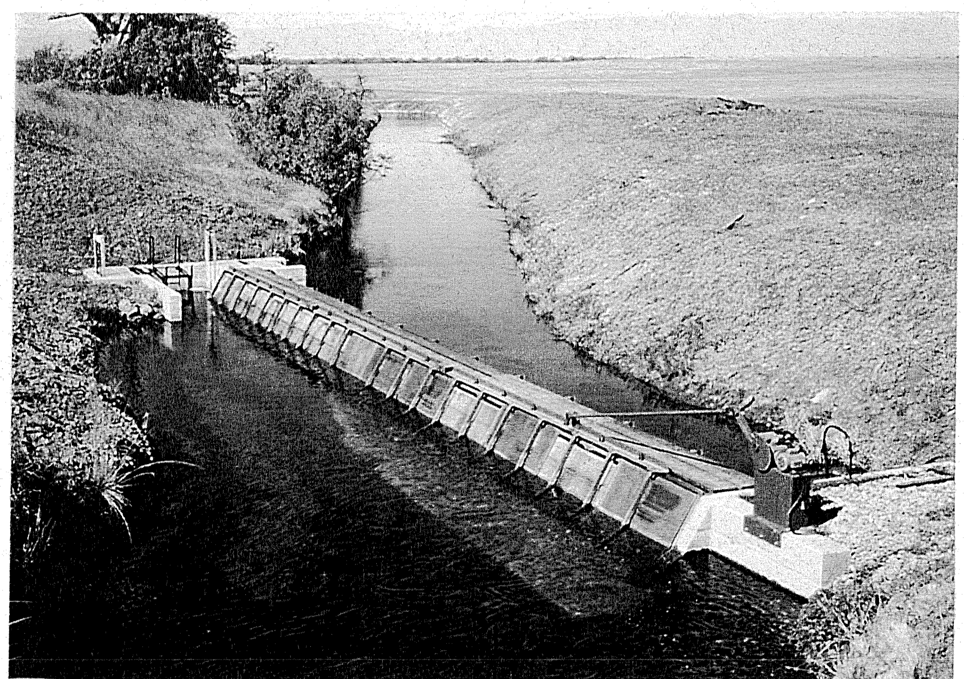


Photo 4-17. North Canal fish screen and fish bypass, Stanford-Vina Irrigation Dam. (Photo by S. Cepello)

Photo 4-18. Fish screen across North Canal at Stanford-Vina Ranch Dam. (Photo by S. Cepello)

Photo 4-19. Young man wading in Deer Creek Viewed from Red Bridge (Leininger Road) looking downstream. (Photo by J. Stanley, September 1994)

Photo 4-20. Alders and willows lining streambanks of Deer Creek upstream of Red Bridge. (Photo by J. Stanley, September 1994)

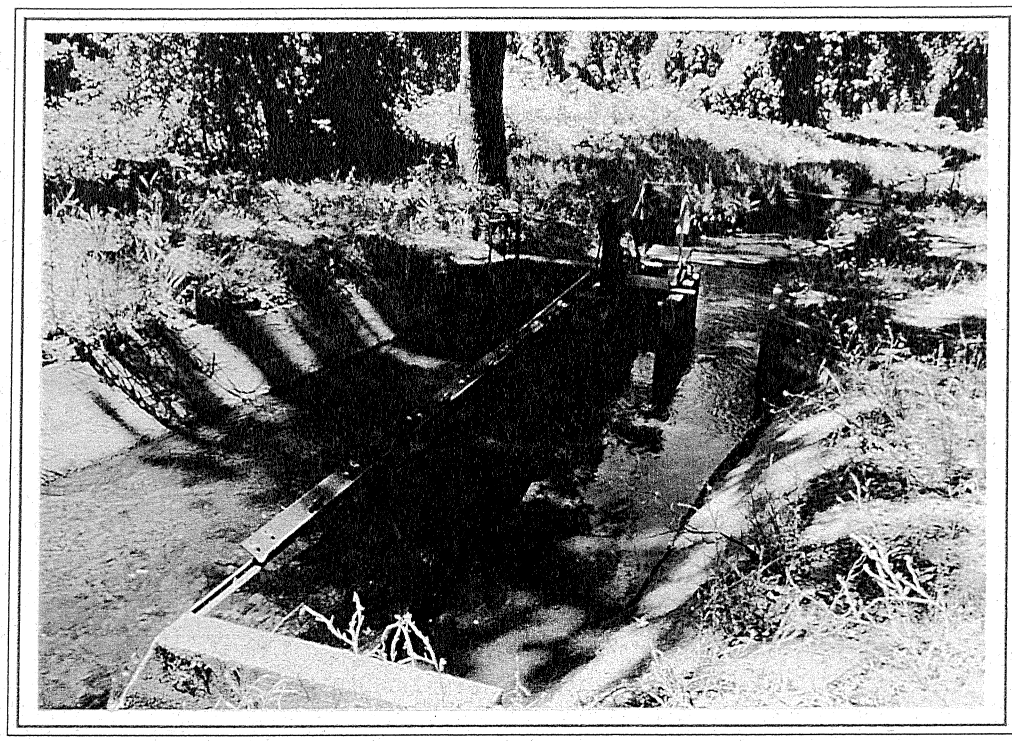


Photo 4-21. Fish screen at Cone-Kimball Diversion. (Photo by J. Stanley, June 1997)

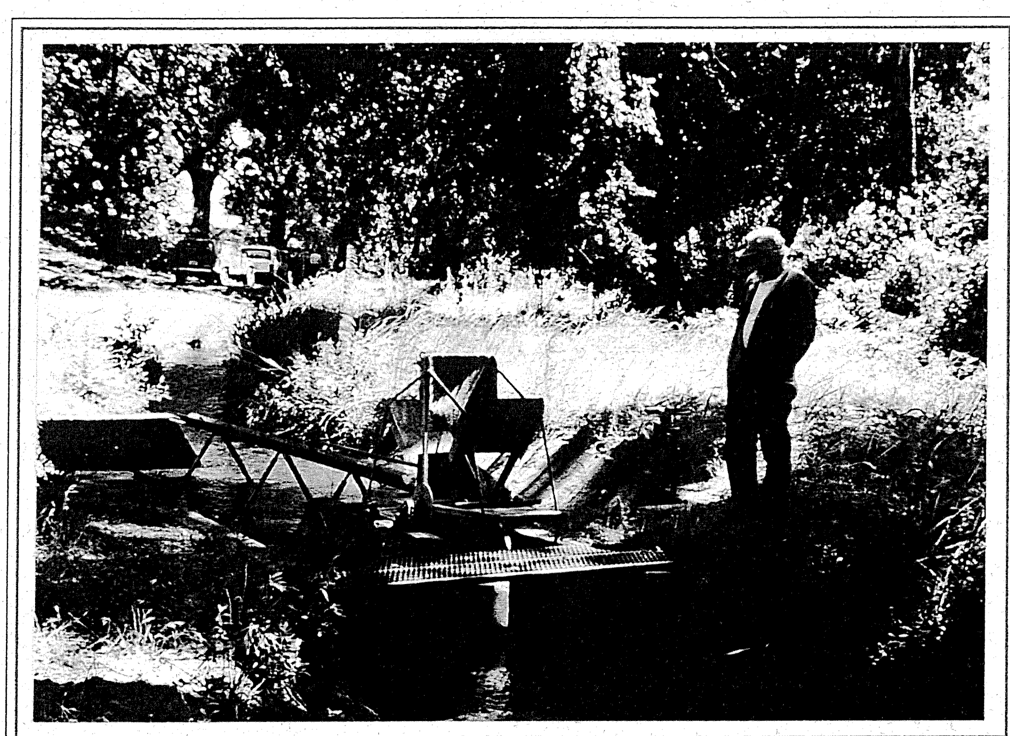


Photo 4-22. Stu Hanna, Manager, Stanford-Vina Ranch Irrigation Company, observing self cleaning mechanism on fish screen at Cone-Kimball Diversion. (Photo by J. Stanley, June 1997)

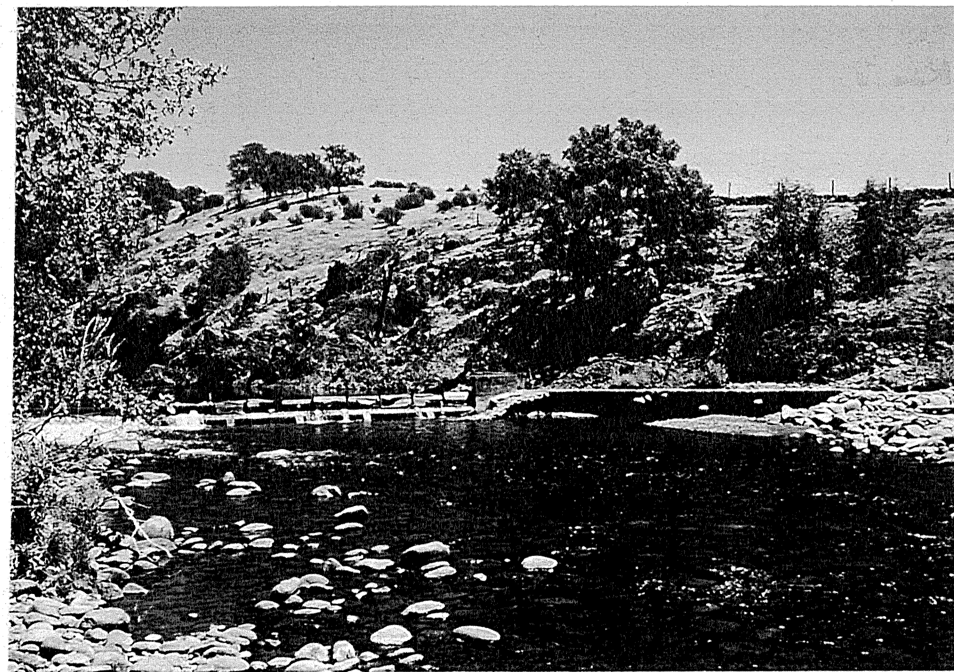


Photo 4-23. Looking upstream at DCID Diversion Dam from north side of Deer Creek. (Photo by J. Stanley, June 1997)

Photo 4-24. Diversion canal and fish screen on south side of Deer Creek at Deer Creek Irrigation District Diversion. (Photo by J. Stanley, November 1996)

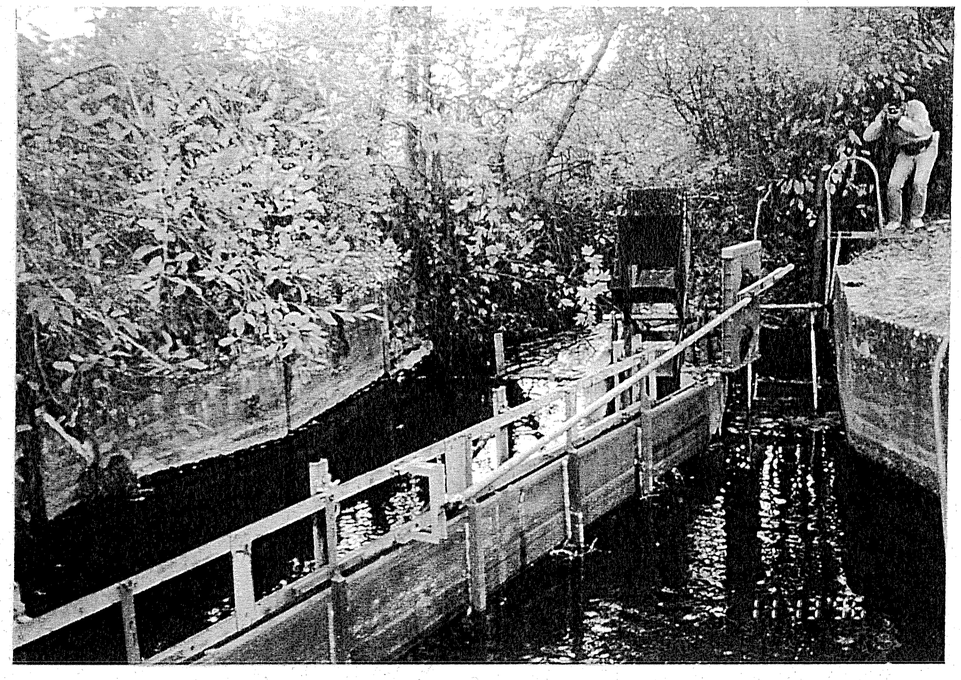


Photo 4-25. Fish screen on DCID Diversion canal. (Photo by V. Haley, November 1996)

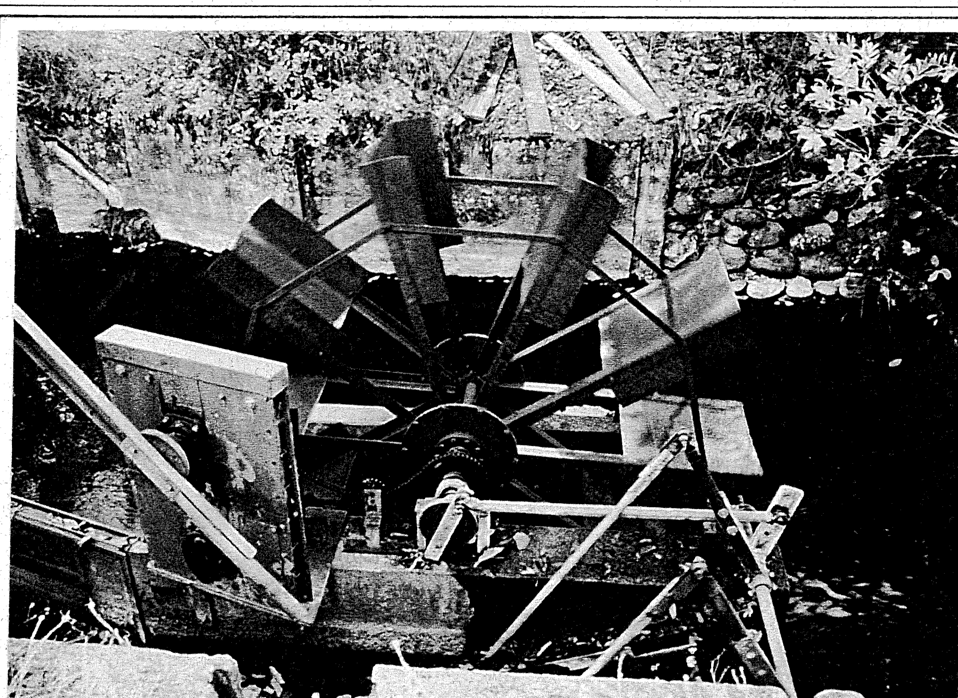


Photo 4-26. Water wheel used to drive self cleaning mechanism for fish screen at DCID diversion. (Photo by J. Stanley, November 1996)

5.0 FLUVIAL GEOMORPHOLOGY

INTRODUCTION

The floods of 1997, occurring as they did during the preparation of a watershed management plan for Deer Creek, raised concerns about geomorphic processes on Deer Creek and the inherently dynamic nature of the channel. The floods resulted in damage to levees and extensive flooding of agricultural land, and attracted Federal funds to address flood damage in the alluvial lower Deer Creek (encompassing the "Valley Floor" and "Mouth" Reaches), extending about 11 miles from the upper diversion dam to the Sacramento River confluence. However, as shown by this study, the floods of 1997 were not unusual when viewed on a longer time scale, having been exceeded twice since gauging records began in 1912, and being only one of seven floods of 15,000 cfs or greater since 1912. Moreover, the nature of lower Deer Creek is such that channel change is a normal part of events, and concepts of stability derived from rivers elsewhere apply poorly here.

Deer Creek is one of the few Sacramento Valley drainages still providing good habitat for spring-run chinook salmon (*Oncorhynchus tshawytscha*), reflecting the relatively limited human intervention in many reaches of Deer Creek. This probably reflects a combination of good stewardship by most riparian land owners and the inherent resiliency of Deer Creek. Lower Deer Creek has been the object of flood control efforts by the U.S. Army Corps of Engineers (COE), the California Department of Water Resources, and Tehama County Flood Control, as detailed by Dan Keppen elsewhere in the Existing Conditions Report. These flood control and levee repair projects were undertaken with good intentions and reflected the best thinking at the time, but there is increasing recognition worldwide that channelization and other river control efforts are frequently detrimental to aquatic and riparian habitat, and often expensive to maintain because they are, in effect, "fighting" river processes (Brookes 1988). It is well established in the scientific literature that rip-rapping and channelization reduce the quality of fish habitat, and that aquatic habitat is usually maximized with an unfettered, naturally migrating river channel. This should come as no surprise, since the latter are the freshwater stream conditions with which the fish evolved.

While channel dredging, bank protection, and water diversions have had a negative effect on salmon habitat, Deer Creek can be viewed as a resilient stream, owing to its high energy and ability to reconstruct a natural channel geometry during high flows. In a stream such as this, the most effective ecological restoration strategy is usually to permit natural processes to operate with as little hinderance as possible, rather than undertake direct interventions (which, while well-intentioned, are often counter-productive).

There may be reasons besides aquatic habitat to limit human interventions in the channel of lower Deer Creek. Deer Creek has broken through its confining levees more than once, often at the same points. Levee repair is not only expensive, but by confining the flow in an unnaturally narrow channel, levees eliminate the ability of a natural stream to absorb high flows on its floodplain. Residents of the Abbey of New Clairvaux (hereafter referred to as the monastery) observed that the rise in Deer Creek waters abruptly stopped (before serious flooding of the monastery) at about the time when Deer Creek broke through its levee about 5.4 miles upstream of the Sacramento River. The monastery's escape from serious flooding was (probably correctly) attributed to the upstream levee failure. The interaction could also have been put a different way: The monastery had been put at an increased risk of flooding because of the upstream levees. Without the upstream levees, the floodplain of Deer Creek would have naturally absorbed much of the excess flood waters, but by eliminating this natural flood storage, flood waters were routed in a more concentrated form to the downstream reaches, thereby increasing the flood risk downstream.

Increased downstream flooding was foreseen in 1948 by F.T. Robson of the Stanford-Vina Ranch, who warned the COE that the proposed flood control project, "will deliver at the said Southern Pacific Bridge more water and at greater velocity than under existing conditions" (Robson 1948). By better understanding the geomorphology and hydrology of Deer Creek, we can perhaps better approach such issues from a larger perspective, understanding and anticipating effects of our management actions on other parts of the complex Deer Creek system.

The purpose of this chapter is to provide a historical geomorphic analysis of Deer Creek as background for other components of the Existing Conditions Report, and to provide a context within which more recent events can be viewed and future management decisions can be taken. The chapter also considers several specific geomorphic subjects relevant to salmon habitat and river management, such as spawning gravel (availability, quality, and mobility), fine sediment supply and deposition, effects of levees on channel processes, the potential of Deer Creek to restore a more natural morphology. Because lower Deer Creek has erodible bed and banks, it is more prone to channel change than the largely bedrock and boulder-controlled upper reaches, and thus this chapter focuses mostly on lower Deer Creek. Because the overall basin physiography and bedrock geology have been well-described in other chapters, we focus here on the channel form and process.

METHODS

Hydrologic Analysis

We obtained annual peak flows from the U.S. Geological Survey (USGS) published database through 1995, and preliminary estimates of peak discharge for 1996 and 1997 from the USGS (Water Resources Division) California District Office in Sacramento (P. Shiffer pers. comm.). We plotted these data as a histogram.

We also conducted a flood frequency analysis on the period of continuous gauging record, 1921 to 1997. (There was a gap in gauge operation from 1916-1920.) We used the standard formula,

$$RI = (n + 1)/m,$$

where RI is recurrence interval (return period) in years, n is the number of years of record, and m is the rank of the year, with the largest year of record being ranked as 1, the smallest annual peak ranked n (Dunne and Leopold 1978). We plotted the resulting values of RI, termed "plotting positions", on Gumbel extreme-value paper, with the y-axis on a logarithmic scale because of the wide range of annual peak values to produce a flood frequency curve from which the magnitudes of floods for various return periods can be read.

Analysis of Aerial Photography

The historical analysis relied largely on the excellent historical aerial photography, with good coverage back to 1938 and 1939 (Table 5-1). Earlier maps proved less useful because of their small scale and lack of detail. We searched for aerial photography among the USDA, USGS, and NOAA photo indices at the library map collection of the University of California, Davis (UC Davis), which is the repository in the UC Davis system for aerial photographs of the Central Valley. We also searched the collections of the COE, Sacramento Branch. Between these two sources, adequate coverage of the reach was obtained, so other sources (such as the Caltrans Index of State and Federal photography) were not consulted. In the event that specific questions about events in certain historical time frames arise, they could potentially be answered through consulting additional photography through one of these other sources. For the photography of 1952, only the minimum frames needed for stereoscopic coverage were ordered as these prints must be obtained from the National Archives at considerable expense.

Table 5-1. Aerial Photography Used in Historical Channel Mapping of Deer Creek

Year	Agency	Scale	Coverage	Comments
1939	USACE	1:10,000*	Alluvial reach	Obtained from Contractor
1952	USDA	1:20,000	Entire County	Obtained from National Archives
1966	USDA	1:20,000	Alluvial reach	Obtained from USDA
1972	USDA	1:40,000	Alluvial reach	Obtained from USDA
1979	USDA	1:40,000	Alluvial reach	Obtained from USDA
1985	USACE	1:9,600	Entire stream	Not stereo, Obtained from Contractor
1997	Chico State		Alluvial reach	Obtained from Chico State

*Approximately.

We mapped historical channel features from aerial photographs to document past conditions and changes over time. Because the images on aerial photographs (especially older photography) are subject to distortion, we rectified the image by identifying features (such as buildings, road intersections, etc.) that appeared on all (or most) years of the photography and also on the USGS 1:24,000 topographic map. The locations of these features were digitized and were subsequently used as the framework within which the channel features were mapped, with the images being rectified by the computer program, based on the mapped landmarks.

We plotted the resulting patterns of channel change on a base map screened from the USGS 1:24,000-scale topographic maps, which provide a framework for recognizing the extent of past channel change. Of course, the resulting maps of channel change do not reflect the full extent of past channels, only those evident over the last nearly six decades (in which many human elements have endeavored to control and reduce channel change). The maps are so large and expensive to reproduce (on the color plotter) that is was not practical to include them in the report. However, complete sets of these maps are available for inspection at the office of the Deer Creek Watershed Conservancy in Vina and the Department of Geography and Planning at California State University in Chico.

Longitudinal Profile and Historical Channel Elevations

We measured the distance along the channel of Deer Creek on the USGS 1:24,000-scale topographic map, following our estimate of the bankfull channel. We measured distances upstream of the Sacramento River confluence (in thousands of feet) and marked these stations to provide an unambiguous referencing system for future observations (Figure 5-1). For this we used the bankfull channel course, which yields a shorter length (and thus higher slope) than obtained by following the more sinuous low-flow channel, but more accurately reflects the energy grade at the geomorphically effective flows at bankfull stage and above. We measured the longitudinal profile (from the topographic maps) along this channel course.

We analyzed the (limited) available information concerning historical bed elevations in lower Deer Creek. We plotted two bed elevation points in lower Deer Creek from a 1931/1932 plan (scale 1:31,680) and profile (USGS 1933) that could be located, one at a section line crossing near the upstream end of the alluvial reach, and another point at the Red (Leininger) Bridge crossing downstream. We also reviewed the Caltrans bridge files for all bridges over Deer Creek, most of which are in the Highway 32 Reach and upstream. Despite voluminous notes and calculations concerning load-bearing capacity, the file for Red Bridge (Leininger Road) did not include any cross section data. However, historical cross sections under the Highway 99 Bridge were available. We resurveyed the streambed below the bridge to document any change since the initial survey.

Because the USGS topographic map is based on aerial photographs taken in 1947, and because Deer Creek was channelized 1949, it is quite possible that the current profile differs significantly from that based on the topographic maps. The best way to assess any such changes would be to re-survey the longitudinal profile through lower Deer Creek. We did not have time to do this in preparing this chapter, but propose that it may be worthwhile to do in the future.

Field Reconnaissance and Data Collection

Field reconnaissance was conducted on lower Deer Creek, visiting a number of sites on a Conservancy-organized tour in late January (shortly after the January flood), and a canoe trip from the Leininger Ranch downstream to the monastery in February, as well as other opportunities to walk different parts of lower Deer Creek in February, April, and October of 1997. We also toured portions of the upper watershed (with Ken Roby and other USFS personnel) in June and hiked other portions of the upper Deer Creek drainage in August.

We sampled gravel size on five bars along the channel (between the upper diversion and the Southern Pacific Railroad Bridge) by pebble count (Wolman 1954 and Kondolf 1997) to provide a measure of bed material size and its downstream change along the channel. We also conducted a pebble count on one riffle used by spawning chinook salmon in October, measuring grain size in the bed surrounding a recently constructed redd. We also measured the sizes of lag gravels in the pitts of several other fresh redds and noted the occurrence of these redds within geomorphic channel features as an initial basis for evaluating potential spawning gravel quality.

Review of Other Sources

We also reviewed relevant reports, such as the road survey of the upper watershed (Meadowbrook Conservation Associates 1997) and reports on quaternary geology of the region (Helley and Harwood 1985 and Harwood and Helley 1987). We reviewed (with Bill Travers of UC Davis) the photographs taken on the Kroeber Expedition to Mill and Deer Creeks with Ishi (held in the Hearst Museum of Anthropology) in an effort to locate any views that might shed light on the channel conditions earlier in the century. We also reviewed correspondence between the Stanford-Vina Ranch and the COE in 1948 to 1950 concerning the flood control project of 1949 (correspondence supplied by Bill Travers).

GEOMORPHIC SETTING

Deer Creek drains the slopes of Mount Lassen. The basin lithology is dominated by the Tuscan Formation, Pliocene-aged basaltic and andesitic lahars, tuffs, lava flows, intrusive rocks, and fluvial deposits. The Tuscan Formation is overlain by rhyolitic flows of the Mill Creek Plateau. As is typical of southern Cascade streams, Deer Creek flows through canyons cut into volcanic strata, before emerging onto the Sacramento Valley floor.

From about 5,000 to 4,500 feet elevation, Deer Creek flows through an alluvial valley (Childs Meadows and Deer Creek Meadows). Downstream of this alluvial valley and upstream of the Sacramento Valley floor, the channel is largely controlled by bedrock outcrops and its width is confined by canyon walls. Shear stresses are high, with relatively few sites for deposition of sediment. Because of control by bedrock, the channel is stable, with changes (on time scales measurable by humans) only occurring in the marginal or surficial sediment deposits in the channel.

Below the canyon reaches, Deer Creek has built up a substantial alluvial fan on the valley floor. In the upper part of the fan (from the Upper Diversion, Station 58,000, downstream to about Station 45,000), the channel is incised into older, cemented alluvium units: the upper member of the Riverbank Formation (130,000 to 450,000 years old), the Red Bluff Formation (450,000 to 1,100,000 years old), and older terrace gravels (Figure 5-2) (Helley and Harwood 1985). These

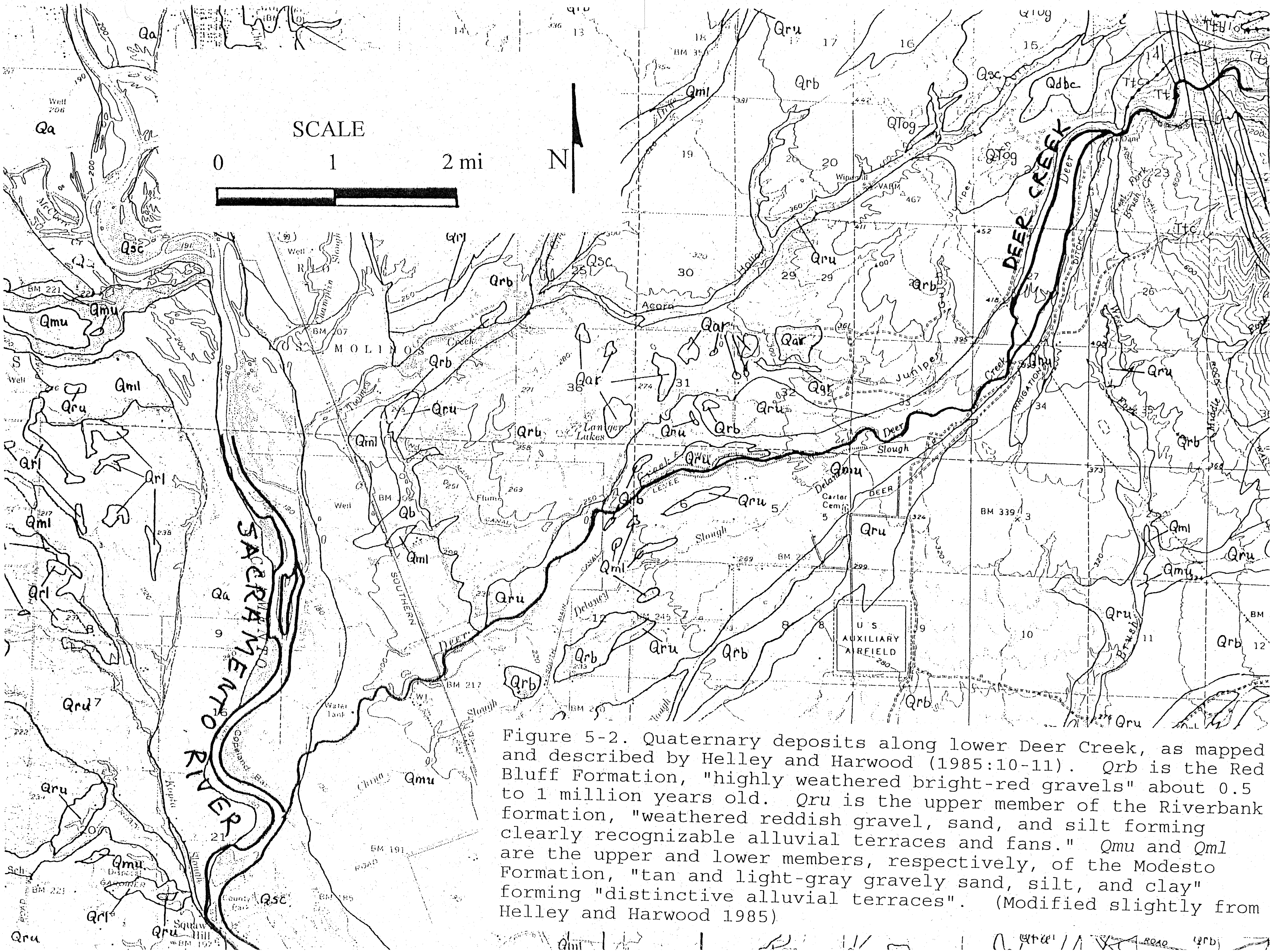


Figure 5-2. Quaternary deposits along lower Deer Creek, as mapped and described by Helley and Harwood (1985:10-11). *Qrb* is the Red Bluff Formation, "highly weathered bright-red gravels" about 0.5 to 1 million years old. *Qru* is the upper member of the Riverbank formation, "weathered reddish gravel, sand, and silt forming clearly recognizable alluvial terraces and fans." *Qmu* and *Qml* are the upper and lower members, respectively, of the Modesto Formation, "tan and light-gray gravely sand, silt, and clay" forming "distinctive alluvial terraces". (Modified slightly from Helley and Harwood 1985)

older units form bluffs (typically about 5 miles high) within which the active channel can migrate across its active channel bottom, about 1,000 to 1,200 feet wide. (The modern, active channel bed is mapped as the upper member of the Modesto Formation, Qmu, by Helley and Harwood [1985], but should probably be mapped as modern alluvium, as it is clearly reworked frequently by contemporary channel processes.)

Downstream of about station 45,000, the form of the alluvial fan, and the characteristic multiple channels radiating from the apex of the fan, are clearly expressed in the contour lines (Figure 5-3). The multiple channels reflect the process by which the alluvial fan builds up: A channel (or more than one channel) is active, and carries sediment from steep upstream reaches. Because of the overall flattening of the gradient on the valley floor, sediment deposits, and the channel aggrades (builds up with sediment) until the gradient in this active channel becomes less due to the deposition, and the stream abandons the channel in favor of another channel which now offers a relatively higher gradient until it too aggrades and the channel shifts again. Thus, over centuries and millennia, the locus of deposition shifts around the entire alluvial fan such that a low-gradient cone of sediment is created.

In this light, we can see that it is natural not only for Deer Creek to occupy secondary channels like Delaney Slough during floods, but also to periodically shift its main channel to another such channel. This has not happened within historical time (essentially the last century) but after the events of the 1997 winter, it is not difficult to imagine Deer Creek shifting to Delaney Slough during a large flood.

Moreover, within a given active channel, it is natural for the channel to shift among various multiple sub-channels within the larger channel. Channel changes at this smaller scale are quite visible on the historical maps and aerial photographs, and reflected in the maps of channel changes prepared for this chapter.

Hydrology

Deer Creek drains 208 mile^2 (at the USGS Gauge upstream of the upper diversion) and has an average flow of 317 cfs (computed over the years 1912 to 1915, 1921 to 1937, and 1940 to 1990), for an average water yield of about 1.5 cfs/mi^2. Under natural conditions, Deer Creek has a strong baseflow maintained by groundwater contributions, typical of Cascade Range streams. There are no large dams upstream of the Upper Diversion (operated by the Deer Creek Irrigation District since 1923), located just downstream of the canyon mouth on the alluvial valley. Two more diversions are found downstream, the Cone-Kimball Diversion and Stanford-Vina Diversion, the latter being the largest with a drop of over 10 feet. Together, these diversions have the right to divert all flow from Deer Creek during their months of operation.

Forty percent of the Deer Creek watershed lies above 4,000 feet, so there is a significant snowmelt component to run-off (as discussed in the Basin Description chapter), with the highest peak flows deriving from rain-on-snow events. Deer Creek experienced a flood of 20,800 cfs in January 1997, the third largest flood in the period of continuous record for the stream gauge,

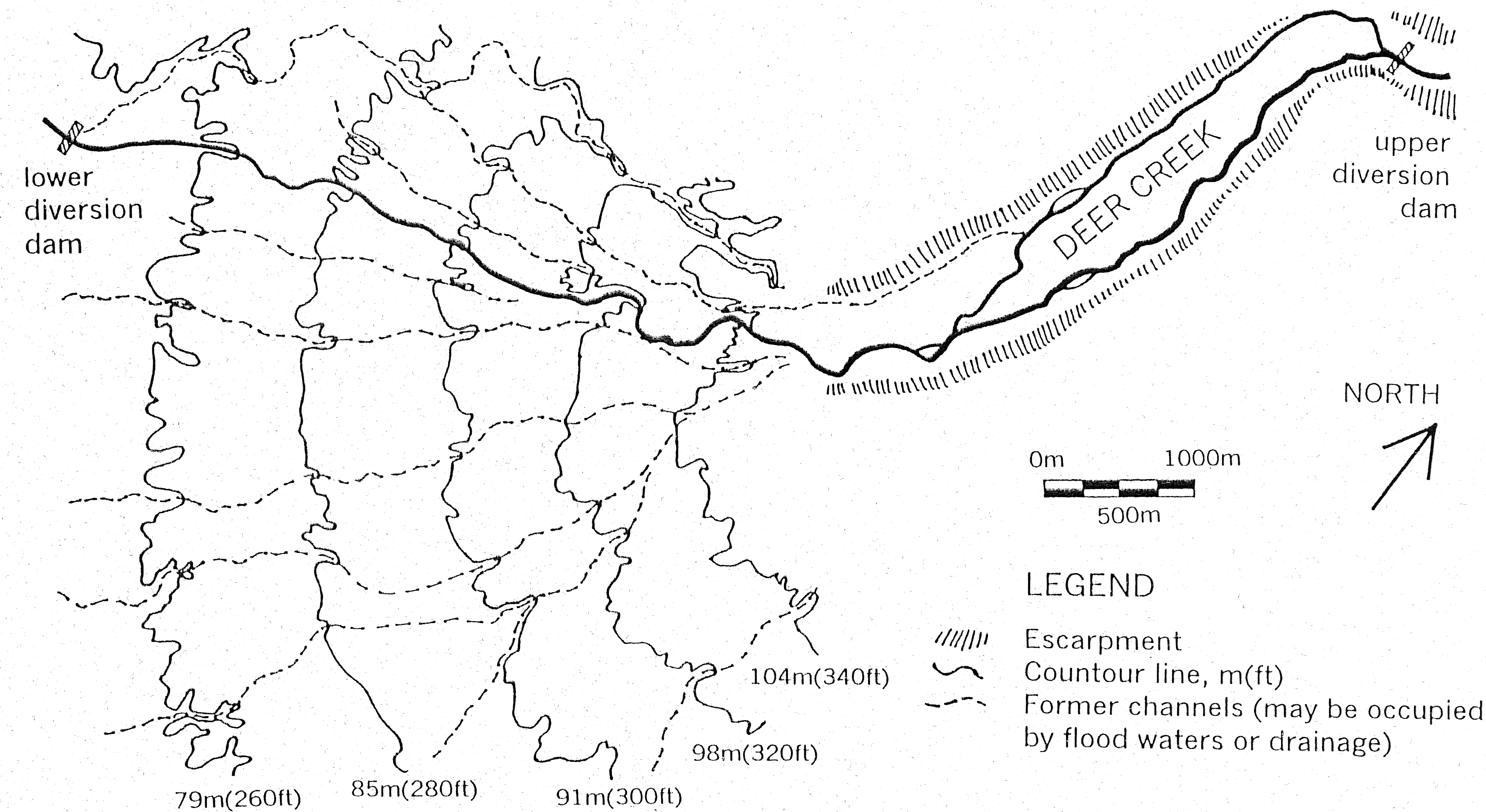


Figure 5-3. Characteristic multiple channels radiating from the apex of the alluvial fan.

1921 to present. The 1938 (December 1937)[1] and 1940 floods were larger, with peaks of 23,800 cfs and 21,600 cfs, respectively. The 1970 and 1965 (December 1964) floods were close, at 20,100 cfs and 18,800 cfs, respectively (Figure 5-4).

By virtue of the formula used to calculate recurrence interval for floods, the 1997 flood is considered a 25-year flood (as the third highest flood in the 75-year continuous gauging record since 1921). Based on the flood frequency analysis (Figure 5-5), return periods for various floods are presented below.

RI	Q (cfs)
2	5,500
5	10,500
10	14,500
20	19,000
50	23,000
100	25,000

Longitudinal Profile and Historical Changes in Bed Elevation

Deer Creek drops 300 feet in its alluvial reach (i.e., from the base of the upper diversion dam) to the Sacramento River confluence (about 11 miles). Its average gradient is about 0.005 (one-half of one percent) through the alluvial reach overall, with the gradient becoming gradually less steep downstream, with a concave upward profile typical for such an alluvial channel (Figure 5-6). No sharp change in gradient appears upstream of the diversion dam, indicating the channel of Deer Creek has developed, through erosion and deposition, a consistent grade above the wide alluvial reach for some distance into the canyon reaches above. No unusual features appear on the profile, save the drops created by the diversion dams and another a sharp drop in the profile at about Station 39,000 feet, downstream of the deflector levee at Station 41,400 feet. When viewed in more detail, the reach from Station 20,000 to 50,000 feet also shows relatively few features (Figure 5-7). Because the profiles are drawn from a composite of topographic maps with 5 to 40 feet contours, they cannot show many smaller-scale features of potential importance for fish habitat. Moreover, the topographic maps were drawn from aerial photographs, which cannot, of course, show bottom topography under water.

It is worth noting that these profiles are drawn from 1:24,000-scale topographic maps nearly 30 years old, which were largely reproduced from topographic maps based on aerial photography 50 years old, except where indicated as having been photo-revised. The spot bed elevations in lower Deer Creek reported by the USGS (1933) plot directly on the map-based longitudinal profile (Figure 5-6), suggesting that, at least at the observed points, any channel change between 1931 and 1947 would have been too small to be detected by this comparison.

[1] Hydrologic data are reported by *water year*, from 1 October to 30 September. Thus, a flood in December 1937 is reported as part of the 1938 water year.

More significantly, the topographic map predated the COE flood control project of 1949, which effectively channelized much of lower Deer Creek, affecting the profile directly by dredging and indirectly by increasing in-channel bed shear stress. Thus, there is reason to expect the longitudinal profile today could be different from the pre-1949 profile.

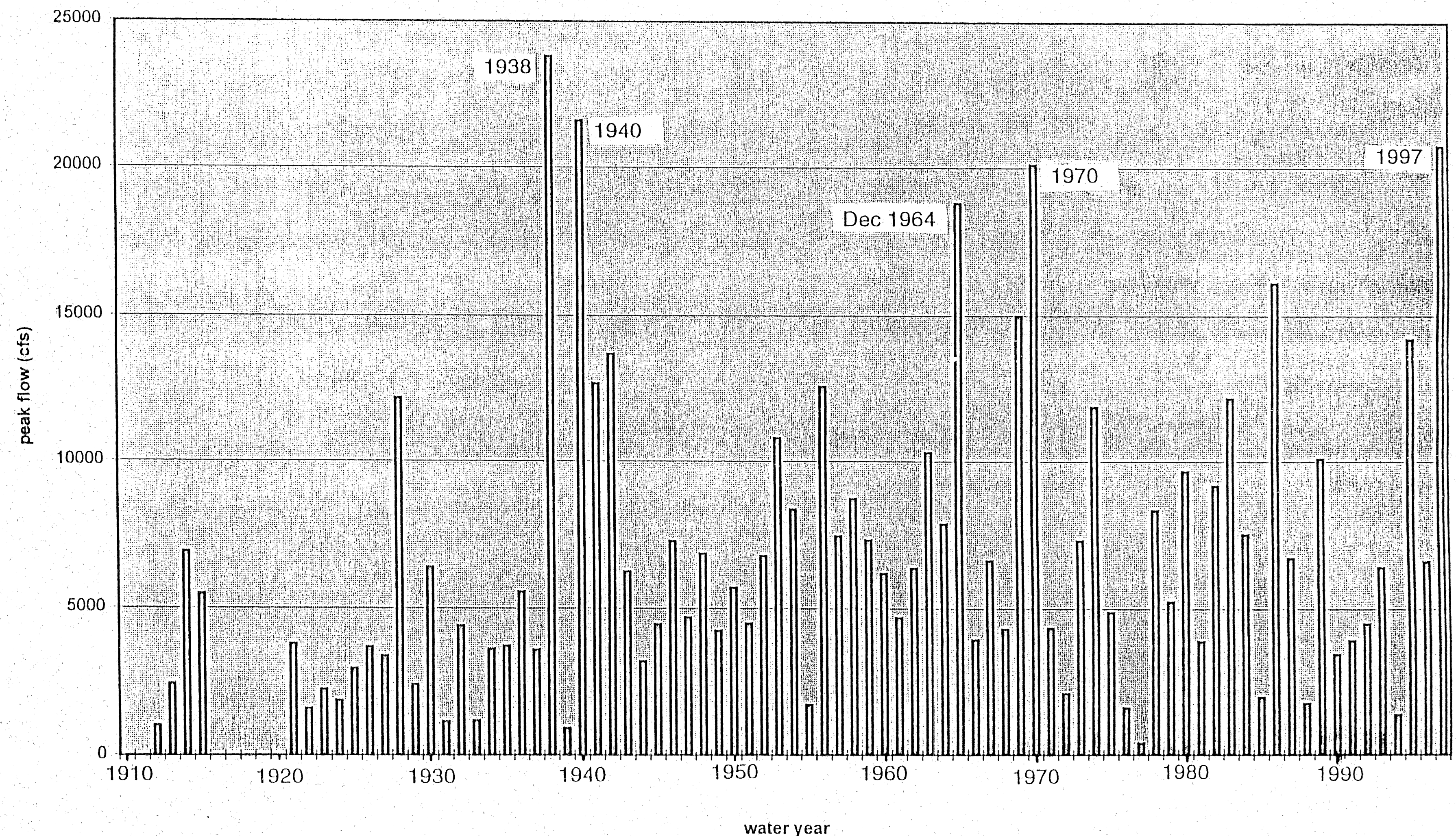
The Highway 99 Bridge was originally built in 1921 by Tehama County and widened in 1951 by Caltrans. The channel bed below the bridge has been repeatedly subject to scour, as reported in Caltrans bridge inspection reports, and reflected in the fact that the originally shallow piers have been lowered and rock placed along several of the piers. It is unclear how much the scour under the bridge has reflected natural seasonal and short-term cyclic scour in lower Deer Creek, the result of the bridge constriction, a long-term change in channel bed elevation, or the effects of channelization projects. Unfortunately, the bridge files do not contain channel cross sections before 1951, so it is difficult to confirm the statement the "the stream profile at Deer Creek is now lower than when the bridge was constructed" (Gallippi 1991). Moreover, the 1951 cross section postdates the 1949 channelization project, so we do not have good documentation of the pre-project geometry.

The 1951 channel probably largely reflected the recent channelization, with a deep single channel near the left bank, between Piers 2 and 3 (Figure 5-8). In 1974, the main channel had shifted towards the right-bank, between Piers 4 and 6, and the thalweg had aggraded about 2 feet. This change may have been the result of a channel realignment proposed by the COE in 1970, which was the subject of a Caltrans comment letter in the bridge files (McMahon 1970). In 1997, the channel was broader, with two deep points centered on Piers 3 and 6, but with the thalweg about 5 feet higher than in 1951. The aggradation of the thalweg (and widening of the channel) may reflect recovery of the channel from the original channelization works and subsequent alignment an/or maintenance projects. A high gradient river such as this would not necessarily have a single channel, and we could expect its channel to shift, even under "very moderate rises" in Deer Creek, as noted by Sullivan (1921).

In any event, our re-survey of the Highway 99 Bridge and plotting of historical cross sections does not indicate long-term channel incision, nor long-term channel aggradation, as the observed changes could simply reflect filling of artificially excavated channels. The channelization work, by constricting flow and increasing bed shear stresses, could be expected to increase scour, at least until the straightened channel form is modified by erosion and deposition during floods.

Subsequent channel maintenance, channel clearing, and gravel removal projects have physically removed gravel from the bed, and by straightening the channel, reduced roughness and increased slope under the Highway 99 bridge. These activities have potentially increased scour, as noted in a Caltrans engineer's report:

Figure 5-4. Histogram of annual peaks flows on Deer Creek near Vina for period of record: 1912-1915, 1921-1997. Data for 1996 and 1997 are preliminary and subject to revision. Source: US Geological Survey published records and Pat Shiffer (USGS Sacramento) personal communication 1997.



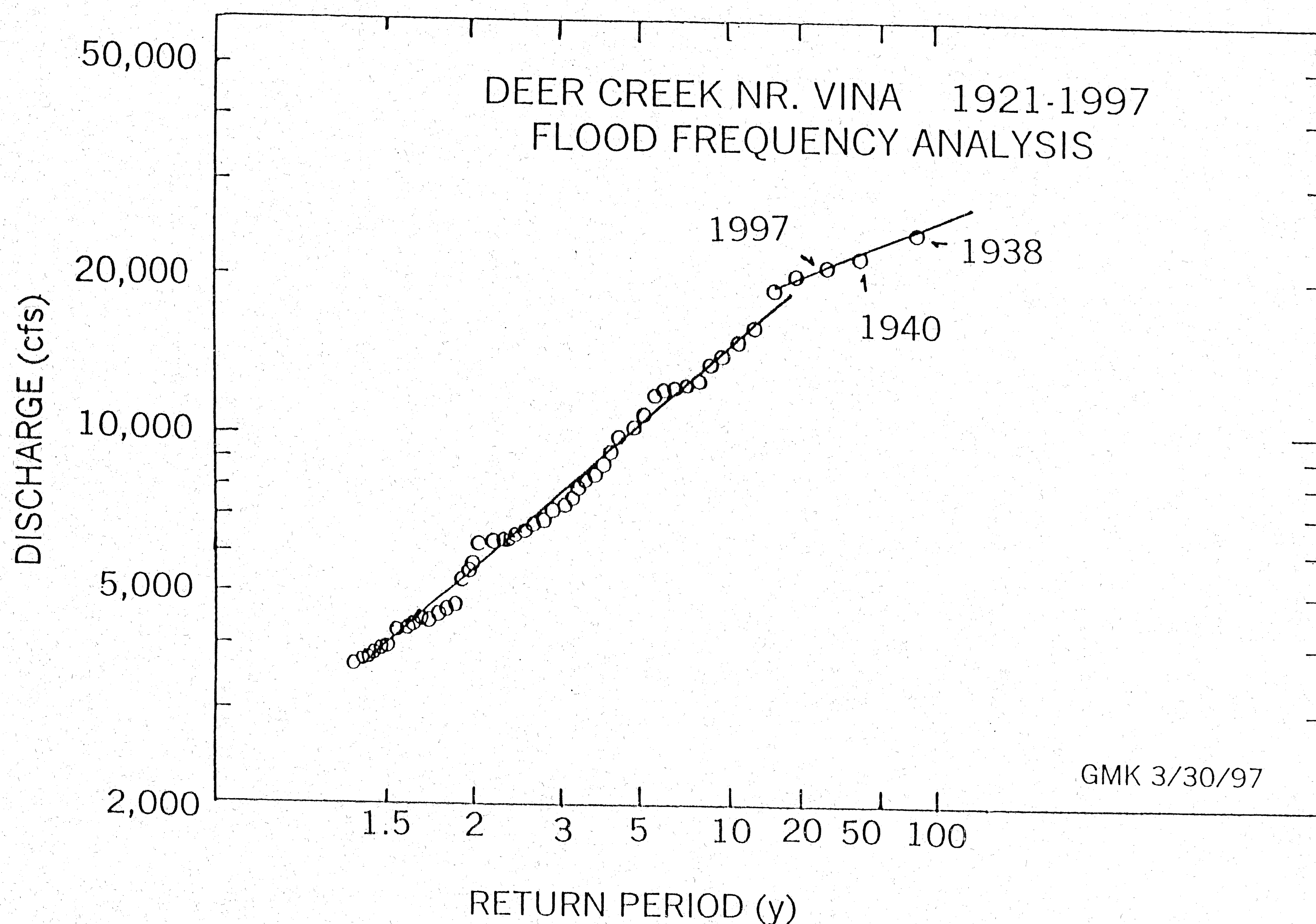
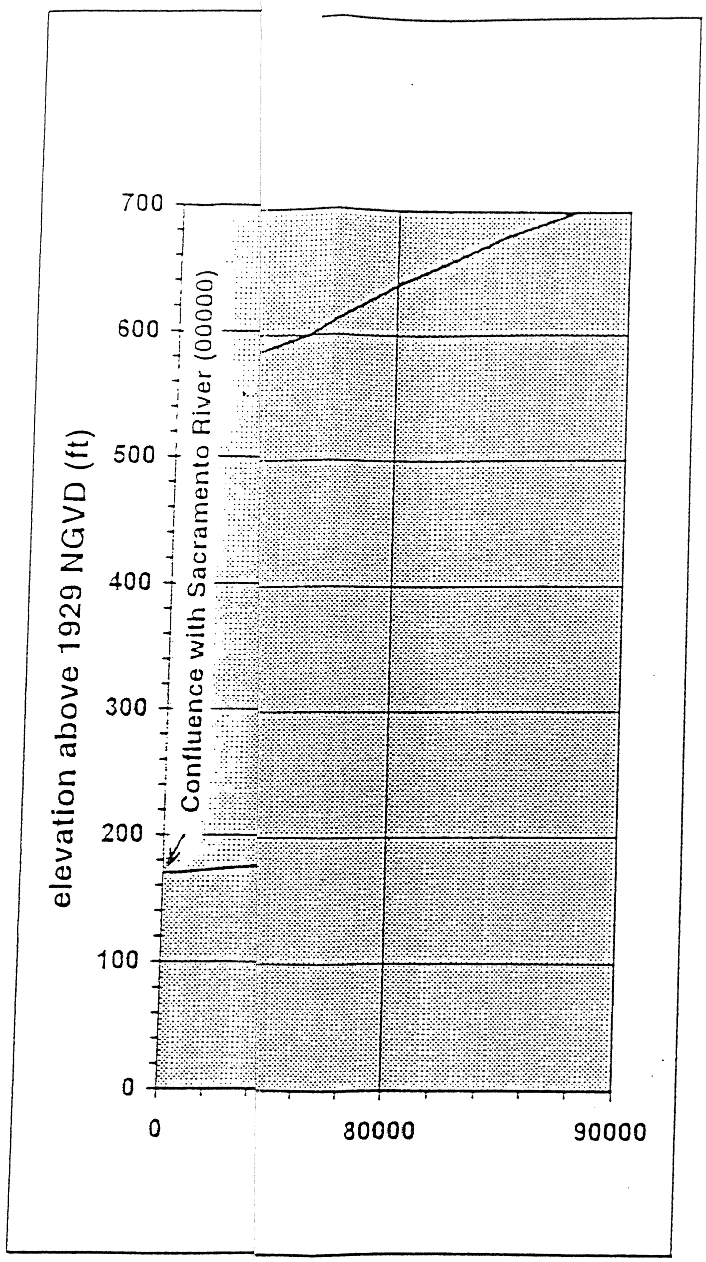


Figure 5-5. Flood frequency analysis for Deer Creek near Vina, for period 1921-1997. (Data from the US Geological Survey: 1921-1995, published records; 1996-1997, unpublished, preliminary data)



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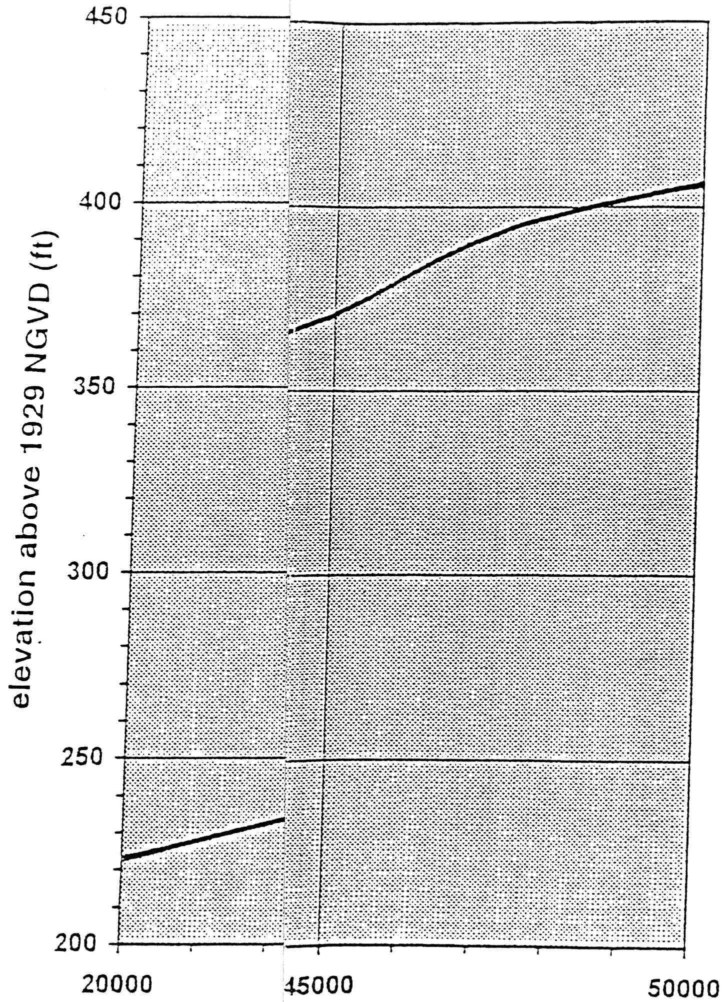
450
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elevation above 1929 NGVD (ft)
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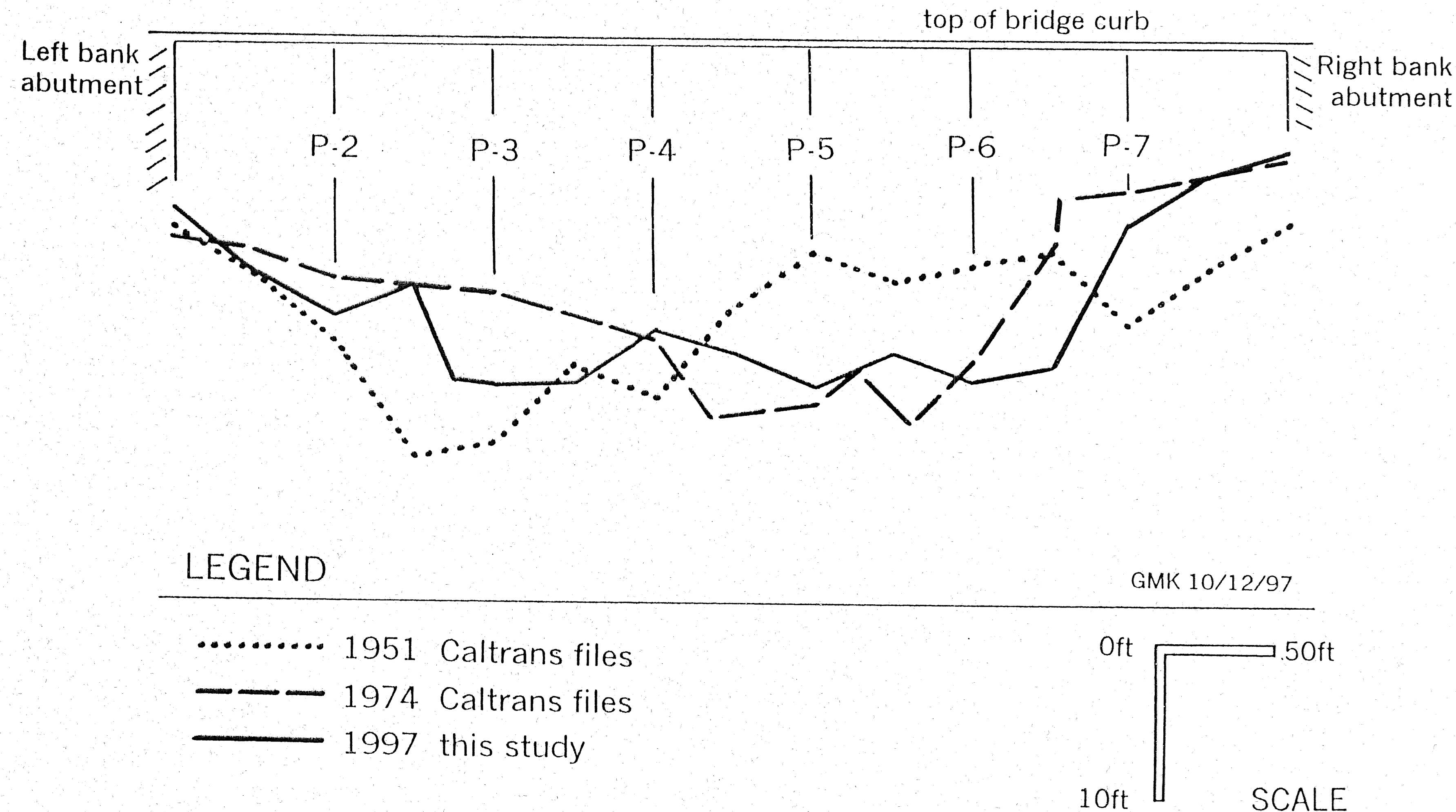

Figure 5-8. Cross sections along the upstream side of the Highway 99 bridge. 1951 and 1974 data from Caltrans bridge files (Caltrans, Sacramento), 1997 data from survey for this study in October 1997. (View is looking downstream, vertical exaggeration 5 x)

The Division of Water Resources completed a contract in September of 1986 that lowered the channel bed grade at the upstream side of the bridge. A contract completed the previous year lowered bed grades downstream. This condition could contribute to the scour problems at this structure. A stream profile was completed at this location in June 1987, it did not indicate substantial scour problems in the stream bed (Copelan 1988).

The exposure of clay hardpan at several points in the channel bed (Photo 5-1) may be further evidence of incision and suggests that the modern gravels of Deer Creek are relatively shallow, at least in some reaches.

BED MATERIAL SIZE DISTRIBUTION

Our pebble count data (Figure 5-9) show a downstream decrease in grain size on bars from a median size (D50) of 190 mm near the upper diversion to 55 mm between the Highway 99 and Southern Pacific Railroad Bridges (Table 5-2, Figure 5-10). The D84 (the size at which 84 percent of the sample is finer) ranged from 290 mm near the upper diversion to 128 mm between the Highway 99 and Southern Pacific Railroad Bridges . These are coarse gravels, but not unexpectedly so for such a high-energy channel. Sorting decreased with distance downstream, with the geometric sorting coefficient, sg (Inman 1952) increasing from 1.9 near the upper diversion to 2.4 below the Highway 99 Bridge (Table 5-2). The better sorting upstream probably reflects the inability of finer gravels to deposit (or remain) in the high shear stress environment there.

Table 5-2. Size Descriptors for Pebble Counts, Deer Creek

Peeble Count	Feature	Station	D16	D50	D84	DG	SG
A	Bar	13,700	22	55	128	52.5	2.4
C	Bar	28,800	35	99	185	80.5	2.3
D	Bar	31,000	42	116	210	93.9	2.2
E	Bar	43,000	62	135	215	115.5	1.9
F	Bar	56,500	84	190	290	156.1	1.9
B	Spawning gravel	13,200	31	51	88	52.2	1.7

As noted by Li in the chapter on Fisheries and Aquatic Resources, the gravels appear too coarse for spawning, but fall run chinook salmon are know to spawn successfully in these gravels. The pebble count we conducted on a riffle with fresh redds (between Highway 99 and Southern Pacific Railroad Bridges) had a D50 of 51 mm, which is within the range of sizes known to be used by salmon and trout from studies elsewhere (Kondolf and Wolman 1993). Of the fish and gravel sizes plotted in Figure 5-11, the larger fish sizes are all chinook salmon. The redd's gravel was better sorted than the bar gravels, with a sg of 1.7.

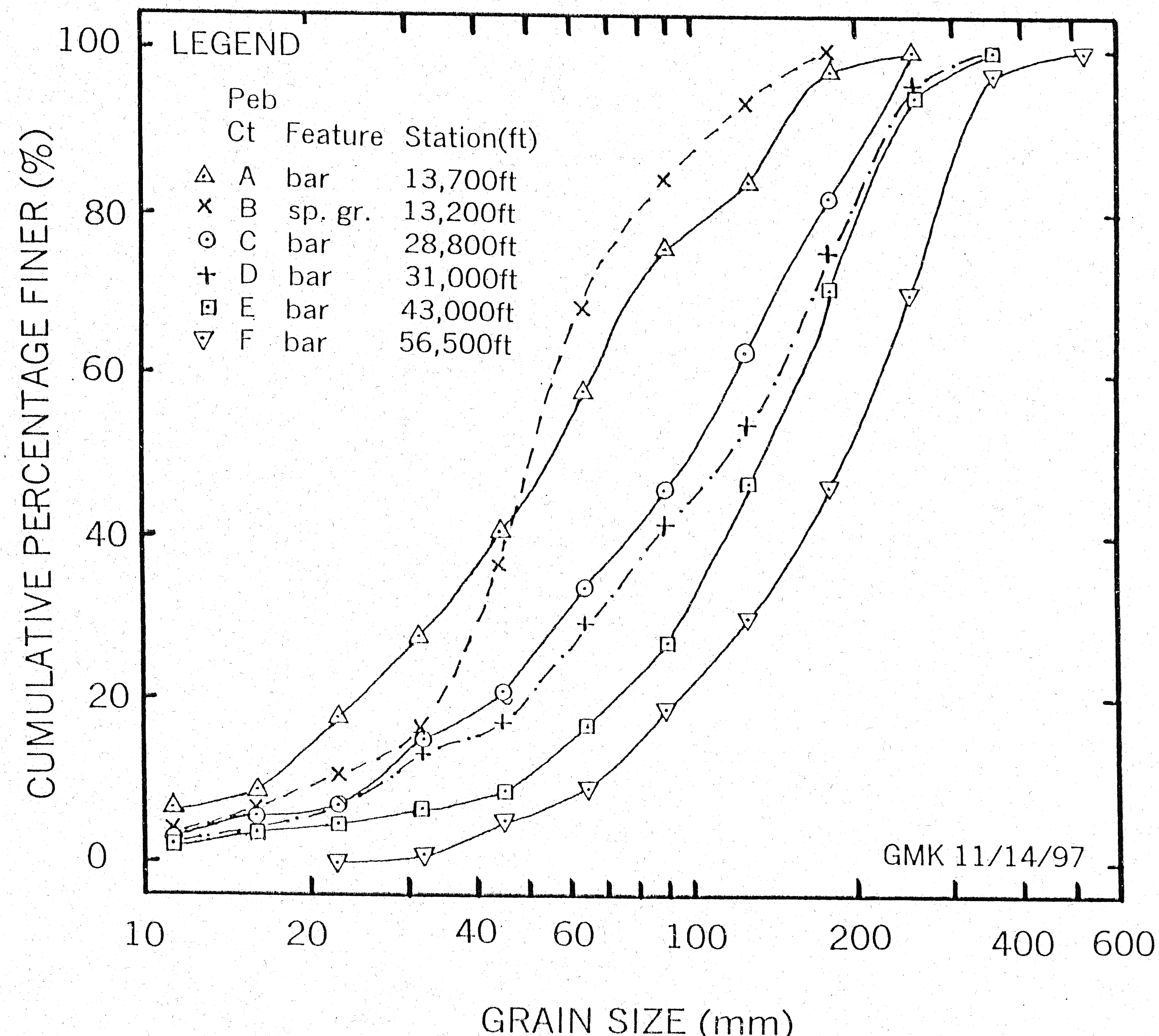

Figure 5-9. Surficial grain size distributions from pebble counts, October 1997.

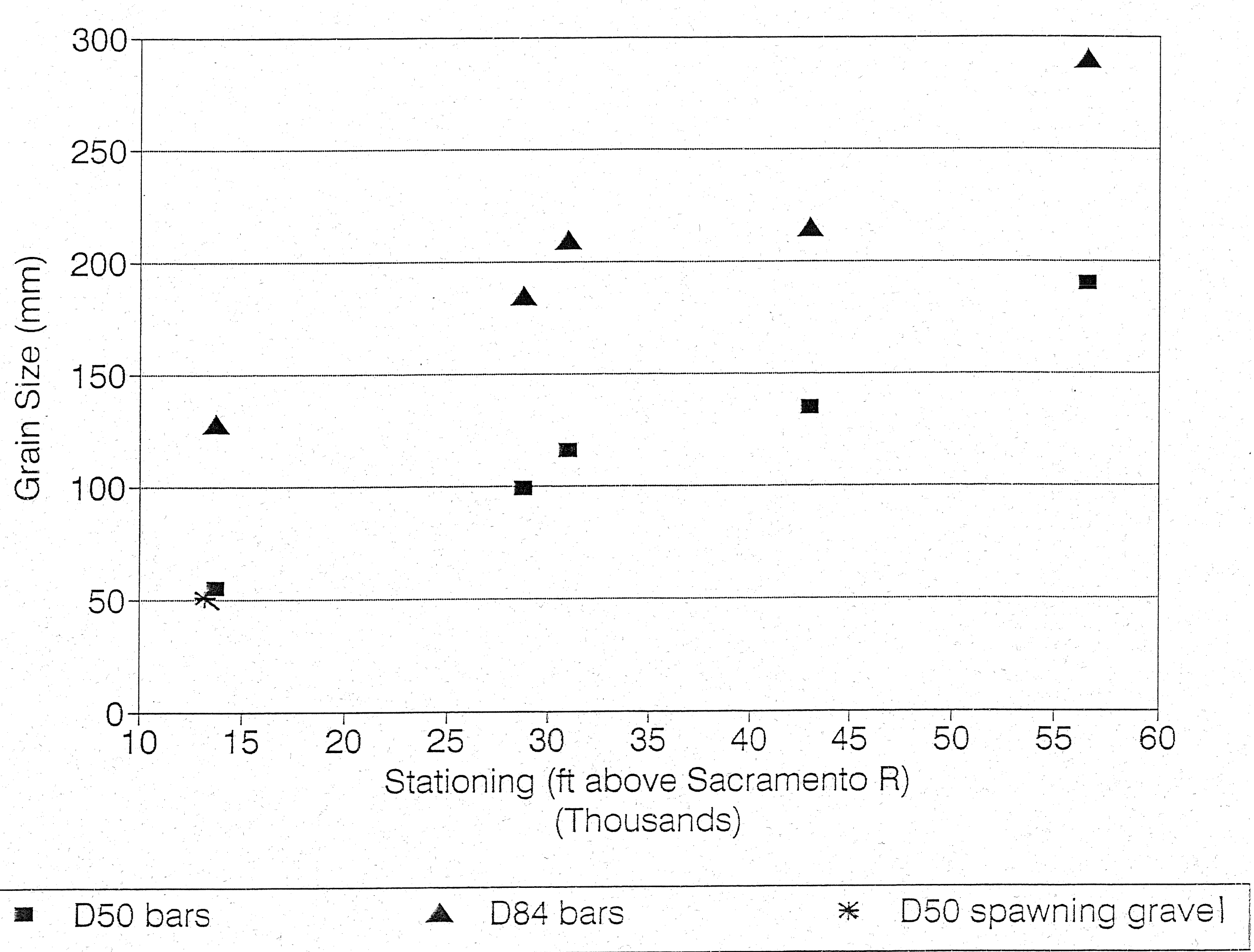

Figure 5-10. Change in grain size on bars with distance downstream along Deer Creek, October 1997

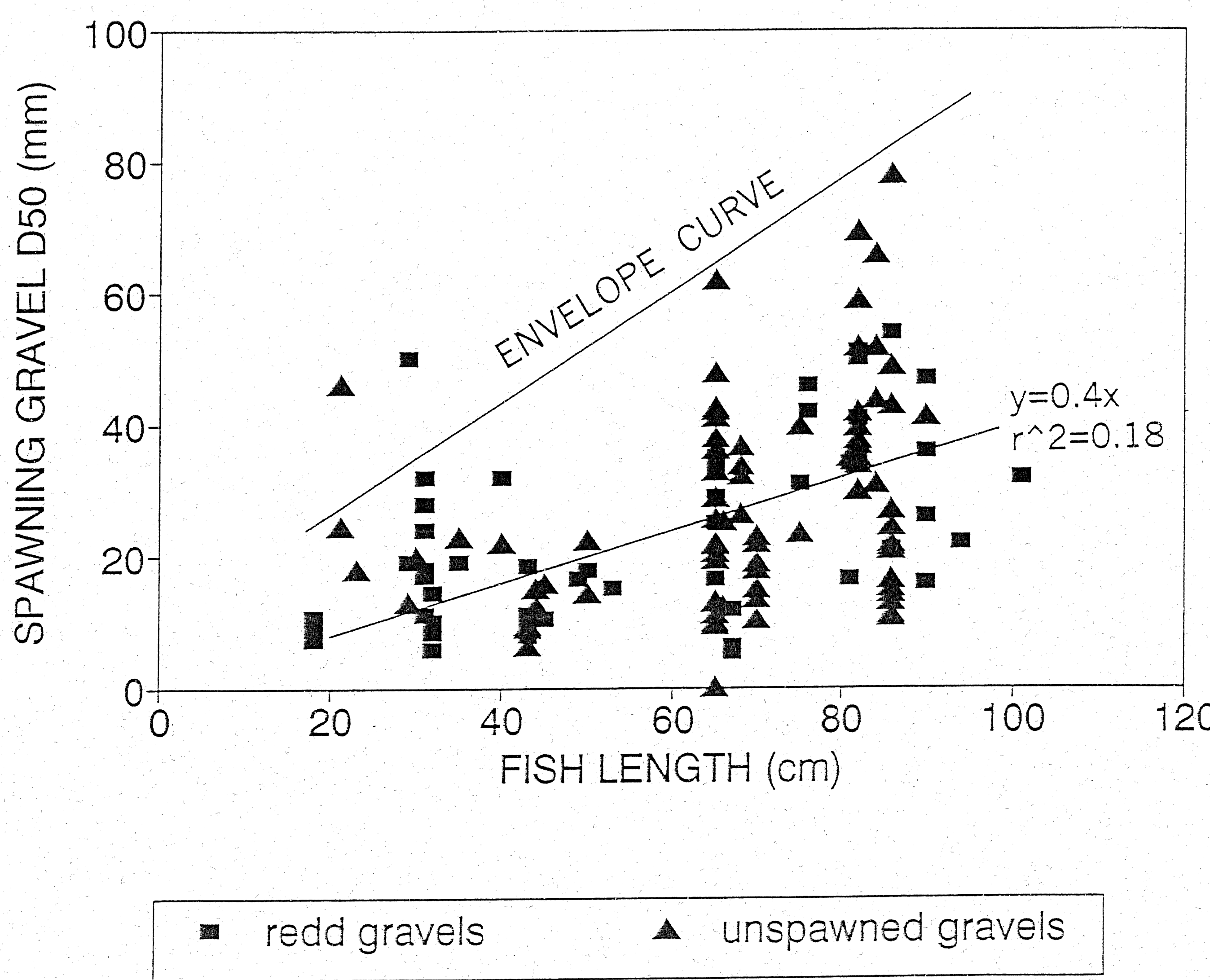

Figure 5-11. Range of gravel sizes known to be used by spawning salmonids from published studies. (adapted from Kondolf and Wolman 1993)

The redds we observed in this reach and in the reach immediately below the upper diversion dam did not have the classic deep pitt of redds observed elsewhere in finer gravels because the gravel mixture contains so many large cobbles that cannot be moved by the fish; these cobble remain behind as a lag that largely fills the pitt (the depression in the gravel created by the spawning fish). In effect, the spawning salmon here move the smaller particles interstitial to the large cobbles, deposit their eggs in the interstices, and attempt to cover the eggs by continued digging upstream.

The document "Restoring Central Valley Streams: A Plan for Action" (CDFG 1993:VII-56) stated that "some spawning areas are lightly armored, but could be enhanced for use by fall-run chinook salmon." Similarly, the "Working Paper on Restoration Needs" (USFWS 1995:3-Xb-51) stated that salmon production in Deer Creek is limited by "armored spawning gravel" and recommended mechanical ripping and construction of "spawning areas with graded gravel." The document "Ecosystem Restoration Program Plan Programmatic Actions" (Calfed 1997) listed as a target, "Maintain gravel recruitment and transport in Deer Creek at about 3,600 tons per year" and recommended that an "adequately balanced sediment budget" be provided "to sustain quality spawning conditions for fall-run and late-fall-run chinook salmon," but these recommendations were not explained.

None of these documents presented evidence to support the assertion that gravel in Deer Creek was "armored". The term "armoring" refers to the development of a relatively immobile, coarse surface layer in gravel bed, typically in response to sediment starvation below a dam (Dietrich *et al.* 1989), as opposed to a mobile surface gravel layer, typically referred to as a "pavement" (Parker and Klingeman 1982), which is a feature of active gravel beds. The bed material in Deer Creek has a pavement, but a poorly developed one. The surface layer is somewhat deficient in fine fractions relative to the subsurface layers, but bulk sampling (which we did not do) would probably show that the difference between surface and subsurface layers was less here than in undammed rivers with finer gravel beds, probably because of interactions of the very coarse framework particles.

If the bed was armored, it might imply that formerly good spawning gravels have become unusable as a result of progressive coarsening of the surface layer due to reduced bedload supply from upstream, commonly encountered downstream of dams (Kondolf 1997b). Evidently based on the (undocumented) concept that the bed of Deer Creek was armored, physical modifications to disrupt the surface layer and/or add smaller gravels to improve spawning habitat were proposed (CDFG 1993 and USFWS 1995) to make up for the reduced upstream supply. If a condition of armoring actually existed here, such proposals might have some merit, provided appropriate basin-level sediment supply/transport analyses and reach-level shear stress analyses were conducted as input to project design. However, in Deer Creek, the bed material size simply reflects the watershed and local channel conditions (in part resulting from channelization). Mechanical ripping of the bed is unlikely to result in smaller gravels on the surface, at least not past the next high flow. Similarly, because the shear stresses in this channel are so high, constructed spawning areas will not result in long-term improvement in spawning conditions in Deer Creek because the emplaced gravels (along with "hydraulic controls" installed) will wash away in high flows. If evidence of other such projects built in the Central Valley is any indication, such imported gravels could wash out at very modest discharges, such as flows with a return period of 1.5 years (Kondolf *et al.* 1996).

Although we lack documentation of bed material sizes before 1949, the evidence suggests that there were probably more deposits of smaller gravels in Deer Creek before it was channelized due to the more irregular nature of the channel (discussed below). In any event, a more sustainable approach to restoring former spawning gravel deposits would be to restore natural channel morphology, rather than ripping the bed, importing gravel, or constructing artificial structures to hold the gravel in place. At best, gravel importation might create habitat for a year or so before it was washed out.

FINE SEDIMENT SUPPLY/TRANSPORT

The road survey conducted in the upper watershed (Meadowbrook Associates 1997) was a comprehensive, systematic inventory of sediment related to roads, which constitute the largest chronic sources. This study (based on field work conducted in 1996) found sediment yields were tied closely to geology, with the greatest yields from areas underlain by rhyolite and dacitic pyroclastic rocks. Moreover, the study concluded that most of the erosion was associated with a handful of preventative problems, such as plugged culverts, poorly designed low-water crossings, intercepted run-off from skid trails and landings, and sloughing of fill-slope material. Total road-related erosion was estimated to be 15,450 yard^3 or 18 yard^3/mi^2/year. Ironically, one landslide upstream of Deer Creek Meadows in 1997 probably mobilized more sediment than this estimated annual total, although most of the landslide debris did not reach the stream channel. The failed slope that generated the landslide is crossed by roads/skid trails, so the landslide itself may have been triggered by road effects.

What happens to sediment that reaches the channel in the upper watershed? Some has probably contributed to channel instability in the Deer Creek Meadows Reach, potentially mobilizing more sediment from floodplain storage. However, once the sediment is transported downstream to the steeper, Canyon reaches, it appears to flush through. The first opportunity for deposition is within the downstream alluvial reach. This inference is based on observations (ours limited, more extensive by Stacy Li, Ken Roby, and Patricia Parker) that fine sediment deposition appears not to be a problem in the Highway 32 or Canyon Reaches of Deer Creek. This is geomorphically consistent with the expected fate of fine sediment introduced during high flow, which would be swept through these steep reaches. In general, such streams of the northern Sierra Nevada and southern Cascades have stream power in excess of that needed to move the sediment load supplied to them, so they can often accommodate increased supply. However, if fine sediment is introduced at low flow, there is the potential for its accumulation in pools and site of flow divergence behind boulders, etc., because stream power is so low that little transport occurs. Thus, fine sediment appears not to be a problem to important spawning and holding habitats in Deer Creek at present, but it cannot be dismissed as a potential issue in the future.

CHANNEL FORM

The upstream-most reach of Deer Creek (designated as the Butt Mountain Reach) consists mostly of steep, boulder and bedrock controlled channels. In the alluvial Deer Creek Meadows Reach, the channel has pools and riffles, but has widened in recent decades and has been unstable. In the Highway 32 Reach, the channel has a predominantly step-pool morphology with some bedrock controls (including Deer Creek Falls). Bedrock and boulder-control is even more pronounced in the canyon reaches, before the transition onto the floor of the Sacramento Valley, across the Deer Creek alluvial fan.

In the Valley Floor Reach, Deer Creek has multiple channels, some of which are only occupied during floods. Much of the upper reach is flanked by terraces composed of more resistant material (i.e., older, cemented sand, and gravels). The main channel(s) of Deer Creek can be seen to shift among its multiple channels during floods, such that the entire active channel may be occupied over the period of centuries. Deer Creek is a high-energy, potentially unstable alluvial stream. With its slope of approximately 0.005 and a bankfull discharge of about 5,000 cfs (approximately Q2), the alluvial reach of Deer Creek plots in the braided field of the channel pattern graph of Leopold *et al.* (1964) (Figure 5-12). This graph is best viewed not as an actual predictor of channel form, but rather a broad indicator of potential stream power. Actual channel form reflects a number of variables besides those shown here, and many channels may be braided at one flow level and not at another.

The aerial photographs, especially the 1939 photographs, show multiple channels. Some multiple channels were occupied at nearly all flows, others only during floods. Similarly, the thalweg wanders from side to side of the active channel, but it frequently bounces off hardpan or otherwise follows a path that, while alternating, is hardly a symmetrical meander and could better be termed "wandering". This pattern, typical for a high-energy channel such as this, illustrates the difficulty in applying any one type to some channels, and in any case, "typing" a channel is perhaps the least interesting and challenging aspect of geomorphic study. The real value of the plot shown in Figure 5-12 is to simply illustrate Deer Creek's high-energy channel, capability of dynamic behavior, and proneness to channel change during floods.

CHANNEL CHANGE

Channel courses and channel change are documented on a set of five large maps, printed in color, with mapped channels shown against a screened image of the USGS topographic map for sequential pairs of years, beginning in 1939. To avoid reducing them to such a small scale that the lines would become difficult to read, these maps are at 1:24,000 scale and cover the alluvial reach, from the upper diversion dam to the Sacramento River confluence. The maps are so large and expensive to reproduce (on the color plotter) that was not practical to include them in the report. However, sets of these maps are available for inspection at the office of the Deer Creek Watershed Conservancy in Vina and the Department of Geography and Planning at the

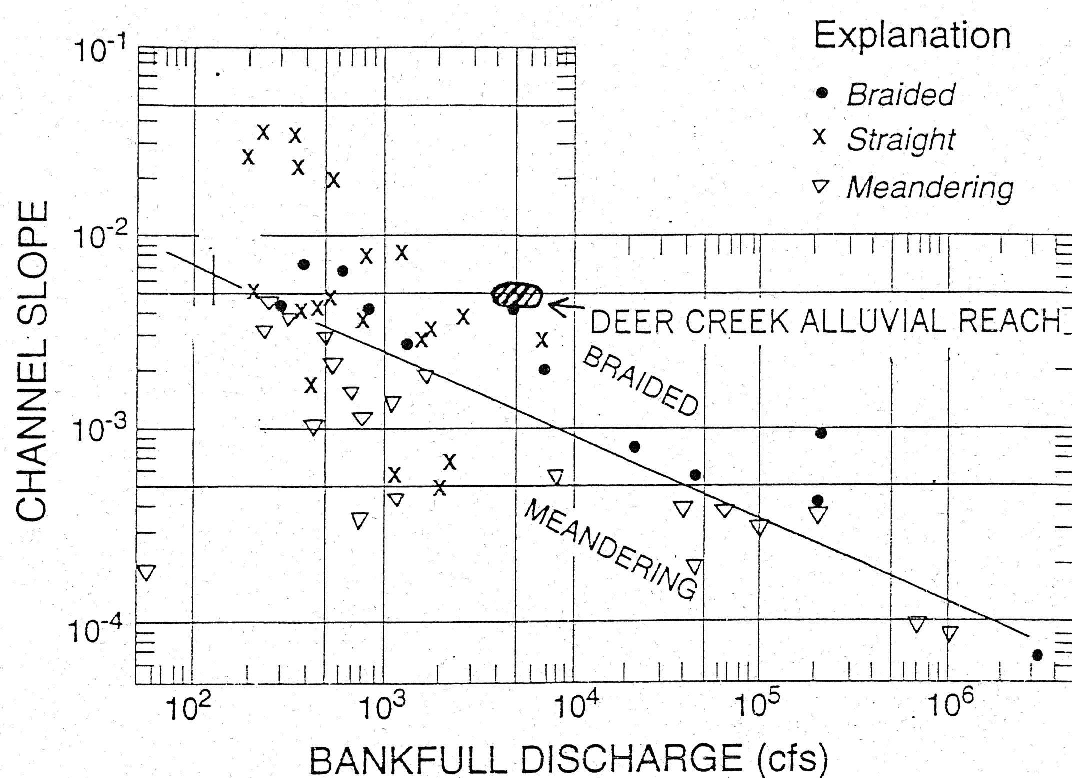

Figure 5-12. Channel pattern field of Leopold et al (1964) showing fields of braided and meandering channel patterns, with the alluvial reach of Deer Creek shown for gradient of approximately 0.005 and bankfull discharge of approximately 5,000 cfs. (Base figure adapted from Newbury and Gaboury 1993)

California State University at Chico. In addition, a detail from the maps, for the reach from the upper diversion dam (Station 58,000) downstream to about Station 45,000, showing changes from 1939 to 1952 is shown (in black-and-white) to give an indication of the nature of the resulting maps (Figure 5-13).

Channel Change 1939 to 1997

Considerable change in channel position can be seen from 1939 to 1997, especially where the stream leaves its confined canyon-like valley in the volcanic units and enters the broad alluvial valley. It is common to observe that rivers are especially unstable in such points of flow expansion and reduction in gradient. The many channels occupied by Deer Creek in this braided reach in 1939 and 1952 are illustrated on Figure 5-13.

The most dramatic changes evident between 1939 and 1952 were not the result of natural dynamic river processes, but of the extensive clearing and straightening of the river channel carried out in 1949 by the COE under the 1944 Flood Control Act. The 1939 low-flow channel was more sinuous, had more bank vegetation, and overall a much more irregular plan form than the 1952 channel. The reduction in sinuosity (the ratio of the channel length to the valley length) and reduction in riparian vegetation is illustrated in the reach at the Red (Leininger Road) Bridge and upstream (Photo 5-2).

These 1939 aerial photographs also show that most of the channel was flanked by riparian vegetation on at least one bank, despite passage of the largest flood of record (23,800 cfs) the previous year. Well-vegetated banks are apparent in Photo 5-2 and even more extensive downstream. The bank vegetation shaded the channel, and also provided structure to the banks in root mats that locally increased the bank stability, roots that created excellent cover for fish, and served as a source of large woody debris to the channel. By 1952, most of this bank vegetation was gone, the channel unshaded, and the banks less complex, conditions that have persisted to the present.

We can infer that, in addition to an irregular planform, the natural, pre-1949 channel had a more irregular bed profile, with pronounced pool-riffle undulations, and deep scour pools associated with bank vegetation and large woody debris. The channelization project included excavation of the bed, eliminating these habitats.

In the 1939 air photos (and on the 1:62,500-scale 1904 USGS topographic map), the channel is seen to have a pronounced northward bend just upstream of the Red Bridge, and the 1939 photographs show what appears to be a recently active channel to the north of the present channel downstream of the bridge. In 1997, the levees along the north bank here were damaged, the stream nearly washed out the road north of the creek, and succeeded in breaking through the north bank levee downstream of the bridge.

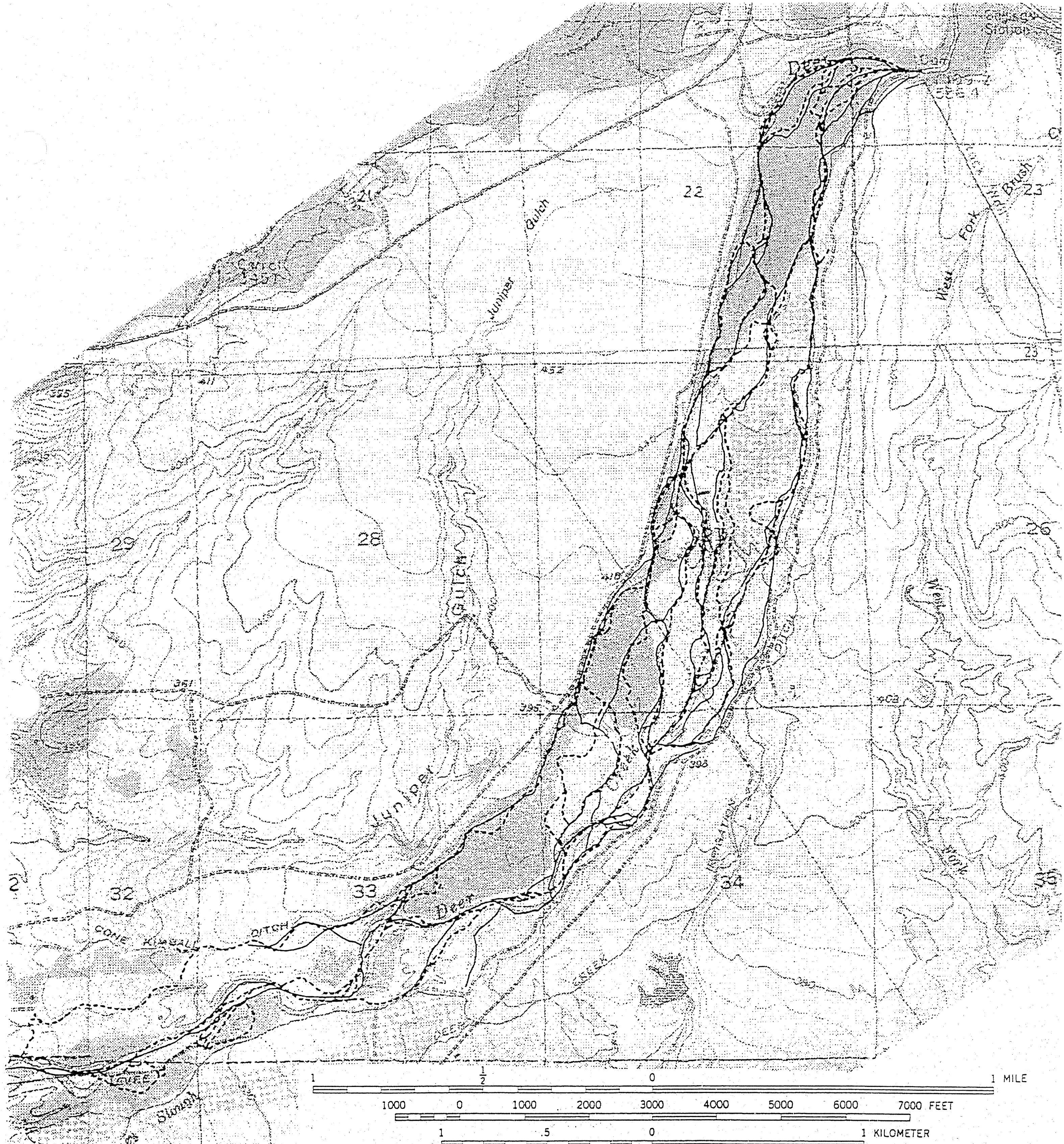

Figure 5-13. Multiple channels of Deer Creek as mapped from aerial photographs of 1939 (dashed line) and 1952 (solid line) from upper diversion dam downstream (station 58,000) to approximately station 45,000, detail from maps covering entire alluvial reach from 1939-1997. Complete sets of channel change maps are available for inspection at the Geography Department of the California State University at Chico and the offices of the Deer Creek Conservancy, Vina.

Changes in Spawning Habitat Extent

Viewed under magnification and stereoscopically, the 1939 aerial photographs clearly display riffles and pools, well-developed point bars and riffles associated with sharp bends, and abundant large woody debris in the channel. As a result of this irregular plan form, bed topography, and large woody debris, the 1939 channel would have had a greater range of shear stress conditions, permitting the deposition of smaller-sized spawning gravels than can remain under the conditions of increased shear stress that have resulted from channelization. This is consistent with recent theoretical predictions for Washington streams by Buffington *et al.* (1997), demonstrating the greater potential for deposition and retention of spawning gravels in channels with irregular geometry and large woody debris than in channels with more simplified structure. Although we do not have direct measurements of spawning gravel availability before the channelization project, observations on the 1939 aerial photographs and theoretical considerations would suggest that more spawning-sized gravel was available in the irregular, hydraulically-rough channel existing before the channelization project.

Since 1939, the channel has changed position in a number of places, but (probably because of continued "maintenance" such as the gravel removal projects of the 1980s), the character of the channel has resembled the 1952 channelized condition more than the 1939 condition. Given the high energy of Deer Creek, there is potential for the more natural pre-channelization topography to redevelop over time if levees were set-back and channel maintenance activities ceased or greatly reduced.

Near the point of dike construction at the Soski Ranch, the main channel has become considerably more sinuous since 1939, evidently in response to dike construction.

FIELD OBSERVATIONS OF GEOMORPHIC - AQUATIC HABITAT INTERACTIONS

The cobble bar deposited in the channel at the point of the levee breach (due to reduced mainstem velocities where flows exited through the breach) has been suggested to constitute a barrier to fish migration. However, field inspection with Stacy Li indicates that this bar is not a barrier to migration. Similarly, other bars that may appear to be barriers to migration are probably not passageway problems, and their removal is not necessarily warranted. Moreover, these features represent the downstream migration of coarse sediment in Deer Creek, sediment that is ultimately destined for the mainstem Sacramento River, which has been demonstrably starved of coarse sediment since construction of Shasta Dam, extensive gravel mining on the river and its tributaries, and extensive bank protection. Thus, removal of these bars can be viewed as interrupting the flux of sediment through Deer Creek. A better approach, and one justified biologically as well (S. Li pers. comm. 1997) is to leave these bars in place, and to cut smaller channels through them only if they are demonstrably hampering upstream migration.

Field inspection suggests that much of the recent deposition of cobble upstream of the Red Bridge results from the constriction created by the bridge. This constriction effect, if significant, may have other geomorphic consequences as well, as the dropping of coarse load upstream would tend to induce channel migration. The effect of the bridge on passing high flows could be modeled to indicate the extent to which it acts as a constriction, and possible replacement designs (that could be more river-friendly) could be modeled for evaluation as well.

The literature is replete with evidence that natural, complex channels (i.e., channels with irregular banks, undulating bed morphology, and large roughness elements such as large woody debris) provide better aquatic habitat than simplified, channelized reaches (Brookes 1988). Impacts of channelization include: loss of aquatic habitat area and diversity, reduction in shading of the channel with attendant increase in water temperature, loss of riparian habitat for wildlife, specifically loss of undercut banks and overhanging vegetation, loss of pool-riffle structure, and loss of spawning habitat. This relationship is visible from field observation on Deer Creek, and would probably be evident from detailed habitat mapping within channelized/leveed vs. more natural reaches of Deer Creek. One way in which channelization and levees reduce the quality of habitat in Deer Creek is by eliminating refuge from high flows: all the flow is concentrated between the levees, leading to increased shear stress in this narrow band. Not only do fish have no place to hide in such channelized/leveed reaches, but the resulting channel typically becomes simpler as well. Thus, the initial 1949 channelization project and subsequent channel clearing, gravel removal, and levees repairs (including post-1997-flood emergency work) were most likely detrimental to aquatic habitat in Deer Creek.

Channel modifications are commonly accompanied by installation of rip-rap on banks. Rip-rapped banks lack bank overhangs, trees and roots, and other irregularities. Although the interstices of rip-rap can provide some habitat for juveniles, overall there is a loss of habitat when a natural bank is converted to rip-rap. Numerous studies have shown that rip-rapped banks support lower densities of fish (e.g., Cederholm and Koski 1977, Chapman and Knudsen 1980, and Knudsen and Dilley 1987). Moreover, hardening riverbanks in one location typically produces a reaction elsewhere along the channel, because flows speed up, slow down, or change in direction. As a result, erosion is initiated elsewhere, and bank protection may be proposed for the new site of erosion, initiating a cycle of erosion and costly rip-rap projects, ultimately with substantial, negative, cumulative effects on aquatic habitat.

CONCLUSIONS

The most significant changes in Deer Creek resulted from the channelization and levee construction of 1949. The direct effects of channelization resulted in a significant change in habitat quality by eliminating irregularities that would provide sheltered, marginal habitat for juveniles, more pronounced variations in bed topography, and opportunities for deposition of smaller gravels. Moreover, clearance of riparian vegetation reduced shading of the channel by overhanging vegetation and contribution woody debris from the banks.

Levee construction eliminated the river's natural overflow areas, artificially constraining high flows in a narrower channel and thus increasing shear stress in the channel for a given flood discharge. This resulted in more rapid downstream propagation of floods, potentially increasing flood risk downstream. Within the channel, the increased shear stresses (combined with the reduced hydraulic roughness caused by simplifying the channel in channelization) make it less likely that smaller gravels can deposit and provides less refuge habitat for fish during high flows.

Its high energy, alluvial fan setting makes Deer Creek inherently difficult to control, as reflected in the repeated levee failures. However, its high energy also makes Deer Creek resilient in the sense that floods can reshape the channel, thereby recreating more natural channel form over time. Alternative management strategies using (rather than fight) river processes (e.g., setting back levees and permitting the river to erode and migrate within a broad meander belt) should be considered.

Although bed material gravels are relatively large, the spawning gravel sampled near Highway 99 was well within the range of spawning gravels used by chinook salmon elsewhere. Redds can be observed in the bed even in areas with coarser bed material and successful natural reproduction occurs (as noted in the Fisheries chapter). The suggestion that the bed of Deer Creek is "armored" (USFWS 1995) is incorrect, and proposals to rip the bed to improve spawning habitat would be ill-advised. Similarly, if smaller gravels are to be added to the channel to improve spawning habitat, it should be done with the understanding that with the current, channelized configuration, these smaller gravels will likely not remain stable. Artificial structures to stabilize the gravel in place are very unlikely to work and may do more damage than good.

ACKNOWLEDGEMENTS

Dan Keppen (Tehama County Public Works) kindly provided background information on and photographs of past flooding and flood control efforts, and shared insights into channel processes on Deer Creek. Stacy Cepello (Department of Water Resources, Red Bluff) shared aerial photographs, bridge files, hydrologic information, and insights and knowledge of Deer Creek from his long experience with the system. Bill Travers (California State University, Chico) shared information on historical sources and provided copies of historical correspondence concerning the COE flood control project. Stacy Li shared insights into salmon habitat-geomorphic interactions. Ken Robey (U.S. Forest Service) and Mike Kossow (Meadowbrook Conservation Association) provided an excellent overview tour of the upper watershed and shared results of the watershed analysis and road erosion survey, as well as their observations of channel conditions in the upper reaches. John Stanley provided valuable overall guidance for the project and facilitated arrangements in numerous ways. Chris Leininger and Sue Knox assisted with field arrangements and landowner permissions for access. Jennifer Vick planned and supervised the process of digitizing channel features from historical aerial photographs and maps, and Keith Lichten assisted with the digitizing work. Kelly Garrison contributed substantially to the preparation of the final images and screened topographic map background, and Mintai Kim produced the final, rectified map images.

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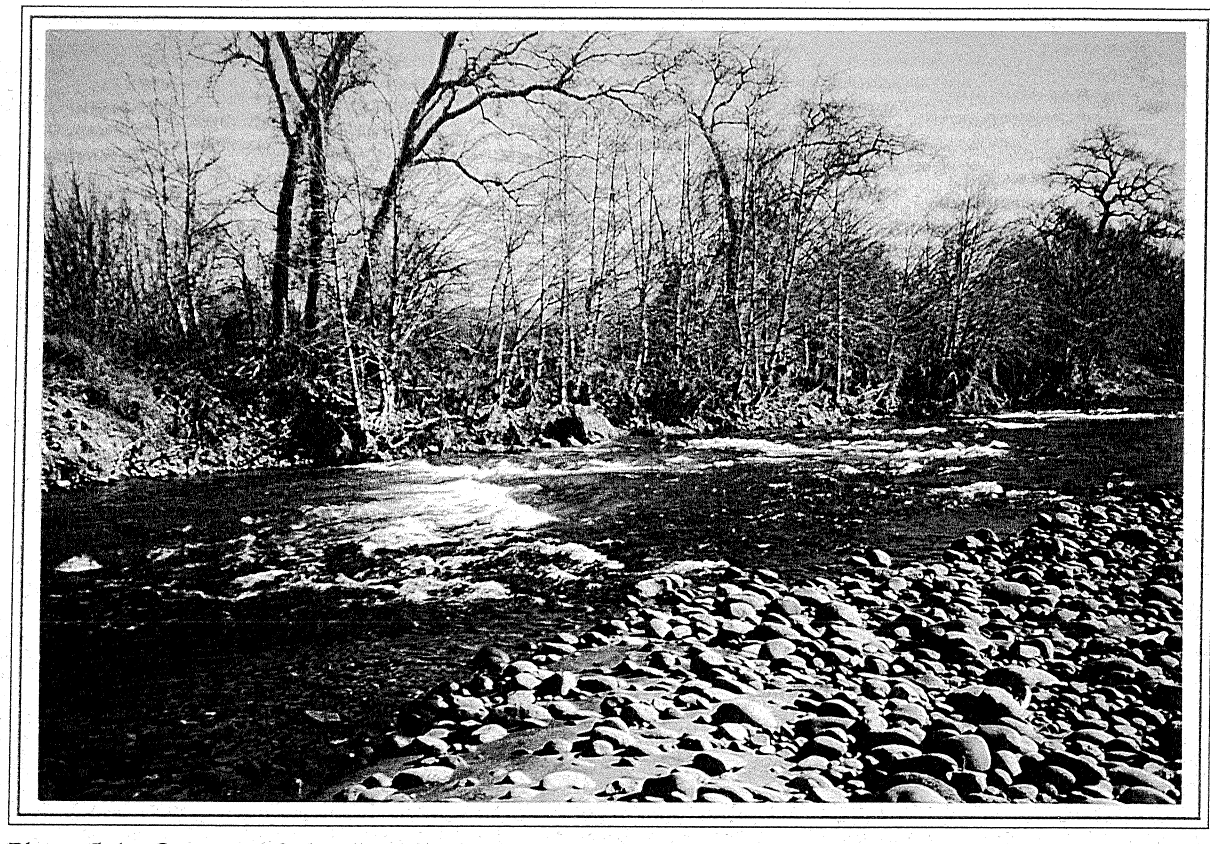

Photo 5-1. Outcrop of clay hardpan in the bed of lower Deer Creek. (Photograph by M. Kondolf February 1997)

Next page:
Photos 5-2, 5-3, 5-4. Details from sequential aerial photographs of Deer Creek near the Red (Leininger) Bridge from 1939, 1952, and 1997. Flow is from right to left.

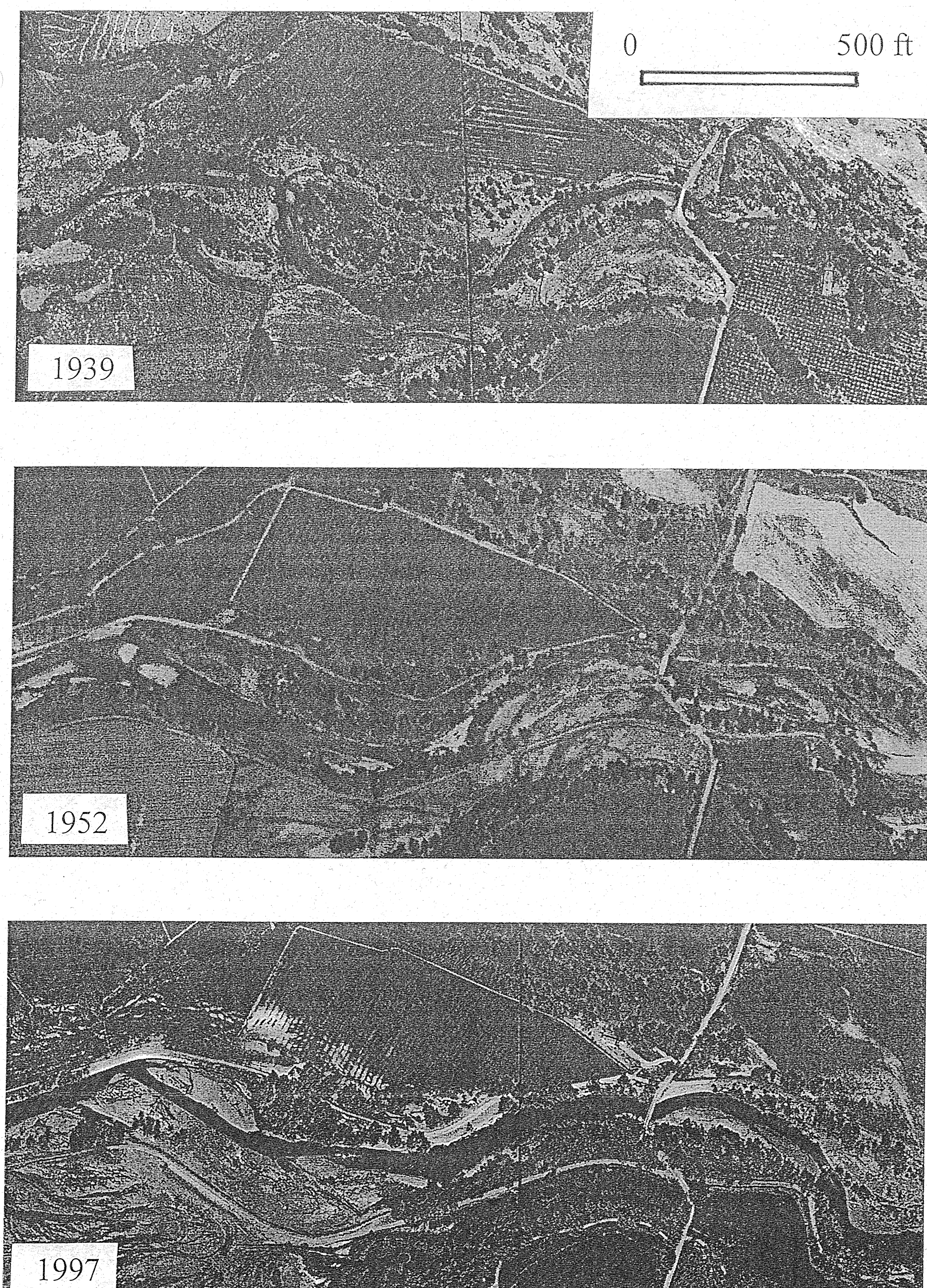
0
500 ft
1939
1952
1997

Photo 5-5. Looking west at multiple channels of Deer Creek as it enters the floor of the Sacramento Valley just to the west of the mouth of Deer Creek canyon. (Photo by J. Stanley, January 1997)

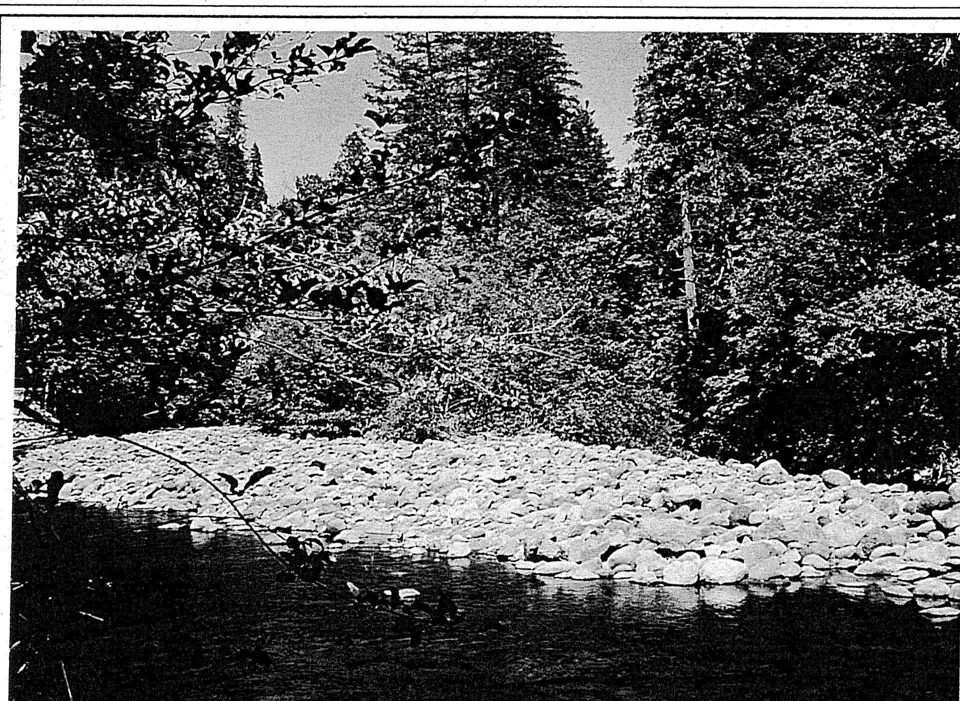

Photo 5-6. Boulders deposited on channel bar upsteam of Upper Deer Creek Falls following January 1997 storm event. (Photo by J. Stanley, June 1997)

6.0 EROSION AND SEDIMENTATION

SOIL ERODABILITY

Fluvial Erosion

Fluvial (initiated by flowing water) erosion processes are evident in the form of raindrop splash on bare soil, sheetwash on compacted or saturated soils, rill erosion, and gullying where run-off concentrates. Rainfall intensity, vegetation cover (type and density), soil characteristics, slope steepness, and antecedent moisture conditions are factors that control hillslope erosion rates. The mitigation of fluvial erosion usually involves: 1) the maintenance of soil infiltration capacity via retention of adequate soil cover and limiting the areal extent of severely disturbed/compacted soil and 2) dispersing overland run-off via drainage structures to minimize concentration of flow.

Appendix A (Table A-4) provides a listing of soils found within the Deer Creek watershed and their major characteristics extracted from the 1967 Tehama County Soil Survey. A summary of soil groupings by Erosion Hazard Rating is shown below in Table 6-1.

Table 6-1. Percentage of Deer Creek Watershed Area by Erosion Hazard Rating

Erosion Hazard Rating	Percentage of Watershed Area
Low	34
Moderate	30
High	29
Variable*	7

*Variable includes map units with high rock content.

The soil series associated with the rhyolite zone (Jiggs and Lyonsville soil series) are most prone to fluvial erosion. These soils are very young and poorly developed and as a result, are thin, coarse textured, and have very low cohesive strength. Texturally, these soils are classified as gravely/stony sandy loams. When disturbed, these soils tend to produce copious amounts of overland run-off that is often channeled into roads and skid trails producing gully erosion. Rhyolitic soils are found on (approximately) the upper 25 percent of the watershed.

With some exceptions, the andesite/basalt-derived soils of the middle and lower watershed tend to be less susceptible to fluvial erosion. These soils (primarily the Windy and McCarthy soil series) are finer textured with greater cohesive strength. The exceptions are the agglomerates and mudflows that tend to have low infiltration capacity. As a result, these areas are poorly vegetated and tend to be significant producers of surface run-off.

Most land uses involve some reduction of vegetative cover and direct mechanical disturbance of soils via road construction or site development. Thus, most commercial land uses offer the potential to increase fluvial erosion rates.

Forest roads have been shown to have the potential to be a significant source of accelerated erosion. In 1996, a survey of the road system in the watershed above the Ishi Wilderness was conducted to assess the magnitude of road-related sediment contributions in the watershed (Meadowbrook Conservation Associates, 1997). The results of this study indicated that overall, road-related erosion rates are generally moderate (averaging 22.3 $yd^3/mi^2/year$) and that related erosion probably constitutes somewhere between 5 to 20 percent of the average annual sediment load.

Factors contributing most significantly to road erosion included geology, topographic setting, and ownership. In line with expectations, road erosion rates on rhyolitic soils were more than twice the rate for roads on andesitic soils. Roads crossing landforms with high drainage densities (alluvial fans and toe slopes primarily) were much more prone to problems with stream crossings resulting in erosion rates three times higher than the overall average. Higher road densities, more low standard roads, and majority ownership of rhyolitic areas resulted in erosion rates on private land that averaged 58 percent higher than those on public land. The large extent of roadless or lightly roaded areas helped to keep overall road-related erosion rates lower than they otherwise might have been.

SLOPE STABILITY

Mass movement features are mostly associated with the andesite/basalt soil complexes and are dominated debris flow/debris torrent processes. Debris flows develop in the headwater basins of steep tributaries. Hundreds to thousands of years of sediment and colluvial material, accumulated in these headwater basins, is mobilized *en masse*, usually by large infrequent storms. Saturation of this material increases its weight, decreases cohesion by increasing pore water pressure, and reduces shear strength along the soil-rock boundary. Once mobilized, this material acts much like a snow avalanche, entraining soil, rock, air, water, and anything else in its path as it scours out the entire length of channel below it. By nature this process is very episodic. Large events are very infrequent, smaller ones more frequent. A recent example of this type of process is evident in a small unnamed tributary just above Black Rock in the neighboring Mill Creek watershed. On a geologic time scale, this process results from the steepening of side slopes that results from the incision of the main channel. Thus, this process is most active in the most deeply incised portions of the watershed.

SEDIMENT SOURCES

Primary sediment sources, listed in decreasing order of magnitude, include: 1) mass movement processes; 2) erosion of channel bed, banks, and adjacent inner gorge slopes; 3) erosion from land use disturbances, especially roads, landings, and skid trails; and 4) naturally-occurring sheet, rill, and gully erosion from hillslopes. Actual data on most of these sources is non-existent and the ranking presented above is based on professional judgment and experience with data from other watersheds with similar histories.

The contribution of sediment from mass movement processes is extremely difficult to quantify precisely because their occurrence is episodic (sporadic) over extremely long time frames. However, the volume of material generated by any one event is so large as to dwarf contributions from other sources.

Active bank erosion associated with channel adjustment is evident in both Childs Meadows and Deer Creek Meadows. Below Deer Creek Meadows in the canyon reach, sloughing of inner gorge slopes adjacent to the main channel is the dominant channel erosion process. Channel instability is fairly common and, to some degree, natural in the lower eight miles of Deer Creek from the USGS Gaging Station to the confluence with the Sacramento River. Here the channel has formed an extensive alluvial fan from millennia of sediment deposition. Alluvial fans are fan-shaped precisely because the channel changes course frequently over time as the existing channel aggrades from deposition. The very lowest reach of the channel near Vina has been extensively modified by levees and bridges and shows evidence of bank erosion in response to some of these modifications.

The magnitude of natural sheet, rill, and gully erosion from hillslopes is unknown. From studies elsewhere in the region, it tends to be a very small fraction of the volumes generated from the sediment sources previously discussed.

EROSION PROBLEMS

Erosion problems that can and should be addressed through management actions are those that: 1) are primarily human-caused, 2) result in significant adverse effects, existing or potential, and 3) offer a reasonable hope of successful treatment at a reasonable cost. Using this logic, road-related erosion and certain types of channel erosion problems offer some promise for improvement. For example, the previously cited road survey found that 50 percent of the erosion volume from roads was coming from just 10 percent of road miles. The implication is that treatment can be efficiently targeted to get the most reduction in sediment for the smallest capital investment. Streambank erosion where recovery is likely through small scale changes in management practices are good candidate sites to address sediment reduction.

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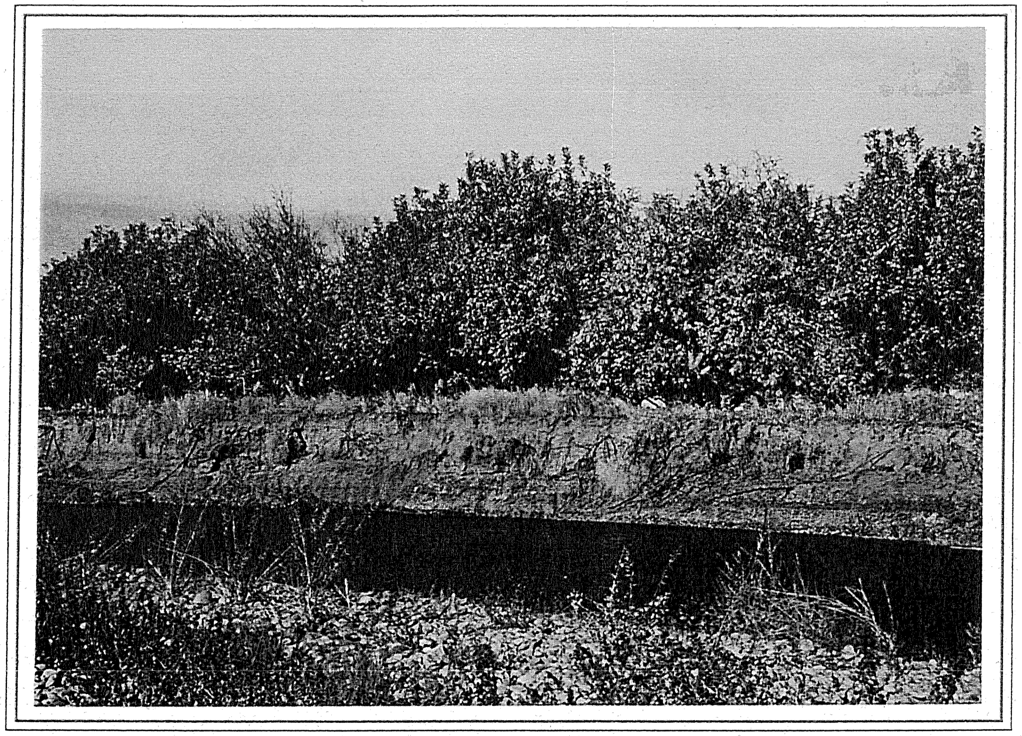


Photo 6-1. Bank Erosion on north side of lower Deer Creek downstream of the Highway 99 bridge. (Photo by J. Stanley, November 1996)

Photo 6-2. Bank erosion on north side of Deer Creek just downstream of the Highway 99 bridge. (Photo by J. Stanley, January 1997)

Photo 6-3. Looking upstream at walnut tree lost due to streambank erosion on north side of Deer Creek downstream of Highway 99 bridge. (Photo by J. Stanley, November 1996)

Photo 6-4. Looking downstream at streambank riparian vegetation being undermined by bank erosion on north side of Deer Creek downstream of Highway 99 bridge. (Photo by J. Stanley, November 1996)

Photo 6-5. Looking northwest at erosion on north bank of Deer Creek (approximately 1/4 mile downstream of the Cone Kimball Diversion) from atop groin extending from south bank. (Photo by J. Stanley, June 1997)

Photo 6-6. Closer look at bank erosion on north bank adjacent to sycamore tree. Note debris from January 1997 flood piled up against base of tree. (Photo by J. Stanley, June 1997)

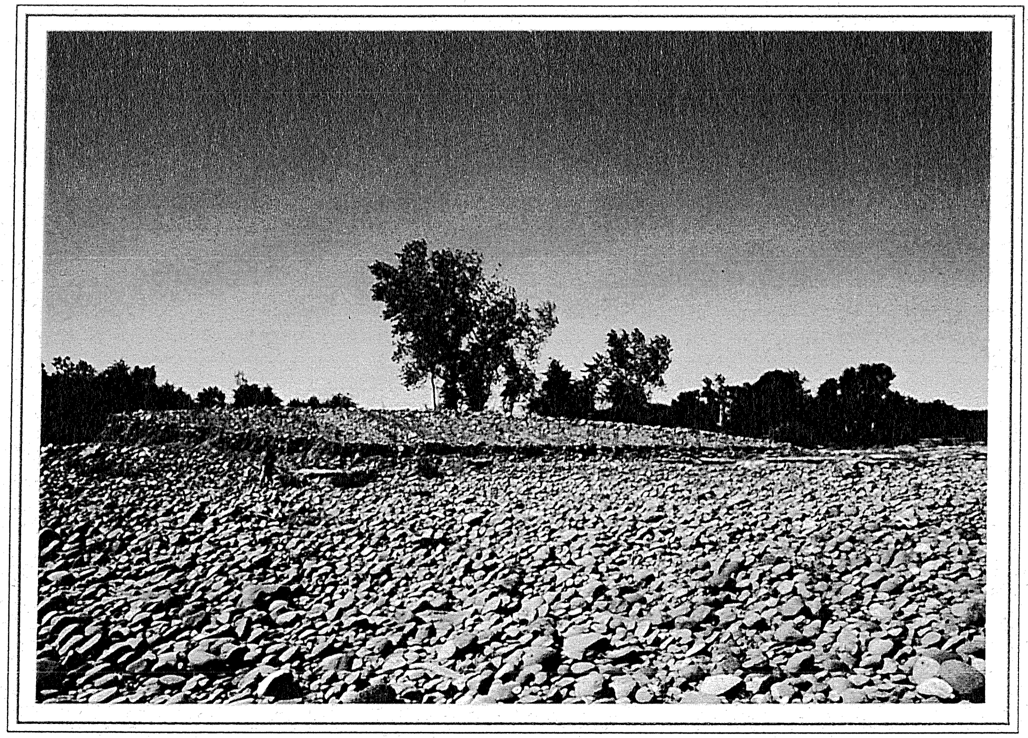


Photo 6-7. Looking at partially eroded groin (constructed of river gravels) extending from south bank of Deer Creek upsteam of Red Bridge. (Photo by J. Stanley, June 1997)

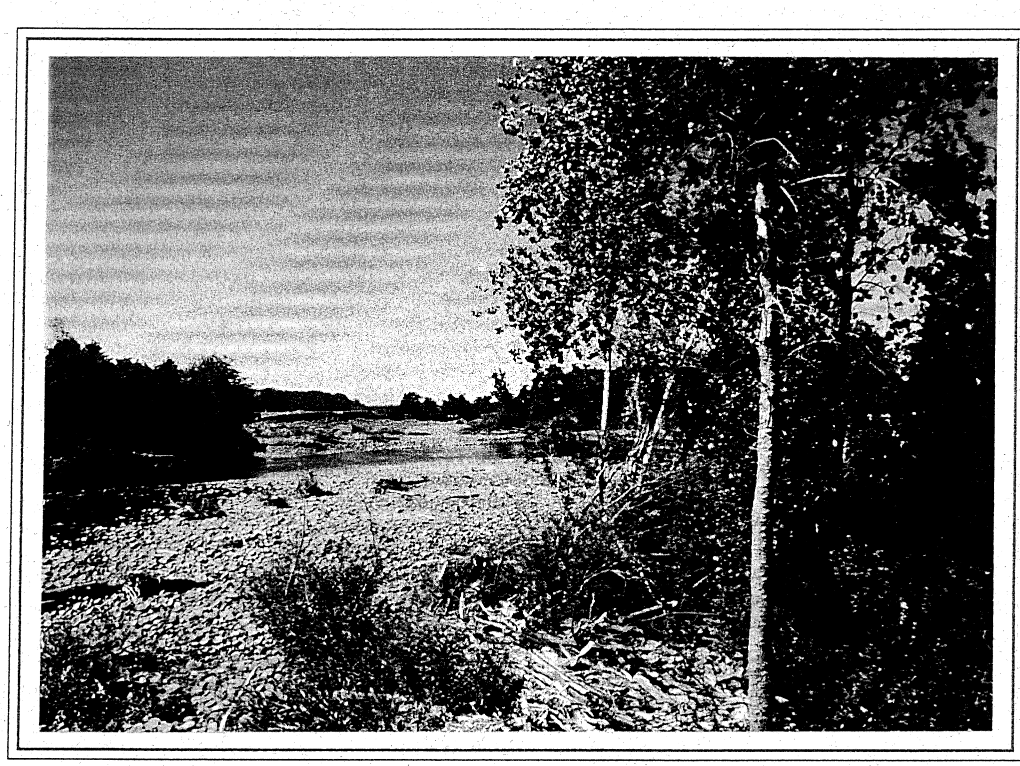


Photo 6-8. Looking south from north bank at channel/bank erosion on south bank downsteam of groin. (Photo by J. Stanley, June 1997)

Photo 6-9. Debris flow in Gurnsey Creek Watershed resulting from rain on snow event in January 1997. (Photo by J. Stanley, June 1997)

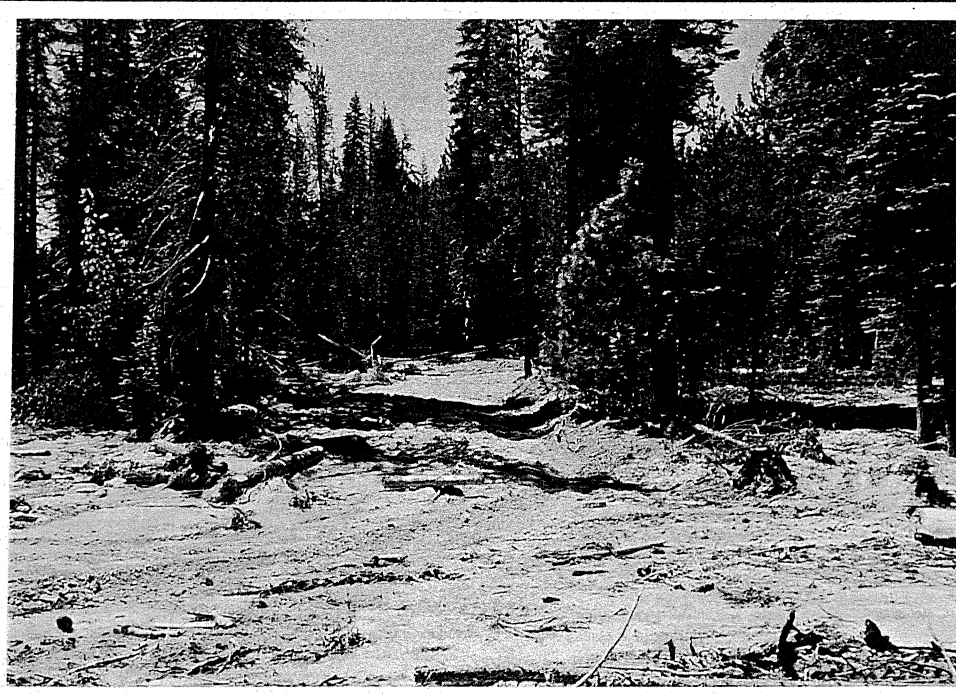
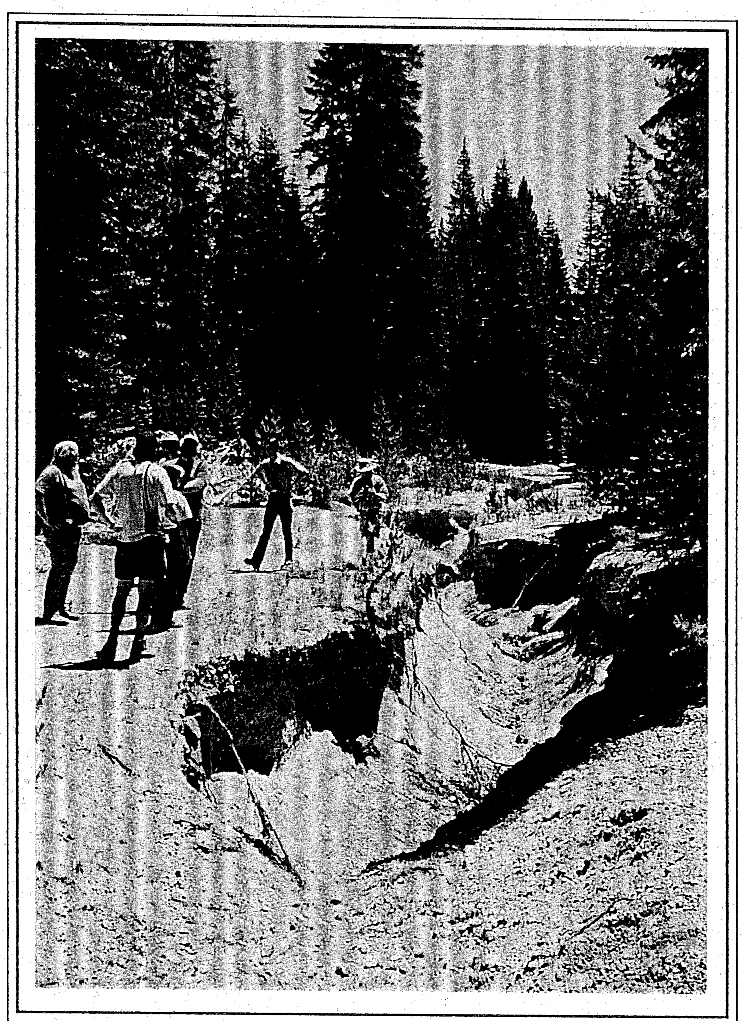


Photo 6-10. Material deposited at bottom of debris flow a short distance from Gurnsey Creek. (Photo by J. Stanley, June 1997)



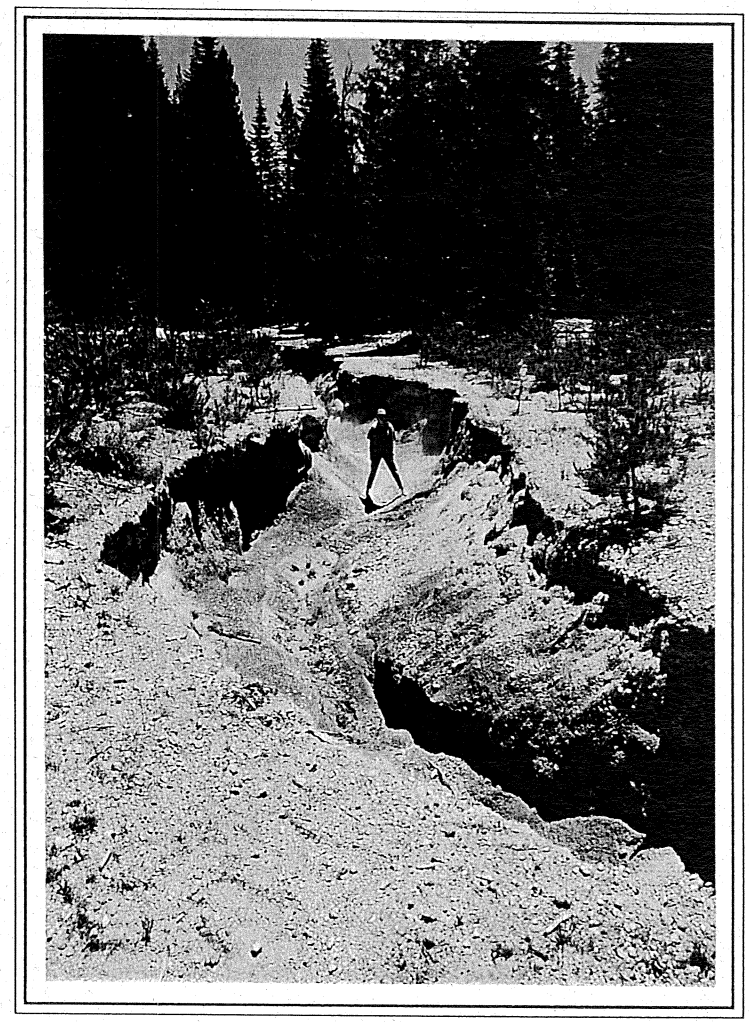


Photo 6-11 and 6-12. Erosion gully in Gurnsey Creek Watershed (west of Gurnsey Creek) (Photos by J. Stanley, June 1997)

Photo 6-13. Gurnsey Creek (North Fork Deer Creek) flowing through Childs Meadow. (Photo by J. Stanley, June 1997)

Photo 6-14. Eroded streambank along Gurnsey Creek in Childs Meadow. (Photo by J. Stanley, June 1997)

7.0 WATER QUALITY

SURFACE WATER QUALITY (HISTORIC DATA SUMMARY)

The main body of chemical water quality data is contained in the California Department of Water Resources (DWR) files. No other significant sources of such data were found to date. Some basic physical parameters have been measured on a sporadic basis, usually associated with fishery studies.

DWR has data for the station at Highway 99 dating from 1952 to the present. Much of the older data consists primarily of field measurements and mineral analyses, but more recent analyses include field measurements and mineral, nutrient, and minor element analyses. Limited nutrient data are available for the period of 1964 to 1988 on nine sampling occasions. A cursory review of the DWR computer data files from the station at Highway 99 during the period of 1988 to the present provides the following conclusions on surface water quality.

Nutrients

Nutrient values measured were within an acceptable range and generally less than State and Federal drinking water and freshwater aquatic life Maximum Contaminant Level (MCL) standards where they have been established (see Table 7-1). Ammonia concentrations were reported above laboratory detection levels on two dates (October 1992 and September 1994) at a level of 0.01. The freshwater aquatic life MCL for ammonia is based on temperature and pH of the individual sample. The calculated Four-day Average Continuous Concentration MCL values for these dates are 0.0186 mg/L (October 1992) and 0.035 mg/L (September 1994). The detected concentrations are below these calculated MCL values.

Table 7-1. Range of Surface Water Quality Data (Nutrients) for DWR's Highway 99 Station (1988 to present)

Nutrient	Range (mg/L)	EPA Primary Drinking Water MCL (mg/L)	EPA Secondary Drinking Water MCL (mg/L)	Freshwater Aquatic Life MCL (mg/L)
Total ammonia and organic nitrogen (NH^3 + Org. N)	<0.1 to 0.8	--	--	--
Dissolved nitrite and nitrate ($N0^2 + N0_3$)	<0.01 to 0.15	10.0	--	--
Dissolved nitrate ($N0_3$ as N)	<0.1	10.0	--	--
Dissolved nitrite ($N0_2$ as N)	<0.1 to 0.2	0.1	--	--
Dissolved ammonia (NH_3)	<0.01 to 0.01	--	--	calculated for individual sample*
Dissolved orthophosphate ($P0_4$)	<0.01 to 0.01	--	--	--
Total phosphorus (P)	<0.01 to 0.05	--	--	--

* Temperature and pH dependent. mg/L = micro-grams/liter

Minerals

Few established water quality criteria for minerals have been established, except for sulfate and chloride. The measured concentrations for these constituents are well below the established water quality standards (Table 7-2). The Central Valley Regional Water Quality Control Board (CVRWQCB) has reported that the mineral quality of Deer Creek is acceptable for all stated beneficial uses.

In 1994, Jones and Stokes Associates, Inc. completed a report on the suitability of including Deer Creek in the State Wild and Scenic Rivers System. Part of this study included an assessment of resources, including water quality conditions. The authors concluded that the mineral quality of Deer Creek was good and suitable for all beneficial uses indicated by the CVWQCB's Water Quality Control Plan (1989).

Table 7-2. Range of Surface Water Quality Data (Minerals) for DWR's Highway 99 Station (1988 to present)

Mineral	Range (mg/L)	EPA Primary Drinking Water MCL (mg/L)	EPA Secondary Drinking Water MCL (mg/L)	Freshwater Aquatic Life MCL (mg/L)
Dissolved Calcium (Ca)	6.0 to 27.0	--	--	--
Dissolved Magnesium (Mg)	3.0 to 22.0	--	--	--
Dissolved Sodium (Na)	3.0 to 17.0	--	--	--
Dissolved Potassium (K)	1.0 to 4.0	--	--	--
Dissolved Sulfate (SO4)	1.0 to 11.0	250	--	--
Dissolved Chloride (Cl)	1.0 to 9.0		250	860
Dissolved Boron (B)	<0.1 to 0.3	--	--	--
Total Hardness	34.0 to 158.0	--	--	--
Dissolved Bromide	<0.01	--	--	--

Minor Elements

Measured minor element concentrations are primarily within established water quality standards (Table 7-3). Arsenic and copper were detected in concentrations well below the standards. On one occasion in September 1994, cadmium was reported at 0.003 mg/L, but it normally occurs in concentrations less than the laboratory detection level of 0.001 mg/L. Chromium, mercury, molybdenum, and selenium were all found at concentrations less than detection levels. Iron was detected on three occasions (January 1993 and 1995, and September 1988) at levels at or very slightly above the Environmental Protection Agency (EPA) secondary standard of 0.3 mg/L. Normally found in concentrations less than laboratory detection levels, lead concentrations exceeded these levels slightly on two occasions (September 1988 and March 1989). Manganese concentrations were usually less than the established standard of 0.05 mg/L. However, levels exceeded this value on September 1988 and March 1989 (0.123 mg/L and 0.308 mg/L, respectively). Zinc was detected at levels considerably less than the established standard.

Table 7-3. Range of Surface Water Quality Data (Minor Elements) for DWR's Highway 99 Station (1988 to present)

Minor Element	Range (mg/L)	EPA Primary Drinking Water MCL (mg/L)	EPA Secondary Drinking Water MCL (mg/L	Freshwater Aquatic Life MCL (mg/L)
Arsenic (As)	<0.005 to 0.007	0.05	--	0.19
Cadmium (Cd)*	<0.001 to 0.003	0.005	--	0.0013
Chromium[1] (Cr)*	<0.005 to <0.01	--	--	--
Copper (Cu)*	<0.005 to 0.009	0.1	0.1	0.014
Iron (Fe)	<0.1 to 0.35	--	0.3	--
Lead (Pb)*	<0.003 to 0.028	0.015	--	0.0033
Manganese (Mn)	<0.005 to 0.308	--	0.05	--
Mercury[1] (Hg)	<0.0004 to <0.001	0.002	--	0.012
Molybdenum[1] (Mo)	<0.005 to <0.1	--	--	--
Selenium[1] (Se)	<0.001 to <0.002	0.05	--	0.005
Zinc (Zn)	<0.01 to 0.13	--	5.0	--

[1] Below laboratory detection level.
* Hardness dependent (hardness value for the highest concentration in the range used for this calculation).
** Four-day Average Continuous Concentration MCL standard used for these comparisons.

Field Measurements

The field measurements for dissolved oxygen, pH, conductivity, alkalinity, and turbidity have all been within acceptable limits.

Water Temperature

Temperature concerns on Deer Creek are focused primarily on the effects to the anadromous fishery, with particular respect to the spring-run chinook salmon. Temperatures greater than 80°F will affect the migration of adult spring-run salmon during their historic migration period of approximately May 1 to June 30 (C. Harvey DFG pers. comm.). Adult chinook salmon have exhibited poor survival when held at temperatures above 60°F, and produce eggs less viable than when held at lower temperatures (DWR 1988). Salmon eggs incubated in gravels with water temperatures exceeding 57.5°F have been shown to suffer higher mortality. Both adults held and eggs incubated at high temperatures have produced fry that subsequently succumb, even though the fry may be reared at cooler temperatures. Salmon fingerlings have been found to have a preferred temperature range of 53.6°F to 57.2°F, with an upper lethal limit of 78.5°F. Upstream migration of adult fish have been found to be inhibited at temperatures above 70°F, while downstream migration of salmon smolts has been inhibited at temperatures between 54°F and 59°F.

Water temperatures have been monitored with continuous recorders at the Highway 99 Station by DWR for the past several years. Water temperatures are also monitored by the private timber companies to assess the impact of forest management practices within the Deer Creek Watershed. Other various groups have conducted temperature monitoring over the years.

Historical Temperature Monitoring Efforts on Deer Creek. The following is a list of sources of temperature data for Deer Creek (see Table 7-4).

1. DWR has maintained a temperature data logger at the Highway 99 Bridge. Data records exist in a computerized database for the period of July 1993 to present. This station is part of the DWR Water Quantity and Quality Measurement Program for collecting long-term basic data at various stations. Since May of 1997, DWR has also maintained continuous water temperature recorders at eight stations in Deer Creek (i.e., at the mouth, Highway 99, upper diversion dam, Ponderosa Way, A Line Road, the Meadows, Upper Falls, and Apperson Camp).

   A review of the data from July 1993 to the present for the Highway 99 Station indicates that, during the period of mid-May through mid-September, water temperature exceeded 80°F on numerous occasions.

2. The California Department of Fish and Game (DFG) had data loggers on Deer Creek at Stanford-Vina Dam, A Line Road Crossing, and Ponderosa Way. Data exist for portions of the years 1992 to 1996. These units were displaced in the floods of January 1997. The purpose for temperature monitoring was to evaluate spring-run salmon life history patterns (e.g., adult/juvenile migration patterns). DFG has particular concerns about temperatures greater than 80°F below Stanford-Vina Dam.

   Reviews of the DFG data indicate that maximum water temperatures at Stanford-Vina Dam for April, May, and June of 1994 were 77.2°F, 81.1°F, and 86.0°F, respectively. There is only one year of record for this station. At the next station upstream (Ponderosa Way), the maximum 1992 temperature occurred on July 17 (76.1°F). Records for 1993, 1994, and 1996 are incomplete. The maximum temperature for 1995 was 67.6°F on July 18. Records for 1996 are incomplete. The uppermost station at A Line Road Crossing had a maximum water temperature in 1992 of 69.6°F (July 17). In 1993, the maximum temperature at this station was 66°F on August 2. The maximums for 1994 and 1995 were 69.8°F (July 20) and 62.2°F (August 5), respectively. No records exist for the summer and fall in 1996 at A Line Road Crossing.

Table 7-4. Summary of Available Sources of Water Quality Sampling Data

Agency	Sampling Location(s)	Data Collected	Sampling Method/ Frequency	Period of Record	Computer Files
DWR	Highway 99 Bridge	Water temperature	Data logger	1964-1988	July 1993-present
		Nutrients	9 occasions	1964-1988	
		Nutrients		1988-present	July 1993-present
		Minerals		1952-1991(?)	Microfiche
		Minor elements		1988-present	July 1993-present
		Physical parameters		1988-present	July 1993-present
	Highway 99 Bridge	Water temperature	Real-time gages	Installed in 1997	No data
		Turbidity			
	USGS Gaging Station	Water temperature	Real-time gages	Installed in 1997	No data
		Turbidity			
DFG	Stanford-Vina Dam	Water temperature	Data logger	1994	
	A-Line Road Crossing	Water temperature	Data logger	1992-1996 (93, 94, 96 incomplete)	
	Ponderosa Way	Water temperature	Data logger	1992-1995	
SPI	Cement Creek	Water temperature	Data logger	1996	1996
	Deer Creek above the Upper Falls	Water temperature	Data logger	1996	1996
Collins Pine	Deer Creek (where?)	Water temperature	Data logger	1994-1996	1994-1996
	Gurnsey Creek	Water temperature	Data logger	1994-1996	1994-1996
	Carter Creek	Water temperature	Data logger	1994-1996	1994-1996
USGS	USGS Gaging Station	Bed sediment and sampling		1996	
		Trace elements			
		Minor element contaminants			
		Organic compounds			
		Tissue sampling			
Los Molinos High School	Abbey of New Clairvaux	Water temperature??			
		Total coliform			
		Fecal coliform			

Table 7-4. Summary of Available Sources of Water Quality Sampling Data (Cont'd.)

Agency	Sampling Location(s)	Data Collected	Sampling Method/ Frequency	Period of Record	Computer Files
USFS-LNF	Slate Creek	Water temperature	Data logger	1995 &/or 1996 &/or 1997	1995/96
	Cub Creek	Water temperature	Data logger	1995 &/or 1996 &/or 1997	1995/96
	Gurnsey Creek	Water temperature	Data logger	1995 &/or 1996 &/or 1997	1995/96
	Lower Deer Creek Meadows	Water temperature	Data logger	1995 &/or 1996 &/or 1997	1995/96
	Elam Creek	Water temperature	Data logger	1995 &/or 1996 &/or 1997	1995/96
	North Fork Calf Creek	Water temperature	Data logger	1995 &/or 1996 &/or 1997	1995/96
	Main Stem of Deer Creek at Red Bridge	Water temperature	Data logger	1995 &/or 1996 &/or 1997	1995/96
	Deer Creek at Ponderosa Way	Air temperature Water temperature?	Data logger	1995 &/or 1996 &/or 1997	1995/96

3. Sierra Pacific Company operated data loggers on Cement Creek and Deer Creek above the Upper Falls in 1996. Data exist in computer files for 1996 only.

4. Collins Pine Company maintained data loggers on Deer, Gurnsey, and Carter Creeks. Data exist in computer files for the years 1994 through 1996.

5. The U.S. Forest Service also maintained some data loggers within the watershed as part of its PACfish requirements for anadromous fish streams.

Historic Information. There are several publications that have included limited temperature data that was collected in the past, usually as part of fisheries work. Some of these include:

Cramer, F. and D. Hammack. Salmon research at Deer Creek, California. U.S. Fish and Wildlife Service. Special Scientific Report Fisheries No. 67. 1952.

Hanson, H. and L. Parker. Experiments on transfer of adult salmon into Deer Creek, California. Journal of Wildlife Management. Vol. 8, No. 3. July, 1944.

California Department of Fish and Game. Raw data from stream surveys performed on Deer Creek June through September, 1986.

Needham, P.R., H.A. Hanson, and L.P. Parker. Supplementary report on investigations of fish-salvage problems in relation to Shasta Dam. USFWS. Special Scientific Report No. 26. 1943.

Organic Compounds

No historic analyses for organic compounds have been conducted by DWR on Deer Creek. No data were found from other sources. However, organic analyses will be collected as part of DWR's current monitoring program.

Bacteriology

Data on coliform concentrations in the watershed are very limited and no conclusive results have been determined. One reference from the CVRWQCB reports total coliform values greater than 1,600 MPN/100 mL (most probable number per 100 milliliters of sample) at two stations downstream from grazing areas in the Deer Creek Meadows area.

The Regional Board Basin Plan water quality objective for fecal coliforms in waters used for contact recreation is no more than a mean of 200 MPN/100 mL, based on a minimum of five samples in a 30-day period. No more than 10 percent of the total number of samples taken during a 30 day period shall exceed 400 MPN/100 mL. Fecal coliform numbers ranged from 50 to greater than 1,600 MPN/100 mL.

The Los Molinos High School "Partners in Education" program has collected coliform data on a sporadic basis at one station near the Monastery in Vina. Data from October and November 1996 show total coliform counts of 240 MPN/100 mL and greater than 1,600 MPN/100 mL, respectively. Fecal coliform counts of 50 MPN/100 mL and 900 MPN/100 mL from these same dates were reported. In January 1997, the total coliform count was 130 MPN/100 mL and the fecal coliform count was 2 MPN/100 mL.

Sediments

No publications were found dealing with the subject of sediments in the stream channel of Deer Creek. A recent study by Meadowbrook Associates was conducted to determine the effects of sediment deposition from roads and associated structures in this watershed (Meadowbrook Conservation Associates, 1997).

The U.S. Forest Service is measuring the percent of the length of pools occupied by fine sediments at various stations along Deer Creek as part of its PACfish studies. Also included will be pebble and large woody debris counts in key salmon holding and spawning areas.

DWR is also including sediment analyses in its current monitoring program.

The U.S. Geological Survey has instituted a National Water Quality Assessment Program in the Sacramento River Basin. The USGS program has chosen Deer Creek to be one of the watersheds in which to conduct bed sediment and tissue surveys as well as ecological sampling. Bed sediments are analyzed for a suite of 46 trace element and minor element contaminants, plus approximately 115 organic compounds. Tissue samples are collected from *Corbicula sp.* and bottom-feeding fish species (e.g., riffle sculpin [*Cottus gulosus*]). These tissues are analyzed for a selected suite of trace elements, minor elements, and organics. Analyses for organic, total, and carbonate carbon are also conducted.

USGS data exist for one year (1996) so far, which include some physical parameters in addition to the above parameters. Only one station (at the gaging station) was sampled in 1996. According to USGS staff, data analyses on sediments and tissues both have revealed no problems. Minor element concentrations in sediments were what would be expected from normal erosion from sedimentary rock. Mercury concentrations were insignificant and sedimentary organo-chlorines were non-detectable (Joe Domagalski pers. comm.).

In 1997, USGS plans to sample four stations. At all four sites, data on fish, algae, aquatic invertebrates, inorganics, nutrients, and dissolved organic carbon will be collected. The USGS will only analyze bed sediments at the site by the gaging station for comparison to 1996 data.

FLOW (ALSO SEE CHAPTER 4.0 AND 5.0)

The USGS currently maintains a gaging station above the upper diversion dam, where Deer Creek exits the canyon. Some flow records exist at the following historic stations, including the period of record:

- Deer Creek near Vina (1912 to current);
- Deer Creek below Slate Creek near Deer Creek Meadow (1962 to 1970);
- Deer Creek at Polk Springs (1929 to 1931); and
- Deer Creek at Red Bridge near Vina (January to May 1977).

DWR has installed two real-time gages capable of measuring flow, turbidity, and temperature. Data is transmitted by remote telemetry. One gage was installed near Vina and one was installed inside the existing USGS Gaging Station. An additional gage will be installed at some point along Highway 32 in the upper watershed, possibly next year.

COMPREHENSIVE WATER QUALITY MONITORING PROGRAM

The water quality data for Deer Creek indicate that water quality conditions are generally good for all beneficial uses, based on the little data available. The main concern appears to be water temperature in critical migration, holding, and spawning areas along the creek. The Northern District of DWR has, in cooperation with the Deer Creek Conservancy, DFG, private timber companies, and other parties, designed a Comprehensive Water Quality Monitoring Program for this watershed. Sampling began in May 1997 and will continue on a regular basis for three years. The resulting data will provide more definitive information on existing water quality conditions and can be used to guide future watershed management decisions. This extensive program includes: continuous temperature recorders at 8 sites; field measurements at 12 sites; mineral, nutrient, and minor element analyses at 4 sites; aquatic macro-invertebrate analyses at 8 site; coliform bacteria analyses at 12 sites; water column and bed sediment toxicity analyses at 2 sites; sediment particle size analyses at 8 sites; fish tissue analyses at 2 sites; and pesticide analyses at 3 sites.

GROUNDWATER QUALITY

One of the most unusual characteristics of water is its ability to dissolve a greater range of substances than any other liquid. The slow percolation of water through the ground results in sustained contact of water with minerals in the soil/bedrock matrix. Many of these minerals are dissolved slowly as groundwater passes over them, and in time, an approximate chemical equilibrium can be reached between the groundwater and the minerals in the soil and rock. The water is then saturated with dissolved solids derived from these minerals. This ability of water to dissolve minerals strongly dictates the chemical nature of groundwater.

Sacramento Valley groundwater, on the eastside of Tehama County, is generally of good quality. Like most eastside groundwater, they are usually calcium bicarbonate in type and moderately hard to very hard. The waters are of excellent quality for irrigation and domestic uses (DWR 1967).

Groundwater quality data have been collected intermittently by DWR since the 1950's for a small number of wells located along the lower reaches of Deer Creek. The data indicate that the groundwater meets drinking water quality standards with moderately hard to very hard total hardness, no detected organics, and acceptable levels of minor elements. However, this data is very limited and may not reflect actual conditions of the groundwater in the area.

Water is said to be either acidic or alkaline (basic), depending on the hydrogen ion concentration (pH). Excess hydrogen ion activity in water causes it to act as an acid. The capability of water to neutralize acid is called alkalinity. The pH range is from 0.0 to 14.0, with a pH value of 7 indicating a neutral solution. At one well located west of Highway 99E along Deer Creek, 17 samples taken since 1956 have yielded field pH readings consistently in the 7.0 range.

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Jones & Stokes Associates, Inc. 1994. Deer Creek wild and scenic river suitability report (JSA 94-047). Chapter 2C, Water Quality and Water Resources. Prepared for the Resources Agency of California. Sacramento, CA. #OCA38453. October 1994.

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8.0 BOTANICAL RESOURCES

METHODS

Review of Available Technical Data

A comprehensive search was made for available published and unpublished information on the vegetation resources in the Deer Creek Watershed. The watershed is located to the east of the Sacrament River primarily in Tehama County, California. The Deer Creek Watershed extends from the Vina Plains eastward to Butt Mountain. The literature reviewed for information on the vegetation resources of the watershed included: Status of the Sierra Nevada, (Sierra Nevada Ecosystem Project, 1996); Historic Range of Vegetation: Inferences from General Land Office Survey Data, Potential Natural Vegetation Information and Fire History Patterns, (Lassen National Forest, Fites March 24, 1997); Deer Creek Wild and Scenic River Suitability Report (Jones and Stokes 1994); Manual of the Vascular Plants of Butte County (Oswald California Native Plant Society 1994); The Jepson Manual of Higher Plants of California (Hickman 1993); and the Manual of California Vegetation (Sawyer and Keeler-Wolf California Native Plant Society 1995). For a more complete literature listing, see the Bibliography of References and Literature Cited section. As appropriate, information from these references has been incorporated into the existing conditions text.

Electronic Inventories

Research on the sensitive plant communities and plant species of the Deer Creek Watershed included the review of two electronic data bases/inventories. The California Native Plant Society's (CNPS) Inventory of Rare and Endangered Vascular Plants (1994) and the California Department of Fish and Game (CDFG) Natural Diversity Data Base (NDDB) "Rare Finds" (1996) were searched for the 14 USGS quadrangles (7.5 minute) that occur within the boundaries of the watershed.

Reconnaissance Surveys

The botanical resources of the lower portion of Deer Creek, from the confluence with the Sacramento River to the upper weir and fish screen at the mouth of Deer Creek Canyon (DCID Diversion), were surveyed on November 12 and 13, 1996 and on June 23 and 24, 1997. Selected areas on the lower portion/reach of Deer Creek were spot checked during a Deer Creek Watershed Action Committee field day. Notes were recorded on plant communities and species composition in the riparian corridor, including invasive non-native plant species. A one-day field survey was also conducted of the upper watershed along Highway 32 on June 25, 1997. Plant species observed during the November and June field surveys were recorded and have been included as Appendix B. Additional species are likely to occur, and would require additional investigation.

Personal Communications

Various people were contacted for information on the botanical resources of the watershed including: Tom Griggs (The Nature Conservancy), Beth Corbin (USFS Lassen National Forest), Jo Ann Fites (USFS Plumas National Forest), Joyce Lacey and Gail Kuenster (California Department of Water Resources, Red Bluff), Sue Knox and Stuart Hanna (Vina residents), Doug McCreary (UC Regents, Sierra Foothills Field Research Station), and Ted Adams (Agronomy Department, UC Davis).

EXISTING PLANT COMMUNITIES AND THEIR DISTRIBUTION

The Deer Creek Watershed has a diverse flora and a variety of plant community types, which have resulted from the varying topography, substrate, and elevations present. Elevations range from approximately 100 feet at the Vina Plains of the Sacramento Valley Floor to 7,300 feet at Butt Mountain, which is located in the southern portion of the Cascade Range. Native plant communities include riparian forest, wetlands (i.e., freshwater marsh, vernal pools, seeps, and montane wet meadows), valley and foothill grassland, blue oak-foothill pine woodland, chaparral, and coniferous forests at the eastern higher elevations.

The Deer Creek Watershed lies primarily within Tehama County in the southern portion of the Cascade Range. Hickman (1993) has divided this volcanic region into sub-regions based on changes in elevation and vegetation (Hickman, 1993). The High Cascade Range sub-region, in which the upper section of Deer Creek occurs, is found above about 2,500 feet, and is characterized by coniferous forest. Deer Creek flows through montane wet meadows within the coniferous forest at the highest elevations. The middle section of Deer Creek occurs within the Cascade Range Foothills sub-region, which is characterized by chaparral and blue oak-foothill pine woodland.

The lower elevations of the watershed include portions of the Sacramento Valley, ending at the confluence of Deer Creek and the Sacramento River. This region once supported large expanses of grassland, but has been converted primarily to orchards and row crops or is grazed by livestock. Human development is concentrated in the lower section of the Deer Creek drainage, especially near Highway 99.

The designations used for naming the plant communities within the watershed are based in part on the broader classification names used by the California Department of Fish and Game's Preliminary Descriptions of the Terrestrial Natural Communities of California (Holland 1986). Some of the plant community names used in this report coincide with those listed in A Manual of California Vegetation (Sawyer and Keeler-Wolf 1995). Using broader plant community names was desired due to limited field time for mapping and also due to broader names used in previous studies.

Table 8-1 shows the relationship between the plant community designations used by Sawyer & Keller-Wolf, Holland, and the Lassen National Forest. The designations used by the National Forest correspond to the types used in the CALVEG mapping system. The vegetation map included in this report (Figure 8-1) depicts the distribution of the CALVEG types within the Deer Creek Watershed.

Table 8-2 presents the number of acres of each vegetation type in the Deer Creek Watershed upstream of the USGS Gaging Station.

Descriptions of the broader vegetation types/plant communities follow. Sensitive habitats (i.e., wetlands, riparian forest, blue oak woodland) are described in the Sensitive Plant Communities section. The elevations listed for the plant communities were determined by reviewing A Manual of California Vegetation (Sawyer and Keeler-Wolf 1995) and Preliminary Descriptions of the Terrestrial Plant Communities of California (Holland 1986). For further information on these plant communities and their associated plant community series, the reader is directed to the following references: A Manual of California Vegetation (Sawyer and Keeler-Wolf CNPS 1995); A California Flora and Supplement (Munz and Keck 1968), Status of the Sierra Nevada (Sierra Nevada Ecosystem Project 1996); and Historic Range of Vegetation: Inferences from General Land Office Survey Data, Potential Natural Vegetation Information and Fire History Patterns (Lassen National Forest Fites March 24, 1997).

Grasslands

Annual Non-native Grassland. Annual grassland occurs at lower elevations in the Sacramento Valley (i.e., Vina Plains) and extends into openings within blue oak-foothill pine woodland in the foothill zone of the Cascade Range. According to Fites (March 24, 1997), the foothill zone generally occurs below 2,500 feet in elevation. The grassland typically borders agricultural lands to the west and chaparral habitat along the eastern higher elevations. Annual grasslands typically occur on finely textured soils, having a high clay content, which tend to be very wet in the winter and very dry in summer (Holland 1986).

Annual grassland supports a variety of annual grasses and associated forbs, the majority of which are non-native species. Dominant species include wild oats (*Avena* spp.), foxtail chess (*Bromus madritensis*), soft chess (*Bromus hordeaceus*), ryegrass (*Lolium perenne*), dogtail grass (*Cynosurus echinatus*), and ripgut brome (*Bromus diandrus*). Annual and perennial forbs are common associates and include filaree (*Erodium* spp.), California poppy (*Eschscholzia californica*), bluedicks (*Dichelostemma capitatum*), elegant brodiaea (*Brodiaea elegans*), and common brodiaea (*Brodiaea californica* var. *californica*). Scattered valley oaks (*Quercus lobata*) and interior live oaks (*Quercus wizlizenii*) are also found in this community. Portions of the annual grassland have been invaded by invasive exotic plant species such as yellow starthistle (*Centaurea solstitialis*), medusa-head (*Taeniatherum caput-medusae*), and bull thistle (*Cirsium vulgare*).

Table 8.1. Plant Community Designations, Botanical Resource

Plant Communities Designations Used in This Report	Sawyer and Keeler-Wolf Designation*	Holland Designation**	LNF Designation (CALVEG Type)***
Grasslands			
Annual Non-native Grassland	California Annual Grassland Series	Non-native Grassland	Grass - species not determined
			Annual Grass
Native Grassland/Prairie	Foothill Needlegrass Series	Valley Needlegrass Grassland	Grass - species not determined
			Perennial Grass
	California Oatgrass Series	Valley and Foothill Grassland	Grass - species not determined
			Perennial Grass
Agriculture and Pasture			
Agricultural Lands			Urban - Agriculture
Irrigated Pasture			Urban - Agriculture
Chaparral Communities			
Whiteleaf or Common Manzanita Chaparral	Whiteleaf Manzanita Series	Montane Manzanita Chaparral	Mixed Chaparral
		Upper Sonoran Manzanita Chaparral	Montane Mixed Shrub
Green-leaf Manzanita Montane Chaparral	Green-leaf Manzanita Series	Montane Manzanita Chaparral	Montane Chaparral
		Upper Sonoran Manzanita Chaparral	Montane Mixed Shrub
Scrub Oak Chaparral	Scrub Oak Series	Scrub Oak Chaparral	Scrub Oak
Wedgeleaf Ceanothus Chaparral	Wedgeleaf Ceanothus Series	Montane Mixed Chaparral	Wedgeleaf Ceanothus
Wetlands			
Freshwater Marsh	Bulrush Series	Coastal and Valley Freshwater Marsh	Herbaceous
	Cattail Series	Montane Freshwater Marsh	Wet Meadows Grass/Sedge/Rush
Vernal Pools	Northern Hardpan Vernal Pools	Northern Hardpan Vernal Pools	Grass - species not determined
Montane Wet Meadows	Spikerush Series (in part)	Montane Meadow	Herbaceous
	Nebraska Sedge Series (in part)		Wet Meadows Grass/Sedge/Rush
	Sedge Series (in part)		
Sphagnum Bog	(under Fen habitat)	Sphagnum Bog	Herbaceous
			Wet Meadows Grass/Sedge/Rush

Table 8.1. Plant Community Designations, Botanical Resource (Cont'd.)

Plant Communities Designations Used in This Report	Sawyer and Keeler-Wolf Designation*	Holland Designation**	LNF Designation (CALVEG Type)***
Fen	Bulrush Series	Fen	Herbaceous
	Sedge Series		Wet Meadows Grass/Sedge/Rush
	Spikerush Series		
Seeps	Bulrush Series	Freshwater Seep	Herbaceous
	Sedge Series		Wet Meadows Grass/Sedge/Rush
	Spikerush Series		
Riparian Communities			
Mixed Riparian Forest	Fremont Cottonwood Series (in part)	Great Valley Mixed Riparian Forest	Cottonwood
	Black Willow Series (in part)		Cottonwood-Alder
	Mixed Willow Series		Willow
Early Successional Riparian Channel Bed & Gravel Bars	Mulefat Series	Mulefat Scrub	Barren/Rock
Fremont Cottonwood Riparian Forest	Fremont Cottonwood Series	Great Valley Cottonwood Riparian Forest	Cottonwood
Willow Riparian Scrub	Mixed Willow Series	Great Valley Willow Scrub	Willow
	Narrow-leaved Willow Series		
White Alder Riparian Forest	White Alder Series	White Alder Riparian Forest	White Alder
Woodlands			
Blue Oak-Foothill (Gray) Pine Woodland	Blue Oak Series (in part)	Digger Pine-Oak Woodland	Blue Oak (in part)
	Foothill Pine Series (in part)		Gray Pine (Digger) (in part)
Canyon Live Oak Woodland	Canyon Live Oak Series	Canyon Live Oak Forest	Canyon Live-Oak
Black Oak Woodland	Black Oak Series	Black Oak Woodland	Black Oak
Interior Live Oak Woodland	Interior Live Oak Series	Interior Live Oak Woodland	Interior Live Oak

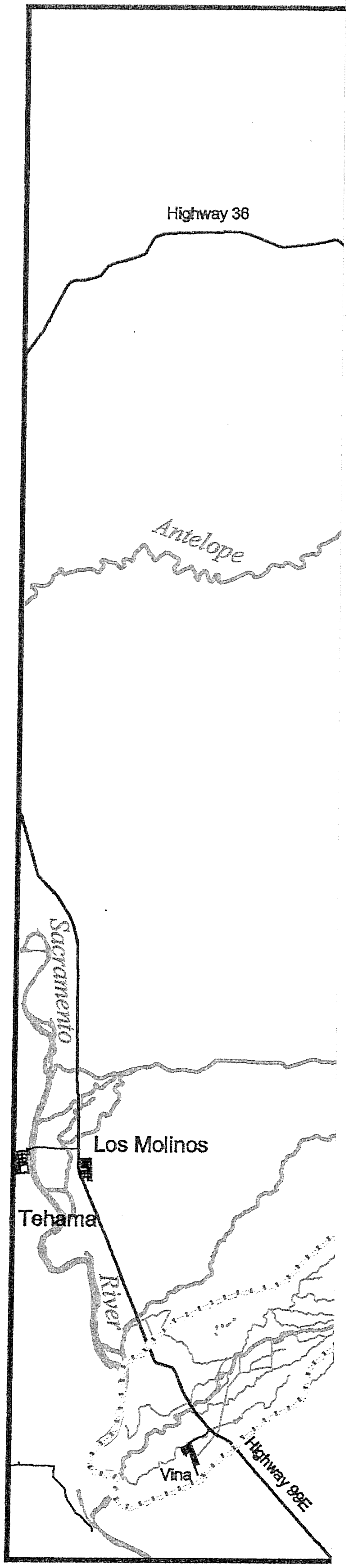
Table 8.1. Plant Community Designations, Botanical Resource (Cont'd.)

Plant Communities Designations Used in This Report	Sawyer and Keeler-Wolf Designation*	Holland Designation**	LNF Designation (CALVEG Type)***
Mixed Conifer Forests			
Ponderosa Pine Mixed Conifer Series	Ponderosa Pine Series (in part)	Westside Ponderosa Pine Forest	Ponderosa Pine (in part)
	Mixed Conifer Series	Sierran Mixed Conifer Forest	Mixed Conifer Pine
Douglas Fir Mixed Conifer Forest Series	Mixed Conifer Series	Sierran Mixed Conifer Forest	Douglas Fir – (Tan Oak – Madrone)
	Douglas Fir-Ponderosa Pine Series		Douglas Fir (in part)
White Fir Mixed Conifer Series	White Fir Series (in part)	Sierran White Fir	Mixed Conifer - Fir
			Lodgepole Pine (in part)
	Incense Cedar Series (in part)	Sierran Mixed Conifer Forest	White Fir (in part)
Conifer Forest (non-mixed)			
Red Fir Forest	Red Fir Series	Red Fir Forest	Red Fir
Mountain Hemlock Forest	Mountain Hemlock Series	Whitebark Pine-Mountain Hemlock Forest	Mountain Hemlock
Miscellaneous Plant Communities			
Cliffs & Rock Outcrops	None	None	Barren/Rock
			Montane Chaparral (mid elev.)

* Per "A Manual of California Vegetation." John O. Sawyer and Todd Keeler-Wolf. California Native Plant Society, 1995.

** Per "Preliminary Descriptions of the Terrestrial Natural Communities of California." Robert F. Holland. CDFG, 1986.

*** CALVEG designations per "CALVEG Mosaic of Existing Vegetation of California". Wendy J. Matyas and Ike Parker, U.S. Forest Service, 1979. Additional CALVEG vegetation types are shown to occur in the Deer Creek Watershed on the GIS vegetation map. The following types are not described in this Draft Existing Conditions Report: Black Oak, Canyon Live Oak, Scrub Oak, Interior Live Oak, Mountain Hemlock, and Cottonwood-Alder.



Highway 36
Antelope
Sacramento
Los Molinos
Tehama
River
Vina
Highway 99E

Table 8-2. Number of Acres of Each Vegetation Type in the Deer Creek Watershed (Derived from GIS Mapping)

Label	Acres
Vegetation Types	
Barron/Rock	241
Black Oak	3,587
Blue Oak	7,014
Canyon Live Oak	4,562
Cottonwood-Alder	40
Douglas Fir	946
Grass - Species Not	5,543
Gray Pine	779
Interior Live Oak	164
Lodgepole Pine	1,691
Mixed Chaparrel	9,307
Mixed Conifer Fir	40,076
Mixed Conifer Pine	25,162
Montane Chaparral	6,948
Montane Mixed Shrub	794
Mountain Hemlock	12
Ponderosa Pine	9,712
Red Fir	946
Scrub Oak	3,578
Water	101
Wedgeleaf Ceanothus	3,115
Wet Meadow Grass	1,406
White Fir	7,589
Unclassified (below USGS Gaging Station)	13,293
Total Acres	**146,606**

Inclusions of vernal pools and their associated, often endemic flora are present within grasslands at lower elevations (see Sensitive Plant Communities Section).

Much of the grassland that historically occurred in the Sacramento Valley has been converted to agriculture, pasture, and rural residential uses. The valley grasslands and grassy understory of the foothill woodlands have undergone the most extensive changes following European settlement compared to other plant communities in the watershed (Fites March 24, 1997). The introduction of grazing has altered the hydrologic cycle of these communities, and has resulted in shifts in species composition from native perennial grasses to exotic annual grasses (*ibid.*).

Native Grassland/Prairie. Remnant areas of native grassland may still exist within the Deer Creek Watershed. Although extensive stands of native grassland were not observed during the field surveys, small patches (less than 500 square feet) of native perennial bunch grasses were observed scattered within the annual non-native grassland in the vicinity of the gaging station in Deer Creek canyon. Additional areas of native grassland are expected to occur as small remnants along the edge of the Sacramento Valley and in the foothills, especially where competition is low with non-native annual grasses, non-native herbs, and/or invasive exotic species. Areas supporting native grassland vegetation may occur on terraces, knolls, hills having shallow soils, or in remote areas less subject to development, and/or where grazing practices have promoted the establishment of native grasses and wildflowers. Native grasslands usually contain a mixture of native and non-native plant species, and often intergrade with oak woodlands on moist, better drained sites (Holland 1986). Typically, the soils are moist in the winter, but very dry in the summer. Purple needlegrass (*Nassella pulchra*) is usually the dominant perennial bunchgrass. Native or non-native annual species occur between the perennials, and often exceed the bunch grasses in cover (*ibid.*). Associated native species include: California oatgrass (*Danthonia californica* var. *americana*) (at high elevations), Nuttall's fescue (*Vulpia microstachys*), big squirrel tail (*Elymus multisetus*), bluedicks, Indian soap root (*Chlorogalum pomeridianum* var. *divaricatum*), California brodiaea (*Brodiaea californica*), and wild onion (*Allium* spp.).

Agriculture and Pasture

The lower portion of the Deer Creek drainage, in the Sacramento Valley, is flanked by agricultural lands which includes orchards, row crops, and irrigated pasture for livestock. Common orchard crops include English walnut, peach, almond, and prune. For example, near the confluence of Deer Creek and the Sacramento River, the New Clairveaux Monastery was once a winery with a vineyard, but has converted to walnut (*Juglans* spp.) and prune orchards.

The irrigated pastures in the lowlands of the Sacramento Valley are dominated by seeded or naturally occurring grasses and forbs, such as perennial ryegrass (*Lolium perenne*), crop barley (*Hordeum vulgare*), alfalfa (*Medicago sativa*), rose clover (*Trifolium hirtum*), and white clover (*Trifolium repens*).

Chaparral Communities

The chaparral community types are generally distributed on harsh sites with rocky substrates in the foothills and montane portions of the watershed, and consist of short-statured shrubs and trees (less than 15 feet tall). Chaparrals are fire-adapted communities, and have reproductive methods that are dependent on periodic and/or recurring fires. Chaparrals often grow in harsh exposures, where few other plants can survive; and therefore, are highly prized for vegetative cover in watersheds (Flora Nature Briefs, n.d.). Table 8-3 lists special-status plant species that are associated with chaparral habitat including: Bidwell's knotweed (*Polygonum bidwelliae*), white-stemmed clarkia (*Clarkia gracilis* ssp. *albicaulis*), Butte County fritillary (*Fritillaria eastwoodiae*), Butte County calycadenia (*Calycadenia oppositifolia*), and pale yellow stonecrop (*Sedum laxum* ssp. *flavidum*). Two chaparral plant community series are described below.

Table 8-3. Special Status Plants Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California

SPECIES	LEGAL STATUS* FEDERAL/STATE/CNPS	DISTRIBUTION**	HABITAT**	QUADRANGLE CODES***
Adobe-Lily (*Fritillaria pluriflora*)	--/--/1B	Inner north coast Ranges, northern Sierra Nevada foothills, and edges of the Sacramento Valley; also in southern Oregon	Adobe soils of interior foothills; <1,640 feet	594A
Ahart's Paronychia (*Paronychia ahartii*)	--/--/1B	Butte, Shasta, and Tehama Counties	Well-drained, rocky outcrops, often vernal pool edges, and volcanic uplands; <1,640 feet	593B
Baker's Navarretia (*Navarretia leucocephala* ssp. *bakeri*)	--/--/1B	Colusa, Lake, Mendocino, Marin, Napa, Solana, Sonoma, and Tehama Counties	Cismontane woodland, lower montane coniferous forest, valley-foothill grassland, and vernal pools; 100 to 8,100 feet	None
Bidwell's Knotweed (*Polygonum bidwelliae*)	--/--/4	Butte, Shasta, and Tehama Counties	Chaparral, cismontane woodland, valley-foothill grassland; gravelly ridges and rock outcrops of tuscan formation mudflow; 200 to 3,500 feet	N/A
Big-scale Balsamroot (*Balsamorhiza macrolepis* var. *macrolepis*)	--/--/1B	Scattered locations in the Sacramento Valley, Sierra Nevada foothills, and San Francisco Bay region	Open grassy slopes and valleys; generally <4,590 feet	608C
Boggs Lake Hedge-Hyssop (*Gratiola heterosepala*)	--/CE/1B	Fresno, Lake, Lassen, Madera, Placer, Sacramento, Shasta, San Joaquin, Solano, Modoc, and Tehama Counties	Vernal pool, freshwater marsh, lake margins, clay soils; <5,000 feet	593B
Butte County Calycadenia (*Calycadenia oppositifolia*)	--/--/4	Butte County endemic	Chaparral, cismontane woodland, valley-foothill grassland; grassy slopes, road cuts, and brushy openings; 700 to 2,800 feet	N/A
Butte County Fritillary (*Fritillaria eastwoodiae*)	--/--/1B	Butte, Shasta, Tehama, and Yuba Counties	In openings on dry beaches and slopes in chaparral, woodland, and lower coniferous forest communities; 1,640 to 4,920 feet	None
Cantelow's Lewisia (*Lewisia cantelovii*)	--/--/1B	Butte, Nevada, Plumas, Shasta, and Siskyou Counties	Wetter areas in chaparral, cismontane woodland, lower montane coniferous forest; granite outcrops; 1,800 to 3,500 feet	None
Clustered Lady's-Slipper (*Cypripedium fasciculatum*)	--/--/4	Widespread from San Francisco Bay region to British Columbia	Open coniferous forest, usually along serpentine seeps and streambeds; 330 to 5,580 feet	N/A
Cut-leaved Ragwort (*Senecio eurycephalus* var. *lewisrosei*)	--/--/1B	Butte and Plumas Counties	Chaparral, cismontane woodland, lower montane coniferous forest; serpentine outcrops; 900 to 5,000 feet	None

Table 8-3. Special Status Plants Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES	LEGAL STATUS* FEDERAL/STATE/CNPS	DISTRIBUTION**	HABITAT**	QUADRANGLE CODES***
Depauperate Milk Vetch (*Astragalus pauperculus*)	--/--/4	Butte, Placer, Shasta, Tehama, and Yuba Counties	Cismontane woodland, valley-foothill grassland; grassy flats with thin soils and poor drainage (volcanic clay - tuscan mudflow); 200 to 2,600 feet	N/A
Dwarf Downingia (*Downingia pusilla*)	--/--/2	Merced, Mariposa, Napa, Placer, Sacramento, Solano, Sonoma, Stanislaus, and Tehama Counties	Valley-foothill grassland, vernal pools; foothill woodland; <450 feet	None
Four-Angled Spikerush (*Eleocharis quadrangulata*)	--/--/2	Butte, Merced, and Tehama Counties	Freshwater marsh, lake and pond margins; <1,500 feet	593B
Fremont's Calycadenia (*Calycadenia fremontii*)	--/--/3	Sacramento Valley and Cascade foothills in Butte, Tehama, and Shasta Counties	Sparsely vegetated, low-fertility soil (often rocky) in annual grasslands, oak woodland, and yellow pine forest; 200 to 300 feet	None
Green's Tuctoria (*Tuctoria greenei*)	E/SR/1B	East edge of the Central Valley from Tehama to Tulare Counties and Shasta County	Bottoms of large vernal pools; 100 to 3,400 feet	594A, 593B
Hairy Orcutt Grass (*Orcuttia pilosa*)	E/CE/1B	Widespread but spotty along the east edge of the Central Valley from Tehama to Madera County	Bottoms of large vernal pools; 100 to 300 feet	594A, 593B
Hall's Rupertia (*Rupertia hallii*)	--/--/1B	Butte and Tehama Counties	Woodland openings; <5,000 feet	609D, 608C
Hoover's Spurge (*Chamaesyce hooveri*)	T/--/1B	Central Valley from Tehama County south to Tulare County	Below high-water mark of larger northern hardpan vernal pools; <750 feet	594A, 593B
Long-leaved Starwort (*Stellaria longifolia*)	--/--/2	Butte County from Butte Meadows to Jonesville	Wet meadows; about 4,500 to 5,000 feet	608D, 608A?
Marsh Claytonia (*Claytonia palustris*)	--/--/4	Butte, Fresno, Plumas, Siskyou, Tehama, and Tulare Counties	Lower montane coniferous forest, wet meadows, and stream edges, open seeps; 3,700 to 5,500 feet	N/A
Mingan Moonwort (*Botrychium minganense*)	--/--/2	Butte, Fresno, and Tehama Counties and outside California	Coniferous forest along streams; 4,900 to 5,900 feet	607B
Northern Spleenwort (*Asplenium septentrionale*)	--/--/2	Known in California from fewer than 10 occurrences in Shasta, Tehama, and Tulare Counties	Crevices of granite and dacite rocks; 8,200 to 11,000 feet	None

Table 8-3. Special Status Plants Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES	LEGAL STATUS* FEDERAL/STATE/CNPS	DISTRIBUTION**	HABITAT**	QUADRANGLE CODES***
Pale Yellow Stonecrop (*Sedum laxum* ssp. *flavidum*)	--/--/4	Del Norte, Glenn, Humbolt, Shasta, Siskyou, Tehama, and Trinity Counties	Broad-leaved upland forest, chaparral, cismontane woodland, and lower montane coniferous forest; serpentinite or volcanic basalt; 2,400 to 6,000 feet	N/A
Red Bluff Dwarf Rush (*Juncus leiospermus* var. *leiospermus*)	--/--/1B	Butte, Shasta, and Tehama Counties	Vernal pool margins and wet places in chaparral and woodlands; 200 to 3,500 feet	None
Sanford's Arrowhead (*Sagittaria sanfordii*)	--/--/1B	Butte County near Tehama County line, and TNC Vina Plans Preserve	Marshes and swamps in standing or slow-moving freshwater (ponds, marshes, ditches); 0 to 1,800 feet	593B
Scalloped Moonwort (*Botrychium crenulatum*)	--/--/1B	Distributed in patches in Butte, Los Angeles, San Bernardino, Tehama, and Tulare Counties and outside California	Marshes and meadows; 4,900 to 8,200 feet	607B
Shield-bracted Monkeyflower (*Mimulus glaucescens*)	--/--/4	Butte, Colusa, Lake, and Tehama Counties	Lower montane coniferous forest, valley-foothill grassland, serpentineite seeps; bogs along drainages and streams; 200 to 4,000 feet	N/A
Shore Sedge (*carex limosa*)	--/--/2	Butte, El Dorado, and Plumas Counties; near Butte Meadows	Bogs and fens, associated with lakes, wet meadows; 3,600 to 8,100 feet	608D
Sierra Corydalis (*Corydalis caseana* ssp. *caseana*)	--/--/4	Butte, Lassen, Placer, Plumas, Shasta, Siskyou, Tehama, and Tulare Counties	Upper montane coniferous forest, wet meadows, and along shaded streams and seeps; 4,400 to 5,800 feet	N/A
Silky Cryptantha (*Cryptantha crinita*)	--/--/1B	Shasta and Tehama Counties	Sandy streambanks and gravel bars; 1,800 to 3,600 feet	None
Slender Orcutt Grass (*Orcuttia tenuis*)	T/CE/1B	Widespread but spotty from eastern Shasta County, Plumas, Lassen, and Lake Counties, and the Sacramento Valley (from Sacramento to Shasta County)	Bottoms of vernal pools typically underlain by volcanic substrates; 100 to 5,780 feet	594A, 593B
Slender or Pale Greater Bulrush (*Scirpus heterochaetus*)	--/--/2	Tehama County, Wilson Lake	Marshes and swamps, lower Montane coniferous forest (Montane Lake margins); about 4,800 feet	625C
Suksdorf's Milk-vetch (*Astragalus pulsiferae* var. *suksdorfii*)	--/--/1B	Lassen, Plumas, and Shasta Counties; Washington State	Lower montane coniferous forest, volcanic, often rocky soil; about 3,900 feet	625D

Table 8-3. Special Status Plants Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES	LEGAL STATUS* FEDERAL/STATE/CNPS	DISTRIBUTION**	HABITAT**	QUADRANGLE CODES***
Tehama County Western Flax (*Hesperolinon tehamense*)	--/--/1B	Glenn and Tehama Counties, Mendocino National Forest and BLM lands	Chaparral, cismontane woodland, serpentinite; 300 to 3,000 feet	None
Tehama Navarretia (*Navarettia heterandra*)	--/--/4	Butte, Colusa, Lake, Shasta, Tehama, Trinity, and Yuba Counties; Oregon state	Valley-foothill grassland, wet meadows, vernal pools; often heavy clay soils; 100 to 300 feet	N/A
Tracy's Sanicle (*Sanicula tracyi*)	--/--/1B	Butte and Tehama Counties (taxonomic questions) and northwestern California	Openings in coniferous forests and in woodlands; 33- to 3,300 feet	608A
Upswept Moonwort (*Botrychium ascendens*)	--/--2	Butte and Tehama Counties near Jonesville	Lower montane coniferous forest and grassy fields near streams; 5,000 to 6,000 feet	607B
Veiny Monardella (*Monardella douglasii* ssp. *venosa*)	--/--/1B	Butte, Sutter, and Tuolumne Counties	Valley-foothill grassland; heavy clay; 200 to 300 feet	None
Western Campion (*Silene occidentalis* ssp. *longistipitata*)	--/--/3	Butte, Plumas, Shasta, and Tehama Counties	Chaparral and coniferous forests; 3,300 to 6,600 feet	None
Western Goblin (*Botrychium montanum*)	--/--/2	Butte and Tehama Counties; widespread outside of California	Shady coniferous woods; 4,900 to 5,900 feet	607B
White-stemmed Clarkia (*Clarkia gracilis* ssp. *albicaulis*)	--/--/1B	Butte and Tehama Counties	Chaparral, cismontante woodland, lower coniferous forest; openings on dry brushy slopes and road cuts; 800 to 2,000 feet	609D
Wilkin's Harebell (*Campanula wilkinsiana*)	--/--/1B	Siskyou, Tehama (probably extirpated), and Trinity Counties	Wet meadows and streamsides; 5,900 to 8,500 feet	None
Woolly Meadowfoam (*Limnanthes floccosa* ssp. *floccosa*)	--/--/2	Cascade, Klamath, and inner north Coast Ranges	Moist meadows and vernal pools in grassland and woodland communities; 200 to 3,500 feet	None

Table 8-3. Special Status Plants Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

* **CNPS Status:**

List 1B: These plants (predominately endemic) are rare through their range and are currently vulnerable or have a high potential for vulnerability due to limited or threatened habitat, few individuals per population, or a limited number of populations. List 1B plants meet the definitions of Section 1901, Chapter 10 of the CDF&G Code.

List 2 Rare, threatened, or endangered plant species in California, but more common elsewhere.

List 3: This is a review list of plants which lack sufficient data to assign them to another list.

List 4: List 4 is a watch list of plants with limited distribution in the state that have low vulnerability and threat at this time. These plants are uncommon, often significant locally, and should be monitored.

* **State List:**

SE = endangered
SR = rare
ST = threatened

***Federal List:**

FE = endangered
FT = threatened
FPT = Federally proposed threatened
PE = Federally proposed endangered
PT = Federal proposed threatened
candidate = sufficient data to support listing

** Habitat requirements and distribution of special-status plants were determined by reviewing information from Hickman (1993), Skinner and Pavlik (1994), and Oswald (1994).

*** **Quadrangle Codes**

1. 593B Richardson Spring NW
2. 594A Vina
3. 607A Humbug Valley
4. 607B Humbolt Peak
5. 608A Onion Butte
6. 608B Barkley Mountain
7. 608C Devils Parade Ground
8. 608D Butte Meadows
9. 609C Acorn Hollow
10. 609D Ishi Caves
11. 610D Los Molinos
12. 625C Childs Meadows
13. 625D Stover Mountain
14. 626D Mineral

N/A = Note that species with CNPS legal status List 4 only (no State or Federal status) are not included as recorded occurrences in the CNDDB; however, many have numerous known sites in the watershed (Corbin September 18, 1997).

None = No recorded occurrence in watershed, per CNDDB.

Whiteleaf or Common Manzanita Chaparral. This is the predominant chaparral series in the Deer Creek Watershed. Whiteleaf manzanita (*Arctostaphylos viscida* ssp. *viscida*) is common and widespread in the foothills and the lower coniferous forest, extending from northeast of the town of Chico northward to near the town of Los Molinos. It occurs on ridges and upper slopes with shallow soils that may be derived from ultra-mafic material (Sawyer and Keeler-Wolf 1995). Whiteleaf manzanita chaparral occurs at a lower elevation range (about 500 to 5,000 feet) compared to green-leaf manzanita montane chaparral. In some areas, white-leaf manzanita may extend to higher montane elevations. Associated shrub species include chamise (*Adenostoma fasciculatum*), big manzanita (*Arctostaphylos manzanita*), Fremont's silk-tassel (*Garrya fremontii*), buckbrush (*Ceanothus cuneatus*), mountain whitethorn (*Ceanothus cordulatus*), deerbrush (*Ceanothus integerrimus*), and scrub oak (*Quercus berberidifolia*) (*ibid.*). The herbaceous ground layer is sparsely distributed.

Green-leaf Manzanita Montane Chaparral. This montane chaparral community is located in the northeast corner of the watershed, including an area by the headwaters of Deer Creek. It typically occurs on south-facing slopes having shallow, rocky volcanic soils that are located within the upper coniferous forest. The elevation range is approximately 2,800 to 7,000 feet (Oswald 1994). Higher elevations also occur in the Sierra Nevada. The dominant shrub is green-leaf manzanita (*Arctostaphylos patula*). Additional shrub species include pinemat manzanita (*Arctostaphylos nevadensis*) (high elevations in chaparral), bitter cherry (*Prunus emarginata*), mountain whitethorn, and tobacco-brush (*Ceanothus velutinus* var. *velutinus*) (Sawyer and Keeler-Wolf 1995). The herbaceous layer is poorly developed, and may support Gray's bedstraw (*Galium grayanum* var. *grayanum*) on scree slopes (Oswald 1994).

Wetlands

Numerous types of wetlands occur within the Deer Creek Watershed, including freshwater marsh, vernal pools, seeps, montane wet meadows, bogs, fens, and artificial ones such as irrigation canals, reservoirs, and cattle ponds. Although many of the wetland areas in the watershed are known, many locations remain to be determined and studied. Further information on the location of known wetlands may be obtained by ordering wetland maps from the National Wetlands Inventory prepared by the United States Fish and Wildlife Service. Locations of non-forested wetlands are also depicted on the "Deer Creek Watershed Land Use/Cover" color GIS map, prepared by the California Department of Water Resources, Northern District (March 11, 1997). Some of the major wetland types within the watershed are described below.

Freshwater Marsh. Freshwater marshes occur along the edges of lakes, ponds, sloughs, and creeks located at lower elevations of the watershed where the water becomes slow flowing, warm, and shallow. The water often contains a low level of dissolved oxygen. This zone supports emergent (raised above the water) vegetation and algae, and is referred to as the lentic zone. Lentic zones also occur in areas having standing water such as agricultural ponds, sloughs, and reservoirs. Many small habitats for freshwater marsh species have been artificially created by irrigation systems.

Common freshwater marsh species include: broad-leaved cattail (*Typha latifolia*), hard-stemmed tule (*Scirpus acutus* var. *occidentalis*), emersed bur-reed (*Sparganium emersum* ssp. *emersum*), slender rush (*Juncus tenuis*), Mexican rush (*Juncus balticus* var. *mexicanus*), ample-leaved sedge (*Carex ampifolia*), and leafy bracted dwarf rush (*Juncus capitatus*).

Sensitive plant species that may occur in freshwater marsh habitat include four-angled spikerush (*Eleocharis quadrangulata*) and Sanford's arrowhead (*Sagitarria sanfordii*) (CNPS List 1B) (Table 8-3). These species have been collected from either Dry Creek Preserve or from the Vina Plains Preserve (Peggy McNutt 1997).

Vernal Pools. Vernal pools are seasonal bodies of water that form in shallow depressions following winter rains. These depressions typically have an underlying hardpan layer that allows water to persist for several months (U.C. Integrated Hardwood Range Management Program September 1996).

In general, State-wide vernal pools share similar physical and biological attributes (e.g., long-term inundation during the growing season, desiccation during the fall, and a flora dominated by native annual species that have adapted to both aquatic and terrestrial habitats, and stress associated with yearly climatic differences) (Ikeda and Schlising 1990).

The vernal pools within the Deer Creek Watershed occur primarily in the south central portion of Tehama County, including the Vina Plains (Holland 1978). The vernal pools located in the TNC Vina Plains Preserve (located to the south of the Deer Creek Watershed) have been well-documented (Holland 1978; Ikeda and Schlising 1990). Native plant species associated with vernal pools in Tehama County include: Fremont's goldfields (*Lasthenia fremontii*), hairy sidalcea (*Sidalcea hirsuta*), Ahart's paronchia (*Paronchia ahartii*), Green's tuctoria (*Tuctoria greenei*), hairy orcutt grass (*Orcuttia pilosa*), slender orcutt grass (*Orcuttia tenuis*), Green's popcorn flower (*Plagiobothrys greenei*), dwarf woolly marbles (*Psilocarphus brevissimus* var. *brevissimus*), and Hoover's spurge (*Chamaesyce hooveri*). Both hairy orcutt grass and slender orcutt grass have been observed on the drying bottoms of vernal pools having volcanic mud flows in The Nature Conservancy (TNC) Vina Plains Preserve (NDDB; CDFG 1996). Green's tuctoria, hairy orcutt grass, and slender orcutt grass are now Federally listed (see Table 8-3).

According to Holland (1978), the vernal pools located in Tehama County are associated with several soil types/series: Redding, volcanics, Hillgate, and alluvial. The majority of the vernal pools are found in Redding soil series, which is very acidic and has an impervious layer composed of a Fe-Si cemented hardpan (*ibid*). This type of vernal pool has been referred to as a the northern hardpan vernal pool in CNDDB Natural Communities Descriptions (Holland 1986). Occasionally, there are also impervious layers composed of clay hardpans. For further information on the mapped distribution of vernal pools in Tehama County, the reader is directed to the results of a study done by Robert F. Holland in 1978, "Distribution of Vernal Pools in Sacramento Valley, California", CNPS Special Publication No. 4.

Seeps. This wetland vegetation type is characterized by perennial herbaceous plant species that are associated with permanently moist or wet soil (Holland 1986). Sedges (*Carex* sp.), rushes (*Juncus* sp.), and grass species are common. Seeps often occur in wet areas within grasslands and meadows. Seeps were observed on rocky, wet cliff faces along Highway 32 near Upper Falls. Existing mapped locations of seeps within the Deer Creek Watershed were not found during literature review. Special status plants associated with seeps include marsh claytonia (*Claytonia palustris*) and shield-bracted monkeyflower (*Mimulus glaucescens*).

Montane Wet Meadows. This herbaceous plant community occurs at upper elevations generally above 5,000 feet, and has a shorter growing season due to cold winters compared to freshwater marsh. The soils are less acidic and nutrient-rich compared to bogs and fens (Holland 1986). Hydrophytic sedges are common and may include ample-leaved sedge, golden-fruited sedge (*Carex aurea*), slender-beaked sedge (*C. athrostachya*), and Nebraska sedge (*C. nebracensis*). Additional species may include tufted hair-grass (*Deschampsia cespitosa* ssp. *cespitosa*), meadow barley (*Hordeum brachyantherum* ssp. *brachyantherum*), Mexican rush, Sierra rush (*Juncus nevadesis*), and buttercups (*Ranunculus* spp.). Representative montane wet meadows include Deer Creek Meadows, Childs Meadows, and Jones Meadow. At Childs Meadows, hydrophytic plant species observed in June included: Drummond's cinquefoil (*Potentilla drummondii* ssp. *drummondii*), tinker's penny (*Hypericum anagalloides*), common monkeyflower (*Mimulus guttatus*), brown-headed rush, mountain selfheal (*Prunella vulgaris* var. *lanceolata*), and western bistort (*Polygonum bistortoides*).

Several special-status plant species have the potential to occur in montane wet meadows such as Sierra corydalis (*Corydalis caseana* ssp. *caseana*), scalloped moonwort (*B. crenulatum*), shore sedge (*Carex limosa*), Red Bluff dwarf rush (*Juncus leiospermus* var. *leiospermus*), and Wilkin's harebell (*Campanula wilkinsiana*) (Table 8-3).

Bogs and Fens. Bogs and fens develop in sites having blocked or limited drainage, and the water pH ranges from strongly acidic (bog) to alkaline or neutral (fen) (Gillett et al.). Such wet areas with species associated with peatlands are called bogs. Bogs receive nutrients from precipitation only, whereas fens receive nutrients from rocks and streams (Sawyer and Keeler-Wolf 1995). Sphagnum bogs are characterized by a dense growth of low-growing herbaceous perennials and low shrubs. Representative plant species in sphagnum bogs include: Douglas' spiraea (*Spiraea douglasii*), Laborador-tea (*Ledum glandulosum*), Sphagnum moss spp., sedges (*Carex* spp.), rynchospora moss (*Rynchosposa* sp.), and western blueberry (*Vaccinium uliginosum*) (Holland 1986). Fens are similar to bogs, but have a higher diversity of species and more large shrubs. Species characteristic of fens include: California myrtle (*Myrica californica*), tinker's penny (*Hypericum anagalloides*), buck-bean (*Menyanthes trifoliata*), spike rush, and western lady fern (*Athryium felix-femina* var. *cyclosorum*).

Riparian Communities

The following types of riparian communities occur within the Deer Creek Watershed: mixed riparian forest, Fremont cottonwood forest, willow riparian scrub, and white alder riparian. Due to its location within the riparian corridor, early successional riparian channel bed and gravel bars has been included as a riparian plant community type. This type or designation is not recognized as plant community name by Holland (1986) nor by Sawyer and Keeler-Wolf (1995).

Mixed Riparian Forest. Mixed riparian forest is the predominant riparian type along Deer Creek from the confluence with the Sacramento River to the entrance of Deer Creek Canyon. It also occurs along China Slough and Delaney Slough). Mixed riparian forest occurs at an elevation range of approximately 100 to 3,000 feet. The soils are usually fine-textured and set back from the active channels (Holland 1986).

The extent of mixed riparian forest along the lower reach of Deer Creek is substantial, but has been reduced from historical extent by local agricultural practices, flood control and urban expansion (*ibid.*). In some areas, mixed riparian forest grades into cottonwood riparian forest closer to the creek channel. A GIS map (scale 1" = 1,000') prepared in 1996 by the CSU Chico GIS Center for DWR and TNC (Figure 8-2) depicts the distribution of six riparian vegetation types along Deer Creek and Delany Slough between the Sacramento River and the USGS Gaging Station.

The tree overstory tends to be densely distributed with broad-leaved deciduous trees such as western sycamore (*Platanus racemosa*), Fremont cottonwood (*Populus fremontii*), yellow willow (*Salix lasiandra*), and California black walnut (*Juglans hindsii*). There is often a lower tree layer of shorter statured trees including box elder (*Acer negundo*), red willow (*Salix laevigata*), and sandbar willow (*Salix exiqua*). Scattered groves of valley oak may occur along the outer edges of the riparian corridor and in the outer flood plains (i.e., adjacent to Red Bridge). Interspersed in the understory and along the gravel bars and sandy deposits are thickets of willow species, primarily sandbar willow. Understory species include California blackberry (*Rubus ursinus*), Himalaya berry (*Rubus procerus*), mugwort (*Artemisia douglasiana*), lovegrass (*Eragrostis pectinacea* var. *pectinacea*), blue elderberry (*Sambucus mexicana*), California button-willow (*Cephalanthus occidentalis*), mulefat (*Baccharis salicifolia*), and lianas of California wild grape (*Vitus californica*), pipe vine (*Aristolochia californica*), and virgin's bower (*Clematis ligusticifolia*).

The habitat has also been invaded by exotic species such as giant reed (*Arundo donax*), Himalaya blackberry, Johnson grass (*Sorghum halepense*), poison hemlock (*Conium maculatum*), yellow starthistle and edible fig (*Ficus carica*).

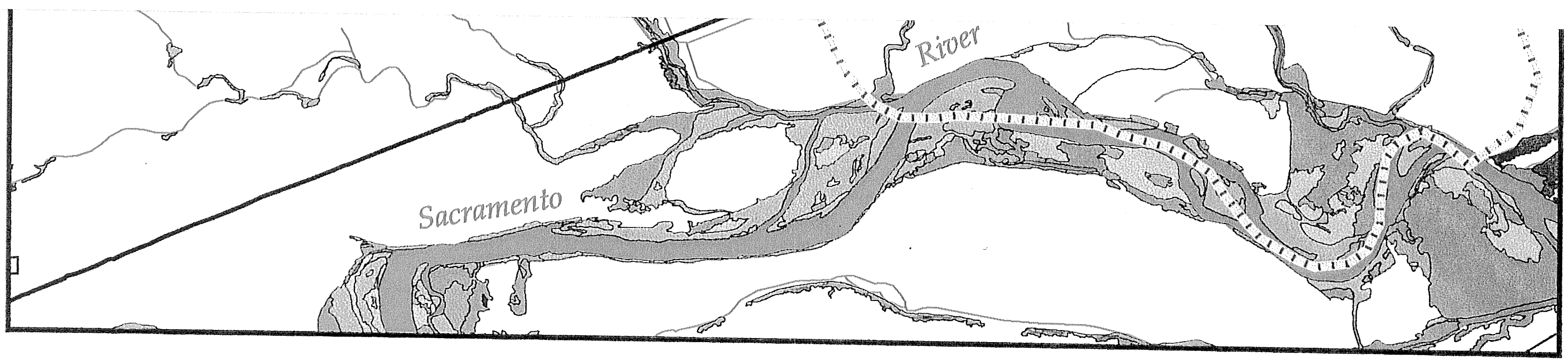
A distinctive seral stage of mixed riparian habitat was observed on the riparian "island" north of Deer Creek on the island crossing (Leininger property) near the Cone-Kimball canal channel. In this area, the majority of the western sycamore trees were smaller sized and younger compared to other riparian areas. Portions of the "island" were dominated by western sycamore trees. Additional tree species include valley oak, Fremont cottonwood, sandbar willow, and yellow willow. Foothill pine (*Pinus sabinianna*) also starts to occur in this portion of the riparian corridor. Skunk brush (*Rhus trilobata*) and blue elderberry are the dominant shrubs. Common herbs include mugwort, soft chess, and hoary nettle (*Urtica dioica* ssp. *holosericea*). Several invasive exotic plant species were observed on the island crossing, primarily yellow starthistle, common cocklebur (*Xanthium strumarium*), sweet white clover (*Melilotus alba*), and wooly mullein (*Verbascum thapsis*).

Early Successional Riparian Channel Bed and Gravel Bars. Due to the dynamic nature of the Deer Creek watercourse, yearly shifts occur in locations of portions of the riparian channel and in the composition of the vegetation. Some areas within the channel are exposed to frequent scouring and flooding, which prevent long-term establishment of vegetation. Gravel bars with areas of silted soil in between create a mosaic of barren rocky areas and scattered herbaceous vegetation. In the areas of silted soil, a mix of native and non-native early successional (generally short-lived) plant species were observed. Fremont cottonwood, willow, and mulefat seedlings may also become established. Most of these seedlings will be disrupted by subsequent flood events. Common non-native species observed in active portions of channel during the June 1997 surveys include: common cocklebur, sweet white clover, weedy cudweed (*Gnaphalium luteo-album*), prickly lettuce (*Lactuca serriola*), and birdfoot trefoil (*Lotus corniculatus*). Early successional native plant species observed include: Pursh's trefoil (*Lotus purshianus*), common monkeyflower, scarlet monkeyflower (*Mimulus cardinalis*), mugwort, and mulefat.

Several special-status plant species have the potential to occur along sandy stream banks and/or gravel bars such as silky cryptantha (*Cryptantha crinita*) and shield-bracted monkeyflower (*Mimulus glaucescens*) (Table 8-3).

Fremont Cottonwood Riparian Forest. Fremont cottonwood riparian forest occurs within the Deer Creek Watershed at elevations below 1,000 feet. This type of riparian forest is associated with low-gradient portions of creeks and streams, and was once prevalent in the Sacramento Valley. It now occurs as scattered remnants or as small young stands because of habitat loss due to flood control, agriculture and urban development (Holland 1986). Cottonwood riparian forest occurs on fine-grained alluvial soils near a perennial water source. Several small areas of Fremont cottonwood riparian forest occur along China and Delaney Sloughs and north of Reed Orchard Road along Deer Creek. The tree overstory is dominated by Fremont cottonwood. Additional deciduous tree species may include Goodding's black willow (*Salix gooddingii*), sandbar willow, Oregon ash (*Fraxinus latifolia*), western sycamore, and box elder. The understory vegetation is densely distributed, and may consist of the following species: California button-willow, poison oak (*Toxicodendron diversilobum*), California wild grape, and alkali rye grass (*Leymus triticoides*). Cottonwood riparian forest may intergrade with mixed riparian forest at sites that are farther away from the creek (*ibid.*).

Willow Riparian Scrub. Willow riparian scrub is distributed as shrubby streamside thickets along the Deer Creek at elevations that are usually below 1,000 feet. A representative area of riparian scrub is located along Deer Creek just east of Leninger Road (Figure 8-2). The soils tend to be sandy, and the tree overstory may be dominated by several willow species such as sandbar willow, Goodding's black willow, and arroyo willow (*Salix lasiolepis*) and mulefat. In dense thickets there is a minimal herbaceous layer. Where the trees are more widely distributed, non-native grasses and forbs tend to occur within openings in the willow thickets. Common understory plant species include ripgut brome, foxtail barley (*Hordeum jubatum*), soft chess, poison hemlock, and thistle (*Cirsium* sp). Willow scrub commonly occurs adjacent to mixed riparian forest or patches of California blackberry.


Sacramento
River

White Alder Riparian Forest. The white alder (*Alnus rhombifolia*) riparian forest is found primarily along the rapidly flowing, well aerated portion of watercourses in the watershed. Tree and shrub species are generally deciduous. White alder trees are common along the edges of streams and creeks from the valley floor into the lower coniferous forest, an elevation range of 100 to 4,000 feet (Oswald 1994). The presence of large cobbles in the creek channel indicates that high stream velocities are experienced during spring runoff. The riparian corridor is much narrower compared to other riparian areas in the Sacramento Valley. The narrow riparian corridor may be explained by the topography. Steep side canyons and fast flows limit the lateral movement of water needed for riparian plant species, and therefore limit the extent of the riparian habitat. Common species include white alder, big-leaf maple (*Acer macrophyllum*), willow (*Salix* spp.), western azalea (*Rhododendron occidentale*), American dogwood (*Cornus sericea* ssp. *sericea*), common snowberry (*Symphoricarpos albus* var. *laevigata*), and coyote brush (*Baccharis pilularis*).

Woodland

Blue Oak-Foothill Pine Woodland. This plant community occurs on dry foothill slopes and valley borders from about 200 to 1,600 feet elevation (Oswald 1994). This foothill woodland type is distributed in a nearly continuous belt between valley/foothill grassland and mixed conifer forest or mixed chaparral (Holland 1986). The substrates are typically well drained and rocky, or are exposed with shallow soils (*ibid.*). This community is co-dominated by two overstory species, blue oak (*Quercus douglasii*) and foothill pine with each species periodically occurring in pure stands. Blue oaks tend to have a high tolerance for extended periods of drought, and frequent fires favor the establishment of blue oak, a stump-sprouter, over foothill pine.

The understory is characterized by annual grasses and forbs, as described in the Non-native Grassland section, and less commonly by shrubs. Associated species include interior live oak (*Quercus wislizenii* var. *wislizenii*), California buckeye (*Aesculus californica*), whiteleaf manzanita, poison oak, and California redbud (*Cercis occidentalis*). Drier, harsher sites tend to support chaparral, and more mesic sites are characterized by locally abundant occurrences of black oak (*Quercus kellogii*) on the outskirts of this community.

In general, blue oak woodlands have been greatly reduced in extent throughout California by various activities, particularly settlement and firewood harvesting. Natural regeneration of blue oaks has been widely recognized as a statewide problem at many sites (Bolsinger 1988; Griffen 1971; Muick and Bartolome 1987; and Swiecki and Bernhardt 1993). For a further discussion of oak woodlands, see the Sensitive Plant Communities Section below.

Mixed Conifer Forest Communities

According to Fites (March 24, 1997), there are three main mixed conifer forest series: Douglas fir mixed conifer, ponderosa pine mixed conifer, and white fir mixed conifer. For further descriptions of these forest series, the reader is directed to "Ecological Guide of Mixed Conifer Plant Associations: Northern Sierra and Southern Cascades" (Fites 1993). Mixed conifer forests are the most common forest types in the watershed. Special-status plant species that may occur in the coniferous forest include: Butte County fritillary, Cantelow's lewisia, clustered lady's slipper (*Cypripedium fasciculatum*), Tracy's sanicle (*Sanicula tracyi*), Hall's rupertia (*Rupertia hallii*), western campioin (*silene occidentalis* ssp. *longistipitata*), western goblin (*Botrychium montanum*), and Sierra corydaliss (Table 8-3).

Ponderosa Pine Mixed Conifer Series. This forest community occurs on ridges and south-facing and west-facing slopes above the foothill zone, extending to about 5,000 feet (Fites March 24, 1997). Soils tend to be well drained, and are often basaltic (Holland 1986). Ponderosa pine (*Pinus ponderosa*) is the dominant tree in the overstory. Additional common trees include incense cedar (*Calocedrus decurrens*), Douglas fir (*Pseudotsuga menziesii*), canyon live oak (*Quercus chrysolepis*), and sugar pine (*Pinus lambertiana*) (Fites March 24, 1997). White fir (*Abies concolor*) may occur at higher elevations. In some areas there is a lower tree layer composed of broad-leaved deciduous trees, primarily black oak and mountain dogwood (*Cornus nuttallii*). The shrub layer is variable. In dry rocky, areas it is either sparse or absent; whereas in more mesic areas the understory is more developed. On dry sites, the following shrub species may occur: creeping snowberry (*Symphoricarpos mollis*), naked-stemmed buckwheat (*Eriogonum nudum*), greenleaf manzanita, buckbrush, poison oak, and deerbrush (*ibid.*). The herb layer is also variable, and where there are openings in the tree canopy, there may be a high diversity of herbaceous species including milkwort (*Polygala californica*), Bolander's bedstraw (*Galium bolanderi*), soap root, iris (*Iris* sp.), and multi-stemmed sedge (*Carex multicaulis*).

Douglas Fir Mixed Conifer Forest Series. Douglas fir mixed conifer forest is distributed within upland areas from about 3,000 to 6,000 feet, and typically grows on moist sites having north-facing or east-facing slopes (Fites March 24, 1997). Some areas have rocky substrates. Douglas fir is the dominant species in the tree overstory. Incense cedar, white fir, and sugar pine frequently occur as subdominants. On drier, rocky sites ponderosa pine and canyon live oak occur; whereas in wetter areas tree species may include Pacific yew (*Taxus brevifolia*), mountain dogwood, and big-leaf maple (*ibid.*). Red fir (*Abies magnifica*) becomes an associate species at the higher elevations, approximately 5,000 feet.

The density of the understory shrub and herb layers is variable depending on the substrate and available moisture. Shrub species may include hazelnut (*Corylus cornuta*), woodrose (*Rosa gymnocarpa*), thimbleberry (*Rubus parviflorus*), Utah service-berry (*Amelanchier utahensis*), and creeping snowberry. Common herbaceous species include sword fern (*Polysticum* sp.), rattlesnake plantain (*Goodyera oblongifolia*), small-flowered heuchera (*Heuchera micrantha*), trail plant (*Adenocaulon bicolor*), mountain sweet-cicely (*Osmorhiza chilensis*), fragrant bedstraw (*Galium triflorum*), and western fescue (*Festuca occidentalis*) (*ibid.*). In some areas the understory is sparsely distributed due to an accumulation of needle and twig litter.

White Fir Mixed Conifer Series. This series occurs at higher elevations (at about 4,000 to 5,000 feet) within the mixed conifer zone, and may intergrade with red fir forests (Fites March 24, 1997). In some areas, white fir forest occurs on cool, moist sites with moderately deep or deep soils (*ibid.*)

White fir dominates the tree overstory. To a lesser extent sugar pine, red fir, and incense cedar are present, and on drier sites ponderosa pine and Jeffrey pine (*Pinus jeffreyi*) may occur. In general, the understory is poorly developed, and there may be patchy occurrences of creeping snowberry, thimbleberry, greenleaf manzanita, Utah service berry, bush chinquapin (*Castanopsis sempervirens*), and Sierra gooseberry (*Ribes roezlii* var. *roezlii*). On moister sites, the following herbaceous species may occur: trail plant, mountain sweet-cicely, starflower (*Trientalis latifolia*), false Solomon's seal (*Smilacina racemosa*), and Hooker's fairy bells (*Disporum hookeri*). On drier sites, herb and grass species include: purple needlegrass, California groundsel (*Senecio aronicoides*), naked-stemmed buckwheat, mountain monardella (*Monardella odoratissima* ssp. *pallida*), lupine (*Lupinus* spp.), and squirrel tail grass (*Elymus elymoides* ssp. *californicus*).

Conifer Forest (non-mixed)

Red Fir Forest. Red fir forest occurs in the northeastern portion of the watershed, in the Childs Meadows quadrangle at an elevation range of about 5,500 to 8,000 feet. Soils tend to be coarse and well drained, but moist. The forest has a dense canopy with overlapping tree crowns that cast a deep shade (Holland 1986). The dominant tree species is red fir, which may form pure stands or may include white fir and Jeffery pine, as the red fir forest grades into other forest types (*ibid.*). Forest growth is limited by cool temperatures rather than by draughty conditions. The understory vegetation tends to be sparsely distributed, and needle litter and downed branches are abundant. To a lesser extent, the following species may also occur: bog wintergreen (*Pyrola asarifolia* var. *asarifolia*), tufted hair-grass, mountain pink current (*Ribes nevadense*), and creeping snowberry. The special-status fern, western goblin has the potential to occur at the lower elevations of the red fir forest, as this species prefers shady coniferous forests (Table 8-3).

Miscellaneous Plant Communities

Cliffs and Rock Outcrops. Cliffs and rock outcrops are prevalent in the middle and upper sections of the watershed. The majority of the rock formations are of volcanic origin. Rhyolite, a type of volcanic rock, is prevalent on Lassen National Forest lands in the vicinity of Childs Meadows. During the June 1997 field surveys, cliffs and rock outcrops were observed in Deer Creek Canyon, including an area just downstream of the gaging station. These rocky substrates tend to be steep and sparsely vegetated, typically supporting short-statured herbs and grasses. Many of the rock surfaces support colorful lichens, club moss (*Sellaginella* sp.), and a occasional cliffbrake fern (*Pellaea* sp.). Some portions of the rock outcrops have pockets of soil that support herbaceous species such as dwarf lessingia (*Lessingia nana*), blue dicks, and farewell to spring (*Clarkia* sp.). Occasional shrubs and trees may also occur such as buckbrush, manzanita, toyon (*Heteromeles arbutifolia*), and foothill pine. Scattered volcanic boulders and rocks also occur in lower grassland areas of the watershed including pastures near the Cone-Kimball canal channel.

SENSITIVE BOTANICAL RESOURCES

Special-Status Plant Species

Definition. Special-status plant species are species that are legally protected under the State and Federal Endangered Species Acts or other regulations, and species considered sufficiently rare by the scientific community so that they may qualify for official protection.

Special-status plant categories:

- Plants listed or proposed for listing as threatened or endangered under the Federal Endangered Species Act (50 CFR 17.12 [listed plants] and various notices in the Federal Register [proposed species]);

- Plants listed or proposed for listing by the State of California as threatened or endangered under the California Endangered Species Act (14 CCR 670.5);

- Plants listed under the California Native Plant Protection Act (California Fish and Game Code, Section 1900 et seq.);

- Plants that meet the definitions of rare or endangered under CEQA (State CEQA Guidelines, Section 15380);

- Plants considered by CNPS to be "rare, threatened, or endangered in California" (Lists 1b and 2 in Skinner and Pavlik, 1994) ; and

- Plants listed by CNPS as plants about which more information is needed to determine their status and plants of limited distribution (lists 3 and 4 in Skinner and Pavlik 1994), which may be included as special-status species on the basis of local significance or recent biological information.

Deer Creek Watershed Special-Status Plant Species List. Review of available literature and searches of the Natural Diversity Database and the CNPS Inventory of Rare Plants resulted in 44 special-status plant species that are either known to occur or that are suspected to occur in the Deer Creek Watershed (Table 8-3). The special-status plant species list is based on a review of special-status plants listed as occurring in Tehama County by the CNPS Skinner and Pavlik 1994 and an assessment of their elevational distributions and habitat requirements (Munz and Keck 1973; Hickman 1993; Oswald 1994), and the California Natural Diversity Data Base (CNDDB 1996).

Table 8-3 lists the legal status, distribution, habitat, and quadrangle code, as applicable for each of these special-status plant species. The majority of the status codes/designations are updated as per the CDFG Natural Heritage Division Plant Conservation Program's List of Endangered, Threatened, and Rare Plants of California (CDFG January 1996). Four special-status species associated with vernal pools that were previously proposed for Federal listing have recently been listed at the Federal level: Green's tuctoria - endangered; hairy orcutt grass - endangered; Hoover's spurge - threatened; and slender orcutt grass - threatened (Tom Griggs The Nature Conservancy pers. comm. July 1997).

Documented Occurrences. Special-status plant species have known occurrences in eleven of the sixteen quadrangles located within the watershed: Childs Meadows, Stover Mountain, Onion Butte, Humbolt Peak, Ishi Caves, Devils Parade Ground, Butte Meadows, Vina, Richardson Spring NW, Campbell Mound, and Cohassett. Two quadrangles in particular, Vina and Richardson Spring NW have the greater number of special status species, five species and seven species, respectively (Table 8-3). The greater number of special-status plant species in these two quadrangles may be attributed to the presence of vernal pools and their associated sensitive plant species including: Ahart's paronchia, Green's tuctoria, hairy orcutt grass, slender orcutt grass, and Hoover's spurge. Hoover's spurge has been observed in a dried mudflat near the town of Vina, and has also been recorded to grow with Green's tuctoria in a large hardpan vernal pool in the Vina plains near Leininger Road and Highway 99 (CNDDB 1996).

Additional occurrences of special-status plant species include Adobe lily (*Fritillaria pluriflora*) which has been observed growing at the Los Molinos Rancho (*ibid.*) and big-scale balsamroot (*Balsanorhiza macrolepis* var. *macrolepis*) at the Graham Pinery northwest of Campbellville. Tracy's sanicle has also been recorded to occur in the Onion Butte quadrangle at Potato Patch Camp along Deer Creek (*ibid.*). Note, although Tracy's sanicle is recorded in the CNDDB, the species may not occur in Tehama County (taxonomic questions) probably is *S. graveolens* instead (Corbin September 18, 1997). According to Beth Corbin, Botanist with Lassen National Forest, white-stemmed clarkia (*Clarkia gracilis* var. *albicaulis*) and Hall's rupertia (*Rupertia hallii*) have been observed near Campbellville (pers. comm. October 1996).

Four special-status ferns have recorded occurrences in the Humbolt Peak quadrangle: western goblin, scalloped moonwort, mingan moonwort (*B. minganense*), and upswept moonwort (*B. ascendens*). Their locations are associated with wetland habitats such as freshwater marsh, bogs, montane wet meadows, and along creeks and streams.

In accordance with the CNDDB policy on species protection, this document does not include detailed locations of known occurrences of special-status species. For further information, the reader is referred to the NDDB (CDFG 1996) print outs of the 14 quadrangles in the watershed.

Note that focused field surveys for special-status plant species have not been conducted in the majority of the watershed, so additional population areas and/or other sensitive plant species may be present.

Potential Threats to Existing Populations. The NDDB also provides information on threats to special-status plant species. Threats to special-status species recorded within the watershed include damage from agriculture, cattle grazing, human activities, and competition with invasive non-native plant species. For example, some of the adobe lily locations in the Vina quadrangle are threatened by road maintenance activities along Highway 99 and competition from the exotic grass, Medusahead

(*Taeniatherum caput-medusae*). In the Vina Plains three miles east of Leninger Road, common cocklebur, swamp pricklegrass (*Crypsis schnoides*), and field bindweed (*Convolvulus arvensis*) have been observed to be associated with the decline of Hoover's spurge (CNPS List 1B) (NDDB 1996). In the TNC Vina Plans Preserve, past grazing practices have caused soil disturbance and may have contributed to the establishment of weedy exotics. Confiscation of whole plants of the rare fern, scalloped moonwort has been reported along Willow Creek in the Humbolt Peak quadrangle.

Sensitive Plant Communities

Sensitive habitats are defined by local, State, or Federal agencies as those habitats that support special status species, provide important habitat values for wildlife, represent areas of unusual or regionally restricted habitat types, and/or provide high biological diversity. The following vegetation types occurring within the Deer Creek Watershed are considered by public agencies to be sensitive habitats: riparian forest, riparian scrub, blue oak woodland (blue oak-foothill pine woodland), native grassland, freshwater marsh, vernal pools and other wetlands such as seeps, sloughs, and montane wet meadows.

In general, the wetland, riparian and native grassland/prairie plant communities are considered sensitive habitat due to their high wildlife value, limited distribution, and decreasing acreages statewide. These sensitive habitats have been significantly reduced from their historical distributions. Wetlands are a significant resource that are under the protection and jurisdiction of the U.S. Army Corps of Engineers, and are subject to a no net loss policy.

Vernal pools are considered a unique type of wetland that should be preserved, as they typically support uniquely adapted or locally rare plant and animal species. Vernal pools rank the highest globally for numbers of endemic plant species (*ibid*). The number of vernal pools in the Sacramento Valley that were historically present have been reduced and/or fragmented by agriculture and urbanization (Holland 1978).

Freshwater marsh habitats, as they now exist represent only fragments of what was historically present in California. Past agricultural practices have converted marsh habitat into farmland by draining, diking, and leveling (Mason 1969). Marshes have also been degraded by weedy non-native plants, including Asian plants that were introduced into the ricefields (*ibid.*). Locations within the Deer Creek Watershed supporting freshwater marsh include China and Delaney Sloughs.

At the State level, riparian plant communities are considered sensitive habitat and have been identified by the California Department of Fish and Game (CDFG) as habitat of special concern (Wetlands Resource Policy, California Department of Fish and Game Commission 1987). Riparian habitat is valuable because it supports a high density and diversity of wildlife species and because it is a diminishing resource. In the State of California, at least 89.0 percent of riparian areas existing 130 years ago have been lost (*ibid*). The following types of riparian communities occur within the Deer Creek Watershed: mixed riparian forest, Fremont cottonwood forest, willow riparian scrub, and white alder riparian.

In general, blue oak woodlands have been greatly reduced in extent throughout California by various activities, particularly settlement and firewood harvesting. Natural regeneration of blue oaks has been widely recognized as a statewide problem at many sites (Bolsinger 1988; Griffen 1971; Muick and Bartolome 1987; and Swiecki and Bernhardt 1993). The reasons for poor blue oak regeneration are complex, and an active area of research. No single factor or cause is responsible for the poor blue oak regeneration problem. A number of factors including animal grazing, acorn depredation, plant competition and environmental extremes can affect recruitment success, depending on site conditions (U.C. California Integrated Hardwood Range Management Program Publication 3368 1996).

Blue oak woodlands may also be in decline because regeneration rates are insufficient to sustain current stand structures (Mayer et al. 1986, Muick and Bartolome 1986). As losses of blue oak woodlands continue, the relative importance of undeveloped stands will increase. In response to the decline of all oak woodland types, the California Department of Forestry and Fire Protection, California Native Plant Society (CNPS), and The Nature Conservancy have identified the conservation and management of oak woodlands as major issues. The California State Senate passed a resolution identifying the conservation of oak woodlands as a priority of State agencies when authorizing actions and projects (Senate Concurrent Resolution No. 17 January 18, 1989). Tehama County has adopted oak woodland management guidelines for private land owners.

The sensitive plant communities occurring in the Deer Creek Watershed are listed below. See the Existing Plant Communities and their Distribution Section for descriptions. For further information on these plant communities and their associated plant community series, see the following references: A Manual of California Vegetation (Sawyer and Keeler-Wolf CNPS 1995); Preliminary Descriptions of the Terrestrial Natural Communities of California (Holland, 1986), A California Flora and Supplement (Munz and Keck 1968), and the Status of the Sierra Nevada (Sierra Nevada Ecosystem Project Report 1996).

List of Sensitive Plant Communities in the Deer Creek Watershed

- Native Grasslands/Prairie
- Freshwater Marsh
- Montane Wet Meadow
- Vernal Pool
- Mixed Riparian Forest
- Fremont Cottonwood Riparian Forest
- Willow Riparian Scrub
- White Alder Riparian Forest
- Blue Oak-Foothill Pine Woodland

INVASIVE NON-NATIVE/EXOTIC PLANT SPECIES

Background

In accordance with the policy on invasive exotic plants adopted by the CNPS in September 1996, land managers are urged to control/eradicate invasive, exotic plant species (CNPS September 1996). According to the CNPS, the definition of an invasive exotic plant is a non-native plant species which did not occur naturally in California prior to European settlement, and that is able to proliferate and aggressively alter or displace indigenous plant communities (*ibid.*). Exotic plants are detrimental to the environment and economy in many ways, and often out-compete California native plant species to their exclusion. According to Warner (1993), exotic plants disrupt soil fungi and microorganisms relationships with plants, and they also disrupt nutrient cycles. Certain exotics such as pampas/jubata grass (*Cortaderia jubata*) and eucalyptus (*Eucalyptus* sp.) can contribute to the intensity of wild fires.

In some cases, a monoculture of an exotic plant species results, which may decrease biodiversity and lower habitat values for wildlife and fisheries. The eradication of exotic plant species in riparian forests is important for habitat improvement for fisheries. Riparian forests with high habitat value have well developed tree overstories that provide fish shade for moderating water temperature. In addition, a well developed riparian corridor provides a source of insects for fish consumption and provides vegetative cover to lower bank erosion and sedimentation of creeks, which can lower the habitat value for fisheries (Stacy Li pers. comm. November 1996).

According to the Wildland Resources Center, SNEP report (June 1996), exotic plant species threaten native plant diversity in the Sierra Nevada. The invasion of exotic plants has been the most severe in the Sierran foothills, and it is associated with livestock grazing and settlement patterns (*ibid*). The invasion of valley and foothill grasslands by exotic plant species (e.g., medusa-head and yellow starthistle) has lowered the habitat value of these grasslands.

Both State (Department of Pest Regulation) and Federal governments have enacted legislation declaring the worst aggressive weeds as "noxious weeds" that should be eradicated wherever they are found (Hickman 1993). The California Exotic Pest Plant Council (CalEPPC) has developed a statewide list of exotic plant species.

Invasive Exotic Plant Species Occurring in the Deer Creek Watershed

Riparian habitats and grasslands are often targets for invasion by exotic vegetation, particularly in areas where there has been ground disturbance due to human activities (i.e., construction, agriculture, grazing). A major portion of the Sacramento Valley floor is now either under agricultural use or is urbanized. This has resulted in major changes to the composition of the native flora and the introduction of many exotic plant species (Oswald 1994).

A preliminary list of invasive exotic (non-native) plant species observed and predicted to occur in the Deer Creek Watershed (primarily Tehama County) is presented in Table 8-4. This list was compiled from field observations, literature review (i.e., Butte County Flora, Oswald 1994), and personal communications with local botanists and The Nature Conservancy. In general, exotic plant species are more prevalent in the lower elevations of the watershed such as the Sacramento Valley and the lower Deer Creek riparian corridor, which have been disturbed by human activities. Additional exotic plant species not listed in Table 8-4 are expected to exist within the boundaries of the watershed. It appears from the literature that there have been no detailed field surveys, nor mapping of areas, with significant concentrations of exotics.

Some of the more invasive exotic plant species occurring within the watershed include: medusa-head, yellow starthistle, Johnson grass, common ragweed (*Ambrosia artemisiifolia*), Himalayan blackberry (*Rubus discolor*), common cocklebur, Scotch broom (*Cytissus scoparius*), Spanish broom (*Spartium junceum*), French broom (*Genista monspessulana*), field bindweed, milk thistle (*Silybum marianum*), tree-of-heaven (*Ailanthus altissima*), edible fig, bull thistle, giant reed, and Klamath weed (*Hypericum perforatum*). See Table 8-4 for a further listing of exotic plant species.

Several problem areas having invasive non-native plant species are described below. Giant reed and edible fig invade riparian habitats, and are known to occur along streams, ponds, and canals from the Sacramento Valley floor into the foothills (Oswald 1994). During the field reconnaissance surveys (November 1996), giant reed was observed near the confluence of Deer Creek and the Sacramento river. According to Brother Paul at the Abby of New Clairvaux, the giant reed near the confluence had been planted intentionally in the 1950s for erosion control and bank stabilization. During the June 1997 field surveys giant reed was observed to extend upstream from the confluence to the railroad track. Field bindweed has become a severe problem in the agricultural fields and orchards at the New Clairvoix Monastery. Johnson grass, common cocklebur, yellow starthistle, Himalayan blackberry, and white sweet clover (*Melilotus alba*) are also common along the Deer Creek riparian corridor. Severe concentrations of yellow starthistle were observed in the grasslands adjacent to Deer Creek on the Robinson's property west of Highway 99. Yellow starthistle was also observed to be the dominant herbaceous species growing on the riparian "island" north of Deer Creek on the island crossing (Leininger property) near the Cone-Kimball canal channel. The exotic grass medusa-head and yellow starthistle have become severe problems in the Vina Plains grasslands (pers. comm. Tom Griggs, TNC). According to local residents in the town of Vina, common ragweed has become a severe problem in agricultural fields and pastures (Sue Knox and Stuart Hanna pers. comm. June 1997).

Competition with Special-status Species. Invasive exotic plants are competing with and are contributing to the decline of several special-status plant species in the watershed. In the Vina Plains three miles east of Leininger Road, common cocklebur, swamp pricklegrass, and field bindweed have been observed to be associated with the decline of Hoover's spurge (CNPS List 1B) (NDDB 1996).

Note, that additional exotic species and infestations are likely, and that further field studies are necessary to develop a more comprehensive exotic's plant species list and to document the distribution of exotics in the watershed.

Table 8-4. Preliminary List of Invasive Exotic (Non-native) Species Observed and Predicted to Occur in the Deer Creek Watershed, Tehama County, California

SCIENTIFIC NAME	COMMON NAME
Acacia decurrens	Green Wattle
Ailanthus altissima	Tree of Heaven
Albizia lophantha	Plume Acacia
Amaranthus albus	Tumbleweed
Ambrosia artemisiifolia	Common or Annual Ragweed
Arundo donax	Giant Reed
Bromus madritensis	Red Brome
Bromus tectorum	Cheat Grass
Cardaria chalapense	Lens-podded White-top
Carduus pycnocephalus	Italian Thistle
Centaurea calcitrapa	Purple Starthistle
Centaurea solstitialis	Yellow Starthistle
Cirsium arvense	Canada Thistle
Cirsium vulgare	Bull Thistle
Conium maculatum	Poison Hemlock
Convolvulus arvensis	Field Bindweed
Cortaderia jubata	Pampas Grass or Jubatagrass
Cotula coronopifolia	Brass Buttons
Crataegus monogyna	Hawthorne
Crypsis schoenoides	Swamp Pricklegrass
Dipsacus fullonum	Fuller's Teasel
Genista monspessulana (*Cytisus monspessulanus*)	French Broom
Cytisus scoparius	Scotch Broom
Ficus carica	Edible Fig
Foeniculum vulgare	Wild Fennel or Anise
Hedera helix	English Ivy
Hypericum perforatum	Klamath Weed
Lepidium perfoliatum	Perrennial Pepperweed
Marrubium vulgare	Horehound
Melilotus alba	White Sweet Clover
Mentha pulegium	Pennyroyal
Oryzopsis miliacea	Smilo Grass
Parentucellia viscosa	Yellow Parentucellia
Phalaris aquatica	Harding Grass
Phyla nodiflora (*Lippia nodiflora*)	Lippia
Pyracantha spp.	Pyracantha or Chinese Firethorn
Ricinus communis	Castor Bean

Table 8-4. Preliminary List of Invasive Exotic (Non-native) Species Observed and Predicted to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SCIENTIFIC NAME	COMMON NAME
Robinia pseudoacacia	Black Locust
Rubus discolor (=*R. procerus*)	Himalaya Blackberry
Salsola tragus	Russian Thistle or Tumbleweed
Sorghum halepense	Johnson Grass
Spartium junceum	Spanish Broom
Taeniatherum caput-medusae	Medusahead
Tamarix gallica	French Tamarisk
Tanacetum vulgare	Tansy
Verbascum thapsus	Woolly Mullein
Vinca major	Periwinkle
Xanthium strumarium	Cocklebur

AVAILABLE MAPPED INFORMATION

Various mapped information for the vegetation resources of the Deer Creek Watershed have been generated. Much of this information exists in digital form. The following list summarizes some of the vegetation maps that are available for the watershed:

1. **Draft Potential Natural Vegetation for Antelope, Mill, and Deer Creeks**
   Source: Lassen National Forest, Fites (March 24, 1997) and Source Environmental Systems Research Institute, Inc. September 30, 1996
   Coverage: Map depicts 19 potential natural conifer habitats for Antelope, Mill, and Deer Creeks
   Scale: Approximately 1:3,000,000 (1" = 17,424')
   Units:

2a. **Vegetation (Calveg)**
   Source: California Department of Forestry; Landsat data
   Coverage: Depicts mapping of existing vegetation
   Scale: 1:250,000 (1" = 20,833')
   Units: Meters

2b. **Vegetation Deer Creek USFS Coverage's (Deereveg)**
   Source: United States Forest Service; Landsat data
   Coverage: Depicts broad scale vegetation mapping for existing plant communities, including chaparral, conifer forest, and hardwood forest
   Scale: 1:3,000,000 (1" = 250,000') and (1" = 15,000')
   Units: Meters

3. **Deer Creek Tehama County, Sacramento River Riparian Project**
Source: Cherie Montague in 1996 at the GIS Center, California State University, Chico
Coverage: Map depicts six riparian vegetation types: blackberry scrub, cottonwood forest, herbland, mixed forest, riparian scrub, and valley oak woodland. Map covers the riparian areas along Deer Creek from the confluence with the Sacramento River to the gaging station in Deer Creek Canyon.
Scale: 1:4,368 (1" = 1,000')
Units: Meters

4. **Deer Creek Watershed Vegetation Types**
Source: California Department of Water Resources, Northern District; Lassen National Forest; Landsat, CalVeg, and USFS information
Coverage: Depicts 19 vegetation types on National Forest Lands
Scale: 1:115,200 (1" = 9,600')
Units:

5a. **Deer Creek Land Use/Land Cover**
Source: California Rivers Assessment; United States Geological Survey (USGS), Calif. Department of Fish and Game, U.S. Environmental Protection Agency (EPA), and the Teal Data Center
Coverage: Depicts 22 land uses or cover types including non-forested wetlands, deciduous forest, evergreen forest, herbaceous rangeland, and agricultural lands
Scale: 1:250,000 (1" = 20,833')
Units:

5b. **Deer Creek Watershed Land Use/Cover**
Source: California Department of Water Resources, Northern District (4-11-97); USGS
Coverage: Depicts the same 22 land uses or cover types as described for the map above, including non-forested wetlands, forest lands, rangelands, and orchards
Scale: 1:115,200 (1" = 9,600')
Units: Meters

6a. **National Wetlands Inventory**
Source: U.S. Department of the Interior, Fish and Wildlife Service
Coverage: Depicts locations of known wetlands based on aerial photograph interpretation
Scale: 1:1,440,000 (1" = 120,000')
Units:

6b. **Wetlands Inventory**
Source: Department of Fish and Game
Coverage: Depicts locations of wetlands
Scale: 1:24,00 (1" = 2,000')
Units: Meters

7. **Habitat Map of the Deer Creek Study Area**
Source: Deer Creek Wild and Scenic River Suitability Report (Jones and Stokes, October 1994)
Coverage: Depicts broad scale habitat mapping adjacent to Deer Creek, for six plant communities: riparian forest, grassland, grassland/agriculture/pasture, - foothill pine woodland, chaparral, and coniferous forest Information sources are the Soil Conservation Service (1967) and reconnaissance-level field survey in 1994. The study area was a two-mile wide portion of t he riparian corridor (one mile from either creek bank).
Scale: 1:63,360 (1" = 5,280')
Units: Miles

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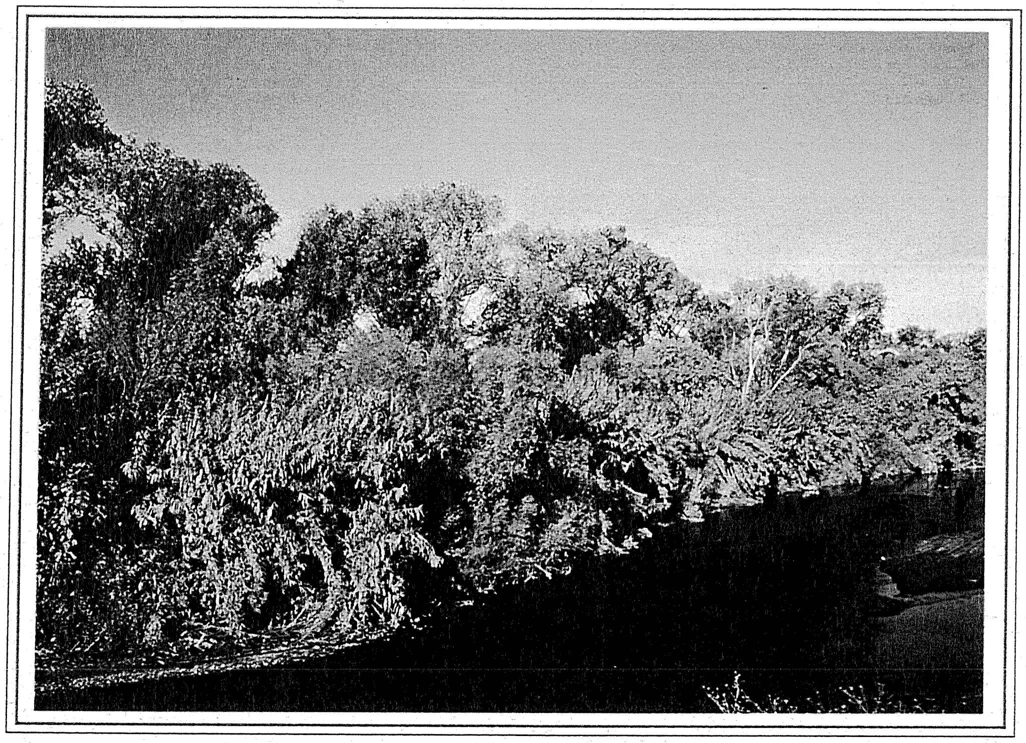

Photo 8-1. Giant Reed *(Arundo donax)* growing among native riparian vegetation near the mouth of Deer Creek. (Photo by J. Stanley, November 1996)

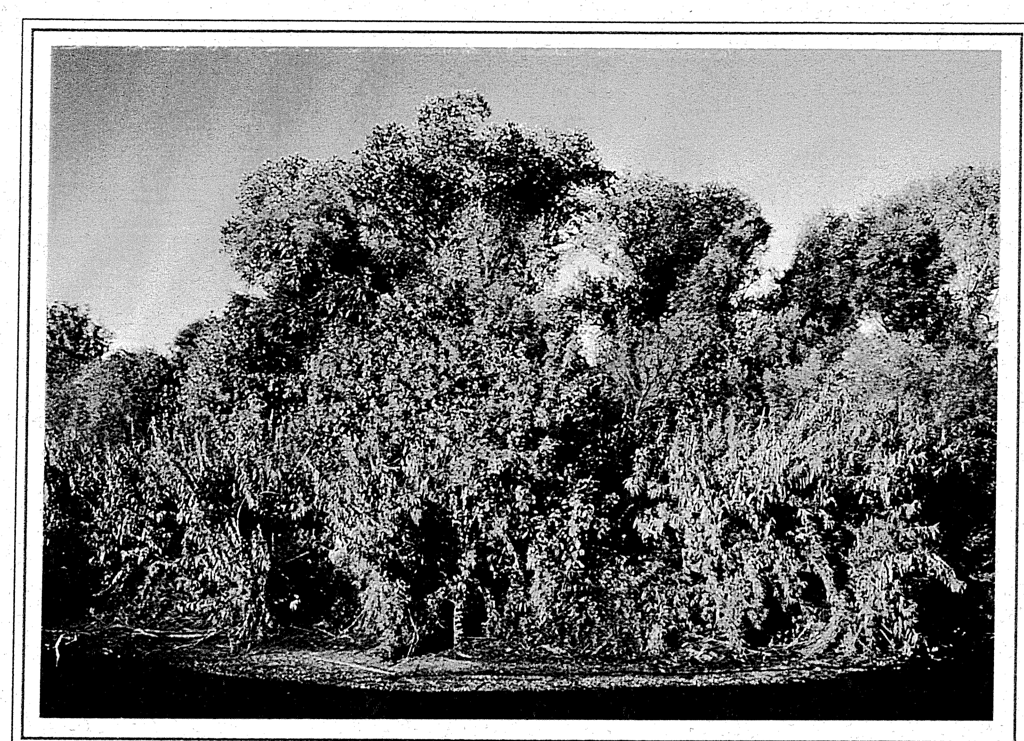

Photo 8-2. At one time in the past, Giant Reed was planted along portions of lower Deer Creek to stabilize eroding streambanks. (Photo by J. Stanley, November 1996)

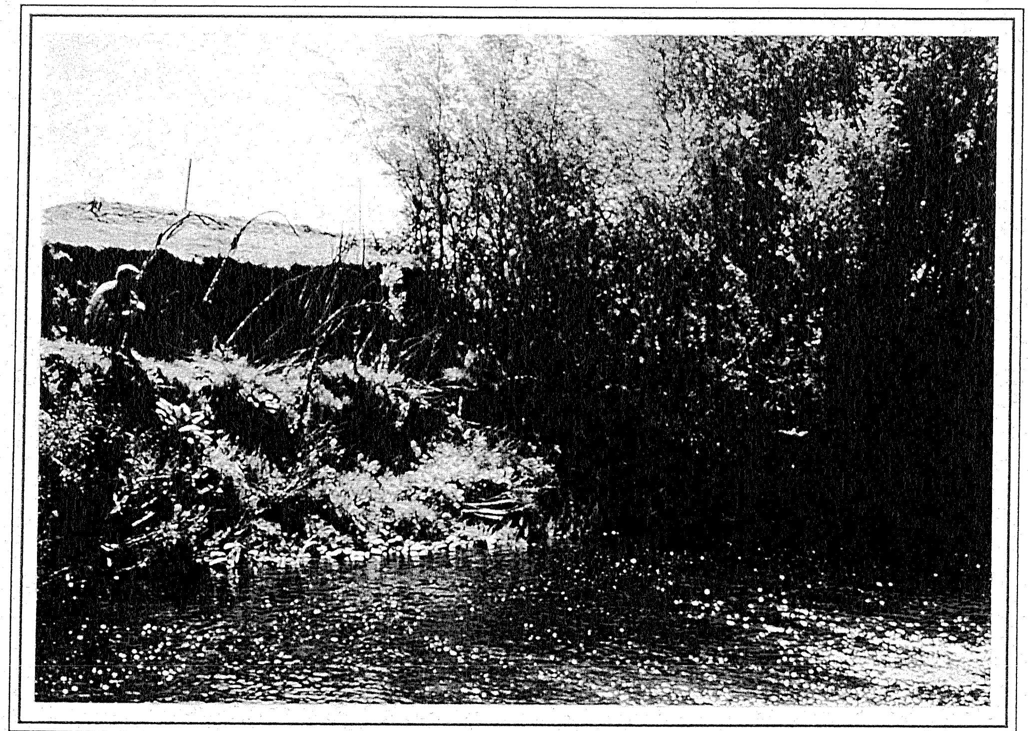

Photo 8-3. Difference between grazed and ungrazed sections of streambank. South side of Deer Creek approximately one mile upstream of Highway 99. (Photo by S. Cepello, 1986-87)

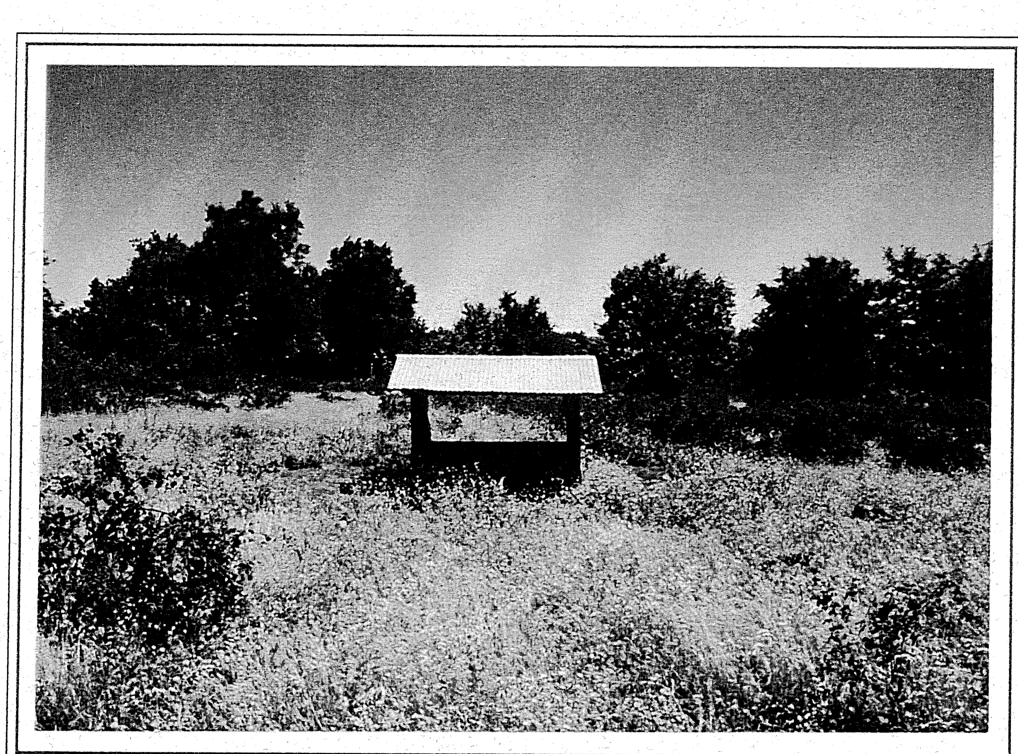

Photo 8-4. Non-native grasses and yellow star thistle growing in trampled area around livestock feeding bin on "island" south of Cone-Kimball Canal channel. (Photo by J. Stanley, June 1997)

Photo 8-5. Maturing riparian habitat growing on "island" south of Cone-Kimball Canal channel. (Photo by J. Stanley, June 1997)

Photo 8-6. Native (wild grape) and non-native (yellow star thistle) groundcover in open (grazed) areas on "island" south of Cone-Kimball Canal channel. (Photo by J. Stanley, June 1997)

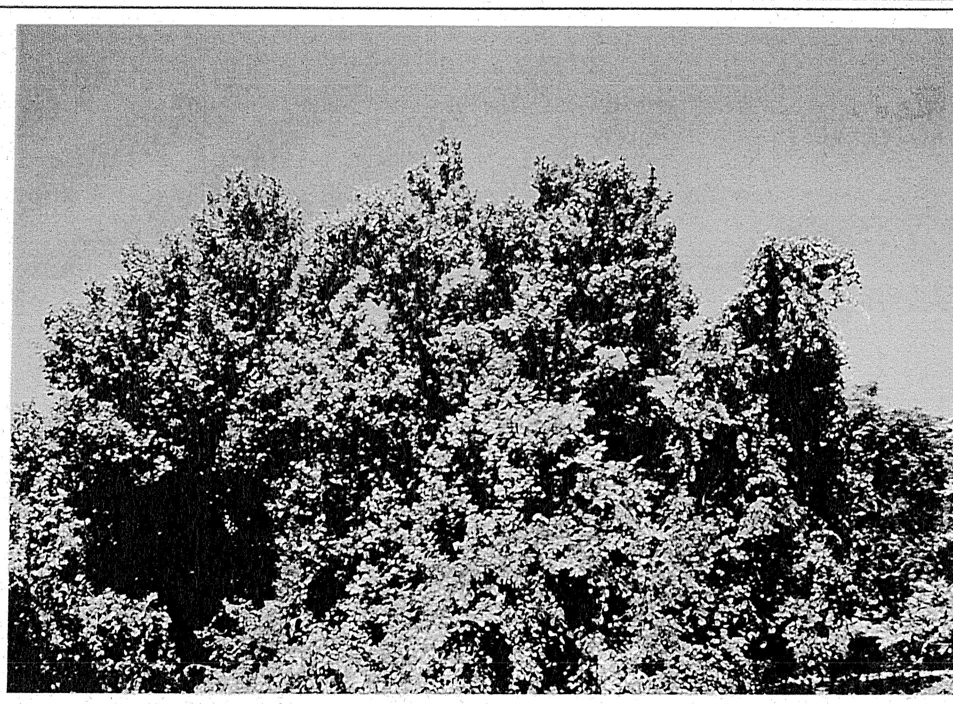

Photo 8-7. Sycamores covered with wild grape growing on "island" south of the Cone-Kimball Canal channel. (Photo by J. Stanley, June 1997)

Photo 8-8. Young sycamore sprouting in sandy swale on "island" south of the Cone-Kimball Canal channel. (Photo by J. Stanley, June 1997)

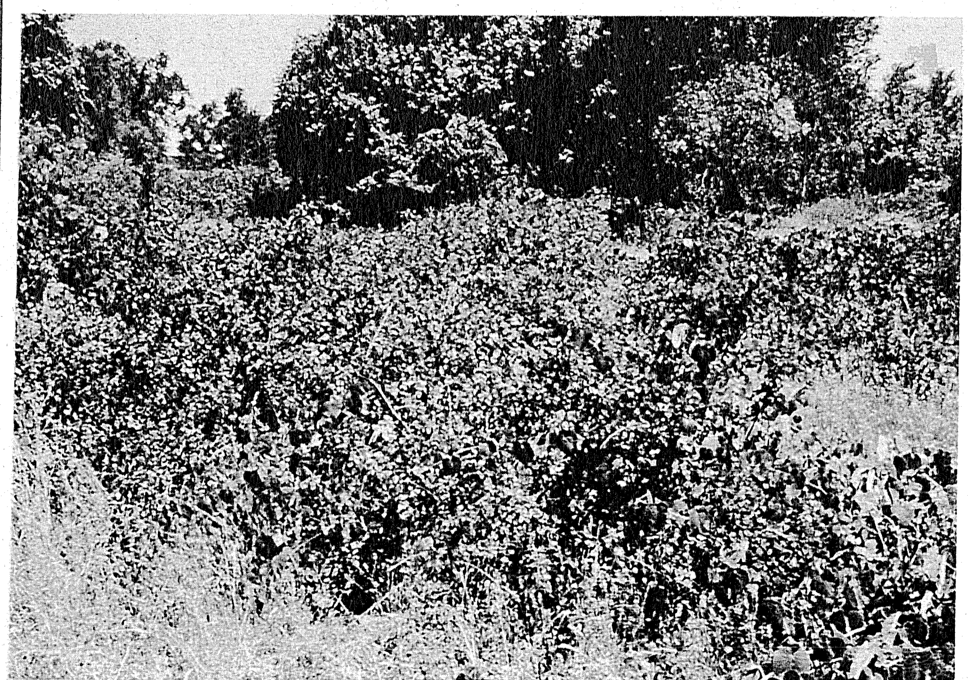

Photo 8-9. Shrub layer of *Rhus trilobata* and wild grape growing on "island" south of the Cone-Kimball Canal channel. (Photo by J. Stanley, June 1997)

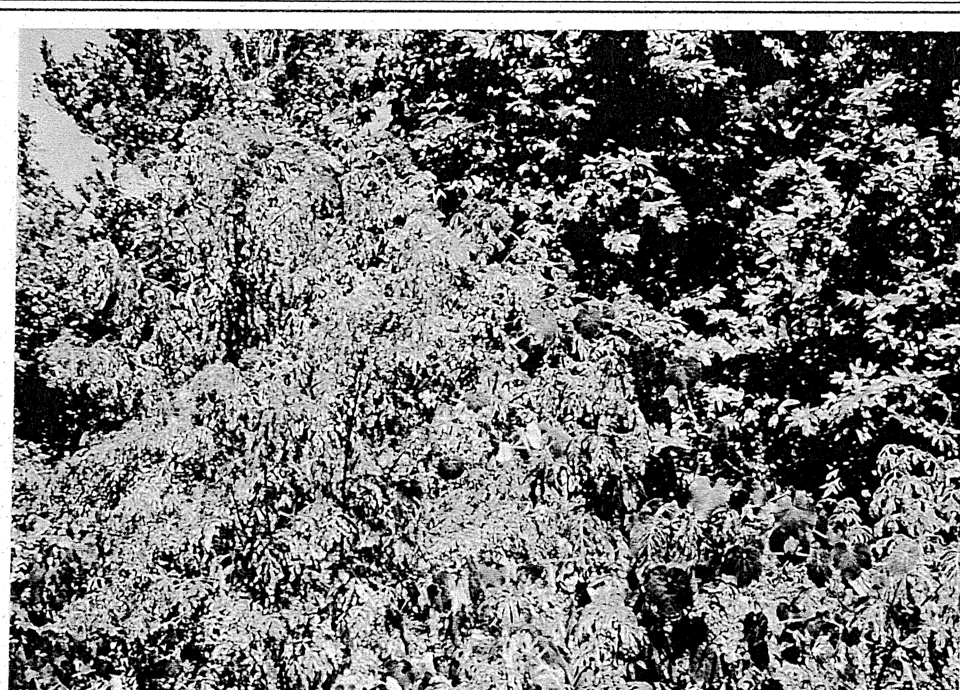

Photo 8-10. Dense growth of elderberry and wild grape growing on "island" south of the Cone-Kimball Canal channel. (Photo by J. Stanley, June 1997)

Photo 8-11. Dense growth of mule fat and sandbar willow growing along Deer Creek just downstream of the USGS gaging station. (Photo by J. Stanley, June 1997)

Photo 8-12. Flowering button-willow growing along Deer Creek downstream of the USGS gaging station. (Photo by J. Stanley, June 1997)

Photo 8-13. Single (compound) leaf of Oregon Ash growing along Deer Creek upstream of the DCID diversion dam. (Photo by J. Stanley, June 1997)

Photo 8-14. Single (compound) leaf of California black walnut growing along Deer Creek upstream of the DCID diversion dam. (Photo by J. Stanley, June 1997)

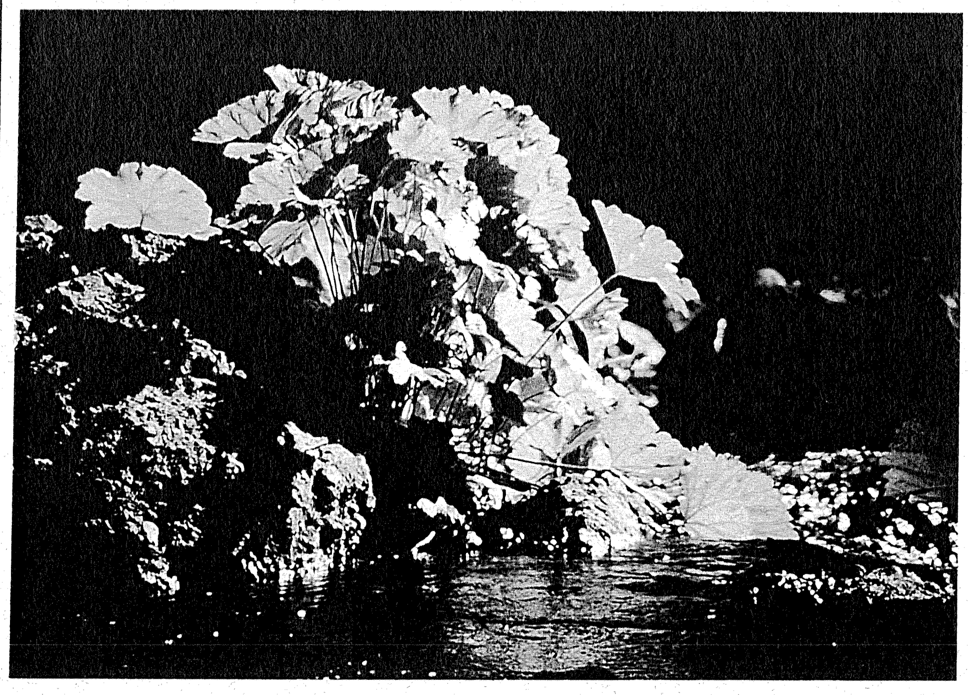

Photo 8-15. Western coltsfoot growing along upper Deer Creek near Potato Patch Campground. (Photo by J. Stanley, June 1997)

Photo 8-16. This sedge and the western coltsfoot above survived the high flows of the January 1997 storm. (Photo by J. Stanley, June 1997)

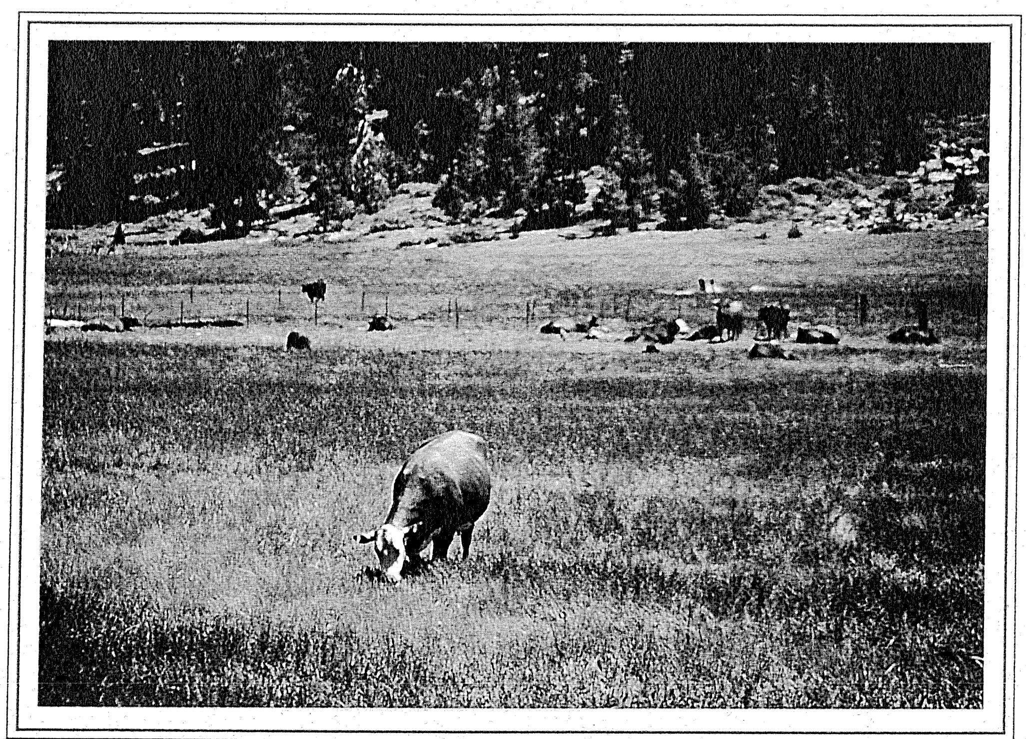

Photo 8-17. Cattle grazing in Deer Creek Meadows. Note fencing in background along Deer Creek. (Photo by J. Stanley, June 1997)

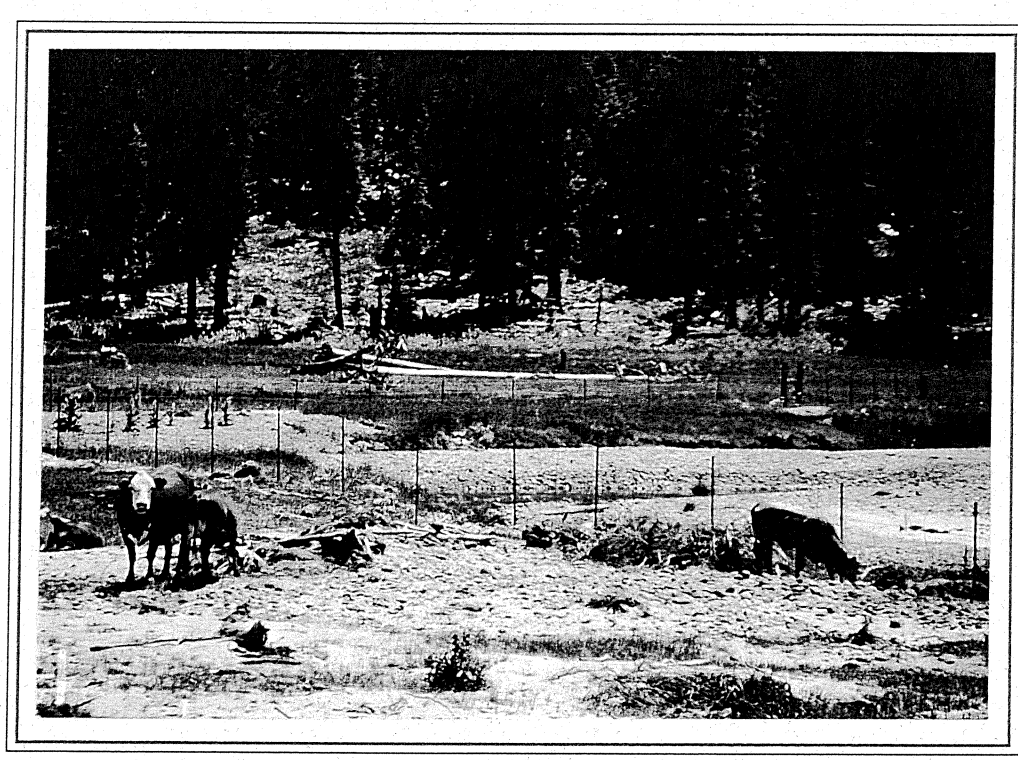

Photo 8-18. Livestock exclusion fencing erected along Deer Creek at lower end of Deer Creek Meadows. (Photo by J. Stanley, June 1997)

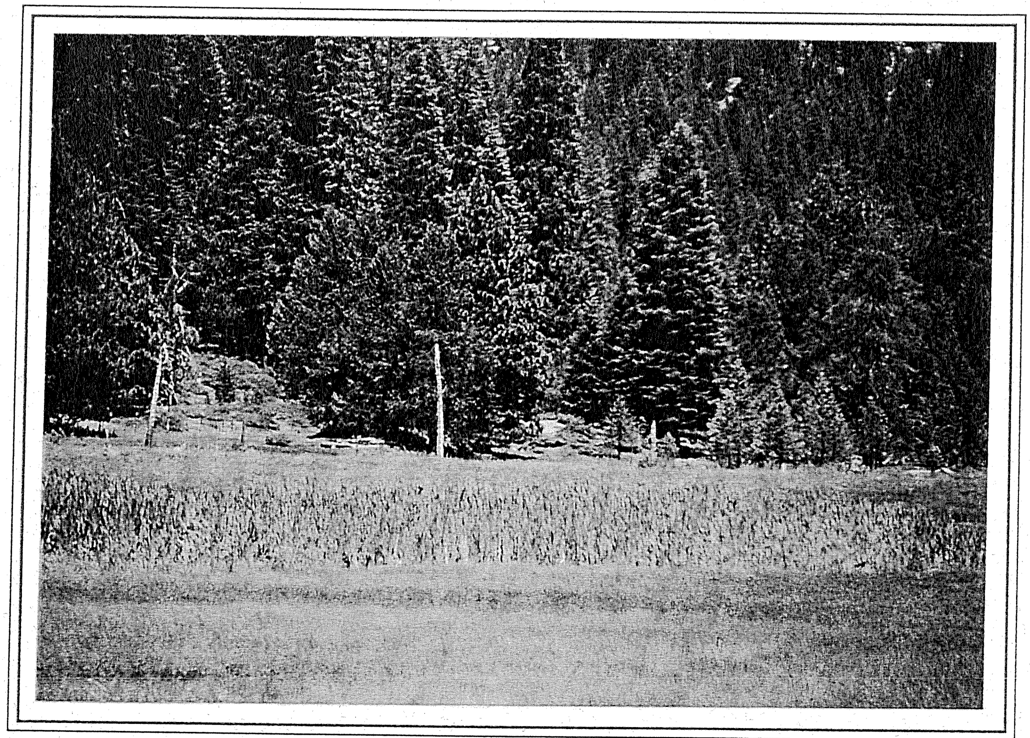

Photo 8-19. Freshwater marsh in Deer Creek Meadows, upper Deer Creek Watershed. (Photo by J. Stanley, June 1997)

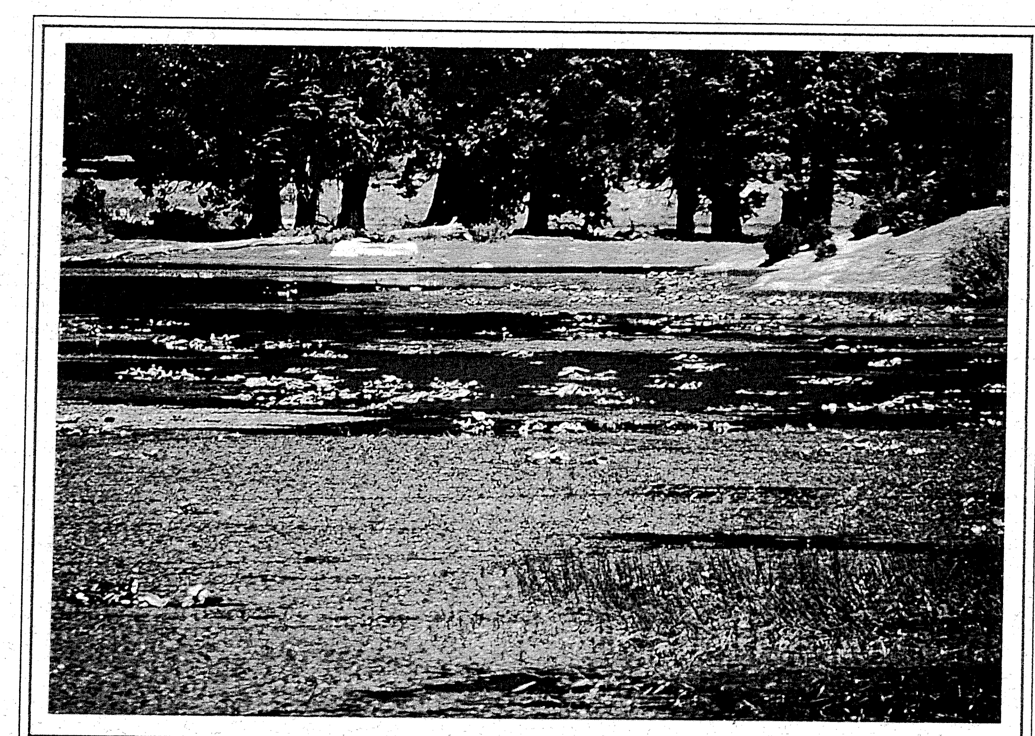

Photo 8-20. Emergent and aquatic vegetation growing in small pond near upper end of Childs Meadow, Gurnsey Creek Watershed. (Photo by J. Stanley, June 1997)

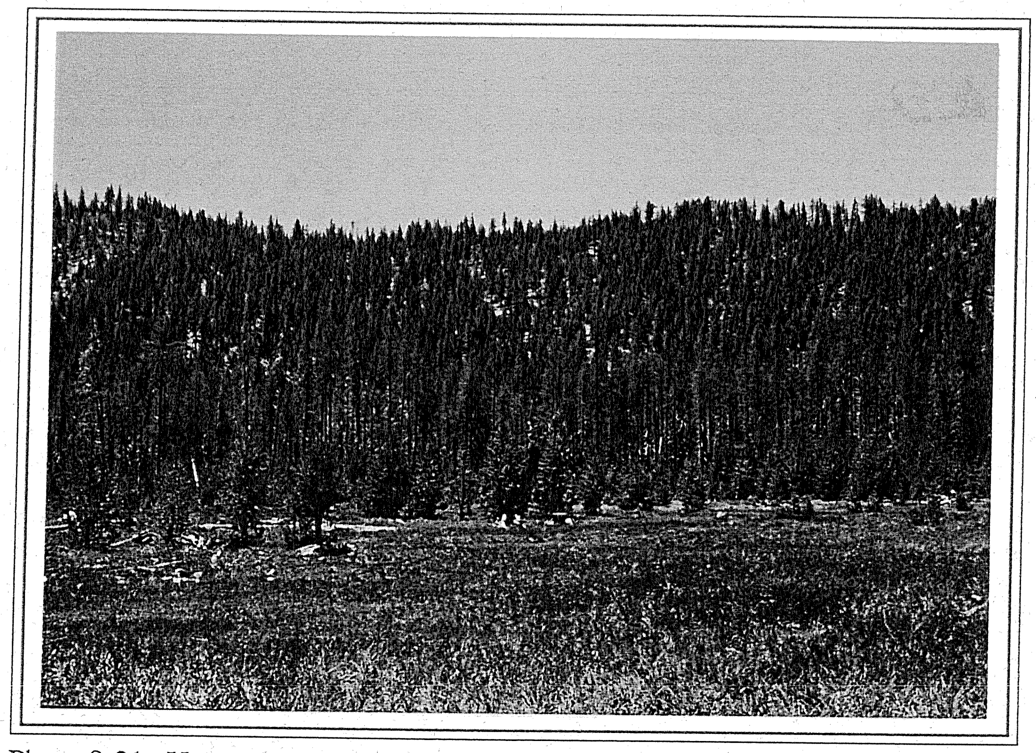

Photo 8-21. Young lodgepole pine trees invading westside of Childs Meadow, Gurnsey Creek Watershed. (Photo by J. Stanley, June 1997)

Photo 8-22. Accumulation of downed woody debris on forest floor beneath lodgepole pine forest, Gurnsey Creek Watershed. (Photo by J. Stanley, June 1997)

9.0 WILDLIFE RESOURCES

METHODS

The following information sources were reviewed in order to assess known and potential wildlife species in the region: 1996 California Natural Diversity Data Base (CNDDB) files for all quad sheets in the Deer Creek Watershed; Land and Resource Management Plan for Lassen National Forest (LNF) (LNF1992); Avian Species of Management Concern: Mill and Deer Creek Drainage's, Tehama County, California, (England *et al.* 1988); California Department of Fish and Game Amphibian and Reptile Species of Special Concern (Jennings and Hayes, 1994); Aquatic Resource Survey of Deer and Mill Creek Tributaries: Herptofauna Observed In The Deer Creek Drainage (LNF 1997); Watershed Analysis Report of Mill, Deer and Antelope Creek Watersheds: Wildlife Analysis (Armentrout 1997); Deer Creek Wild and Scenic River Suitability Report (Jones and Stokes 1994); Mill Creek Watershed Management Strategy Report (CH2M HILL 1997); Master Plan of Yahi Indian State Historic Park (Stewart 1978); and Significant Resources of the Deer Creek and Mill Creek Drainages, Tehama County, California (Sato *et al.* 1988). For a more complete literature listing, see the Literature Cited section. Information from other sources is cited within the text.

Due to the size and multiple landowners in the Deer Creek Watershed, many agency personnel and experts were consulted regarding wildlife and wildlife resources in the Deer Creek Watershed. The following list of people contributed to this effort and are cited in the text: Tom Griggs, The Nature Conservancy; Scott Armentrout, Wildlife Biologist, Lassen National Forest; Susan Chappell, Fisheries Biologist, Lassen National Forest; Dr. Gary Fellers, USGS Research Scientist, Point Reyes National Sea Shore; Dr. Mark Jennings, USGS Research Scientist and California Academy of Science Research Associate; Colleen Harvey, Associate Fisheries Biologist, CDFG; Melanie McFarland, Fisheries Biologist, Lassen National Forest; David Walker, Associate Wildlife Biologist, CDFG; Julie Kelley, Wildlife Biologist, Sierra Pacific Industries; Will Bishop, Warden, CDFG; Bill Howe, Forest Manager, Collins Pine Company; David Bogener, California Department of Water Resources; and Dana Bland, Wildlife Biologist, The Habitat Restoration Group.

Reconnaissance-level field surveys were conducted by HRG Wildlife Biologists, Dana Bland on November 13-14, 1996 and by Dawn Reis on June 23-26, 1997. Where access allowed, the surveys were conducted to ground proof the literature review of the wildlife habitat descriptions and habitat value in the lower, middle, and upper areas of Deer Creek Watershed. These site visits also served as a tool for personal communication and clarification of specific wildlife issues with key personnel. Private land owners and agency personnel experienced with the area guided the site visits to representative habitats or areas of special evaluation. These site visits were traversed on foot or by car. All species observed and their signs were recorded in a field notebook.

Map resources available for use, regarding wildlife locations and wildlife habitats, include: NDDB latitude and longitude coordinates for species location; Lassen National Forest Service Map (#1993-785-501 revised in 1996); Lassen National Forest Land and Resource Management Plan Environmental Group Prescriptions (#1992-686-371); and Lassen National Forest Land and Resource

Management Plan Preferred Prescriptions (#1992-686-371). Other maps pertaining to wildlife species in the Deer Creek Watershed are included in the following reports: Land and Resource Management Plan for Lassen National Forest (LNF1992); California Rivers Assessment website (CARA 1997); Avian Species of Management Concern: Mill and Deer Creek Drainage, Tehama County, California (England *et al.* 1988); California Department of Fish and Game Amphibian and Reptile Species of Special Concern (Jennings and Hayes 1994); Deer Creek Wild and Scenic River Suitability Report (Jones and Stoke 1994); and California Wildlife (Zeiner *et al.* 1990).

The information gathered from the literature and electronic inventory review, consultations with agency personnel and experts, and field reconnaissance surveys have been used in this report to describe the existing conditions of wildlife habitat and sensitive wildlife habitat areas.

A compiled species list with both animals known to occur or with the potential to occur can be found in Appendix C. Appendix D contains background information regarding wildlife species of special concern.

WILDLIFE HABITATS

Wildlife Habitat Overview

The total size and arrangement of habitats in the Deer Creek Watershed not only enhances the over-all value of each habitat type, but also provides exceptional wildlife value. However, large-scale management efforts such as burns (as discussed under Black-tailed Deer populations) and removal of non-native flora, especially in grassland and riparian habitat types in the upper and lower watershed, can enhance the wildlife value of several habitats. The removal of exotic fauna (bullfrogs, brown-headed cowbirds, and wild pigs) can enhance wildlife habitats for native species of the Deer Creek Watershed by lessening competition for space and reproductive success.

Habitats in the lower watershed have the potential for the greatest enhancement through restoration efforts. There is concern for the long-term regeneration of the valley oak trees (described under the Mixed Riparian Forest habitat type) of the lower water watershed. Large-scale management practices aimed at restoring the grassland habitats in the lower watershed can greatly enhance grassland habitat values for wildlife. The continuous amount of riparian habitat in the watershed is of great wildlife value. However, there are localized areas, especially in the lower watershed, where removal of exotic vegetation and increasing the width of the riparian corridor can greatly improve the habitat value for wildlife.

There is concern that human occupancy is increasing in the upper watershed near Lassen National Park and that this will impact habitat values for wildlife use in this area (pers. com Armentrout 1997, pers. com. Chappell 1997, McFarland 1997). As the water quality within Deer Creek affects the health of many wildlife species, there are specific concerns surrounding the increased use of Highway 32, where trucks have overturned and have contaminated Deer Creek with fuel (McFarland 1997, pers. com. Chappell 1997).

Descriptions of the vegetation (i.e., plant community types) corresponding to the wildlife habitats can be found in Chapter 8. A crosswalk between the habitat types used in this report and the habitat types as defined and used in the Wildlife Habitat Relationship System (Mayer and Laudenslayer 1988) has been constructed in Table 9-1.

Grasslands (Annual Non-native Grasslands, Native Grasslands/Prairie, and Grazed Pasture Lands)

In general, the wildlife values of grasslands are highest when interspersed with trees or shrubs and when adjacent to other habitats; creating a diversified habitat which supports wildlife that utilize both the grasslands for feeding, as well as trees and shrubs for cover and/or nest sites. The mosaic of open grassy areas surrounded by forest increases the wildlife species richness of the grasslands, especially at the edges of the grassland where shrubs predominate.

Grasslands provide an important foraging resource for a wide variety of wildlife species. The grasses and forbs produce an abundance of seeds and attract numerous insects, providing food for granivorous and insectivorous wildlife. Sparrows, rabbits, and rodents are commonly found in this habitat. Consequently, grasslands are valuable foraging sites for raptors (e.g., hawks and owls) and other predators (e.g., coyote, fox, skunk and snakes).

The condition of the grasslands in the Deer Creek Watershed varies greatly due to management practice (e.g., irrigation, seeding and grazing). Grasslands should be productive habitats for small mammals, providing abundant food plants and cover. Observations during reconnaissance level surveys of the lower watershed indicated that some pasturelands provide beneficial habitat while other pasture areas do not. Some pasturelands with either short rotations of grazing or year-round irrigation provided beneficial wildlife habitat. Other pastures that were grazed to stubble do not provide the foraging material need by prey base (e.g., California ground squirrels and other rodents) for carnivorous animals. In over-grazed pastures, star thistle replaced both native and non-native grasses that provide grains and roots for small mammals at the base of the food chain. Seasonally prolonged grazing in non-irrigated fields may also degrade the grassland value to wildlife by eliminating foraging material and by creating conditions conducive to the eventual takeover of star thistle and other undesirable exotics.

Aerial foraging species observed occurred over the grasslands of Deer Creek and included: bats, swallows, red-tailed hawks (*Buteo jamaicensis*), and turkey vultures (*Cathartes aura*).

Passerine birds observed to forage in the grasslands of the lower Deer Creek Watershed include: barn swallows (*Hirundo rustica*), cliff swallows (*Hirundo pyrrhonota*), house finch (*Carpodacus mexicanus*), western bluebird (*Isialia mexicana*), meadow lark (*Sturnella neclecta*), mountain king bird (*Tyrannus verticalis*), loggerhead shrike (*Lanius ludovicianus*), and American robin (*Turdus migratorius*). These birds forage for invertebrates in the ground and grasses. Additional information is needed in order to describe the species assemblages of passerine birds in the Deer Creek Watershed.

Table 9.1. Crosswalk of Wildlife Habitat Designations

Wildlife Habitats	Wildlife Habitat Relationships Program
Grasslands	
Annual Non-native Grassland	Annual Grassland
Native Grassland/Prairie	Annual Grassland
Agriculture	
Agricultural Lands	Cropland
Irrigated Pastures	Cropland
Chaparral Communities	
Whiteleaf or Common Manzanita Chaparral	Mixed Chaparral
Green-leaf Manzanita Montane Chaparral	Montane Chaparral
Wetlands	
Freshwater Marsh	Fresh Emergent Wetland
Vernal Pools	Annual Grasslands
Montane Wet Meadows	Wet Meadows
Sphagnum Bog	Wet Meadows
Fen	Wet Meadows
Seeps	Wet Meadows
	No corresponding type
Riparian Communities	
Mixed Riparian Forest	Montane Riparian
	Valley Oak Woodland
Early Successional Riparian Channel Bed and Gravel Bars	No corresponding type
	Riverine
Fremont Cottonwood Riparian Forest	Valley Foothill Riparian
Willow Riparian Scrub	Valley Foothill Riparian
White Alder Riparian	Montane Riparian
Woodlands	
Blue Oak-Foothill Pine Woodland	Blue Oak
	Montane Hardwood
	Blue Oak Woodland
Mixed Conifer Forest	
Ponderosa Pine Mixed Conifer Series	Ponderosa Pine
Douglas Fir Mixed Conifer Forest Series	Sierra Mixed Conifer
	Montane Hardwood-Conifer
White Fir Mixed Conifer Series	White Fir
	Lodgepole Pine
Conifer Forest (non-mixed)	
Red Fir Forest (non-mixed)	Red Fir Forest
Miscellaneous	
Cliffs and Rock Outcrops	No corresponding type

Representative mammal species of grasslands include: rabbits, Botta's pocket gopher (*Thomomys* spp.), western harvest mouse (*Reithrodontomys megalotis*), California vole (*Reithrodontomys megalotis*), American badger, and coyote (*Canis latrans*). Black-tailed deer are often seen browsing in the late evening.

Typical reptile species in this habitat include: northern alligator lizard (*Elgaria/Gerrhonotus coeruleus*), common garter snake (*Thamnophis sirtalis*), western rattlesnake (*Crotalus viridis*), western terrestrial garter snake (*Thamnophis elegens*), and gopher snakes (*Pituophis melanoleucus*). Amphibians are not generally abundant in grasslands but may occasionally use mammal burrows for cover while traveling between other habitats.

Agriculture

Grazed Pasture Lands. (See discussion of grazed pasture lands under annual grasslands.)

Orchards. The value of orchards for wildlife varies and is highly dependent on the management practice and type of orchard tree. Management practices that result in a lack of understory canopy, use of pesticides, and disking of the soil reduces the overall wildlife value of orchards. However, many wildlife species of the Deer Creek Watershed currently depend on the fruits, nuts, and foliage provided by orchards. Year-round irrigation and plantings of understory cover crops can provide beneficial value to wildlife. Irrigation ditches and water diversion channels (not to be confused with natural slough channels or water diversion channels with adjacent riparian corridors) provide drinking water for medium and large sized mammals.

Orchards have been planted in the fertile soils of the floodplain. In general, the species diversity of the central valley orchards, when compared to the historical accounts of the species diversity of the riparian flood plains that the central valley orchards replaced, is comparatively low (Zeiner *et al.* 1990). However, depending on the species, species abundance in riparian habitat adjacent to orchards may be increased due to the presence of the orchards. (See the list of animals associated with orchards below for species type.)

The following animals are associated with foraging on nuts provided by the Deer Creek Watershed orchards and are likely to be found in relatively high abundance: northern flicker (*Colaptes auratus*), scrub jay (*Aphelocoma coerulescens*), Brewer's blackbird (*Euphagus cyanocephalus*), plain titmouse (*Parus inornatus*), house finch (*Carpodacus mexicanus*), California ground squirrel (*Spermophilus beecheyi*), band tailed pigeon (*Columba fasciata*), and western bluebird (*Sialia mexicana*). Animals associated with foraging on orchard fruits include: American robin *Turdus migratorius*), varied thrush (*Ixoreus naevius*), northern mocking bird (*Mimus polyglottos*), black headed grossbeak (*Pheucticus melanocephalus*), western gray squirrel (*Sciurus griseus*), black bear (*urus americanus*), raccoon (*Procyon lotor*), and coyotes (*Canis latrans*). Deer and rabbits will browse on trees and vines.

Croplands. A limited amount of cropland exists in the lower Deer Creek Watershed. The wildlife value of cropland varies with management practices and the type of crop. Irrigated grain crops may provide ample food for rodents that in turn becomes a food base for migratory hawks and kites. Grain eating birds also can benefit from crops. The value of croplands to wildlife is reflective of specific management practices (e.g., tilling dates and pesticide use); croplands can be of significant value for ground nesting bird species depending on tilling date.

Chaparral Communities

White-leaf or Common Manzanita Chaparral and Green-leaf Manzanita Montane Chaparral. Like all habitat types, wildlife species abundance and diversity in chaparral habitats is dependent on the plant community structure of the habitat type, as well as the availability of water. Habitat preferences of wildlife are described in relation to plant community successional stage, plant cover, proximity to openings, and the amount of habitat edge. These characteristics are primarily a function of habitat disturbances; the most important of which is fire. Disturbed and more open stands of chaparral are frequented by those species that require open areas for foraging adjacent to dense cover. There are also many areas where chaparral habitats in the Deer Creek Watershed are interspersed with other habitat types (e.g., grasslands, conifer forest series, blue oak-foothill pine, or rock outcrops) creating mosaics of high value to wildlife.

A wide variety of reptiles make use of chaparral habitat. Prey populations of rodents and invertebrates provide foraging resources, while rock outcrops and the abundance of low-growing shrubs offer excellent cover, sunning, and display sites. Typical species include: northern alligator lizards (*Gerrhonotus coeruleus*), western rattlesnake (*Crotalus viridis*), ringneck snake (*Diadophis punctatus*), western whiptail (*Cnemidophorus tigris*), and gopher snakes (*Pituophis melanoleucus*).

Numerous mammal species utilize chaparral habitats. The Tehama deer herd (one of the largest deer herds in the State) depends on whitethorn and deerbrush ceanothus for food, especially during the winter. Deer also use chaparral habitats for escape cover and fawning. Pronghorn antelope (*Antilocapra americana*), known to occur in the adjacent Mill Creek Watershed, are dependent on sagebrush and other chaparral species to browse during certain times of the year. Rabbits and hares forage and take cover in chaparral plant communities.

Chaparral, especially at the edges of the grasslands, provides important structural cover for many species including: bobcats, raccoons, skunks, mountain lions, coyotes, California quail, and garter snakes. Chaparral habitats provide abundant food for many rodents and birds in the form of seeds, fruits, and insects. Manzanita berries provide a source of fluid for many species associated with this otherwise arid habitat. Coyote and black bear may forage heavily on manzanita berries, while bobcats and hawks will hunt for rodents and reptiles, skunks will forage on insects, rodents, and bird eggs.

The chaparral supports a distinctive avifauna. The dense vegetation offers excellent cover for secretive birds and those requiring dense cover adjacent to open foraging sites. Representative birds of this habitat include: blue-gray gnatcatcher (*Polioptila caerulea*), California thrasher (*Polioptila caerulea*), fox sparrow (Passerella iliaca), white-crowned sparrow (*Zonotrichia* *leucophrys*), wrentit (*Chamaea fasciata*), California towhee (Pipilo crissalis), and California quail (*Callipepla californica*). Manzanita and sage provide important nectar sources for black-chinned hummingbird *(Archilochus alexandri*).

Wetlands

Freshwater Marsh. The surface water is of great value to terrestrial wildlife by providing drinking water. The freshwater marshes of the lower watershed are excellent breeding areas for marsh wrens (*Cistothorus palustris*) and red-winged black birds (*Agelaius phoeniceus*), as well as for Sierra newts (*Taricha torosa sierrae*) and western toads. Freshwater marshes provide foraging habitat for Kingfisher (*Ceryle alcyon*), night heron (*Nycticorax nycticorax*), blue heron (*Ardea herodias*), and green back herons (*Butorides striatus*). Barn swallows, cliff swallows, tree swallows, and bats have been observed to drink and forage on insects while on the wing over marsh areas. Raccoons will forage on adult and larval amphibians, fish, and crawfish.

Vernal Pools. Vernal pools (seasonal ponds) located in the lower Deer Creek Watershed are habitats for several Federally-listed invertebrate species of special concern (see Table 9-2) (e.g., tadpole shrimp, conservancy fairy shrimp, and California linderiella). Vernal pools are of high wildlife value for waterfowl, shore birds, mammals, predatory birds, reptiles, and amphibians. The vernal pools of the Deer Creek Watershed are located in the grasslands and may be occasionally subject to flooding by Deer Creek (pers. com. Tom Griggs 1997). Vernal pool invertebrate species include: clam shrimp, tadpole shrimp (*Lepidus packardi*), conservancy fairy shrimp (*Branchinectaa conservatio*), vernal pool fairy shrimp, and snails. These invertebrate species have evolved reproductive strategies that are dependent on the dry down of surface water.

Vernal pools are used as watering holes for many mammals, and as foraging and nesting areas for many birds. Small rodent populations may particularly rely on the presence of vernal pools for seasonal water. Representative mammal species include: Deer mouse, Botta's pocket gopher, and black-tailed hare.

Migratory waterfowl and shorebirds feed on the invertebrate and amphibian species of the vernal pools. Birds observed, by the Vina Plains Nature Conservancy staff, in the vernal pools include: great egret, great blue heron, greater yellowleg, black-necked stilt, killdeer, snow geese (*Chen caerulescens*), Canada geese (*Branta canadensis*), American widgeon (*Anas americana*), mallard (*Anas platyrhynchos*), and pintail duck (*Anas acuta*) (Holing 1988). Invertebrate populations found in vernal pools provide an important energy source for waterfowl during the spring migration (McNutt 1997).

Montane Wet Meadows. Sheep and cattle since have grazed the montane meadows of the upper Deer Creek Watershed before the turn of the century. Cattle's grazing still occurs in the montane wet meadow areas of the Deer Creek Watershed. Certain areas where the creek flows through the meadows have been fenced off from cattle to create a riparian buffer between the creek and the meadows. As these streamside strips become naturally revegetated, they will provide protective cover for wildlife attracted to the available surface water.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Invertebrates					
Vernal Pool Tadpole Shrimp	*Lepidurus packar*	E/--	Vernal pools in the Sacramento Valley from the Vina plains in Butte County south to Sacramento County and west to the Jepson Prairie region of Solano County.	Vernal pools with either clear or turbid water in grass bottomed swales of unplowed grasslands. Bottoms of pools are either mud or old alluvial soils underlain by hard pan. Pools typically have neutral pH, and very low conductivity, alkalinity, and total dissolved solids (Federal Register 1992).	Known populations near the lower Deer Creek Watershed on the Vina Plains Nature Conservancy property.
California Linderiella	*Linderiella occidentalis*	P/--	East side of Central Valley from east of Red Bluff to east of Madera, across the Sacramento area, and through the central and south Coast Ranges from Lake County to Riverside County.	Found in vernal pools formed by seasonal swales of unplowed grasslands with alluvium soils underlain by hard pan or sandstone depression.	Known populations near the lower Deer Creek Watershed on the Vina Plains Nature Conservancy property. Known population is located at the intersection of Hailli Road and Highway 99.
Conservancy Fairy Shrimp	*Branchinecta conservatio*	E/--	Endemic to grasslands of the Central Valley and Coast Range Mountains in rain-filled pools. Found in Vina Plain, Tehama County; Jepson Prairie Preserve, Solano County; and near Haystack Mountain, Merced County.	Conservancy fairy shrimp are free swimming filter feeders. They are found in vernal pools including small, clear water sandstone depression pools and grassed swales, earthen slump, or basalt-flow depressed pools. Populations have also been located in intermittent creek/swale flowing though agricultural field.	Known populations near the lower Deer Creek Watershed on the Vina Plains Nature Conservancy property. Found along Highway 99 and east of Vina.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Vernal Pool Fairy Shrimp	*Branchinecta lynchi*	T/--	Central Valley, central and south Coast Ranges from Tehama County to Santa Barbara County; isolated populations also in Riverside County.	Vernal pool fairy shrimps are bottom dwelling insects that feed on detritus. They are found in vernal pools and in sandstone rock outcrop pools. Eggs left in the mud and bottom sediments after the pools dry down require cool flood water or winter rain to stimulate development.	Known populations near the lower Deer Creek Watershed on the Vina Plains Nature Conservancy property.
Valley Elderberry Longhorn Beetle	*Desmocerus californicus* dimorphus	T/--	Occurs within Central Valley of California. Streamside habitats below 2,000 feet throughout the Central Valley and Sacramento River in 1985.	Elderberry shrubs in riparian areas in association with blue elderberry (*Sambucus mexicana*). Prefers to lay eggs in elderberry with 2 to 8-inch diameter, some preference shown for "stressed" elderberries.	Known population located on the west bank of the Sacramento River at the confluence of the Sacramento River and Deer Creek (pers. comm. T. Griggs 1997).
Amphibians and Reptiles					
California Red-legged Frog	*Rana aurora draytonii*	T/--	Found along the coast and coastal mountain ranges of California from Humboldt County to San Diego County and in the Sierra Nevada and Cascade Range from Tehama County to Fresno County.	Associated with cold water ponds with emergent submergent vegetation and riparian species along the edges.	Populations unknown in the Deer Creek Watershed: limited or no surveys conducted in the lower watershed. No red-legged frogs found during recent surveys conducted in the middle and upper reaches of the Deer Creek Watershed.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Cascade Frog	*Rana cascadae*	--/E	Occurs discontinuously along the Cascade Mountain ranges between northern Washington and northern California to the extreme north end of the Sierra Nevada. Elevation range is from sea level to 4,600 feet (i.e., Deer Creek Meadows) (McFarland 1997). In California, Cascade frog distribution occurs from Shasta-Trinity region eastward toward Modoc Plateau and south to the Lassen region and upper Feather River.	Cascade frogs occur and reproduce in ephemeral and permanent ponds or streams. It is thought that Cascade frogs can not survive ephemeral habitats unless there is moist substrate. Hibernation occurs underwater or in saturated ground. Cascade frogs are typically found in ponds without predatory fish, and indications exist that there is a shift away from usage of permanent pond areas after fish are introduced.	Known occurrences in the tributaries of the upper Deer Creek Watershed including Deer Creek Meadows and Carder Meadow (pers. comm. Fellers 1997). Populations also known in the adjacent Butte Creek Watershed in Colby Creek (McFarland 1997).
Foothill Yellow-legged Frog	*Rana boylei*	--/T	Occurs in the Klamath, Cascade, north Coast, south Coast, and Transverse Ranges; through the Sierra Nevada from the Cascade Range south to Kern County.	Occurs in streams with rock and gravel substrate and low overhanging vegetation along the edge.	Occurs in the lower, middle, and upper watershed to the bridge crossing at Highway 36. Occurs in Pine Creek and on both sides of Forest Service Roads 28 and 29 (pers. comm. G. Fellows 1997).
Northwestern Pond Turtle	*Clemmys marmota* marmota	--/SC	In California, extends from Oregon border of Del Norte and Siskiyou Counties, south along coast to San Francisco Bay, inland through Sacramento Valley, and western side of Sierra Nevada; range overlaps southwestern pond turtle range through the Delta and Central Valley to Tulare County.	Found in ponds, marshes, rivers, streams, and irrigation canals with muddy or rocky bottom sand with aquatic vegetation. Basking sites include floating logs and partially submerged branches. Nesting habitat includes upland areas with sun exposure in grassland, woodland and open forest.	Known locations of western pond turtles occur throughout Deer Creek from the confluence of the Sacramento River up to the HWY 36 bridge (pers. comm. S. Chappell. 1997, and pers. comm. G. Fellers 1997). Turtle hatchlings sighted at the Ponderosa Road Crossing, approx. 13 miles down stream of the HWY 32 bridge (pers. comm. C. Harvey 1997). Upland (nesting site) locations remain unknown. Focused surveys limited to wet areas.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Western Spadefoot Toad	*Scaphiopus hammondi*	--/T	California's Central Valley from Shasta County south to northern Baja. Found in elevation ranges from near sea level to 1,363-foot elevations.	Occupies lowland areas, including washes, floodplains, and foothills with sandy to gravelly soils; survives dry periods in rodent burrows or self-made holes. Requires pools to breed in with water temperatures between 9°C and 30°C. Pools need to stay wet for at least 3 weeks for larvae to successfully metamorphose. Requires pools that lack predatory fish, bullfrogs, and crayfish.	Unlikely, although potential habitat exists and the Deer Creek Watershed is within the known Spadefoot toad range. Marc Hayes (1974-75) surveys for Spadefoot toads and California tiger salamanders on the nearby Vina Plains Nature Conservancy property were unsuccessful locating either species (pers. comm. T. Griggs 1997).
Birds					
American Peregrine Falcon	*Falco peregrinus* anatum	E/E	Permanent resident on the north coast and south Coast Ranges; may summer on the Cascade and Klamath Ranges south through the Sierra Nevada to Madera County; winters in the Central Valley south through the Transverse and Peninsular Ranges and the plains east of the Cascade Range.	Nests and roosts on protected ledges of high cliffs, usually adjacent to lakes, rivers, or marshes which support large populations of birds.	Two known successful eyries located in the lower Deer Creek Watershed and on Iron mountain. Complete status unknown. Limited survey conducted. There are 60 suitable cliffs with nest sites in Deer and Mill Creeks drainages.
Bald Eagle	*Haliaeetus leucocephalus*	T/E	Nests in Siskiyou, Modoc, Trinity, Shasta, Lassen Plumas, Butte, Tehama, Lake, and Mendocino Counties and in the Lake Tahoe Basin. Small breeding populations also occur in Monterey County, Santa Cruz Island. Winter range includes the rest of California, except the southeastern deserts, very high altitudes in the Sierra Nevada, and east of the Sierra Nevada south of Mono County.	Nests and roosts in coniferous forests usually within 1 mile of a lake, reservoir, river, or the ocean. Adults forage on fish and waterfowl. Juvenile eagles scavenge on fish and mammal carrion. Adult requires rivers, large lakes, streams, or reservoirs for foraging.	Commonly seen foraging throughout Deer and Mill Creeks. Nest and roost sites unknown due to limited surveys. Known nest sites located in high elevations in the adjacent watershed of Lake Almanor. Known winter roost site in the adjacent lower Mill Creek Watershed.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Bank Swallow	*Riparia riparia*	--/T	Nesting areas includes the plains east of the Cascade Range south through Lassen County, northern Siskiyou County, along the Sacramento River from Tehama County to Sacramento County, and in the Owens Valley. Small populations near the coast in Monterey, Santa Cruz, and San Mateo Counties.	Nests in bluffs or banks adjacent to water where the soil consists of sand or sandy loam to allow digging.	Nest sites located in the lower Deer Creek Watershed in eroded banks. Comprehensive status of bank swallows in Deer Creek Watershed is unknown, as focused surveys for nest sites have not been conducted. Suspected nest site occurs in Deer Creek meadows where a pair was seen during the breeding season. Additional known nest sites adjacent to the Deer Creek Watershed occur in Lassen Volcanic National Park and Feather River at Lake Almanor, and a large nest colony on Sacramento River.
Black-shouldered Kite	*Elanus caeruleus*	--/SC, FP	Open habitats throughout California, excluding deserts.	Nests in riparian habitats, woodlands, and isolated trees; forages in agricultural fields, grasslands, and wetlands.	Foraging adults confirmed. Nest sites unknown. Limited or no surveys conducted.
Burrowing Owl	*Athene cunicularia*	--/SC	Open habitats throughout California.	Found in lower elevation prairie habitat or grassland habitats. Native grass cover or grazed grasslands with short vegetation height is needed in order for the owls to forage on small rodents and other prey items. Burrowing owls use old ground squirrel burrows for nesting and fence posts or burrow mounds as foraging perches.	Nest sites unknown. Limited or no focused surveys conducted.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
California Spotted Owl	*Strix occidentalis* occidentalis	--/ FS	Occurs in the Cascade Range and Sierra Nevada and more localized areas of the Transverse and Peninsular Ranges of southern California.	Prefers mature forest with permanent water and suitable nesting trees and snags. In southern California, nearly always associated with oak and oak-conifer habitats.	Extensive inventories have been conducted in the study area. Nest sites found in all suitable habitat areas (old growth and mixed conifer forest) of Deer Creek Watershed (Lassen National Forest 1992).
Cooper's Hawk	*Accipiter cooperii*	--/SC, FP	Montane forests, foothill woodlands, and riparian forests throughout California.	Oak woodlands, coniferous forest, and riparian forests with closed canopies for nesting; oak woodlands, forests, and savannas for foraging.	Nest sites unknown. Limited or no surveys conducted.
Golden Eagle	*Aquila chrysaetos*	--/SC, FP	Resident throughout California in suitable habitat areas of grasslands and/or open forest types.	Golden eagles utilize cliffs or trees in a variety of habitats for nesting. Nest sites usually overlook grasslands where prey is available. Dense forests are seldom used.	Adult golden eagles have been recorded in Deer Creek Watershed. Nesting status unknown. Limited or no survey conducted.
Great Blue Heron Rookery	*Ardea herodias*	--/FP Nest sites are protected by CDFG	Permanent resident throughout most of California. Heron rookeries are scattered throughout northern California and uncommon in southern California.	Found in shallow estuaries and fresh and saline emergent wetlands; less common along rocky marine shores and in croplands, pasture, and mountains above foothills.	Heron rookery located in the Deer Creek Watershed in 1980 by Airola at Lake Wilson (England *et al.* 1988). Known nest site located in the lower Mill Creek Watershed (NDDB 1997).
Great Egret Rookery	*Casmerodius albus*	--/FP Nest sites are protected by CDFG	Common resident throughout California, except high mountain areas; nesting colonies throughout valleys and coastal areas in suitable habitat.	Found in marshes; prefers foraging habitat with aquatic vegetation for stalking prey. Rookeries are usually isolated from human disturbance.	Egret rookery located in the Deer Creek Watershed at Lake Wilson (England et al. 1988). Known nest site located in the lower Mill Creek Watershed (NDDB 1997).
Great Gray Owl	*Strix nebulosa*	--/E, FS	Known from Sierra Nevada and Cascade Range.	Associated with old-growth coniferous forests bordering meadows; red fir, Jeffrey pine, and lodgepole pine dominant.	Great gray owls have been recorded in the upper Deer Creek Watershed in 1980 (England et at. 1988). Nesting status unknown. Limited or no survey conducted.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Loggerhead Shrike	*Lanius ludovicianus*	---/FS	Resident and winter visitor in lowlands and foothills throughout California; rare on coastal slope north to Mendocino County, occurring only in winter.	Prefers open habitats with scattered shrubs, trees, posts, fences, utility lines, or other perches.	Adults have been recorded in lower Deer Creek Watershed. Nesting status unknown. Limited surveys conducted.
Long-eared Owl	*Asio onis*	--/SC	Permanent resident east of the Cascade Range from Placer County north to the Oregon border, east of the Sierra Nevada from Alpine County to Inyo County, along the coast from Sonoma County to San Luis Obispo County, and eastward over the north Coast Range to Colusa County. Winter populations occur throughout the Central Valley, Mojave and Colorado Deserts, and the Inyo-White Mountains. Summer populations occur along the eastern rim of the Central Valley and Sierra Nevada Foothills from Tehama to Kern Counties.	Found in dense riparian stands of willows, cottonwoods, or live oaks; uses adjacent open lands for foraging; nests in abandoned crow, hawk, or magpie nests.	Nesting status unknown. Limited survey conducted. Unconfirmed sightings of Long-eared owls are recorded in Lassen National Forest near the headwaters to Mill Cr. (England *et al.* 1988).
Mountain Quail	*Oreortyx pictus*	--/SC	Occurs in most major montane habitats of California.	Found in open, brushy stands of conifer and deciduous forest and woodland and chaparral.	Adults have been recorded in Deer Creek Watershed. Nesting status unknown. Limited or no survey conducted.
Northern Goshawk	*Accipiter gentilis*	--/SC, FS	Permanent resident of Klamath and Cascade Ranges, the north Coast Range from Del Norte County to Mendocino County, and the Sierra Nevada south to Kern County. Winter resident in Modoc, Lassen, Mono, and northern Inyo Counties. Rare resident in southern California.	Usually nest near water on the north slope of mature conifer forest. Goshawks require a mix of different forest age classes and forest structures for foraging and nesting. Known to nest in red fir, Jeffrey pine, and lodgepole pine forests types.	Extensive surveys have been conducted. There are 11 known Goshawk nest sites with in Deer Creek Watershed. Nest localities include: Colby Creek and upper Yellow Creek (Armentrout 1997).
Northern Harrier	*Circus cyaneus*	--/SC	Lowlands and valleys throughout California.	Nests in dense grasslands and wetlands; forages in wetlands, grasslands, and agricultural fields.	Adults have been recorded in Deer Creek Watershed. Nesting status unknown. Limited or no survey conducted.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Osprey	*Pandion haliaetus*	--/SC	Nests along the north coast from Marin County to Del Norte County, east through the Klamath and Cascade Ranges, and the northern tip of the Sacramento Valley; also nests at Lake Tahoe, Mono Lake in Mono County, Owens Lake in Inyo County, and Lake Isabella in Kern County. Winter resident along the coast from San Mateo County to San Diego County.	Nests in treetops, power or telephone poles, and snags near the ocean, large lakes, or rivers with abundant fish populations.	Known nest sites currently located west of Elam campground and two miles northwest of the junction between Highways 89 and 36 (NDDB 1996). Complete status unknown. Limited surveys conducted.
Prairie Falcon	*Falco mexicanus*	--/SC	Permanent resident on the south Coast, Transverse, Peninsular, and northern Cascade Ranges, the southeastern deserts, Inyo-White mountains, Modoc, Lassen, and Plumas Counties, and the foothills surrounding the Central Valley. Winters in the Central Valley along the coast from Santa Barbara to San Diego Counties, and in Marin, Sonoma, Humboldt, Del Norte, and Inyo Counties.	Nests on cliffs or escarpments adjacent to dry, open terrain, uplands, marshes, or seasonal agricultural wetlands.	Adults and historical nesting sites have been recorded in Deer Creek Watershed. Current nesting status unknown. Limited or no survey conducted.
Purple Martin	*Progne subis*	--/SC, FS	Nests in California throughout the north Coast, south Coast, Klamath, Cascade, and Sierra Nevada Ranges; there are also small localized populations in Yolo, Sacramento, Santa Barbara, Orange, Riverside, and San Diego Counties.	Nests in trees cavities, snags, and under bridges in a variety of conifer, riparian and hardwood forest types. Found from sea level to 6,000-foot elevation. Will use abandoned woodpecker or tree swallow nest sites.	Adults and historical nesting sites have been recorded in the Deer Creek Watershed at Lassen Peak (Grinnell and Miller 1944). Current nesting status unknown. Limited or no survey conducted.
Sharp-shinned Hawk	*Accipiter striatus*	--/SC	Sierra Nevada, Cascade, and northern Coast Ranges.	Montane forest for nesting; woodland and forest habitats for foraging.	Adults have been recorded in Deer Creek Watershed. Nesting status unknown. Limited or no survey conducted.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Short-eared Owl	*Asio flammeus*	--/SC	Permanent resident along the coast from Del Norte County to Monterey County, in the Sierra Nevada north of Nevada County, the plains east of the Cascade Range, and Mono County. Winter resident on the coast from San Luis Obispo County to San Diego County, the Central Valley from Tehama County to Kern County, the eastern Sierra Nevada from Sierra County to Alpine County, the Channel Islands, and Imperial County. Small isolated populations also nest in the Central Valley.	Uses freshwater and saltwater marshes, lowland meadows, and irrigated alfalfa fields; needs dense tule or tall grass for nesting and daytime roosts. Will use oak savannah, chaparral, and a mix of foothill pine/oak habitats during the non-breeding season.	Adults have been recorded in Deer Creek Watershed. Nesting status unknown. Limited or no survey conducted.
Swainson's Hawk	*Buteo swainsoni*	--/T	Uses the lower Sacramento and San Joaquin Valleys, the Klamath Basin, and Butte Valley; most nesting occurs in Yolo County.	Nests in oaks, foothill pine, and cottonwoods in or near riparian habitats; only a few trees needed for nesting. Forages in grasslands, irrigated pastures, and grain fields.	Nesting status unknown. Limited or no survey conducted. Closest recorded nest site occurs 9 miles south of Deer Creek in Glen County (NDDB 1996).
Tri-colored Blackbird	*Agelaius tri-color*	--/SC	Permanent resident in the Central Valley from Butte County through Kern County, on the south Coast and Peninsular Ranges, and in parts of San Diego, Los Angeles, Alameda, Sonoma, and Lake Counties. There are breeding colonies in Siskiyou, Modoc, and Lassen Counties, around the San Francisco Bay from Marin County to Santa Cruz County, and east through the Delta to Solano County.	Nests in freshwater marshes with heavy growths of cattails and tules; other forms of dense vegetation, including blackberry thickets may also be used for nesting. Blackbirds forage in grasslands and fields surrounding the nest colony.	Adults have been recorded in Deer Creek Watershed. Nesting status unknown. Limited or no survey conducted. Known nesting colony occurs in the riparian-blackberry habitat along the Sacramento River near Vina (NDDB 1996).

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Willow Flycatcher	*Empidonax traillii*	--/E, FS	Summer range includes a narrow strip along the eastern Sierra Nevada from Shasta County to Kern County, another strip along the western Sierra Nevada from El Dorado County to Madera County, and a small population in San Diego County.	Uses riparian areas with abundant willows. Prefers riparian willow thickets for breeding. Breeds between 2,000 and 8,000-foot elevations in the willow thickets of riparian and wet meadow habitats. Usually breeds in meadows that are greater than 20 acres.	Known nesting populations in Deer Creek Watershed include: a small population located between Spencer Meadows and Gurnsey Creek, Battle Creek Meadows, Willow Lakes, and three miles west of Butt Reservoir (NDDB 1996). In addition, territorial males were located along the upper Deer Creek drainages (England *et al.* 1988).
Yellow-billed Cuckoo	*Coccyzus americanus* occidentalis	--/E, FS	Nests along the upper Sacramento, lower Feather, South Fork, Kern, Amargosa, Santa Ana, and Colorado Rivers.	Found in large, dense riparian forests with a thick understory of willows for nesting. Forages and breeds in dense riparian forest of larger river systems. Nests within dense willow often mixed with cottonwood and lower story of blackberry and wild grape.	Large nesting colony located on Sacramento River approximately 1/2 mile from the confluence of Deer Creek and the Sacramento River at Woodson Bridge (NDDB 1996). Surveys have been conducted along the lower reaches of Deer Creek (England *et al.* 1988).
Yellow-breasted Chat	*Icteria virens*	--/SC	Isolated populations throughout California.	Breeds and forages in dense riparian forest, usually near permanent water.	Adults have been recorded in the lower Deer Creek Watershed (England *et al.* 1988). Current nesting status unknown. Limited or no survey conducted.
Yellow Warbler	*Dendroica petechia*	--/SC	Nests throughout California except the Central Valley, the Mojave Desert region, and high altitudes in the Sierra Nevada. Winter resident along the Colorado River and in parts of Imperial and Riverside Counties. Two small permanent populations are in San Diego and Santa Barbara Counties.	Nests in riparian areas dominated by willows, cottonwoods, sycamores, or alders up to 8,000-foot elevations. Also known to nest in montane chaparral, open ponderosa pine and mixed conifer habitats with lots of brush.	Adults have been recorded in the lower Deer Creek Watershed. Nesting status unknown. Limited or no survey conducted.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Mammals					
American Badger	*Taxidae taxus*	--/SC	Uncommon resident throughout California except north coast region.	Herbaceous shrubs, grasslands, and open habitats with dry soil.	Status unknown. No recorded surveys conducted.
Pine Marten	*Martes americana*	--/FS	Uncommon to common resident of the Sierra Nevada, Klamath, Cascade mountains, and the north coast regions.	Surveys in the Almanor District located Marten's primarily in red fir habitat. Prefers mixed evergreen forests with more than 40% crown closure, with large trees and snags. Found that Martins prefer lodgepole pine in riparian settings and red firs at higher elevations.	Martens occur throughout the conifer forest habitats in Deer Creek Watershed of Lassen National Forest (pers. comm. Armentrout 1997).
Wolverine	*Gulo gulo* luteus	--/T, FS	Historic range in study area; no confirmed sightings in Sierra Nevada since early 1980's. Klamath and Cascade Ranges south through the Sierra Nevada to Tulare County.	Sighted in a variety of habitats from 1,600 to 14,200-foot elevations; most common in open terrain above timberline and sub-alpine forests.	Status unknown. Limited or no surveys conducted. However, several unconfirmed sightings of wolverines in the upper Deer Creek Watershed have been reported to Lassen National Forest staff (Armentrout 1997). One such sighting, of a wolverine in a den, was reported by a USFWS biologist.
Pacific Fisher	*Martes pennanti* pacifica	--/FS	Occurs from the Oregon border south through the north Coast Range to Sonoma County and through the Sierra Nevada to Kern County.	Prefers old-growth mixed conifer forests; uses trees cavities, downed logs, or rock crevices for nesting; riparian areas provide important foraging and hunting habitats.	Status unknown. Limited surveys conducted. Visitors (Armentrout 1997) have reported several unconfirmed sightings to Lassen National Forest staff.

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Sierra Nevada Red Fox	*Vulpes vulpes* necator	--/T, FS	Cascade Range east to the Sierra Nevada then south to Tulare County.	Red fir and lodgepole pine forests, generally from 4,000 to 8,400-foot elevation; associated with mountain meadows.	Status of sierra red foxes in Deer Creek Watershed unknown due to limited surveys and lack of genetic studies of foxes in the region. Unconfirmed sighting located near the upper Deer Creek Watershed at Chester Airport (Armentrout 1997).
Sierra Nevada Snowshoe Hare	*Lepus americanus* tahoensis	--/FS	Occurs in the Sierra Nevada from mount south to Mono and Tulare Counties, generally staying between the 4,800 and 8,000-foot elevations.	Found in conifer forest and in dense thickets of riparian vegetation or chaparral. Often located in the edge habitats.	Presence known in upper elevations of the Deer Creek Watershed (Armentrout 1997). Population status unknown due to limited surveys.
Pale Big-Eared Bat	*Plecotus townsendii* pallescens	--/SC	Throughout California except in humid coastal forests.	Coniferous and broad-leaved forests, oak and coniferous woodlands, arid grassland, deserts, and meadows; caves and abandoned buildings for roosting and breeding.	Status unknown due to no or limited surveys. Deer Creek Watershed is believed to be within range for this species (Zeiner *et al.* 1990).
Spotted Bat	*Euderma maculatum*	--/FS	Usually found in the foothills, mountains, and desert regions of southern California. Known to occasionally be found outside its southern range.	Spotted bats use areas with rocky cliffs as roost sites.	Spotted bats have been located in the Tehama County portion of Deer Creek Watershed (Armentrout 1997). Population status unknown due to limited survey.
Little Brown Myotis	*Myotis lucifugus*	--/SC	Common and widespread in North America. Found in the northern California Coastal Ranges and in the Sierra Nevada Ranges.	Roost in large colonies in trees, buildings, cliffs, and caves. Forages over open water and riparian corridors.	Status unknown due to no or limited surveys. Deer Creek Watershed is believed to be within range for this species (Zeiner *et al.* 1990).

Table 9-2. Special Status Wildlife Known or With Potential to Occur in the Deer Creek Watershed, Tehama County, California (Cont'd.)

SPECIES		LEGAL STATUS*	GENERAL DISTRIBUTION	ASSOCIATED HABITAT	OCCURRENCE within the Deer Creek Watershed and in nearby areas
Common Name	Species Name	Federal/State			
Townsend's Western Big-eared Bat	*Plecotus townsendii* townsendii	--/ FS	Found throughout California except in sub-alpine and alpine habitats in the Sierra Nevada; species distribution not well known.	Roosts in caves, tunnels, mines, and buildings; very sensitive to disturbances.	Status unknown due to no or limited survey of this bat in the Deer Creek Watershed. Many potential caves on site (within Ishi Wilderness).
Ringtailed Cat	*Bassaricus astutus*	--/FP	Found throughout most of California with the exception of the very northeast corner of the State.	Rock out crops, riparian habitats, forest and shrub habitats within 1K (0.6 miles) of water. Ringtails are found at middle to low elevations. They nest in rock outcrops, logs, cavities and use abandoned burrows of other species (Zeiner et al. 1990).	Status unknown due to no or limited focused surveys for ringtails in the Deer Creek Watershed.

***STATUS EXPLANATIONS**

Federal

E = Listed as endangered under the Federal Endangered Species Act.
T = Listed as threatened under the Federal Endangered Species Act.
P = Proposed for Federal listing as endangered under the Federal Endangered Species Act.
FS = U.S. Forest Service sensitive species.

State

E = Listed as endangered under the California Endangered Species Act.
T = Listed as threatened under the California Endangered Species Act.
SC = Species of special concern.
FP = Fully protected under the California Fish and Game Code.

Sources: Natural Diversity Data Base, 1996; Zeiner *et al.*, 1990; Jennings, M. and M. Hayes, 1994; California Department of Fish and Game 372, 1996.

The current grazing management practices, other than areas that allow cattle to trample riparian corridor along the creeks, appear to be compatible with the meadow habitat. The meadow habitat includes meadow grasses that are of medium height, apparent native grass species, and the grasses with a bunched quality which provides cover for small rodents that will move into the meadows as the meadows dry up in the summer).

The meadows and associated wet swales, seasonal ponds, and creeks of the upper Deer Creek Watershed are breeding habitat for amphibians which include: Pacific tree frogs (*Hyla regella*) and Cascade frogs (*Rana cascadae*) (a CDFG species of special concern). Deer forage in the meadow and utilize available surface water for drinking.

The insect life associated with the meadow habitats and creeks (e.g., crickets, dragonflies, damselflies, and mosquitoes) provide ample food for common nighthawks (*Chordeiles minor*), poorwill (*Phalaenoptilus nuttallii*), bats, and swallows.

Riparian Communities and the Associated Lotic Habitat

Mixed Riparian Forest, Fremont Cottonwood Riparian Forest, and White Alder Riparian. One of highest levels of wildlife species diversity and abundance in California is associated with riparian habitats. Factors contributing to the high wildlife value include the presence of surface water, the variety of niches provided by the high structural complexity of the habitat, the condition of the associated upland habitat, and the abundance of plant growth. Riparian habitat within the Lassen National Forest is used by wildlife for food, water, escape cover, nesting, migration and dispersal corridors, and thermal cover.

Mature valley oak mixed with cottonwood was observed in the lower Deer Creek Watershed adjacent or overlapping with the riparian corridor. This habitat type is particularly valuable to wildlife due to the close proximity of water and dense under growth of wild grape, elderberry, blackberry, and willow. The understory species, Ashthroated flycatcher (*Myiarchus cinerascens*), swallows, bushtits (*Psaltriparus minimus*), osprey (*Pandion haliaetus*), American goldfinch (*Carduelis tristis*), and black phoebe (*Sayornis nigricans*), were abundant in these areas during the reconnaissance survey.

Streamside pools and low-flow shallows provide breeding habitat for Pacific tree frogs, Western toads, and Sierra newts. Other species (i.e., Ensatina salamanders [*Ensatina eschscholtzi]i*), utilize moist, terrestrial habitats (e.g., underneath fallen logs and woodland debris) for breeding and refuge. Common reptile species that utilize aquatic habitat for foraging or escape cover include: western aquatic garter snake, western skinks, and western terrestrial garter snake.

Where deciduous trees are prevalent, the abundant insects these plants attract will create areas especially suitable for neo-tropical migrants that feed on the numerous insects to replenish their migratory fat reserves. Examples of neo-tropical migrants include: Wilson's warbler, warbling vireo, and American redstart. Residents (e.g., winter wren, Swainson's thrush, and song sparrow) are more abundant in riparian habitats than in adjacent forests. American dippers, herons, belted kingfishers, and waterfowl utilize the near shore areas of rivers and creeks. Swifts, swallows, and flycatchers can be found hawking their insect prey over water. Red-shouldered hawks utilize riparian trees for nesting.

Raccoon, skunks, opossum, ringtail cat, long-tailed weasel, gray fox, mountain lions, and bobcat are likely to drink from the creeks and forage on rodents, amphibians, and insects. The riparian habitat provides movement corridors and water sources for black-tailed deer and birds as well. Bats associated with riparian forests include: Townsend's big-eared bat (a Federal and State species of concern), California myotis, long-eared myotis, and fringed myotis.

Willow Riparian Scrub. Riparian habitat dominated by willow has wildlife use similar to that of the mixed riparian habitat as discussed above. Since the major vegetative component of this habitat is willow, relatively high use by neo-tropical migrant birds is expected, increasing the importance of this habitat to bird species.

Riverine and Early Successional Riparian Channel Bed/Gravel Bars. Succession riparian river rock beds are dry rock beds in the river channel, deposited by the meandering at high water flows. During the summer, these areas often contain calm, shallow, backwater pools when water levels drop and water becomes restricted to the main channel flow. Western toads and western toad tadpoles were observed in backwater pools of these areas in the lower Deer Creek Watershed during the reconnaissance level surveys. The warmer water temperature associated with shallow, calm water and the presence of alga growth create areas that are good for Pacific tree frog reproduction. Raccoons, skunks, and herons will forage for stranded fish, tree frogs, and tree frog tadpoles in these areas.

Sierra newts, northwestern pond turtles, and foothill yellow-legged frogs have all been reported in Deer Creek as far upstream as the Highway 32 bridge crossing. Northwestern pond turtle hatchlings have been recorded 13 miles south of the Highway 32 (Red Bridge) crossing (McFarland 1997).

Willows, mulefat, sticky monkey flowers, and other flowering plants will colonize the rock bars where sandy patches are exposed. Hummingbirds find and forage from the sticky monkey flowers until the next high water event. The hot microclimate of the rocks combined with deposits of woody debris from the river provide basking habitat for many heat seeking reptiles (e.g., northern alligator lizards, garter snakes [*Thamnophis sirtalis*], and northwestern pond turtles *[Clemmys marorata marmorata*]).

Woodlands

Blue Oak-Foothill Pine Woodlands. The lack of an understory or mix of age class in the lower Deer Creek Watershed oak habitats is typical of oak habitats Statewide and is thought to be a result of management practices that suppress oaks from regenerating. The lack of oak regeneration is attributed to flood and fire suppression, and to management practices which result in over-grazing (Zeiner *et al.* 1990) or the timing of grazing (McNutt 1997). Oak regeneration in the lower Deer Creek Watershed, and management practices to enhance oak regeneration in the Deer Creek Watershed for wildlife, warrant further investigation.

Acorns buried by scrub jays, western gray squirrels, and California ground squirrels are likely to germinate because they root better and are less likely to be eaten by other species (Zeiner *et al.* 1990). Although mature oak woodlands are valuable to wildlife, oak woodland habitats with a matrix of age classes and plant heights allow a greater diversity of wildlife and important cover required by many species. Valley oak woodlands that are not overgrazed will develop a partial shrub layer of poison oak, coffeeberry, toyon, and ground cover.

Oak woodlands are considered critical habitats for the conservation of many bird and mammals species (Block *et al.* 1990). Important habitat features of oak woodlands include acorn production and the presence of cavity-bearing trees (cavity-bearing trees are usually mature). As a seasonal food, acorns are important for the survival of many species of wildlife in the fall and winter (Tietje 1990). Animals that are dependent on acorns as a seasonal food source include: deer, western gray squirrel (*Sciurus griseus*), northern flicker (*Colaptes auratus*), woodpecker, scrub jay (*Aphelocoma coerulescens*), band-tailed pigeons (*Columba fasciata*), California quail (*Callipepla californica*), wild turkeys *Meleagris gallopavo*), black bears (*Ursus americanus*), and feral pigs (*Progne subis*).

Cavity-nesting birds and small/medium-sized mammals depend on the natural cavities associated with mature oak trees. Mature oak trees often have broken limbs that contain some degree of decay and are then excavated by birds and mammals for nest and roosting sites. These cavities receive high levels of use by secondary cavity-nesting birds (e.g., woodpeckers, owls, tree swallow [*Tachycineta bicolor*], violet-green swallow [*Tachycineta thalassina*], and purple martin [*Progne subis*]).

The insects associated with oaks are prey for several birds (e.g., bushtit [*Psaltriparus minimus*], kinglets [*Regulus* spp.], and warblers). California towhee (*Pipilo crissalis*], and sparrows will forage for insects on the ground beneath the oaks.

Mixed Conifer Forest Communities

Douglas Fir Mixed Conifer Forest Series and Ponderosa Pine Mixed Conifer Series. Mixed conifer forest of the Sierra Nevada support approximately 355 animal species (Mayer *et al.* 1988). Species of special concern known to occur in the mixed conifer forest of the upper Deer Creek Watershed include: pine marten, bald eagle, osprey, spotted owl, and peregrine falcon. Table 9-2 provides the specific status and known locations of these special status species within the Deer Creek Watershed.

The abundance of water in the Deer Creek Watershed enhances the value of the Douglas fir mixed conifer forest for wildlife. The composite mosaic of running water, Douglas fir mixed conifer forest, ponderosa pine mixed conifer series, chaparral, meadow, and oak woodland in the upper watershed enhances the wildlife habitat by creating a wide variety of habitats and ecotones.

The wildlife value of the mixed conifer forest varies with the degree of canopy cover and density and the diversity of understory plant species present. Wildlife species diversity and abundance are highest where vegetation is highly stratified, offering a greater variety of niches for wildlife species. Areas where the Douglas fir mixed conifer forest or ponderosa pine mixed conifer intergrade with scrub communities create a mosaic that is also highly stratified and of high value to wildlife.

Some of the other important food plants for wildlife that occurs in these forest types includes: California hazelnut, *Ceanothus*, tanoak, gooseberry/current (*Rhibes* spp.), black oak, manzanita, madrone (only in the mixed conifer forest), coffeeberry, blackberry, and poison oak. These plants provide seasonal wildlife foods (e.g., berries and nuts) which are consumed by many bird and mammal species.

Significant habitat features include the presence of cavity bearing trees. Mature, fire burnt, and wind-damaged trees bear natural cavities that are important resources for cavity-nesting birds and small/medium sized mammals.

Mature and fire-damaged forests typically contain snags (standing dead trees). Snags are valuable resources for mammals and woodpeckers that prefer dead trees and limbs for excavation of roost and nest sites (Thomas 1979). Snags receive high levels of use by secondary cavity-nesting birds (e.g., chickadees and wrens). Snags also support wood-boring insects that provide food for bark-gleaning insectivorous birds. Bird species richness and abundance is high in the Douglas fir mixed conifer and ponderosa pine mixed conifer forest where the understory is stratified and dense.

Great horned owls and western screech owls nest in mixed conifer forest and prey on rodents that are active at night. Five diurnal raptors (all of which are State species of special concern) are known to nest in the evergreen forest trees include: goshawks, golden eagle, white-tailed kite, Cooper's hawk, and sharp-shinned hawk. Whereas, sharp-shinned hawks forage on birds in dense forest and Cooper's hawks forage on birds in the habitat edges or in open woodlands. White-tailed kites and golden eagles forage on mammals and reptiles in adjacent grasslands or open woodlands. These raptors feed primarily on small mammals or other birds, but golden eagles may take larger prey.

Another important feature of the mixed conifer forest is the abundance of fallen woody debris (e.g., limbs and logs). Woody debris adds structural complexity to the forest habitat and is important as cover, nesting, roosting, and foraging substrate for wildlife. Woody debris provides habitat for prey base (e.g., rodents). Downed wood also helps moderate arid conditions, creating microclimates suitable for amphibians and reptiles.

Downed woody debris provides suitable breeding and cover sites for several species (e.g., arboreal salamander (*Ensatina* sp.). Aquatic breeding species (e.g., Sierra newt [*Taricha torosa sierrae*]), typically spend their terrestrial existence in rodent burrows in grasslands, but may also take refuge under woody debris in adjacent forests.

The mixed conifer forest supports a high diversity of reptiles due to the abundant prey and cover provided by understory vegetation and fallen woody material. Representative species (e.g., common kingsnake, garter snakes, and ringneck snake) prefer the moist, wooded drainage bottoms.

Representative mammal species known in the Deer Creek Watershed that utilize both the Douglas fir mixed conifer forest or ponderosa pine mixed conifer habitat include: broad-footed mole (*Scapanus latimanus*), dusky-footed woodrat (*Peromyscus maniculatus*), deer mouse (*Peromyscus maniculatus*), black-tailed deer, Merriam's chipmunk (*Sciurus griseus*), bobcat (*Lynx rufus*), gray fox (*Urocyon cinereoargenteus*), striped skunk (*Mephitis mephitis*), Virginia opossum (*Didelphis virginiana*), and many bat species. Mountain lions (*Felis concolor*) and black bear (*Ursus americanus*) are also expected to use these habitat areas. Fisher (*Martes pennanti*), which are not confirmed in the Deer Creek Watershed (studies are being conducted), are also associated with the mixed conifer Douglas fir and ponderosa pine forest.

White Fir Mixed Conifer Series. White fir proceeds through serial stages following fire or other disturbances (Mayer *et al.* 1988). In mature stages, white fir forests are climatically cool and moist. A high percentage of white fir trees tend to rot out in the center due to a heart fungus or break in wind storms. Fungus rot, fire damaged, and wind-damaged white fir trees provide excellent habitat for snag and cavity dwelling species. After a fire occurs, the white fir forest becomes scrub habitat, dominated by manzanita, deerbrush, ceanothus, chinquapin, huckleberry, and gooseberry. The white fire seedlings, dependent on this brush cover for shade, will eventually regenerate to mature stands of white fir.

The suppression of fire in Lassen National Forest, including the upper elevations of Deer Creek Watershed, has interfered with this process. There is an attempt to use logging practices to simulate the natural serial change from white fir to scrub back to white fir. Population studies of the Tehama deer herd indicate that the lack of scrub habitat at higher elevations, due to the suppression of fire in white fir habitat, may be partially responsible for the deer herd decline (pers. com. Armentrout 1997).

White fir forest provides foraging habitat for the following insect-gleaning birds: western tanagers (*Piranga ludonciana*), mountain chicadees (*Parus gambeli*), chestnut-backed chickadees (*Parus rufescens*), yellow warblers (*Dendroica petechia*), and golden-crowned kinglets (*Regulus satrapa*). Martens (*Martes americana*) (also known as American marten) are known to occur in the white fir forest of Deer Creek (Kelley 1997).

Conifer Forest (non-mixed)

Red Fir Forest (non-mixed). Species diversity is relatively low in non-mixed stands of red-fir forest. However, the red-fir habitats of the Deer Creek Watershed are significant to the many species of special concern. These species include: goshawk (*Accipiter gentilis*), Sierra Nevada red fox (*Vulpes vulpes necator*), pine marten (*Martes americana*), and great gray owl (*Strix nebulosa*). The red fir habitat is also associated as habitat for wolverines (Mayer *et al.* 1988). Table 9-2 provides the specific species status and known locations of these species of special concern within the Deer Creek Watershed. The red fir habitat is important to blue grouse (USDA 1988) which is managed as a game species.

Miscellaneous Communities

Cliffs and Rock Outcrops. The rock outcrops and cliffs in the Deer Creek Watershed, especially throughout the canyon reaches, provide excellent habitat. The numerous ledges and crevices in the rock cliffs of the Deer Creek Watershed are of great value as nesting and foraging perches for the following species: American peregrine falcon (*Falco peregrinus anatum*), prairie falcon (*Falco mexicanus*), golden eagles (*Aquila chrysaetos*), turkey vultures (*Carthartes aura*), ravens *Corvus corax*), American kestrel (*Falco sparverius*), and many highly ignored bat species. Other birds (e.g., canyon wren [*Catherpes mexicanus*], barn swallow, Cooper's hawk [*Accipiter cooperii*], and red-tailed hawk [*Buteo jamaicensis*]) most likely use this habitat as well. Ringtail cats (*Basssariscus astutus*) and many of the birds listed in association of rock outcrops are listed as State or Federal species of special concern (see Table 9-2).

Sixty suitable cliffs with nest sites (a single cliff can contain multiple nests) have been identified in the Deer Creek and Mill Creek Watersheds (Jones and Stokes 1994). The adjacent riparian corridors of Deer Creek and the tributaries to Deer Creek provides foraging areas for the peregrine falcon and Cooper's hawk, which prey on song birds.

SENSITIVE WILDLIFE HABITATS

Sensitive habitats are defined by local, State, or Federal agencies as those habitats that support special status species, provide important habitat values for wildlife, represent areas of unusual or regionally restricted habitat types, and/or provide high biological diversity. The following plant communities occurring in the Deer Creek Watershed and are considered sensitive wildlife habitats: freshwater marshes, perennial and annual ponds, riparian woodlands, oak woodlands, red fir forest, rock outcrops, old growth red fir, or old growth mixed conifer forest. The value of these habitats and a description of the existing conditions are discussed under the Wildlife Habitat section.

Rock Outcrops

The abundance of ledges and crevices in the rock cliffs of the Deer Creek Watershed are suitable nesting locations and foraging perches for several of the State and Federally-listed raptors (see Table 9-2 for species status). Listed species known to occur and that would potentially nest on cliff ledges and crevices include: American peregrine falcon (*Falco peregrinus anatum*), prairie falcon (*Falco mexicanus*), and golden eagles (*Aquila chrysaetos*). Cooper's hawks (*Accipiter cooperii*), as well as other raptors, are likely to use cliff ledges and rock outcrops as forging perches.

Oak Woodlands

Oak Woodlands are recognized as a sensitive wildlife habitat due to the State-wide phenomenon of a lack of oak regeneration and the high abundance of wildlife species associated with this habitat (Mayer *et al.* 1988). The lack of recruitment of young oaks to replace older oak stands occurs under grazing or agricultural development and when there is fire and flood suppression. Grazing or trampling of new oaks and the decrease in rodent populations associated with grazing are threats to oak regeneration. Animal damage to acorns and the burying of acorns by scrub jays, western gray squirrels, and California ground squirrels promotes the reproduction of oaks. Acorns buried by scrub jays, western gray squirrels, and California ground squirrels are likely to germinate because they root better and are less likely to be eaten by other species.

Wetlands

Riparian Woodlands. At the State level, riparian plant communities are considered sensitive habitat and have been identified by the California Department of Fish and Game (CDFG) as habitat of special concern (Wetlands Resource Policy, California Fish and Game Commission, 1987). Riparian habitats are valuable because they support a high density and diversity of wildlife species and because they are a diminishing resource. In the State of California, at least 89.0% of riparian areas existing 130 years age have been lost (*ibid*).

These areas provide potential habitat for the following State or Federally-listed species: yellow-billed cuckoo, willow flycathcher, foraging peregrine falcons, and greater western mastiff bat. Other species of special concern known to occur in the riparian corridor of the Deer Creek Watershed include: foothill yellow-legged frog, pine marten, osprey, and northwestern pond turtles.

Riparian forest along the tributaries and creeks also provides movement corridors and cover for a large number of mammal and amphibian species, as well as for residential and migrating neo-tropical birds.

Vernal Pools. The vernal pools (seasonal ponds) located in the lower Deer Creek Watershed are habitats for several Federally-listed invertebrate species of special concern and are of high wildlife value for waterfowl, shorebirds, mammals, predatory birds, reptiles, and amphibians. Species of special concern which are dependent on vernal pools include: tadpole shrimp (*Lepidurus packar*), conservancy fairy shrimp (*Branchinecta conservatio*), vernal pool fairy shrimp (*Branchinecta lynchi*), and California linderiella (*Lindriella occidentalis*). These invertebrate species have evolved reproductive strategies with the dry down of surface water.

Fresh Water Marshes and Ponds. In general, wetlands and their associated riparian plant communities, including the plant communities surrounding the agricultural ditches, are considered sensitive habitats due to their high wildlife value, limited distribution, and decreasing acreage Statewide. These sensitive habitats have been significantly reduced from their historical distributions.

In addition, the ponds provide potential foraging habitat for bald eagles, peregrine falcons, herons, and many of the listed species of bats.

The marsh habitats enhances all other habitat areas located adjacent to the marshes. Wildlife (e.g., mammals, birds, reptiles, and amphibians) from adjacent areas are likely to use the open water and cover in route to surrounding areas.

WILDLIFE SPECIES OF SPECIAL CONCERN

Federally-Listed Species

Seven Federally-listed species are known to occur in the Deer Creek Watershed. Four species are listed as Federally-endangered and three are listed as Federally-threatened (Table 9-2). The status of the Federally-listed vernal pool invertebrate species occurring on The Nature Conservancy property is well studied. There is limited vernal pool habitat occurring in the lower Deer Creek Watershed on private property that has not been evaluated in regard to these species. Surveys for the elderberry longhorn beetle (*Desmocerus californicus dimorphus*) have been conducted along the lower reaches of the Deer Creek Watershed (pers. com. Tom Griggs 1997, and pers. com. Brother Paul 1997). However, the status of this beetle, in the middle and upper reaches, remains unknown or undocumented, although reconnaissance level surveys indicated potential habitat with the presence of the beetle's host plant (i.e., elderberry).

The population status (numbers of individuals and nest locations) of the California spotted owl (*Strix occidentalis occidentalis*) has been well studied in the upper Deer Creek Watershed, especially in the Lassen National Forest (USDA 1992). The occurrence of California spotted owls in the lower Deer Creek Watershed, outside of Lassen National Forest, has not been documented.

The status of the Federally-listed bald eagle and the American peregrine falcon (also known to occur in the Deer Creek Watershed) (England *et al.* 1987), is less understood. Bald eagle nest sites have not been systematically surveyed throughout the watershed. However, sightings of bald eagles within Deer Creek Watershed and nest locations adjacent the Deer Creek Watershed have been reported. Adult eagles have been observed recently in the lower (pers. com. Bland 1997) and upper Deer Creek Watershed (pers. com. Armentrout 1997). See Table 9-2 for locations of nesting bald eagles adjacent to Deer Creek Watershed.

Recent surveys for American peregrine falcon nests have not been conducted although they had been in the past (England *et al.* 1987). Excellent habitat for cliff nesting species (e.g., the peregrine falcon and prairie falcon) has been noted in the middle Deer Creek Watershed along cliff faces and rock out-crops. In general, the numbers of peregrine falcons Statewide has increased due to management practices (i.e., careful removal of wild falcon eggs, incubation of the pesticide-ridden eggs, and translocation of falcon chicks' back to the wild). However, current reproductive success of wild peregrine falcons still remains experimental due to the accumulation of pesticide by-products/residue remaining in wild populations of adult falcons and the associated reproductive problems.

State-Listed Species

Twenty-one State-listed species are known to occur in the Deer Creek Watershed. Five of the State-listed species are listed as endangered, 3 are listed as threatened, and 14 are listed as species of special concern (Table 9-2). Species of special concern are "those whose populations in California are so low that extirpation is a real possibility" (Remsen 1978). An additional 13 special status species may potentially occur in the Deer Creek Watershed. Due to lack of adequate data to establish presence or absence, the presence of these species remains unknown.

Six species that are known to occur in the Deer Creek Watershed are fully protected under the DFG Code Section 3511. These species include: greater sandhill cranes (*Grus canadensis tabida*), black-shouldered kite (also known as white-tailed kite) (*Elanus caeruleus*), bald eagle (*Haliaeetus leucocepthalus*), American peregrine falcon (*Falco peregrinus anatum*), and golden eagle (*Aquila chrysaetos*). In addition, the Migratory Bird Treaty Act protects all migratory birds (with or without State or Federal listings) and their nest, including the great blue heron (*Ardea herodias*) and great egret (*Casneridius albus*) rookery sites in the Deer Creek Watershed. Known occurrences of these species are listed in Table 9-2.

See Appendix D for background information regarding wildlife species of special concern that are known to occur or have the potential to occur within the Deer Creek Watershed.

WILDLIFE POPULATIONS

Overview

The large amount of public lands in and adjacent to the Deer Creek Watershed, the inaccessibility of the canyons to humans in the middle reaches of the Deer Creek Watershed, and the low human occupancy in the lower and upper reaches of the watershed provide exceptional habitat value for wildlife. The large sizes of adjacent and uninterrupted habitat types are of particular value to wildlife species with large home ranges or migrations. This alone may explain why some wildlife populations in the Deer Creek Watershed (e.g., pine martens and fishers) are maintaining their status while they have declined in other parts of the State.

Black-tailed Deer

Historical population estimates of black-tailed deer are based on the number of bucks reported killed, multiplied by the number of deer remaining in the herd for each buck taken. In this herd, a multiplier of 20 to24 was developed in the 1940's and still is a good rule of thumb. Since populations reached a high point in the late 1950's and early 1960's with buck kills of about

4,000, the estimated high population for the herd is about 100,000 animals. Large fluctuations in the population are common. The drought years of the mid-1970's produced lows comparable to today's population, but the population rebounded to around 70,000 by the mid-1980's.

Data on the number of bucks taken, the ages of those animals, and the ratio of bucks in the remaining population (Table 9-3) enable us to develop a minimum number of bucks and, therefore, a minimum population estimate. This method of population estimation is always four years behind, so we are getting an estimate of the minimum population that existed four years ago. Therefore, there are no figures for the last few years. Furthermore, in 1996, the Almanor Basin biologist noted seeing a handful of deer come through the check station, resulting in a sample size to small to be useful. Table 9-3 includes information from 1980 through 1990.

Table 9-3. Minimum Population Estimate

Year	Minimum Number of Bucks	Total Number of Bucks	Does	Fawns	Total
1980	2,630	3,945	39,450	20,120	63,515
1981	2,314	3,471	34,710	13,537	51,718
1982	2,138	3,207	45,814	25,383	74,404
1983	3,488	5,232	34,880	20,928	61,040
1984	3,881	5,822	27,724	10,535	44,081
1985	3,289	4,934	18,274	8,589	31,797
1986	2,939	4,409	24,514	9,806	38,729
1987	3,065	4,598	19,991	7,597	32,186
1988	3,105	4,657	20,248	7,897	32,802
1989	2,791	4,186	23,255	11,163	38,604
1990	2,454	3,681	24,540	13,252	41,473

The population of the east Tehama deer herd was over the long-term carrying capacity of the range during the early 1980's. Good fawn survival years led to a population level that could not be sustained indefinitely. The first seven years of unfavorable precipitation began in 1987. Some were dry years, while during the other years precipitation was near normal. This came at a time that did little to increase necessary forage production. The decline during these years was predictable; poor forage production provides fewer resources to support the population. The winter of 1991 was particularly devastating when extreme cold hit the forests that had no insulating snow layer. This froze and killed a large percentage of the browse plants on the summer range.

More recently, the total precipitation levels have increased, but the timing has not. For example, in the east Tehama deer herd, there is a strong correlation between high October rainfall and fawn survival the following year. In 1995, there was no measurable rainfall (or green up) until December. Combined with a general failure of the acorn crop, there was practically no forage available on the winter range and no recovery for the herd. These, however, are annual fluctuations that have and will always occur.

An alarming, but subtle, trend is in the general loss of productivity of the forests for deer. The forests are generally getting older and denser, crowding and shading out the forage species deer need to flourish. This is easily seen in comparative photographs taken over the last 100 years from virtually any lookout. Scenes that showed forest openings and shrub lands now show dense tree growth. In a recent Lassen National Forest proposal to create a firebreak around the town of Mineral, this closing in and aging of the forest was noted. In informal discussions with the Almanor Ranger District biologist, there have not been major fires on the summer range since the early 1940's. Logging activity has been largely curtailed due to policies that are designed to favor and promote older forest growth. When logging does occur, active steps are taken to maximize tree growth and minimize the amount and duration of shrub growth within replanted areas. In summary, natural, political, social, and economic forces are all focused on suppressing activities that open the forest up so young, nutritious shrubs can flourish.

Unless there is a major change in the management of public and private forest lands, there will not be a return of the deer population to historic levels.

Pronghorn

Promhorns (*Antilocapra americana*) are known to occur in the adjacent Mill Creek Watershed (Jones and Stokes 1994, Armentrout 1997) and should be considered a potential species to the Deer Creek Watershed. Pronghorns (*Antilocapra americana*) are native to California and fairly common in the northeastern corner of the State. Herbaceous plants are the most important summer food source for pronghorns, while grasses are used to a lesser extent. Browsing foliage is utilized year-round and is particularity important as a winter food source. Browsing foliage includes: sagebrush, bitterbrush, and shrubs.

Home ranges are extremely variable and depend on the habitat, year, and location. Daily movements range between 0.06 and 5.8 miles (0.1 to 9.7 km). Water is necessary and may limit daily ranges, especially if there is a lack of succulent green vegetation. However, seasonal migration between summer and winter ranges may be up to 93 miles (150 km).

Cattle, sheep, and wild horses directly compete for food resources and can reduce the carrying capacity for pronghorns. Fencing also limits the pronghorns historic range.

Pronghorns rely on speed and the ability to detect moving predators from long distances. Pronghorns will use shrubs and uneven topography for cover. Predators include: bobcats, mountain lions, and coyotes.

EXOTIC SPECIES

Exotic Species Overview

Several "exotic" or non-native species populations occur within the Deer Creek Watershed. Brown headed cowbird (*Molthrus ater*), wild pig (*Sus scrofa*), and bullfrog (*Rana catesbeiana*) populations are known to occur. There have been no focused studies to monitor these populations over time or evaluate their interaction with other species within the Deer Creek Watershed. However, brown-headed cowbirds, wild pig, and bullfrog populations have all been studied in other areas and are well known to cause ecological problems. Background information regarding the known occurrences and concerns regarding these three populations are discussed separately.

Feral Pigs

In the United States, wild pigs (*Sus scrofa*) are called many names reflecting their mixed ancestry. Wild pigs are not native to North America and should not be confused with the collared peccary (*javelina*) of the Southwest. The "wild pig" in California is a cross between the pure-strain European wild boar introduced to the State in Monterey County during the mid-1920's and the free-roaming pig released by early settlers.

Wild pigs have been observed in the lower portion of Deer Creek Watershed. Although the current population of wild pigs in this area does not appear to be large (there has been no studies assessing the wild pig population in the Deer Creek Watershed), wild pig populations have the potential to create ecological and health problems if not addressed early on. Reportedly, there is some hunting of wild pigs in the lower watershed. Densities of pigs in Tehama County were reported as 5 to 8 pigs per km^2 (14 to 20 per mi^2) (Zeimmner *et al.* 1990). In Tehama County, home ranges of male wild pigs averaged about 52 km^2 (20 mi^2) and females averaged about 13 km^2 (5 mi^2) (Pine and Gerdes 1973, Barrett 1978).

It is the policy of the California Fish and Game Commission that, "The wild pig population of the State must be controlled to minimize the threat of increasing damage to California's native plants and animals, to agricultural operations, and to park and recreational activities from the foraging habits of the animals".

Wild pigs are abundant, non-native animals of forests, oak woodlands, and chaparral. The minimum requirements for good wild pig habitats are escape cover of dense vegetation (e.g., chaparral and forest) with a surface water distribution of at least one source per square mile (Nee 1992). Wild pigs thrive where they have: 1) permanent water; 2) an adequate food supply including acorns, bulbous plants, clover, and soils animals; and 3) security from hunting or human harassment. Suitable habitat consists of a mixture of dense brush and mature forest habitats for cover and reproduction. Also, oak forests, herbaceous/forb openings, and agricultural lands are used for foraging (Zeiner *et al.* 1990). They occur in riparian areas, mature conifer and hardwood forests with moderate to high canopy closure, chaparral, and other brush types. Production of mast crops is an important factor influencing pig distribution. Adjacent agricultural lands also enhance the value of the pig's habitat.

Wild pigs are omnivorous; their diet changing with the season. During the dry summer months, pigs eat green plants. During autumn, they consume acorns, walnuts, and fruit when these nutritious foods are available. During winter, when rains soften the soil, wild pigs eat roots, bulbs, insects, and worms that they locate by plowing or "rooting" the ground with their tough snouts. In the spring, as the soil dries, they gradually shift back to green plant parts. In some agricultural areas, barley and alfalfa are preferred foods. Small animals and carrion form a minor part of the pig's diet year-round.

Rooting by pigs in moist or irrigated soil is normally quite visible. Sometimes only a few small sites are rooted or the disturbed area may cover several hundred square feet or more. Rooted fields look like they have been roto-tilled. Rooting can harm pastures, crops, and native plants and may cause soil erosion. Pig rooting can alter the relative abundance of different plant species at the site and can change the functioning of natural ecosystems. Damaged grasslands are usually revegetated within 1 to 2 years, but sometimes with less desirable plants (e.g., thistles) (Nee 1992).

In years of acorn shortage, when competition is most likely to occur, wild pigs may compete with wild turkeys, mule deer, squirrels, and black bears. Destruction by pigs of native vegetation and nests of ground-nesting birds may also be a serious problem (Wood and Barrett 1979).

Wild pigs carry parasites and diseases that are potentially transmittable to livestock, pets, wildlife, and humans. In California, the following parasites and diseases have been isolated in wild pig: trichinella, brucellosis, Q fever, pseudorabies, leptospirosis, avian tuberculosis, toxoplasmosis, and plague (Clark *et al.* 1983 and Drew *et al.* 1992). The brucellosis bacterium affecting pigs also occurs in other domestic animals and man. The disease is spread mainly by animal-to-animal contact and is spread to humans by contact with the blood of infected animals. Leptospirosis is a bacterial disease of pigs transmitted to nearby wild animals when pigs urinate in their wallows and then other animals drink from those basins (Nee 1992). See Clark *et al.* (1983) and Drew *et al.* (1992) for more information about zoonotic diseases of wild pigs in California.

Recreational hunting is the primary method recommended by the CDFG for controlling wild pig populations and associated damage. This control method utilizes licensed hunters who are allowed to kill and keep one pig per day year-round in most areas of the State. Population models predict that in normal years at least 70 percent of a wild pig population must be cropped annually to result in a stable population for the following year (Nee 1992).

Bullfrogs

Bullfrogs are a non-native frog that preys, as best we can tell, unselectively on native frogs. Bullfrogs occur throughout the lower and middle reaches of the Deer Creek Watershed. Bullfrogs are known to prey on yellow-legged frog adults and tadpoles found in the lower elevation tributaries of Deer Creek (e.g., Dye Creek) (McNutt 1997). A management practice that will aid native frog populations is the elimination of the non-native bullfrog. Successful methods of removing bullfrogs populations include long-term extermination efforts (e.g., physically gigging adult bullfrogs). Such a method has been conducted at Año Nuevo State Park (San Mateo County). This resulted in the successfully recruitment of a native frog populations (in this case, California red-legged frogs) (pers. com. Mike Westfal 1997).

Brown-headed Cowbirds

The brown-headed cowbird is a non-native species that reproduces by parasitizing all native passerine bird nests within their range. Brown-headed cowbirds parasitize other nests by exclusively laying their eggs in the nest of other birds, leaving their eggs to be raised by the host parents. In central California, female brown-headed cowbirds laid about 30 eggs each season, with 1 to 2 eggs in each host bird nest (Zeiner *et al.* 1990). Young brown-headed cowbird chicks then kick out the host bird chicks so the host parents exclusively raise the brown-headed cowbird chicks.

Brown headed cowbirds have been observed in the lower Deer Creek Watershed. Due to limited access in the middle or canyon reaches of the Deer Creek Watershed, the presence and status of brown-headed cowbirds remains unknown. Focused mist netting studies of avian species, currently being conducted by the Lassen National Forest Service, will hopefully clarify the status of brown-headed cowbirds within the Deer Creek Watershed.

AVAILABLE MAPPED INFORMATION

1. **Known Location of Special Status Species in the Deer Creek Study Area**
   Source: Deer Creek Wild and Scenic River Suitability Report (Jones and Stokes, October 1994).
   Coverage: Two mile-wide portion of the Deer Creek corridor (one mile from either creek bank).
   Scale: 1:63,360 (1" = 5,280')
   Units: Miles

2. **Known Location of Special Status Species in the Deer Creek Study Area**
   Source: California Department of Fish and Game, Natural Diversity Data Base Rare Find Reports.

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Photo 9-1. Wildlife Biologist Dawn Reis inspecting tree stump gnawed by beaver on north bank of Deer Creek downstream of the Cone-Kimball Diversion
(Photo by J. Stanley, June 1997)

10.0 FISHERIES AND AQUATIC RESOURCES

DEER CREEK FISH HABITAT AND POPULATIONS

Deer Creek is a major tributary of the Sacramento River, entering the Sacramento River at River Mile (RM 230) near the town of Vina, approximately 1.5 miles north of Woodson Bridge State Park (Reynolds *et al.* 1993). It is downstream of Shasta Dam (storage begun in 1943) and the Red Bluff Diversion Dam (gates first closed in 1966). The Deer Creek drainage is part of the lower Cascade mountain range with the geomorphology governed by the volcanic history of the area (Sato *et al.* n.d.). The watershed drains 229 square miles and is 60 miles in length.

Deer Creek rises from three distinct and primary sources. Childs Meadow which feeds Gurnsey Creek; Willow Lake which feeds Lost Creek; and Butt Mountain which feeds Deer Creek (Evans 1997). Butt Mountain is a remnant of the stratovolcano Mount Yana, about six miles east of the town of Mineral. Childs Meadows is near the center of an area of about ten square miles which is the origin of several tributaries of the Sacramento River, all celebrated as salmon streams. These tributaries are Battle, Mill, and Deer Creeks and the North Fork of the Feather River (Hanson *et al.* 1940). However, the runs of anadromous fish on North Fork of the Feather River have been extirpated by the closure of Oroville Dam and the lack of fish passage facilities at the dam. As part of the Sacramento-San Joaquin Watershed, Deer Creek was part of one of the richest chinook or king salmon (*Oncorhynchus tshawytscha*) rivers in North America (Netboy 1980).

Gurnsey Creek (North Fork Deer Creek) flows from Childs Meadows in a southeasterly direction about six miles to Deer Creek Meadows, where it joins Deer Creek. Deer Creek flows approximately 45 miles to join the Sacramento River near the town of Vina. Similar to other streams which drain the western slope of the lower Cascade Range, Deer Creek (after its beginning in a mountain meadow) threads its way through steep-sided gorges, cutting through basalt and tuff-breccia cliffs for several miles before flowing out onto the central valley plain. It then winds through shallow gullies toward the main river (Sato *et al.* n.d.). Like those of Battle and Mill Creeks, the Deer Creek Canyon is a deep cut in an ancient lava flow. At higher elevations the terrain is forested with conifers; in the lower regions the cover is typical California valley oak-grassland association (Hanson *et al.* 1940).

Part of the upper stream is paralleled by State Highway 32. The lower ten miles flows through the valley where the agricultural diversions are located and where stream flow has been diverted. There are no mandated instream flows and the water diverters have water rights to divert all the stream flow because water rights exceed natural stream flow. Historically, three diversion dams and four diversion ditches have adversely affected stream habitat in this reach (Jones and Stokes 1994). However, the Stanford Vina Ranch Irrigation Company (SVRIC) has responded to California Department of Fish and Game (CDFG) requests for voluntary system shut downs to provide "transport windows" for migrating anadromous salmonids (Hanna 1997). SVRIC has also constructed a holding pool downstream of their dam for upstream migrating adult salmonids and has made fish ladder improvements (Hanna 1997). The negative impacts of water diversion may be mitigated by a proposed water exchange project, which will provide replacement water in lieu of water from water diversions during biologically critical periods. Replacement water may be from groundwater wells or other sources. Development of this replacement water requires some funding. All of the diversion structures have CDFG designed and operated fish ladders and screens.

The first natural barrier in the stream is a falls about nine miles upstream of Polk Springs and approximately 40 miles from the mouth. This falls is about 16 feet high, and salmon had never been known to pass beyond it (Hanson *et al.* 1940) until a fish ladder was constructed in 1943 (Harvey 1997b). There is a second falls on Deer Creek about ten miles upstream of the falls near Polk Springs. This falls is a sheer drop of about 20 feet (Hanson *et al.* 1940). A fish ladder was also constructed at this barrier in early 1950s, but is not operated to allow spring-run chinook salmon to move upstream because the upstream areas are thought to lack holding habitat (Colleen Harvey per. comm.).

Reach Characterization

The following habitat descriptions and reaches generally follow those of Sato and Moyle (1988) and Jones and Stokes (1994). See Table 2-3 for a comparison of the reach designations used in this report with those used in Sato and Moyle (1988) and Jones and Stokes (1994). The Lassen National Forest has made physical stream surveys on Deer Creek from the confluence with Elam Creek downstream to the confluence of Calf Creek in 1992 and from Calf Creek to approximately one mile downstream of Ponderosa Way in 1994. These data were unavailable at the time of writing this report, but should add greater detail of aquatic habitats and their condition to each delineated reach.

Detailed aquatic habitat delineation is a very important aspect of any environmental assessment program because it describes and documents all the habitat features (i.e., spatial variables) of a stream. Valuable insights as to where chinook salmon or steelhead migrate (potential barriers), hold, spawn, and rear are frequently taken from habitat delineation surveys. The quantity, quality, and location of potential spawning, holding, and rearing habitat are critical questions that should be answered relative to spring-run chinook salmon and steelhead populations in Deer Creek. It provides a baseline and also defines the "universe" from which future sampling or monitoring can be based. With spatial features described, variability associated with time can be more effectively addressed.

It is likely that the USFS aquatic habitat delineation surveys will require resurveying because methods to determine habitat length and width of habitat units were inconsistent, some were measured while others were estimated (Gale 1992). However, if the habitat delineation surveys are adequate, the remainder of Deer Creek (within the reaches described below) should be described in the following terms: habitat composition (USFS Region 5 aquatic habitat criteria) and representation; bank cover complexity; instream cover; bank stability; spawning gravel availability and distribution pattern; dominant substrate; level of sedimentation (embeddedness); pool residual volume index (V^*); drift quality; benthos quality; chinook salmon and steelhead habitat quality; and constraints to quality.

Butt Mountain Reach. Deer Creek originates in steep, heavily forested terrain on Butt Mountain. This reach extends from the headwaters down to Collins Pine Company Road 1110, a distance of 2.25 miles. Access to Deer Creek is limited in this reach. The creek has a high gradient, is very narrow, and flows over large boulders. The only species observed was rainbow trout (Sato and Moyle 1988).

Deer Creek Meadows Reach. This reach extends from Collins Pine Company Road 1110 to the confluence with Gurnsey Creek (also known as North Fork Deer Creek), a distance of 4.0 miles. The headwaters have two different geologies. At Deer Creek Meadows to the east following Deer Creek, it is andesite. Following Gurnsey Creek to the west, it is rhyolite and is very erodible. Fine sediment is stored on the plateau of Deer Creek Meadows. Lost Creek enters at the upper end and Gurnsey Creek at the lower end of the meadows. Lost Creek flow adjacent to Highway 36 and is highly altered. There have been private hatcheries, channel relocations, rearing of domestic waterfowl, construction of houses beside the stream, and small diversions that adversely affect habitat quality in Lost Creek. The privately owned open meadow area is used mainly for pasture, and access to Deer Creek is limited. The channel meanders or braids; slow runs predominate, but it also has a few riffles. The dominant fish is brown trout; however, rainbow trout dominate above and below the meadows (Sato and Moyle 1988).

Highway 32 Reach. This reach parallels Highway 32, from Gurnsey Creek downstream to the lowermost crossing of Highway 32, a distance of 11.6 miles. Several bridge crossings, many turnouts, and three USFS campgrounds make this reach easily accessible to anglers and other recreationalists. Not surprisingly, this reach of Deer Creek receives the most public use (Sato and Moyle 1988).

The Upper Deer Creek Falls, which is a barrier to all upstream migration by spring-run chinook salmon, lies within this reach (Sato and Moyle 1988). However, McFarland (1997) reports that an occasional anadromous fish has been observed upstream of the Upper Falls. A fish ladder constructed at this location in the early 1950s is functional. It is closed during adult spring-run chinook salmon spawning migrations due to the lack of holding habitat and heavy angling pressure upstream of the falls (Colleen Harvey pers. comm.). The ladder is opened from late-fall to early spring to allow adult steelhead to migrate (Harvey 1997a). Approximately 13 miles of potential habitat for anadromous salmonids are located upstream of this point (Marcotte 1982).

Spring-run chinook salmon, steelhead trout, resident rainbow trout, Sacramento sucker, riffle sculpin, and exotic brown trout use the portion of this reach up to the falls, whereas resident rainbow trout, brown trout, and riffle sculpin inhabit the section above the falls (Sato and Moyle 1988 and Colleen Harvey pers. comm.).

This reach from Upper Falls downstream to the Highway 32 bridge is a prime holding and spawning habitat for adult spring-run chinook salmon. Typically 25 percent of the total adult spring-run chinook salmon population hold in this reach. Actual percent of spawning is unknown, but numerous redds are typically counted between Upper Falls downstream to Potato Patch Campground (Harvey 1997a).

The Deer Creek channel in this reach is typically a Rosgen B type channel (Rosgen 1994). Sediment from the meadows reach is transported through the upper watershed quickly because the channels have no significant flood plains or terraces to store deposited sediments. A few bars of deposited sediment within channel were evident during reconnaissance field trips by Stacy Li in 1997. Similarly, woody debris must also be transported quickly because there were almost no woody debris observed, except as aggregations at channel restrictions and inflection points (Roby 1997). Sediment sizes are large, instream boulder occurrence is extensive and provides complexity to rearing habitat.

USFS campgrounds are located adjacent to Deer Creek. Foot traffic has caused bank erosion. Angling pressure is heavy near the campgrounds.

Elam Creek, a tributary to Deer Creek, is significantly cooler than Deer Creek and joins Deer Creek in this reach. Elam Creek and possibly other tributaries may be important in maintaining adequate water temperatures in Deer Creek for holding adult spring-run chinook salmon and rearing juvenile spring-run chinook salmon and steelhead.

Upper Canyon Reach. This reach extends from the lowermost bridge crossing of Highway 32 downstream to Ponderosa Way, a distance of 14.3 miles. This reach has only limited access and provides the prime holding and spawning habitat for spring-run chinook salmon on Deer Creek. Resident rainbow trout reach their highest relative abundance densities in this reach. Cold water native fishes (e.g., chinook salmon, rainbow trout, riffle sculpin, and Sacramento sucker) dominate the fish fauna in this reach. Speckled dace, California roach, and exotic brown trout also occur in the Upper Canyon Reach (Sato and Moyle 1988). Pacific lamprey has been observed upstream of the transfer bridge and presumably occurs as far upstream as the Lower Deer Creek Falls (Dr. Peter Moyle pers. comm.). CDFG have found Pacific lamprey ammoecetes (i.e., larvae) as far upstream as A-line road; no ammoecetes were found in samples at Highway 32 from 1994 to 1997 (Harvey 1997a).

The upper part of this reach from Lower Falls upstream to Highway 32 bridge has limited deep pools and the gravel deposits necessary for spring-run chinook salmon holding and spawning. On average approximately three percent of total adult spring-run chinook salmon population hold in part of this reach and there are no data for percent spawning (Harvey 1997a). The lower part, generally downstream of the Lower Falls typically consist of long deep pools with short steep drops, that are used as holding habitat by spring-run chinook salmon.

Not all of Deer Creek is surveyed for spring-run chinook salmon spawning activity. Instead, a selected reach is surveyed as an index of spawning activity. The "Indicator Reach" is located in the Upper Canyon Reach, where there are numerous deep pools and gravel deposits (Roby 1997). Several spring-run chinook salmon spawning surveys of the complete Deer Creek should be performed to so that the "Indicator Reach" is calibrated to total spawning activity.

Generally, all of the canyon reaches have pools and gravels, but pool use tends to decrease in the downstream direction (Roby 1997). This may be a reflection of stream water temperatures or perhaps some other habitat quality feature.

The Lower Deer Creek Falls, which has a functioning fish ladder, lies within this reach (Sato and Moyle 1988). The construction of the ladder was completed in June 1943 (Cramer and Hammack 1952).

Lower Canyon Reach. This reach and the Valley Floor Reach differ from Moyle and Sato's (1988) reach delineation. This reach extends from Ponderosa Way downstream to the Deer Creek Irrigation District (DCID) Dam, the downstream end of the canyon, a distance of 18.0 miles. Access to Deer Creek is difficult due to precipitous terrain. Many long, deep runs and large boulder riffles characterize this reach. The fish fauna is almost exclusively native fish, except for an occasional smallmouth bass. Warm-water native fish predominate. Sato and Moyle (1988) found that Sacramento squawfish and hardhead do not occur upstream of this reach, which also marks the downstream limit of spring-run chinook salmon holding habitat and rainbow trout distribution during the summer. However, CDFG personnel have subsequently observed Sacramento squawfish and hitch from the Beaver Creek confluence to Ponderosa Way during snorkel surveys (Harvey 1997a). California roach, riffle sculpin, Sacramento sucker, speckled dace, and tule perch reach their highest densities in this reach (Sato and Moyle 1988). Fall-run chinook salmon spawn in the lower portions of this reach. This is the extreme upstream limit of fall-run chinook salmon spawning (Harvey 1997a).

Valley Floor Reach. The Valley Floor Reach along with the Mouth Reach represents the most adversely affected habitat in the watershed. Land clearing, soil movement, and land leveling occurs more frequently and over larger areas in the Valley Reach compared to other reaches. This reach extends from DCID Dam to the Southern Pacific Railroad Bridge, a distance of 9.5 miles. Geomorphologically, Deer Creek is no longer confined by the walls of the steep canyon which alter the pattern of bedload transport. Wide runs predominate, but streambanks are steep and incised. Fish species composition is influenced by proximity to the Sacramento River and significant loss of stream flow downstream of the diversion dams. Sacramento squawfish reach their greatest densities in the slow, warm water of this reach. Most of the introduced species occurred only in this (Sato and Moyle 1988) and the Mouth Reach.

Three irrigation diversions are present in the lower portion of this reach: DCID Dam, Kimball Diversion, and Stanford-Vina Dam. Kimball Dam and Stanford-Vina Dam are owned and operated by the SVRIC. Fish ladders are present at each dam. A holding pool for immigrating adult salmonids has been constructed downstream of the Stanford-Vina Dam by SVRIC. Reduced instream flows from the three diversions and other riparian water rights can adversely affect stream habitat in this reach, particularly during late spring, summer, and fall. There are no minimum flow requirements on any of these diversions. DCID has water rights that allow a diversion up to a third of Deer Creek flow and SVRIC owns water rights which allows them to take the rest (Stacy Cepello pers. comm.). These water rights exceed natural flow (McFarland 1997). Appropriate physical habitat, water temperature, and transportation flows for upstream and downstream migrating salmon and steelhead can be adversely affected in this reach. However, since 1989 both the SVRIC and DCID have left minimum flows in-stream to allow for upstream and downstream migration of salmon and steelhead (D. Gaumer DCWC pers. comm.).

Most riffles in this reach after the January 1997 flood are in the form of transverse bars of large cobble and boulders, with the dominant substrate size decreasing in downstream direction. These substrate elements appear too large to allow chinook salmon spawning. However, some salmon do use it (Terry Healy per. comm.). There is little evidence of embedded interstitial space by fine sediment. There is some braiding and evidence of channel avulsion. Some of the channels may make upstream migration difficult, but not so difficult to be considered impassable. Some banks were scoured away. There are extremely large rocks in banks that probably represented the substrate that is recruited during high flow events. Some of the riparian trees, particularly the alders were scoured away.

Downstream of where high power lines cross Deer Creek, Stacy Li and Mike Kossow observed the first evidence of more appropriately sized chinook salmon spawning gravels (i.e., 4 to 6 inches in median dimension). Fine sediment consisted mostly of sand with no evidence of clay.

Levees protect orchards, Vina, outlying homes and farms, Highway 99, other public roads, and the Southern Pacific Railroad in this reach.

Mouth Reach. This reach extends from the Southern Pacific Railroad Bridge to the mouth of Deer Creek; a distance of 2.1 miles. This reach was not included in Sato and Moyle's (1988) reach delineation. Backwater effects from the Sacramento River affect the mouth of Deer Creek. Rutter made the earliest fish collection at the mouth of the Deer Creek in 1907.

Fish Population Characterization

The Deer Creek Watershed has exceptional features that make Deer Creek one of the more important streams in the Central Valley. CDFG believes that all four runs of chinook salmon and steelhead use Deer Creek (CDFG 1966, Reynolds *et al.* 1993).

Anadromous species with consistent runs up Deer Creek include spring-run chinook salmon, fall-run chinook salmon, winter-run steelhead trout, and Pacific lamprey. All these species are native to Deer Creek. Spawning winter-run chinook salmon, pink salmon, chum salmon, and sockeye salmon have been observed rarely in Deer Creek and are considered strays when they occur rather than a specific run; the status of late-fall-run chinook salmon and winter-run chinook salmon is uncertain. Warm water temperatures would limit successful spawning in winter-run chinook salmon and fry from later spawning late-fall-run chinook salmon have a reduced chance of survival due to high temperatures and stranding (Harvey 1997a). However, all runs may occur due to chinook salmon's tendency to use non-natal streams as rearing areas.

Resident native species occurring in Deer Creek include: rainbow trout, hardhead, California roach, riffle sculpin, speckled dace, tule perch, Sacramento squawfish, and Sacramento sucker (Dettman 1977). Native fish species typically decline and introduced species increase in abundance when habitat is disturbed by human activities (e.g., impoundments, stream flow diversions, organic pollution from livestock and sewage, and siltation) (Moyle and Nichols 1973 and 1974). However, Sato *et al.* (1988) found that native fish comprise 95 percent of the fish populations in 86 percent of the Deer Creek drainage ten years ago. Baltz and Moyle (1993) studied Deer Creek and found the native fish assembly to be highly organized and resistant to invasion by introduced species. Consequently, the relatively undisturbed habitat, in terms of both flow regime and physical habitat, in most of Deer Creek supports a high degree of native fish fauna rarely seen today in any of California's diverse aquatic habitats (i.e., estuaries, rivers, streams, springs, lakes, reservoirs, ponds, and canals).

Exotic species known to occur in Deer Creek are brown trout, bluegill, carp, white catfish, smallmouth bass, largemouth bass, and green sunfish; they are typically found near the Deer Creek mouth.

CDFG plants hatchery-reared rainbow trout and brown trout in the Deer Creek Meadow Reach and the Highway 32 Reach to manage a recreational fishery on Deer Creek.

Figure 10-1 shows the fish distribution within the anadromous reaches of Deer Creek. This includes Deer Creek's confluence with the Sacramento River upstream to Upper Deer Creek Falls. The fish species occurring at monitoring stations are listed at each sampling site. Fish sampling equipment used includes beach seine, electroshocking unit, and a rotary screw trap. The primary and secondary spawning habitat for fall- and spring-run chinook salmon illustrates the spatial separation necessary to prevent hybridization between the two runs. The information presented on Figure 10-1 has been compiled from research performed by Dr. Peter Moyle *et al.* (Sato & Moyle 1988) and the California Department of Fish and Game Field Records (IFD Red Bluff).

Deer Creek is important because of its natural production of spring-run chinook salmon. Deer and Mill Creeks produce the most consistent self-sustaining wild populations in the Sacramento River drainage (Vogel 1987). These spring-run chinook salmon are thought to be the only pure strains of spring-run chinook salmon because these creeks allow spatial separation from fall-run chinook salmon that minimizes hybridization. While spring-run chinook salmon in Deer Creek may be pure spring-run chinook salmon, they may not be pure Deer Creek spring-run chinook salmon. Upper Sacramento River spring-run chinook salmon were transplanted into Deer Creek shortly after Shasta Dam was closed. The effects of these exotic spring-run chinook salmon on Deer Creek spring-run chinook salmon is not known. Spring-run chinook salmon from the Feather River, Yuba River, and the upper Sacramento River are thought to be affected by hybridization with fall-run chinook salmon. Vogel (1987) identifies Antelope, Battle, and Big Chico Creeks as other sources of spring-run chinook salmon in some years. Butte Creek also produces spring-run chinook salmon (Reynolds *et al.* 1993). Mill Ck

Deer Creek is also identified along with Mill and Antelope Creeks as having the greatest potential for restoring wild steelhead populations in the entire Central Valley System (McEwan and Jackson 1996).

Another reason for Deer Creek's importance is its apparent relatively good fish habitat quality with at least some stretches of near stream habitat that are near pristine (Roby 1997). Due to the precipitous cliffs along the course of the stream, Deer Creek has an unusual characteristic relative to other California streams of similar size. Some people believe Deer Creek to be in an almost pristine condition (Sato *et al.* n.d.), while others (as a whole) do not think Deer Creek Watershed is pristine (Roby 1997). Deer Creek has had limited public use because of steep cliffs, private property, and its distance from major metropolitan areas. Except for 10 miles (17 kilometers) that parallel Highway 32, Deer Creek has only four road crossings, two in the canyon area, and two in the valley. It has hiking areas in the Ishi Wilderness Reaches; however, the trails offer only limited access to the creek. Access to some of the creek's tributaries is by way of undeveloped private lumber company and national forest roads (Sato *et al.* n.d.).

Most (53%) of Deer Creek is owned by the Lassen National Forest, one percent is owned by the Bureau of Land Management, and 46 percent by private individuals and organizations, including Pacific Gas and Electric Company for corridors beneath their power lines. The major uses of the surrounding land are timber and range for cattle (Sato *et al.* n.d.).

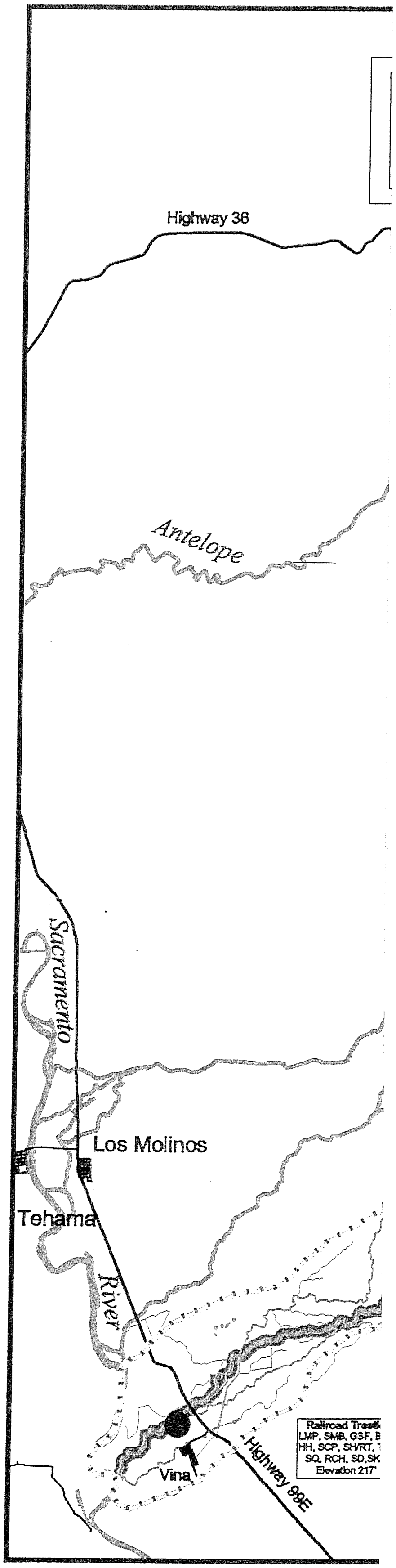
Deer Creek is one of the few streams in California that is not altered by a major storage dam. The decline in fall-run chinook salmon numbers in Deer Creek was attributed primarily to the irrigation diversions (Fry 1961). There are no minimum flow requirements for these diversions. Rich *et al.* (1944) recommended a minimum flow of 50 cfs. However, they did not elaborate how this flow level recommendation was determined. If the shortage of instream flows in critical months can be overcome, then the potential to rebuild the fall-run chinook salmon population is relatively high (Hayes and Lindquist 1967). A proposed water transfer project is under development to address this concern. Under this proposed project, water from other sources (e.g., groundwater) will be found to replace Deer Creek water that would otherwise be diverted. Reynolds *et al.* (1993) asserts that the gravel is lightly armored and USFWS (1995) claims the amount and condition of this gravel is insufficient to double the existing populations. However, they provide no evidence to support their assertions.

While other drainages lose many juvenile migrating fish to water diversions, entrainment of juvenile chinook salmon or steelhead in Deer Creek is assumed to be low because the three water diversions from Deer Creek have fish screens that comply with CDFG fish screen design criteria. These screens are operated, maintained, and monitored by CDFG.

Large private landowners along the stream have limited public access to Deer Creek. With few exceptions, land use practices of landowners have remained unchanged in terms of kind and level of activity for many years. It is inferred from this condition that Deer Creek aquatic habitat for anadromous salmonids has also remained unaffected by land use activity upstream of the Valley Floor Reach. However, documentation of existing habitat conditions is needed to demonstrate this inference.

The January 1997 flood, which was at least a 25-year event, may have altered habitat conditions in Deer Creek. Under normal circumstances, this kind of episodic disturbance is normal and provides necessary changes needed to improve the long-term health of the stream.

If an ecosystem disturbance is sufficiently high, the elasticity of an ecosystem is compromised and will not continue to function similarly to pre-disturbance conditions. Such an event would be catastrophic. The trend of declining anadromous salmonid stocks may be a symptom of such an



Highway 36
Antelope
Sacramento
Los Molinos
Tehama
River
Vina
Highway 99E
Elevation 217'

ecological disturbance. A detailed discussion of ecosystem disturbance is found in Resh *et al.* 1988.

CDFG's (Harvey 1997) best available data indicates that recent (last 20 years) spring- and fall-run chinook salmon and steelhead adults returns have been consistently lower (less than 2,000 for spring-run, about 500 for fall-run, several hundred for steelhead) than historical (1940 to 1975) levels. Historically, there were 2,000 to 4,000 for spring-run, as much as 12,000 for fall-run and 1,000 for steelhead (Figure 10-2). It is not known whether these lower adult returns are the result of changing conditions within Deer Creek, or from conditions in the Sacramento River stem, in the Delta, or in the ocean. Habitat quality of Deer Creek is only one component of anadromous fish habitat. Habitat conditions and activities that alter those conditions in the delta and the ocean must also be considered simultaneously. If Ecological Significant Unit (ESU) refuges for rare, threatened, or endangered species must include all of the different and necessary habitats for each life stage (Li *et al.* 1995), then they should also be included for the adequate management of any anadromous fish.

FISH SPECIES ACCOUNTS

There are three different kinds of fish living in Deer Creek: anadromous, resident, and exotic species. The species accounts describe not only pertinent information of these fish within Deer Creek, but also additional information of what may affect them outside Deer Creek.

Native Anadromous Fish

Anadromous fish emigrate to the ocean or estuary early in their life, typically grow to large size in the ocean or estuary, and return inland as adults to spawn in freshwater streams and rivers.

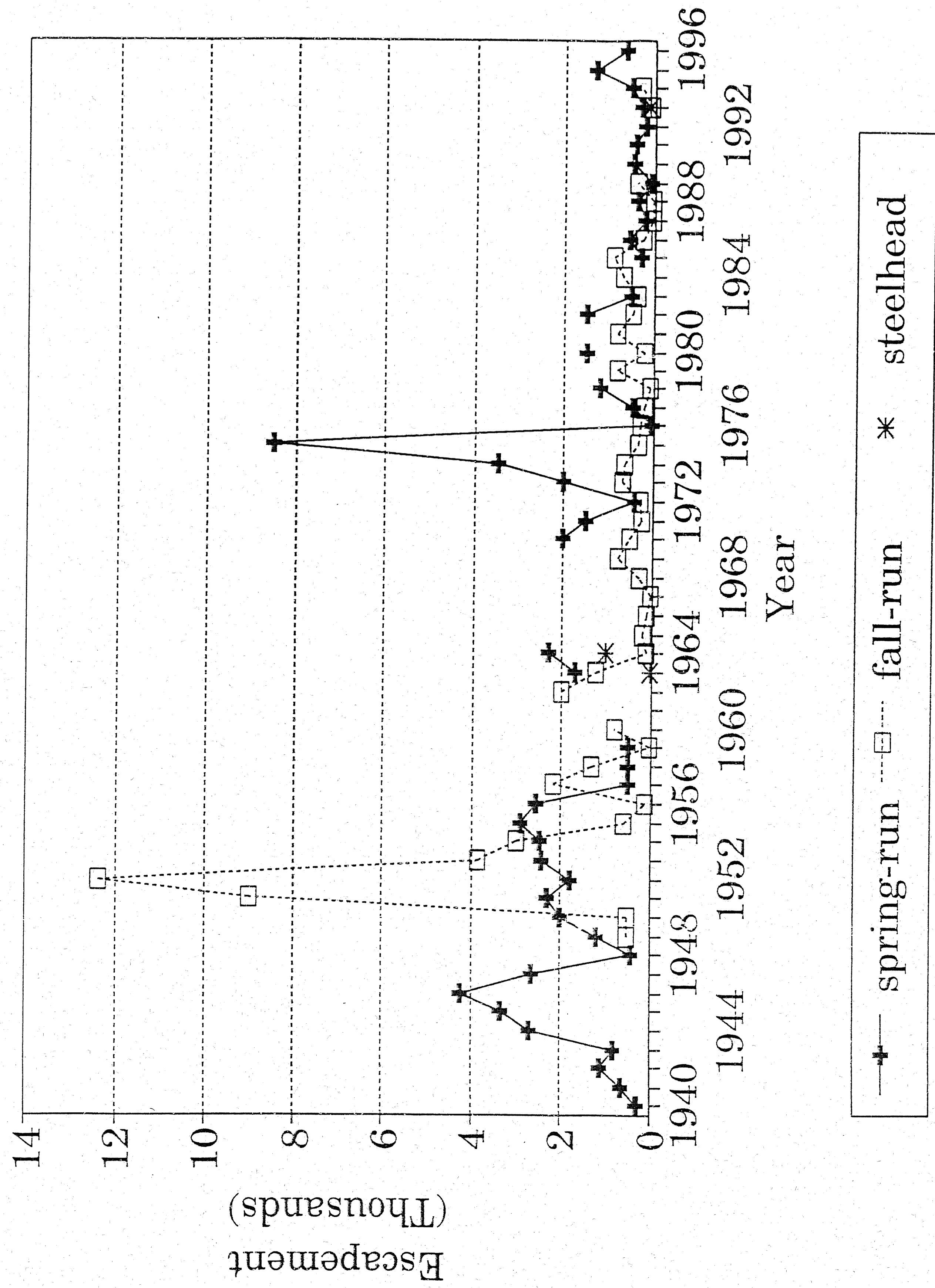
Salmonid anadromy has occurred only when food resources in the ocean exceed those in freshwater (Gross 1987). The larger size of the adult salmon or steelhead is a reflection of this rearing potential (Pearcy 1992). The larger size of the female also increases her fecundity because number of eggs is directly related to the female's size.

Chinook salmon and steelhead are anadromous game fish using the Sacramento River and its tributaries in the California's Great Central Valley. The habitat requirements of salmon and other anadromous fish in the freshwater environment vary by lifestage, season, species, and race.

The general life history of all the runs of chinook salmon is presented before run-specific information is presented. Site specific information on Deer Creek is presented in the sections under each run.

Chinook salmon is an anadromous species. Four distinct races of chinook salmon spawn in the upper Sacramento River and its tributaries. They are named for the season during which the majority of the run enters freshwater as adults. The timing of the immigration run is not the only feature that made each race distinct. Each chinook salmon race spawned in different portions of

Figure 10-2. Anadromous Salmonids, Deer Creek Run Strength



the watershed. Fall-run chinook salmon usually spawn within a few weeks of their arrival to spawning grounds in the low gradient sections of the river in the fall. Late-fall-run chinook salmon immigrate at the same time as fall-run chinook salmon, but hold in the river and delay their spawning until winter. Late-fall-run chinook salmon spawn in mid-elevation regions of the watershed. Winter-run chinook salmon enter the river during the winter and wait until early the following summer in the headwaters of a volcanic watershed to spawn. Spring-run chinook salmon immigrate in the spring and spend the summer in deep, cool pools of the headwaters, and spawn in the upper elevations early in the fall. Given this diversity in life history timing of immigration, spawning, and hence, incubation, emergence, rearing, and emigration, chinook salmon may be found in the Sacramento River at any time of year.

Chinook salmon life history is closely associated with hydrology and water quality. Timing of immigration of adults, spawning, and emigration of juveniles and smolts is also affected by local events that include: photo-period or water temperature (environmental trigger, or a water quality factor), rearing conditions (rapid growth accelerates emigration), or seasonal storms sometimes called spates (facilitates emigration). While timing of life history stages between races of chinook salmon are distinct, timing of life history events within a race may differ. For instance, there may be as much as a month difference in timing of life stage periodicity within the same chinook salmon race in different streams because of the variation in latitude in California and the consequent differences in water temperature (Frank Fisher pers. comm.). Since spates do not occur consistently, differences in timing also vary from year to year. Consequently, life history timing tables can only be general guides because local water temperature, habitat quality, or hydrologic events can either accelerate or postpone fish movement and these factors can change from year to year even on the same stream.

The precision of the information on timing of life history stages in different streams depends upon the quality of data. Some races of chinook salmon have more information than others. Most detailed information is available only for fall-run chinook salmon emigrants because CDFG has historically focused attention (i.e., sampling) on the spring emigration of this race almost to the exclusion of the others (Frank Fisher pers. comm.). Some streams have more information than others do, for instance, more is known about timing of life history of fall-run chinook salmon inhabiting the upper Sacramento River because there have been more large water manipulation projects proposed, and consequently, more investigations have been performed.

Chinook salmon spawning typically occurs in swift, relatively shallow riffles or along edges of fast runs where there is an abundance of loose gravel. Chinook salmon require clean, loose gravel that will remain stable from embryo incubation through alevin (larvae with yolk sac and still residing within the gravel) emergence for successful reproduction. The territory required for pre-spawning (nuptial) activity is between 200 and 650 square feet, but this varies widely according to population density. The average size chinook salmon redd is 165 square feet. The minimum spawning area for a chinook salmon female is between 75 and 100 square feet. This may vary with the size of the female. The female digs a spawning redd in the gravels and deposits her eggs in several egg pockets. The eggs are fertilized by the male and buried in the gravel by the female. The adults die within a few days after spawning. An average female chinook salmon produces 3,000 to 6,000 eggs depending on the size and race of fish (Reynolds *et al.* 1993).

Chinook salmon select spawning areas within a narrow range of water velocity and stream depth. Water velocity is more important than depth for determining the hydraulic suitability of a spawning site. The water velocity determines the amount of water that will pass over the incubating embryos. Sufficient water must percolate through the gravel to supply oxygen and remove metabolic wastes from the developing embryos or alevins. In general, optimal water velocity for chinook salmon spawning is 1.5 feet per second (fps). However, water velocities from 1.0 to 3.5 fps have been observed. Larger females tend to spawn is faster water. Central Valley chinook salmon typically spawn at depths ranging from one to five feet, however, there have been some chinook salmon observed to spawn in 20 feet of water. A stream depth less than six inches can be physically prohibitive to spawning. Central Valley salmon probably exhibit differences in preferred depths for spawning based upon their race and the size of their natal watershed (Reynolds *et al.* 1993).

Substrate composition is another critical factor in spawning suitability. It is vitally important that spawning gravels percolate to deliver fresh oxygen to the embryos and alevins, and to remove accumulated metabolic wastes within the redd. Generally, fine sediment reduces interstitial percolation. Adequate substrate composition have low proportions of sand and fine sediment less than about 0.8 mm in median dimension (fines) so that the gravel will allow adequate percolation for successful incubation of embryos within the gravels and emergence of alevins from the gravels. Fines should generally be no higher than five percent after the female has built the redd. Redds with higher proportions of fines have reduced hatching success and fry emergence (Bjornn *et al.* 1977). Researchers have used percentage of fine sediment in gravel as an index of gravel percolation. However, such an index must be used with care. For instance, Stacy Li found total failure of chinook salmon redds with less than 3 percent fine sediment on the Tucannon River in Washington State. The sediment was fine Palouse loessial soil and was effective in reducing intra-gravel water exchange to near zero (Kelley 1980). Generally, the substrate chosen by female chinook salmon for spawning is composed mostly of gravels from 0.75 to as large as 6.0 inches in median dimension with smaller percentages of coarser and finer materials. Some believe that chinook salmon use larger substrate (Reiser and Bjornn 1979). Larger females in faster currents have been known to use larger. Sub-optimal substrates reduce the reproductive success with higher embryo mortality and reduced alevin emergence. Gravels are unsatisfactory when they are cemented with clays or other fines, when fine sediments deposit and smother either the incubating embryos or alevins, or when the substrate is crushed (Reynolds *et al.* 1993, Chevalier *et al.* 1984).

Successful chinook salmon immigration and spawning requires well-oxygenated cool water. Migrating and holding adults prefer water temperatures less than 60°F, however acceptable temperatures for upstream migration range from 57°F to 67°F. The preferred stream temperature for chinook salmon spawning is generally 52°F with lower and upper threshold temperatures of 42°F and 56°F. Stream temperatures beyond this range result in reduced viability of incubating embryos or increased mortality of developing alevins and fry (Reynolds *et al.* 1993).

Chinook salmon embryo, alevin, and fry development is stream temperature dependent. The embryo life stage is more sensitive to water temperature stress than any other chinook salmon life stage. Half the embryos die at temperatures colder than 37.4°F (Beacham and Murray 1990), but some embryos can tolerate temperatures as cold as 35°F if the embryos have developed beyond 128-cell stage (Boles 1988). However, Beacham and Murray (1990) found that there is total embryo mortality at 35°F. Lowest embryo mortality (i.e., a background mortality that is typically about 5 percent in the Sacramento River) was within the range of 53°F to 57.5°F during incubation (Boles 1988). Beacham and Murray (1990) found that half the embryos die at stream temperature in excess of 57.5°F with total mortality occurring at 62°F. Differences between Boles (1988) and Beacham and Murray (1990) may reflect either different thermal tolerances between Canadian chinook salmon that Beacham and Murray studied and California chinook salmon that Boles reviewed, or the abrupt nature of chinook salmon suitability for thermal tolerance. Embryos usually hatch within 40 to 60 days. When embryos become alevins, their tolerance for both colder and warmer stream temperatures increases (Frank Fisher, pers. comm.). Only 10 percent of the alevins die at temperatures as low as 35.6°F (Beacham and Murray 1990). Alevins usually remain in the gravel for an additional four to six weeks until the yolk sac is completely absorbed; they then emerge from the gravel as fry. The rate of embryo and alevin development is faster at higher temperatures, but oxygen requirements also increase with increasing stream temperatures while dissolved oxygen concentrations decrease with increasing temperature at the same time. Fingerling chinook salmon have a preferred range of 53.6°F to 57.2°F, with maximum growth occurring at 55°F (Boles 1988). The upper lethal temperature for chronic exposure to chinook salmon in the Sacramento River is 78.5°F, although higher temperatures can be tolerated for brief periods (Boles 1988).

In addition to instantaneous mortality, there are latent effects of exposing any life stage beyond their ranges of thermal tolerance. Adverse effects from high or low temperatures on adults holding or embryo and alevin incubating within the gravels may not become apparent until after the embryo stage of development. Boles (1988) noted that chinook salmon eggs, taken from adults holding at high stream temperatures but apparently successfully incubated at lower temperatures, have produced fry that eventually succumb despite being reared at apparently optimal temperatures. Boles also noted that coagulated yolks were found in many of the fry that succumbed due to high egg incubation temperatures. The greatest mortality of fry from early incubation of eggs at unfavorably high temperatures occurs during the transition period from complete yolk absorption to active feeding due to some physiological problem. Other sources of mortality during the intra-gravel incubation period of chinook salmon include disease, redd exposure to air, physical disturbance, and water-borne contaminants (NMFS 1993).

Chinook salmon embryos of all races require approximately 750 degree-days to hatch. They also need an additional 675 degree-days for alevins to reabsorb its yolk sac and emerge as "buttoned up" fry from the gravel. A degree-day, also known as a thermal unit, is one degree (°F) the stream water is above freezing (32°F) for 24 hours. Degree-days are computed by multiplying the incubation temperature (°F-32°F) by the number of elapsed 24-hour periods. Therefore, the total time from spawning through emergence at 50°F is 79 days. However, These degree-days data were developed in the Pacific Northwest and may be biased toward higher latitude populations of the Pacific Northwest. Harvey (1994) found that emergence in Deer Creek is sometimes later than expected when back-calculated from peak of spawning. Therefore, number of degree-days for necessary for hatching and fry emergence may be higher.

Because the four different chinook salmon runs spawn at distinct times, fry emerge at different times, it is theoretically possible to discriminate different races of juvenile chinook salmon based upon differences in size upstream of the delta (Fisher 1992). However, this assumes that growth rates of the different races of juvenile chinook salmon are equal. Maslin *et al.* (1997) claim that juvenile chinook salmon that use non-natal streams to rear increase their growth rates in intermittent streams. The reason for the increase in growth was not explained. It may be attributable to more favorable water temperatures or higher food supplies. A thorough examination of growth rates of juvenile chinook salmon throughout the Sacramento Basin and the level of use of non-natal streams is needed to determine the significance of use of non-natal streams by juvenile chinook salmon as rearing habitat. Important factors that need to be determined are what triggers this behavior, what makes the juvenile salmonids stay and leave, and how long do they typically use these habitats. Another aspect to consider is which non-natal stream makes better rearing habitat, small intermittent streams (e.g., Mud Creek) or larger tributaries (e.g., Deer Creek)? In addition, other anadromous species may also use this strategy.

Chinook salmon fry typically attempt to hold position in the water column and feed mostly on drifting aquatic invertebrates in low velocity water or in eddies. Fry move into stations with higher stream velocities as they grow larger.

The fry of different races emigrate at different ages. Fall-run chinook salmon fry can begin emigrating to the estuary soon after emerging from the gravel. Most late-fall-run, winter-run, and spring-run chinook salmon fry spend a year rearing in freshwater prior to emigrating. However, there may be episodic organized movements downstream during the year. Timing of emigration also varies for each salmon race. Fall-run fry chinook salmon emigrate January through June, late-fall-run chinook salmon fry emigrate from April through mid-October, and the yearlings leave for the sea from November through January. Winter-run chinook salmon emigrate July through March at Red Bluff Diversion Dam (RBDD) and September through June in the delta. Spring-run chinook salmon fry begin moving downstream from late November through April and yearlings have significant movement from September through December.

Chinook salmon generally reach full maturity at three to four years of age. However, some two-year-old males ("jacks" or "grilse") become sexually mature, and other chinook salmon are as old as seven years. Clark (1929, cited in Hanson *et al.* 1940) concluded that 50 percent of the Sacramento-San Joaquin chinook salmon mature at four years, and the age of maturity in decreasing order of abundance was four years, five years, three years, six years, and two years. Ocean harvest has probably changed the age structure of chinook salmon. Commercial fisheries continually remove larger and older individuals, leaving mostly three year-old fish to return to spawn. It is inferred that run resiliency may be adversely affected in at least the spring-run and late-fall-run chinook salmon (Moyle *et al.* 1994). All Pacific salmon die after spawning.

The abundance of chinook salmon has been declining. Prior to 1915, the peak chinook salmon runs in the Sacramento River may have been as large as 800,000 to one million spawners, with an average run size of 600,000 (Reynolds *et al.* 1990). During the period of 1976 through 1985, the average annual run of all races of chinook salmon in the upper Sacramento River and its tributaries has been 233,888 (Reynolds *et al.* 1990).

Fall-run Chinook Salmon. Adult fall-run chinook salmon migrate upstream into freshwater from July through December and spawn from early October through late December (Reynolds *et al.* 1993). Migration activity increases with seasonal rainstorms. Fall-run chinook salmon spawn in the low gradient portions of Central Valley streams (e.g., the main stem Sacramento River, Feather, Yuba, Bear, American, Cosumnes, Mokelumne, Stanislaus, Tuolumne, and Merced Rivers, and Mill and Deer Creeks). Peak spawning occurs in October and November, although the timing of runs varies from stream to stream (Reynolds *et al.* 1993). Embryo incubation occurs from October through March, and juvenile rearing and smolt emigration occurs from January through June (Mills and Fisher 1994). Timing of emigration varies with water year, juveniles emigrate past RBDD during winter in normal precipitation years, but delay until spring in dry years (Johnson *et al.* 1992). Unlike the other chinook salmon races, the majority of young fall-run chinook salmon emigrate to the ocean during the first few months following fry emergence from the spawning gravels (i.e., they smolt on the run) (Dr. Hiram W. Li pers. comm.). However, a small number of juveniles may remain in fresh water and migrate as yearlings, although this phenomenon is not currently observed in the Sacramento River System (Paul Ward, pers. comm.).

Fall-run chinook salmon migrate upstream into Deer Creek during the late-fall (late October through early December) after the first autumn rains have increased stream flow. Fall-run chinook salmon spawn during this period in the lower reaches of Deer Creek; the bulk of the run spawns in the Valley Floor Reach, and only a few migrate a short distance into the Lower Canyon Reach (Hayes and Lindquist 1967; Jones and Stokes 1994). It appears that the upstream limit of fall-run chinook salmon migration into Deer Creek is near Moak Cave (Colleen Harvey pers. comm.). When lower-than-usual flows are present, the fall-run is limited generally to that section of the stream downstream of Stanford-Vina Irrigation Dam (Cramer and Hammack 1952). These downstream areas may have been altered by the January 1997 flood.

Field inspections after the new years flood of 1997 by Mike Kossow and Stacy Li, and Matt Kondolf and Stacy Li noted that riffles in the Valley Floor Reach consisted of small boulder and large cobble. Terry Healy (per. comm.) has observed that the fall-run chinook salmon do spawn in this large substrate.

After hatching in December through March, the fry rear for only a few months and emigrate to the ocean primarily during April through June. It is not known where emigrating fry go or how long they stay after they leave Deer Creek and prior to entering the ocean.

Fall-run chinook salmon fry emerge during the same time period and are of similar size as spring-run chinook salmon fry (Harvey 1994), making determination of peak timing of emigration for these two races difficult.

Natural (i.e., excluding hatchery stocks) fall-run chinook salmon, as are all chinook salmon, are declining in abundance. They are also presently the most abundant of the races of chinook salmon. Much of the area where fall-run chinook salmon spawned historically is downstream of the major dam sites. Therefore, this race was not as severely affected by early water manipulation projects as were the spring-run and winter-run chinook salmon that spawned historically further upstream of the major dams.

Beginning in 1950, complete data on the distribution of fall-run chinook salmon spawners became available for the Sacramento River System. A peak value of 403,000 fish was observed in 1953, which was considered the highest escapement during the 1939 to 1969 period (Reynolds *et al.* 1993). Sacramento River fall-run chinook salmon abundance ranged from 92,442 to 256,817 from 1967 to 1991 with a 25 year average of 176,092 (Mills and Fisher 1994).

Historically, Deer Creek probably supported fairly large numbers of fall-run chinook salmon (Hayes and Lindquist 1967). In 1952, DFG estimated that 12,000 fall-run chinook spawned in Deer Creek (Fry 1961). Thereafter, the fall-run population in Deer Creek exhibited a downward trend, fluctuating between 16 and 820 since 1964 with an average at about 650 (Harvey 1997b). However, the spawning escapement during 1953-1968 was still the fourteenth highest for all Central Valley streams (Fry and Petrovich 1970).

Late-fall-run Chinook Salmon. Late fall-run chinook salmon are proposed as a State species of special concern (Moyle *et al.* 1995). Late-fall-run chinook salmon are a recent addition to chinook salmon stock inventory in the Central Valley because it has been only since the construction of RBDD, the fish ladders, and the trap that has made counting and separation of this chinook salmon race possible. Therefore, life history information is limited because of relative lack of time and effort.

Late-fall-run chinook salmon probably were more widely distributed historically, but have been restricted by anthropogenic habitat alteration, mostly dams. Dr. Peter Moyle (pers. comm.) believes that the late-fall-run chinook salmon historically spawned in the middle elevation reaches (or sufficiently high in the watershed to receive adequate cold water) of the little Sacramento, McCloud, and Pit Rivers, and Battle Creek. They probably spawn in the middle elevation reaches of the San Joaquin River and other San Joaquin westside Sierra drainages. However, Harvey (1997a) considers them to spawn at lower gradients rather than at mid-elevation since the closure of Shasta Dam.

Presently, late-fall-run chinook salmon are found mainly in the Sacramento River, and most spawning and rearing of juveniles takes place in the reach between Red Bluff and Redding (Keswick Dam). According to Vogel and Marine (1991), however, approximately 15-30 percent of the late-fall-run can spawn downstream of Red Bluff when water quality is good. Late-fall run chinook salmon have apparently spawned in Battle, Cottonwood, Clear, and Mill Creeks and the Yuba and Feather Rivers, but these are a small fraction of the total spawners (R. Painter cited in Moyle *et al.* 1994). Late-fall-run chinook salmon are thought to occur in Deer Creek (Reynolds *et al.* 1993).

Adult late-fall-run chinook salmon immigrate into the river system from mid-October through mid-April. Their migration occurs at the same time as the fall-run chinook salmon, but they hold in the river and delay spawning. They begin spawning in January and continue to spawn through mid-April. Embryo incubation occurs from January through June (Moyle *et al.* 1994). Rearing and emigration of fry and smolts occurs from April through mid-October (Mills and Fisher 1994). Juvenile late-fall-run chinook salmon rear in freshwater for a year prior to emigrating and smolting. Significant emigration of naturally produced juvenile late-fall-run chinook salmon occurs through November and perhaps into January. Hatchery late-fall-run juveniles emigrate well into February.

Most late-fall-run chinook salmon appear to spawn in the mainstem Sacramento River (Richard Painter pers. comm. in Moyle *et al.* 1995), but they have been noted in nearby Central Valley eastside tributary streams (Big Chico and Butte Creeks). Marcotte (1982) identified small numbers of late-fall-run salmon in lower Deer Creek. Occasionally, late-fall-run chinook salmon have been observed spawning in Deer Creek (Reynolds *et al.* 1993). It is unknown whether a self-sustaining population of late-fall-run chinook salmon occurs in Deer Creek because spawning stock surveys are not conducted for late-fall-run chinook salmon in Deer Creek (Colleen Harvey pers. comm.). Since they tend to be larger than fall-run chinook salmon, late-fall-run chinook salmon would be expected to either spawn in the Upper Valley or Lower Canyon Reaches of Deer Creek, or perhaps begin spawning downstream of fall-run chinook salmon (Colleen Harvey pers comm.). Their larger size may also make them more sensitive to passage barriers due to low stream flow levels during migration (Colleen Harvey pers. comm.). Condition of spawning areas would have to be assessed and the quantity and quality of holding pools would have to be surveyed to determine potential of Deer Creek as late-fall-run chinook salmon habitat.

Sacramento River late-fall-run chinook salmon abundance ranged from 1,141 to 37,208 from 1967 to 1991 with a 25 year average of 14,159 (Mills and Fisher 1994). There are no run estimates from Deer Creek.

The Recovery Plan for Sacramento-San Joaquin Native Fishes (Moyle *et al.* 1994) identifies as the reasons for the late-fall-run chinook salmon decline: 1) passage problems over dams; 2) loss of habitat; 3) poor survival of emigrating smolts; 4) excessive harvest; and 5) other factors disease and pollutants.

Late-fall-run chinook salmon have been affected by passage problems over dams. When Shasta and Keswick Dams were built in the 1940s, access was denied to late-fall-run chinook salmon to upstream spawning areas where run-off and spring water originating from Mt. Shasta and other areas kept water temperatures cool enough for successful spawning, egg incubation, and summer survival of juvenile salmon. The effects of RBDD were most subtle and were only recently recognized. This dam delayed adult passage to upstream spawning areas and also concentrated predators, increasing mortality on emigrating smolts.

Rearing habitat degradation reduced the abundance of late-fall-run chinook salmon. Extensive bank alteration, especially rip-rapping, reduces the amount of cover available to protect the emigrants from striped bass and other predators. Levee construction and dredging in the delta has reduced marsh, floodable and shallow habitat used by migrants and contributes to mortality.

Harvest of late-fall-run chinook salmon contributed to decreased abundance. Returns from coded wire tags reveal that sport ocean harvest is intense. Available data indicate that harvest is as high as 80 percent. Commercial fisheries may also affect late-fall-run chinook salmon populations through continual cropping of larger and older individuals. This resulted in spawning runs composed of smaller, three and four year old fish, which produce fewer eggs per female. The removal of older fish through harvesting also decreases the resilience natural populations have against disasters. Because older fish return later to spawn than most of their cohorts, so they can supplement year classes that have poor returns (Moyle *et al.* 1994).

Winter-run Chinook Salmon. Winter-run chinook salmon is a Federally listed endangered (Federal Register 440, January 4, 1994) and a State-listed endangered species due to declining numbers since 1970. It is a unique race of chinook salmon; there is no other analogous race in any other chinook salmon river system (Healey 1991). Perhaps that is due to the unusual spring and volcanic hydrology of the historical habitat of the winter-run chinook salmon. These northeastern California streams have numerous springs and stored large amounts of groundwater because of the porous nature of the volcanic soils and consequently had stream flow levels that were almost constant and stream temperatures that were near groundwater temperatures the year around.

Adult winter-run chinook salmon begin to immigrate into the river system by passing under the Golden Gate Bridge from November through May and pass the RBDD from December through early August. Adult winter-run chinook salmon first appear in the Sacramento River near Red Bluff during December (Vogel and Marine 1991). They continue to pass Red Bluff through May with a peak in March (Hallock and Fisher 1985). Timing may vary with river flow, water year type, and operation of RBDD (NMFS 1993). Winter-run chinook salmon typically spend a relatively long time holding in the river before spawning, making eggs within the female more susceptible to high stream temperatures (Hallock and Fisher 1985). Due to lack of fish passage facilities at Keswick Dam, adult winter-run chinook salmon tend to migrate to and hold in deep pools between RBDD and Keswick Dam before initiating spawning activities (NMFS 1993). They generally spawn from mid-April through August, with a peak in spawning activity in June (Vogel and Marine 1991). Embryo incubation and subsequent fry emergence occurs from mid-April through mid-October (NMFS 1993). River rearing of winter-run chinook salmon juveniles begins at the end of July and continues through May of the following year (Hallock and Fisher 1985).

Historically, Sacramento River winter-run salmon spawned from April through August in the upper reaches of tributaries including the McCloud, Pit, and Little Sacramento Rivers, and Battle Creek. The completion of Shasta and Keswick Dams in the early 1940s denied the winter-run chinook salmon access to the upper Sacramento tributary streams. Presently, the vast majority of Sacramento River winter-run chinook salmon spawn in the main stem from the Redding area downstream at least as far as Tehama. They spawn in greatest numbers upstream of Red Bluff. Although the winter-run chinook salmon spawns primarily in the main stem of the Sacramento River, they have also spawned in small numbers in tributary streams including Battle and Mill Creeks as well as in the Calaveras River, a tributary to the lower San Joaquin River (Hallock and Fisher 1985). The eastside investigation (Hayes and Lindquist 1967) states that a few winter-run chinook salmon also spawn in Deer Creek with little or no success. A few winter-run were reported to spawn in Deer Creek in the early 1960s, but high water temperatures likely precluded successful spawning during early summer (Hayes and Lindquist 1967). These observations were made when winter-run populations were quite large, and some straying would have been likely. Winter-run chinook salmon, therefore, should not be considered to be a species spawning in Deer Creek.

Emigration of fry and smolts occurs from July through March at the RBDD and from September through June in the delta. Many winter-run chinook salmon fry emigrate almost immediately upon emergence, but substantial numbers rear in the upper Sacramento River for several months. It may be that these juveniles are waiting winter rains to begin emigration (NMFS 1993). USFWS and CDFG have observed *en masse* migration pulses in association with storm events. These episodic events change timing of movement.

While winter-run chinook salmon do not spawn in Deer Creek, they may occur in Deer Creek. Some juvenile chinook salmon will use streams where they were not born to rear. This is not an uncommon phenomenon. There are observations from the Taku River in Alaska (Murphey *et al.* 1989), from the Fraser River, British Columbia (Murray and Rosenau 1989), and from Columbia River tributaries (Reimers and Loeffel 1967). Winter-run chinook salmon juveniles also rear in non-natal streams as they emigrate downstream. It is not known how far upstream these juvenile might migrate, but Maslin and McKenney (1994) found winter-run sized juveniles far upstream in several tributaries (Mud and Rock Creeks) of the Sacramento River near Chico. Marked winter-run chinook salmon from Coleman National Hatchery have also been recovered in the Sutter Bypass and at Nimbus Hatchery on the lower American River (Deborah McKee pers. comm.). Nimbus Hatchery is more than 20 miles upstream of the Sacramento River. It is not known whether these winter-run chinook salmon juveniles use all the tributaries to rear because there has been no effort to document how widespread is this phenomenon.

The winter-run chinook salmon run may have exceeded 200,000 spawners historically (NMFS 1993). Sacramento River winter-run chinook salmon abundance ranged from 191 to 117,808 from 1967 to 1991 with a 25 year average of 23,109 (Mills and Fisher 1994).

Hallock and Fisher (1985) identify the following factors that have contributed to the decline of the post-Shasta Dam winter-run chinook salmon: 1) drought, 2) the Red Bluff Diversion Dam, 3) river temperature downstream of Red Bluff, 4) juvenile salmon mortality, and 5) harvest. Deborah McKee (pers. comm.) also identifies pollution and degradation of juvenile rearing habitat as other factors that have contributed to the winter-run's decline.

Drought has reduced winter-run chinook salmon abundance. Two-year classes of winter-run were lost due to drought conditions in 1976-1977. Year classes have failed to recover in subsequent generations. In addition, the strong year class of 1981 failed to return well in 1984, and at present no dominant year class exists. Low fecundity would contribute to the difficulty of recovering from any particular disaster.

All adult chinook salmon are delayed from upstream migration by RBDD. The delay is directly related to flow level. Delays ranged from one day to 40 days at flows between 4,000 and 16,000 cfs. Average monthly flow of the Sacramento River at Red Bluff between January-May from 1967 through 1983 ranged from 12,743 cfs to a high of 23,535 cfs. Delays reduce reproductive success because migrating adults do not feed but must subsist by catabolizing their body tissues. There have been recent changes in RBDD operations to mitigate for these effects. RBDD gates are closed from May 15 - September 15 a period that affects approximately 15 percent of the winter-run chinook salmon and open the remainder of the year (Harvey 1997a).

During most years, winter-run salmon are not able to spawn successfully downstream of Red Bluff due to high water temperatures. Water temperatures are determined by releases from upstream dams and limnological dynamics within the reservoirs.

Any ocean harvest of winter-run chinook salmon is significant because there are so few of this race remaining that any wild fish caught will affect the population.
Habitat degradation also affects winter-run chinook salmon populations (Hallock and Fisher 1985). They noted the following factors in habitat degradation. There is a loss of spawning habitat upstream of Shasta and Keswick Dams because of lack of fish passage facilities and the inundation by the reservoirs of the spawning and rearing areas. There is a lack of gravel recruitment due sediment trapping behind dams. This lack is exacerbated by gravel mining activities. The remaining spawning gravel tends to be armored due to controlled flows from the reservoirs and the subsequent reduction of necessary flushing flows. Rip rapping the banks for flood control purposes removes riparian habitat that changes water table relationships and reduces shading on the river. Rip rapping also degrades rearing habitat and increases predation on salmon juveniles.

Spring-run Chinook Salmon. California supports the southern-most runs of spring-run chinook salmon on the Pacific coast of North America (Gerstung 1990). Adult spring-run chinook salmon immigrate into freshwater from late March through September. They generally ascend their natal streams during spring snow melt run-off and spend the summer in deep pools with suitable water quality. Spring-run chinook salmon spawn from mid-August through late October with a peak in September. Embryo incubation occurs from mid-August through mid-March and rearing and emigration of fry and smolts beginning in late November and continuing through April. A significant migration of yearlings from upper tributary watersheds also occurs from September through December (Moyle *et al.* 1994).

Deer Creek is an important spring-run chinook salmon streams in the Central Valley. Mill, Butte, and Battle Creeks are other important spring-run chinook salmon streams. These streams have self-sustaining wild populations of spring-run chinook salmon, but Deer Creek populations have been historically more numerous (Vogel 1987).

Generally, adult spring-run chinook salmon with immature gonads immigrate into freshwater from late March through September in California. The pattern of spring-run chinook salmon migration up the Sacramento tributaries is in a south to north sequence (i.e., Butte Creek then Big Chico Creek) followed by Deer and Mill Creeks (Colleen Harvey per. comm.). This pattern may be due solely to location since the migrating adults would encounter the tributaries in that order. However, there may be additional factors (e.g., water temperature) that may modify migration patterns. For instance, Mill Creek's water temperature is colder than Deer Creek's because its snow pack is at a higher elevation and consequently peak of snowmelt run-off occurs later. This may have some affect on the timing of upstream migration. The adult spring-run chinook salmon migration in Deer Creek generally begins two weeks sooner, peaks earlier (April or May), and usually ends about 40 days earlier than Mill Creek (McFarland 1997).

Cramer and Hammack (1952) observed salmon migration behavior at a fish ladder in Deer Creek. These behaviors at the fish ladder are probably not limited to association with water use at dams and diversion, but are more widely applicable to upstream migration. They found the following conditions to affect chinook salmon in Deer Creek:

1. After a period of clear weather, a rain sufficient to cause slight discoloration of the water will bring a surge of fish.

2. At the close of a period in which the weather has been clear and the water relatively cool, sudden increases in water temperature to about 75°F will cause an upsurge of fish.

3. After maximum water temperatures approaching 80°F become common, the fish rest in deep pools throughout the day and move upstream only at night.

4. Water temperatures of 81°F to 82°F are lethal to adult chinook salmon.

5. Fingerling salmon in Deer Creek have remained alive in water of a temperature that is lethal to adults.

6. Adult migration counts between 1940 and 1948 ended with the lack of sufficient flow downstream of irrigation diversions for salmon to ascend readily and the onset of high water temperatures.

Adult spring-run chinook salmon migrate up Mill and Deer Creeks from March through July (McFarland 1997) and aggregate in the upper areas in the upper reaches (Airola and Marcotte 1985). Many early arriving adults hold in cool habitats through the summer, where the gonads mature and then spawn in the fall.

Although spring-run chinook salmon in nearby Mill Creek will move long distances between their holding and spawning areas, spring-run chinook salmon in Deer Creek are believed to spawn near where they hold because good spawning habitat occurs throughout their holding areas (Sato and Moyle 1988, Colleen Harvey pers. comm.). A significant portion of Deer Creek spring-run chinook salmon spawn in the tails of pools that is so typical of fall-run chinook salmon; some also spawn in the middle of riffles or runs, often as single redds (McFarland 1997, Roby 1997). This may reflect the character of the spawning substrate in a small steep stream such as Deer Creek.

Deer Creek provides excellent spawning and holding habitat throughout the utilized range, from Dillon Cove in the Lower Canyon Reach upstream to the Upper Deer Creek Falls in the Highway 32 Reach (Colleen Harvey pers. comm.). Most hold and spawn between the Ponderosa Way Bridge and Upper Deer Creek Falls, which apparently is a barrier to migrating fish (Marcotte 1984). While there have been no complete spawning distribution surveys on Deer Creek, Harvey

(1994) found that the highest density of spring-run chinook salmon redds of those areas surveyed in Deer Creek in 1993 was between Upper Deer Creek Falls and Potato Patch Campground. However, there have been no studies to demonstrate that this area is where the highest density of fry is produced.

Unlike most chinook salmon, which migrate to the ocean within a few months after emergence from the gravel, juvenile spring-run chinook salmon in the Sacramento River system are thought to spend a year in fresh water (Healey 1991). The runs in Deer and Mill Creeks, and perhaps Butte Creek, represent the southernmost extant populations in North America that spend this much time in fresh water. Spring-run and fall-run chinook salmon fry emerge at the same time and are the same size. Therefore, some spring-run fry may emigrate as fry and be mistaken for fall-run chinook salmon fry.

There is variability in the age of spawning in spring-run chinook salmon. While most spawn at age 3, some males spawn at age 2, and a significant portion of the cohort spawns at age 4. Recent surveys of spring-run chinook salmon in Deer Creek have not assessed age structure beyond age three (i.e., survey category used age three and older fish rather than age three, age four, etc.). However, spring-run chinook salmon that were tagged with coded wires from 1976 to 1984 broods and returned to the Trinity Hatchery were 11 percent age 2, 54 percent age 3, and 35 percent age 4 (Gerstung 1990). This variability in age of sexual maturation is an important element in chinook salmon life history because it provides resilience to cohort loss (i.e., several cohorts are spawning in any one year).

Critical habitat for spring-run chinook salmon in freshwater is adult holding area. Numbers of adults holding in an area seems to depend upon the volume and depth of pools, amount of cover, proximity to patches to gravel suitable for spawning, and water temperature (Grimes 1983). Typical holding pools for adults were 3 to 9 feet deep with bedrock bottoms and moderate stream velocities. Use by adult spring-run chinook salmon decreased in Deer Creek when pools were shallower than 8 feet. Holding pools usually have a bubble curtain at the head, underwater rocky ledges and shade throughout the day. Salmon will also seek cover in smaller pocket water behind large rocks in fast water. Spring chinook salmon in the Sacramento-San Joaquin System spend the summer holding in pools where temperatures are usually below 69.8°F to 77°F. Sustained temperatures above 80.06°F are lethal to adults (Moyle *et al.* 1994).

Mean water temperatures in pools where adult chinook salmon held during the summer of 1986 in Deer and Mill Creeks were 60.8°F (range: 53.1°F to 64.4°F) and 68°F (range: 64.9°F to 70.0°F), respectively. The temperature ranges for juveniles in Mill Creek were 55.9°F to 72.0°F (Moyle *et al.* 1994). These measurements reflect the geothermal activity in upper Mill Creek that Mill Creek is warmer than Deer Creek during the summer (Roby 1997). In contrast, Mill Creek snowmelt generally peaks later than Deer Creek.

Water temperature in Mill Creek typically declines as it travels downstream (Roby 1997) during the spring and summer. This infers that either geothermal activity in upper Mill Creek elevates water temperature above atmospheric equilibrium conditions and it loses energy and cools as it travels downstream, or there is tremendous lateral accretion from spring contribution or bank seepage to cool Mill Creek. In contrast, Deer Creek warms as it travels downstream (Roby 1997).

Spring-run chinook salmon spawn from mid-August through early October with a peak in September. In Deer and Mill Creeks, spawning occurs from late August through October, although in Deer Creek spawning is generally completed by late September (Peter Moyle unpublished observation). However, CDFG has found spawning spring-run chinook salmon into late October (Harvey 1997a). In 1993, Harvey (1994) found the first spring-run chinook salmon redd on 25 August 1993 and determined an approximate spawning peak on 29 September 1993 between Lower Falls and A-line bridge. Spawning usually begins earlier in the upper reaches of the stream and progresses downstream as water temperatures decrease (Cramer and Hammack 1952). In Deer Creek, preferred mean water velocities measured during 1988 were 60 to 80 cm sec^{-1} (2 f/s - 3 f/s) for adults (Sato and Moyle 1988).

Embryo incubation typically occurs from mid-August through mid-March (Reynolds *et al.* 1993). Harvey (1994) found that incubation began on 25 August 1993 and emergence of fry began in the first week of March 1994 continuing through the second week in June 1994 on Deer Creek.

In Deer Creek, spring-run chinook salmon fry emerge in early March (Harvey 1994). Because of the late emergence time and cold water temperatures that the fry rear in, these juveniles may not reach smolt size by May and June. Instead, they may stay the summer in the cool water of the Deer Creek Canyon. Although juvenile chinook salmon were not observed in summer 1986, they were seen in abundance in 1987 and in past years had occurred in relatively large numbers (Ekman 1987). Therefore, maintaining sufficient amounts of good-quality rearing habitat throughout the summer may be an important factor in perpetuating spring-run chinook salmon in Deer Creek.

Rearing and emigration of fry and smolts begins in late November and continuing through April. Juveniles in Deer Creek were found to prefer runs or riffles with gravel substrates, depths of 8 inches to four feet (20-120 cm), and mean water column velocities of 0.67 feet/second to 1.3 feet/second (20-40 cm sec^{-1}) (Sato and Moyle 1989). By the end of the summer they are three to four inches (8-10 cm) SL (Moyle, unpublished data). Their main food during this period is drifting aquatic insects. In Deer and Mill Creeks, juvenile salmon, during most years, spend 9-10 months in streams, although some may spend as long as 18 months in freshwater (F. Fisher, personal communication). Most of these juveniles seem to move downstream in the first high flows of the winter during November through January, although some may persist through March (Frank Fisher pers. comm.). The peak of downstream movement in Deer Creek between 1942-1948 occurred in February or March, most frequently in March (Cramer and Hammack 1952). A significant migration of yearlings from upper tributary watersheds also occurs from September through December (Reynolds *et al.* 1993 and Moyle *et al.* 1994).

Behavior of emigrating juvenile spring-run chinook salmon after they leave Deer Creek is unknown. It is not known whether smoltification occurs as fingerlings or yearlings or a combination of both, how long smolts reside in the delta prior to ocean entry (Harvey 1994). To begin to assess the significance of this portion of their life history, a tagging and tag monitoring program of emigrating juveniles could be initialed. Tag returns would provide valuable information of where and when they travel and some estimate of their survivorship away from Deer Creek.

Spring- and fall-run chinook salmon spawning overlaps in early October in the main stem Sacramento River and in other places where habitat has been compromised and reduced by dams. It is likely that some spring-run chinook salmon have interbred with fall-run chinook salmon in the main-stem Sacramento River. A pure strain of spring-run chinook salmon may exist in Deer and Mill Creeks where they are geographically separated from the fall-run chinook salmon. However, some spring-run adults were salvaged from Shasta Dam operations and dumped into Deer Creek (Harvey 1997b). It is not known whether the genetics of these fish differed from Deer Creek fish. There may also be pure spring-run chinook salmon in Butte Creek (Paul Ward pers. comm.). Spring-run chinook salmon may also be present in Antelope, Battle, Cottonwood, and Big Chico Creeks, and the Feather River. The Feather River fish may have interbred with fall-run chinook salmon, but the earliest spawning Feather River spring-run chinook salmon are probably true spring-run chinook salmon (Moyle *et al.* 1994).

Sacramento River spring-run chinook salmon abundance ranged from 1,641 to 27,335 from 1967 to 1991 with a 25 year average of 12,990 (Mills and Fisher 1994).

For the past four decades, the average annual adult spring-run chinook salmon population for Deer Creek was nearly 2,800 fish (California Resources Agency 1989). In 1986, the estimated total spring-run chinook salmon population was only 543 adult salmon. This figure represents a decline of more than 80 percent compared to the 1943-1947 average run size and 73 percent compared to the 1963-1964 average run size (Vogel 1987). Based on preliminary run counts, mean run size for 1991-1993 was 306 adult spring-run chinook salmon (Colleen Harvey pers. comm.).

The Recovery Plan for Sacramento-San Joaquin Native Fishes (Moyle *et al.* 1994) identifies loss of upstream habitat, harvest, losses during migration, limited access to upstream habitat, poaching and introgression of wild stocks through inbreeding with hatchery-reared genotypes as the reasons for the spring-run chinook salmon decline. Various forms of predation may also be significant in affecting populations.

Historically, spring-run chinook salmon spawned in the middle and headwater reaches of the following rivers and creeks: San Joaquin River, Kings River, Merced River, Tuolumne River, Stanislaus River, Mokelumne River, South Fork American River, North Fork American River, Middle Fork American River, North Fork Yuba River, Middle Fork Yuba River, South Fork Yuba River, North Fork Feather River, Middle Fork Feather River, South Fork Feather River, West Branch Feather River, Thomas Creek, Cow Creek tributaries, Stoney Creek, Deer Creek, Mill Creek, Antelope Creek, Cottonwood Creek, Battle Creek, Butte Creek, Big Chico Creek, Little Sacramento River, McCloud River, Hat Creek, and Pit River (Gerstung 1990). Jim Gaumer (1997) does not believe that spring-run chinook salmon ever occurred in Stoney Creek.

It is not known whether spring-run chinook salmon ever spawned in the Calaveras River. However, it appears unlikely because the headwater streams are less than 6,000 feet in elevation, where snowpack typically occurs and where year around cold water would be available. Spring-run chinook salmon did not use the Cosumnes River because Latrobe Falls that is located at a low elevation blocked access to its headwaters and the Cosumnes lacked adequate water quality for spring-run chinook salmon downstream of the falls (Eric Gerstung, pers. comm.).

Spring-run chinook salmon spawn in the upper reaches of Central Valley streams. Their decline began in the period between 1850 to 1880 when the Feather, Yuba, American, Tuolumne Rivers and many other streams were mutilated in their upper reaches by hydraulic gold mining (Gerstung 1990, Moyle *et al.* 1994). Fine silt and mining debris clogged or buried the spawning gravels and eliminated holding and rearing habitat.

Dams have denied access to upstream habitat to many spring-run chinook salmon stocks to contribute to the decline of this salmon race. Shasta Dam, on the Sacramento River began storage in 1943 and completed in 1947, denied spring-run chinook salmon access to the McCloud and Pit Rivers. Thus, extirpating the spring-run chinook salmon from these systems. Centerville Dam built in 1917 and other smaller diversion dams on Butte Creek, and Oroville Dam completed in 1966 on the Feather River have denied spring-run chinook salmon access to the headwater reaches. Englebright Dam built in the late 1930s on the Yuba River reduced spring-run stock to a remnant. Folsom Dam built in 1955 extirpated spring-run chinook salmon from the American River. Pardee and Comanche Dams extirpated the spring-run chinook salmon from the Mokelumne River. Goodwin Dam extirpated spring-run chinook salmon from the Stanislaus River. A series of La Grange Dams built in 1852, 1884, and 1894 extirpated spring-run chinook salmon from the Tuolumne River. Exchequer Dam extirpated spring-run chinook salmon from the Merced River. Pine Flat Reservoir built in 1954 extirpated spring-run chinook salmon from the Kings River. Friant Dam built in 1948 extirpated a spring-run chinook salmon run from the San Joaquin River that may have been as large as a half a million spawners (Gerstung 1990).

Loss or degradation of habitat stemming from water manipulation continues to be a problem. Within the Great Central Valley, water diversions may take all the water in lower reaches during spring and summer, blocking upstream migration of adults and downstream migration of juveniles. These potential problems have been identified on Deer Creek (Reynolds *et al.* 1993). On other streams, low stream flows also result in elevated summer temperatures in spring-run chinook salmon holding areas (Gerstung 1990, Moyle *et al.* 1994). Deer Creek"s diversions are downstream of the holding areas.

There is a water exchange project on Deer Creek that may mitigate for water diversion caused migration passage problems in Deer Creek. There has not been an instream flow assessment to measure stage-discharge relationships to determine adequate migration passage flows.

Spring-run chinook salmon are exceptionally vulnerable to dams, diversions, and other impacts because their unusual life history requires access to isolated canyon areas at mid-elevations that maintain cool water temperatures during the summer for holding habitat and during the early fall for spawning. Ekman (pers. comm. cited in Jones and Stokes) attributes the decline of chinook salmon numbers in Deer Creek largely to irrigation withdrawals in the Valley Floor Reach, noting that water use in late spring has increased in recent years and dry years have exacerbated the problems. In contrast, Hanna (1997) notes that in the past 20 years, orchard irrigation has replaced pasture irrigation and water use has declined. Ekman (pers. comm. cited in Jones and Stokes) further warns that the spring-run chinook salmon population in Deer Creek could vanish within a few years if problems facing it were not identified and corrected.

Spring-run chinook salmon stocks are harvested by ocean and river fisheries. Although fisheries capture mainly hatchery fish, they are also taking wild fish at least in proportion to their abundance to hatchery fish. Given the low abundance of the remaining runs of wild fish, the take of even a few wild fish may have a significant effect on their populations. It is likely that approximately one-half of the all wild fish are cropped by the fisheries (Moyle *et al.* 1994). Commercial fisheries may also affect spring-run chinook salmon populations through continual cropping of larger and older individuals. This harvesting results in spawning runs composed of smaller, three and four year old fish, which produce fewer eggs per female. The removal of older spawning fish also decreases the resilience populations have against natural disasters. Because older fish return later to spawn than most of their cohorts, they can supplement year classes that have poor returns.

Adult spring-run chinook salmon are especially susceptible to poaching because they hold in headwater pools during the summer when more people are out in the woods.

Spring-run chinook salmon interbreeding with both wild and hatchery fall-run chinook salmon has the potential to eventually eliminate the adaptive genetic distinctiveness of the few remaining naturally reproducing stocks. Hybrids tend to behave as a fall-run chinook salmon. Spring- and fall-run chinook salmon were previously separated by time and spawning area. Construction of dams eliminated the use of ancestral spawning grounds of spring-run chinook salmon in upper reaches of streams, forcing those runs to use lower elevation areas that are also used by fall-run chinook salmon. Because flow of the Sacramento River is regulated by Shasta Dam and other dams, cold water is present in some areas throughout the summer, which may allow greater temporal overlap, and as a consequence, hybridization of the different runs in the Sacramento drainage. There has also been inadvertent hybridization of the races at the hatcheries (Gerstung 1990, Moyle *et al.* 1994).

Stocks of spring-run chinook salmon have declined to such low levels that the California Fish and Game Commission has recently identified spring-run chinook salmon as a candidate endangered species and as a Sensitive Species by the USFS in the Klamath basin of California (Moyle *et al.* 1994; McFarland 1997).

Steelhead Trout. Steelhead trout (*Oncorhynchus mykiss*) is an anadromous rainbow trout that emigrates to sea and later returns to inland waters as adults to spawn. California steelhead total age rarely exceeds six years (Shapovalov 1967). In California, first time spawners are composed mainly of fish which have spent years in fresh water and years in the sea as follows: 2 stream, 1 ocean; 2 stream 2 ocean; and 3 stream 1 ocean (Shapolavov 1967). Unlike Pacific salmon, not all steelhead die after spawning. Shapovalov and Taft (1954) found that first time spawners comprised 82 percent of the run, second time spawners were 15 percent, third time spawners 2.1 percent, and fourth time spawners 0.1 percent of the run during their long term study on Waddell Creek in Santa Cruz County. Scale samples taken in the fall of 1954, from naturally produced upper Sacramento River steelhead, agree closely with these proportions with 83 percent first time spawners, 14 percent spawning for the second time, 2 percent three time spawners, and 1 percent spawning for the fourth time (Hallock 1989). Shapovalov (1967) found in general that first time spawners compose 55 to 95 percent of runs, that repeat spawners may form an important contribution, contributing over 50 percent of a run, and that fish spawning more than twice form very minor parts of runs.

In California, males predominate in life history categories comprising lesser total ages, while females predominate those comprising greater total ages. Survival following spawning is higher among females than among males and males predominate early portions of steelhead runs, while females predominate in the later portions (Shapalavov 1967).

CDFG is the resource agency responsible for species inventory throughout California. Despite the facts that chinook salmon and steelhead life histories and ecological requirements are similar, and steelhead is an important gamefish, CDFG has not studied steelhead as they have chinook salmon and, consequently, less is known of the distribution, abundance, or timing of this species (Hallock 1989). It may be that since steelhead is a gamefish and has no commercial fishery, less attention was paid to them. There has also been some discriminatory management practices against steelhead because they are known to eat salmon eggs.

As a consequence of hatchery practices and the general lack of monitoring of steelhead (Hallock 1989), the status of which steelhead stock occurs in any stream in the Central Valley is unknown. It is impossible to appraise the current status of any steelhead run in California in any kind of historical context. There are no significant records of historical distribution or abundance (Roelofs 1983). It is assumed that the winter-run is the most common form and the other forms have been reduced to remnants or have been extirpated.

There are different ways to differentiate forms of steelhead. CDFG has traditionally treated steelhead as if they were chinook salmon. They have named steelhead races for when they begin their immigration into freshwater. Under this scheme, there are three races: the summer-run steelhead, the fall-run steelhead, and the winter-run steelhead (McEwan and Jackson 1994). However, Hallock, Van Woert and Shapavalov (1961) found that there were migrating adult steelhead in the Sacramento River during any month of the year; the steelhead were more numerous then. An alternate perspective is to identify steelhead forms using the behavioral concepts of "stream-maturing steelhead." They enter freshwater with immature gonads and consequently must spend several months in the stream before they are ready to spawn (summer-run). "Ocean-maturing steelhead" immigrate into freshwater with ripe gonads and spawns soon thereafter (winter-run). However, these delineations are not either taxonomically or genetically consistent. Steelhead are a part of a very complicated species complex of rainbow trout that is still taxonomically unsettled. *Oncorhynchus mykiss* gairdneri is a stream-maturing steelhead, and occupies upper Columbia River tributaries east of the Cascades. *Oncorhynchus mykiss* irideus is from coastal steelhead stocks and can either be ocean maturing or stream-maturing steelhead. All steelhead populations in California are *Oncorhynchus mykiss* irideus (Behnke 1992).

The summer-run steelhead is a stream-maturing steelhead and migrates to freshwater with immature gonads in May and June and holds in deep headwater pools until January through March to spawn. During the holding period, the gonads mature (McEwan and Jackson 1994). However, little is known about spawning time and location of California stream-maturing steelhead populations (Roelofs 1983). In many ways the life history of summer-run steelhead resembles that of spring-run chinook salmon. Both species immigrate to the headwaters of streams during the snow-melt run-off and hold in pools where their gonads mature before spawning. This steelhead run existed in the American River, but was extirpated by the wash-out and subsequent abandonment of the old Folsom Dam fish ladder, and the closure of the American River by Folsom and Nimbus Dams. It may also be the run that migrates up Mill and Deer Creeks (Eric Gerstung, pers. comm.). Most summer-run steelhead data were collected in the Trinity-Klamath drainages (Roelofs 1983),

The fall-run steelhead is also a stream-maturing steelhead and is the native run of the Central Valley (McEwan and Jackson 1994), but is frequently considered a part of the summer-run race. It migrates in late July through September and spawns in December and January. These fish are generally small (12" to 18"), and are called "half-pounders" by anglers. However, a large male can weight as much as 12 pounds. Van Woert (1964) found a bimodal peaks in migration, indicating that both fall-run steelhead and winter-run steelhead occur in Deer Creek.

The winter-run steelhead is an ocean-maturing steelhead that has been introduced through hatchery practices from the Pacific coast (Mad and Eel rivers in California and the Washougal River in Washington) to the Great Central Valley because of its larger size (McEwan and Jackson 1994). They are larger because they stay in the ocean until they are three or four years old before immigrating into freshwater. Consequently, they can be as large as 20 pounds. In contrast to the summer-run steelhead, the winter-run steelhead immigrate with mature gonads (McEwan and Jackson 1994). They immigrate in November, but peak in January, and spawn from January through March. Winter-run steelhead are thought to dominate the Central Valley fishery. USFWS (1995) believes that only winter-run fish occur in the Sacramento River System.

Adult winter-run steelhead migrate into the upper Sacramento River system from July through the middle of the following March (Hallock 1989). Hallock (1989) believes that there is but one annual run, the peak of which passes the mouth of the Feather River near the end of September. He notes however, that during some years a few steelhead migrate into the upper river in June. The June migrants hint of a possible spring-run. If such a run exists, it appears to be only sporadic.

Winter-run steelhead probably migrate upstream into Deer Creek during the late-fall and winter, primarily when flows increase from storms. There are no steelhead counts on Deer Creek to establish timing of migration. Based on fish counts at Clough Dam on nearby Mill Creek from 1953 and 1964, the peak of steelhead migration is in November (sometimes called a fall-run steelhead although genetic differences from winter steelhead have not been proven) and February (Van Woert pers. comm., cited in Jones and Stokes). Steelhead have even greater migrating abilities than salmon and migrate far upstream on Deer Creek to spawn shortly after migration during the winter. Fry emerge in spring, and juveniles will generally spend 2 years in the stream before emigrating to the ocean.

If Deer Creek steelhead behave the same as Mill Creek steelhead, then timing of migrations occurs with two peak periods. Between 1953 and 1963, steelhead were counted at Clough Dam on Mill Creek. About 60 percent of the run migrates past Clough Dam in October-December and 30 percent in January-February. The beginning of the run occurs with the onset of the first heavy run-off in the fall and ends when stream flows become too low (Hallock 1989).

Most steelhead spawning in the upper Sacramento River system occurs in tributaries. Deer Creek provides essential habitat for this important and highly prized sport fish; an estimated 25 percent of all steelhead migrating into the upper Sacramento River system spawn in Mill, Deer, and Antelope Creeks. Steelhead populations in Mill Creek averaged 1,006 upstream migrants during 1953-1964, but no other data are available (Hayes and Lindquist 1967). Juvenile steelhead and resident rainbow trout of the same size are indistinguishable by visual examination unless the steelhead show signs of smoltification; consequently, it is difficult to measure population levels of steelhead based on juvenile estimates.

Steelhead prefer to spawn in clean, loose gravel, and swift, shallow water. The size of a steelhead redd's spawning area ranges from 22.5 to 121 square feet and average 56 square feet. The female steelhead digs six-to-seven egg pockets in each redd. The male steelhead fertilizes the eggs as they are deposited. A female steelhead from the American River produces an average of 3,500 eggs with a range of 1,500 to 4,500 eggs (Reynolds *et al.* 1993).

Steelhead tend to prefer shallower stream depths and smaller gravel but the same water velocities for spawning as the chinook salmon. Steelhead will spawn in streams as shallow as 0.75 foot in gravel from 0.25 to 3.0 inches in median dimension and in 1.5 fps stream velocity (Reynolds *et al.* 1993).

Steelhead are less tolerant of fine sediment in the gravel than chinook salmon, probably because the eggs are smaller and the oxygen requirements for developing embryos are higher (Reynolds *et al.* 1993).

There is some confusion in the literature as to the tolerance of steelhead to water quality because some of the studies were performed not only with resident rainbow trout, but hatchery rainbow trout that have been artificially selected for wider tolerances for water temperature and other water quality parameters. At the very worst, their tolerances are equal to those of chinook salmon (Dr. Alice Rich pers. comm.)

All freshwater life stages of steelhead, except rearing, require lower stream temperatures than chinook salmon. The preferred stream temperatures for steelhead migrating and holding in the Sacramento River are between 50°F and 58°F. Preferred temperatures for spawning are generally lower, from 39°F to 55°F, and the optimal incubation and hatching temperature is 50°F (Reynolds *et al.* 1993).

The rate of steelhead embryo development is stream temperature dependent, and consistency of stream temperature is also important. Hatching occurs in 31 days at 50°F and in 24 days at 55°F. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F (Leitritz and Lewis 1980). The embryo is very sensitive or tender during the first half of the incubation period. A sudden change in stream temperature generally results in high mortality. Fry usually emerge from the gravel about four to six weeks after hatching, but factors (e.g., redd depth, gravel size, siltation, and temperature) can accelerate or retard this time (Shapovalov and Taft 1954). The optimal temperature range for fry and juvenile rearing is from 45°F to 60°F and <57°F for smoltification (McEwan and Jackson 1994).

Newly hatched steelhead alevins remain in the gravel until the yolk sac is completely absorbed, a period of four to six weeks. Alevin emergence from the gravel is followed by a period of active feeding and accelerated growth. The emergent fry's diet consists primarily of aquatic invertebrate drift. As they grow, fry move from shallow quiet margins of streams to deeper, faster water (Reynolds *et al.* 1993).

Juvenile steelhead usually remain in freshwater for at least one year before emigrating to the ocean. Unless there are adequate water temperatures, high rearing mortality will occur. The steelhead in the Sacramento River typically emigrate during spring and early summer months. Emigration is more closely associated with size than age. Emigrants are generally six to eight inches, but may vary in age from less than one to two years (Reynolds *et al.* 1993).

Historically, steelhead were distributed throughout the tributaries and headwaters of the Sacramento prior to closure of rivers by dams, water manipulation, and watershed perturbations of the 19th and 20th centuries (McEwan and Jackson 1994). There is no historical evidence that steelhead occurred in the San Joaquin River drainage. It is likely that they occurred in these drainages because of the historical presence of spring-run chinook salmon. Steelhead were probably extirpated early because of water manipulation, the consequent reduced water quality, and steelhead's intolerance of degraded water quality (Eric Gerstung pers. comm.).

Steelhead populations in the Sacramento-San Joaquin system are mostly dependent on hatcheries to maintain fishable populations because natural spawning is greatly reduced (Reynolds *et al.* 1990). The effects of hatcheries may have long term adverse impacts to natural populations due to artificial selection (Reisenbichler and McIntyre 1977).

Sacramento River steelhead that naturally spawned ranged in abundance from 470 to 19,615 with a 25-year average between 1967 to 1994 of 6,574 (Mills and Fisher 1994).

Dams have denied access to upstream habitat to many steelhead trout runs and contributed to their decline. Shasta Dam built in 1947 on the Sacramento River denied steelhead access to the McCloud and Pit Rivers. Centerville Dam (built in 1917 on Butte Creek) and Oroville Dam (completed in 1966 on the Feather River) have denied access to the headwater reaches to steelhead. Camp Far West Dam and the South Sutter Diversion Dam reduced the steelhead run from the Bear River. Englebright Dam built in the late 1930s on the Yuba River reduced the steelhead stock. Folsom Dam built in 1955 extirpated summer-run steelhead from the American River. Comanche Dam completed in 1963 reduced steelhead from the Mokelumne River. Steelhead used to occur in westside streams (e.g., Stoney and Thomes Creeks) (McEwan and Jackson 1994).

McEwan and Jackson (1994) identified diversions, high stream temperatures, pollution, channelization, and the delta pumps as important factors in the decline of anadromous fishes in the main stem Sacramento River.

Elevated water temperatures in the upper Sacramento River has been a major factor in the decline in winter-run chinook salmon and may affect the rearing in the river. High water temperatures result from inadequate carryover storage in Shasta and other reservoirs. Agricultural drainage is also typically several degrees warmer in temperature and can result in elevated temperatures in the lower Sacramento River. The Colusa Basin Drain, which captures agricultural run-off in Glenn, Colusa, and Yolo Counties, discharges into the lower Sacramento River and is responsible for causing higher water temperatures (McEwan and Jackson 1994).

Bank stabilization projects generally entail removal of riparian vegetation and loss of habitat through replacement of natural bank with large rock rip-rap. This has led to extensive removal of large tracts of riparian forest, which results in reduced shading, a reduction of instream habitat and a reduction of organic inputs. Central Valley riparian forests have been reduced to about one percent of the pre-gold rush acreage (Abell 1989 cited in McEwan and Jackson 1994).

Pacific Lamprey. Pacific lamprey, *Lampetra tridentata*, spend the predatory phase of their life in the ocean (Moyle 1976). Adults usually migrate upstream to spawn between April and late July. Lampreys construct a circular redd and die after spawning. Larval lampreys, called ammocoetes, live in soft sand or mud and feed as filter feeders. They mature in three to seven years, metamorphose to the adult form and emigrate to sea.

Native Resident Fishes

Resident fish spend all their lives in freshwater. However, there may be organized movements within the freshwater for specific life history needs. Resident fish species that inhabit Deer Creek are Sacramento squawfish, Sacramento sucker, hardhead, California roach, tule perch, and sculpin (Dettman 1977, Alley 1978).

Rainbow Trout. Rainbow trout (*Oncorhynchus mykiss*) is abundant and widely distributed. It is frequently the only fish found in cool, well shaded headwaters. However, they are typically most abundant and reach larger size when in association with other species, usually sculpin, speckled dace, sucker, or California roach (Moyle 1982).

Resident rainbow trout is widely distributed in Deer Creek, ranging from the headwaters in the Butt Mountain Reach down into the Lower Canyon Reach, where warm water temperature probably sets the downstream limit of distribution (Sato and Moyle 1988).

Sacramento Squawfish. Sacramento squawfish (*Ptychocheilus grandis*) is a pisciverous predator and is associated with other species of native fishes, especially Sacramento sucker and hardhead (Moyle 1976). Adults are consistently found in large deep pools of larger streams, where gradients are moderate, temperatures warm, and cover abundant. Juvenile squawfish are found in a much wider variety of habitats, including shallow pools of intermittent streams and riffles and runs of permanent streams. Both juveniles and adults are most abundant in waters where summer temperatures exceed 68°F for extended periods of time (Moyle *et al.* 1982). There may be a spawning migration from the Sacramento River in the spring. They spawn in April or May by broadcasting their gametes near shore on rocky bottoms (Moyle 1976).

The Sacramento squawfish populations are likely a combination of year-round residents and migratory populations. Adult Sacramento squawfish are known to migrate up from the Sacramento River in the spring to spawn in Deer Creek (Hayes and Lindquist 1967, Vogel 1987). Sacramento squawfish were not found above the Lower Canyon Reach (Sato and Moyle 1988).

Hardhead. Hardhead (*Mylopharodon conocephalus*) is identified as a species of special concern (Moyle *et al.* 1995). Hardhead have the most restricted microhabitat utilization of all the widely distributed Sacramento-San Joaquin fishes. They are found only in the sections of large, warm streams that contain deep, rock-bottomed pools. The juveniles are found in the side pools and shallow areas of these same sections of streams. This strong habitat preference of the hardhead gives them a very spotty distribution pattern that is further interrupted by the construction of dams in areas of optimal habitat (Moyle *et al.* 1982). They are closely associated with Sacramento squawfish and Sacramento sucker in the mid-elevation (100-1,000 m) portions of Sierra streams. This location has been called the squawfish-sucker-hardhead zone (Moyle 1976).

In Deer Creek, hardhead are most abundant in the Lower Canyon Reach. They also occur within the Valley Floor Reach (Sato and Moyle 1988).

California Roach. California roach (*Hesperoleucus symmetricus*) is characteristic of small, warm, intermittent streams. It can frequently be found in high densities in isolated pools in such streams, where water temperatures are high and oxygen levels are low. However, the roach is not confined to this habitat. They are frequently abundant in small trout streams of moderate gradient, as well as in larger streams in association with other native cyprinids. In the latter situation roach are frequently found in the shallow edges of the pools and riffles. Roach were often abundant in areas that had been altered by man, either through reduced stream-flows or through the creation of pools by dredging or small dams.

California roach are found primarily in the Upper and Lower Canyon Reaches and Valley Floor Reach of Deer Creek. The most common species observed in Deer Creek by Sato and Moyle (1988) was California roach; however, the roach's predominance may be an artifact of sampling near the spawning season.

Speckled Dace. Speckled dace (*Rhinichthys osculus*) are most abundant in small, warm streams, especially in riffle areas with coarse bottoms. Their consistent lack of association with shade and bank cover indicates their ability to find cover under rocks and in flowing water. Their wide distribution indicates their ability to use a wide range of habitats. It may be that their absence from many areas results largely from interactions with other species, especially sculpins and California roach (Moyle *et al.* 1982).

Speckled dace are found primarily in the Upper and Lower Canyon Reaches and Valley Floor Reach of Deer Creek (Sato and Moyle 1988).

Sacramento Sucker. Sacramento sucker (*Catostomus occidentalis*) are so widely distributed that they show no strong associations with any particular set of environmental variables. They are associated with Sacramento squawfish and hardhead at mid-elevation Sierra streams (Moyle 1976). They are largely absent from cold, swift, high gradient waters in which large pools are infrequent. The adults and juveniles show some segregation in habitats, with the juveniles being abundant in many small, shallow streams from which adults are absent. These streams are in fact nursery areas for juvenile suckers that move up into them to spawn in the spring. The adults are abundant whenever deep pools or runs provide cover (Moyle *et al.* 1982).

Sacramento suckers spawn during the spring over riffles by broadcasting their gametes. The fertilized eggs settle in the cracks between the rocks.

The Sacramento sucker populations are likely a combination of year-round residents and migratory populations. Sacramento suckers are known to migrate up from the Sacramento River in the spring to spawn in Deer Creek (Hayes and Lindquist 1967, Vogel 1987). Sacramento suckers were widely distributed in Deer Creek, ranging from the valley floor up through the canyon but not beyond the Upper Deer Creek Falls in the Highway 32 Reach (Sato and Moyle 1988).

Tule Perch. Tule perch (*Hysterocarpus traski*) were present but not abundant in the valley portion of Deer Creek (Sato and Moyle 1988, Hayes and Linquist 1967).

Riffle Sculpin. Riffle sculpin (*Cottus gulosus*) are widely distributed in the Central Valley. They typically occupy the cool upper reaches of streams (Moyle 1976). They occur in Deer Creek from the Highway 32 Reach downstream through the Lower Canyon Reach.

Anadromous Exotic Fishes

Striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*) are two anadromous exotic fish in California that emigrate to the ocean or estuary early in their life, typically grow to large size in the ocean or estuary, and return inland as adults to spawn in freshwater streams and rivers. These two species have not been observed in Deer Creek (Colleen Harvey pers. comm.).

Resident Exotic Fishes

Resident exotic fish spend all their lives in freshwater. However, there may be organized movements within the freshwater for specific life history needs. Exotic and resident fish species that inhabit Deer Creek are brown trout, carp, green sunfish, smallmouth bass, largemouth bass and bullheads (Dettman 1977, Alley 1978).

Brown Trout. Brown trout (*Salmo trutta*) were imported from Loch Leven, Scotland in 1883 and from Germany in 1895. Brown trout spawns in the fall is relatively scarce in Deer Creek compared to rainbow trout but can be found generally throughout the creek, especially in Deer Creek Meadows.

Carp. Carp (*Cyprinus carpio*) were introduced to California in 1872 by Julius Poppe of Sonoma (Fritz 1987). They are occasionally found in the valley portion of Deer Creek (Hayes and Lindquist 1967).

Green Sunfish. Green sunfish (*Lepomis cyanellus*) were introduced into California in 1891 and has shown considerable ability to disperse upstream into undisturbed or semi-natural habitats, but are unable to establish populations of any size in such areas Moyle *et al.* 1982). Green sunfish have been found in the Valley Floor Reach of Deer Creek but were not abundant (Sato and Moyle 1988.).

Smallmouth Bass. Smallmouth bass (*Micropterus dolomieui*) were introduced into California in 1874. They frequent the squawfish-sucker-hardhead zone (100-1,000 m in elevation). Smallmouth bass have been observed in the Valley Floor Reach of Deer Creek but they are not abundant, probably due to low flows (Hayes and Lindquist 1967).

Largemouth Bass. Largemouth bass (*Micropterus salmoides*) were introduced into California in 1874. They are a warm-water gamefish that are occasionally found in the valley portion of Deer Creek (Hayes and Lindquist 1967).

Bullheads. Bullheads (*Ictalurus* sp.) are a warm-water gamefish that are occasionally found in the valley portion of Deer Creek (Hayes and Lindquist 1967).

FISHERY MANAGEMENT PRACTICES AND CONCEPTS

Management practices can directly affect relative abundance of species of interest. These include:

Hatchery Practices

Historically, fish hatcheries have been used to mitigate for projects that have created large habitat alterations. This form of mitigation has failed to maintain fish populations. The artificial increases in abundance from hatchery planting have inevitably lead to increases in angling pressure. The increase in angling pressure increased losses in the wild populations that have lead to population declines.

Both State and Federal hatchery practices in California have hybridized spring-run with fall-run chinook salmon.

Angling Regulation

CDFG has lacked the personnel to perform comprehensive species inventory. Consequently, bag limits have been made based on regional rather than site specific data.

There are different angling regulations on three reaches of Deer Creek for rainbow and brown trout. From the point, 250 feet of the Upper Deer Creek Falls, on upstream, trout may be taken from the last Saturday in April through November 15. Bait and barbed hooks may be used and the limit is 5 trout per day and 10 in possession. From 250 feet downstream of the Upper Deer Creek Falls downstream to the USGS gaging cable crossing at the mouth of Deer Creek Canyon, there is a daily bag and possession limit of zero from the last Saturday in April through November 15. Only artificial lures with barbless hooks may be used. Downstream of the USGS cable crossing at the Deer Creek Canyon mouth to the mouth of Deer Creek there is a zero possession and bag limit from June 16 through September 30 (CDFG 1997). Angling for chinook salmon and steelhead is prohibited.

Predation

Excessive predation is an area of management attention. Excessive predation by Sacramento squawfish has been blamed for the decline of salmon. However, Brown and Moyle (1981) found that this predation has little impact on numbers of returning adults.

Level of predation by striped bass and largemouth bass on juvenile salmonids has not been examined, nor has the level of predation by pinnipeds on adult salmonids.

Competition

Some management techniques are based upon the premise that competition exists between different fish species and that can influence these competitive outcomes through a variety of management techniques. Competition has been inferred between various species in the fish community and many fish poisoning programs are generally based on this assumption (Moyle, Vondracek, and Grossman 1983).

Several studies examined whether competition occurs between Sacramento squawfish and rainbow trout in Deer Creek (Dettman 1977, Baltz and Moyle 1993) and between Sacramento sucker and rainbow trout (Li 1977), and between hardhead, Sacramento squawfish, Sacramento sucker, rainbow trout, chinook salmon and California roach in Deer Creek (Alley 1978). All these studies concluded that there was no competition between these species.

Commercial and Sportfishing Regulation

Commercial ocean and sportfishing regulations on salmon harvest are designed to take three out of every four adults. Theoretically, the harvest is matched to expected salmon-run size and escapement goals and is targeted primarily at the fall-run chinook salmon. However, winter-run and spring-run and late-fall-run chinook salmon are taken in the salmon fishery.

POTENTIAL ADVERSE FACTORS

Logging

Poor logging practices are often associated with increased stream sedimentation that can decrease embryo survival and fry emergence. Timber harvesting may also increase stream temperature, and reduce nutrient supply and dissolved oxygen levels (Marcotte 1982).

Logging occurs on both private and public lands. These activities occur upstream of the Valley Floor Reach. Private companies appear to harvest their trees using current Best Management Practices (BMP) (i.e., selective harvest, wide buffer strips) along stream corridors.

Road Construction

Road construction can increase sediment and organic debris accumulation, alter water quality and quantity, and increase human access to previously remote or isolated areas (Yee and Roelofs 1980).

Road construction activity is higher where timber is harvested. Roads, particularly in the rhyolite area, can have large yields of fine sediment. Roads in the upper watershed suffered greatly during the January 1997 storm event. Fine sediment is stored in the Deer Creek Meadows area. However, it is apparently transported rapidly through the Highway 32, Upper Canyon, and Lower Canyon Reaches because there are no bars evident.

Livestock Grazing

Livestock grazing may degrade or remove streamside vegetation, change channel morphology, and affect water quality and quantity (Platts 1981). Loss of riparian vegetation can increase stream temperatures and eliminate cover and fish food. Terrestrial insects that fall into streams from riparian vegetation provide an important food source for juvenile anadromous salmonids (Reiser and Bjornn 1979).

Livestock grazing activities occur in the Butt Mountain, Deer Creek Meadows, and Valley Floor Reaches. There has been streambank damage due to grazing in the Deer Creek Meadows Reach, but there are also riparian restoration projects (riparian enclosures and revegetation) to mitigate for these activities.

Mining

Mining can affect aquatic ecosystems by causing sediment increase, changes in pH, increase in toxic heavy metals, and alterations in channel morphology and stream flow regime (Martin and Platts 1981).

CDFG is proposing to allow suction dredge mining in Deer Creek, on the assumption that spring-run chinook salmon and winter-run steelhead will simply move to another holding pool if disturbed by such activities (Evans 1997).

Flood Protection

Bank protection activities typically are designed to increase flow conveyance during high flow events, which also increases stage. Assuming the banks are resistant to eroding, increases in depth (stage) also increases shear force on the bed, increasing likelihood of scour. When these structures fail, there is greater scour and more erosion loss than banks without flood protection. Rip-rap also reduces relative abundance, biomass, and species diversity of aquatic invertebrates and fish (Hjort *et al.* 1984; Jackson *et al.* 1987; House *et al.* 1989; Davis 1988; Li *et al.* 1984; Barclay 1980; Kehe 1984; Kehe and Klingeman n.d.; Schmal and Sanders 1978; Everest and Sedell 1983; Wydoski and Helm 1980; Gregory *et al.* 1991; Moore and Gregory 1988; and Gurtz *et al.* 1988.).

Levees are in the Valley Floor and Mouth Reaches. There was a levee failure at (location) that caused loss of soil. This was the third time this location has failed, and due to the limitations Federal criteria for funding of repair existing flood control facilities, the levee was rebuilt to original specifications. This is an inadequate solution to flood protection. Hydraulic studies should be made to study the feasibility of offset levees. It may be that by allowing Deer Creek to retain its flood plain that sediment deposition will occur rather than soil loss from scour. The hydraulic studies would also provide the probability of flood occurrence that orchards along Deer Creek would be flooded. This would provide information of how frequently streamside orchards would be put out of production.

Fish Screens

Inadequate fish screens due to design or inadequate maintenance can lose or trap spawning adults or emigrating juveniles. There are CDFG approved and operated fish screens on all the water diversions in the Valley Floor Reach of Deer Creek.

Water Diversions

Water diversions reduce stream flow in Deer Creek that have stopped migration of adult and juvenile spring-run chinook salmon, juvenile fall-run chinook salmon, and juvenile steelhead in the Valley Floor Reach.

There is a proposed water exchange project that may allow adequate flows during periods of fish migration. However, an instream flow assessment is necessary to determine appropriate flow levels in Deer Creek.

POTENTIAL ADVERSE FACTORS AFFECTING FISH RESOURCES OUTSIDE OF DEER CREEK WATERSHED

After anadromous fish migrate away from Deer Creek, they must travel down the Sacramento River and through the Sacramento-San Joaquin Delta in order to reach the ocean for those phases of their life cycles. There are various conditions that can affect anadromous fish. The following sections describe some of the other factors outside The Deer Creek Watershed that affect numbers of returning spawners to Deer Creek.

Non-natal Stream Rearing

Some anadromous fish not born in Deer Creek may immigrate into Deer Creek to rear. Conversely, Deer Creek juvenile salmonids may migrate into other tributaries to rear. Benefits or costs are dependent upon habitat conditions in each tributary. This phenomenon is widespread. Maslin *et al.* (1997) has documented this behavior in 24 small tributaries in the Sacramento River. It has also been observed in chinook salmon in the lower Fraser River in British Columbia, Canada (Murray and Rosenau 1989) and in the Taku River in Alaska (Murphey *et al.* 1989). Tagged winter-run chinook salmon from Coleman National Hatchery have been recovered in the lower American River far upstream from the mouth (Bill Snider pers. comm.) and in the Sutter Bypass (Katherine Hill pers. comm.).

Water Diversions

Juvenile and smolt mortality is a major factor affecting chinook salmon and steelhead abundance in the Sacramento-San Joaquin drainage. All runs of chinook salmon are experiencing increased mortality (McFarland 1997). Anadromous salmonid juveniles are susceptible to entrainment into unscreened or inadequately screened water diversions along the Sacramento River and its tributaries that is operated during the period of their emigration. Fall-run chinook salmon juveniles emigrate from January through June. Late-fall-run rearing and emigration of fry and smolts occurs from April through mid-October (Mills and Fisher 1994). There is a significant emigration of naturally produced yearling late-fall-run chinook salmon that occurs through November and perhaps into January. Hatchery late-fall-run yearlings emigrate well into February. Emigration of winter-run fry and smolts occurs from July through March at the RBDD and from September through June in the delta. Rearing and emigration of spring-run fry and smolts begins in late November and continues through April. Steelhead emigrate during the spring and summer months. Given these periods of migratory activity, there are no safe windows from which water diversions can be made without entraining or impinging emigrating anadromous salmonid juveniles (HRG 1997).

There are large-scale diversions on the Sacramento River that entrain or impinge large numbers of juvenile salmonids. Anderson-Cottonwood Irrigation District (ACID) which can divert 400 cfs, and the Tehama-Colusa and Corning Canals at the Red Bluff Diversion Dam (RBDD) which can divert 3,000 cfs. The RBDD has reduced salmon populations by 114,000 fish, which is assumed to be a mean annual estimate (Hallock 1991). Hallock (1991) states that: 1) the combination of mining pollution, flow fluctuations, and warm water releases from the Shasta/Keswick Dam complex; 2) lack of suitable spawning gravel and gravel recruitment; 3) unscreened diversions and inefficient screened diversions; 4) predation; and 5) operation of the Anderson-Cottonwood Irrigation District Diversion Dam and RBDD have caused an estimated 85 percent loss in natural stocks (counting between eggs deposited in the gravel and smolts entering the ocean). While these conditions are upstream of Deer Creek, there is growing evidence, in spite of no research directed at this question, that emigrating juveniles will not only swim downstream towards the sea, but also swim upstream after they reach the main stem of the Sacramento River (Bill Snider, pers. comm.). Therefore, the adverse conditions upstream can not be dismissed as not affecting Deer Creek anadromous salmonid populations.

The Glenn-Colusa Irrigation District (GCID), located near Hamilton City, can divert 3,000 cfs. Many fish are lost at the diversion despite heroic attempts to design and construct fish safe screens. New perforated plate screens and different diversion operations have reduced entrainment and impingement problems. Hallock (1991) states that GCID alone has reduced the salmon populations by 35,000 fish, which is assumed to be a mean annual estimate.

Reclamation District 108 diverted 560 cfs from April 21 through June 30, 1992 on Wilkins Slough and the Sacramento River and trapped 50,106 chinook salmon juveniles (Cramer and Demko 1992).

There is no physical fish screen on the Reclamation District 1004 diversion. RD 1004 has experimented with a sound barrier to screen fish, but is presently installing a positive barrier.

The delta diversion facilities consisting of the Harvey O. Banks pumping plant (SWP) and the Tracy Pumping plant (CVP) have a combined maximum pumping capacity of 14,900 cfs or nearly 30,000 acre-feet per day. Kjelson and Brandes (1989) have found salmon survival to be highly correlated to river flow, temperature, and percent of inflow diverted by State and Federal water projects. Fish screens are located at the intakes to the pumping plants, but juvenile fish of many species are lost to the louver screens because they are antiquated and inadequate. There are fish salvage operations at each facility. However, large numbers of fish die through handling and trucking associated with fish salvage operations. High levels of predation takes many fish at the export facilities or in Clifton Court Forebay or where the salvaged fish are released.

Small water diversions also cause problems. There are at least 300 unscreened diversions on the Sacramento River between Keswick and the delta (McEwan and Jackson 1994). Smolts emigrating are susceptible to every unscreened or inadequately screened diversion that is operating along the Sacramento and San Joaquin River or their tributaries.

Since the listing of spring-run chinook salmon and steelhead as candidate threatened species, many of the diverters have entered into cooperative efforts with State and Federal agencies, conservation groups and others to address these concerns.

Dams

The following dams have precluded access to upstream anadromous salmonid holding, spawning, and rearing habitats: Shasta Dam (on the main stem Sacramento River), Centerville Dam, smaller dams on Butte Creek, Oroville Dam on the Feather River, Englebright Dam on the Yuba River, Folsom Dam on the American River, Pardee, and Comanche Dams on the Mokelumne River, Goodwin Dam on the Stanislaus River, La Grange Dam on the Tuolumne River, Exchequer Dam on the Merced River, Pine Flat Dam on the Kings River, and Friant Dam on the San Joaquin River. Changed water temperature regimes, altered flow regimes, interrupted bedload transport, and starved downstream reaches of spawning gravel and reduced input of woody debris have all contributed to reduced stocks of anadromous salmonids.

Delta Outflow

Export pumping operations have changed the hydrological and ecological dynamics of the delta. The large amount of water diverted by the delta pumps has also reduced outflow to San Francisco Bay, a key clue to where the ocean is located. This along with the associated flow reduction and altered river flow pattern (flow reversal of five rivers) in the delta has disrupted adult and juvenile salmonid migration and reduced their abundance (McEwan and Jackson 1994).

During periods of low net outflow to San Francisco Bay, large numbers of emigrants travel down Georgiana Slough and are lost in the maze of the delta channels. They are subject to entrainment by the SWP and CVP export pumps rather than remaining in the Sacramento River (Frank Fisher, pers. comm.). The SWP and CVP operations also kill, directly and indirectly, many smolts attempting to traverse through the delta.

Channelization, Channel Cuts, and Habitat Alteration

The delta estuary, once an important rearing area for juvenile salmonids, is no longer a safe haven for juvenile rearing. There are four general zones of the delta:

1. The north delta includes the Sacramento River around Rio Vista. This route through the delta is probably the safest for migrating juvenile fish from the Sacramento River and its tributaries.

2. The central delta is where all the rivers come together. It includes the NF Mokelumne River, SF Mokelumne River, San Joaquin River, Franks Tract and is generally east of Chips Islands. The flow patterns are complicated more by dredging projects and water export operations. All alterations effect the natural flow patterns and probably lend to migratory confusion. Not many fish get to the ocean from this section of the delta.

3. The south delta includes Old River, Middle River, Clifton Court Forebay and the SWP, CVP, and Contra Costa Irrigation District water diversions. Very few fish successfully escape these export facilities.

4. The west delta is west of Chips Island and is largely marine in nature. This portion of the delta includes Honker Bay, Suisun Bay, Grizzley Bay.

River channels have been dredged and straightened to increase water conveyance across the delta to the water export facilities or to facilitate traffic of ocean going vessels. Included in the habitat alteration are near shore areas used as nursery rearing areas by fish. This has simplified habitat complexity. There is increased tidal current due to dredging operations to enhance flow to export pumps. There may be higher metabolic maintenance cost for fish dealing with increased current.

There also are numerous channel "cuts" in the delta (e.g., Empire Cut, Turner Cut, Columbia Cut, Holland Cut, Dredge Cut, and Honker Cut) created to facilitate boat traffic. The migration through the delta is made more difficult by the resultant maze of channels.

The Delta Cross Channel was constructed to facilitate water export from The Sacramento River across the delta to the CVP and SWP pumps. It also entrains many juvenile salmonids from the relatively safe north delta into the relatively more dangerous central delta. Due to the level of water export and the unnatural water patterns in the central delta, salmonids that are entrained rarely find their way to the ocean.

Flood control activity has resulted in the loss of riparian vegetation on virtually all riverbanks due to levee construction and maintenance operations. The loss of riparian vegetation has a variety of consequences. There is a loss of shade and an increase in water temperature. There is a loss of woody debris and habitat complexity is simplified. Finally, the diet of steelhead smolts in the delta was heavily dependent upon terrestrial drift (W.C. Fields, Jr. pers. comm.).

There is an increased abundance of aquatic vegetation in the delta relative to vegetation abundance in the 1950s (Li unpublished data). This may be due to deposition of fines because of loss of bedload transport due to the many channel cuts, or lack of delta outflow.

Introduction of Exotic Pisciverous Species

Largemouth bass, striped bass, smallmouth bass, spotted bass, green sunfish, white crappie, black crappie, and channel catfish are all exotic pisciverous fish that have been introduced into the Sacramento-San Joaquin System. Their relative abundance is probably directly related to the level of predation on juvenile salmonids. American shad, another anadromous exotic gamefish, are an unlikely predator of emigrating juvenile salmonids because they feed chiefly upon zooplankton (Jenkins and Burkhead 1994; Moyle 1976; Scott and Crossman 1973).

Another exotic pisciverous predator, the northern pike (*Esox lucius*), has been illegally planted in Frenchman's Reservoir, Davis Lake, and the Middle Fork of the Feather River. If the northern pike spreads, they represent another threat to juvenile salmonids. Northern pike are considered cool-water fishes, it is anticipated that they will proliferate in cooler zones upstream of Sacramento squawfish and will add an additional predator to juvenile salmonids. The degree of threat to salmonids is undetermined, but it could potentially be disastrous since this species would be freed from the ecological constraints of their native habitat (Li and Moyle 1982). Potentially, they could become another ecological disaster such as the carp, acting as a piscine starling, invading habitat unrelated to any habitat within their native range.

Yet another exotic pisciverous predator, the white bass (*Morone chysops*), was illegally transported from Lake Nacimiento to Pine Flats Reservoir by anglers. If white bass reach the Sacramento-San Joaquin system, they present a threat of additional predation pressure on emigrating juvenile salmonids.

Introduction of Other Exotic Species

There have been numerous exotic species introduced to the Sacramento-San Joaquin drainage that may alter community interactions, most likely in adverse way (See Li and Moyle 1981). The impacts of these introductions have yet to be fully realized, documented, and understood. However, it is likely that some of these introductions may affect salmonid stocks in some way. There have been various types of exotic species introductions: 1)inadvertent introductions (Bigscale log perch were initially introduced in a bass plant in a pond on Beale Air Force Base and now spread throughout the Sacramento-San Joaquin System); 2) illegal introductions (Mississippi silversides were planted in Clear Lake to reduce phytoplankton biomass; they also compete with larval gamefish for a limited zooplankton resource); 3) ill-advised introduction (wagisaki were introduced as a forage fish to Almanor Reservoir and have threatened the genetic integrity of delta smelt); and 4) unregulated activities (yellow fin goby, mitten crab, Potamacorbula [another clam] are probably from bilge discharge activities of visiting transpacific freighters), to name just a few.

Pollution and Water Quality

Pollution has been identified as a factor contributing to the decline of anadromous fishes (Moyle *et al.* 1994, McEwan and Jackson 1996). Spring Creek Dam was built to capture pollution-laden run-off from the Iron Mountain Complex so that lethal effects of the mining effluent could be attenuated by controlled releases from the reservoir. Spring Creek Reservoir has insufficient capacity and uncontrolled spills have resulted in documented fish kills in the 1960's and 1970's. Greater releases from Shasta Reservoir are required to dilute the uncontrolled releases, which diminishes storage needed to maintain adequate flows and water temperatures later in the year (McEwan and Jackson 1994). There are other potential pollution sources near Anderson and near Red Bluff (Fisher and Hallock 1985). Ricefield return flows occur at Butte Slough, Reclamation District 108, Colusa Basin Drain, Sacramento Slough and Jack Slough and may contain chemical residues that will be accumulated and concentrated is tissues of plants and animals (Smith 1993).

Large volumes of water draining from rice fields during the spring are significantly warmer than the receiving water in the Sacramento River (Smith 1993).

Because of latitude, water diversion, and damming, California has water temperatures that stress anadromous salmonids. The approach to water temperature problems has been approached on a project by project basis rather than a regional basis.

Ocean Influences

Once smolts reach the ocean, they grow rapidly to large size. However, there are relatively few data of where they go or what environmental conditions affect them.

Salmon mortality is typically highest at initial entry into ocean (Pearcy 1992).

Migration continues in the ocean with different stocks using different migratory routes. For stocks of chinook salmon from Oregon, Washington, British Columbia and Alaska, there are two general migratory routes, one near shore and the other oceanic. It is not known whether California salmonids also use these routes, or the same strategies. However based on coded wire tag returns, Sacramento system spring-run chinook salmon stocks tend to be caught between Point Arena and Morro Bay, while Klamath system spring-run chinook salmon stocks tend be caught between Point Arena and Point Blanco, Oregon (Moyle *et al.* 1994).

California has set sport fishing and commercial harvest to take three out of four adults (Alan Baracco pers. comm.). Ocean salmon harvest rates are based on estimates of stock abundance and escapement goals. With the exception of 1991 and 1992, the harvest rate for Central Valley chinook salmon stocks has generally increased (Moyle *et al.* 1995) while chinook salmon stocks have remained at a depressed level. From coded wire tag data from the Trinity River and Feather River hatcheries, spring-run chinook salmon are harvested at a lower rate than fall-run chinook salmon by the commercial ocean fishery. It is thought that the spring-run chinook salmon are of a legal size for a shorter period of time during the commercial season than fall-run chinook salmon (Moyle *et al.* 1995).

There is unauthorized or incidental harvest of salmonids in other fisheries. In some of these (e.g., the squid fishery), there are no observers to document the level of incidental take, nor is there any effort to search for coded wire tags on salmon that are taken that would provide valuable data (Pearcy 1992).

There is predation of adult anadromous salmonids by pinnipeds. The rate of predation may be increasing since the numbers of pinnipeds have increased since the National Marine Mammal Protection Act of 1973.

There are density independent factors in the ocean (e.g., El Niño conditions) that may have greater effect than rearing conditions in tributaries or migratory conditions through the delta.

AVAILABLE MAPPED INFORMATION

Various mapped information for fisheries and aquatic resources of the Deer Creek Watershed have been generated. Much of this information exists in digital form. The following list summarizes some of the maps that are available for the watershed:

1. **Fish**
   Source: CARA
   Coverage: Moyle & Sato sample sites - Deer Creek
   Scale:
   Units:

2. **Survey Sites on Deer Creek, Tehama County, June through September 1986**
   Source: Sato & Moyle 1987
   Coverage:
   Scale:
   Units:

3. **Survey Sites on Tributaries of Deer Creek, Tehama County, June through September 1986**
   Source: Sato & Moyle 1987
   Coverage:
   Scale:
   Units:

4. **Reaches of Deer Creek, Tehama County, where all pools were investigated for presence of spring-run chinook salmon in 1986**
   Source: Sato & Moyle 1987
   Coverage:
   Scale:
   Units:

5. **Elevational distribution, reaches of predominance, and area of maximum density for each fish species found in Deer Creek, Tehama County, July through September 1986**
Source: Sato & Moyle 1987
Coverage:
Scale:
Units:

6. **Holding reaches, spawning reaches, nursery reaches, and migration routes for spring-run chinook salmon in Deer Creek and Mill Creek, Tehama County, 1986 and 1987**
Source: Sato & Moyle 1987
Coverage:
Scale:
Units:

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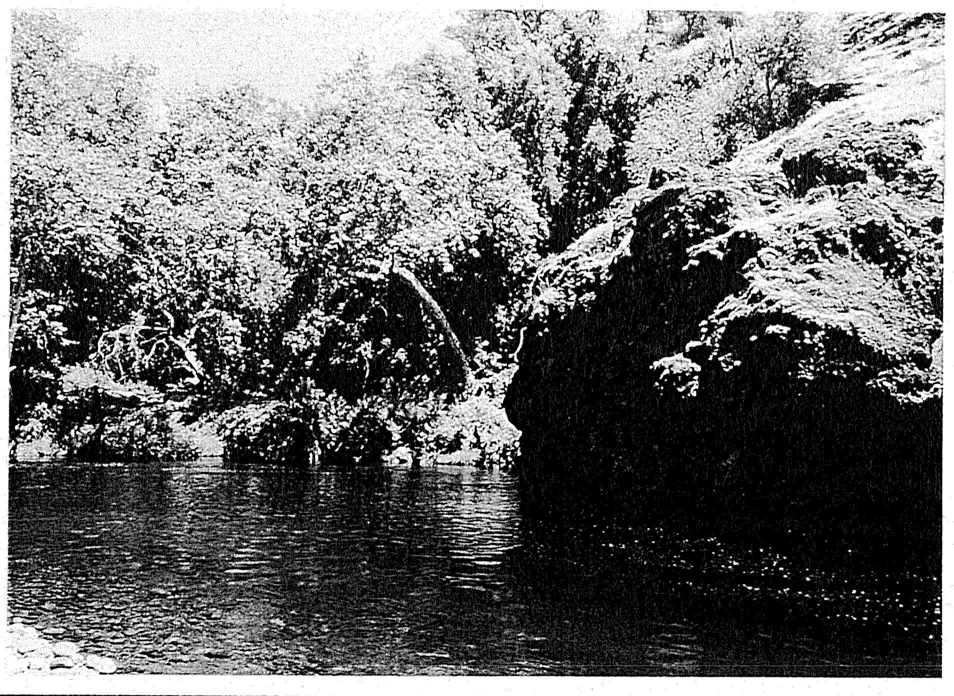


Photo 10-1. Quiet pool just upstream of Deer Creek Irrigation District diversion and downstream of USGS gaging station. (Photo by J. Stanley, June 1997)

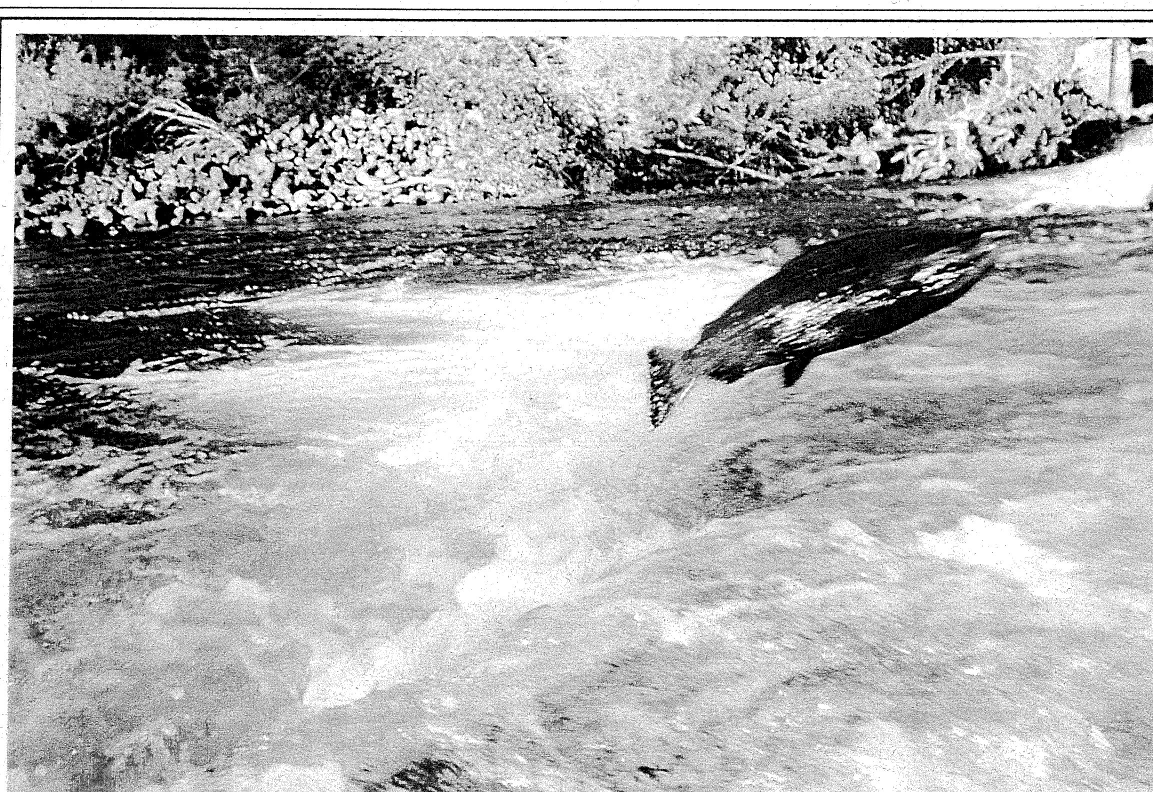


Photo 10-2. Fall-run chinook salmon jumping over spillway of Deer Creek Irrigation District Diversion. (Photograph by Sue Knox, October 1997)

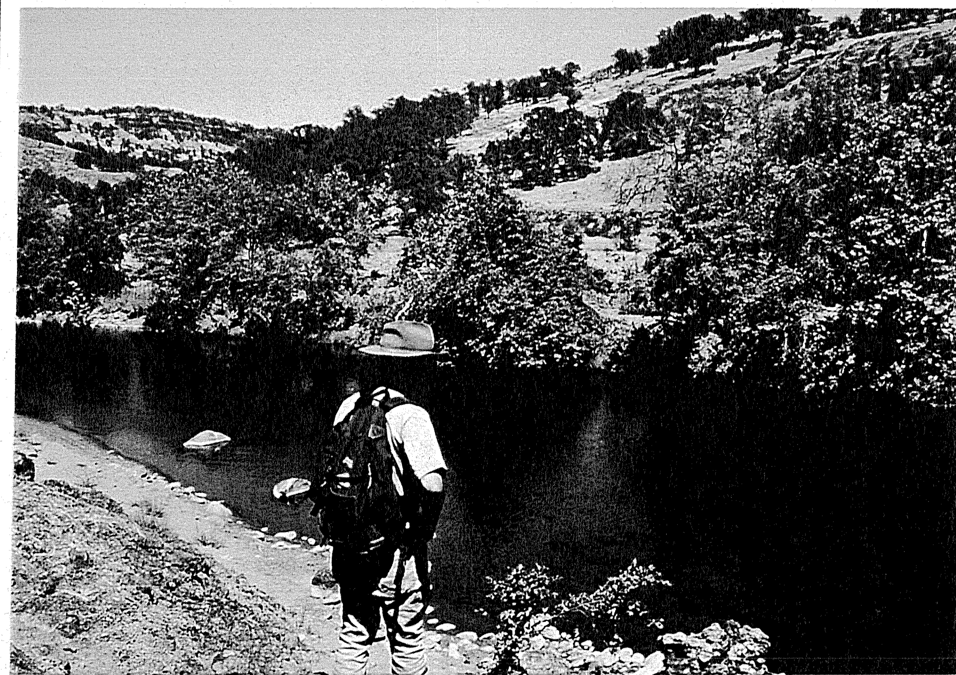


Photo 10-3. Dr. Stacy Li inspecting channel of Deer Creek below the USGS gage following the high flows of the prior winter. (Photo by J. Stanley, June 1997)

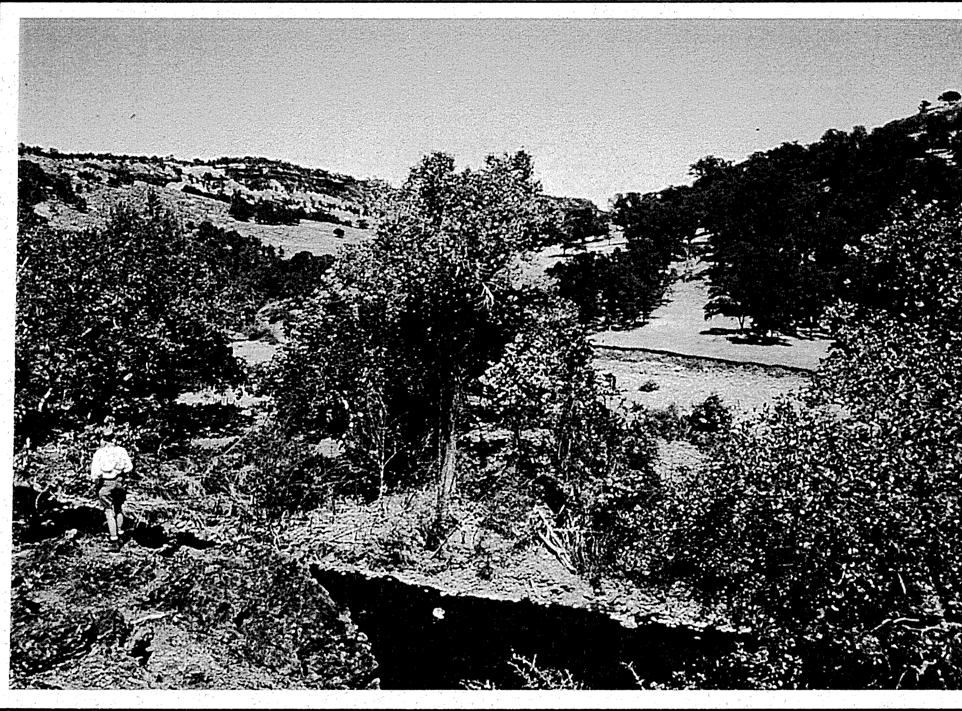


Photo 10-4. Looking upcanyon from north side of Deer Creek upstream of DCID Diversion and downstream of USGS gage. Note erosion on west bank in distance resulting from high flows in January 1997. (Photo by J. Stanley, June 1997)

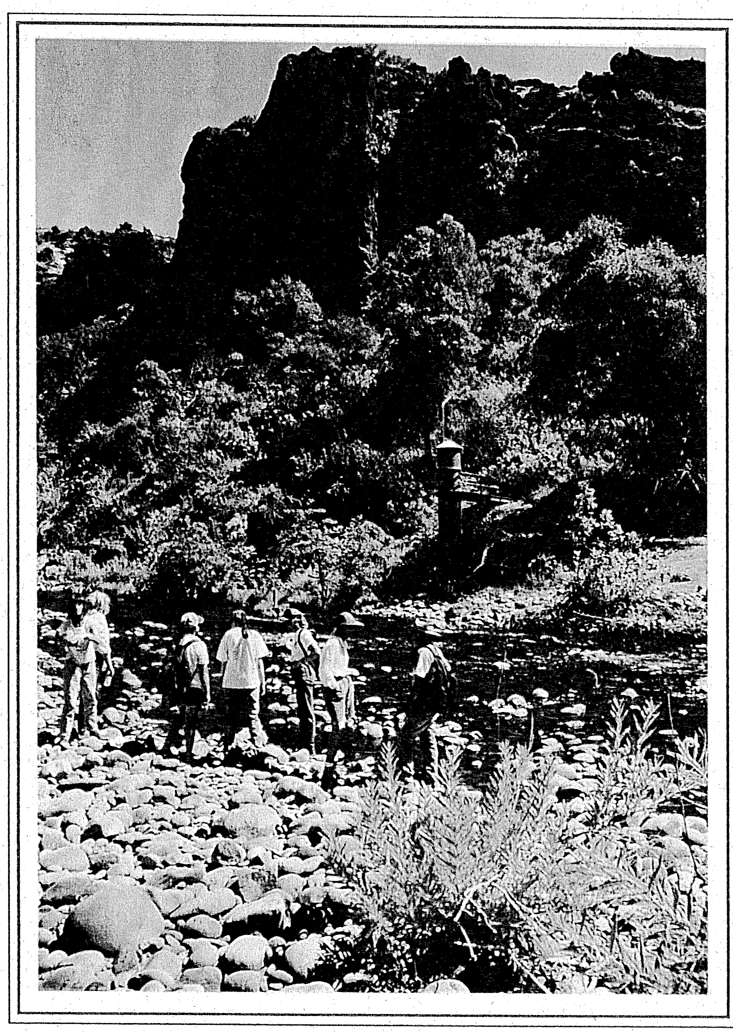


Photo 10-5. USGS gaging station viewed from north side of Deer Creek. (Photo by J. Stanley, June 1997)

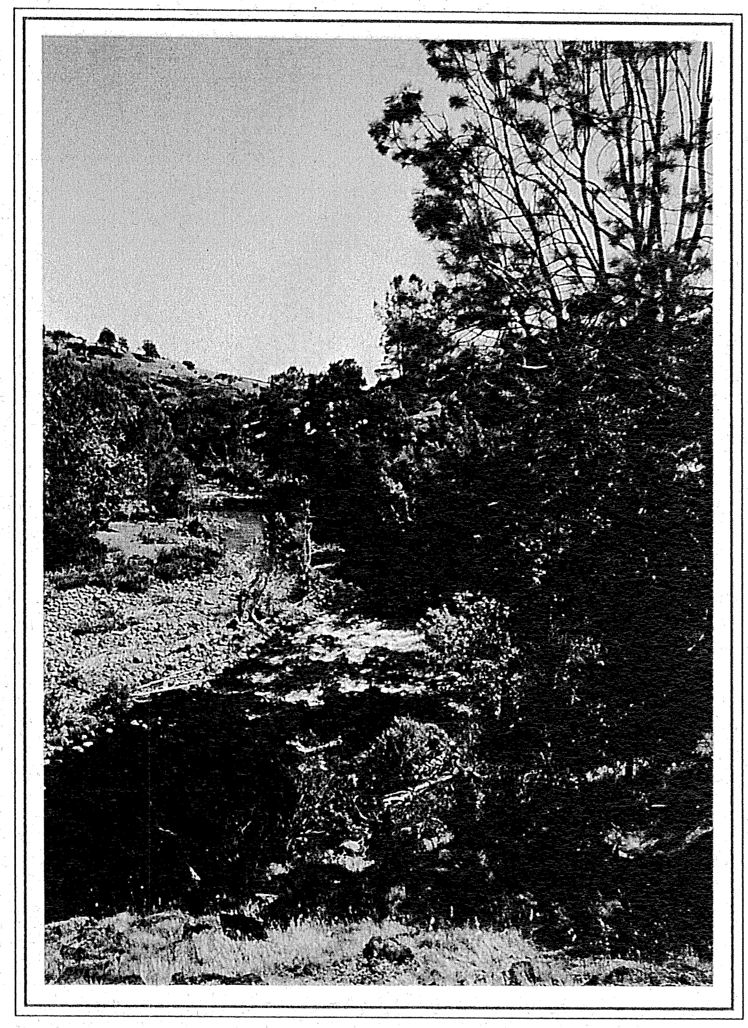


Photo 10-6. Looking downstream from north side of Deer Creek upstream of the DCID Diversion. (Photo by J. Stanley, June 1997)

Photo 10-7. Looking downstream at Deer Creek from the Ishi Wilderness Bridge. (Photo by D. Bland, November 1996)

Photo 10-8. Looking upstream at Deer Creek from the Ishi Wilderness Bridge. (Photo by D. Bland, November 1996)

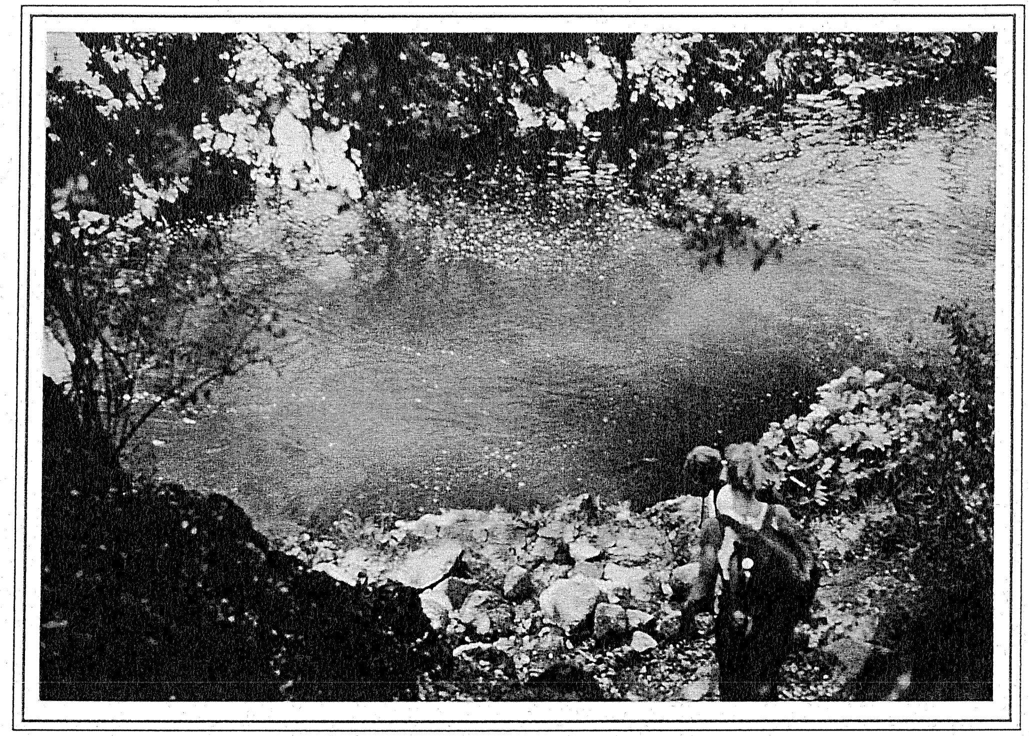


Photo 10-9. Spring run holding area, Upper Deer Creek. (Photo by S. Cepello, 1992)

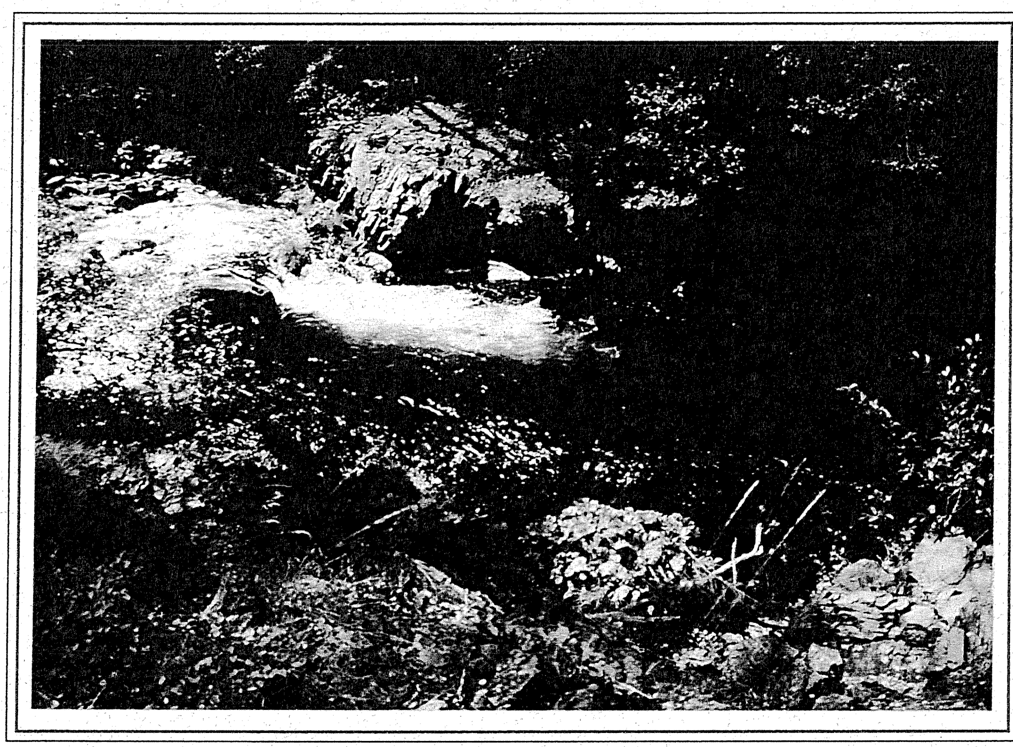


Photo 10-10. Spring-run holding habitat, Deer Creek. (Photo by S. Cepello, 1993)

Photo 10-11. Spring-run chinook salmon holding in Upper Deer Creek. (Photo by S. Cepello)

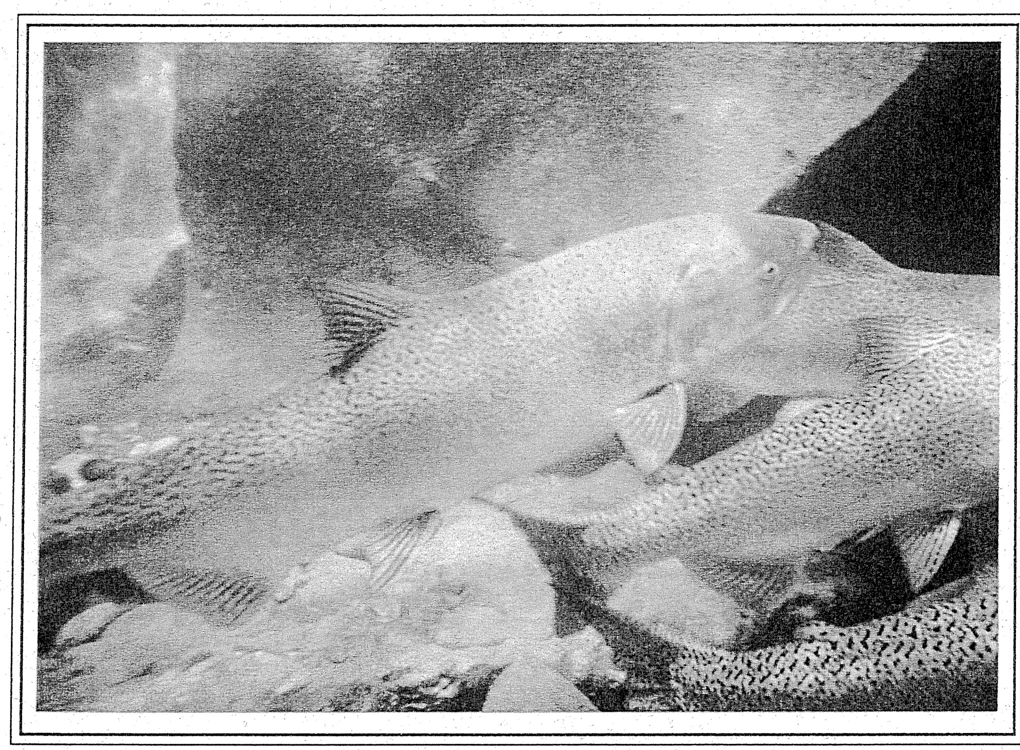


Photo 10-12. Spring-run salmon, Upper Deer Creek. (Photo by S. Cepello)

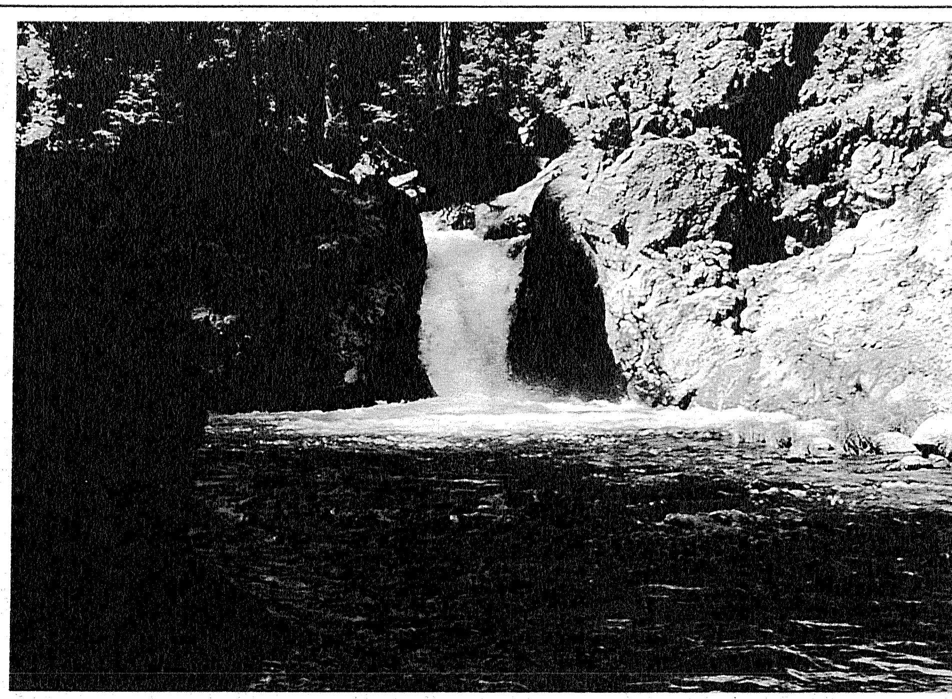


Photo 10-13. Upper Deer Creek Falls-uppermost barrier to fish passage. (Photo by S. Cepello, July 1993)

Photo 10-14. Upper Deer Creek Falls. (Photo by J. Stanley, June 1997)

Photo 10-15. Grate over upper end of fish ladder tunneled through rock at Upper Deer Creek Falls. (Photo by D. Bland, November 1996)

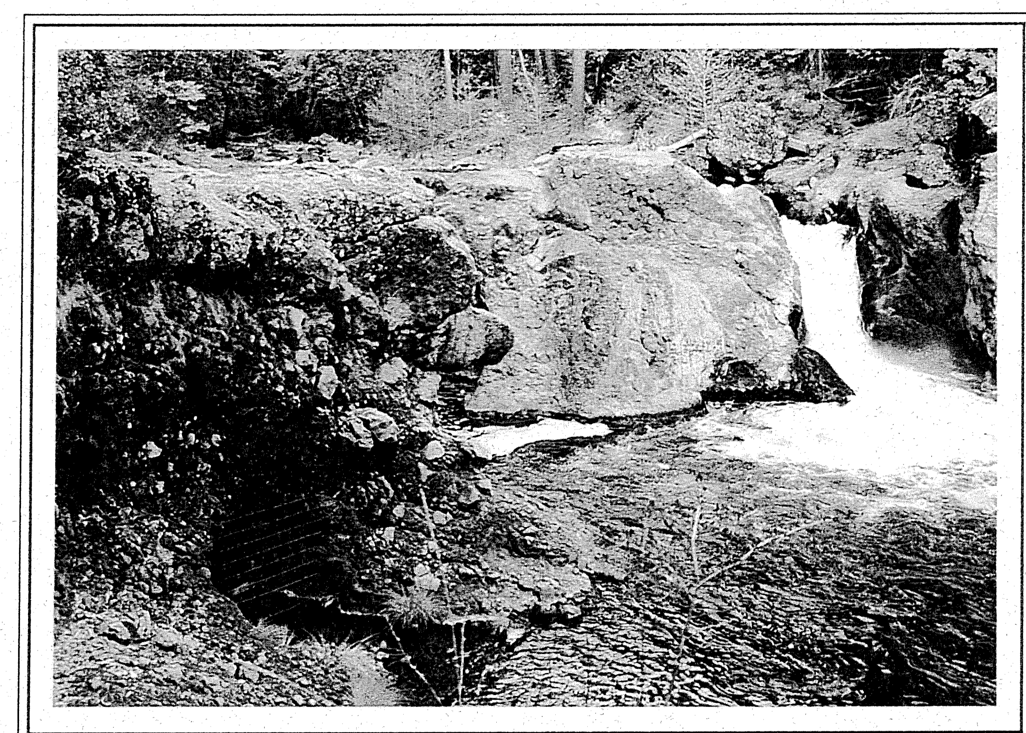


Photo 10-16. Old intake (note wire grate in left hand corner of picture) for fish passage, Upper Deer Creek Falls. (Photo by D. Bland, November 1996)

11.0 FIRE AND FIRE MANAGEMENT

FIRE WEATHER

The nature of the climate on the eastern side of the Sacramento Valley (i.e., hot dry summers with convective summer storms) makes the middle and upper Deer Creek Watershed especially prone to fire. Additionally, the steep slopes of the middle "canyon" reach, much of which is vegetated with chaparral, increase the likelihood of the spread of wildfire.

Lightning during summer and fall causes 70 percent of the wildfires on Lassen National Forest lands. The remaining fires are caused by humans (i.e., arsonists, hunters, anglers, campers, and other Forest users) (USDA Forest Service 1992).

FIRE HISTORY

Fire, ignited by lightning and Native Americans, was common in the Sierra Nevada prior to 20th century suppression efforts. Pre-settlement fire return intervals were generally less than 20 years throughout a broad zone extending from the foothills through the mixed conifer forests (K.S. McKelvey *et al.* 1996). Prior to European settlement, Native Americans residing in the Deer Creek Drainage set frequent fires to achieve desired conditions (e.g., as a means of creating an abundance of preferred herbs and forage for game). Although these fires were eliminated with the coming of Europeans, sheep headers probably set fires between the 1860's and the 1920's in order to improve forage and eliminate saplings invading meadows.

Repeated wildfires have occurred in the Deer Creek Watershed in the historic past. Fire history records indicate a total of 388 fires within the Deer Creek Watershed. Lightning was the cause of 257 of these fires whereas people caused 131 fires. There have been 19 fires that have exceeded 100 acres in size. The sizes of fires decreased dramatically after a policy of fire suppression was instituted in the Lassen National Forest (Taylor 1990). From 1931 to 1982 Lassen National Forest employed an aggressive fire suppression policy (CH2MHILL 1997).

Figure 11-1 shows the locations of some of the larger fires that have occurred in the Deer Creek Watershed since records have been kept. Table 11-1 presents a list of some of the major fires that have been documented in the Deer Creek Watershed since 1943.

The most recent large fire to have occurred in the Deer Creek Watershed was the Barkley Fire that burned 15,304 acres in the middle "canyon" reach in September of 1994. The largest fire of record is the Campbell Fire that burned 28,584 acres in the middle "canyon" reach in August of 1990.

The Deer Creek Watershed Conservancy's Fire Management Committee is in the process of obtaining additional information regarding the history and location of specific fires that have occurred within the Deer Creek Watershed.

Table 11-1. Significant Fires that have Occurred in the Deer Creek Watershed Since 1943.

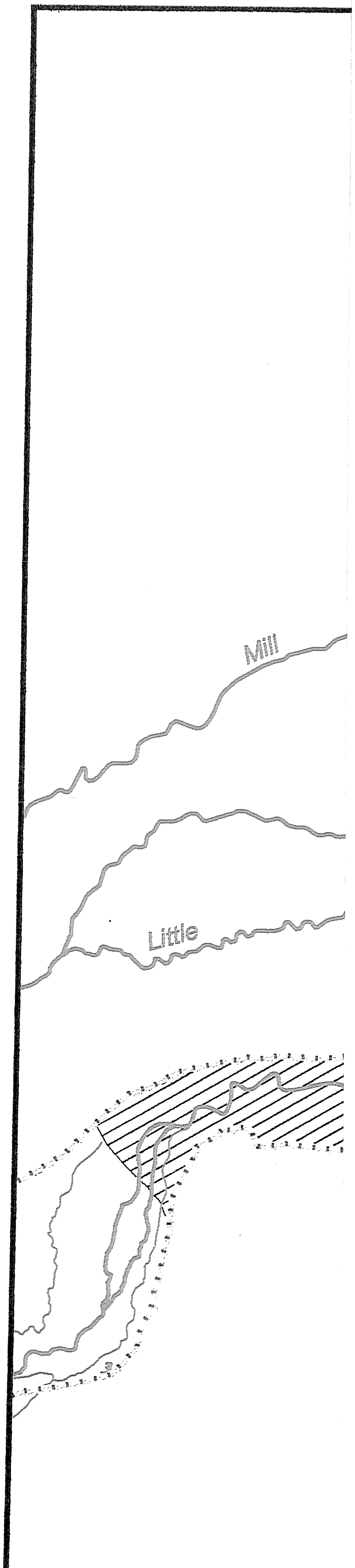
Fire ID #	Fire Name	Date	Fire Type	Total Acres	Acres Burned in Deer Creek Watershed
100	Dry Creek Fire	09-30-43	Unprescribed	7,000	3,314
82	Deer Creek Fire	09-08-49	Unprescribed	1,000	1,224
28	Lightning #6/Brushy	07-23-69	Unprescribed	1,500	119
1	Roney Fire	01-01-79	Prescribed	0	469
105	Brushy Fire	01-01-83	Prescribed	3,300	997
2	Brushy Fire	01-01-84	Prescribed	2,530	469
12	Campbell Fire	08-13-90	Unprescribed	131,499	28,584
126	Barkley Fire	09-18-94	Unprescribed	12,462	15,304

Fire Frequency Within Lassen National Forest Lands

In the Upper Deer Creek Management Area of the Lassen National Forest (USFS Management Area 36), where the forests consist of mixed conifers at the lower elevations and red fir at higher elevations, fires are reported to occur at a rate of about two per year. Well over half are from lightning, and nearly all are smaller than ten acres (USDA Forest Service 1992).

In the Middle Deer Creek Management Area of the Lassen National Forest (USFS Management Area 41), where the forests are mainly comprised of mixed conifers, fires average one per year and are started equally by humans and lightening. While a few large fires burned in the past, none recently has exceeded ten acres (USDA Forest Service 1992).

In the Lower Deer Creek Management Area of the Lassen National Forest (USFS Management Area 42), where there is mixed conifer forest on the ridge tops and oaks, chaparral and grasslands at lower elevations, average fire occurrence is about three fires every two years. Eighty percent are lightening-caused, and rarely do they burn more than 10 acres each. An exception is the Campbell Fire that burned 131,000 acres in the western portion of this area in 1990 (USDA Forest Service 1992).



Mill
Little

Tree Ring Analysis of Fire Scars

In June of 1996, Steven P. Norman and Alan H. Taylor of the Department of Geography at the Pennsylvania State University conducted a study of the fire history of selected sites in the Deer Creek and Mill Creek Watersheds for Lassen National Forest, California. These researchers collected samples from trees and stumps (wedges from live trees and disks from stumps) showing multiple fire scars, cross dated the specimens using the known pattern of marker rings and then analyzed the frequency of fire scars occurring in each specimen. From two to five samples were collected at each site. A total of 36 fire-scarred trees and stumps were collected in the field, although only 30 were considered viable for cross dating and interpretation.

Analysis of data from all sites indicated that there were 78 fires prior to 1900 (i.e., period of tree record from 1800-1899) and 3 thereafter. Samples with over 10 fire scars were not uncommon, but most fire scars collected were dates to the nineteenth century; the researchers believe that the sample if of insufficient size to make inferences of the fire regime before the 1790's.

Fire Interval. The 12 sites evaluated in this study (all of which represent mixed conifer forest sites) present a wide range of mean fire intervals. The maximum historic interval between fires at any of the 12 sites was 56 years. The minimum historic interval was 17 years and the average was 33 years. The mean historic intervals had a range of 11 to 38 years, with a mean of 20 years (Norman and Taylor 1996).

In some locations fire return intervals of less than 10 years were common, especially before 1875. Sites lowest in the landscape (lower slopes and bottomland sites) experienced a fire every 26 years on average, while middle slopes averages 17 years, and upper slopes and ridge tops averaged a fire every 12 years (Norman and Taylor 1996).

These fire return intervals for mixed conifer forest sites in the Mill Creek and Deer Creek Watersheds appear somewhat consistent with the results of other researchers. Solem (1995) described a mean fire interval of 19 years in the mixed conifer communities of the Caribou Wilderness of Lassen National Forest. In the Siskiyou Mountains of Oregon, fire return intervals averaged 18 years (Agee 1991).

Fire Frequency. The distribution of fire through time varied considerably. Although fires all but stopped at the turn of the twentieth century, the period from 1875 to 1899 experienced significantly fewer fire events than had the two previous 25-year periods (Norman and Taylor 1996).

Season of Burning. In a few locations, the season of burning also varied through time. Most fires occurring in the watersheds occurred during the dormant season, after the trees had stopped growing. Yet significantly, 11 percent of the fires occurred late in the growing season, and 9 percent occurred during the primary growing season. Of interest, these non-dormant fires were relatively site-specific (i.e., some sites appear more vulnerable to non-dormant season fires than others do) (Norman and Taylor 1996).

Fire Regime. The 12 sites studied by Norman and Taylor showed significant variation in their fire regimes. Light ground fires are suggested by low fire-return intervals for some sites. These fires may have been less likely to leave a record of their passing than more intense fires. As a result, the inferred fire-return intervals presented in this study must be deemed maximum intervals. At minimum, the fires burned with this frequency, but more events undoubtedly occurred, which either did not scar the trees or were not sampled (Norman and Taylor 1996).

Fire Frequency by Topographic Position. Upper slopes and ridge tops exhibited frequent fires; once every 11 to 13 years on average, but occasionally experienced return intervals comparable to some of the least burned site. Middle slopes burned every 14 to 24 years on average, apparently independent of aspect. Lower slopes typically burned much less often than sites further up slope and experienced fires every 25 to 30 years on average (Norman and Taylor 1996).

Implications for Land Management. Norman and Taylor (1996) concluded that "Perhaps the most critical results of this study for land management are the marked differences between the time since the last fire and the known maximum interval of the range before fire suppression. All sites have greatly exceeded their maximum fire return interval of the 1800's. Some locations . . . should have experienced at least four fires since the last recorded fire event even when the maximum return interval of the last century is applied". They suggest that " The unavoidable increase in fuel loading and probable modification of species regeneration patterns and wildlife habitat that normally follow such a significant change in the natural fire regime may have also reached levels unmatched at any time during the last few centuries" (Norman and Taylor 1996).

FIRE ECOLOGY

Fire has played an important role in shaping the composition and structure of the montane coniferous forests in the Sierra Nevada and Cascade Range. The plant communities in the middle and upper Deer Creek Watershed have evolved over time to co-exist with the natural fire regime. Many of the shrub-dominated communities (i.e., chaparral) require fire to maintain health and vigor.

Changes in Forest Composition and Structure in Response to a Changed Fire Regime

Fire strongly influenced the composition and structure of forests in the Deer Creek Watershed prior to European settlement. The elimination of fires started by Native Americans followed by effective fire suppression beginning in the early 1900's have resulted in fire frequencies very different than those prior to European settlement. It is estimated that 3 to 10 fire cycles have been removed from lower elevation pine and mixed conifer forests in Lassen National Forest since 1905 (Taylor 1997). In high elevation red fir forests, it is estimated that 1 to 3 fire cycles have been lost over the same period (Taylor 1997).

It has been observed that there has been a shift in tree species composition in the mixed conifer forests on Lassen National Forest lands as an indirect result of fire suppression. White fir, a shade tolerant species, has invaded the understory of many of the forested areas. Without fire the shade intolerant forest tree species will be unable to regenerate, the result being not only a shift in species composition of the forest but also a decrease in plant species diversity (pers. comm. Ken Roby).

Department of Fish and Game biologists have expressed concern that because of fire suppression there has been a general loss of productivity of the forests for deer (refer to Chapter 9.0). Apparently, there have not been any major fires on the summer range of the East Tehama Deer Herd since the early 1940's.

More information is needed on the trends in species composition, which are occurring on the forested lands in the Deer Creek Watershed. Evaluations need to be made of the effects of these shifts in plant species composition on the wildlife species that depend on these forested areas.

Additional information is also needed on the age structure of the forested areas within the watershed.

FIRE PROTECTION

Prevention, detection, presuppression, suppression, and fuels management are the five programs in fire protection on the lands of the Lassen National Forest within the Deer Creek Watershed. Prevention includes public contracts, law enforcement, building inspection, and patrols. Detection activities are carried out through use of fire lookouts and aerial (aircraft) surveillance. Presuppression involves arranging for fire forces, training, equipment, and structural improvements before they are needed. Suppression includes fire-fighting activities with hand crews, engines, helitack, retardant aircraft, etc. Fuels management prevents or reduces fires by removing or rearranging logging slash, brush, or other accumulations of burnable material (USDA Forest Service 1992).

The Susanville Interagency Fire Center (SIFC) is shared by the Forest Service, Bureau of Land Management, Lassen Volcanic National Park, and the California Department of Forestry. SIFC dispatches suppression forces, monitors air operations, and coordinates other fire operations for all agencies jointly.

The Forest Service conducts prescribed burns within Lassen National Forest. Acreage is burned to dispose of logging and thinning slash, prepare areas for timber or range regeneration, reduce hazardous brush accumulations, improve wildlife habitat and livestock forage, or to improve water yields. The use of prescribed fire is being studied as a means of returning fire to its natural role in the ecosystem within the Ishi Wilderness (USDA Forest Service 1992).

In cooperation with CDF and adjacent landowners, the Forest Service conducts prescribed burns on hundreds (?) of acres each spring in the front country near lower Deer Creek (USDA Forest Service 1992). More information is needed on the past and anticipated use of prescribed fires in the Deer Creek Watershed.

FIRE HAZARD AND FIRE HAZARD REDUCTION

"In the 20th century the areal extent of fire" (in the Sierra Nevada) "was greatly reduced" (due to fire suppression efforts). "This reduction in fire activity, coupled with the selective harvest of many large pines, produced forests which are today denser, with generally smaller trees, and have higher proportions of white fir and incense cedar than were present historically. These changes have almost certainly increased the levels of fuel, both on the forest floor and "ladder fuels" – small trees and brush which carry the fire into the forest canopy. Increases in fuel, coupled with efficient suppression of low and moderate intensity fires, has led to an increase in general fire severity" (McKelvey, K. S. *et al.* 1996).

Fuel Loads and Fuel Management

Lassen National Forest has inventoried dead and down fuel loadings within the Deer, Mill and Antelope Creek Watersheds. Most of the heavier fuel loadings exist at higher elevations of within the Deer Creek Watershed (Forbes 1996). An average range of 3 to 43 tons per acre were recorded within the Deer Creek Watershed (Forbes 1996).

Prescribed fire is just one strategy applied by the Forest Service in fuels management. The Forest Service considers timber sales as providing the primary opportunity for fuels management. Lassen National Forest also treats excess fuels (both activity caused and natural) by rearranging it into less flammable configurations, or utilizing it for products such a posts, chips, fuelwood or biomass the objective being to reduce the potential for a damaging wildfire (USDA Forest Service 1992).

Fire Management Plan

There is apparently no fire management plan for Lassen National Forest lands nor is there a let burn policy (pers. comm. Ken Roby).

The Deer Creek Watershed Conservancy has begun the process of developing a Fire Management Plan for the Deer Creek Watershed. Measures for the protection of private property and commercial forest resources will be addressed in this plan. This plan is being developed in conjunction with the California Department of Forestry and Fire Protection, Lassen National Forest and the Mill Creek Conservancy.

AVAILABLE MAPPED INFORMATION

1. **Fire History in Tehama County**
Source: California Department of Forestry
Coverage: Shows extent of fires (300 acres or more) within Tehama County CDF Ranger District
Scale: 1:24,000 and 1:63,650 (1" = 2,000' and 1" = 5,280')

2. **Fire Hazard Severity Zones**
Source: California Department of Forestry
Coverage: Fire Hazard Severity Zones for CDF Ranger Units Statewide
Scale: 1:24,000 (1" = 2,000')

3. **Fire History**
Source: U.S. Forest Service, Lassen National Forest
Coverage: Composite of significant fire boundaries covering areas from headwaters down to USGS Gaging Station
Scale: 1:24,000 (1" = 2,000')

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12.0 RECREATIONAL RESOURCES

INTRODUCTION

The Deer Creek Watershed provides a wide variety of outdoor recreation opportunities, including sightseeing, camping, hiking, backpacking, fishing, whitewater boating, horseback riding and nature appreciation. Most of this recreation occurs on public lands in the upper watershed (from the various sources of Deer Creek to the western boundary of the Lassen National Forest). Except at a few limited points, recreational access is extremely limited in the lower watershed due to the predominance of private land.

Public Access

The primary visitor attraction in the upper watershed is the Deer Creek/Highway 32 corridor. This highly scenic corridor offers three developed and popular campgrounds at Elam Creek, Alder Creek and Potato Patch, numerous access points for anglers, two waterfalls, and the upper Deer Creek hiking trailhead. Highway 32 is also a key route for tourists visiting Lassen Volcanic National Park, Lake Almanor, and other regional recreation attractions. Highway 32's narrow, winding character and its relatively high level of use on summer weekends have prompted calls for highway improvements and widening.

Other attractions in the upper watershed include the Gurnsey Creek and Lost Creek campgrounds, privately owned resorts along Highways 36/89 which offer cabin rentals (Childs Meadow, Fire Mountain Lodge, and Deer Creek Lodge), the Pacific Crest Trail along the eastern rim of the watershed, and the Ishi Wilderness downstream. Secondary roads such as Ponderosa Way and road 27N08 ("A Line" road) provide access to primitive campsites and trailheads where they cross Deer Creek.

Approximately 36 percent of the public land in the upper watershed are managed by the Forest Service for wilderness or semi-primitive recreation. Much of the remaining public land is managed for timber with some constraints to protect visual quality, water quality, and fish and wildlife habitat. The extensive road system on public and private lands in the upper watershed facilitates timber management and is also used by hunters and others for dispersed recreation.

Most of the lower watershed (from the western boundary of the Lassen National Forest to Deer Creek's confluence with the Sacramento River) is privately owned range and agricultural land. Public recreation is limited in the lower watershed due the predominance of private lands and lack of public access. The Bureau of Land Management (BLM) administers some scattered parcels of public land in the lower watershed but recreation is almost non-existent on these parcels because there is no public access. Some fishing and boating access occurs at the Highway 99 crossing of lower Deer Creek. The confluence of Deer Creek with the Sacramento River is a popular access point for anglers and is located on public land managed by the California Department of Parks and Recreation as part of the Woodson Bridge State Recreation Area.

Camping

The upper watershed has five developed public campgrounds, one public group campground, one developed day use area, and several primitive camping areas managed by the Forest Service (see Figure 12-1). One undeveloped campsite on private land just downstream of Deer Creek Meadows has been fenced to prevent camping and to restore the site to its natural riparian habitat. The public campgrounds in the upper watershed provide a total of 94 campsites and one group campsite suitable for 20 people.

The Forest Service plans to rehabilitate the Gurnsey Creek campground and establish a lower Deer Creek rest area, but these projects are not on the priority list for the first decade of forest plan implementation (USDA 1992). The primitive campsite at the road 27N08 crossing receives little or no regular maintenance and is located near important spring run salmon holding habitat. Since the institution of fishing regulations along Deer Creek, this use of this primitive camp has probably declined.

The only developed camping opportunity for the public in the lower watershed is at the Woodson Bridge State Recreation Area. This state facility provides 41 campsites and one large group campsite.

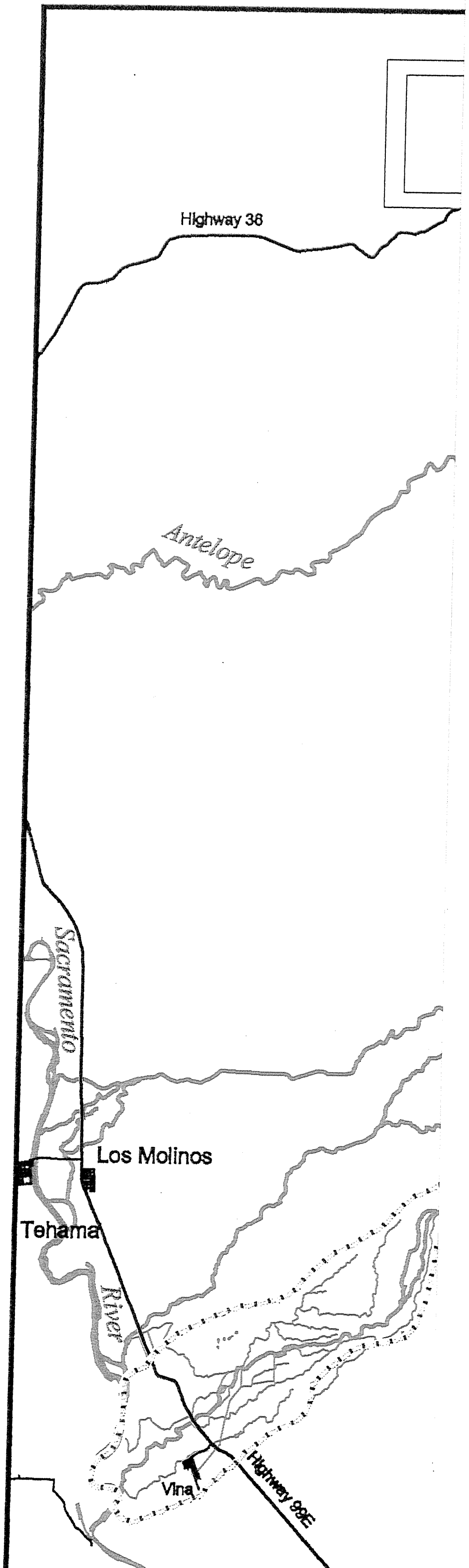
Picnicking

Picnicking is generally associated with road access and at developed recreation sites in the upper watershed (see Figure 12-1). It also occurs at the Leininger Road Bridge and at the Woodson Bridge State Recreation Area in the lower watershed.

Hiking

Popular hiking trails in the upper watershed include a portion of the upper Deer Creek Trail and the Pacific Crest National Scenic Trail, several trails in the Ishi Wilderness, and numerous angler access trails along Highway 32. The trailhead for the Spencer Meadow National Recreation Trail is located within the Deer Creek Watershed but most of the trail is located within the adjacent Mill Creek Watershed. Unmaintained secondary trails provide access to Polk Springs, the Devil's Parade Ground, and Carter Creek. The Forest Service has plans for several trail and trailhead construction and reconstruction projects in the upper watershed, including Ishi Wilderness trails and trailheads for the lower Deer Creek Trail and the Pacific Crest Trail at Humboldt Summit (USDA 1992).

Portions of the upper watershed encompass the 41,000 acre Ishi Wilderness, which was established by Congress in 1984. Ponderosa Way has three Ishi Wilderness trailheads that access the lower Deer Creek Trail, the Moak Trail, and the Devil's Den Trail. Portions of three historic trails — the lower Deer Creek Trail, Steamboat Ridge Trail, and Sulphur Creek Trail — meet at the confluence of Sulphur Creek and Deer Creek. These trail segments are located on private inholdings in the Ishi Wilderness. Although these trail segments have no public easements, continued public use has resulted in trespass and vandalism problems for the private inholders.



Highway 36
Antelope
Sacramento
Los Molinos
Tehama
River
Vina
Highway 99E

More than 1,500 acres of the southern portion of the Ishi Wilderness in the lower Deer Creek Watershed have no legal public access because of the pattern of private inholdings and lack of public easements on existing trails.

Fishing

Fishing for catchable (hatchery) trout is a dominant recreation activity along the Highway 32 corridor in the upper watershed. The Department of Fish and Game plant Deer Creek upstream of upper Deer Creek Falls with catchable trout. State fishing regulations prohibit take of salmon throughout Deer Creek. Downstream of upper Deer Creek Falls, State regulations require catch and release fishing with the use of barbless hooks and artificial lures only to discourage inadvertent take of salmon. No take of salmon or trout is allowed downstream of the USGS stream gauge where Deer Creek flows out of the foothills and into the Sacramento Valley.

Hunting

Hunting for deer, dove, quail, and turkey is a popular seasonal activity in portions of the Deer Creek Watershed. Much of the watershed north of the creek proper and west of Round Valley is located in a state game refuge, which is off limits to hunting.

Off-Highway Vehicle Use

The upper watershed has one designated off highway vehicle (OHV) trail. The Murphy OHV Trail provides access to Deer Creek through the Devils Parade Ground. Use of this trail is relatively light. OHVs and high clearance vehicles also use existing logging roads and secondary roads throughout the watershed to gain access for fishing, hunting, and other dispersed forms of recreation.

Winter Sports

The so called "Carter Bowl" area of the 7,866 foot-high Butt Mountain in the upper watershed is reserved for potential future downhill ski area development by the Forest Service (USDA 1992). There is currently no active proposal to develop this area for downhill skiing. The Carter Bowl area is the headwaters of the South Fork of Deer Creek. The development of this area for downhill skiing would probably require extensive widening of Highway 32 to accommodate additional traffic and could create water quality problems in upper Deer Creek. Some cross country skiing and snowmobiling occurs at Carter Meadow and Childs Meadow when cold winter storms drop sufficient amounts of snow at mid-elevations.

Whitewater Boating

Deer Creek offers more than 40 miles of expert-only Class IVV spring season boating for kayaks, whitewater canoes, and small rafts. At least three whitewater guidebooks provide information on whitewater boating on Deer Creek (Martin 1974, Holbek & Stanley 1988, Cassady & Calhoun 1990). According to Holbek and Stanley, "The wilderness journey through Deer Creek Canyon is one of the finest in California." Cassidy and Calhoun state that "...experts who can handle the non-stop rapids and the possible portages will find themselves in one of the most gorgeous wild river canyons anywhere."

Whitewater boaters begin their run either at Potato Patch Campground or Ponderosa Way . The runs normally require at least two to three days and numerous portages. The normal boating season for Deer Creek is April through May, although the season is extended during high water years. The difficulty of the run and access problems in the predominantly privately owned lower watershed generally restrict whitewater boating, although this run is becoming increasingly popular among experts. Private landowners are concerned about trespass, litter, fishery impacts, and wildfire issues associated with whitewater boating. Reportedly, there is no public access easement associated with the Leininger Road take out. Numerous problems are occurring between trespassers and private property owners. Lately, many citations have been issued.

Recreation Demand

Currently, the Lassen National Forest supports twice as much developed recreation as dispersed recreation (USDA 1992). Much of this use is from local counties in the region (Tehama, Lassen, Plumas, Butte, Glenn, Yuba, Sutter). Statewide trends indicate an increase in overall recreation demand corresponding to the increase in population in the region. From 1990 to 1995, recreational use of public land nationwide, including fishing, hiking, and camping, increased about 17 percent (GAO 1997). Current developed and dispersed recreation demand outstrips recreation supply on the forest by 20 percent and 11 percent respectively. By the year 2030, developed and dispersed recreation demand will outstrip recreation supply on the forest by 48 percent and 61 percent, respectively.

The increase in recreation demand, coupled with the short supply, argues for more public investment in providing recreational opportunities, as well as additional management to ensure resource protection and reduce user conflicts. However, this requires an increased budget. Federal, State, and local budget outlays for recreation have actually declined in the last decade.

In addition, accommodating significantly increased recreation use in the watershed could have an adverse impact on the watershed's sensitive natural values, including endangered spring run chinook salmon and winter steelhead, water quality, wildlife, cultural sites, scenery, and the primitive recreation experience. Increased recreation could also adversely impact private property rights. At the minimum, continued and increased coordination between public and private entities is needed to address the many unresolved issues associated with recreation use in the Deer Creek Watershed, as well as to manage recreation activities, protect public lands and resources, and private property rights.

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13.0 ARCHAEOLOGICAL AND HISTORICAL RESOURCES

INTRODUCTION

The following compilation is taken largely from The Resources Agency of California Deer Creek Wild and Scenic River Suitability Report (1994) with the cultural resource sections written by Dana McGowan and Steve Heipel. The 1994 report deals with a two-mile wide corridor divided by the creek itself and includes different reaches from its upper origination to its terminus than dealt with in other chapters of this document. However, when considered in light of The Resources Agency report and added data provided by this writer, a considerate appreciation of the archaeological and historical values of the watershed can be garnered. Furthermore, when the reader appraises the historical summaries offered elsewhere herein, the heritage picture becomes more complete.

Cultural resources (prehistoric, historic and ethnographic) in the Deer Creek drainage are among the most significant in the State. The cultural history of the Deer Creek area is in many ways unique, and the archaeological sites that provide evidence of this history represent irreplaceable resources that are important to both scientific and educational orientations to this stream. Some sites are of public interpretive value. Appendix F in the 1994 report discussed above provides more detailed information on cultural and historical resources in the watershed and formed the main source for this chapter. The following discussion is not a history of the watershed but more of a heritage resource appraisal geared toward cultural resource appreciation, protection and education.

DATA SOURCES AND METHODOLOGY

The evaluation of the prehistoric and historical resources of the Deer Creek Watershed was based on conversations with resource experts and review of numerous published and unpublished sources. The extensive files of the Almanor Ranger District, Lassen National Forest, were examined to gather information on documented archaeological sites, inventory and excavation reports, and National Register of Historic Places (National Register) evaluations and nominations. The input of Diane Watts, Almanor Ranger District archaeologist, was particularly valuable for the assessment of cultural resources in the upper reaches of Deer Creek. Other individuals with an in-depth personal knowledge of the archaeological resources of Deer Creek were consulted regarding current research issues and for additional advice on resource values in the study area. These individuals included: Dr. Jerald J. Johnson, California State University, Sacramento; Greg Greenway, Mendocino National Forest; James D. Johnston, Lassen National Forest; Elena Nilsson, Dames and Moore, Chico; and Dr. Mark Kowta, California State University, Chico.

The published and unpublished literature used to characterize the prehistoric, ethnographic, and historic past of the Deer Creek drainage included previous cultural resources investigations, an extensive array of ethnographic and ethno-historical material concerning the Yana in general and

Ishi, the last Yahi Yana, in particular. General Land Office (GLO) survey plats, USFS and other historical maps, county and forest histories, and the site records filed at both the Almanor Ranger District and the Northeast Information Center at California State University, Chico, also provided valuable cultural resources information.

RESOURCE CHARACTERIZATION

Prehistory

Much of our understanding of the prehistory of the southern Cascade Range foothills has come from archaeological investigations conducted within the Mill and Deer Creek Watersheds since the early 1950s. Past research has included: 1) extensive and intensive surface inventories; 2) subsurface excavations at sites such as Kingsley Cave (CA-TEH-1 — official State site numbering designation), Dead Man's Cave (CA-TEH-290), CA-TEH-563 in the Ishi Wilderness, and Spider Rockshelter (CA-TEH-1432); and 3) excavations at nearby localities with demonstrable temporal and cultural similarities to the current study area. Because the Deer Creek drainage originates high in the mountains and terminates within the Sacramento Valley, it straddles two distinct cultural areas: the southern Cascade Mountains and the northern reaches of the Central Valley. Information on the archaeological reconstruction's of prehistory in both of these areas is described in the 1994 Resources Agency report previously cited.

Southern Cascade Mountains

Between 1952 and 1956, the University of California, Berkeley, undertook the excavation of two archaeological sites within the project vicinity. The analysis and interpretation of materials recovered from Kingsley Cave (CA-TEH-1), above Mill Creek, and Payne's Cave (CA-TEH-193), on Antelope Creek, resulted in the first formal reconstruction of a prehistoric temporal and cultural framework for the area (Baumhoff 1955, 1957). A two-phase sequence, consisting of an early Kingsley Complex, followed by the Mill Creek Complex (associated with ethnographic Yana occupations), was postulated at this time. A significant amount of research has occurred in subsequent years, much of which was conducted by field schools or students from the University of California, Davis, and California State University, Sacramento, or both, and the Bureau of Land Management and Forest Service. These more recent studies resulted in the refinement of the Kingsley and Mill Creek Complexes and the addition of three new periods, including an early Deadman Complex, the intermediary Dye Creek Complex, and the Historic Yana Complex, the latter occurring during the period from 1845 to 1911.

Northern Central Valley

Efforts to define the prehistoric sequence of the Sacramento Valley originated in the late 1890s but did not begin in earnest until the 1930s. In that decade, Sacramento Junior College and the University of California, Berkeley, conducted a number of excavations in the Sacramento-San Joaquin River Delta and along the major drainage systems entering the Central Valley. The interpretations of the materials recovered during these excavations included: 1) the definition of Early, Middle/Transitional, and Late periods which eventually led to the establishment of the Central California Taxonomic System and 2) the identification of the well-known Early, Middle, and Late Horizons (Beardsley 1948, 1954; Lillard and Purves 1936; Lillard et al. 1939; Moratto 1984). Recognizing that the archaeological assemblages associated with this generic, three-phase classificatory scheme were not always evident in all parts of central California, subsequent research has focused on the definition and interpretation of the regional expressions of those sequences that pertain to lower reaches of Deer Creek within the current study area.

Research Models

One of the prehistoric research topics of considerable interest to many investigators working in the northern Sacramento Valley is oriented toward the refinement and understanding of the large-scale population movements that took place before Euro-American contact in the region. Nilsson et al. (1991) present a brief summary of the issues related to this topic and the models, hypotheses, and views of researchers who have been most prominently involved in the debate. The hypothesized movement of Penutian-speaking peoples into the northern valley and the resulting displacement of Hokan speakers (e.g., the Yana/Yahi) into the surrounding foothills, may have begun in the past 1,500 years and is thought to have been a dynamic interaction still taking place when Euro-American explorers first entered the region (Johnson and Theodoratus 1984).

Other regional research topics related to prehistoric peoples include culture chronology and technology, subsistence and settlement (mobility) strategies, the interplay of cultural and natural ecology from a dynamic perspective, trade and exchange, social and political organization, ideology, and management of the cultural resources themselves. When considering the historic remains from settlers and itinerants alike, there are numerous research and education avenues open that can include oral history, archival research and field archaeology. These relate to early settlement and homesteading, historic roads and trails, architecture and engineering, commerce, lumbering, turpentine extraction, power development, ranching and agriculture, water control, railroad construction, recreation development, mining, Native American contact, community development, etc. Historical and prehistoric archaeology share many goals and opportunities are plentiful in the watershed for such studies providing the remnants are protected. Historical archaeology can serve as a supplement to history. Studies can be conducted on reconstructing past lifeways, understanding the process of culture and culture change; ethnic studies, such as with evidence left by the Chinese or other minorities; gender roles of the pioneers and later regional inhabitants, social and political changes, etc.

CULTURAL RESOURCE DATABASE

Because of the size and complexity of the Deer Creek Watershed, the following discussion of the cultural resource database is presented using a framework of four discrete stream reaches (i.e., Butt Mountain to lower Deer Creek Falls, Deer Creek Falls to the eastern Ishi Wilderness boundary, the Ishi Wilderness, and western Ishi Wilderness boundary to the Sacramento River). These are based on The Resource Agency's analysis and are not congruent with other sections of the Deer Creek Watershed Conservancy report). These reaches were identified by The Resources Agency based on a combination of archaeological, historical, managerial, and geomorphological factors. But they are, in essence, arbitrarily defined areas intended to simplify the ensuing analysis. They do not necessarily coincide with any particular orientation to the Deer Creek drainage during the prehistoric or historical past.

Butt Mountain to Lower Deer Creek Falls

This 18 mile-long reach incorporates the headwaters of Deer Creek near Butt Mountain, trends north for several miles to Deer Creek Meadows where the drainage bends to the southwest. The study reach continues approximately 9 more miles to lower Deer Creek Falls, about one mile downstream from the point where Highway 32 leaves the stream. For most of its length, within this study reach, Deer Creek is closely paralleled by developed roads, principally Highway 32. The private resort developments in and around St. Bernard, Deer Creek, and the Black Forest Lodge are located within this study reach. The study corridor in this vicinity incorporates more than 20,000 acres of privately owned and Federally managed lands.

Previously Recorded Sites. A review of the site record files maintained at the Lassen National Forest (Almanor Ranger District) and at the Northeast Information Center in Chico as of 1994 indicated that only 10 archaeological sites have been recorded within this reach of Deer Creek. This total includes eight prehistoric sites and two historical sites. Most of these recorded properties are relatively small scatters of flaked and/or ground stone artifacts and reflect task-specific activities oriented toward resource procurement or processing. However, one basalt quarry (CA-TEH-1586) and one resource classified as a "temporary campsite" have also been identified (University of California Archaeological Survey n.d.), indicating more than casual use of this area during the prehistoric past. The two historical sites documented in the Butt Mountain to Deer Creek Falls reach are the Smith Cabin and an unnamed late nineteenth- or early twentieth-century deposit, both on private land within Deer Creek Meadows.

Given that 10 sites have been found when only about 7.5 percent of this study reach has been adequately inventoried and that the private lands along Deer Creek in this area are largely unsurveyed, as many as 100 archaeological sites may be present in this reach. In addition, the upper reaches of Deer Creek are at the point of contact between Yana and Maidu ethnographic populations. Little systematic archaeological excavation has occurred in this region and nearby sites have been found to be significant (see Greenway 1982). The archaeological record in this area has considerable potential to expand our understanding of prehistoric adaptations to this area. The historical resources that remain from the 1860s and 1870s recreational movement in this same area are also of potential importance to our knowledge of this time period.

Designated Properties. No resources with formal designations (e.g., National Register properties, State Historical Landmarks, Points of Historical Interest) have been identified within this reach of the Deer Creek study area.

Lower Deer Creek Falls to Eastern Boundary of Ishi Wilderness

This reach incorporates approximately 14 linear miles of the Deer Creek drainage, extending from Deer Creek Falls, past the Polk Springs vicinity, and terminating at the eastern boundary of the Ishi Wilderness. This study reach incorporates approximately 15,000 acres of land in the two mile wide corridor, most of which is managed by Lassen National Forest. With the exception of a north-south-trending road near the Wilderness boundary, this area is virtually inaccessible except by trail.

Previously Recorded Sites. Lassen National Forest and Northeast Information Center files as of 1994 indicate the presence of 30 archaeological sites within this reach's corridor of Deer Creek. This total includes 19 prehistoric sites, four historical sites, and seven resources with both prehistoric and historical components. The recorded prehistoric sites represent a relatively even mixture of resources classified as "lithic scatters", "occupation sites", and "temporary campsites" (University of California Archaeological Survey n.d.). This reach of the Deer Creek study area contains the uppermost of the prehistoric and contact-period occupation rockshelters that continue to be found in downstream stretches of the stream. Just beyond the corridor within this reach on BLM land a historic road, road camp and probable evidence of Civil-war era turpentine extraction were recorded.

The historical sites documented in the Deer Creek Falls to Ishi Wilderness reach include materials associated with a number of late nineteenth and early twentieth century occupations by Euro-Americans (e.g., Lee Gaithers Camp [CA-TEH-200] and the Matkins Site [CA-TEH-704]). The unique historic-era sites are those associated with the placer mining activities of the Polk Springs District, which occurred between circa 1880 and 1935 and the 1860s turpentine sites. Mined-out areas, occupational areas, ditches, and flumes have all been encountered in the mining area. Because of the geologic setting, sites of this ore removal type are unusual in the Deer Creek Watershed. The turpentine extraction sites are part of a larger system that extends locally to at least the Paradise Ridge area where former distilleries were located.

With an inventory of about 15 percent of this study reach corridor leading to the recording of 30 prehistoric and historical sites, as many as 150 archaeological properties may still remain to be identified along this two-mile wide stretch of Deer Creek, along its tributary streams, and in caves and rockshelters situated on the rugged cliffs of the area. Even more sites would be expected away from the corridor within the watershed, but probably at a lower density. The nature and distribution of the identified and unrecorded sites within this study reach in relation to those upstream and downstream of this location provide an excellent opportunity to study seasonal transhumance patterns of the Yahi and their predecessors. In particular, the evaluation of ecological models such as that presented by Wiant (1981) could be tested. Because of the unique mining resources and turpentine related sites in the pineries located here and the fact that much of this study reach has been relatively free from post-contact developments, the value of the cultural resources is further enhanced.

Designated Properties. No resources with formal designations (e.g., National Register properties, State Historical Landmarks, Points of Historical Interest) have been identified within this reach of the Deer Creek study area.

Ishi Wilderness

This reach of Deer Creek winds westerly for about nine miles, coursing through the southern portion of the Ishi Wilderness (note that there is a 1-mile-long reach of the stream that crosses private land in this reach; this is technically outside of the Wilderness). This study reach incorporates approximately 9,000 acres of land within a steep, remote section of the Deer Creek canyon that can be accessed only by pedestrian trail. The western boundary of the Wilderness coincides with the western limits of Lassen National Forest; Lassen National Forest and the Bureau of Land Management oversee all but approximately 1,500 acres of private land within this study reach.

Previously Recorded Sites. Twenty-five archaeological sites have been recorded as of 1994 along this stretch of Deer Creek, including 19 prehistoric sites, three historical sites, and three multi-component resources. The historical remains are related to early Euro-American settlements, such as the Graham Place (CA-TEH-1564), Apperson Cow Camp (CA-TEH-236), and Speegles (FS 05-06-51-60). Included with the prehistoric site types noted above (i.e., lithic scatters, occupation sites, temporary camps) are numerous rockshelters and several sites containing rock art features (pitted or cupule boulder petroglyphs). Several of the open-air sites within this study reach contain housepits, remnants of prehistoric structures. CA-TEH-293, for example, was documented as a midden site along Deer Creek with at least five observable housepits.

As noted above, no more than 25 percent of this study reach has been adequately inventoried for archaeological properties, and recent surveys suggest a large number of sites remain to be discovered along tributaries and flats away from Deer Creek. The presence of undocumented rock shelters within the steeper terrain above the creek is also known based on informal surveys by this writer and others. More than 100 archaeological sites are probably present within this 9,000-acre corridor with more beyond, especially on flats and along secondary drainages and near springs.

The value of the sites within the Ishi Wilderness is enhanced by several factors, including the lengthy post-contact period (circa 1845-1911), during which the surviving Yahi Yana who lived in this area were adapting to extraordinary conditions. Bear's Hiding Place, the Yahi encampment where Ishi and others were discovered in 1908 and the subject of a recent film, is within this study reach. The role of the prehistoric sites within this area relative to a larger settlement and subsistence pattern is also of scientific value, particularly given the probability that sites with limited amounts of disturbance still occur in many secluded spots along Deer Creek (see Wiant 1981). Furthermore, some of the sites within the Ishi Wilderness probably served as winter villages, so the full range of prehistoric human activities, from subsistence through ceremonial and mortuary practices, may be represented in this area. The historical resources that remain from

Euro-American ranching locations that were located in this remote region as early as the 1860s may also provide insight into the pioneer spirit of this time.

Designated Properties. No resources with formal designations (e.g., National Register properties, State Historical Landmarks, Points of Historical Interest) have been identified within this reach of the Deer Creek study area. However, the Lassen National Forest and Bureau of Land Management have been considering the possibility of evaluating and nominating an archaeological district encompassing portions of the Deer Creek drainage for more than a decade, and the Ishi Wilderness reach would logically be included in these plans.

Western Boundary of Ishi Wilderness to Sacramento River

This reach incorporates approximately 19 linear miles of the Deer Creek drainage, extending from the western edge of the Ishi Wilderness and Lassen National Forest boundary, past the vicinity of Acorn Hollow where the Deer Creek canyon widens and enters the Sacramento Valley, and ending at the confluence with the Sacramento River. This study corridor reach incorporates nearly 20,000 acres of land, most of which is privately owned. The eastern portion of this study reach is quite remote, with increasing numbers of ranching roads and other developments (e.g., diversion dams, ditches, a Pacific Gas and Electric Company transmission line) being encountered as one approaches Vina, Highway 99, and the Sacramento River.

Previously Recorded Sites. A 1994 review of the files maintained by the Northeast Information Center in Chico revealed the presence of 11 archaeological sites within this reach of Deer Creek, all but one of which is prehistoric in origin. The historical resource is the location of a Chinese cemetery that had all the human remains removed and sent back to China in the 1920s. It is located just east of town. Vina and its associated developments and various historic ranches and places are historic locations deserving extensive treatment beyond the scope of this brief review. Based on historical documentation that describes extensive use of this area for more than 150 years, the dearth of recorded historical archaeological sites in this study reach reflects the minimal amount of professional inventory and the biases of surveyors and recorders rather than the actual nature of the archaeological record.

As with the preceding reach, several of the recorded prehistoric sites in this area are located within caves or rock shelters. Of the 10 prehistoric sites documented on the index for this study reach, at least two (20%) are in rock shelters/caves (University of California Archaeological Survey n.d.), including one with cupule and groove petroglyphs. The remaining resources include lithic scatters, open-air occupation sites, and temporary camps. Absent from the existing database are the winter villages found at similar elevations along nearby Mill Creek; this situation is interpreted as another gap in the available information, rather than a reflection on the level or intensity of prehistoric use of the area.

It is extremely difficult to draw conclusions on the archaeological record given the minimal amount of work completed to date. But, based on a general knowledge of the region and the amount of prehistoric and historical use of the lower Deer Creek Watershed and along the

Sacramento River, it is considered feasible that hundreds of archaeological sites occur within this area. Significantly, archaeological and ethnographic indications are that this region was at the western margin of ethnographic Yahi settlement, with Penutian-speaking peoples living between the Sacramento River and the valley/foothill contact. A wide range of cultural expressions, probably from at least two distinct culture groups and their ancestors, may be found within the prehistoric sites of this study reach. The value of the archaeological sites within this area of cultural interaction may be enhanced by the fact that much of the study reach is either physically remote or has been offered a certain level of protection by the conservative nature of ranchland management that has dominated the area for almost 150 years. This region undoubtedly contains nearly pristine resources containing valuable data concerning the Yahi and their predecessors.

Historic resources and activities for the entire watershed, including those related to Peter Lassen and later occupants and itinerants are discussed elsewhere in this greater study and a form a very important and cherished legacy.

Designated Properties. Benton City, an exploration/settlement location along deer Creek near modern Highway 99 is listed in the California Inventory of Historic Places.

Database Summary

The Deer Creek drainage, which extends 60 miles from the vicinity of Butt Mountain in eastern Tehama County to the Sacramento River, has been the scene of archaeological investigations for more than 40 years. The wide range of anthropological, archaeological, and cultural resource management projects completed within this area has resulted in the inventory of more than 6,000 acres of land and the recording of more than 75 prehistoric and historical archaeological sites within the study area. Table 13-1 summarizes the cultural resources data identified within the four Deer Creek study area corridor reaches described above.

The cultural resources inventories and excavations within the Deer Creek study area have occurred in the past 40 years, with the most rigorous work having been conducted in the last decade. With the exception of the large project areas surveyed on the Lassen National Forest and, to a lesser degree, within private forests in the upper portions of this drainage, these inventories have focused on areas immediately adjacent to Deer Creek. It is likely that many of the most impressive sites have been documented. However, given the number and nature of sites recently encountered by USFS and BLM surveyors working in peripheral areas, it is clear that a large number of sites remain to be recorded and that these resources will be critical to an understanding of the full range of past human behavior. A conservative estimate would suggest that at least 400, and perhaps 500 or more, prehistoric and historical archaeological properties exist within the Deer Creek study area, with only a small percentage of those currently documented in the archaeological record.

Table 13-1. Cultural Resources Data Identified within the Four Deer Creek Study Area Reaches (The Resources Agency 1994)

Study Reach	Approximate Acres	Percent Surveyed	Recorded Sites				Designated Properties
			P	H	P/H	Total	
Butt Mountain to Lower Deer Creek Falls	20,000	7.5	8	2	0	10	None
Lower Deer Creek Falls to Ishi Wilderness	15,000	15.0	19	4	7	30	None
Ishi Wilderness	9,000	25.0	19	3	3	25	None
Ishi Wilderness to Sacramento River	20,000	1.0	10	1	0	11	None
Deer Creek Totals	**64,000**	**10.0**	**56**	**10**	**10**	**76**	**None**

Notes:
H = Historic site.
P = Prehistoric site.
P/H = Prehistoric/historic site.

For more than 40 years, the archaeological sites within the Deer Creek canyon have been subject to vandalism and inadvertent damage (see Johnson and Wiant 1975). The continuing problems of accidental damage caused by hikers, anglers, and other users of the area, combined with the willful destruction of sites by amateur and professional "pot-hunters", are of paramount concern to those interested in the cultural resources of the area. Ongoing efforts to minimize the impact of these disturbances include rerouting recreational trails and subsurface excavations at the most seriously threatened sites (Johnson and Watts pers. com.), and education at all levels. Despite these unfortunate impacts, the archaeological record of the Deer Creek drainage must be considered relatively intact. The remoteness of the canyon, management of lands by the Federal government, the conservative amount of development that occurs on private ranching lands, regulations and self-regulation related to timber harvesting, and other developments on public and private lands have all combined to lend a level of protection that has spared many of the archaeological sites of this area from broad-scale destruction.

The results of past surveys and excavations, combined with ethnographic and historical data, indicate that Deer Creek has been the scene of human activities for at least 4,000 years. During most of that time, the canyon and surrounding uplands were the home of the Yahi and their predecessors. The combination of low-elevation winter villages and a transhumance pattern that led to seasonal forays into the forested mountains resulted in Yahi use of virtually the entire drainage. The unique conditions of the caves and rockshelters of the area provide for a degree of preservation of perishable archaeological materials (e.g., basketry, cordage) that is not commonly encountered elsewhere in California. The scientific value of a relatively pristine archaeological database that reflects the full range of prehistoric adaptations cannot be overstated. The fact that

Deer Creek served as the final refuge for a number of surviving Yahi Yana, including Ishi, between the years of 1845 and 1911 adds further interest to the sites of the region, with archaeological, ethnographic, and historical ramifications that occur nowhere else in the State.

The historical sites of the Deer Creek Watershed may represent the same level of import as do the earlier resources. Early settlement of isolated ranching/farming and mining loci within the remote canyon, at a time when Native Americans continued to pursue a relatively traditional (and occasionally violent) lifestyle, provides the opportunity to investigate perhaps the most adventurous of the early Euro-American pioneers. Settlement in the Sacramento Valley from Lassen's time on has left valuable remains and still-used places that have values of many sorts to many people at the local level and beyond.

The cultural resource values along Deer Creek have been found to be extraordinary from Deer Creek Falls to the Sacramento River. The upper reaches of Deer Creek do not contain as significant a number or diversity of cultural resources, and there has been a substantial amount of disturbance from improvements such as Highway 32 and the recreational developments near Deer Creek Meadows.

EXTRAORDINARY RESOURCE VALUES

The review of published and unpublished materials relative to the cultural resources has indicated that, although only about 10 percent of the watershed has been adequately inventoried for archaeological sites, there can be little doubt that the resources of the Deer Creek drainage present a vast amount of data on human use of the area over the past 4,000 years or more. Because of the number and quality of often-fragile cultural resource sites, these resources are considered to be extraordinary from the Highway 32 bridge to the Sacramento River, encompassing prehistoric, ethnographic and historic assets for humankind. Aside from considerable interest in these resources from local inhabitants, visitors, historians, archaeologists and other researchers, individuals and groups, there is also an interest in the Ishi legacy and Ishi's remains by neighboring Native American Indians who are pursuing (as of 1997) repatriation of Ishi's remains in the watershed. The story continues.

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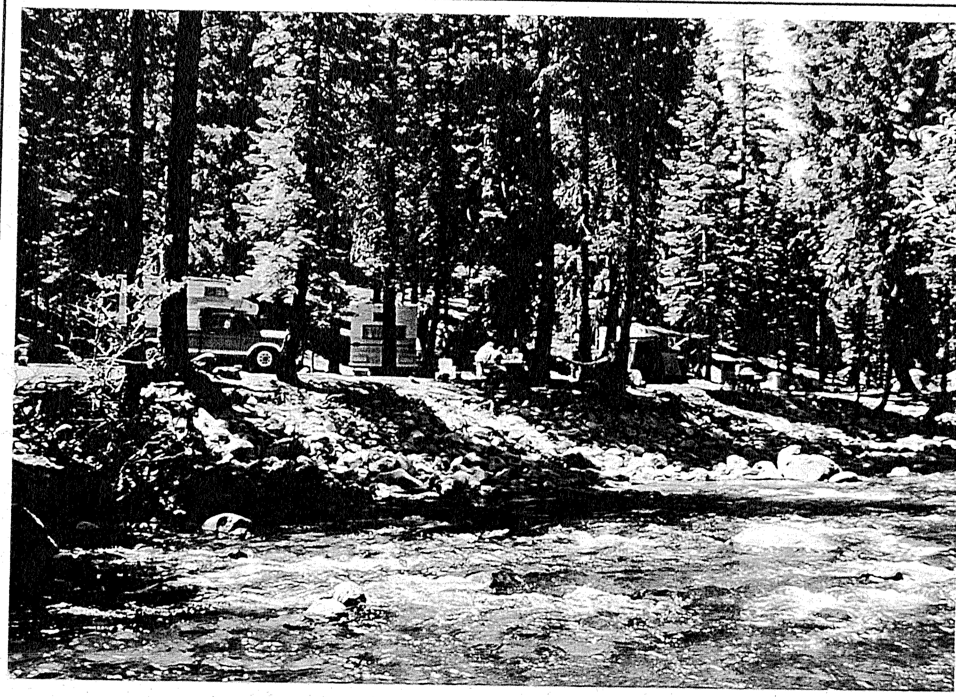

Photo 13-1. View of Elam Creek Campground from the southeast side of Deer Creek. Note unvegetated streambank adjacent to campground. (Photo by J. Stanley, June 1997)

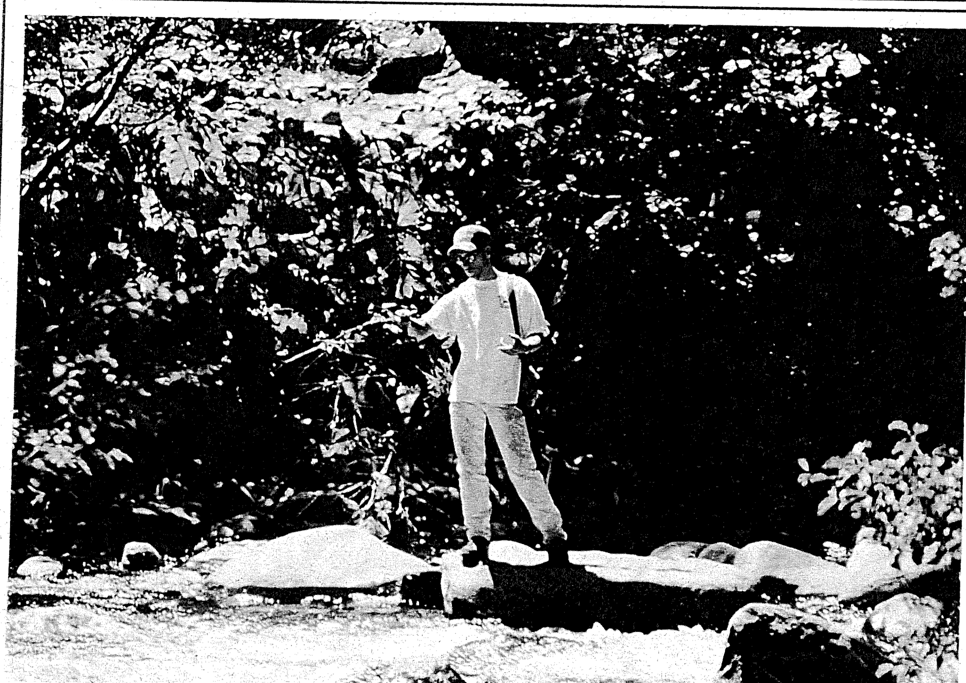

Photo 13-2. Camper fishing for trout along bank of Deer Creek downstream of Elam Creek Campground. (Photo by J. Stanley, June 1997)

APPENDIX A

SOIL ERODIBILITY AND EROSION HAZARD IN THE DEER CREEK WATERSHED

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APPENDIX A

SOIL ERODIBILITY AND EROSION HAZARD IN THE DEER CREEK WATERSHED

EROSION CONCEPTS AND PRINCIPLES-INTRODUCTION

The process of erosion by water involves detachment from the soil mass, transportation primarily by flowing water, and eventual deposition of the sediment. Soil is detached mostly by raindrop impact and by run-off shear forces.. Downslope movement of soil by water is primarily by channelized run-off. Significant run-off does not occur until the rainfall intensity is greater than the soil infiltration rate; but once run-off begins, the quantity and size of material moved is a function of run-off velocity and turbulence. Deposition of eroded sediment may occur when the velocity or turbulence of run-off decreases significantly. Soil eroded from upland areas comes from locations of channelized flow called rills and from sheet erosion above and between rills. Rill erosion primarily results from the effects of run-off and is greatly affected by slope and flow rate.

On a world scale, the erosion caused by rainfall is more serious than that caused by wind. However, there are areas where wind erosion is just as disastrous as water erosion. On a large scale, wind erosion is mostly confined to arid and semi-arid climates, however, this does not alter the fact that very serious local wind erosion can occur in humid areas. Generally, the physical nature of the soil will affect the ease with which particles are dislodged, but far more important than these is the fact that only dry soil blows, and any soil will be unmoved by wind while its surface is moist.

EROSION PREDICTION

Different soils and different soil surface conditions greatly influence the erosion and sedimentation process. The effect land management practices have on the erosion process is exposing disturbed soils to land and storm run-off. Soil disturbances alter the soil cover and the soil in many ways - protective vegetation is removed or at least reduced, topography altered, on site drainage and storm run-off patterns changed, and the physical properties of the soil itself are changed. A number of methods have been used to predict or estimate the susceptibility of soil to erosion. All of these have involved measuring certain soil properties and then relating these properties, in combination, to degrees of erosion judged in a relative way from field measurements or observation. There are many variable factors that act in combination to determine erodibiity. These factors can include soil texture and structure, infiltration rate, soil permeability and depth, and changes in soil character from top to bottom of the soil mantle. And they include also such variables as surface gradient, and length and regularity of slope, which modify the erosive action of water even within small areas of otherwise uniform soil.

California Soil Survey Committee Erosion Hazard Rating (EHR) System

The California Soil Survey Committee (CSSC) Erosion Hazard Rating (EHR) System has been developed by an interagency task group under the direction of the CSSC. The purpose of this effort was to provide a consistent method for use by different agencies and individuals that helps to: 1) evaluate the likelihood that a specific soil disturbing activity will cause accelerated sheet and rill erosion, 2) evaluate the relative risk for adverse consequences, and 3) identify approximate soil cover amounts needed to achieve an acceptable risk level. The EHR system is a highly developed checklist and is not a mathematically exact equation. It is designed to appraise the relative risk of accelerated sheet and rill erosion. The system does not rate gully erosion, dry ravel, wind erosion, or mass wasting. The major factors used in the system are soil erodibility, run-off production, run-off energy, and soil cover. Soils are then given a relative low, moderate, high, and very high rating.

Universal Soil Loss Equation

The Universal Soil Loss Equation (USLE) enables planners to predict the average rate of soil erosion for each feasible alternative combination with a specific soil type, rainfall pattern, and topography. When these predicted losses are compared with given soil loss tolerances, they provide specific guidelines for effecting erosion control within specified limits. The equation groups the numerous interrelated physical and management parameters that influence erosion rate under six major factors whose site-specific values can be expressed numerically. The USLE is an erosion model designed to compute longtime average soil losses from sheet and rill erosion under specified conditions. It is also useful for construction sites and other non-agricultural conditions, but it does not predict deposition and does not compute sediment yields from gully, streambank, and streambed erosion.

The soil loss equation is **A = R, K, L, S, C, and P**

A - is the computed soil loss per unit area, expressed in tons per acre per year.

R - is the rainfall and run-off factor.

K - is the soil erodibility factor for each soil type that is mapped. This erosion factor "K" indicates the susceptibility of the whole soil (including rocks and rock fragments) to sheet and rill erosion by water. Values of K range from 0.05 to 0.69. The higher the value, the more susceptible to soil is to sheet and rill erosion by water.

L - is the slope length factor, is the ration of soil loss from the field slope length to that from a 72.6 feet length under identical conditions.

S - is the slope-steepness factor, is the ratio of soil loss from the field slope gradient to that from a 9-percent slope under otherwise identical conditions.

C - is the cover and management factor, is the ratio of soil loss from an area with specified cover and management to that from an identical area in tilled continuous fallow.

P - is the support practice factor, is the ratio of soil loss with a support practice like contouring, strip cropping, or terracing to that with straight-row farming up and down the slope.

Highly Erodible Land (HEL) Evaluations

The 1985 Food Security Act, as amended by the 1990 and the 1996 Acts provided provisions of the Highly Erodible Land Conservation Provisions (HELC). The objectives of HELC are (1) to remove certain incentives for persons who produce agricultural commodities on highly erodible land without proper conservation treatment; (2) reduce non-point source pollution, (3) reduce soil loss from wind and water erosion (4) protect the Nation's long-term capability to produce food and fiber (5) reduce sedimentation and improve water quality. The soil erodibility index (EI) is the measure selected to determine whether a soil map unit is highly erodible. To determine the potential erodiblility of a soil map unit, four factors from the USLE equation are multiplied together: R factor x K factor x LS factor.

Slope Failures or Mass Wasting

This type of erosion is usually a process of geological erosion, and although it may be accelerated as in the sides of gullies, it can occur without human intervention. Before Euro-American settlement in the area, it is expected that the frequency and intensity of mass wasting was minimal. With land development over the years, it is possible that more landslides have occurred. A more detailed study to locate these areas is needed for the Deer Creek Watershed.

SOIL PERSPECTIVES FOR DEER CREEK WATERSHED (PAST STUDIES)

The soils of the Deer Creek Watershed derive from geologic formations found in this county (see geologic section). In general, the upper watershed areas nearer to Lassen Peak exhibit rhyolite/dacite surface geology whereas the older and more complex Tuscan Formation occurs lower in the watershed. The distinction between these two geologic bodies is important due to the great difference in erosion potential of the soils derived from them. Rhyolitic soils are young skeletal soils high in quartz and relatively low in ferromagnesian minerals giving rise to course textured soils with very little cohesion. In general, soils of the Tuscan formation have opposite characteristics. They are formed from basaltic and andesite parent materials giving rise to soils with gravely loam to gravelly clay loam textures and moderate to good resistance to erosion (Meadowbrook, 1997).

Tehama County Soil Survey

The 1967 survey contains information that can be applied in managing farms, ranches, and woodlands; in selecting sites for roads, ponds, buildings, or other structures; and in appraising the value of tracts of land for agriculture, industry, or recreation. There are approximately 80 different map units within twenty-six soil series in the Deer Creek Watershed. These map units can be grouped into five land categories relative to their position on the landscape. These categories are: mountain, foothills, low terraces, alluvial, and miscellaneous. The percentages of map units within these categories are presented in the following table.

Table A-1. Percentage of Soil Map Units Within Land Categories — Deer Creek Watershed

Land Category	Percent
Alluvial	13
Low Terrace	16
Foothill	14
Mountain	51
Miscellanous*	6

* High rock content.

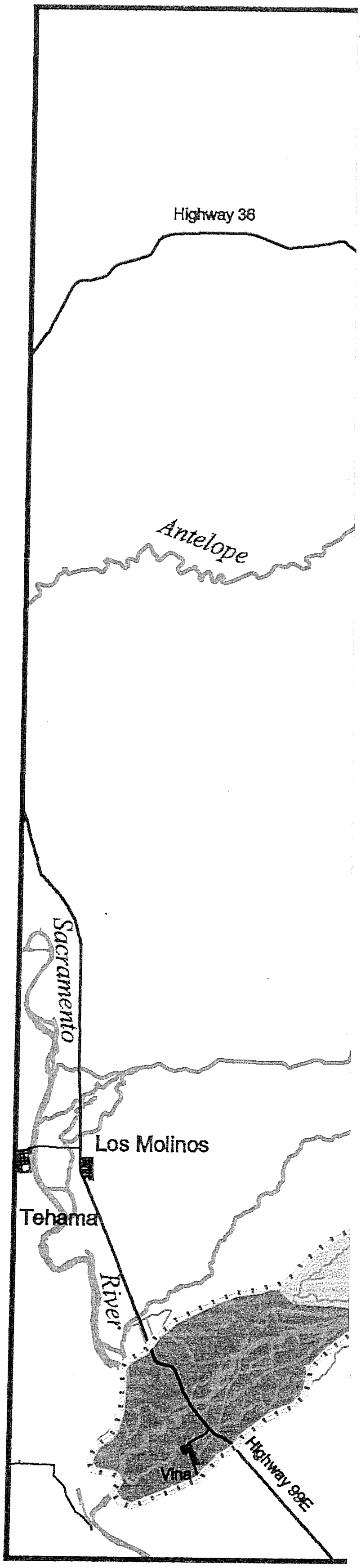
Erosion Hazard Rating (EHR)

The CSSC EHR system was used to rate soils within the Deer Creek Watershed based on soil erodibility, run-off production, run-off energy, and soil cover (see Table A-4.). Numerical values are given to factors that are used to compute an erosion index. These factors are soil erodibility, run-off production, run-off energy, and soil cover. The erosion index is then rated low (<4), moderate (4-12), high (13-29), or very high (>30). Table A-2 gives percentages of erodibility ratings for Deer Creek Watershed.

Table A-2. Percentages of Soil Map Units Within Four Categories Using the CSSC EHR System — Deer Creek Watershed

Categories	Percent
Low	34
Moderate	30
High	29
Variable*	7

* Variable includes map units with high rock content.


Highway 36
Antelope
Sacramento
Los Molinos
Tehama
River
Vina
Highway 99E

Low erosion hazard rating soils are those that occur on low terraces and alluvial reaches with very low slope percentages. Moderate erosion hazard rating soils include those on mountain and foothill soils on 10 to 30 percent slopes. High erosion hazard rating soils include those on mountain and foothill soils on slopes that are 30 percent or more. Figure A-2 depicts the distribution of erodible soils within the Deer Creek Watershed.

"Survey of Road-Related Sediment Sources in the Deer (and Mill) Creek Watershed" by Meadowbrook Conservation Associates

The objective of the survey was to assess the extent of sediment contribution from road systems (see Table A-3), identify patterns of recurring problems that may help in future road construction, and identify, map, and prioritize specific road-related sediment sources. One result from this survey was that road-related erosion rates for Deer Creek was 22.3 cubic yards per square mile per year. Typical erosion rates (from all sources) for similarly situated watershed might range from 50 to 200 cubic yards per square mile per year. Thus, the road erosion inventories in this study probably amounts to a 10 percent to 20 percent of the total sediment load. This is a rough estimate that could only be refined by inventorying all non-road sediment sources and completing a detailed sediment budget for the watershed. For more information about the results of the study, see the source (Meadowbrook Conservation Associates 1997).

Table A-3. Deer Creek Watershed Survey Results

Miles of Road Surveyed	476.9
Watershed Area Surveyed (sq. mi.)	174.5
Total Existing Erosion (cu. yd.)	11,690.0
Existing Sediment Delivered to Channel (cu. yd.)	9,675.4
Potential Sediment Delivered to Channel (cu. yd.)	2,691.9

PAST TREATMENTS

The Natural Resource Conservation Service has assisted a few landowners in the watershed on conservation projects in the past. The only project that related to soil erosion was a water development project that had a soil savings of 1/2 ton of soil per acre per year on 400 acres. The goal of the project was to distribute livestock use.

MANAGEMENT CONSIDERATIONS

1. Erosion Survey: More research/survey work is needed to determine how much erosion is occurring. The Meadowbrook Associates survey of roads is a good start, but an overall sediment budget is needed. This survey should include information on landslides. Data on existing sediment dams on the creek might be helpful with this. (What is their capacity?)

2. Knowledge base: The overall knowledge base of stakeholders on watershed based management and ecology will be helpful. Educational workshops could be held to help with this need.

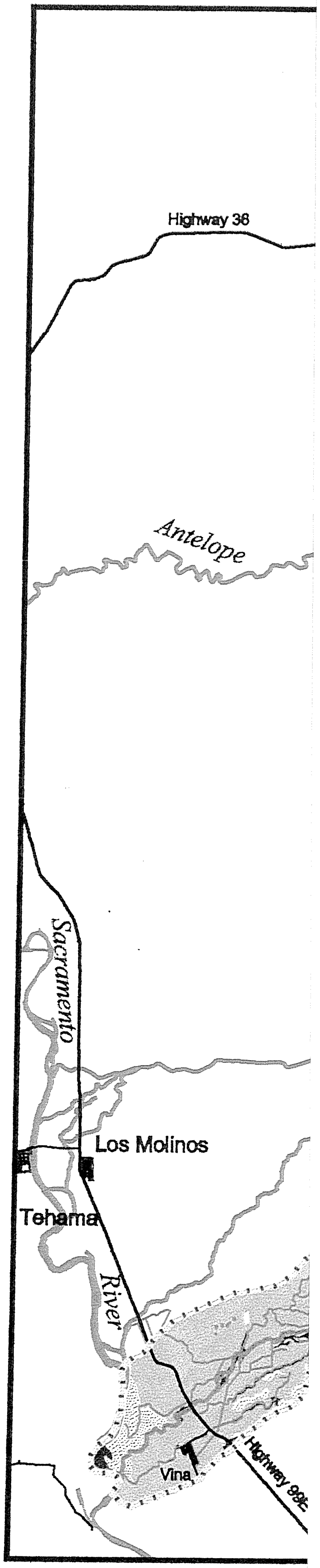

Highway 36
Antelope
Sacramento
Los Molinos
Tehama
River
Vina
Highway 99E

Table A-4. Summary of Soil Characteristics Found Within the Deer Creek Watershed

Soil Group Name	Soil Series Name	Map Unit	Map Unit Description	Slope Class	Erosion Index	Erosion Rating **	Hydrologic Group
Low Terrace	Anita	Ad	Clay	10 to 20 %	1.4	LOW	D
Low Terrace	Anita	Af	Clay, Mod. Deep	0 to 3 %	0.02	LOW	D
Low Terrace	Anita	Ag	Clay, Deep	0 to 3 %	0.02	LOW	D
Low Terrace	Anita	An	Cobbly Clay	0 to 3 %	0.02	LOW	D
Low Terrace	Anita	Ao	Cobbly Clay, Mod. Deep	0 to 3 %	0.02	LOW	D
Alluvial	Berrendos	Bc	Clay	0 to 3 %	0.26	LOW	D
Mountain	Chummy	Cb	Silty Clay Loam	0 to 3 %	0.4	LOW	C
Mountain	Cohasset	CdD	Loam	10 to 30 %	5.4	MODERATE	B
Mountain	Cohasset	CdE	Loam	30 to 50 %	13.2	HIGH	B
Mountain	Cohasset	CeD	Loam, Very Deep	10 to 30 %	5.4	MODERATE	B
Mountain	Cohasset	CfD	Gravelly Loam	10 to 30 %	5.4	MODERATE	B
Mountain	Cohasset	CfE	Gravelly Loam	30 to 50 %	13.2	HIGH	B
Mountain	Cohasset	CgD	Stony Loam	10 to 30 %	5.4	MODERATE	B
Mountain	Cohasset	CgE	Stony Loam	30 to 50 %	13.2	HIGH	B
Mountain	Cohasset	ChD2	Stony Loam, Mod. Deep, Eroded	10 to 30 %	6.6	MODERATE	B
Miscellaneous	Colluvial lan	CkF	Colluvial land, Volcanic Rocks	Variable	Variabl	Variable	NA
Miscellaneous	Colluvial lan	ClF	Colluvial land, Sedimentary Rocks	Variable	Variabl	Variable	NA
Mountain	Elam	EgB	Very Gravelly Loamy Sand	0 to 8 %	0.4	LOW	A
Mountain	Elam	EmB	Very Gravelly Loamy Sand, Mod. Deep	0 to 8 %	0.4	LOW	C
Mountain	Elam	Ew	Very Gravelly Loamy Sand, Not Drained	0 to 3 %	0.2	LOW	D
Foothill	Guenoc	GnD	Loam	10 to 30 %	7.92	MODERATE	C
Foothill	Guenoc	GsD	Stony Loam	10 to 30 %	7.92	MODERATE	C
Low Terrace	InKs	IcD	Cobbly Loam	3 to 30 %	8.4	MODERATE	D
Foothill	Inskip	ImD	Very Rocky Silt Loam, Mod. Deep	10 to 30 %	10.56	MODERATE	C
Mountain	Iron Mnt.	IrD	Rocky Sandy Loam	10 to 30 %	10.5	MODERATE	D
Mountain	Iron Mnt.	IrE	Rocky Sandy Loam	30 to 50 %	15.48	HIGH	D
Mountain	Iron Mnt.	IrF	Rocky Sandy Loam	50 to 65 %	23.2	HIGH	D
Mountain	Iron Mnt.	IxE	Complex	30 to 50 %	15.48	HIGH	D/B
Mountain	Jiggs	JgD	Stony Sandy Loam	10 to 30 %	4	MODERATE	C
Mountain	Jiggs	JgE	Stony Sandy Loam, Eroded	10 to 30 %	4	MODERATE	C
Low Terrace	Keefers	Kf	Loam	0 to 3 %	0.48	LOW	C
Low Terrace	Keefers	Km	Loam, Mod. Deep	0 to 3 %	0.48	LOW	C
Low Terrace	Laniger	LaB	Fine Sandy Loam	0 to 8 %	0.43	LOW	B
Low Terrace	Laniger	LbB	Fine Sandy Loam, Deep	0 to 8 %	0.43	LOW	B
Mountain	Los Gatos	LgE*	Gravelly Loam	30 to 50 %	12	MODERATE	C

* This soil is shown in the Deer Creek Watershed but probably have been mis-mapped.

** High Erosion areas include Rock Rubble soils which may have variable erosion hazard ratings.

Table A-4. Summary of Soil Characteristics Found Within the Deer Creek Watershed (Cont'd.)

Mountain	Los Gatos	LgF*	Gravelly Loam	50 to 65 %	17.82	HIGH	C
Alluvial	Los Robles	Lm	Clay Loam, Mod. Deep	0 to 3 %	0.5	LOW	B
Alluvial	Los Robles	Lo	Loam	0 to 3 %	0.5	LOW	B
Mountain	Lyonville	LvD	Gravelly Sandy Loams	10 to 30 %	6.6	MODERATE	B/C
Mountain	Lyonville	LvE	Gravelly Sandy Loams	30 to 50 %	13.2	HIGH	B/C
Mountain	Lyonville	LvF	Gravelly Sandy Loams	50 to 65 %	19.8	HIGH	B/C
Mountain	Lyonville	LyE	Stony Sandy Loams	30 to 50 %	13.2	HIGH	B/C
Mountain	Lyonville	LyF	Stony Sandy Loams	50 to 65 %	19.8	HIGH	B/C
Mountain	McCarthy	MkD	Sandy Loam	10 to 30 %	4	MODERATE	C
Mountain	McCarthy	MkE	Sandy Loam	30 to 50 %	11.88	MODERATE	C
Mountain	McCarthy	MkF	Sandy Loam	50 to 65 %	17.82	HIGH	C
Mountain	McCarthy	MmE	Stony Sandy Loam	30 to 50 %	11.88	MODERATE	C
Mountain	McCarthy	MmF	Stony Sandy Loam	50 to 65 %	17.82	HIGH	C
Mountain	McCarthylro	MnE	Complex, Stony Sandy Loam	30 to 50 %	11.88	MODERATE	C/D
Alluvial	Millrace	Mp	Gravelly Fine Sandy Loam	0 to 3 %	0.24	LOW	B
Alluvial	Molinos	My	Fine Sandy Loam	0 to 3 %	0.24	LOW	B
Alluvial	Molinos	MzD	Fine Sandy Loam, Deep over Gravel	0 to 3 %	0.24	LOW	B
Alluvial	Molinos	MzM	Fine Sandy Loam, Mod. Deep/Gravel	0 to 3 %	0.24	LOW	B
Alluvial	Molinos	MzT	Complex, Channeled	Variable	Variabl	Variable	Variable
Mountain	Nanny	NkB	Stony Loam	0 to 8 %	1.2	LOW	B
Mountain	Nanny	NmB	Stony Loam, Mod. Deep	0 to 8 %	1.2	LOW	C
Miscellaneous	Riverwash	Rr	Riverwash	Variable	Variabl	Variable	NA
Miscellaneous	Rockland	RtF	Rock	Variable	Variabl	Variable	NA
Miscellaneous	Rubbleland	RuF	Rubble	Variable	Variabl	Variable	NA
Mountain	Sheetiron	SnE	Gravelly Loam`	30 to 50%	12.8	HIGH	D
Foothill	Supan	SuD	Stony Loam	10 to 30 %	4.8	MODERATE	B
Foothill	Supan	SuE	Stony Loam	30 to 50 %	12.8	HIGH	B
Foothill	Toomes	TfD	Rocky Loam	10 to 30%	7.2	MODERATE	D
Foothill	Toomes	TfE	Rocky Loam	30 to 50 %	19.2	HIGH	D
Foothill	Toomes	TgD	Very Rocky Loam	10 to 30 %	9.6	MODERATE	D
Foothill	Toomes	TgE	Very Rocky Loam	30 to 50 %	19.2	HIGH	D
Foothill	Toomes	ThE	Extremely Rocky Loam	1 to 50 %	14.4	HIGH	D
Foothill	Toomes	TkB	Very Rocky Silt Loam	1 to 10 %	2.8	LOW	D
Low Terrace	Tuscan	TsB	Loam	1 to 5 %	1.44	LOW	D
Low Terrace	Tuscan	TuB	Clay Loam	1 to 8 %	1.92	LOW	D
Low Terrace	Tuscan	TxC	Very Stony Loam	3 to 15 %	5.05	MODERATE	D
Alluvial	Vina	VnA	Loam	0 to 3 %	0.48	LOW	B
Alluvial	Vina	Vw	Loam, Water Table	0 to 3 %	0.48	LOW	B

* This soil is shown in the Deer Creek Watershed but probably have been mis-mapped.
** High Erosion areas include Rock Rubble soils which may have variable erosion hazard ratings.

Table A-4. Summary of Soil Characteristics Found Within the Deer Creek Watershed (Cont'd.)

Mountain	Windy	WgD	Gravelly Sandy Loam	10 to 30 %	4.4	MODERATE	C
Mountain	Windy	WgE	Gravelly Sandy Loam	30 to 50 %	13.2	HIGH	C
Mountain	Windy	WnF	Rocky Sandy Loam	50 to 65 %	19.8	HIGH	C
Mountain	Windy	WrE2	Rocky Sandy Loam, Mod.Deep, Eroded	10 to 50 %	13.2	HIGH	C
Mountain	Windy	WsD	Stony Sandy Loam	10 to 30 %	4.4	MODERATE	C
Mountain	Windy	WsE	Stony Sandy Loam	30 to 50 %	13.2	HIGH	C
Mountain	Windy	WsF	Stony Sandy Loam	50 to 65 %	19.8	HIGH	C

* This soil is shown in the Deer Creek Watershed but probably have been mis-mapped.

** High Erosion areas include Rock Rubble soils which may have variable erosion hazard ratings.

APPENDIX B

PRELIMINARY VASCULAR PLANT CHECKLIST FOR THE DEER CREEK WATERSHED

APPENDIX B

PRELIMINARY VASCULAR PLANT CHECKLIST FOR THE DEER CREEK WATERSHED, TEHAMA COUNTY, CALIFORNIA[1,2]*

(Species observed during November 1996 and June 1997 field surveys)

FERNS AND FERN ALLIES

DENNSTAEDTIACEAE
- *Pteridium aquilinum* var. *pubescens* (bracken fern)

EQUISETACEAE
- Equisetum hyemale ssp. affine (common scouring rush)

POLYPODIACEAE
- *Polypodium californicum* var. *californicum* (California polypody)

PTERIDACEAE
- *Pellaea mucronata* var. *mucronata* (bird's-foot fern)

CONIFERS

CUPRESSACEAE
- *Calocedrus decurrens* (insense cedar)
- *Juniperus californica* (California juniper)

PINACEAE
- *Abies concolor* (white fir)
- *Abies magnifica (red fir)*
- *Pinus ponderosa* (ponderosa pine)
- *Pinus contorta* (lodge pole pine)
- *Pinus lambertiana* (sugar pine)
- *Pinus sabiniana* (foothill pine)
- *Pseudotsuga menziesii* (Douglas fir)

TAXACEAE
- *Torreya californica* (California nutmeg)

FLOWERING PLANTS-DICOTS

ACERACEAE
- *Acer macrophyllum* (big-leaf maple)
- *Acer negundo* var. *californicum* (box elder)

AMARANTHACEAE
- *Amaranthus californicus* (California amaranth)

ANACARDIACEAE
- *Rhus trilobata* (skunkbrush)
- *Toxicodendron diversilobum* (poison oak)

APIACEAE
- *Anthriscus caucalis** (bur-chervil)
- *Conium maculatum** (poison hemlock)
- *Lomatium macrocarpum* (large-fruited lomatium)
- *Sanicula bipinnata* (poison sanicle)
- *Sanicula crassicaulis* (Pacific sanicle)
- *Torilis arvensis** (field hedge-parsley)

ARALIACEAE
- *Aralia californica* (elk clover)

ARISTOLOCHIACEAE
- *Aristolochia californica* (pipevine)

ASTERACEAE
- *Ambrosia artemisifolia** (common ragweed)
- *Artemisia douglasiana* (mugwort)
- *Baccharis douglasii* (marsh baccharis)
- *Baccharis pilularis* (coyote brush)
- *Baccharis salicifolia* (Mule fat)
- *Carduus pycnocephalus** (Italian thistle)
- *Centaurea soltitialis** (yellow star-thistle)
- *Chamomilla suaveolens** (pineapple weed)
- *Cirsium vulgare** (bull thistle)
- *Conyza canadensis* (horseweed)
- *Cotula coronopifolia** (brass-buttons)
- *Gnaphalium luteo-album** (weedy cudweed)
- *Gnaphalium purpureum* (purple cudweed)
- *Grindelia hirsutula* var. davyi. (foothill gumplant)
- *Helenium puberulum* (sneezeweed)
- *Helianthus annuus** (annual sunflower)
- *Hemizonia congesta* ssp. *luzulifolia* (hayfield tarweed)
- *Hemizonia fitchii* (Fitch's spikeweed)
- *Heterotheca grandiflora* (telegraph weed)
- *Heterotheca oregana* (Oregon golden-aster)
- *Lactuca serriola** (prickly lettuce)
- *Lessingia nana* (dwarf lessingia)
- *Madia gracilis* (slender tarweed)
- *Picris echioides** (bristly ox-tongue)
- *Wyethia sp.* (mule's ears)
- *Xanthium spinosum** (spiny cocklebur)
- *Xanthium strumarium** (cocklebur)

BETULACEAE
Alnus rhombifolia (white alder)
Corylus cornuta var. *californica* (hazelnut)

BRASSICACEAE
*Brassica rapa** (field mustard)
Cardamine oligosperma (few-seeded bitter-cress)
*Raphanus sativus** (radish)

CALYCANTHACEAE
Calycanthus occidentalis (Western spicebush)

CAPRIFOLIACEAE
Lonicera involucrata var. *ledebourii* (twinberry)
Sambucus mexicana (mexican elderberry)

CARYOPHYLLACEAE
*Petrorhagia dubia** (grass pink)

CHENOPODIACEAE
*Chenopodium album** (lamb's quarters)

CONVOLVULACEAE
*Convolvulus arvensis** (bindweed)

CORNACEAE
Cornus nuttallii (mountain dogwood)

CUCURBITACEAE
Marah fabaceus (California man-root)

ERICACEAE
Arctostaphylos patula (green-leaved mamzanita)
Arctostaphylos nevadensis (pinemat manzanita)
Arctostaphylos viscida ssp.viscida (white-leaved manzanita)
Ledum glandulosum (Labrador tea)
Pyrola picta (white-veined wintergreen)
Rhododendron occidentale (western azalea)

EUPHORBIACEAE
Eremocarpus setigerus (dove weed)

FABACEAE
*Cytisus scoparius** (Scotch broom)
*Lotus corniculatus** (birdfoot trefoil)
Lotus micranthus (small-flowered trefoil)
Lotus purshianus var. *purshianus* (Pursh's trefoil)
*Melilotus alba** (white sweet clover)

FAGACEAE
Quercus douglasii (blue oak)
Quercus kelloggii (California black oak)
Quercus lobata (valley oak)
Quercus wislizenii var. *wislizenii* (interior live oak)

GROSSULARIACEAE
Ribes nevadense (mountain pink current)

HYPERICACEAE
Hypericum anagalloides (tinker's penny)
*Hypericum perforatum** (Klamath weed)

IRIDACEAE
Sisyrinchium bellum (blue-eyed grass)

JUGLANDACEAE
Juglans california var. *hindsii* (northern California black walnut)
*Juglans regia** (English walnut)

LAMIACEAE
*Marrubium vulgare** (horehound)
*Mentha pulegium** (pennyroyal)
Monardella villosa ssp. *villosa* (villose coyote mint)
Prunella vulgaris var. *lanceolata* (self-heal)
Trichostema lanceolatum (vinegar weed)

LAURACEAE
Umbellularia californica (California bay)

LOASACEAE
Mentzelia lindleyi (Lindley's blazing star)

LYTHRACEAE
*Lythrum hyssopifolium** (hyssop loosestrife)

OLEACEAE
Fraxinus latifolia (Oregon ash)

ONAGRACEAE
Clarkia arcuata (Kellogg's clarkia)
Epilobium densiflorum (dense-flowered boisduvalia)

PLATANACEAE
Platanus racemosa (western sycamore)

POLYGONACEAE
Polygonum bistortoides (western bistort)
Polygonum hydropiperoides (water pepper)

PORTULACACEAE
Calyptridium umbellatum (pussy paws)

PRIMULACEAE
*Anagallis arvensis** (scarlet pimpernel)
Trientalis latifolia (starflower)

RANUNCULACEAE
Delphinium sp. (larkspur)
Ranunculus alismellus (water plantain)

RHAMNACEAE
Ceanothus cordulatus (mountain whitethorn)
Ceanothus cuneatus (buck brush)
Ceanothus diversifolius (pinemat)
Ceanothus integerrimus (deer brush)
Rhamnus rubra (Sierra coffeeberry)

ROSACEAE
Adenostoma fasciculatum (chamise)
Amelanchier utahensis (Utah service-berry)
Cercocarpus betuloides (birch-leaf mountain-mahogany)
Fragaria vesca (wood strawberry)
Heteromeles arbutifolia (toyon)
Potentilla drummondii (Drummond's cinquefoil)
Rosa californica (California rose)
Rosa gymnocarpa (wood rose)
*Rubus discolor** (Himalaya blackberry)
Rubus parviflorus (thimbleberry)
Rubus ursinus (creeping blackberry)
Spiraea densiflora (dense-flowered spiraea)

RUBIACEAE
Cephalanthus occidentalis (California button-willow)

SALICACEAE
Populus fremontii (Fremont cottonwood)
*Salix babylonica** (weeping willow)
Salix exigua (sandbar willow)
Salix gooddingii (Goodding's willow)
Salix laevigata (red willow)
Salix lasiolepis (arroyo willow)

SAXIFRAGACEAE
Darmera pertata (Indian rhubarb)

SCROPHULARIACEAE
Mimulus cardinalis (scarlet monkeyflower)
Mimulus guttatus (common monkeyflower)
*Verbascum thapsus** (woolly mullein)
*Veronica catenata** (Chain speedwell)

SIMAROUBACEAE
Ailanthus altissima (tree-of-heaven)

SOLANACEAE
*Datura stramonium** (Jimson weed)
*Solanum nigrum** (black nightshade)

URTICACEAE
Urtica dioica ssp. *holosericea* (hoary nettle)

VIOLACEAE
Viola purpurea (purple violet)

VISCACEAE
Phoradendron (mistletoe)

VITACEAE
Vitis californica (california wildgrape)

ZYGOPHYLLACEAE
*Tribulus terrestris** (puncture-vine)

<u>FLOWERING PLANTS - MONOCOTS</u>

ALISTMACEAE
Alisma plantago-aquatica (water plantain)
Sagitarria latifolia (wapato)

CYPERACEAE
Carex amplifolia (large-leaved sedge)
Carex bolanderi (Bolander's sedge)
Carex densa (dense sedge)
Carex nudata (torrent sedge)
Cyperus erythrorhizos (red-rooted cyperus)
Cyperus esculentus (yellow nutgrass)

IRIDACEAE
Sisyrinchium bellum (blue-eyed grass)

JUNCACEAE
Juncus effusus var. *pacificus* (Pacific rush)
Juncus patens (spreading rush)
Juncus phaeocephalus var. *phaeocephalus* (brown-headed rush)
Juncus tenuis (slender rush)

LILIACEAE
Chlorogalum pomeridianum var. *divaricatum* (Indian soap root)
Dichelostemma capitatum ssp. *capitatum* (blue dicks)
Lilium pardalinum ssp. *pardalinum* (leopard lily)

ORCHIDACEAE
Epipactis gigantea (stream orchid)

POACEAE
Arundo donax (giant reed)
*Avena barbata** (slender wild oat)
*Avena fatua** (wild oat)
*Avena sativa** (cultivated oat)
Brachypodium distachyon (brachypodium)
*Briza maxima** (rattlesnake grass)
*Briza minor** (quaking grass)
Bromus carinatus var. *carinatus* (California brome)
*Bromus diandrus** (ripgut grass)
*Bromus hordeaceus** (soft chess)

APPENDIX C. WILDLIFE SPECIES OBSERVED OR PREDICTED TO OCCUR IN THE DEER CREEK WATERSHED PROJECT SITE/STUDY AREA, JUNE 1997.

KEY:

O	-	Wildlife species or their signs observed in the study area.
P	-	Wildlife species expected to occur in the study area.
P?	-	Wildlife species that may occur in the study area, but information on this species occurrence in the study region is incomplete or lacking.

CLASS: AMPHIBIA	
ORDER: CAUDATA (Salamanders)	
FAMILY: SALAMANDRIDAE (Newts)	
Rough-skinned Newt (*Taricha granulosa*)	O
Sierra Newt (*Taricha torosa* sierrae)	O
FAMILY: PLETHODONITDAE (Lungless Salamanders)	
Ensatina Salamander (*Ensatina eschscholtzi*)	O
ORDER: SALIENTIA (Frogs and Toads)	
FAMILY: BUFONIDAE (True Toads)	
Western Spadefoot Toad (*Scaphiopus hammondi*)	P?
Western Toad (*Bufo boreas*)	O
FAMILY: HYLIDAE (Treefrogs and Relatives)	
Pacific Treefrog (*Hyla regilla*)	O
FAMILY: RANIDAE (True Frogs)	
Bullfrog (*Rana catesbeiana*)	O
California Red-legged Frog (*Rana aurora* draytoni)	P?
Cascade Frog (*Rana aurora* cascadae)	O
Foothill Yellow-legged Frog (*Rana boylei*)	O
CLASS: REPTILIA	
ORDER: TESTUDINESS (Turtles)	
FAMILY: EMYDIDAE (Pond and Marsh Turtles)	
Northwestern Pond Turtle (*Clemmys marmorata* marmorata)	O
ORDER: SQUAMATA (Lizards and Snakes)	
SUBORDER: SAURIA (Lizards)	
FAMILY: IGUANIDAE (Iguanids)	
Coast Horned Lizard (*Phrynosoma coronatum*)	P?
Northwestern Fence Lizard (*Sceloporus occidentalis* occidentalis)	O
Western Sagebrush Lizard (*Sceloporus graciosus*)	O
FAMILY: SCINCIDAE (Skinks)	
Skilton Skink (*Eumeces skiltonianus* skiltonianus)	O
Western Skink (*Eumeces skiltonianus*)	P?
FAMILY: TEIIDAE (Whiptails and Relatives)	
Western Whiptail Lizard (*Cnemidophorus tigris*)	P?
FAMILY: ANGUIDAE (Alligator Lizards and Relatives)	
Alligator Lizard (*Gerrhonotus* spp.)	O
Northern Alligator Lizard (*Elgaria/Gerrhonotus coeruleus*)	O
SUBORDER: SERPENTES (Snakes)	
FAMILY: BOIDAE (Boas)	
Pacific Rubber Boa (*Charina bottae bottae*)	O
Rubber Boa (*Charina bottae*)	P?
FAMILY: COLUBRIDAE (Colubrids)	
California Mountain Kingsnake (*Lampropeltis zonata*)	O
California Striped Whipsnake (*Masticophis taeniatus*)	P?
Chaparral Whipsnake (*Masticophis lateralis* lateralis)	O
Common Garter Snake (*Thamnophis sirtalis*)	P
Common King Snake (*Lampropeltis getulus*)	P
Garter Snake (*hamnophis* sp.)	O
Gopher Snake (*Pituophis melanoleucus*)	O

Mountain Garter Snake (*Thamnophis elegens* elegens)	O
Racer (*Coluber constrictor*)	P
Valley Garter Snake (*Thamnophis sirtalis* fitchi)	O
Western Aquatic Garter Snake (*Thamnophis couchi*)	O
Western Ringneck Snake (*Diadophis punctatus*)	O
Western Terrestrial Garter Snake (*Thamnophis elegens*)	P
FAMILY: VIPERIDAE (Vipers)	
Western Rattlesnake (*Crotalus viridis*)	P
CLASS: MAMMALIA	
ORDER: MARSUPIALIA (Opossums, Kangaroos, and Relatives)	
FAMILY: DIDELPHIDAE (Opossums)	
Virginia Opossum (*Didelphis virginiana*)	O
ORDER: INSECTIVORA (Shrews and Moles)	
FAMILY: SORICIDAE (Shrews)	
Adorned/Ornate Shrew (*Sorex ornatus*)	P
Vagrant Shrew (*Sorex vagrans*)	P
FAMILY: TALPIDAE (Moles)	
Broad-footed/handed Mole (*Scapanus latimanus*)	P
ORDER: CHIROPTERA (Bats)	
FAMILY: VESPERTILIONIDAE (Vespertilionid Bats)	
Big Brown Bat (*Eptesicus fuscus*)	P?
California Myotis (*Myotis californicus*)	P?
Fringed Myotis (*Myotis thysanodes*)	P?
Hoary Bat (*Lasiurus cinereus*)	P?
Little Brown Myotis (*Myotis lucifugus*)	P?
Long-eared Myotis (*Myotis evotis*)	P?
Long-legged Myotis (*Myotis volans*)	P?
Pale Big-eared Bat (*Plecotus townsendii* pallescens)	P?
Pallid Bat (*Antrozous pallidus*)	P?
Red Bat (*Lasiurus borealis*)	P?
Silver-haired Bat (*Lasionycteris noctivagans*)	P?
Small-footed Myotis (*Myotis leibii*)	P?
Spotted Bat (*Euderma maculata*)	O
Townsend's Big-eared Myotis (*Corynorhinus townsendii*)	O
Western Long-eared Myotis (*Corynorhinus rafinesquei*)	P?
Western Pipistrelle (*Pipistrellus hesperus*)	P?
FAMILY: MOLOSSIDAE (Free-tailed Bat)	
Western Mastiff Bat (*Eumops perotis*)	O
ORDER: LAGOMORPHA (Rabbits, Hares, and Pikas)	
FAMILY: LEPORTIDAE (Rabbits and Hares)	
Audubon's Cottontail (*Sylvilagus audubonii*)	P
Black-tailed Hare or Jackrabbit (*Lepus californicus*)	P
Brush Rabbit (*Sylvilagus bachmani*)	P
Sierra-Nevada Snowshoe Hare (*Lepus americanus tahoensis*)	P
ORDER: RODENTIA (Squirrels, Rats, Mice, and Relatives)	
FAMILY: SCIURIDAE (Squirrels, Chipmunks, and Marmots)	
California Ground Squirrel (*Spermophilus beecheyi*)	O
Fox Squirrel (*Sciurus niger*)	O
Merriam's Chipmunk (*Tamias merriami*)	O
Western Gray Squirrel (*Sciurus griseus*)	O
Yellow-bellied Marmot (*Marmota flaviventris*)	O
FAMILY: GEOMYIDAE (Pocket Gophers)	
Pocket Gopher (*Thomomys* spp.)	O
FAMILY: HETEROMYIDAE (Pocket Mice and Kangaroo Rats)	
California Pocket Mouse (*Perognathus californicus*)	P
Porcupine (*Erethizon dorsatum*)	P
FAMILY: CRICETIDAE (Deer Mice, Voles, and Relatives)	.
California Mouse (*Peromyscus californicus*)	P
California Meadow Mouse (*Microtus californicus*)	O
Deer Mouse (*Peromyscus maniculatus*)	P
Western Harvest Mouse (*Reithrodontomys megalotis*)	P
FAMILY: ARVICOLIDAE (Voles and Allies)	
California Meadow Vole (*Microtus californicus*)	O
Muskrat (*Ondatra zibethicus*)	P
FAMILY: MURIDAE (Old World Rats and Mice)	
Black Rat (*Rattus rattus*)	O
House Mouse (*Mus musculus*)	O
Norway Rat (*Rattus norvegicus*)	O

ORDER: CARNIVORA (Carnivores)	
FAMILY: CANIDAE (Foxes, Wolves, and Relatives)	
Beaver (*Castor canadensis*)	O
Coyote (*Canis latrans*)	O
Gray Fox (*Urocyon cinereoargenteus*)	P
Red Fox (*Vulpes vulpes*)	O
Sierra-Nevada Red Fox (*Vulpes vulpes* necator)	P
FAMILY: PROCYONIDAE (Raccoons and Relatives)	
Raccoon (*Procyon lotor*)	O
Ringtail (*Bassariscus astutus*)	P
FAMILY: MUSTELIDAE (Weasels, Badgers, and Relatives)	
American Badger (*Taxidea taxus*)	P?
Striped Skunk (*Mephitis mephitis*)	O
Western Spotted Skunk (*Spilogale gracilis*)	P
FAMILY: FELIDAE (Cats)	
Bobcat (*Lynx rufus*)	O
Mountain Lion (*Felis concolor*)	O
FAMILY: MUSTELIDAE	
Marten (*Martes americana*)	P?
Pacific Fisher (*Martes pennati pacifica*)	O
FAMILY: URSIDAE (Bears)	
Black Bear (*Ursus americanus*)	O
ORDER: ARTIODACTYLA	
FAMILY: SUIDAE (Pigs)	
Wild Pig (*Sus scrofa*)	O
FAMILY: CERVIDAE (Deer, Elk, and Relatives)	
Tehama Black-tailed Deer (*Odocoileus hemionus*)	O
CLASS: CRUSTACEA	
ORDER: ANOSTRACA	
FAMILY: BRANCHINECTIDAE	
Conservancy fairy shrimp (*Branchinectaa conservatio*)	O
Vernal pool fairy shrimp (*Branchinecta lynchi*)	O
FAMILY: LINDERIELLIDAE	
California Linderiella (*LinderiellaA occidentalis*)	O
ORDER: NOSTRALA	
FAMILY: TRIOPSIDAE	
Tadpole shrimp (*Lepidus packardi*)	O
CLASS: INSECTA	
ORDER: COLEOPTERA	
FAMILY: CERAMBYCIDAE	
Valley elderberry longhorn beetle (*Desmocerus californicus* dimorphus)	O
CLASS: AVES	
ORDER: GAVIIFORMES (Loons)	
FAMILY: GAVIIDAE (Loons)	
Common Loon (*Gavia ssp.*)	P
ORDER: PODICIPEDIFORMES (Grebes)	
FAMILY: PODICIPEDIDAE (Grebes)	
Western Grebe (*Aechmophorus occidentalis*)	P
ORDER: CICONIIFORMES (Herons, Storks, Ibises, and Relatives)	
FAMILY: ARDEIDAE (Herons and Bitterns)	
American Bittern (*Botaurus lentiginosus*)	O
Black-crowned Night Heron (*Nycticorax nycticorax*)	P
Cattle Egret (*Bubulcus ibis*)	P
Great Blue Heron (*Ardea herodias*)	O
Great Egret (*Casmerodius albus*)	O
Green-backed Heron (*Butorides striatus*)	P
Little Blue Heron (*Egretta caerulea*)	P
Snowy Egret (*Egretta thula*)	O
ORDER: ANSERIFORMES (Screamers, Ducks, and Relatives)	
FAMILY: ANATIDAE (Swans, Geese, and Ducks)	
American/Common Goldeneye (*Bucephala clangula*)	P
American Wigeon (*Anas americana*)	O
Barrow's Goldeneye (*Bucephala islandica*)	O
Blue-winged Teal (*Anas discors*)	P
Brant (*Branta bernicla*)	P

Bufflehead (*Bucephala albeola*)	P
Canada Goose (*Branta canadensis*)	O
Canvasback (*Aythya valisineria*)	P
Cinnamon Teal (*Anas cyanoptera*)	P
Common Merganser (*Mergus merganser*)	P
Eurasian Wigeon (*Anas penelope*)	P
Gadwall (*Anas strepera*)	P
Greater Scaup (*Aythya marila*)	P
Green-winged Teal (*Anas crecca*)	P
Harlequin Duck (*Histrionicus histrionicus*)	P
Hooded Merganser (*Lophodytes cucullatus*)	P
Lesser Scaup (*Aythya affinis*)	P
Mallard (*Anas platyrhynchos*)	P
Northern Pintail (*Anas acuta*)	P
Northern Shoveler (*Anas clypeata*)	P
Oldsquaw (*Clangula hyemalis*)	P
Redhead (*Aythya americana*)	P
Ring-necked Duck (*Aythya collaris*)	P
Ruddy Duck (*Oxyura jamaicensis*)	P
Shoveler (*Spatula clypeata*)	P
Snow Goose (*Chen caerulescens*)	O
Tundra Swan (*Cygnus columbianus*)	O
White-winged Scoter (*Melanitta fusca*)	P
Wood Duck (*Aix sponsa*)	P
ORDER: FALCONIFORMES (Vultures, Hawks, and Falcons)	
FAMILY: CATHARTIDAE (American Vultures)	
Turkey Vulture (*Cathartes aura*)	O
FAMILY: ACCIPITRIDAE (Hawks, Old World Vultures, and Harriers)	
Bald Eagle (*Halieaeetus leucocephalus*)	O
Cooper's Hawk (*Accipiter cooperii*)	O
Ferruginous Hawk (*Buteo regalis*)	P?
Golden Eagle (*Aquila chrysaetos*)	O
Marsh Hawk/Northern Harrier (*Circus cyaneus*)	O
Northern Goshawk (*Accipiter gentilis*)	O
Osprey (*Pandion haliaetus*)	O
Red-shouldered Hawk (*Buteo lineatus*)	O
Red-tailed Hawk (*Buteo jamaicensis*)	O
Rough-legged Hawk (*Buteo lagopus*)	P?
Sharp-shinned Hawk (*Accipiter striatus*)	O
Swainson's Hawk (*Buteo swainsoni*)	P
White-tailed Kite (*Elanus leucurus*)	O
FAMILY: FALCONIDAE (Caracaras and Falcons)	
Peregrine Falcon (*Falco peregrinus*)	O
Pigeon Hawk/Merlin (*Falco columbarius*)	O
Prairie Falcon (*Falco mexicanus*)	O
Sparrow Hawk/American Kestrel (*Falco sparverius*)	O
ORDER: GALLIFORMES (Megapodes, Currassows, Pheasants, and Relatives)	
FAMILY: PHASIANIDAE (Quails, Pheasants, and Relatives)	
California Quail (*Callipepla californica*)	O
Mountain Quail (*Oreortyx pictus*)	O
Ring-necked Pheasant (*Phasianus colchicus*)	O
Wild Turkey (*Meleagris gallopavo*)	O
ORDER: GRUIFORMES (Cranes, Rails, and Relatives)	
FAMILY: RALLIDAE (Rails, Gallinules, and Coots)	
American Coot (*Fulica americana*)	O
Common Moorhen (*Gallinula chloropus*)	O
Sandhill Crane (*Crus canadensis*)	O
Sora Rail (*Porzana carolina*)	P
ORDER: CHARADRIIFORMES (Shorebirds, Gulls, and Relatives)	
FAMILY: CHARADRIIDAE (Plovers and Relatives)	
Killdeer (*Charadrius vociferus*)	O
Mountain Plover (*Charadrius montanus*)	O
FAMILY: RECURVIROSTRIDAE (Avocets and Stilts)	
American Avocet (*Recurvirostra americana*)	O
Black-necked Stilt (*Himantopus mexicanus*)	O
FAMILY: SCOLOPACIDAE (Sandpipers and Relatives)	
Greater Yellowlegs (*Tringa melanoleuca*)	O
Lesser Yellowlegs (*Tringa flavipes*)	O

ORDER: COLUMBIFORMES (Pigeons and Doves)

FAMILY: COLUMBIDAE (Pigeons and Doves)

Band-tailed Pigeon (*Columba fasciata*)	O
Mourning Dove (*Zenaida macroura*)	O
Rock Dove (*Columba livia*)	O

ORDER: CUCULIFORMES (Cuckoos and Relatives)

FAMILY: CUCULIDAE (Typical Cuckoos)

California Yellow-billed Cuckoo (*Coccyzusamericanus occidentalis*)	O
Road Runner (*Ceococcyx*)	O

ORDER: STRIGIFORMES (Owls)

FAMILY: TYTONIDAE (Barn Owls)

Barn Owl (*Tyto alba*)	O

FAMILY: STRIGIDAE (Typical Owls)

Great Gray Owl (*Strix nebulosa*)	O
Great Horned Owl (*Bubo virginianus*)	O
Long-eared Owl (*Asio otus*)	P
Northern Pygmy-Owl (*Glaucidium gnoma*)	P
Northern Saw-whet Owl (*Aegolius acadicus*)	P
Short-eared Owl (*Asio flammeus*)	O
Spotted Owl (*Strix occidentalis*)	O
Western Screech-Owl (*Otus kennicotti*)	P

ORDER: CAPRIMULGIFORMES (Goatsuckers and Relatives)

FAMILY: CAPRIMULGIDAE (Goatsuckers)

Common Nighthawk (*Chordeiles minor*)	P
Common Poorwill (*Phalaenoptilus nuttallii*)	P
Lesser Nighthawk (*Chordeiles acutipennis*)	P

ORDER: APODIFORMES (Swifts and Hummingbirds)

FAMILY: APODIDAE (Swifts)

Vaux's Swift (*Chaetura vauxi*)	P
White-throated Swift (*Aeronautes saxatalis*)	O

FAMILY: TROCHILIDAE (Hummingbirds)

Allen's Hummingbird (*Selasphorus sasin*)	P
Anna's Hummingbird (*Calypte anna*)	P
Calliope Hummingbird (*Stellula calliope*)	P
Costa's Hummingbird (*Calypte costae*)	P
Rufous Hummingbird (*Selasphorus rufus*)	P

ORDER: CORACIIFORMES (Kingfishers and Relatives)

FAMILY: ALCEDINIDAE (Kingfishers)

Belted Kingfisher (*Ceryle alcyon*)	O

ORDER: PICIFORMES (Woodpeckers and Relatives)

FAMILY: PICIDAE (Woodpeckers and Wrynecks)

Acorn Woodpecker (*Melanerpes formicivorous*)	P
Downy Woodpecker (*Picoides pubescens*)	P
Hairy Woodpecker (*Picoides villosus*)	P
Lewis' Woodpecker (*Melanerpes lewis*)	P
Northern Flicker (*Colaptes auratus*)	O
Nuttall's Woodpecker (*Picoides nuttallii*)	P
Pileated Woodpecker (*Dryocopus pileatus*)	O
Red-shafted Flicker (*Colaptes cafer*)	P
White-headed Woodpecker (*Dendrocopos albolarvatua*)	O
Williamson's Sapsucker (*Sphyrapicus thyroideus*)	O
Yellow-bellied Sapsucker (*Sphyrapicus varius*)	P

ORDER: PASSERIFORMES (Perching Birds)

FAMILY: TYRANNIDAE (Tyrant Flycatchers)

Ash-throated Flycatcher (*Myiarchus cinerascens*)	O
Black Phoebe (*Sayornis nigricans*)	O
Dusky Flycatcher (*Empidonax oberholseri*)	P
Gray Flycatcher (*Empidonax wrightii*)	P
Hammond's Flycatcher (*Empidonax hammondii*)	P
Olive-sided Flycatcher (*Contopus borealis*)	P
Say's Phoebe, (*Sayornis saya*)	P
Western Kingbird (*Tyrannus verticalis*)	O
Western/Pacific-slope Flycatcher (*Empidonax difficilis*)	P
Western Wood-Pewee (*Contopus sordidulus*)	P
Willow Flycatcher (*Empidonax traillii*)	P

FAMILY: ALAUDIDAE (Larks)

Horned Lark (*Eremophila alpestris*)	O

FAMILY: HIRUNDINIDAE (Swallows)

Bank Swallow (*Riparia riparia*)	O
Barn Swallow (*Hirundo rustica*)	O
Cliff Swallow (*Hirundo pyrrhonota*)	O

Northern Rough-winged Swallow (*Stelgidopteryx serripennis*)	O
Purple Martin (*Progne subis*)	P
Tree Swallow (*Tachycineta bicolor*)	O
Violet-green Swallow (*Tachycineta thalassina*)	O
FAMILY: CORVIDAE (Jays, Magpies, and Crows)	
Clark's Nutcracker (*Nucifraga columbiana*)	P
Common/American Crow (*Corvus brachyrhynchos*)	O
Common Raven (*Corvus corax*)	O
Scrub Jay (*Aphelocoma coerulescens*)	O
Steller's Jay (*Cyanocitta stelleri*)	O
Yellow-billed Magpie (*Pica nuttalli*)	O
FAMILY: PARIDAE (Titmice)	
Chestnut-backed Chickadee (*Parus rufescens*)	P
Mountain Chickadee (*Parus gambeli*)	P
Plain Titmouse (*Parus inornatus*)	P
FAMILY: AEGITHALIDAE (Bushtit)	
Bushtit (*Psaltriparus minimus*)	O
FAMILY: SITTIDAE (Nuthatches)	
Pygmy Nuthatch (*Sitta pygmaea*)	O
Red-breasted Nuthatch (*Sitta canadensis*)	O
White-breasted/throated Nuthatch (*Sitta carolinensis*)	O
FAMILY: CERTHIIDAE (Creepers)	
Brown Creeper (*Certhia americana*)	P
FAMILY: TROGLODYTIDAE (Wrens)	
Bewick's Wren (*Thryomanes bewickii*)	P
Canyon Wren (*Catherpes mexicanus*)	P
House Wren (*Troglodytes aedon*)	P
Marsh Wren (*Cistothorus palustris*)	P
Rock Wren (*Salpinctes obsoletus*)	P
Winter Wren (*Troglodytes troglodytes*)	P
FAMILY: CINCLIDAE (Dippers)	
American Dipper (*Cinclus mexicanus*)	O
FAMILY: MUSCICAPIDAE (Old World Warblers, Gnatcatchers, Kinglets, Thrushes, Bluebirds, and Wrentit)	
American Robin (*Turdus migratorius*)	O
Blue-gray Gnatcatcher (*Polioptila caerulea*)	P
Golden-crowned Kinglet (*Regulus satrapa*)	P
Hermit Thrush (*Catharus guttatus*)	P
Mountain Bluebird (*Sialia currucoides*)	P
Ruby-crowned Kinglet (*Regulus calendula*)	P
Swainson's Thrush (*Catharus ustulatus*)	O
Townsend's Solitaire (*Myadestes townsendi*)	P
Varied Thrush (*Ixoreus naevius*)	O
Western Bluebird (*Sialia mexicana*)	O
Wrentit (*Chamaea fasciata*)	O
FAMILY: MIMIDAE (Mockingbirds and Thrashers)	
California Thrasher (*Toxostoma redivivum*)	P
Northern Mockingbird (*Mimus polyglottos*)	O
Sage Thrasher (*Oreoscoptes montanus*)	P
FAMILY: BOMBYCILLIDAE (Waxwings)	
Cedar Waxwing (*Bombycilla cedrorum*)	P
Bohemian Waxwing (*Bombycilla garrula*)	P
FAMILY: LANIIDAE (Shrikes)	
Loggerhead Shrike (*Lanius ludovicianus*)	P
FAMILY: STURNIDAE (Starlings)	
European Starling (*Sturnus vulgaris*)	O
FAMILY: VIREONIDAE (Typical Vireos)	
Bells Vireo (*Vireo bellii*)	P
Hutton's Vireo (*Vireo huttoni*)	P
Red-eyed Vireo (*Vireo olivaceus*)	P
Solitary Vireo (*Vireo solitarius*)	P
Warbling Vireo (*Vireo gilvus*)	P
FAMILY: EMBERIZIDAE (Wood Warblers, Sparrows, Blackbirds, and Relatives)	
American Redstart (*Setophaga ruticilla*)	O
American Tree Sparrow (*Spizella arborea*)	O
Audubon Warbler (*Dendroica auduboni*)	P
Black-chinned Sparrow (*Spizella atrogularis*)	P
Black-headed Grosbeak (*Pheucticus melanocephalus*)	P
Black-throated Gray Warbler (*Dendroica nigrescens*)	P
Blue Grosbeak (*Guiraca caerulea*)	P
Brewer's Blackbird (*Euphagus cyanocephalus*)	O
Brewer's Sparrow (*Spizella breweri*)	P
Brown-headed Cowbird (*Molothrus ater*)	O
Brown Towhee (*Pipilo fuscus*)	O
Bullocks Oriole (*Icterus bullocki*)	P
California Towhee (*Pipilo crissalis*)	P
Clay-colored Sparrow (*Spizella pallida*)	P

Common Yellowthroat (*Geothlypis trichas*)	O
Dark-eyed Junco (*Junco hyemalis*)	P
Fox Sparrow (*Passerella iliaca*)	P
Golden-crowned Sparrow (*Zonotrichia atricapilla*)	P
Grasshopper Sparrow (*Ammodramus savannarum*)	P
Hermit Warbler (*Dendroica occidentalis*)	P
Hooded Oriole (*Icterus cucullatus*)	P
Lark Bunting (*Calamospiza melanocorys*)	P
Lark Sparrow (*Chondestes grammacus*)	P
Lincoln's Sparrow (*Melospiza lincolnii*)	P
Myrtle/Yellow-rumped Warbler (*Dendroica coronata*)	P
Nashville Warbler (*Vermivora ruficapilla*)	P
Northern Oriole (*Icterus galbula*)	P
Orange-crowned Warbler (*Vermivora celata*)	P
Orchard Oriole (*Icterus spurius*)	P
Oregon Junco (*Junco oreganus*)	O
Red-winged Blackbird (*Agelaius phoeniceus*)	O
Rose-breasted Grosbeak (*Pheucticus ludovicianus*)	P
Rufous-sided Towhee (*Pipilo erythropthalmus*)	P
Sage Sparrow (*Amphispiza belli*)	P
Savannah Sparrow (*Passerculus sandwichensis*)	P
Sharp-tailed Sparrow (*Ammodramus caudacuta*)	P
Song Sparrow (*Melospiza melodia*)	O
Swamp Sparrow (*Melospiza georgiana*)	P
Townsend's Warbler (*Dendroica townsendi*)	P
Tricolored Blackbird (*Agelaius tricolor*)	O
Vesper Sparrow (*Pooecetes gramineus*)	P
Western Meadowlark (*Sturnella neglecta*)	O
Western Tanager (*Piranga ludoviciana*)	P
White-crowned Sparrow (*Zonotrichia leucophrys*)	O
White-throated Sparrow (*Zonotrichia albicollis*)	P
Yellow-breasted Chat (*Icteria virens*)	O
Yellow Warbler (*Dendroica petechia*)	O

FAMILY: FRINGILLIDAE (Finches)

American Goldfinch (*Carduelis tristis*)	O
Cassin's Finch (*Carpodacus cassinii*)	P
Evening Grosbeak (*Coccothraustes vespertinus*)	P
House Finch (*Carpodacus mexicanus*)	O
Lesser Goldfinch (*Carduelis psaltria*)	P
Pine Siskin (*Carduelis pinus*)	P
Purple Finch (*Carpodacus purpureus*)	O
Red Crossbill (*Loxia curvirostra*)	P

FAMILY: PASSERIDAE (Weaver Finches)

House Sparrow (*Passer domesticus*)	O

ORDER: LEPIDOPTERA

FAMILY: PAPILIONIDAE

Pipe-vine Swallowtail (*Battus philenor*)	O
Western Tiger Swallowtail (*Papilio nutulus*)	O

APPENDIX D

SPECIES ACCOUNTS FOR SPECIAL STATUS SPECIES THAT ARE KNOWN TO OCCUR OR HAVE THE POTENTIAL TO OCCUR IN THE DEER CREEK WATERSHED

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APPENDIX D

SPECIES ACCOUNTS FOR SPECIAL STATUS SPECIES THAT ARE KNOWN TO OCCUR OR HAVE THE POTENTIAL TO OCCUR IN THE DEER CREEK WATERSHED

CALIFORNIA RED-LEGGED FROG

The Deer Creek Watershed is within the known range of the California red-legged frog (*Rana aurora* draytonii) (Jennings and Hayes 1994 and USFWS 1996) . The breeding season for this frog spans from January to April (Stebbins 1985). Females deposit 1,000 to 4,000 eggs on submerged vegetation at or near the water surface.

The California red-legged frog is listed as a State and Federally-threatened and State species of special concern. This species is found in quiet pools along streams, in marshes, and ponds. Red-legged frogs are closely tied to aquatic environments and favor intermittent streams which include some areas with intact emergent or shoreline vegetation, as well as a lack of introduced bullfrogs and non-native fishes. They are generally found in streams having a small drainage area and low gradient (Hayes and Jennings 1988).

The current range of the red-legged frog occurs west of the Sierra Nevada-Cascade crest and in the Coast Ranges from Point Reyes in Marin County to San Luis Obispo in Monterey County. Scattered populations of red-legged frogs in the Coast Range region, from Marin County to Monterey County, are more intact than in the rest of the State. Much of their habitat has undergone significant alterations in recent years leading to extirpation of many populations. Other factors contributing to its decline include: its former exploitation as food, water pollution, predation, and competition by the introduced bullfrog and non-native fish (Moyle 1973, Hayes and Jennings 1988). The known presence of non-native bullfrogs in the Deer Creek Watershed should be considered an immediate threat to both larval and adult native frogs.

NORTHWESTERN POND TURTLE

Northwestern pond turtles (*Clemmys marmorata*) are a State species of special concern. In general, northwestern pond turtles are found in ponds, marshes, rivers, streams, and irrigation ditches containing aquatic vegetation. They are usually seen sunning on logs, banks, or rocks near banks. They nest in burrows, which may be up to several hundred feet away from river or pond banks, and may be found in woodlands, grasslands, and in open forest. Eggs are laid April to August, although time varies with locality.

Northwestern pond turtles were observed in the lower Deer Creek Watershed, along the Sacramento River, and in Deer Creek in the lower canyon during the 1997 reconnaissance field surveys. Northwestern pond turtles have been observed between upper Deer Creek Falls and lower Deer

Creek Falls at Red Bridge, in Lassen National Forest (pers. com. Susan Chappel 1997). The grasslands adjacent to Deer Creek provide potential burrow/nest sites. The presence of northwestern pond turtles above upper Deer Creek Falls is unknown. Population and upland (nesting) habitat status are unknown and need further study.

During cold weather, they hibernate in bottom mud. The diet of these turtles consists of aquatic vegetation, insects, fish, worms, and carrion. One factor in the decline of this species is the introduction of non-native fish that prey on hatchlings and juveniles.

FOOTHILL YELLOW-LEGGED FROG

The foothill yellow-legged frog (*Rana boylei*) is a Federal and State species of special concern. Foothill yellow-legged frogs have been recorded in middle reaches of the Deer Creek Watershed up to the Highway 32 bridge (pers. com. Fellers 1997). There are no records of foothill yellow-legged frogs in the lower elevations of Deer Creek, although a reproductive population of foothill yellow-legged frogs are known to occur in Dye Creek, a lower elevation tributary to Deer Creek (McNutt 1997).

They are found in or near rocky streams in a variety of habitats which include: valley foothill hardwood, valley-foothill riparian, coastal scrub, mixed conifer, mixed chaparral, and wet meadows (Zeiner *et al.* 1988). This species is very closely tied to its aquatic habitat and is rarely found far from perennial or intermittent streams (Stebbins 1985). Foothill yellow-legged frogs are typically found in shallow water of partly shaded streams. They prefer sites with riffles and at least cobble-sized substrates (Hayes and Jennings 1988). Adults seek moving but usually not swiftly flowing water (Stebbins 1985). Pools are used on intermittent streams during the dry season (Hayes and Jennings 1988). Breeding takes place from mid-March to early June. The female attaches grape-like clusters of eggs to gravel or rocks in moving water near stream margins.

YELLOW WARBLER

Yellow warbler (*Dendroica petechia*) breeding pairs are closely associated with open canopy riparian habitat along streams and lakes. They are most numerous where substantial areas of riparian habitat remain along major creeks and rivers. A variety of riparian trees are used during foraging; habitats with willows and cottonwoods or willows and sycamores, with dense undergrowth, seem to be favored. Outside the breeding season, this species may occur in a variety of habitats, but is still most numerous in riparian areas. Yellow warblers are reduced in numbers over much of their California breeding range, largely due to loss of riparian habitat and nest parasitism by the brown-headed cowbird (Remsen 1978). The yellow warbler's diet consists of spiders and insects, which it gleans from understory vegetation and the canopies of deciduous trees. Nests are constructed in low trees, typically from 2 to 12 feet above the ground (Harrison 1978).

Most transients occur from mid-April to early June and from August to early October. The breeding season spans from April to late July.

COOPER'S HAWK

Cooper's hawk (*Accipiter cooperii*) is a State species of special concern. Like the sharp-shinned hawk, this species is a rare breeder in the California, but is somewhat more numerous than the former. Cooper's hawks feed primarily on small birds, but also take small mammals, reptiles, and amphibians. Cooper's hawks prefer forested habitats in mountainous regions, but also use riparian woodlands. Foraging occurs in both dense cover and open habitats. Nests are constructed in a variety of trees, but stands of live oaks may be preferred (Asay 1987). The breeding season probably spans from March/April through July. Wintering individuals will utilize a variety of habitats, including oak woodland, conifer and mixed broadleaf forests, grasslands, residential areas, and riparian woodland.

SHARP-SHINNED HAWK

The sharp-shinned hawk (*Accipiter striatus*) is a State species of special concern. Potentially suitable breeding habitat occurs over much of the mixed evergreen forest, Douglas fir mixed conifer forest, and riparian forest of the Deer Creek Watershed. Sharp-shinned hawks prefer to build their stick nests in conifers in thick cover. The breeding season spans from April to July. Migrant and wintering individuals frequent a variety of habitats, but favor edges of wooded habitats. Small birds make up the bulk of the sharp-shinned hawk's diet, but small mammals, insects, reptiles, and amphibians are also eaten. Sharp-shinned hawks are expected to occur between September and April as rare migrants or winter residents, foraging in the watershed.

OSPREY

Most ospreys (*Pandion haliaetus*) are seen in the Deer Creek Watershed flying over or foraging. They build their large stick nests atop dead trees or poles, and will readily use artificial platforms. Nesting ospreys have declined in California because of the removal of nesting trees, degradation of lake and river environments, boating, and shooting (Remsen 1978). Ospreys have been observed flying and foraging in the lower, middle, and upper portions of Deer Creek Watershed. Known nest sites occur near Elam campground and near the junction of Highway 89 and Highway 32 in the upper Deer Creek Watershed (CDFG 1997).

MERLIN

Wintering individual merlins (*Falco columbarius*) occur in a variety of habitats, including riparian, dense woodlands, grasslands and agricultural fields, marshes, and developed areas. Merlins prey primarily on small birds, but also take small mammals and insects. Because they prey mostly on birds, merlins may be threatened by the use of pesticides (Remsen 1978). Merlins are expected to be primarily aerial in the Deer Creek Watershed, stopping during their migration to rest and forage only briefly.

GOLDEN EAGLE

The golden eagle (*Aquila chryseatos*) is a State species of special concern. Golden eagles require large expanses of habitat as territory for feeding and nesting. Grasslands and open wooded habitats are needed for hunting, with ground squirrels and jackrabbits being the primary prey species. Nests are built at sites with a good view of the surrounding area, and are usually placed on cliffs, in trees, or occasionally on transmission towers. Golden eagles are very sensitive to human disturbance at nest sites. Agricultural and urban development of grasslands, as well as human persecution, has led to this species' decline in California (Remsen 1978).

The apparent low density of ground squirrels and rodent populations of the grasslands in the lower Deer Creek Watershed, assumed to be in association with cattle grazing, has degraded the potential habitat for golden eagles. However, the large herd of black-tail deer provides potential foraging especially during fawning season.

WHITE-TAILED KITE

White-tailed kite (*Elanus caeruleus*), formerly known as black-shouldered kite, is a State species of special concern. Stick nests are made near the tops of trees, camouflaged from below but open on top. Nests are located near herbaceous and open stages of most habitats. Nest sites may be used from year-to-year with 4 to 5 eggs laid (Erlich *et al.* 1988). Males feed both the females and young during nesting season (Erlich *et al.* 1988, pers. com. B. Walton 1996). Kites feed on rodents, lizards, birds, and insects. Under favorable conditions, kites may nest semi-colonially (Erlich *et al.* 1988).

BURROWING OWL

Burrowing owls (*Athene cunicularia*) are currently listed as a California species of special concern (CDFG 1996). Nests are usually located in mammal burrows (e.g., ground squirrel or prairie dog holes) located in short grassland vegetation (native grasses or disturbed grassland areas due to grazing). Burrowing owl populations have been declining along the Pacific Coast due to poisoning. Nest site loss is a result of human efforts to eradicate ground squirrels and prairie dogs (Erlich *et al.* 1988).

AMERICAN BADGER

The American badger (*Taxidea taxus*) is a State species of special concern. This species primarily occurs in grassland and savannah habitats with friable soils. However, a variety of other habitats are utilized (e.g., shrub and open stages of forests). The abundant supply of prey species (especially fossorial mammals) is an essential habitat requirement. Badgers excavate burrows for denning sites, and dig for ground squirrels, gophers, and other prey species. Once fairly widespread, this species has declined or disappeared over large areas of the State, due to agriculture and urban development (Williams 1986). Predator control programs using indiscriminant trapping and certain poisons may have detrimental affects on badger populations.

LONG-EARED OWL

The long-eared owl (*Asio otus*) is a State species of special concern. This species is a rare but a potential breeding species in the Deer Creek Watershed. Long-eared owls occur in a variety of wooded habitats. They typically use abandoned nests of other raptors and tree squirrels, occasionally nest in tree cavities, and rarely in hollows on the ground (Harrison 1979).

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APPENDIX E

FISHING EXPERIENCES ON DEER CREEK

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(*Authored by Jim Gaumer, Deer Creek Watershed Conservancy*)

"As the green leaves of summer start to turn shades of yellow, red and gold, the fall-run of Chinook salmon, followed closely by steelhead, enter Deer Creek. From March through the early part of June the spring-run Chinook salmon arrive to make their way to Deer Creek's upper reaches where they wait in deep, cold pools until September and October when they fulfill their destiny by spawning.

The summer months find warm water species, such as small mouth bass, squawfish, and sunfish in the valley reach. Rainbow trout and German brown trout, an exotic, thrive within the canyon and upper reaches.

Deer Creek has rendered its bounty to fishermen from the days Native Americans first fished its waters for salmon, steelhead, and rainbow trout. There exist numerous campsites and caves all along the banks of Deer Creek that disclose the secrets of these earliest of inhabitants.

I first started to fish Deer Creek in the mid-50's when as a boy I used to camp within the canyon reach with my parents and brothers. I caught my first rainbow trout on a fly in 1950 on the creek. I not only vividly remember that first fish but I also remember the second fish I caught as well. I was fishing a deep, crystal clear pool when this rainbow trout came from the deep to inhale that fly. I watched it all the way. Exciting stuff for a small boy. I have been an avid fly fisherman ever since.

The other vivid memory I have of fishing the creek in those early years occurred when I was a Boy Scout. An advisor took a number of us scouts fishing on Deer Creek as a final test in pursuit of the fishing merit badge. As evening casted its magic in the canyon, trout began to surface feed. I switched from salmon eggs, which were not particularly effective, to a two fly set-up. On my first cast I caught a double. I not only had an exciting evening of fishing but I got my merit badge as well.

Over the years, Deer Creek has been highly regarded as an excellent winter steelhead fishery. Unfortunately the numbers of steelhead have declined recently to the point where fishing for this specie is now disallowed. Additionally, Deer Creek harbors one of the last remaining runs of native, spring-run Chinook salmon. The spring run is a candidate for listing as an endangered species, and the steelhead has been petitioned to be also so listed.

Because of the problems with these two species, severe restrictions were imposed upon the sport fishing for rainbow trout in 1990. Prior to this time, 10 trout could be taken anywhere in the creek from the last weekend in April until November 15, and 3 trout (including steelhead) could be taken year-round from the mouth to the U.S. Gauging Station (USGS). After the change in 1990, the limit for trout was reduced to 5 trout, 12" minimum size using artificial lures with barbless hooks, in that portion of the creek from the USGS to the falls above the Potato Patch Campground (falls) along State Route 32, and no fishing year -round for any species of fish from the USGS to the mouth. The year 1994 yielded another change in the regulations whereby the limit for trout from the mouth to the falls was reduced to zero. A 5 trout limit was still allowed above the falls. In 1996, one more regulatory change was made to allow the taking of all non-salmonids from the mouth to the USGS from June 16 to September 30. All other aspects of the regulations remain the same.

Interestingly, salmon fishing has never been allowed in Deer Creek. Even back in the 1950's when you could keep 15 trout or for that matter in the 1940's when you could keep 25 trout, salmon fishing was disallowed.

As mentioned above, trout fishing is still allowed above the falls. The California Department of Fish and Game regularly plants catchables there and thus provides recreational opportunities for many people.

The typical aquatic insects such as the mayfly, cranefly, caddisfly, yellow stonefly, golden stonefly, ternarcies stonefly, and midge, to name the dominant species, are present in the creek. Terrestrials, such as grasshoppers, beetles, and ants, provide a rich source of food for feeding fish during the summer months. Unfortunately steelhead fry and spring-run fry offer ready source of protein for the very large populations of rainbow and German brown trout that inhabit the upper reaches of the creek. As the author, I believed this predation of steelhead fry could be a significant component in the decline of this species.

Experience shows that when the Deer Creek Watershed experiences drought conditions for a couple years, aquatic insect populations explode. This situation can provide some memorable fishing experiences for the fly fisherman. Fishermen have experienced evenings when yellow stoneflies, caddis, and mayflies have come off at the same time and in such profusion that they become a distraction by getting in your ears and mouth. It is especially unnerving when a bug enters your mouth as you shout for joy when a 20-inch rainbow launches itself after it swallows your fly.

For those that have fished Deer Creek in the past and who will fish it in the future, the restoration of the two runs of salmon and the steelhead trout takes on a level of importance surpassed by few issues. It is our fervent hope that once again as summer's heat turns to the cool nights and comfortable days of fall, we will be able to ply our patience and skill in pursuit of the majestic steelhead."