Towards a Healthy Wildland Watershed: Willow Creek Watershed Management Plan

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Willow Creek Watershed Management Plan

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Prunuske Chatham, Inc.
Mendocino Redwoods Company
California Department of Fish and Game
Sonoma County Department of Public Works and Transportation
NOAA Fisheries Service
LandPaths
Trout Unlimited

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www.stewardsofthecoastandredwoods.org/willowcreek.htm

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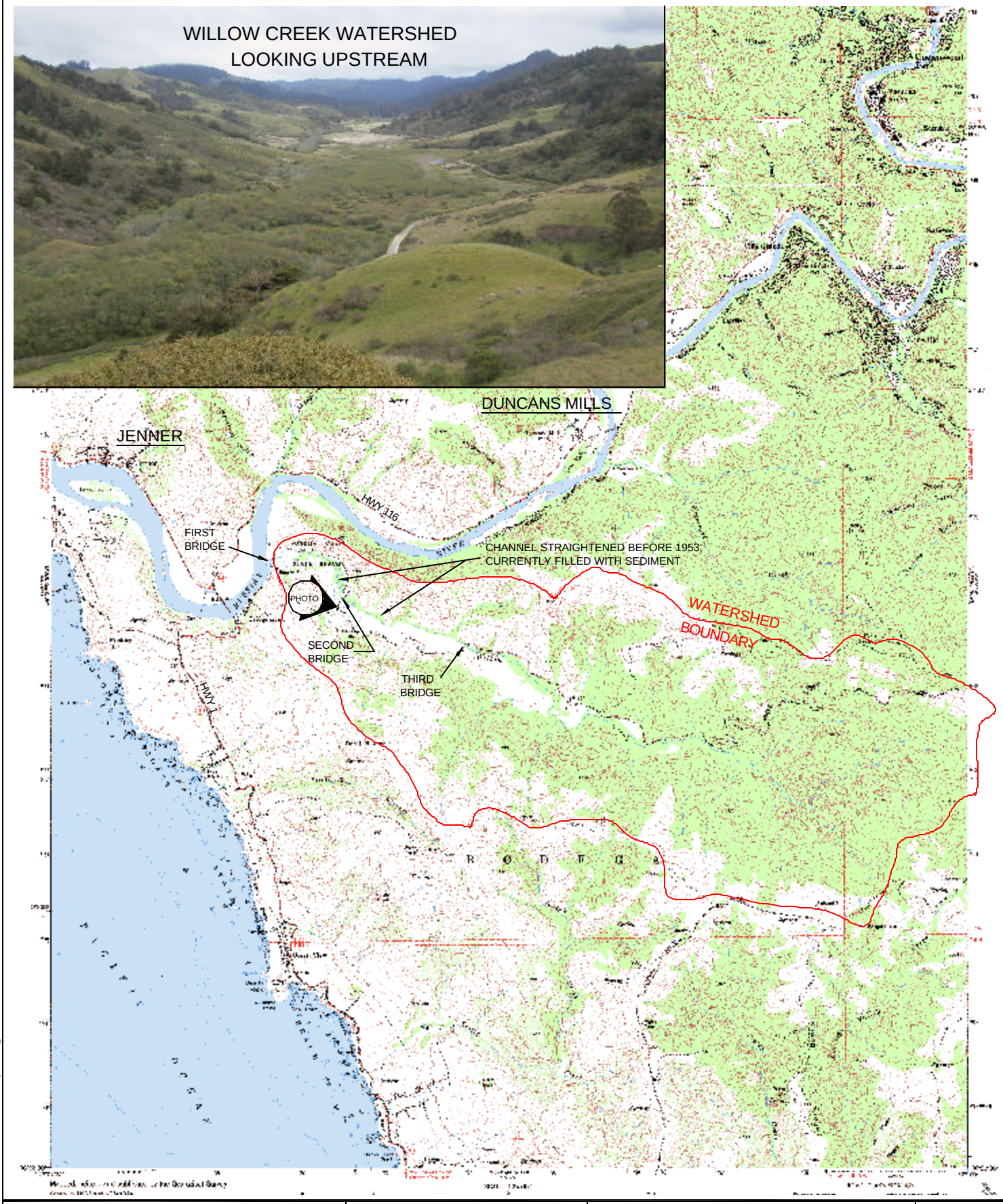

PRUNUSKE CHATHAM, INC. P.O. BOX 828 OCCIDENTAL, CA 95465 (707) 874-0100	DATE: November, 2000 SCALE: 1"= 5000' CHECKED BY: SC DRAFTED BY: EA DESIGNED BY:	WILLOW CREEK SITE LOCATION MAP ON USGS TOPO "DUNCANS MILLS" & SITE PHOTO	Figure 1

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EXECUTIVE SUMMARY

The *Willow Creek Watershed Management Plan* has been developed in response to public and agency concern for the future of the watershed. Partners in the project include two major landowners, the California Department of Parks and Recreation (DPR or State Parks) and Mendocino Redwoods Company (MRC), Stewards of the Coast and Redwoods (Stewards)[1], Prunuske Chatham, Inc. (PCI), Trout Unlimited (TU), LandPaths, and members of the Technical Advisory Committee (TAC). The project began in 2001 when initial funding was awarded by the Sonoma County Water Agency by way of a Proposition 13 grant from the State Water Resources Control Board. Additional funding was also secured from the Russian River Watershed Council, the City of Santa Rosa, the National Fish and Wildlife Foundation, and the Sonoma County Fish and Wildlife Commission.

The *Willow Creek Watershed Management Plan* is a living document that will grow and change as further planning occurs and funding is obtained. Many specific land use issues have been raised during the watershed plan's public input process, some of which will be directed to State Parks to address through their general plan process. The draft of the *General Plan for Sonoma Coast State Beach*, including the Willow Creek Unit, can be found at www.parks.ca.gov/generalplans.[2]

The *Willow Creek Watershed Management Plan* is organized into five chapters, including the introduction, vision and goals for watershed health and function, watershed history, watershed diagnosis, and watershed enhancement projects, as well as a bibliography and two appendices containing summaries of the public meetings. The completed watershed plan is available online on the Stewards' website at www.stewardsofthecoastandredwoods.org/willowcreek.htm. The plan will also be available on the Russian River Interactive Information System (RRIIS).

Chapter 1 describes the watershed and discusses the purpose of the *Willow Creek Watershed Management Plan*, plan development, stakeholders, and the TAC. Chapter 2 includes the community vision identified during the public outreach process for the next 2-5 years, after 10 years, and after 50 years and a discussion of specific goals for the watershed, including wildlife habitat improvement, erosion and sediment control, vegetation management, and recreation. The history and past and current land uses in the watershed are summarized in Chapter 3. Chapter 4 provides a diagnosis of the areas of environmental concern in the watershed, including landscape and habitat alterations, altered sediment production and transport, fisheries decline, and limitations to restoration potential. Chapter 5 discusses watershed enhancement projects, including priority projects, ongoing resource preservation activities, and adaptive watershed restoration projects.

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[1] Stewards of the Coast and Redwoods is a nonprofit cooperating association that works in partnership with State Parks by supporting docent and volunteer programs. Stewards is a leader in providing public information, education, and outreach to visitors in the Russian River area. Stewards also acted as fiscal agent for development of this plan and oversaw the work of PCI, a private restoration consultant.

[2] Click on "General Plans In Progress," then click on "Sonoma Coast State Beach," or type in www.parks.ca.gov/default.asp?page_id=22591" directly.

Figure 2: Willow Creek Unit of the Sonoma Coast State Beach

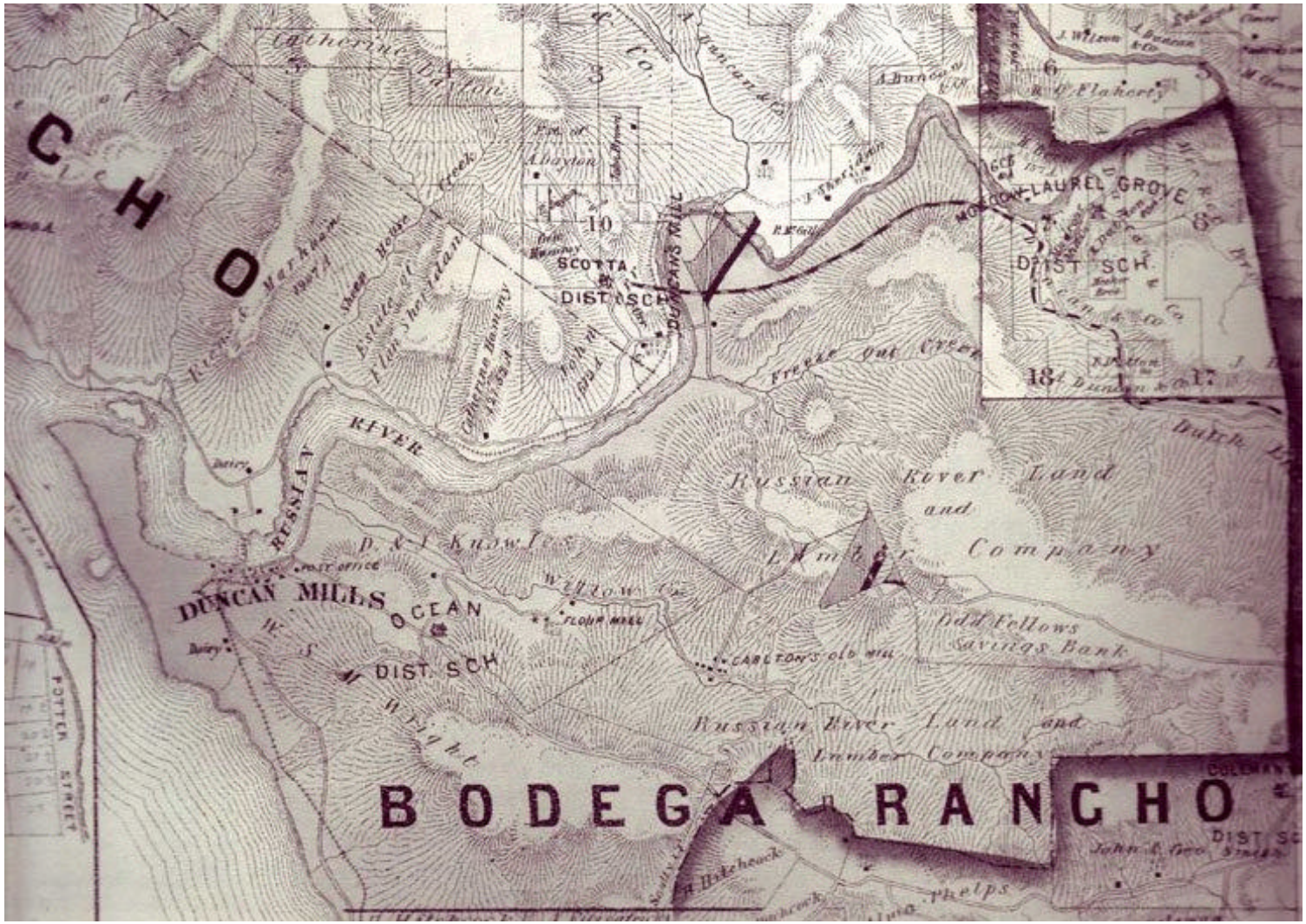


Figure 3: 1877 Historical Atlas of Sonoma County Map 3

(Soutce: Thompson 1877)

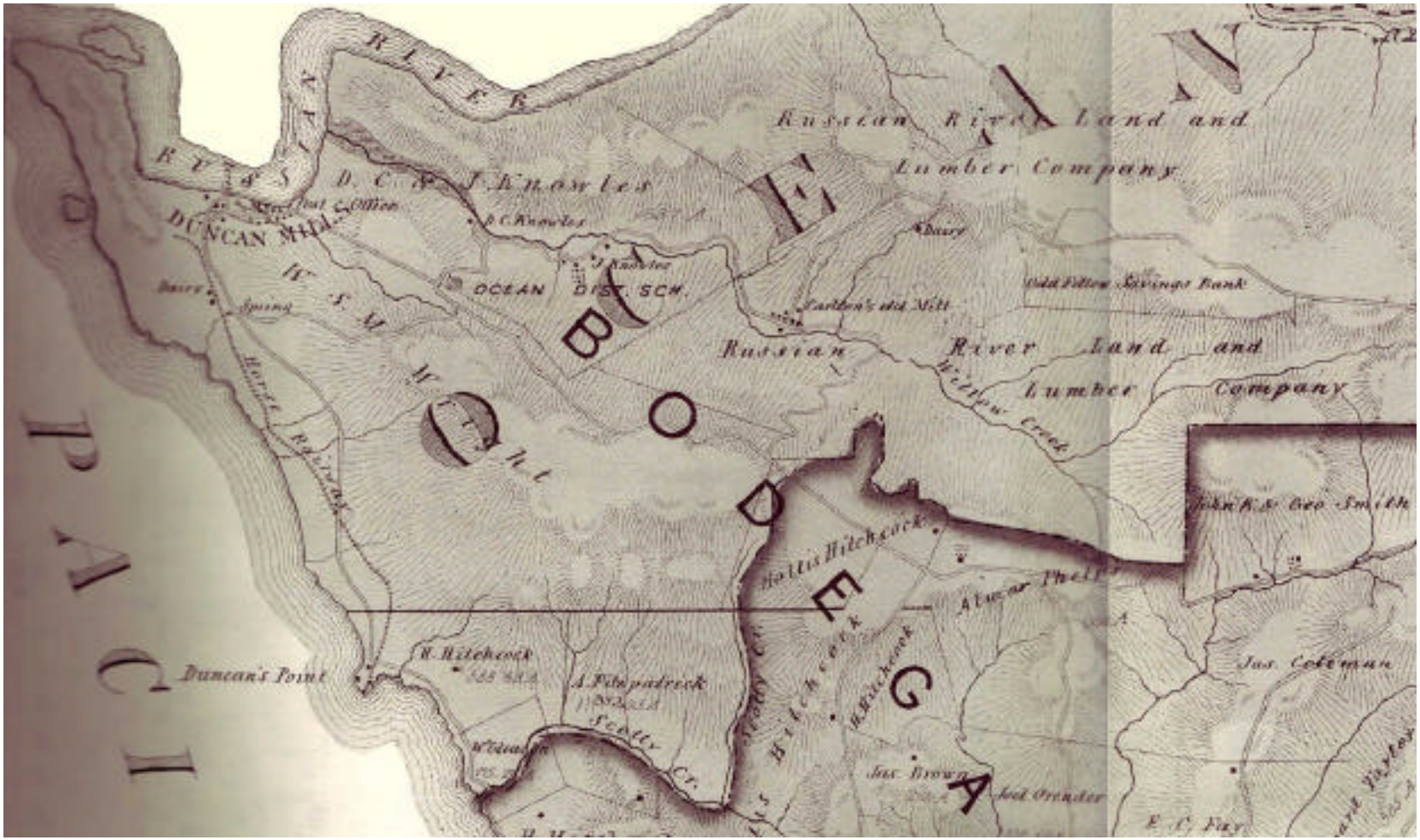


Figure 4: 1877 Historical Atlas of Sonoma County Map 7
(Soutce: Thompson 1877)

CHAPTER 1: INTRODUCTION

Description of the Willow Creek Watershed

Willow Creek flows from an 8.7 square mile watershed into the Russian River approximately 2 miles upstream of its mouth at Jenner. Located on the western edge of the Coast Range, Willow Creek flows in a northwesterly direction following an inactive fault trace. Watershed elevations range from zero feet at the confluence to 1,481 feet at Koerber Peak.

The upper section of the watershed is characterized by precipitous, forested canyons of redwood and Douglas fir that enclose steep, boulder step-pool channels. The steep, gorge-like ridges transition into broader, rounded ridges of mixed forest and grasslands. In the lower section, the broad ridges and valley slopes are separated by a wide, flat, alluvial valley through which Willow Creek flows.

The geology and climate have shaped the topography and vegetation of the Willow Creek watershed. The rock formations underlying it are the Franciscan complex or melange and the Great Valley complex, with zones of igneous rocks and green serpentines within and between them. These geologic formations are highly erodible and subject to slope failures.

Warm summers and mild winters characterize the temperate Mediterranean climate of the Russian River basin. The highest levels of precipitation and runoff occur November through April, when Pacific frontal storms generate peak runoff and recharge groundwater levels. The average annual precipitation in Willow Creek watershed is 54 inches (Trihey 1997, citing Rantz 1967).

Willow Creek watershed has been heavily impacted by human land uses beginning as early as 1812 with construction of roads by Russian settlers traveling between Fort Ross and Bodega Bay. The delicate equilibrium of the natural landscape was disrupted by logging for construction of the Russian settlement in the Willow Creek valley and by clearing of riparian and other native vegetation for fields and grazing. After the Russians departed in 1841, intensive logging and agricultural uses soon followed and continued throughout the 19th and 20th centuries.

Purpose of the Willow Creek Watershed Management Plan

Both governmental agencies and the general public have expressed concern for the Willow Creek watershed. For recovery of the watershed, particularly its salmonid habitat, to be achieved, it is crucial that a comprehensive management plan be prepared. The plan, developed under the scrutiny of the Willow Creek Watershed Technical Advisory Committee (TAC) and other stakeholders, including the public, summarizes available existing information and provides guidance for management and restoration activities. It includes avenues for flexibility to appropriately respond to natural dynamic processes, potential land use changes, endangered species issues, and changing public sentiments. It is meant to be a dynamic tool for use by all stakeholders.

Plan Development

The effort to develop a watershed management plan for Willow Creek began in 2000 when agency and nonprofit representatives met to discuss applying for funding under Proposition 13. It was decided that a watershed management plan to guide future restoration efforts was of great importance. In 2001, Stewards of the Coast and Redwoods, known at that time as Stewards of Slavianka, was awarded a small grant to pursue development of a plan. Work began in July 2001, however, contracts were not in place until the beginning of 2002. By the end of 2002, project partners recruited agency and nonprofit professionals to join the TAC, and their first meeting was held in 2003.

Plan development has been a cooperative effort. The project partners included Stewards, the California Department of Parks and Recreation (State Parks or DPR), TAC members and their agencies or organizations, and Prunuske Chatham, Inc. (PCI), the project contractor. The role of the TAC was to provide independent scientific and technical advice for development and implementation of the watershed management plan. The TAC met bimonthly for two years. They reviewed technical documents and gave input on watershed plan drafts; some TAC members attended and provided technical and scientific comments during the public meetings.

Two public scoping meetings were held to solicit information regarding the management of Willow Creek watershed. Participants were encouraged to contribute either during the meetings or in writing. A summary of these meetings is contained in Chapter 2 with further details in Appendices 1 and 2. The draft *Willow Creek Watershed Management Plan* was released for public review in late January 2005. The final plan was published on March 15, 2005, and is available on the Stewards' website at www.stewardsofthecoastandredwoods.org/willowcreek.htm.

Watershed Stakeholders

Stakeholders are persons who recreate, educate, interpret, live, or work within; who own property, have property interests, or a business within; or who use water or other resources from a watershed. Willow Creek has drawn together an array of people and organizations, including individuals, private nonprofits, volunteers, professionals, businesses, academics and governmental agencies, who are committed to restoration and conservation of one of the few relatively undeveloped watersheds within the Russian River basin. Continued cooperative efforts are needed to plan and design, implement, monitor, and maintain the watershed restoration projects outlined in Chapter 5.

Most of the Willow Creek watershed is owned and managed by two major landowners, State Parks and Mendocino Redwoods Company (MRC). **State Parks** manages most of the lower watershed, and the majority of projects outlined in this plan will occur within park limits (see Figure 2: Willow Creek Unit of the Sonoma Coast State Beach). State Parks' natural resources are actively managed, maintained, and restored under the direction of the natural resources division. State Parks regularly participates in collaborative efforts with other natural resource

management, regulatory, and advisory agencies, nonprofits, volunteers, academia, and private businesses. Although State Parks' natural resource management is specific to each park unit, general guidelines for park management strategies adhere to the principals outlined in the Department Operations Manual (DOM). The prescriptions contained in this plan for restoration and protection of resources on State Parks' lands within the Willow Creek watershed are specific to State Parks' activities; other landowners may have other priorities and other management strategies that are not yet included in the plan.

Mendocino Redwood Company, LLC (MRC) is a forest products company formed in 1998 upon the acquisition of approximately 232,500 acres located in northern Sonoma and Mendocino counties. MRC was formed with the idea that it is possible to manage a large industrial forestland with a high level of environmental stewardship, and at the same time operate a successful business. The Willow Creek Tract, approximately 5,200 acres located near the mouth of the Russian River, is the southern most property owned by MRC. Ongoing activities in the Willow Creek watershed include timber management and forest restoration work. These activities are aligned with MRC's specific objectives of increasing the inventory of the conifer forests by growing more timber than they harvested and by enhancing the quality of wildlife habitat by promoting large trees and developing forest structure. Past activities in the watershed also include limited livestock grazing and hunting.

Stewards of the Coast and Redwoods (Stewards) has been working in partnership with the Department of Parks and Recreation since 1985. Their mission is to promote education, preservation, and restoration of the natural and cultural resources of Russian River area state parks through interpretation and public stewardship. Since 2000, Stewards has been raising funds and implementing public education and resource management projects in the Willow Creek watershed, including the *Willow Creek Watershed Management Plan* and a channel feasibility study. A docent-led, curriculum-based, hands-on environmental education program has taken place in the watershed since 2002. Additionally, a Citizen Action Team (CAT) has performed water quality monitoring at three sites in the watershed since 2003.

Prunuske Chatham, Inc. (PCI) is an ecological restoration firm specializing in watershed planning and design and construction of fish and wildlife habitat. Its headquarters are located in Occidental, California. PCI has taken part in restoration and planning activities in the Willow Creek watershed since 1996. PCI staff have worked with Stewards, State Parks, and the TAC during the course of the development of this watershed management plan. PCI also conducted the field assessments and channel analysis that have provided the basis for the watershed diagnosis and treatment prescriptions contained herein.

LandPaths (Land Partners Through Stewardship) is a non-profit organization that strives to foster a love of the land in Sonoma County through education, stewardship, and public access. LandPaths' involvement in the Willow Creek watershed began in 2002 with the establishment of the Friends of Willow Creek program on the MRC-owned property in the Freezeout and Willow Creek watersheds. This program allows permitted seasonal access for equestrians, cyclists,

and pedestrians in exchange for visitation reports and occasional site stewardship. It will likely continue in some form to initiate public access on the property following the anticipated acquisition and transfer to State Parks' ownership. Through grant funding, LandPaths has also endeavored to improve water quality and fish habitat by reducing sediment contributed to the stream from many forest and ranch roads in the upper Willow Creek watershed.

Although land ownership in the Willow Creek watershed is dominated by the State Park and MRC, a handful of **private landowners** have property mostly along Coleman Valley and Willow Creek Roads. These landowners, along with other local residents, have been invited to participate in public meetings and review the draft plan. One landowner participated in several of the TAC meetings through his representative. Watershed neighbors and landowners from Willow Creek Road have communicated their concerns, which include public access, fire safety, weed management, and other issues, directly to State Parks' staff or to LandPaths.

Sonoma County Department of Transportation and Public Works (Sonoma County) is the current owner of Willow Creek Road, and its concerns relate to the maintenance of the through public roadway access. As the agency that has jurisdiction over any Willow Creek Road or bridge-related changes, representatives have been available at TAC meetings to offer advice and recommendations.

The mission of the **California Department of Fish and Game** (CDFG) is to manage California's diverse fish, wildlife, and plant resources, and the habitats upon which they depend, for their ecological values and for their use and enjoyment by the public. Willow Creek provides a unique opportunity to preserve and restore an entire major watershed within the Russian River system. This watershed provides substantial habitat for a wide variety of sensitive fish, birds, mammals, and plant communities, including coho salmon and steelhead trout. CDFG's **Wildlife Conservation Board** will be contributing to the funding needed to acquire portions of this unique watershed.

NOAA Fisheries Service staff participated in the preparation of the *Willow Creek Watershed Management Plan* as part of the TAC. Their interest in Willow Creek stems from their responsibility for protection and recovery under the federal Endangered Species Act of federally-listed anadromous fish species that have historically utilized the watershed.

Trout Unlimited (TU) is a national, nonprofit organization dedicated to conserving, protecting, and restoring North American salmonid fisheries and their watersheds. Nationwide, TU accomplishes its mission through the volunteer efforts of 130,000 members and a national staff of 55 professionals; TU has 10,000 members in California and 250 in Sonoma County. The TU Redwood Empire Chapter has been working with private timber companies in the Willow Creek watershed since 1997 to address and correct upland sedimentation associated with historic land use practices. The project work includes reducing the sediment load input to Willow Creek by upgrading legacy roads, restoring eroded upland sites, revegetation, and installation of livestock exclusion fencing. This effort is a part of TU's innovative

North Coast Coho Project utilizing watershed planning, habitat restoration, and conservation biology to restore and reintroduce coho salmon on private land in coastal watersheds of northern California.

The Sonoma County Agricultural Preservation and Open Space District (District) has been working cooperatively with MRC, the Trust for Public Land, State Parks, the Wildlife Conservation Board, and the State Coastal Conservancy to protect 3,888 acres of the Willow Creek watershed. In 2004, the District approved funding in the amount of $10,225,000 to assist with acquisition of fee title to 3,373 acres of the Willow Creek watershed as an addition to the Sonoma Coast State Beach and to protect an additional 515 acres through conservation easements over the Seed Orchard and Northern Tract portions of the property. District participation in the project also includes a matching grant of $300,000 to State Parks for initial park development.

The Trust for Public Land (TPL) is a national land conservation organization dedicated to conserving land for people to enjoy as parks, gardens, and other natural places, ensuring livable communities for generations to come. TPL has negotiated an option to purchase 3,888 acres of the Willow Creek watershed from MRC as an expansion of the Sonoma Coast State Beach. In addition to the District, TPL has been working with three state resources agencies, State Parks, the State Coastal Conservancy and the Wildlife Conservation Board, to secure $20.8 million for the acquisition in Willow Creek. If final approvals are secured this spring, the acquisition should be completed by early summer.

The State Coastal Conservancy has been working cooperatively with MRC, the Sonoma County Agricultural Preservation and Open Space District, TPL, State Parks, and the Wildlife Conservation Board to protect 3,888 acres of the Willow Creek watershed. In 2004, the Coastal Conservancy approved funding in the amount of $4,187,000 to assist with acquisition by State Parks. Coastal Conservancy participation also includes a matching grant of $300,000 to LandPaths for interim operations and management of public access for the Willow Creek acquisition.

Technical Advisory Committee

The Willow Creek TAC is composed of agency and private individuals with a wide range of expertise, including fisheries biology, range and watershed management and restoration, water quality, and vegetation management. Agencies that participated include NOAA Fisheries Service, CDFG, the North Coast Regional Water Quality Control Board (RWQCB), State Parks, and Sonoma County Department of Transportation and Public Works. Other participants represented Stewards, PCI, LandPaths, and TU. Lisa Bush, a certified range manager, and Mike Swaney of TU provided an agricultural perspective. The TAC members who were the most consistent participants are listed on page ii.

CHAPTER 2: VISION AND GOALS FOR WATERSHED HEALTH AND FUNCTION

The Willow Creek watershed is widely recognized as a significant ecological resource, a natural open space of spectacular beauty. While their overall vision may differ in the details, stakeholders hold some shared ideals. Most, whether they are landowners, local residents, park visitors, or regulators, have a passionate interest in preserving, restoring, and enhancing the watershed's natural, scenic, and/or cultural resources. Through community meetings, participants contributed to the vision for the watershed's future health and function. The TAC used this vision and the information collected through the planning process to develop the goals and priorities for the watershed.

Community Vision from Public Input

As a part of the process of developing the current *Willow Creek Watershed Management Plan*, there have been opportunities for the public and interested agencies to provide input. The first public meeting was held in January of 2004. Participants were asked to share ideas and concerns on the following topics:

1. Land Use: Recreation and Public Access (hiking, biking, equestrian, birding, fishing, camping)
2. Land Use: Agriculture (timber management, grazing)
3. Land Use: Transportation (County road, private roads, parking)
4. Resources: Biological (flora, fauna, endangered species)
5. Resources: Geological (erosion, sedimentation)
6. Resources: Hydrological (wetlands, riparian corridor, water quality)
7. Cultural Resources: Pre-historic and Historic
8. Education and Outreach: School Programs
9. Education and Outreach: Volunteerism and Monitoring
10. Vision: Next 2-5 years
11. Vision: After 10 years
12. Vision: After 50 years

The same issues were available in survey form. Public comments were gathered between late January and May 1, 2004, and are found in Appendix 1. The community vision is summarized below.

Community Vision for Next 2-5 Years

Over the next 2 to 5 years, many respondents envision a watershed where the issue of fish passage has been addressed. Other suggestions for short-term planning included addressing sedimentation, especially in the upper watershed; removal and/or management of non-native plant species and replacement with native flora; design and management of a multi-use trail system; assessment of the impacts of camping; use of a rating system to show restoration progress over time; and identification of one organization to coordinate all future planning and management within State Parks' property in the watershed.

Community Vision after 10 Years

In 10 years, respondents would like to see Willow Creek watershed managed with sound ecological strategies. In both the short and long term, the public wants restored habitat for fish populations, erosion areas stabilized, and successful management of invasive species. A number of people commented on trails, and many want the old logging roads fixed. Public education (e.g., interpretive signage along the trails to identify flora) was stressed by many. Respondents recommended development of a large volunteer base to help with trails, restoration, and interpretation efforts. There was a diversity of opinion regarding recreational use, which will be addressed in the *General Plan for Sonoma Coast State Beach*.

Community Vision after 50 Years

Many of the same comments were received for the 50-year vision. However, the overall theme was more conservative in terms of uses. The following is a picture of what respondents envision Willow Creek to be like in 50 years:

> *Willow Creek watershed is an oasis, free of development where the land is managed as a preserved, natural resource area. The watershed has been restored to a balanced ecosystem as it was before native Californians were displaced. It is returning to a natural mixed forest and grassland ecosystem, containing magnificent redwood groves, stands of Douglas fir, native grasslands, and complex riparian corridors. It is prime spawning and breeding habitat for salmonid species, including coho. Elk and deer can be seen grazing on the hillsides.*
>
> *Willow Creek no longer suffers from the effects of sedimentation. Willow Creek Road has been redesigned so that it does not cause erosion and is a beautiful scenic drive for the public to enjoy while they traverse the healthy watershed. Some areas are designated as reserves with no public access. Some areas are open for limited, appropriate recreational uses. Diverse educational opportunities are available for visitors to the watershed.*

Goals for Willow Creek Watershed

The current *Willow Creek Watershed Management Plan* began with a concern for restoration of viable salmonid habitat. As the overall health and function of the watershed improve, the potential for sustainable salmonid recovery will increase. The following specific management goals were agreed upon by the TAC.

Goal 1: Improve Habitat for Indigenous Wildlife Species

Restoration of wildlife habitat and native animal populations will focus on the unique structural elements in the landscape and the natural functioning of native plant and animal communities. The watershed will be managed to maintain open grassland areas, to protect unique structural elements such as large, decadent trees, snags, coarse woody debris, multiple canopy layers and canopy gaps, and variation in tree size and spacing, and to enhance riparian forests and wetlands. Disturbance to non-vegetative landscape features, such as rock outcrops and springs, will be minimized. In order to reduce habitat fragmentation and existing barriers to wildlife

movement, selected anthropogenic features, such as some fences and roads, will be removed, and future facilities will avoid significant disruptions to wildlife habitat. Identified landscape features of special significance as wildlife habitat will be monitored for impacts and evaluated for appropriate corrective action.

Goal 2: Increase Populations of Salmon and Steelhead to Sustainable Levels

To accomplish the vision of viable salmonid populations in Willow Creek, fish passage barriers will be removed, in-stream and riparian habitat enhancement (large woody debris, pools, riffles, food sources) will occur, and sedimentation issues will be addressed. Long-term adaptive management actions may include the CDFG brood stock program.

Goal 3: Reduce Sediment Input into Willow Creek

A comprehensive, integrative, and cooperative watershed approach will be taken to address erosion and sedimentation. Evaluation of potential delivery of sediment from both the County road and legacy logging roads in the upper watershed, as well as a partial skid trail inventory, have been completed. The next step will be to identify additional erosion sites, particularly forest and grassland gullies.

Goal 4: Resolve Sedimentation Issues at the Second Bridge

A preferred alternative for treatment of the second bridge will be identified to address fish passage issues and sediment deposition in lower Willow Creek. Implementation of the preferred treatment will follow. Channel function and sediment transport will then be evaluated, and channel and riparian enhancement will occur as needed.

Goal 5: Manage Vegetation for Habitat Diversity

Native plant communities, associations, natural processes (e.g., succession), and examples of rare, endangered, endemic, or otherwise sensitive native California plants will be preserved and maintained in the Willow Creek watershed as part of its natural ecosystem. Management goals include preservation and restoration of the natural abundance, diversity, distributions, stand structure, and species composition of each plant community. Specific actions will include coastal prairie enhancement, forest stand management, and invasive species control.

Goal 6: Manage Recreation for Conservation of Natural Resources

The *General Plan for Sonoma Coast State Beach* will address the issue of recreation in the Willow Creek watershed in detail.[3] Particular attention will be given to the trail system, scenic vistas, and sustainability. Trail locations will be determined based upon access needs and avoidance of sensitive natural and cultural resources. Trails will be designed to provide varied recreational uses for diverse public interests and to minimize potential recreational conflicts. When feasible, trails will be accessible to all.

[3] In 2004, DPR prepared a draft *Preliminary General Plan for Sonoma Coast State Beach*, but its completion has been delayed pending State Parks' acquisition of the upper Willow Creek watershed from MRC. It can be reviewed at www.parks.ca.gov/generalplans. Click on "General Plans In Progress," then click on "Sonoma Coast State Beach."

CHAPTER 3: HISTORY OF WILLOW CREEK WATERSHED

Introduction

An understanding of human habitation and land uses in the Willow Creek watershed provides a clear record of impacts that have resulted in the present-day limiting factors to the watershed's health. The time of initial occupation is unknown; however, Breck Parkman, Senior Archeologist for State Parks, dates the arrival of the first human inhabitants on the Sonoma Coast over 12,000 years ago after coming across a land bridge from Asia (Parkman pers. comm. 2004). Although a number of prehistoric sites have been identified between the Russian River and Bodega Bay since research began in the early 20th century, little archaeological investigation has been performed in the Willow Creek watershed itself.

Suzanne Stewart coordinated the *Cultural Resources Survey of the Willow Creek Unit, Sonoma Coast State Beach* as part of State Parks' planning for development of Pomo Canyon Campground in the mid 1980s (Stewart 1986). In 1997, a short-term (3-4 day), ground-penetrating radar study conducted by U.C. Berkeley students looked for the Russian settlement in the watershed known as the Kostromitinov Ranch, and currently State Parks is working with a U.C. Berkeley doctoral student on a project to locate the Russian ranch. Unfortunately, researchers have found that high sediment depositions throughout the valley limit discovery of early occupation sites.

Native American Settlement and Land Use

The First People:[4] Prior to 1810

The Kashaya Pomo solely occupied the Sonoma Coast for thousands of years until the coming of the Russians in the early 19th century (DPR 1973:3, citing Kroeber 1925). The heart of Pomo territory was the valley of the Russian River, while the Olamentko tribe of the Coast Miwok settled in the area to the south surrounding Bodega Bay (Kroeber 1925:272-273; DPR 2004:2-69). Projectile points found at Willow Creek are assumed to be 2,000 years old. Parkman postulates that the Kashaya have occupied northern California for the past 7,000 years and the coastal region for over 4,000. Kashaya elders believe that they have been here much longer (Parkman pers. comm. 2004).

Prior to contact with Euro-Americans, the Kashaya Pomo population is estimated between 550 (Stewart 1986:6, citing Bean and Theodoratus 1978:295) and 1,500 people (Parrish 1998:6), one of the smallest populations of all Pomoan groups. Important resources to the Kashaya were abundant and accessible along the coast; these included a variety of marine fish, shellfish, seaweed, waterfowl, and sea mammals. Along the Russian River and other drainages, including the freshwater marsh at the mouth of Willow Creek, reeds, willow roots and shoots, and sedge provided raw materials for baskets, nets, clothing, boats, and shelter (DPR 2004:2-69). The redwood forest was only occasionally visited for products or seasonal

[4] "The First Prople" is the name of an article written about the Kashaya Pomo by elder Otis Parrish (Kalani, et al., Eds. 1998:6).

campsites. The shredded bark was used for clothing and basketry, and bark slabs were used to make single-family, conical dwellings (Stewart 1986:6).

Chalanchawi Village at Willow Creek

Kroeber reported that "Chalanchawi and Ashachatiu were villages at the mouth of the Russian River and no doubt related." (1925:234). Some authorities, including Kroeber, consider Chalanchawi to have been the capital village of the local Pomo tribelet (Parkman 1985:1). S.A. Barrett (1908) was the first to identify the Kashaya village of Chalanchawi, which he transcribed as *tcala'ntcawi* and described as located at Willow Creek in the vicinity of the current-day Environmental Campground (Stewart 1986:7, citing Barrett 1908:232).

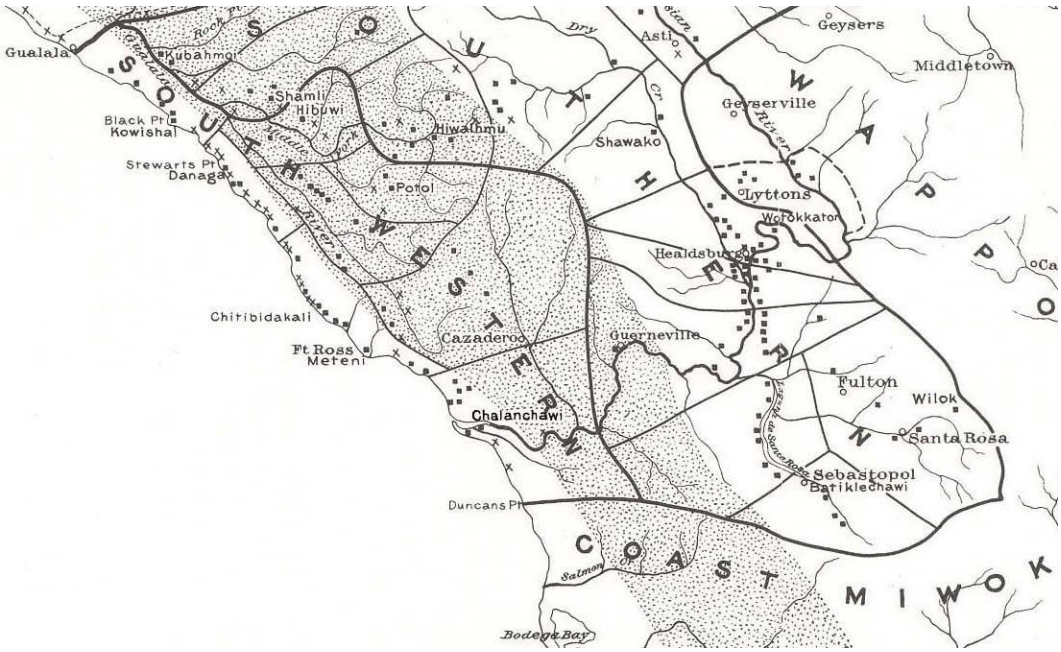


Figure 5: Range of the Kashaya (Southwestern) Pomo[5]

(Source: Kroeber 1925:Plate 36)

Kroeber's map (Figure 5) shows the location of Chalanchawi just south of the Russian River, northeast of the mouth of Willow Creek, but the scale does not allow for exact placement. Another potential location is at the confluence of Willow Creek and the Russian River, although this is questioned due to the high occurrence of winter floods. Parkman suggests that Chalanchawi may have been located near the theorized site of the Kostromitinov Ranch, as precedent for such proximity was set when the Russians established Fort Ross adjacent to the Kashaya village of Meteni (Kroeber 1925:234) in order to facilitate work-trade activities (Parkman pers. comm. 2004).

Both the small population and low-impact land uses associated with the Kashaya inhabitants of the area prior to Euro-American contact resulted in limited impacts to

[5] The Kashaya were referred to as the "Southwestern Pomo" by Kroeber (1925:233).

natural resources in Willow Creek.[6] Stewart's research located few prehistoric artifacts. Nevertheless, they did indicate a fairly wide diversity of activities, including tool production and resource processing (Stewart 1986:29).

Kashaya Pomo after Euro-American Contact

The Kashaya were profoundly affected by Euro-American occupation, although they experienced less acculturation pressure than other California Indians. They escaped much of the forced removal to missions, reservations, or ranchos that the other Pomoan and Coast Miwok groups experienced (Parrish 1998:7). Although their lifeways were abruptly altered after settlement of Russian fur traders in the area, the Kashaya's involvement with the Russian community was reportedly peaceful, and residence at their outposts was voluntary (Stewart 1986:18).

There were about 100 Kashaya employed as agricultural laborers at Fort Ross (Stewart 1986:18, citing Bean and Theodoratus 1978:299). The number of Native Americans working at Kostromitinov Ranch in the Willow Creek area is not documented, but the "wooden house for Indians" could have housed a dozen or more. Others may have stayed in small, stout structures built for livestock herders, and some laborers may have commuted from nearby villages (Stewart 1986:18, citing Toumey 1926:206).

It is not clear whether the Kashaya remained living within Willow Creek after the Russians departed in 1841. Only Native American people "adopted" by Euro-American families are noted in the 1850 and 1860 U.S. population census. A single Native American family headed by a man named Garcia who worked at the Duncansville sawmill is listed on the 1870 census, and a more heterogeneous group totaling 20 people is listed in 1880 (Stewart 1986:19).

Although villages were inhabited in the Bridgehaven area in the early 20th century, no census information was gathered regarding Native American occupation in Willow Creek (Barrett 1908:232; Kroeber 1925:234; Stewart 1986:19). Jenner resident, Josephine Navidad Wright, was born in a village on the south side of the river on December 25, 1904, to her Pomo mother, Mary Santos, and her father, Joseph Santos, an emigré from Guam. Steven Smith, Jr., Mary Santos' son by a previous marriage, recalled the village as located near current-day Bridgehaven (Barr 1979a). Today Kashaya and other Native Americans visit the area to collect seafood and plants for their basketmaking (Stewart 1986:19). Occasionally families gather at a cemetery associated with one village.

Russian Settlement: 1810-1841

By the early 19th century, Russian hunters had virtually decimated the sea otter populations in Alaska. In 1809, Ivan Alexandrovich Kuskov anchored the Russian American Fur Company's ship, the Kodiak, in Bodega Bay. He was soon followed

[6] See also discussion of Native American use of prescribed fire practices in Chapter 4 for the improvement of game and plant resource abundance important to their survival, as well as collection of plant resources.

by Alexander Baranov, who led the company south from Alaska to the Sonoma Coast where they continued hunting sea mammals for fur (DPR 1973; CDFG 2002).

Along with construction of their headquarters at Fort Ross about 10 miles north of the Russian River in 1812, the Russians established the port of Bodega and four main ranches for growing fruits, grains, and livestock. The Kostromitinov Ranch in Willow Creek, the Rumanianyov Ranch at Bodega Bay, the Khlebnikov Ranch near Bodega, and the Tschernisch Farm near Freestone grew wheat, barley, rye, peas, buckwheat, maize, tobacco, flaxseed, hemp, mustard, and poppies for export to their settlements at Fort Ross and Alaska (DPR 2004:2-70).

Kostromitinov Ranch in Willow Creek: 1833-1841

The Kostromitinov Ranch was established in the Willow Creek area in 1833 and operated until 1841. The ranch complex encompassed fields and ranch lands north and south of the Russian River. Its headquarters were likely located in the Willow Creek valley, although the exact location is "a research question that has yet to be resolved" (Stewart 1986:8). It may have been adjacent to the village of Chalanchawi (Parkman pers. comm. 2004). Stewart found only one historic map showing the ranch's location, the 1841 map of Duflot de Mofras (Figure 6); however, due to the scale of the map and the way the ranch's name is written, no location can be pinpointed (Stewart 1986:8).

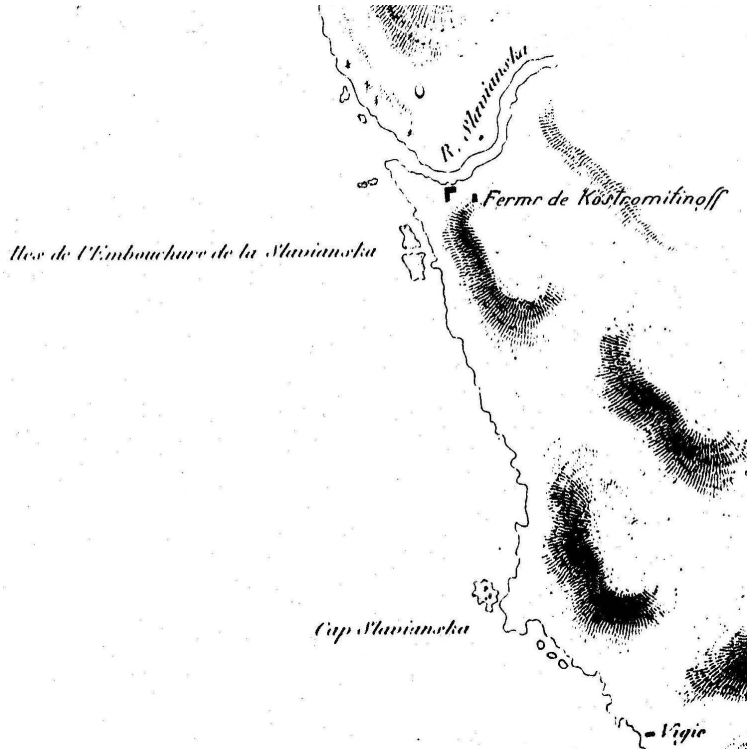


Figure 6: Kostromitinov Ranch in Willow Creek

(Source: Duflot de Mofras 1841, from Steve Watros, Department of History, Sonoma State University)

A late 19th century discussion of agriculture at Fort Ross provides a vague description of the location as "about 100 acres just south of the mouth of the Slavyanka [Russian] River [7] . . . at the half-way point, on or near the river" (Stewart 1986:8, citing Bancroft 1886[ii]:629). Another theory places the ranch near the old Ocean District School in the Willow Creek valley (Stewart 1986:8, citing Haase 1952:59; see Figures 3 and 4: *Historical Atlas of Sonoma County 1877*). The California State Office of Historic Preservation's records place the farm in or adjacent to San Quentin Gulch near current-day Pomo Canyon Campground (Stewart 1986:8, citing Parkman pers. comm. 1985).

Russian Land Uses

It is presumed that some logging occurred in Willow Creek valley to create areas for grazing and crop production and to construct the ranch's numerous structures, which included a barracks, warehouse, house, two threshing platforms, a winnowing platform, a house for Indian workers, a kitchen with two ovens, and a bathhouse (de Mofras 1841:19; Vallejo 1841:229-9-10). It was referred to as "Halfway House" (Gibson 1976:118), an important station for travelers located midway between the Russian's Bodega Bay outpost at Port Rumyantesev and their headquarters at Fort Ross. One of the farm's houses was set apart for the use of travelers, and there was also a boat for crossing the Russian River (Stewart 1986:9).

Records of agricultural uses in the valley indicate that the Kostromitinov Ranch had grain planted on new plowland along the lower section of Willow Creek. After a decent first harvest in 1834, the ranch suffered a total crop failure in 1836. Although the farm was reported to have superior pasturage in 1840, consisting of 98 to 100 acres of cultivated land primarily growing wheat, the company could buy wheat more cheaply from Mexican California than it could grow it (Moore 1980:9, citing Gibson 1976:139). There was a large corral for livestock (Gibson 1976:118). Russian records indicate that cattle, sheep, pigs, and horses were in moderate abundance, and it appears that horse breeding was also practiced (Moore 1980:3, citing Fort Ross 1974:13).

Russian Departure

By 1841, the substantial decline of seal and otter populations had resulted in an unprofitable fur trade economy. The Russians sold their holdings at Fort Ross to John Sutter of Gold Rush fame, but the land could not be legally transferred. Sutter dismantled some buildings and took them to Sacramento, the Russians took their easily moveable property for use at other posts, and the Kostromitinov Ranch in Willow Creek valley was abandoned (Stewart 1986:9; DPR 2004:2-70). Their road system, developed as early as 1812, remained as the major transportation artery throughout the 19th century. Remnants of the Russian roads in Willow Creek may still be extant today (Stewart 1986:21).

[7] Kuskov is credited with naming the Russian River "Slavianka," meaning little Slavic maiden.

19th and 20th Century Euro-American Land Uses

Timber Harvest

The first commercial sawmill on the Pacific Coast may have been installed by Captain Stephen Smith, a New England sea captain who received a grant in the mid-1840s from the Mexican government for the 36,000-acre Bodega Rancho, which included land in the Willow Creek watershed (DPR 1973:4). Smith brought the steam-operated mill by ship into Bodega Bay in 1842 (Hansen & Miller 1962:56).[8] He built his adobe on the site of the old Russian farm near the current hamlet of Bodega (Hansen & Miller 1962:51), and he rapidly developed the area around Bodega Bay with roads (DPR 2004:2-70).

First Recorded Commercial Logging in California: Willow Creek mid 19th Century

Redwoods in the Willow Creek area were likely first cut in 1833 by the Russians and used for construction of the Kostromitinov Ranch, but little or no export occurred during this period (Stewart 1986:23, citing Clar 1959:16). The first recorded commercial logging in California was in the Willow Creek area, as evidenced by a lease signed in 1848 and recorded in 1850 (Stewart 1986:20, citing Deeds Book E:84).[9] In the agreement, Captain Stephen Smith and his wife leased all timber rights to Bethuel Phelps for 99 years. That Willow Creek was included in Phelps' operation was noted when Joseph Knowles purchased his Willow Creek acreage in 1858. His deed states that the sale is subject to conditions of the lease to Bethuel Phelps, which was passed on to John Curry and maintained until at least 1867.

In 1860, Curry was assessed for real estate "known as the Mudge and Phelps Mill Tract, it being the timber and lease of said lands containing 17,687 acres." The tract was valued at $8,843 and improvements at $5,000, which Stewart concluded is "unusually high for the time, suggesting considerable construction; some of these improvements may have been built within Willow Creek Unit, given the open, level access to redwood stands." She postulates that the Knowles Mill may have been one of these improvements (Stewart 1986:20-21). Bowers' 1867 map[10] shows "Kowles (sic) Mill" located somewhere between the Knowles brothers' houses in the Willow Creek valley (see Figure 2).

Phelps' leased holdings were divided into sections, and, once cut, he could not return to a section. Stewart believes that the Phelps/Curry logging lease may have significantly impacted timber resources in the Willow Creek watershed, as stipulations (i.e., no returning to a section once cut) encouraged highly intensive

[8] Some, however, disagree that Captain Smith's sawmill was the first. Williams reported that J.B.R. Cooper built California's first sawmill in what was to become Sonoma County in 1835. Williams also reported much earlier (1818, 1821) logging activities by fugitive whipsawyers, discontented seamen who had jumped ship at Monterey Bay or San Francisco, then called Yerba Buena (1976:39).

[9] In DPR's Preliminary General Plan, the Phelps/Curry Timber Lease is described as "of 1846" (DPR 2004:2-71). No explanation is provided for the discrepancy between this and Stewart's dates from the Sonoma County Deeds Book.

[10] It is uncertain when Bowers mapped the Willow Creek area. He may have begun as early as the mid-1850s because, according to his 1867 statement, it took him 13 years to map Sonoma County. The inclusion of Duncansville on the map, however, indicates that final mapping of this area was completed in or after 1860 (Stewart 1986:12).

logging. Her team noted handcut stumps in San Quentin Gulch and in a grove east of the State Park that could represent this early logging (Stewart 1986:21). The lease allowed construction of sawmills and the digging of wells to bring water to mills; it also allowed grazing for oxen, horses, and cattle, with a combined herd not to exceed 56 head (Stewart 1986:20). It is not known if the Phelps operation engaged in grazing within Willow Creek, but by the 1860s, the Knowles family were running large numbers of livestock in the lower watershed.

Duncan Mills/Duncansville: 1860-1877

In 1848, Samuel Duncan was part of the first company organized to cut lumber in Sonoma County. For several years, they focused operations near Salt Point up the coast from the Russian River (Stewart 1986:11). In 1860, a new lumber mill was established by Samuel and his brother, Alexander, at Duncansville just west of the Willow Creek Unit boundaries on the south side of the Russian River in the area of current-day Bridgehaven (DPR 1973:5; Stewart 1986:11, citing Munro-Fraser 1880:252; see Figures 2, 3, and 4). The company took the name Duncan's Mills, which was later shortened to Duncan Mills (Dickinson 1970:37).

The Duncan brothers recognized the possibilities for transporting cut lumber to the Bay Area in the small, 2-masted ships called dog hole schooners, which were built in San Francisco for that purpose (Hansen & Miller 1962:47).[11] Lumber was hauled by horse train from the mill over a corduroy road that followed the route of present-day Highway 1 south to Duncans Landing, a typical dog hole cove about 2.5 miles south, where it was loaded onto the ships. The Duncan brothers leased the landing from Benjamin C. Bell, whose property was located south of W.S.M. Wright's (see Figure 2). The lease, dated May 23, 1862, was for ten years at $50 per year (*Bodega Bay Navigator* 1993b).

The site of the lumber mill soon grew to a small town of from 100 (Thompson 1877) to 300 (Munro-Fraser 1880) inhabitants (Stewart 1986:11). The settlement included a store, hotel, post office, express agency, and telegraph office (Munro-Fraser 1880:252; Dickinson 1970:37). Their source of timber for milling is unclear, but the proximity of Duncansville to then abundant resources in the Willow Creek watershed would suggest it as a potential source.

Alexander Duncan purchased 3,600 acres of standing timber along Austin Creek in the name of the Duncan's Mill Land and Lumber Association. By 1877, he had persuaded the North Pacific Coast Railroad (NPC) to bring its terminus to the site of modern-day Duncans Mills on the northern bank of the Russian River. He placed the mill and the entire town of Duncansville on rafts and moved upriver to the new railroad termination point (Dickinson 1970:37).

Other 19th Century Lumber Operations in Willow Creek

In the late 1860s, a sawmill was built in the lower Willow Creek meadow area. Narrow gauge rail, constructed in the stream channel, pushed lumber uphill to the headwaters (DFG 2000:1), while steam donkey engines extracted logs to bring them

[11] Dog holes are small indentations in the rocky cliffs along the coast.

downhill (DFG 2002:58). The rail system later moved finished lumber products over the watershed divide for loading onto the schooners in Bodega Bay bound for San Francisco (DFG 2000:1; DFG 2002:58).

The Carlton and Ross sawmill is shown on Bowers' 1860s map (Figure 2) and in the 1877 *Historical Atlas of Sonoma County* (Figures 3 and 4) as the next parcel upstream (southeast) of the Knowles' property. The Sonoma County Surveyor's 1868 map includes the settlement of Rossville in the location of the Carlton and Ross mill. This operation used a tramway up through the drainage southeast of the Willow Creek Unit, where it connected with county roads (Stewart 1986:21).

By the 1870s, the Russian River Land and Lumber Company (RRLLC), which was owned by the founders of the NPC Railroad, had purchased the property within the watershed to the east and the south of the old Carlton and Ross mill (Stewart 1986:21; Figure 3). It is presumed that this area was also used for logging. When the new narrow gauge NPC spur from present-day Duncans Mills reached Willow Creek in the late 1880s, a new rail route was forged up the valley (Stindt 1974:13), undoubtedly to access timber for the RRLLC.

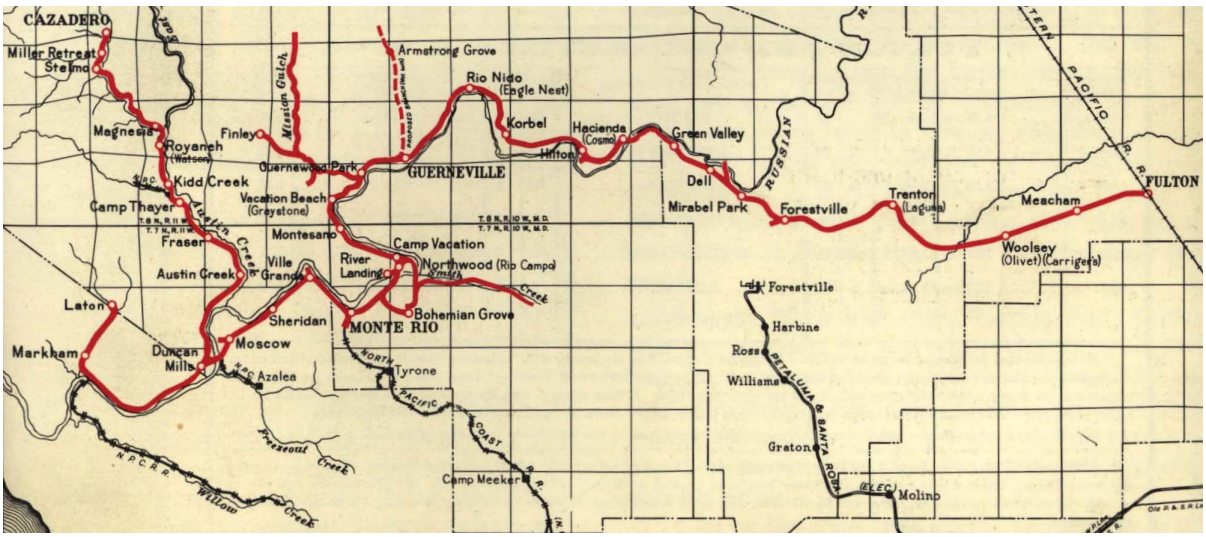


Figure 7: Guerneville Branch of the Northwestern Pacific RR

(Source: Stindt 1974:49)

20th Century Timber Harvest Operations

20th century logging activities were analyzed using aerial photography (Trihey 1995:15-17). Closely spaced, immature conifers covering most of the watershed in 1941 indicate it was almost completely logged 20 years or more earlier based on the size and spacing of the trees. Photographs taken in 1953 show that no new timber harvests had occurred between 1941 and 1953, which indicated "high watershed stability" (Trihey 1995:15).

The most intense 20th century logging in the upper watershed occurred between 1953 and the early 1970s, with extensive removal of second growth and remaining

old growth. Timber rights belonged to the partnership of Hammond, Jenson, and Wallin (O'Neil pers. comm. 2004). According to Trihey and Associates' analysis of 1971 aerial photographs, large tracts of forest within the inner gorge of Willow Creek were clear-cut and tractor-yarded between 1961 and 1971 (Trihey 1995:16).

Louisiana Pacific Corporation (LP) purchased most of the upper watershed in 1979; State Parks had acquired much of the lower watershed in 1978 (see discussion of Recreation and State Parks below). It is unclear how much logging occurred during their tenure; however, according to Willow Creek Road resident, David Dillman, LP logged 900 to 1,000 acres between 1982 and 1992 (*Bodega Bay Navigator* 1992). It was also reported that the watershed was logged 13 times between 1992 and 1999 (*Bodega Bay Navigator* 1999).

Mendocino Redwood Company LLC (MRC) acquired the LP lands in 1998 (*Press Democrat* 2002c), a property consisting of 5,586 acres of coastal ridge bounded by Occidental and Camp Meeker, Willow Creek State Park, Coleman Valley Road, and Freezeout Road (*Bodega Bay Navigator* 1999). Four watersheds drain from the MRC lands, including Willow, Freezeout, and Salmon Creeks and the Russian River. MRC is currently (2005) negotiating with the Sonoma County Agricultural Preservation and Open Space District and the Trust for Public Land for the transfer of ownership of most of their Willow Creek property to State Parks.

Grazing and Other Agricultural Uses

Lowland areas along Willow Creek were converted from thick riparian forest to grasslands for cattle, sheep, and horses by Russian settlers in the 1830s (Stewart 1986:19; CDFG 2002:11). Fencing, usually rail and post, but occasionally picket, was used to prevent livestock from accessing plowed land (Stewart 1986:19-20). Grains, primarily wheat, and other crops were raised on approximately 100 acres in the valley (Gibson 1976:118).

19th Century Agricultural Uses

Agricultural activities were not predominant again until settlement by the Knowles family. In April 1858, Joseph Knowles purchased 1,623.35 acres on Willow Creek, paying $6,493.40 in cash (Stewart 1986:12, citing Deeds Book 6:650). Joseph, his wife, and his younger brother, David C. Knowles, are the first recorded settlers in the Willow Creek valley. They held most of the watershed now owned by State Parks for more than 30 years, while the southwest portion was the property of W.S.M Wright in the 1860s and 1870s (Stewart 1986:16).[12] According to the 1860 U.S. population census, Joseph raised stock, and David farmed.

[12] In 1853, W.S.M. Wright and his family arrived in the area after crossing the Great Plains with about 400 head of cattle. He made extensive land purchases for stock raising and general farming. He owned 4,500 acres of Sonoma County, the largest portion being between Bodega Bay and the Russian River (*Bodega Bay Navigator* 1993b). It appears that the Wrights did not, however, inhabit the Willow Creek area but rather used it for grazing and possibly other agricultural purposes. Stewart did not include the Wright property in her investigation of the Willow Creek Unit because no structures were indicated on Wright's property, and no development of park facilities was planned for the area (Stewart 1986:16), although both Wright's Beach and a sign to Wright's Hill still exist along the Sonoma Coast.

In 1861, the Knowles' recorded stock consisted of cattle, horses, and hogs, which shifted to more sheep and lambs in the following decade (Stewart 1986:19). Stock numbers recorded in the 1876-77 county tax records for David and Joseph Knowles imply serious overgrazing unless they were also using neighboring properties, a common practice at the time. Their livestock numbered 11 horses, 18 cows, 14 cattle, 1,400 sheep, 300 lambs, 75 hogs, and 13 dozen poultry. If grazing was occurring only on their land, it would equate to one acre per head of sheep as compared to a standard of at least 3 acres of prime grazing land per head and 10 to 20 acres for poorer land. Much of the grazing likely occurred on upland slopes, since the fertile bottomlands grew grains for the Knowles' flour mill (Stewart 1986:19-20).

Dairying activities in the Willow Creek valley are included on the 1860, 1870, and 1880 censuses. A family of dairymen is reported to the east of the Knowles' property in 1860 and 1880, and a dairyman is included as part of the Joseph Knowles household in both 1860 and 1870. Nearby dairies are also shown in Thompson's 1877 *Historical Atlas of Sonoma County* (Figures 3 and 4). One is north of the Russian River, and the other is located south of Duncansville and west of the horse railroad to Duncans Landing. Although dairying did not appear significant in the Knowles' operation, it was important locally (Moore 1981b:2-3).

By 1861, the Knowles had divided their holdings, and David's property was assessed separately from his brother's. David took 366 acres. Joseph retained the rest (Stewart 1986:16, citing county tax assessment rolls). The 1880 census indicated David's household was a large one that consisted of 8 adults and Knowles' two youngest daughters. The 1900 census reports no members of the Knowles family in the Willow Creek area (Stewart 1986:16), although the Sonoma County official map for 1908 still lists D.C. Knowles as the owner of "Willow Creek Mouth" (Moore 1981b:1908).

20th Century Agricultural Uses

The tradition of raising grains in the valley and sheep and cattle on the upland meadows was continued by succeeding generations of Brown, Mann, Furlong, and Baxman families. In the mid 20th century, Elmer and W.S. Brown operated the Brown Brothers Ranch,[13] where they ran 800 sheep. A short distance south, the Gossage family imported purebred Suffolk sheep during the late 1940s. Both the Brown and Gossage ranches were the former holdings of Sampson B. Wright, a descendent of W.S.M. Wright. Sampson is reported to have installed the first cream separator in the county there (*Press Democrat* 1950:20).

Jim Baxman bought his Willow Creek ranch in 1956 and raised sheep and cattle. After the ranch was sold to Louisiana Pacific, the Baxman family remained as tenant ranchers to the current day, spanning four generations (*Press Democrat* 2002b:A1). The Baxman family ran sheep on the 1,250-acre ranch for three generations but

[13] The D.C. Knowles Victorian farmhouse, which now serves as a maintenance yard for State Parks, is termed either the Brown or Brown-Mann Ranch.

reduced the operation to 500 acres in 1985 in a 5-year lease renewal with the state (*Press Democrat* 1988:B1).

Current Agricultural Uses

Current-day agricultural activities within Willow Creek are mostly limited to the upper watershed outside of State Parks' boundaries. The primary use is for sheep and cattle grazing. Richard Baxman, grandson of Jim Baxman, and his family graze 80 to 100 cattle, with nearly 200 head during calving season, on the property's hillsides (*Press Democrat* 2002b:A19). Grazing activities also occur on a small portion of State Parks' lands. As part of the Red Hill acquisition, State Parks agreed to allow grazing through 2006. There are no other grazing or agricultural activities on State Parks' lands in Willow Creek (O'Neil pers. comm. 2004).

Transportation

19th Century Russian Road System

The Kostromitinov Ranch was on the main route connecting all the Russian outposts. According to Haase, the Willow Creek area was a focal point of this road system:

> *The approximate road from Kostromitinow Farm (located about at the old Ocean District School, Willow Creek Valley) to the Khlebnikow Farm (the town of Bodega) led up the east side of Red Hill to its crest, following it to what is now Furlong Gulch Road. Then it turned eastward along the crest and followed along to the Coleman Valley Road area, then turned eastward again to the Sheep Ridge and continued south along this ridge until it came to Salmon Creek where it turned east again and went up Salmon Creek and out on the little plain of Bodega. … The approximate road from Kostromitinov Farm (Willow Creek) to Tschernisch Farm (near Sebastopol) crossed Willow Creek up to the crest of the eastern mountain following the crest over to Fern Spring. Still following the crest, it ran to the eastern end of the Coleman Valley Road to Occidental and over to Tschernisch Farm*. (Stewart 1986:21-22 citing Haase 1952:59-60).

The Russian road system continued to be the main travel route throughout the 19th century (Stewart 1986:22).

Trains to the Lower Russian River: 1876-1886

The narrow gauge North Pacific Coast (NPC) Railroad, which was later renamed the North Shore Railroad and still later was incorporated into the Northwestern Pacific Railroad, was constructed for hauling lumber from the lower Russian River region to outside markets. It dramatically boosted the area's timber production industry (CDFG 2002:A-3). Among NPC's founders in 1871 were Austin D. Moore and W.H. Tillinghast, owners of the Russian River Land and Lumber Company (Dickinson 1970:19), whose holdings included areas in the Dutch Bill Creek, Freezeout Creek, and Willow Creek watersheds (see Figure 3). Moore, who has been described as the driving force during the early days of the NPC, became President soon after the company's organization (Stindt 1974:10). He left the railroad in 1877 to develop his timber interests (Dickinson 1970:38).

Trains to Willow Creek: 1886-1917

Although early surveys (pre-1876) on the south bank of the Russian River from Duncans Mills "all the way down to the old settlement of Duncan's Mills" near Bridgehaven were performed (Dickinson 1970:35), the impetus for train service to Willow Creek occurred when John W. Coleman became President of the NPC in 1885 (Stindt 1974:11). His new board of directors included owners of large timber areas in the Austin Creek watershed north of present-day Duncans Mills, and, in 1886, under their direction, service began along Austin Creek up into Austin, the site of present-day Cazadero ((Stindt 1974:13; Dickinson 1970:60).[14] A small branch line led west from Duncans Mills to Markham's and crossed the Russian River at the current Environmental Campground near the mouth of Willow Creek. It then went west between the base of the hills and the river, turned south past the ferry tender's house, and proceeded up the long valley north of Willow Creek (Stindt 1974:13; Stewart 1986:21; see map below). Portions of the current road into Willow Creek were constructed on the old railroad bed (Stewart, citing Mathias pers. comm. 1985).

As a result of the devastation to the whole Bay Area and to the NPC itself caused by the earthquake on April 18, 1906, the railroad was taken over by the Southern Pacific and Santa Fe. In 1907, it was renamed the Northwestern Pacific Railroad (NWP). A number of broad gauge railroads were also part of the takeover, including the rival line of the existing NWP Guerneville Branch (Stindt 1974:15).

1912 "hitchhikers" on the Willow Creek line.
(Source: Dickinson 1970:165)

Although Willow Creek is included on the published list of NWP narrow gauge lines in 1907, there is a "not oper[able]" notation. A survey of the south side of the river west from the Duncans Mills bridge was completed in May 1908 "to connect with the Willow Creek branch, but nothing ever came of it" (Stindt 1974:15).

[14] The name Austin was later changed to Ingram's in honor of the first postmaster and then to Cazadero, which means "hunter" in Spanish, in 1889 (Dickinson 1970:60).

Dickinson, however, includes a photo of 1912 hikers who appear to have hitched a ride on the quaint locomotive pictured below that brought loaded log cars to the NPC at Willow Creek.

In 1915, the NWP's Guerneville Branch broad gauge was extended 2.8 miles along the north side of the Russian River from Duncans Mills to serve Andrew Markham's extensive lumber operation. Narrow gauge passenger service to Markham's station was discontinued (Stindt 1974:56). The Willow Creek line was torn up in 1917 (Stindt 1974:15).

Ferry Service at Bridgehaven: mid 1800s-1931

In 1857, William Benitz, owner of the Muniz Rancho, was licensed by the County Board of Supervisors to operate a cable-pulley ferry across the Russian River about one mile upstream of the mouth (Moore 1981b:1857). Mid-19th century maps show a ferry crossing the river at Duncansville to the west of the current-day Highway 1 bridge (Figures 2 and 4). The 1880 census included "R. McKung the ferryman" (Stewart 1986:18).

In 1897, a house for the ferry boat's operator, referred to as the Toll House, was built farther east near the confluence of Willow Creek and the Russian River near the entrance to the current Willow Creek Environmental Campground (*Press Democrat* 2001a). Photos indicate that the ferry was operated from this area rather than farther west. In January 1910, the *Press Democrat* reported that a James Owen had been appointed the County ferryman, replacing former Supervisor J.J. Button (Moore 1981b:1910).

The children from Markham's on the north side of the river commuted to the Ocean District School in Willow Creek, so it was sometimes called the Markham Ferry (*The Paper* 1982:1B). The Toll House was the home of the last ferryman, Alexander Cuthill, whose brother, Bill, married Lucille Cuthill, the teacher at Jenner's one-room school for 43 years. Alex became the ferry's operator in 1918 and served until his death in 1931.

The ferry was about 15 feet wide and long enough to carry three wagons or autos. Aprons on each end dropped down for loading and unloading. There was a walk on one side and the motor housing on the other. The ferry operated on a two-cable system, one overhead to guide the course and one lower to move the craft. A visible capstan "crawled" the vessel along the lower cable with power furnished by a 4-cylinder gasoline engine (Twohy 2004:1).

Alex Cuthill's widow and son ran the ferry for a short while after his death, but it was put into retirement after the opening of new "Shoreline Highway" bridge at Bridgehaven (*Press Democrat* 1931:A1). There was a huge turnout for the bridge's dedication on October 4, 1931. [15] A replica of the ferry was set afire and floated downstream as part of the ceremony (*Bodega Bay Navigator* 1993a).

[15] Several other dates for the opening of the bridge were encountered during this research. The date of 1931 is based on an original copy of the *Press Democrat*, dated October 4, 1931, which states, "The

Ferry crossing the Russian River with ferry tender's house at Willow Creek in background.

(Source: collection of Elinor Twohy)

Residential and Educational Uses

Early Inhabitants of Willow Creek

Residential use of the Willow Creek watershed has been sparse. It is believed to have begun with the Kashaya Pomo village of Chalanchawi, followed by the Russian settlement at Kostromitinov Ranch between 1833 and 1841 and the Knowles family in 1858. In 1897, the ferry tender's house was built near the confluence of Willow Creek and the Russian River (*Press Democrat* 2001a). Both the historic D.C. Knowles residence and the ferry tender's house continue to be occupied to the present day, the former as a maintenance area for State Parks and the latter as a residence for a State Parks' employee.[16]

Ocean District School: mid 1800s-1972

19th century maps indicate an Ocean District[17] School near the southwestern boundary of the Willow Creek Unit. It was connected to both Duncansville and the Willow Creek valley by roads. Its location was several hundred meters upslope from the later school that served children from both sides of the river well into the 20th

Russian … opened today, which marks the passing of the … ferry …." (*Press Democrat* 1931:1]. The ellipses indicate lapses in the text due to deterioration over time.

[16] Another house known as the "Knowles Ranch," which burned down in 1988, was probably on the site of Joseph Knowles' ranch. At the time of Stewart's survey (1985), it was leased from State Parks and occupied by the Baxman family. It had been abandoned by 1988 (*Press Democrat* 1988).

[17] Ocean Township, which lies between Salt Point and Bodega Townships, was established sometime after 1876 as one of fourteen townships. Originally, Sonoma County was divided into four townships. Eleven townships had been established in 1856, and readjustments were made in 1859 and 1867 (Finley 1937:201).

century (Stewart 1986:31). Stewart found an old roadbed passing through the area of the first school, which could represent the original route through Willow Creek valley seen on Figures 2 and 3. It runs along the base of the hills at a higher elevation than the present road (Stewart 1986:32).

The later Ocean District School's location in Willow Creek valley is indicated near benchmark 28 on Willow Creek Road on the 1943 USGS topographic map for the Duncans Mills Quadrangle. It is later identified as "ruins" on the 1979 USGS topo after the school had burned down in 1972 (Stewart 1986:31). Ocean District had another school on the highway just north of Duncans Landing, which is mapped on the 1943 USGS topo. The 1979 USGS no longer mentions the school. The area is simply designated "Ocean View."

Proposed Residential Developments in Willow Creek: 1960s-1970s

By the mid 20th century, development pressures in Willow Creek became intense. In the early 1960s, Utah Mine and Construction Company had obtained State Lands Commission leases and County permits to dredge the estuary of the Russian River to remove gravel for 20 years, renewable for future dredging in increments of 20 years. After experiencing difficulties with ocean activity and other coastal hazards, they sold to Northern California Aggregates (NCA). NCA planned a technically sophisticated dredging operation to a point five miles upstream to Duncans Mills and a high-density land development (Hechtman 1987:1). In 1969, NCA applied for permits from the County of Sonoma and the U.S. Army Corps of Engineers.

Meanwhile, in the mid 1960s, the Brown-Mann Company sold their lands in Willow Creek to NCA (also known as the Jenner Bay Corporation), including the D.C. Knowles homestead and the coastal terrace between Goat Rock Road and Shell Beach. The area was to be developed into a huge subdivision. The plans showed 40-foot lots with condominiums along Goat Rock Road, a golf course, a sewer plant on the coastal terrace with the sewer outfall at Shell Beach, and a shopping center and Safeway at the intersection of Highways 1 and 116 (*Bodega Bay Navigator* 1989). Willow Creek was part of the high-density (1,100 acre, 2,000 unit) housing development planned by Jenner Bay Corporation.

In 1970, the Jenner Coastside Conservation Coalition was formed to oppose the dredging and subdivision of some 8,000 acres on both sides of the river. With tremendous public support, the coalition was victorious in getting the State Water Resources Control Board to order a "no discharge" requirement on the dredging operation until NCA did extensive environmental studies in the estuary. NCA withdrew its permit applications, and the dredging leases from the State Lands Commission were cancelled.

The issue of development in Willow Creek watershed arose again in 1976 when the Sonoma County Planning Commission approved Jenner Bay Corporation's tentative map for a 3,600-acre, "large-lot" Willow Creek Ranch residential subdivision. The proposal included 36 homes, each on 100 acres, on lower Willow Creek Road (*Press Democrat* 1976b). The Sonoma County Board of Supervisors approved the map in January 1977 (*Press Democrat* 1977), but the North Central Coast Regional

Commission filed suit to stop the development because the County did not have an adopted general plan, the project was inconsistent with the proposed general plan, and the County failed to require an environmental impact report (*Press Democrat* 1978). On February 21, 1978, the Sonoma County Supervisors ruled that the area contained unique features needing preservation and was, therefore, too sensitive environmentally for the proposed subdivision (*Press Democrat* 1978), and the state of California soon thereafter purchased the lower Willow Creek watershed for inclusion within Sonoma Coast State Beach (DPR 2004:4-7).

Current Residential Use: 2004

In addition to State Parks and MRC, current landowners within the Willow Creek watershed boundaries include the Sonoma Land Trust, Sonoma County Agricultural Preservation and Open Space District, and a number of private individuals, mostly in the upper watershed. Part of MRC's negotiations with State Parks for acquisition of their holdings includes reserving several parcels for later residential development. Current Willow Creek land ownership was mapped by the Trust for Public Lands during their negotiations for State Parks' acquisition from MRC.

Recreation and State Parks

The history of the acquisition of the Willow Creek watershed as park land is directly tied to public and agency concern for the watershed's health and preservation. The Willow Creek Unit is managed for recreational pursuits, which include freshwater fishing, kayaking, camping, bird watching, equestrian use, bicycling, and hiking, for wildlife habitat, and for the protection of natural and cultural resources (DPR 2004:2-79). Existing facilities at Willow Creek include environmental camping, restrooms, picnic areas, beach access, and trail access (DPR 2004:2-80).

The California State Park System: A Regional Context

Establishment of public parks began after approval of a $6 million bond issue in 1928 (DPR 1973:5). Armstrong Redwoods was acquired in 1934 as a gift from Sonoma County, with matching funds to purchase almost 700 acres of the Sonoma Coast for under $60 per acre. Much of the coast between the Russian River and Bodega Bay was incorporated into the State Parks' system in 1934 and was classified as a State Beach in 1964 (DPR 2004:ES-1). Sonoma Coast State Beach has become one of the most visited state parks in California, "known for its rugged coastline, sandy coves, sweeping ocean vistas, and a variety of other natural, cultural, and recreational resources" (DPR 2004:ES-1). It extends 19 miles, from Bodega Head near Bodega Bay to beyond the Vista Trail four miles north of Jenner, and currently totals 6,885 acres. It also extends inland, encompassing portions of the lower watershed of the Russian River, including the lower half of Willow Creek.

State Parks' Acquisition of Lower Willow Creek: 1970s

In 1972, the Sonoma County State Park Committee and the California State Parks Foundation launched a $250,000 drive to raise private funds to help purchase state parks on the Sonoma Coast. The money was to provide required matching funds for Senator Randolph Collier's (D-Yreka) successful SB537 funding obtained in 1971 to purchase Penny Island in the Russian River estuary, North Jenner Beach, and other North Coast coves and beaches (*Press Democrat* 1982). The committee also launched

a successful "Pennies for Penny Island" campaign that received donations from local school children.

As early as 1974, the Willow Creek area was considered for inclusion in Sonoma Coast State Beach. A State Parks Acquisition Plan map dated February 1974 shows four lower Willow Creek parcels within the acquisition boundary. In 1976, two important bills were added on the final day of the 1975-76 legislative session. Senator Collier proposed SB1617, a so-called "Christmas Tree Bill" appropriating almost $1.5 million for parks in Sonoma, Mendocino, and Lake counties. Added to the Collier bill was a proposed expenditure by Assemblyman Barry Keene (D-Eureka) of $1,258,000 for acquisition of "Willow Creek Ranch, southeast of Jenner" (*Press Democrat* 1976a).

Meanwhile, development in Willow Creek was imminent. The Jenner Bay Corporation subdivision had been approved in January 1977, and it wasn't until February of the following year that the Board of Supervisors rescinded their decision. It was then that the Jenner Bay Corporation and others sold their Willow Creek properties to the state of California for inclusion in Sonoma Coast State Beach. State Parks bought 2,226-acres in lower Willow Creek because of its nearness to the beaches, its protection from ocean storms, its favorable microclimate, and its accessibility for handicapped and elderly visitors (DPR 2004:4-7).

Planning for Recreational Uses the Willow Creek Unit: 1979-1980s

In the late 1970s, the lack of facilities for recreational vehicles along the coast resulted in hundreds of campers being turned away. Rangers at Doran and Westside Parks were quoted as recommending "wide spots on the road" (*Press Democrat* 1977b). In February 1977, State Parks requested a permit to designate an overnight parking area for recreational vehicles at Goat Rock Beach. Staff of the North Central Coast Regional Commission reviewed the proposal and issued their Initial Summary Report and Staff Comments (NCRC 1977a). The plan was not approved, primarily due to lack of enforcement capabilities (*The Times* 1977).

By 1979, the search for new campsites intensified. A "Recreation on the Sonoma Coast" database, dated August 2, 1979, lists the Willow Creek acquisition as containing 3,700 acres with potential recreational uses to include a trail connecting Duncans Mills with Sonoma Coast (Goat Rock), primitive hike-in and small tent camping areas, vehicle access camping area, and use of existing buildings to create an 1880s American working farm historic site. An October 1979 report to the Sonoma County Community and Environmental Services Planning Division concluded that a general plan for the Willow Creek area, including the upper valley, should be prepared and that impacts from camping and other land uses should be carefully considered (Odom 1979:1-2).

Controversy over Proposed Recreational Development: 1981-1983

In 1981, Senator Barry Keene introduced a bill for use of bond funding voters had approved in November 1980. Proposed projects included a boat launching ramp, parking lot, and walk-in camping at Willow Creek. Although funding was proposed

for preparation of general development plans in other state parks, no funding was provided for planning in the Willow Creek Unit (*Russian River News* 1981).

In 1983, State Parks filed an application with the California Coastal Commission for a permit to construct a boat launching ramp, primitive campsites, toilets, parking, and stock fencing. (CCC 1983a:1), and the U.S. Army Corps of Engineers filed a Public Notice requesting public and agency comment on State Parks' request (ACOE 1983a). The public responded that "before any development takes place, a Master Plan for Willow Creek Park should be designed. A Citizens Advisory Committee should be assembled to work with park staff." (Hechtman 1983:1). As a result of the controversy, State Parks removed its request for the boat ramp, and a permit for construction of primitive campsites, toilets, parking, and stock fencing (CCC 1983b:1) was granted (*The Paper* 1983:11). The 11-unit Willow Creek Environmental Campground on the south bank of the Russian River was completed soon thereafter, along with improvements to the County road.

Sonoma Coast Advisory Committee: 1983 to present

In 1983, the Park Commission appointed a citizens' group, the Sonoma Coast State Beach Advisory Committee, to assist State Parks in planning for the future. Members worked with State Parks' staff to develop the Interim Management Plan (1984) for use on State Parks' lands in Willow Creek and the Sonoma Coast.[18] Implementation of the plan began in 1987 with the opening of new trails and picnic areas within Willow Creek (Jenner Coastside Conservation Coalition 1987:2). The Sonoma Coast Advisory Committee continues to meet with State Parks' leadership on a quarterly basis. Its volunteer members represent a diversity of interests, including recreation, protection of sensitive habitats, watershed restoration, fish biology, and long-range planning.

Willow Creek's Park Status Threatened: 1987

In early 1987, members of the public were dismayed to discover that the state's Legislative Analyst had proposed inclusion of the Willow Creek Unit in the annual surplus property bill for possible sale. Letters and phone calls to Assemblyman Dan Hauser were clear—the public would defend Willow Creek as a State Park. By mid March, Assemblyman Hauser issued letters to interested constituents reporting that the Legislative Analyst's office would withdraw its recommendation (Hauser 1987:1).

Development of Pomo Canyon Campground and Pomo Trail: 1985-1990

In 1985, State Parks commissioned Suzanne Stewart's cultural resources investigation to assess potential impacts of the proposed construction of a 27-site campground and associated parking lot at the base of a steep redwood canyon known locally as San Quentin Gulch. Termed Pomo Canyon Campground, it was to be connected to 3 campsites on the project area's southern ridge by a 2-mile long hiking trail. The campground opened on Memorial Day weekend in 1990 with 24 campsites, but it had to be evacuated 2 days later due to flooding (*Press Democrat*

[18] The "interim" plan has guided park management in the area to this day. It will be replaced upon completion of the *General Plan for Sonoma Coast State Beach*. See footnote 2 on page 1 for more details.

1990). It has, however, operated successfully over the years and is extremely popular with campers. It is reported to have suffered damage from pedestrian traffic in the understory near some of the upland campsites (Luna pers. comm. 2004).

Recreational Use of Private Lands—LandPaths/Friends of Willow Creek: 1996-present

In 1996, a group of landowners, community members, and public agency representatives created LandPaths to meet the need for increased public access and responsible land stewardship (LandPaths 2004). LandPaths established a program called Friends of Willow Creek (FOWC), which permits public use of MRC's 5,200-acre Willow Creek property. FOWC members agree to be stewards while on the property and once a year contribute sweat equity to enhance the property's natural resource values (LandPaths & MRC 2004).

Acquisition of Sequeira Ranch (Red Hill): 2000-2003

Red Hill, elevation 1,062 feet, is located east of Shell Beach between the Sonoma Coast and Willow Creek valley on the former Sequeira Ranch. In 2000, the 910-acre Red Hill parcel was purchased with a $1 million grant awarded to the Sonoma County Land Trust by the State Coastal Conservancy and $1.37 million from the Sonoma County Agricultural Preservation and Open Space District. However, State Parks did not take ownership of the property until March 2003.

Acquisition of MRC Lands for Willow Creek Unit: 2001-present

In 2001, the Trust for Public Lands (TPL) began an effort to purchase 3,373 acres in the Willow Creek and Freezeout Creek watersheds. An additional 515 acres was proposed for conservation easements. This important purchase for State Parks would increase the acreage for Sonoma Coast State Beach, as well as connect to the recently protected 910-acre Sequeira Ranch. This effort attracted the attention of many public agencies, nonprofit organizations, and the public at large, who recognize that the acquisition of the upper watershed presents a unique opportunity for the land to become part of Sonoma County's spectacular public landscape (TPL 2002).

After 3 years of negotiations that included many site visits and coordination with State Parks, TPL obtained adequate funding for the purchase from State Parks, the Sonoma County Agricultural Preservation and Open Space District, the Wildlife Conservation Board, and the state Coastal Conservancy. In 2004, Governor Arnold Schwarzenegger halted the state taking title to newly acquired lands due to its inability to properly manage the properties. This decision has added yet another challenge to the process, but it is hoped that the MRC property will be transferred to State Parks by the spring of 2005.

Conclusion

Recorded human land use in the Willow Creek watershed that began with the Russian road system and was followed by logging and disturbance to the riparian corridor associated with Russian settlement and agricultural uses (grazing and crop production) between 1833 and 1841 set the stage for later activities that have

resulted in the limiting factors facing the watershed today. Timbering under the Phelps/Curry lease appears to have resulted in clear-cutting as early as the mid 19th century, and extensive clear-cutting and tractor-yarding are reported in the mid 20th century. Various trains were used to move timber from the watershed, some of which are reported to have been in the creekbed itself. Grazing by the Knowles family is recorded to have been very intensive in the later 19th century.

All of these historic activities have had tremendous impacts on the watershed. With State Parks' takeover of much of the upper watershed, the prognosis for restoration and protection is good. All of the issues that the TAC identified as limiting factors can be addressed under State Parks' management and in partnerships with Stewards, LandPaths, and others in the public and private sectors.

Chapter 4: Watershed Diagnosis: Areas of Environmental Concern

Introduction

Watershed ecosystems naturally operate in a state of dynamic equilibrium in which changes in the physical environment elicit a response in other parts of the ecosystem, often counteracting the initial change. For example, immediately after a forest fire there may be increased erosion on the barren slopes, but new vegetation is soon established—erosion is abated, and the resulting plant community often is more diverse, providing more complex habitat for animal species. The health of an ecosystem is dependent upon these complex interactions. In a healthy system, physical processes as well as animal and plant populations adjust to small disturbances, maintaining both their equilibrium and the overall ecosystem function. However, in systems that are subject to human land use activities, landscape alterations are often large-scale and persistent. This limits the ability of the ecosystem to regulate itself and maintain equilibrium, resulting in habitat degradation, population declines, landscape changes, and physical process imbalances.

The postglacial, prehistoric Willow Creek watershed was a wildland landscape dominated by natural disturbance and influenced by the livelihood of the Kashaya Pomo and past wildlife assemblages. The natural disturbance regime included hillslope failure, windthrow, fire, and, within the lower valley, flooding. Kashaya Pomo primarily influenced the landscape through their frequent use of fire for the improvement of game and plant resource abundance important to their survival, and secondarily through the collection of plant resources. Relict wildlife populations—including the extant species of Willow Creek and extirpated species such as elk, antelope, grizzly bear, wolf, flying squirrel, salmon, lamprey, fisher, and marten—would have further influenced the structure and composition of vegetation and nutrient cycling through their actions.

Following European settlement, a shift in the prehistoric landscape occurred. Settlers altered the physical landscape as the Willow Creek watershed was logged and grazed and the valley bottom converted for agricultural production. Our physical and social imprint also altered the disturbance regime and extirpated and decreased both wildlife and habitats. While many of the changes have been obvious and intentional (e.g., logging of old growth), past land use practices have also wrought unintentional consequences made evident only recently as interrelated, cumulative watershed impacts.

In an effort to improve the ecological function and health of Willow Creek watershed, resource managers, government agencies, scientists, and private citizens have identified some of the most significant environmental impacts associated with past land use practices. These include landscape and habitat alterations, altered sediment production and transport, fisheries decline, and limitations in restoration potential. These areas of concern are discussed below, and corrective remedies are addressed in Chapter 5.

Landscape and Habitat Alterations

Ecological processes and history define the composition of plant communities and associations of habitat types. It is useful to introduce a few ecological concepts to help explain the processes that govern the gradual, or sometimes abrupt, changes to the ecological system at a landscape level.

The development of forest, riparian, grassland, shrub, and aquatic communities depends on both abiotic (non-living) and biotic factors. Abiotic factors include weather and climate influence, hydrologic regime, soil types, slope, exposure, and parent geology. Biotic factors include all influences related to the interaction of plants and animals, including humans. These may include the presence or absence of pollinators, competition for water, light and nutrients, grazing and browsing, inhibitory chemicals, and mycorrhizal organisms among many others.

The community is generally defined as a recognizable assemblage of plant species and often the wildlife, soil flora, and fauna that tend to occur where similar assemblages are present. The structure of a plant community changes over time in response to climatic, land use, and successional influences. Successional stages are sometimes referred to as "seres" or seral stages by ecologists.

Succession is the process by which there is a gradual change in the species composition from its starting point to what is called the "climax" condition. Climax communities can be defined as those that take maximum advantage of available resources. In the climax condition, the rate of change in community composition is very slow. Climax communities tend to be more resistant to invasion by new species and tend to persist for long periods. In the climax community, large-scale change does not occur until there is an environmental change that results in the landscape becoming less suitable for the climax assemblage and more suitable for other species.

Events, both natural and human-caused or influenced, are the commonest drivers for changing the species composition of a climax community. These events may be prolonged and gradual, such as climate change, deposition, and erosion, or they may be abrupt—fire and timber harvesting are examples of abrupt events. For some communities, fire is an integral part of a cycle within the community, periodically removing some species and renewing successional processes. Communities in which fire plays an identifiable role in determining community composition are called "fire climax" communities. In the absence of periodic fire, the community structure would change, often dramatically.

An example of this is chaparral, a shrub-dominated community that historically occupied drier, more exposed ridges of the coast ranges, including the Willow Creek watershed. The chaparral was dominated by manzanita *(Arctostaphylos* sp.) and ceanothus plant species. In the absence of fire, the chaparral has been invaded by tree species including Douglas fir *(Pseudotsuga menziesii)*, oaks *(Quercus* sp.), madrone (*Arbutus menziesii*), and California bay (*Umbellularia californica*). Should a fire occur in this community, the tree species would likely

be set back or eliminated from the site, and shrub species would return via seeding, resprouting, or colonization. In this area of total absence of fire, California bay tends to eventually dominate the landscape in the tree canopy.

Timber harvesting can have similar effects to those of fire in that it rapidly alters the site and eliminates much of the standing vegetation. Timber operations differ significantly from fire in terms of the community response to the event. With timber harvesting, much of the harvested material (except main stems) remains on the site. This has the effect of reducing erosion relative to what could occur following a fire, but it also leaves a variable layer of organic debris that breaks down slowly. This layer strongly influences the subsequent composition of the community. Resprouters such as coast redwoods (*Sequoia sempervirens*) tend to regrow following the harvest. These trees rarely reproduce from seed since they require relatively sterile soil for germination. The sterile soil condition is unlikely to occur in the absence of fire or a significant flooding or sedimentation event. Douglas fir reproduces abundantly from seed in nearly any soils. This plant is considered a "pioneer species" in that it can reinvade or newly invade a site following a disturbance event. Following timber harvests, the density of Douglas fir tends to increase and to persist over time. Douglas fir is capable of growing faster than redwood in most situations. Consequently, the regrowth of redwood stump sprouts can be suppressed or less vigorous. Although it is a pioneer species, Douglas fir can persist and eventually dominate the forest canopy.

Another concept that is useful in assessing habitats and plant communities is that of "indicator species." These are organisms (plants or animals) whose presence is indicative of a functioning community. The "canary in the coal mine" is a useful metaphor. These species tend to tolerate only narrow ranges of fluctuation in community composition and change. In the Willow Creek watershed, there are several indicator species, and others that represent the limits of a particular set of circumstances within which a species can live. Examples of the former include northern spotted owl, red tree vole, and possibly western leatherwood. The latter category would include grand fir *(Abies grandis)*, which reaches the southern limit of its distribution in the lower Willow Creek watershed.

In the context of community composition and distribution, the present-day watershed differs substantially from historic and prehistoric times in the juxtaposition of community types. Some communities have expanded, while others have retreated, primarily in response to environmental changes. The borders of these communities are sometimes distinct, such as between a riparian woodland and adjacent grassland, and sometimes complex and gradational, such as between Douglas fir forest and mixed forest. These borders are referred to as "ecotones" or edges. Many plant species occur only at these ecotones; others will not occupy land at the edge of the community.

The present-day vegetation of the Willow Creek watershed consists of several communities and many subtypes within those communities. The most evident association is of north coast mixed forest, which is a term commonly used for successional forests dominated by Douglas fir and/or redwood with substantial

cover (shaded areas) provided by hardwood species, including coast live oak, tanoak (*Lithocarpus densiflorus*), California bay and madrone. Additional associations include patches of redwood forest, bay forest, valley grassland, coastal terrace grassland, isolated relict patches of chaparral, coastal sage scrub, freshwater marsh, tidal brackish marsh, willow scrub, and alder-dominated riparian forest.

None of these communities is considered pristine, since the entire watershed has been subjected to human disturbance on an ongoing basis. In general, these communities retain the species composition of the original forest, although the trend has been toward dominance by plant species that can withstand repeated disturbance. The density of the tree cover, usually expressed in terms of stems per acre, is much higher in the forest communities than that which occurred historically.

The complex interactions and interdependency of biological and physical ecosystem elements and watershed processes require a landscape-level analysis. Specific indicators of watershed health—such as population counts—provide useful, but limited, reference for the overall integrity and stability of the ecosystem. Examination of landscape and habitat features of Willow Creek watershed yields useful information about the type, composition, and function of a range of ecological elements. From this information, strategies for achieving restoration goals can be developed with a greater degree of ecological understanding, realistic expectations, and consequently a higher likelihood of success.

Changes in Vegetative Community Composition

Forest Type and Composition Changes

The most obvious significant alteration to the Willow Creek landscape has been the logging of hillslope and riparian forests. Commercial logging of Willow Creek began in the mid-1800s and continues through today, with watershed-wide harvesting occurring in the late 1800s and in the late 1950s to early 1970s. No significant old growth forest stands remain in Willow Creek. As in other coastal California redwood forests, it is likely that the prehistoric forests of Willow Creek ranged in age from early to late-seral (developmental) stages but trended toward far older age classes than is the average today. Most forest stands in Willow Creek currently exhibit early, secondary successional characteristics, with an average age class of approximately 30-80 years.

The change in forest age can also be seen in the average tree size. The prehistoric forest in Willow Creek was composed of presumably larger trees than are seen today – cursory observations of old growth redwood stumps reveal many 10-foot diameter stumps within the alluvial flats and 6-foot diameter stumps on slopes. Average tree size in Willow Creek is currently less than three feet in diameter (www.krisweb.com, citing U.S. Forest Service remote sensing data). Prehistoric, old growth stands in the local area typically ranged from 60 to 160 stems per acre. It is estimated that the number of stems per acre currently ranges from 200

to 2,000. This increase is due to proficient Douglas fir seeding, as well as basal sprouting of redwood, tanoak, and bay trees following logging.

There has also been an increase in the amount of "edge" between stands of varying age and composition. Each tract that is logged becomes a small island of disturbance that begins the successional process as soon as the disturbance concludes. The ecotones associated with both individual timber harvest plans and larger, long-term operations have created an abundance of transitional habitat. It is along these edges that native and exotic weeds tend to colonize. This is the preferred habitat of many animals that would not occur in mature or climax forests. Black-tailed deer are likely more numerous than in historic times because they have an abundance of the ecotonal areas that they favor for browse.

The present-day forest communities can be summarized as lacking the structural and compositional elements of an old growth, late-seral forest. The current forest canopy is dominated in most areas by patches of even-age conifers with a variable understory of hardwoods (bay, madrone, tanoak, and coast liveoak [*Q. agrifolia*]). The canopy forms dense cover that limits light penetration, suppressing herbaceous ground cover and epiphytic plants. In the overly dense stands, lower branches of forest trees tend to die and be retained on the stems. The standing biomass of the current forest is much greater than historical times. However, the complexity of the forest is reduced. Further, there are fewer natural ecotones and more artificial boundaries created by land management practices. Populations of species that are specialized for the occupation of these "niche" ecotones often fail as a result.

Riparian Changes

Riparian forests and wetlands within the floodplain of lower Willow Creek have been impacted by logging activities, conversion to cultivated fields and grazing lands, and the construction of railroads, roads, and buildings (Trihey 1995). The extent and composition of riparian forests and wetlands appears to have changed within historic times. Riparian landscape conversion to cultivated fields and grazing land began with the Russian settlement in lower Willow Creek. It is likely that this included draining wetlands and clearing forests. Riparian forests were logged during the early forest harvesting activities, and the railway for transporting logs and lumber out of the watershed was built immediately adjacent to the creek.

The structure and composition of the riparian corridor has been significantly altered by the land use activities of the past 150 years. The old growth, late-seral redwood riparian forest has been replaced in the upper watershed with an early-seral, hardwood-dominated system that lacks structural complexity and maturity. In the lower Willow Creek valley, wetlands and forests were cleared for cultivation, as well as road building and maintenance, thus destroying the complex, productive, critical landscape features of an intact riparian corridor. Today we see reduced a tidal wetland area, limited freshwater wetlands, narrow patches of secondary-growth forests, and a large area of even-aged, dense, alder-dominated forest.

Grassland Decline and Invasion

Populations of tree and shrub species such as Douglas fir and coyote brush (*Baccharis pilularis*) are known to be kept in check at sustainable levels by fire and grazing. In the absence of these typical environmental pressures in the Willow Creek watershed, trees and shrubs encroached into coastal prairie and coastal scrub habitats. This trend can be expected to continue in the absence of periodic fire, grazing, or mechanical intervention. Paleoecological studies conducted by Susan Bicknell, et al. (1993) reveal that within Fort Ross State Historic Park and Salt Point State Park the extent of coastal grasslands has declined during recorded historic times. To illustrate the potential extent of grassland conversion in the Willow Creek watershed, the existing grassland and forest habitat distribution (as identified in the California Department of Forestry "CalVeg2000" survey) can be compared to forest and grassland soils identified in the USDA *Soils Survey for Sonoma County* (1972).

Exotic Species Invasion

The invasion of non-native species throughout the Willow Creek watershed is another factor in the degradation of the overall integrity and stability of the ecosystem. Invasive species are those that grow rapidly, to the exclusion of other species, and/or dominate the ecosystem to the detriment of other species. Invasive species are typically exotic to the ecosystem, brought in either intentionally or unintentionally by importation of goods, livestock, and feed from other locales. The establishment of invasive species in an area typically decreases native species abundance and diversity. In the most extreme casesm this results in an apparent monoculture, threatening the long-term persistence of the diversity and function of the naturally occurring ecosystem.

Both through direct and indirect means, human land use activities often make conditions favorable to the colonization of wildland areas by invasive species. In the Willow Creek watershed, changes in grazing patterns, suppression of fire regimes, construction and maintenance of roads, timber harvesting, agricultural land conversion, and modification of the creek's form and process have all contributed to invasion of non-native species and alteration of historic habitats.

Within Willow Creek watershed several invasive species are currently documented. Riparian woodlands and wetlands are threatened by Cape ivy *(Delairea odorata*); it currently exists at the confluence of the Russian River and Willow Creek and is known to be toxic to fish. Grasslands are threatened by invasion of various exotic annual and perennial grasses such as purple velvet grass (*Holcus lanatus*), sweet vernalgrass *(Anthoxanthus odoratum),* and tall fescue *(Festuca arundinacea),* as well as pampas grass *(Cortaderia jubata*), French broom *(Genista monspessulana),* and purple starthistle *(Centaurea calcitrapa)* on the slopes and ridges. Medusa head (*Taeniatherum caput-medusa*) is a perennial grass that has been increasing on coastal terrace grasslands in the watershed the last few years. Edge habitat between roads and wetland areas is being colonized by hemlock *(Conium maculatum*), fennel *(Foeniculum vulgare*), biddy-biddy *(Acaena* sp.), Canada thistle *(Cirsium arvense*), and Harding grass *(Phalaris aquatica*) among

other species. Cutleaf burnweed (*Erichtites glomerata*) is an introduced weed that often colonizes cut-over stands thickly for several years. Many of these are also found in disturbed areas along logging roads, and landings, with the potential to further colonize throughout the watershed. Blue gum eucalyptus *(Eucalyptus globulus*) and cotoneaster *(Cotoneaster* sp.) are two common examples of horticultural plant varieties with the potential to escape cultivation and invade wildland areas bordering homes and other developments.

Impacts of invasive plant species in Willow Creek watershed include alteration of ecosystem processes such as nutrient cycling, intensity and frequency of fire, hydrological cycles, sediment deposition and erosion, and displacement of native plant species. Potential impacts further include support of non-native animals, fungi and/or microbes, alteration of gene pools through hybridization with native species, degradation of scenic values and recreation opportunities, and costlier resource management operations.

Habitat Impairment

Conversion of vegetative types and changes in species composition of Willow Creek watershed plant communities have resulted in degraded habitat functions. Logging has removed structural and compositional diversity, which is critical to quality habitat for species such as marbled murrelet (*Brachyramphus marmoratus*), northern spotted owl (*Strix occidentalis*), red tree vole (*Phenacomys longicaudus*), and flying squirrel (*Glaucomys sabrinus*). Old growth trees also provide unique habitat for lichens, bryophytes, and mosses.

Within the floodplain of lower Willow Creek, conversion to agriculture and grazing has resulted in the loss of riparian cover. This vegetation type provides cover for fish, habitat for songbirds, and supports an abundant and diverse insect population, providing biotic and abiotic inputs into the stream network. The reduction of grassland and coastal scrub reduces available habitat for the species associated with these vegetation types, including badger (*Taxidea taxus*), black-tailed deer *(Odocoileus hemionus columbianus*), red tail hawk (*Buteo jamaicensis*), white-tailed kite (*Elanus leucurus*), northern harrier (*Circus cyaneus*), and long-tailed weasel (*Mustela frenata*) among others.

Large redwoods and conifers in the riparian forests in both the upper and lower watershed were logged extensively, and the riparian areas in the lower watershed were converted to fields for cultivated crops and grazing. The young riparian forest that has regenerated since the cessation of agriculture and grazing of the floodplain does not yet provide the same complexity, diversity, or function as mature riparian habitat. The type and quality of stream cover has changed and with it the species that relied on the forest structure. Additionally, as the size and age class of trees in the riparian corridor have likely decreased significantly from prehistoric levels through logging and clearing activities, there is a deficiency of large woody debris, both directly in the channel and available in the near vicinity for recruitment into the channel. Large woody debris in the stream channel serve as important cover and refugia for fish, as well as structure for the formation of instream habitat features.

The reduction of coastal prairie and coastal scrub vegetation impacts the watershed on several spatial levels. Regionally, coastal prairie habitat has declined dramatically throughout its range. Development, agriculture, over-grazing, invasion by weeds, and absence of fire threaten to further reduce this habitat. At the landscape level, vegetative cover trends toward homogeneity and reduces the diversity of habitats within the matrix. The relative proportion of grasslands within the watershed affects its hydrology as grasslands transpire less water on a per acre basis than forested habitats. In addition to transpiring less, grasslands also tend to promote infiltration during rainfall events. These two factors promote increased and lengthened stream base-flow levels.

Barriers to Wildlife Movement

A final landscape feature that has wide-ranging impacts to ecosystem function and habitat values is the existence of anthropogenic structures. These structures include roads, fences, and buildings. While these features comprise less than 5% of the total area in Willow Creek watershed, their impacts can be significant. Features such as roads bisect streams and plant communities, create barriers to wildlife movements, and have the potential to alter the stream network through delivery of sediment and slope failure.

Recommendations

Modifications of the landscape and habitats of Willow Creek watershed have resulted in significant impacts to dependent wildlife populations, including the extirpation of several species, as well as impacts to associated biological and physical natural processes. To the extent possible, management of the Willow Creek watershed should work toward restoration of these habitats and other landscape functions. Initially, the appropriate landscape matrix based upon physical constraints within the Willow Creek watershed must be identified. The effects of fire, flooding, landsliding, and windthrow and the recurrence rates for these disturbance factors for the local region should be considered. The prehistoric compositional and structural elements of the vegetative communities represented within the Willow Creek watershed could be determined through paleoecological studies and / or the analysis of nearby examples. A prescription range for management of structural and compositional elements and age classes of the vegetative communities found within the Willow Creek watershed based upon the above factors should be developed. The vegetative communities and habitats of the Willow Creek watershed may be enriched or restored using the parameters identified. Additional recommendations for habitat improvements are included in other recommendations sections of this chapter.

Invasive species that threaten ecosystem processes represent a significant, long-term threat to wildlands. In order to mitigate this threat, invasive species should be addressed at the earliest opportunity. The extent and cause of the invasion should be determined. Best management practices to prevent further introduction or spread should be applied. Consultation with land managers experienced with a particular invasive species and / or scientific literature review should provide proven methodologies for control or eradication. The most

appropriate method to control or eradicate invasive species should then be employed.

Anthropogenic features that are a detriment to the environment should be improved or removed. The existing road network provides one such example. Treatments may range from general upgrades (improve channel crossings, upgrade culverts, outsloping) of the County Road and other secondary use roads to decommissioning (disconnect hydrologically and/or fully recontour) roads that are no longer used. Removal of roads from the landscape will significantly reduce the likelihood of sediment delivery to the stream network, will deter invasive species propagation, and will eliminate barriers to wildlife passage. Log landings, fencing, and other features can be treated in a similar manner where appropriate.

Altered Sediment Production and Transport

The amount and timing of streamflow and the sediment a stream carries determine the form, maintenance, and adjustment of every channel. A channel in dynamic equilibrium is able to transport the volume of sediment supplied, as well as form and maintain stable instream features such as pool/riffle sequences. In order for a stream to maintain a state of dynamic equilibrium, a balance between the following four variables must occur:

- Sediment discharge or "load" (Q_s)
- Sediment particle size (D_{50})
- Streamflow (Q_w)
- Stream slope (S)

The relationship of these four variables is such that the combination of the sediment discharge and mean particle size is proportional to streamflow and channel slope, as shown in Figure 4.1 below. Thus, if any one of these variables changes, one or more of the other variables must increase or decrease proportionally to maintain channel equilibrium conditions. During the adjustment process, equilibrium will be lost, and the stream will change its level, either by aggradation (rising) or incision (lowering).

For example, in Willow Creek sediment load appears to have increased from historical levels. Thus, either the streamflow or slope must increase to offset the effect of higher amounts of sediment in the system. In this example, the most common response will be channel aggradation, as streamflow over time is generally not adjustable. High rates of deposition and channel infilling are occurring in lower Willow Creek in response to the high sediment loads. Channel aggradation will ultimately increase slope in the low gradient reaches, producing conditions in which sediment and streamflow will exist in a dynamic equilibrium condition for channel-forming and maintenance processes. Lower Willow Creek is acting as a "sink" for excess sediment.

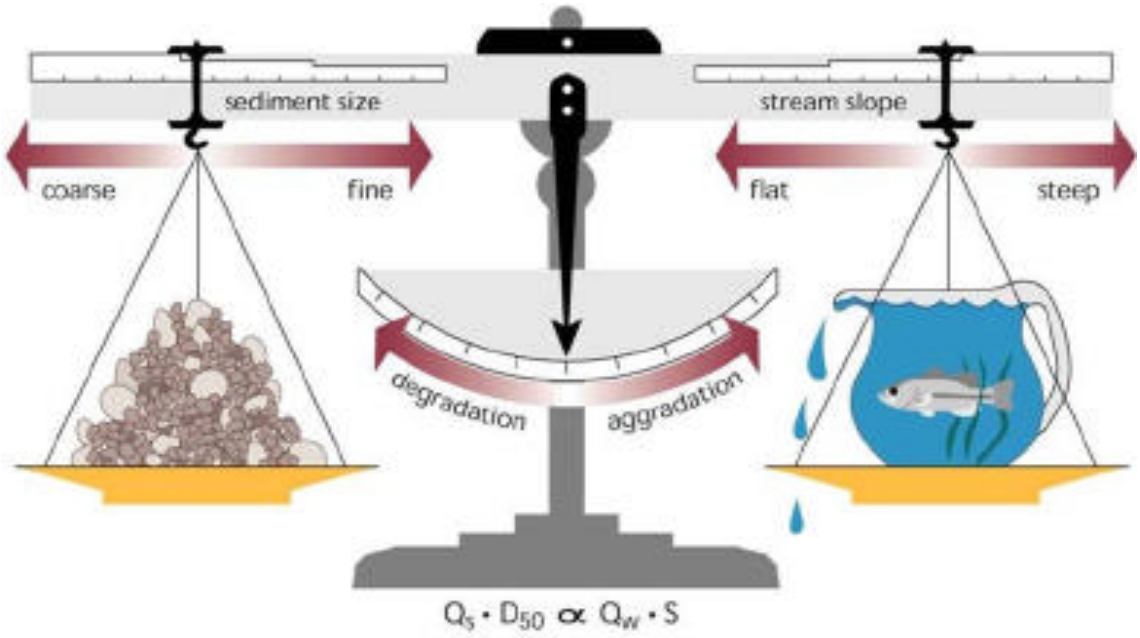


Figure 4.1 Illustration of the balance between sediment, water, and stream slope in determining channel aggradation and degradation.
(Source: NOAA Sediment Removal Guidelines 2004, citing Lane 1955).

The specific form a watershed takes is dependent upon climate, geology, morphology, soils, and vegetation. However, all watersheds have a characteristic longitudinal structure that is related to increasing drainage area and discharge. Figure 4.2 below illustrates how watershed processes such as erosion and deposition, as well as channel structure characteristics (channel depth, width, slope, grain size) follow a standard longitudinal organization regardless of the watershed size or channel pattern. Although erosion, sediment transfer, and deposition can occur in any location within the watershed, each zone exhibits a dominant process (i.e., erosion predominates in the headwater region, while deposition is the dominant process in the flat valleys near the mouth).

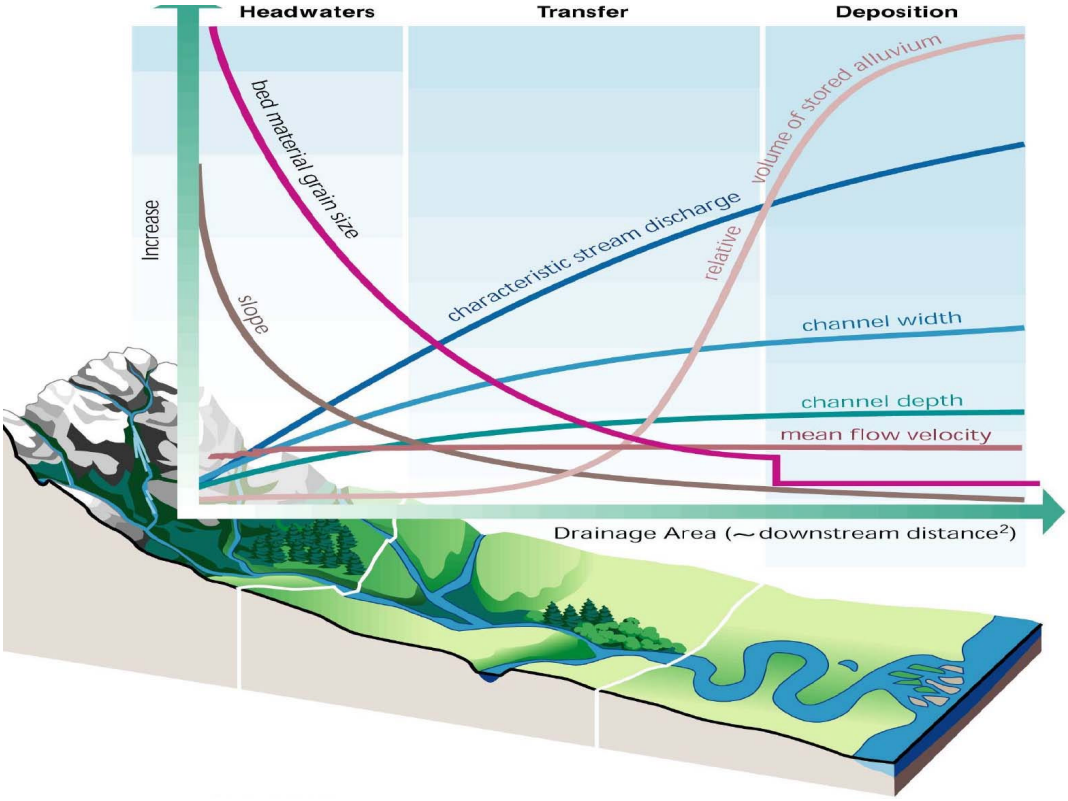


Figure 4.2 Relationship of stream channel processes and characteristics to the location along the longitudinal profile of the watershed.
(Source: Federal Interagency Stream Restoration Working Group).

Physical elements of the watershed, such as geology, topography, and climate, determine the characteristic of the landscape and channel form and behavior, as well as the watershed's vulnerability to land use or climate change. For example, the Willow Creek watershed is underlain by Franciscan mélange and Great Valley conglomerates, both of which have naturally high rates of slope failure and landsliding. Forest harvest practices, especially those using tractors on steep slopes, tend to increase runoff, erosion, and slope instability. This often leads to higher rates of slope failure and landsliding, especially if coupled with high intensity storms. In Willow Creek, the increased slope erosion from high intensity logging in the 1950s through early the 1970s led to increased landslides and tributary gullying. Slope failures and sediment deposition were particularly severe during the large winter storms of 1982 and 1986. This resulted in unusually large sediment loads in the upper watershed channels being transported to the low gradient channel below the third bridge, causing extensive aggradation and channel avulsion/location changes. In addition, lower Willow Creek is subject to backwater effects from Russian River flows. This effect significantly reduces the amount of sediment that can be transported out of the system and promotes rapid sediment deposition in the second bridge

area. The watershed and channels are still adjusting and recovering from these alterations.

Lower Watershed Sedimentation and Loss of Channel Connectivity

Lower Willow Creek has experienced rapid sediment deposition, resulting in channel infilling and abandonment in the vicinity of the second bridge. High sediment loads from the upper watershed are transported to the lower reaches of Willow Creek, producing an average yearly sediment yield of 1,450 to 2,900 yd^3 to the area between the second and third bridges (Trihey 1997). Deposition occurs in this reach for a number of reasons, including:

- Extremely low channel and valley slopes (range from 0.05% to 0.3%) limit the amount and size of particles that can be transported through this reach during any given flow.
- High flow conditions on the Russian River create ponded backwater in the Willow Creek valley that extends up to the second bridge on a five-year return interval and halfway between the first and second bridges on a two-year return interval. As a result, sediment carried by Willow Creek is deposited directly at the upstream edge of the backwater conditions.
- The bermed roadway across the floodplain at the second bridge restricts the natural channel formation processes in this reach, specifically the dynamic erosion and deposition patterns that would be typical of an unrestricted channel system. As a result, excessive channel aggradation and loss of channel continuity are evident.

Increased sediment production and transport rates from aggressive land use practices in the upper watershed over the last 100+ years have exacerbated the natural valley-filling processes occurring in lower Willow Creek.

Attempts to alter the channel structure and control sedimentation have been undertaken in lower Willow Creek since the late 1800s. The early settlers cleared the valley of riparian forest upstream of the second bridge area to develop cultivated fields, attempted to drain the wetlands, and diverted the spring-fed tributary flows into the valley. In the 1940s, it appears that the road up Willow Creek at the second bridge crossing was modified and improved. Concurrently the channel was straightened both upstream (~2,000 ft) and downstream (~1,000 ft) of the second bridge. This channelization was probably done in an attempt to increase flood capacity and facilitate sediment transport through this reach. However, with our understanding of the system today—frequent backwater effects, low channel gradient, and high sediment loads—the channelization may have accelerated the rate of aggradation around the second bridge.

Aerial photographs from this time period indicate that channel avulsions and large sediment splays on the floodplain began occurring almost immediately after channelization. By the 1960s, Willow Creek near the second bridge was dredged on a regular basis to remove accumulated gravel deposits and maintain the capacity of the channel at the bridge. On January 4, 1982, the storm of record (for most watersheds in Marin and southern Sonoma Counties) occurred. A

combination of elevated flows in the Russian River, the bermed roadway across the valley at the second bridge acting as a low dam, and the high flows carrying large amounts of sediment from the upper watershed caused the channelized section of Willow Creek upstream of the second bridge to fill with gravel. The gravel deposits were dredged and used to form a levee along a 1,750-foot stretch of channel on the south bank upstream of the second bridge.

During the February 18, 1986, flood (the storm of record for the Russian River), backwater from the Russian River extended for 1,500 feet above the second bridge crossing in Willow Creek (Swanson 1987). Large splays of sediment were deposited on the floodplain in the leveed reach, and the channelized stretches near the second bridge again experienced significant aggradation. The following year the levee was removed because of its potential contribution to the in-channel sediment load and alteration of channel processes.

Channel dredging, as a channel maintenance tool, was halted in 1987. Willow Creek immediately began to aggrade in the vicinity of the second bridge. By 1995, the historical, channelized reach had accumulated so much sediment that the channel no longer functionally exists. As of 2004, the completely aggraded channel section extends approximately 3,000 feet upstream of the second bridge. The process of channel infilling and overbank deposition is steadily moving upstream at an average annual rate of 175 feet. If this rate of deposition continues, and there is no reason for it to slow, the channel at the third bridge will fill in 12 to 15 years. Evidence of this aggradation at the third bridge is that between 1975 and 2002 the bed of the channel has aggraded 6 feet.

As the channel aggrades, streamflow and sediment spread out over the floodplain. In an unconstricted valley and channel system, the streamflow would recombine in the lowest area, gain power, and carve a new channel downstream. The new channel would transport sediment further down valley and out of the watershed while cutting a channel in the upstream direction. This process would occur regularly as long as sediment yield and transport to the flat, lower reaches remained high. However, in lower Willow Creek, the channel's ability to move, adjust, and self-maintain is arrested by the bermed roadway across the valley at the second bridge. This berm acts as a dam, ponding streamflow and causing sediment deposition upstream.

Streamflow that once went under the second bridge on the north side now flows unconfined across the valley at the upstream zone of aggradation and eventually rejoins in a newly formed, small channel along the southern edge where the valley is topographically low. Three 24-inch culverts were installed across the roadway at the southern end in the late 1980s to facilitate drainage of storm flows and fish migration. These culverts were not sized large enough to accommodate the volume of flows and amount of sediment coming through this area. They quickly filled and became nonfunctional for passage of flood flows and migrating salmon. The culverts in the second bridge bermed roadway are now below grade. In the short time that the culverts were functioning, channel forming processes appear to have occurred in both the downstream and

upstream direction. In fact, the channel forming processes are continuing in an upstream direction with the new channel on the southern edge joining the old channel approximately 1,500 feet upstream of the second bridge. However, because the bermed roadway acts as a dam, the new channel is unable to connect with the channel below the second bridge. This severely limits sediment transport out of the watershed, natural channel development and maintenance processes, and fish passage both in and out of the watershed.

Upper Watershed Sediment Production

The sedimentation concerns in lower Willow Creek between the second and third bridges are a natural process in low-gradient valleys, especially those with tide or flood backwater conditions and elevated sediment loads. The ability of the channel to adjust and develop a self-forming, self-maintaining channel is hindered by the presence of the second bridge and bermed roadway across the valley. Within the next 20 years, it is expected that the third bridge and roadway will experience similar flow capacity and sediment transport problems, further blocking fish passage into the upper watershed and vehicular access during high flows.

The rapid rate of aggradation in the lower watershed is a direct result of increased sediment yields in the upper watershed. Estimates of average, annual coarse-sediment production in the upper watershed range from 1,930 to 2,130 yd^3 per year, with a possibility of actual volumes on any given year being two times these estimated amounts (Trihey 1997). The rate of sediment production in Willow Creek is above natural sediment production rates for coastal streams and is indicative of a disturbed watershed.

Concentrated land use by Europeans began as early as the 1830s with the Russian settlement in lower Willow Creek. Intensive grazing as well as logging occurred on the ridges and tributaries. Between 1850 and 1900, the majority of the watershed was logged, and lumber was hauled out by means of steam donkeys and a railroad that ran along the creek. From aerial photo analysis, the watershed appears to be in fairly good condition in the 1940s, with dense stands of second growth forest and little evidence of channel erosion or deposition (Trihey 1995). In the late 1950s through the 1960s, the condition of the watershed declined precipitously with logging of much of remaining old growth and secondary growth from the lower redwood grove, within the inner gorge, all the way to the watershed divide. Large tracts were clear-cut and tractor-yarded, and small channels were used as skid trails (Trihey 1995).

The clear-cutting and tractor-yarding of the steep, landslide-prone slopes combined with the removal of large woody debris from the small tributary channels led to extensive slope failures, gully erosion, and channel sedimentation in the upper watershed in the 1960s through the 1980s (Trihey 1995). Logging roads and the County road developed significant rill and gully systems during this period. The major storm events in 1982, 1983, and 1995 initiated many deep- and shallow-seated landslides in the inner gorge and transported large amounts of sediment to the main channel. Although the upper watershed is recovering,

the impact of these land use-induced erosion and deposition processes can still be seen in continued gully development, road induced erosion, and large volumes of unconsolidated sediment moving through the system.

Several assessments of erosion sources and estimates of annual yield in Willow Creek have been performed in the last 10 years. Table 4.1 lists the different sediment sources, estimated delivery rate and volumes, as well as the relative contribution of each source to the total annual sediment load. Forested gully erosion and point source pollution from roads are the two largest sediment contributors within the watershed. Grassland gully erosion and mass wasting from landslides and debris flows also produce a significant volume of sediment each year.

Table 4.1. Delivery rates and volumes by sediment source in upper Willow Creek watershed.

Sediment Source	**Estimated Delivery Rate** (tons / mi^2 / year)	**Estimated Volume** (yds^3 / year)	**% of Total Sediment Load**
Forested gullies*	160	920	31-48
Grassland gullies*	100	570	19-30
Landslides			10-32
Trihey (1997)	34-68	200-400	
MRC (2001)	110	(630)	
Road-related erosion			12-44
Trihey (1997)	< 40	< 230	
MRC (2001)	148	(850)	
PCI (2002) – county road only	(31)	179	
Mainstem bank erosion*	< 2	< 10	0.3-0.5
TOTAL	336-520	1,930-2,980	

* from Trihey (1997) (= recalculated value)

The sediment derived from the two primary sources, gully headcutting and roads, is composed primarily of silts, sand, and fine gravel. This fine-grained material is quickly transported off the hillsides and into the main channels. The volume of sediment delivered to the channels appears to be greater than the ability of the channel to transport—pushing the system out of dynamic equilibrium. There has been a consistent decline in pool numbers and depths since the early 1960s. The pools have filled in with sediment, and the riffles have silted in. In fact, there is very little instream feature structure—much of the channel is flat bottomed with unstratified, poorly sorted sand and gravel. This is especially seen in the lower reaches below the “hunting camp” where lower channel slopes promote deposition. The effect of high sediment loads in the channel has been exacerbated by the removal of the in-channel large woody material in the late 1800s and 1950s. Large woody material promotes in-channel

sediment storage in the small, headwater streams and roughness elements for channel structure development and maintenance (pools, gravel bars, riffles) in the larger channels.

Recommendations

Addressing the sediment-related issues in Willow Creek requires a multi-pronged approach. Reducing the volume and rate of sediment production in the upper watershed is essential for long-term ecosystem health. Effective implementation of sediment reduction projects is dependent upon detailed mapping and prioritizing of erosion locations and characteristics. At this time, thorough assessments have been completed for the County road, as well as the majority of the skid trails and logging haul roads in the watershed. Detailed mapping and analysis of forest and grassland gullies is still needed.

Even if sediment input from gully headcutting, landsliding, and road inputs were stopped, accumulated sediment throughout the system would continue to impact lower Willow Creek for decades. Thus, for restoration of channel continuity and dynamic equilibrium in the lower watershed, the obstacles to natural channel forming processes must also be addressed. Ideally this would include removing the barrier to channel migration, sediment transport, and fish migration that is the bermed roadway across the valley at the second bridge. After the second bridge roadway barrier is addressed, small-scale, low impact solutions for encouraging channel development processes, such as selective vegetation removal and placement of large woody debris or other bioengineering structures should be examined and implemented if necessary. This approach (opening up the floodplain at the second bridge and assisting in natural channel development) would provide a long-term, sustainable solution for the sedimentation and fish passage issues at the second bridge.

Alternative options for reestablishing channel continuity and reducing sedimentation include dredging or construction of a new channel between the second and third bridges. Both of these options require heavy initial channel disturbance and long-term, routine maintenance. Sediment deposition and channel avulsion/location changes are a natural process in lower Willow Creek, especially with the current high sediment load conditions, and any attempts to keep the channel in a stable location will require regular upkeep. Further current environmental regulations, including the state and federal Clean Water and Endangered Species Acts and the Coastal Zone Management Act, would probably prevent the selection of either of these options, particularly dredging.

Fisheries Decline

Today across California, wild stocks of coho salmon and steelhead have declined or disappeared from all streams for which data exist, and Willow Creek is no exception. Reasons for the decline of anadromous fish populations in California include loss of habitat above dams or other migration barriers, habitat degradation from channel response to land use activities (sedimentation, loss of canopy and instream woody debris, changes in water quality, and reductions in

streamflow), breakdown of genetic integrity of wild stocks, introduced diseases, and over-harvesting.

Coho salmon spend their adult life in the ocean, migrate up freshwater streams to spawn, rear at least partially in freshwater, and migrate to the ocean as juveniles. Unlike other Pacific salmon in California, their reproductive strategy is completed over a three-year cycle and is fairly rigid. Spawning years with relatively poor reproductive success can result in poor spawning runs three years later. Adult coho start to arrive at spawning grounds in late summer and fall to begin acclimation to freshwater before they migrate upstream. Upstream migration is usually triggered by an increase in flow from a winter storm event. The spawning period in creeks occurs between late October and early February. Coho die soon after spawning. Juvenile coho emerge from the gravel the following spring and usually rear in the stream for one year before migrating to the ocean.

Steelhead, an anadromous form of rainbow trout, usually spend one to three years in the ocean before returning to spawn for the first time. Steelhead are more flexible in their life cycle requirements than other anadromous salmonids in that they may survive spawning, return to the ocean, and spawn again in a later year. Their variable life history, ability to utilize both pool and fast water habitat types for rearing, ability to spawn multiple times, and tolerance of warmer water temperatures enable them to be more resilient than coho to adverse environmental conditions. steelhead typically migrate upstream in the Russian River basin beginning in mid-December and continuing through mid-April. In California, juvenile steelhead generally spend one to three years in freshwater before migrating to the ocean, usually between March and June.

The basic habitat needs of coho and steelhead are similar in that they both require clean spawning substrate ranging in size from 0.8 to 4.5 cm, clean water in the temperature range of 12° to 16° C (with steelhead able to withstand warmer temperatures than coho), adequate food and nutrients for juvenile growth, cover for resting and safety from predators, and unimpeded migration routes. However, steelhead and coho use different instream habitats during successive life stages, indicating distinct survival strategies. While in the stream, juvenile coho often occupy sheltered habitat at the heads of pools, which generally provides an optimum mix of high food availability and good cover with low swimming cost. Young-of-the-year steelhead often utilize riffle and run habitat during the growing season and move to deeper, slower water habitat during the high flow months. Larger steelhead, usually yearlings or older, have been observed using heads of pools for feeding. In these ways, steelhead are more habitat generalists than coho.

Population Behavior

Fisheries population surveys in 1962, 1963, and 1965 documented coho salmon and steelhead throughout the mid-lower, mid, and upper sections of Willow Creek (up to the rock falls) in schools of fifteen to twenty in each pool (CDFG 1995:8). Subsequent surveys indicate a steady decline in population density,

especially of coho salmon. In 1990 seventeen coho were detected in the upper watershed (MRC 2001). Given the 3-year life history of this species, individuals would have been expected to return in 1993, yet none were detected. By 1994, only two coho could be found in the mainstem, and the last coho seen in the watershed was in September 1995.

Steelhead populations began declining precipitously in the late 1960s and 1970s but seem to have stabilized in the early 1990s. Louisiana Pacific calculated the density of steelhead juveniles in the upper reaches of Willow Creek, and during the period 1990-1994 the numbers of individuals per meter^2 in any given year range from 0.1 to 0.6 (MRC 2001). Attempts to boost the salmonid populations in Willow Creek were made by releasing hatchery fingerlings in 1963, 1973 (coho - 6,840 and 10,007, respectively), and 1984 (steelhead - 20,160). Subsequent population surveys do not indicate that the releases were effective.

Concurrent with the population surveys, stream inventories assessing key habitat features were performed. These studies along with other assessments of historic land use practices, sediment supply and deposition, large woody debris, and channel morphology provide some clues to the disappearance of anadromous salmonids in the Willow Creek watershed. These limiting habitat factors are discussed below.

Habitat Factors

Anadromous steelhead and coho salmon have specific habitat requirements for each of their lifestages (i.e. clean, well-aerated gravels for spawning and hatching; deep, well-shaded pools for rearing and resting; and unimpeded channels for migration). Other requirements include adequate supplies of cool, clean, oxygenated water and food. Degradation of one or more of the salmonid habitat factors can lead to population stress and eventual localized extinction.

Barriers to Migration

Severe channel aggradation in lower Willow Creek around the second bridge has led to historic-channel abandonment and loss of channel continuity, as described in the previous section on sedimentation in lower Willow Creek. The bermed roadway across the floodplain at the second bridge acts as a low-head dam, trapping streamflow and sediment and restricting fish passage upstream and downstream during summer and winter base-flow conditions. Culverts are blocked and buried. During annual high flows the streamflow slows and spreads across the floodplain and the roadway at the second bridge, reducing attraction flows and upstream passage for salmonid migration.

Loss of channel capacity and form presently occurs halfway between the second and third bridges, as rapid aggradation continues to fill the channel in an upstream direction. Where the historic channel has filled in, streamflow and sediment now sheet across the floodplain. With no continuous, defined channel in this reach upstream migration by adults may be restricted, and downstream migration by juveniles is definitely restricted.

Degraded Spawning Beds

Fine sediment production from gully development, landslides, and road-related erosion has caused high sediment loads to enter the stream network. This sediment has affected the location, number, function, and sediment size distribution of channel features vital to salmonids. Since the 1950s, pools have shrunk in size and number, and the riffles have become embedded with fine sediment. The degree to which the pool tails and riffles are embedded decreases as one moves up the watershed. For example, in lower Willow Creek between the second bridge and Pomo Creek, 93% of pool tails are highly embedded and of very poor habitat quality, while in the middle, upper reach upstream of the hunting camp, 24% of pool tails are highly embedded (CDFG 2000).

These longitudinal differences in fine sediment incursion are attributed to increasing gradients, which help flush fines from the cobble/gravel substrate. Fine sediment within the pool tails and riffle locations provides poor spawning habitat, as the fine material smothers eggs and emergent fry. Substrate samples taken in 1995 show that fine sediment levels (<0.85mm) ranged from 18 to 20% throughout the watershed (CDFG 2000:8). The mean egg-to-emergence survival rate was calculated with this data using the Fredle Index. It was estimated that steelhead survival rate is 24%, while the rate for coho salmon is only 2.2% (CDFG 2000:13). In general, there is a high level of spawning gravel in the upper reaches of Willow Creek; however, spawning habitat is limited by the prevalence of fine sediment (MRC 2001:F-14).

Reduced Rearing Habitat

In the 1960s, pool habitat was described as good to excellent, with many large pools of two feet or more in depth and good shelter from logjams and undercut banks. Later surveys indicate that pool habitat and shelter ratings declined significantly [or were reclassified] (CDFG 1995). Pools comprise 29% of the total stream survey length in Willow Creek. The ideal percentage of pools for Willow Creek is unknown, however in coastal creeks in Washington State it is suggested the percentage should be at least 40-55% pools depending on stream gradient (www.krisweb.com, citing Washington State Fish and Wildlife Commission (1997)). Only 28% of the pools in Willow Creek are greater than two feet deep (CDFG 1995). Pool depth is important for providing habitat space and avoidance of predators, and coho salmon need deep pools (at least 3 feet) to successfully rear (Brown, et al., 1994).

In 1995, CDFG assessed fish cover (instream woody debris, overhanging banks, bankside root mass) in Willow Creek with a shelter rating. Scores for the shelter rating can range from 0 to 300, with scores less than 100 indicating a need for enhancement. Willow Creek has a low score, with a mean shelter rating for pools of 22-48 and lower scores for flatwater units (CDFG 1995).

The limiting parameters for summer rearing habitat, as well as overwintering habitat, are identified as high influx of sediment and the lack of large wood and deep pools (MRC 2001:F-15). The factors contributing to high rates of sediment influx and deposition in the mainstem and fish-bearing tributaries has been

thoroughly discussed previously. Large woody material or "debris" (LWD) is widely recognized as a vital component of high quality habitat for anadromous fish and an important part of the aquatic ecosystem—providing an organic energy source for aquatic organisms, cover for juvenile fish, a control for the routing of sediment through stream systems, and structure to the streambed and banks (MRC 2001:D-1, citing Bisson, et. al., 1978; Swanson and Lienkaemper 1978; Bilby and Likens 1979). In steep and/or incised channels like Willow Creek, LWD provides one of the few mechanisms for channel habitat (pool, riffle) development and maintenance. All channel segments in areas studied in Willow Creek indicate a need for large woody material, especially key pieces. Key LWD pieces are qualified by their size and stream channel width to provide key functions of channel shape and maintenance. The optimal number of key LWD pieces is 4.9 per 100 meters; Willow Creek only ranges between 1 and 4 pieces (MRC 2001).

Low Food Source

Biological metric values (a measure of the benthic macroinvertebrate community) were found to be notably lower than normal in Willow Creek during 1995-1997 (Harrington et al., 1999). Macroinvertebrates are the primary food source for salmonids during all life stages. The low biologic metric values may indicate impaired habitat and food production conditions within the Willow Creek watershed.

Recommendations

Restoration of steelhead and salmon populations to Willow Creek is not possible unless wide-scale habitat improvements occur. Reducing the volume of fine material entering the system and being transported downstream is an important factor for habitat recovery. See the recommendations for sediment management in the previous section for details. Sediment reduction will, over the long term, slow aggradation and advance channel forming processes in lower Willow Creek, improve sediment distribution in upper watershed spawning gravels, and allow pool development and maintenance to recur throughout the watershed.

Additionally, barriers to upstream and downstream migration must be mitigated by removing or altering the design of the second bridge to allow channel forming processes to occur. The primary factors contributing to obstruction of upstream adult and downstream juvenile migration are the rapid sediment aggradation, widespread flow distribution, and channel disconnection at lower flows. These problems will continue without substantial changes to the bermed roadway at the second bridge.

Large woody debris is needed in the system for development and maintenance of rearing habitat (pools) and spawning gravels (riffles). There is limited supply of large diameter, riparian redwood and Douglas fir in the watershed. Thus, in addition to promoting growth of conifers in the riparian zone for later in-channel recruitment, it may be necessary to plant LWD throughout the watershed.

Limitations in Restoration Potential

Efforts to restore physical processes can be expected to improve habitat function in the Willow Creek watershed. However, management planning must recognize that restoration to a prehistoric condition is not possible because significant elements and processes have been lost and cannot be recovered. Changes in the climate, disturbance regime, land use practices, introduction of exotic species, and extirpation of native species have altered formative processes and function of species-habitat relationships.

Climate Change

In prehistoric, post-glacial Willow Creek, much of the watershed would have supported a range of age classes of forest, dominated by late-seral, old growth redwood forest. These late-seral redwood stands were established under a climate regime different from today's climate. For instance, atmospheric carbon levels are far greater than in prehistory. Various research also suggests that the average rainy season has compressed from an early fall through late spring cycle to a dominantly winter precipitation cycle. In addition to macro-climate differences, micro-climate variations associated with the fog collection and other self-perpetuating moisture cycling functions unique to old growth redwood forest would likely have been present in prehistoric Willow Creek. These processes cannot be re-established.

Irreversible Landscape Changes

Native American management influence on the Willow Creek watershed was characterized significantly by their use of fire. We still lack definitive understanding of the frequency, intensity, and cumulative effects of this management strategy on the landscape. It will not be possible to identify or duplicate the fire patterns used by Native Americans.

The effects of Native American prescribed fire practices cannot be replicated today due to changes in species composition, particularly the introduction of invasive exotic plant species into grassland vegetation types. While control of some invasive exotic plant species is possible, others will persist as part of the current vegetation composition indefinitely.

The logging of old growth forests by European settlers is also significant in this sense. We can enrich existing second and third growth forest stands in an effort to achieve many of the functions of old growth forests. The achievement of climax communities comparable to those that occurred prior to European settlement will take generations to develop.

Species Loss

Changes in climate and land use have altered the capacity of the landscape to support prehistoric vegetation types, reflected in the current distribution, composition, and structure of habitat types in Willow Creek today. Flying squirrel, red tree vole, fisher, marten, and steelhead and coho salmon are all examples of species populations that have been extirpated or reduced from the

watershed due to habitat loss and associated cumulative watershed effects. Grizzly, wolf, black bear, elk, and antelope are all examples of animal populations that have been extirpated or reduced from the watershed due to external pressures (e.g., hunting, regional habitat loss).

All of the above animal populations played a critical role in landscape and / or watershed processes. A notable example is the nutrient cycling facilitated by the life cycle of anadromous salmonids. The return of adult salmonids to their native streams would have resulted in thousands of salmonid carcasses in the Willow Creek watershed which were consumed by various organisms (among them, the now extirpated grizzly bear), ultimately constituting a nutrient input of large proportions throughout the watershed. The consequences of loosing these fish runs is poorly understood, but they may include significant influences on ecosystem productivity. Further gaps in ecosystem function can be avoided through the protection of threatened populations (northern spotted owl, marbled murrelet, and others).

CHAPTER 5: WATERSHED ENHANCEMENT PROJECTS

Introduction

Future management of Willow Creek watershed should take into consideration the consequence of actions on the physical landscape, habitats, and natural processes. The adoption of this perspective is in response to the consequences of past land use decisions, altered habitats, and extirpated and depleted species. This plan recognizes that each landowner within the Willow Creek watershed has their own specific goals and objectives for the management of their property, including uses such as conservation, ranching, logging, residential, and recreation. Unfortunately, the recognition and implementation of considerate land use management strategies alone may not restore proper function to Willow Creek watershed within our lifetimes. However, the treatments, repairs, or removal of legacy land use features and the restoration of altered habitats will improve the rate of recovery for the Willow Creek watershed.

As discussed in Chapter 4, a number of issues of environmental concern have been identified for the Willow Creek watershed, including alterations to the sediment production and transport regime, landscape, and habitats, and, in particular, fisheries decline. A list of proposed watershed assessment and enhancement projects was developed to pursue the recommendations outlined in Chapter 4 and support the watershed enhancement goals stated in Chapter 2. Individual projects fall under one of four project categories:

- Baseline surveys
- Priority implementation projects
- Ongoing resource preservation activities
- Adaptive watershed restoration projects

Each issue of concern, as laid out in Chapter 4, is addressed by a combination of projects. Baseline surveys are suggested where there is a lack of sufficient data to design and implement specific restoration activities. Priority implementation projects have sufficient background data to move forward with on-the-ground restoration projects and are focused on treating critical issues. Ongoing resource preservation activities may occur routinely and are expected to maintain and improve healthy watershed conditions through a long-term process. Adaptive watershed restoration projects may be considered for restoration/enhancement projects in the future after the completion of the baseline surveys and priority projects, or as additional information and needs arise.

Baseline Surveys

The following surveys and data are needed to complete the watershed inventory and provide guidance for future watershed enhancement and implementation projects.

Inventory of Skid Trails

Legacy skid trails are contributors of sediment to Willow Creek. A thorough inventory of legacy skid trails is needed to assess the impacts of this sediment source and to provide for future treatment of priority locations.

Inventories of Tributaries and Gullies

First order tributaries, forest gullies, and grassland gullies are contributors of sediment to Willow Creek. A thorough inventory of these features is needed to assess the current activity and impacts of these sediment sources and to provide information on treatment options and prioritization of erosion stabilization sites.

Survey of Cultural/Historical Elements

A thorough cultural baseline assessment is lacking in Willow Creek, particularly in the upper watershed. The histories of Native American, Russian, and early European settlement within Willow Creek are not fully known at this time. Identifying cultural elements is a critical step in preserving our historic and cultural literacy and avoiding degradation of these important resources.

Population and Distribution of Listed Species

Scale and accuracy of current listed species distribution records are insufficient for project-level management, with the exception of Northern Spotted Owl data. Steelhead are known to inhabit Willow Creek, but the extent and timing of their distribution is dependent on very limited passage at the second bridge and seasonal flow regime. Surveys of all other listed species has been limited to project-level review. Greater extent and intensity of surveying is suggested for comprehensive management of listed species in the watershed.

Extent and Condition of Native Grasslands

Excellent examples of coastal prairie exist scattered throughout the Willow Creek watershed. Comprehensive analysis of the locations and quality of these grasslands should be conducted.

Extent and Condition of Wetland Areas

Wetlands are key to watershed function and are acknowledged as significant habitats within the landscape. Identification of location and condition of wetland areas will allow for improved restoration project design for the improvement of overall watershed function. Delineation of wetlands is a project element required by the U.S. Army Corps of Engineers, California Coastal Commission, and the California Department of Fish and Game.

Forest Compositional and Structural Elements

Comprehensive assessment of forest compositional and structural elements as they relate to habitat values is lacking in the lower portion of Willow Creek watershed. Assessment of these elements may assist in naturalization strategies for these forest stands and improved development of late-seral forest habitats.

Census of Invasive Plant Species

Currently, State Parks manages a Geographic Information System (GIS) database of locations and treatments of invasive plant species in the lower portion of Willow Creek watershed. Invasive plant populations in the remainder of the watershed should be characterized and mapped.

Natural Disturbance Regime Data

The natural frequency of fire, flood, and slope failure and other disturbances for the landscape types found in Willow Creek watershed are not sufficiently understood at this time. Mapping landscape conditions through time will assist in making improved land management decisions, such as frequency of prescribed fire, forest management actions, bridge, culvert and road design, grazing regimes and fuel modification for protection of structures.

Priority Watershed Implementation Projects

Modify the Second Bridge to Provide for Channel-forming Processes

Significant improvement of channel-forming processes at the current Willow Creek Road crossing at the second bridge is a top priority. To promote channel forming processes and provide for long-term fish passage it is necessary to remove the bermed roadway across the channel at the second bridge location. Three alternatives have been identified. Each alternative is expected to improve fish passage, although costs, lifespan, and impacts of each option vary.

The first alternative involves removal of the second bridge and rerouting Willow Creek Road on the north side of valley. This is the preferred alternative for short-term and long-term channel development and maintenance. It will allow natural channel-forming processes to occur, providing fish passage and promoting riparian habitat development. This treatment is expected to have high initial impacts (associated with building a new road), however compared to the other options it will have increased long-term habitat value and sustainability, as well as a lower overall cost.

The second alternative is the construction of a raised causeway within or adjacent to the alignment of the existing second bridge. This treatment is expected to have greater overall costs associated with bridge and roadway design, construction, and maintenance. Long-term lifespan and sustainability is not as high as the preferred alternative, especially when the sedimentation issues with the third bridge are considered.

The third alternative is a modification of alternative #2. This treatment entails replacing the existing culverts in the bermed roadway with larger culverts or a small bridge. The modifications would need to change the current configuration of the roadway and provide passage for the channel-forming discharge. This treatment would incur high initial costs, would require ongoing maintenance, and has a limited lifespan dependent upon sediment deposition and channel dynamics.

Following implementation of the preferred treatment at the second bridge, evaluation of channel function is recommended. Potential channel enhancements could follow this evaluation as needed to improve riparian habitat and fish passage. After a number of seasonal channel-forming discharges have occurred, an evaluation of channel development and the potential for enhancing channel form and sediment transport should be conducted (see discussion under adaptive watershed restoration program below).

Upgrade Roads

Below-standard roads deliver a significant quantity of sediment into associated creeks every year. This high rate of road-related erosion is a critical impact on creek function and a major limiting factor for fish habitat and passage in the lower portion of the watershed. Upgrading current and future roads to meet hydrologic and sediment reduction goals is a high priority for Willow Creek watershed management. Following road upgrades, routine monitoring should be conducted to assure that roads are maintained at acceptable standards. Figure 8 maps roads and trails and indicates road problem locations, and Figure 9 shows priority road treatment locations.

Decommission Legacy Logging Roads

Data indicate that legacy logging roads deliver a significant quantity of sediment into associated creeks every year. This high rate of road-related erosion is a critical impact on creek function and a major limiting factor for fish habitat and passage in the lower portion of the watershed. Legacy logging roads that no longer serve a practical use or that cannot feasibly be upgraded for use due to site location on unstable and steeply sloped terrain should be decommissioned to the extent possible. Decommissioning legacy logging roads could potentially provide additional watershed benefits, such as reducing risk of slope failure, limiting weed introduction vectors, increased public safety, and re-establishing important habitat linkages and terrestrial wildlife corridors.

To the greatest extent possible, decommissioning of legacy logging roads on State Parks' land should involve fully re-contouring the entire length of the roads. Full re-contouring involves replacing the cut material in the roadbed, contouring the resultant slope to match existing, re-connecting channel beds, and promoting native vegetation re-establishment. This treatment option also involves monitoring and maintenance to ensure that short-term impacts to wildlife in the construction phase are minimized, invasive weeds are not established, and sediment is not mobilized from the soil disturbed in the process of re-contouring.

Other decommissioning treatments include outsloping existing roads, and treating hydrologically active problem areas as needed and with appropriate methodologies. These improvements are less costly, however they do not provide the same degree of benefits, such as: the limitation of weed introduction vectors, increased public safety and recreational values, and re-establishment of important habitat linkages and terrestrial wildlife.

Place Large Woody Debris in Deficient Stream Reaches

Stream channel complexity, fish habitat values, and sediment storage capacity will be improved through the appropriate placement of large wood in stream reaches noted as deficient.

Reconnect Springs Bisected by Roads

In lower Willow Creek, springs that are currently routed to inboard ditches along the roads can be brought back into their historic alignments, reconnecting these water sources to the main creek channels. Reconnecting spring-fed tributaries will increase base flows and decrease water temperature in mainstem Willow Creek.

Remove Portions of Existing Cross-fencing

Fencing limits wildlife movement and degrades overall recreational and scenic values of Willow Creek. Needless portions of cross-fencing can be removed to improve habitat and park values within areas no longer requiring fencing.

Ongoing Resource Preservation Activities

Control Invasive Plant Species

Consideration will be given to managing invasive species that have, or potentially could have, a substantial impact on the watershed and that can reasonably be expected to be successfully controllable. Currently, known invasive species problems are limited to exotic plants.

Current priority invasive plant control issues include Cape ivy *(Delairea odorata)* at the confluence of Willow Creek and Russian River; pampas grass *(Cortaderia jubata)* and French broom (*Genista monspessulana*) on slopes of lower valley; hemlock (*Conium maculatum*) and fennel (*Foeniculum vulgare*) creeping from road margins into wetlands; biddy-biddy (*Acaena* sp.) along County road margins; Canada thistle (*Cirsium arvense*) in the floodplain; purple starthistle (*Centaurea calcitrapa*) recently established on northern ridges (introduced in feed); Italian thistle *(Carduus pycnocephalus)* in grassland habitats; and *Cortaderia jubata* and Harding grass (*Phalaris aquatica*) along logging roads, landings, and other disturbed sites throughout the watershed.

Maintain Roads, Trails, and Other Facilities

Facilities that have the potential to deliver sediment to the stream network should be maintained in good working order. Road and trail surfaces should be surfaced appropriately. Culverts and bridges should be inspected throughout the rainy season and maintained as needed.

Recruit Large Woody Debris in Deficient Stream Reaches

The availability of large woody debris for recruitment to the stream channel is linked to the presence of large trees within the riparian area. In areas where stream reaches have been identified as deficient in large wood, riparian forests will be evaluated for potential improvements. Treatment options range from planting trees along stream banks in areas with few trees to thinning riparian

areas overstocked with trees (for release of conifers). Stream channel complexity, fish habitat values, and sediment storage capacity will ultimately be improved through the recruitment of large woody debris.

Monitoring

Existing monitoring efforts should be expanded to include identified significant biotic and abiotic indicators of watershed function and should include, but not be limited to, the following:

- Fluvial geomorphology
- Aquatic organisms
- Erosion and sedimentation locations and rates
- Water quality
- Listed species
- Vegetative succession
- Invasive species
- Post-project monitoring

Monitoring should include the use of volunteers, staff, consulting professionals, and other members of the community in quantitative methods and photo monitoring through future established photo points.

Maintain Coastal Prairies and Native Grasslands

Using data from analysis of the extent and condition of native grasslands in Willow Creek watershed, resource management activities should strive to protect and maintain areas of coastal prairie. The primary means of protecting grassland areas is by limiting invading successional shrubs and trees. Benefits of grassland maintenance include habitat preservation and fuels management.

Treatment options include mechanical and/or prescribed fire. Open areas dominated by non-native grasses will be managed for recreation and forage. Transitions between forested and open habitats will be assessed in an effort to enhance mosaic and edge values.

Forest Stand Naturalization

Management for forest stand diversity will be inclusive of redwood, Douglas fir, riparian, and coastal broadleaf forest types, with methodologies specific to each vegetation type. Forest stand naturalization will promote late-seral conditions and diversity of structural and compositional elements and age classes. Goals include increasing the average basal area/acre, increasing canopy layering, increasing average tree height, increasing average tree age, decreasing stems/acre, and decreasing length of roads/acre.

Prioritization of management locations should consider proximity to stream segments deficient in large woody debris and forest stands lacking structural and compositional diversity.

Adaptive Watershed Restoration Projects

Enhance Lower Willow Creek Channel

Currently, the road design and aggraded channel of lower Willow Creek limit salmonid migration and provide poor habitat values. Following the priority implementation projects described in this plan, particularly modification of the second bridge to provide for channel-forming processes, treatment needs for enhancement of channel-forming processes in lower Willow Creek should be assessed.

Modify the Third Bridge to Provide for Channel-forming Processes

Data suggest that the same suite of issues currently created by the restriction of the second bridge over Willow Creek will ultimately become evident at the third bridge as well. Watershed planning should monitor and provide for a potential treatment of sediment accumulation under the third bridge.

Assess Potential Participation in Captive Brood Stock Fisheries Program

The position and status of the Willow Creek watershed within the Russian River basin makes it a potential candidate for future participation in the Department of Fish and Game captive brood stock fisheries program, as noted in the *Russian River Basin Plan*. Following primary projects described in this plan, particularly improvement of fish passage and channel-forming processes, this potential should be assessed.

Priority Projects

The matrix below describes State Parks' priorities and timeline for the projects described in this chapter. Other landowners may have different priorities.

Primary Watershed Restoration Projects		
Priority	*Project*	*Timeline*
1	Modify the second bridge to provide for channel-forming processes	
2	Upgrade roads	2005
2	Decommission legacy logging roads	2005 - 2010
3	Place large woody debris in deficient stream reaches	2006 - 2010
4	Reconnect springs bisected by roads	
5	Remove portions of existing cross-fencing	

Ongoing Resource Preservation Projects			
Priority	*Project*		
1	Control invasive plant species		
1	Maintain roads, trails and other facilities		
2	Monitoring		
3	Maintain coastal prairies		
3	Forest stand naturalization		
3	Recruit large woody debris in deficient stream reaches		

Adaptive Watershed Restoration Projects			
Priority	*Project*		
	Enhance lower Willow Creek channel		
	Modify the third bridge to provide for channel-forming processes		
	Assess potential for participation in captive brood stock fisheries program		

Regulatory Framework

Implementation of the *Willow Creek Watershed Management Plan* projects described in this chapter is contingent upon compliance with regulatory mandates.

The California Environmental Quality Act (CEQA) establishes the environmental policy for the State of California. CEQA is designed to disclose potential environmental impacts and to require decision makers to consider the environmental implications of their actions in order to avoid or reduce impacts if feasible. The environmental review process also provides an important opportunity for public participation in the decision making process.

Beyond CEQA, several other permits and review may be required before implementation of a project within Willow Creek watershed, including, but not limited to:

- PRC § 5024 (historic resource disclosure) clearance.
- Coastal Act or Sonoma County Local Coastal Program review.
- State and federal Endangered Species Acts review.
- Fish and Game Code §1602 Streambed Alteration Agreement from Department of Fish and Game.
- Clean Water Act §401 Water Quality Certification from the North Coast Regional Water Quality Control Board.
- California Clean Water Act (Porter-Cologne) Waste Discharge Requirements.

- Clean Water Act §404 U.S. Army permit or concurrence for use of Nationwide Permit(s).
- Clean Water Act §404 U.S. Army wetlands review process, which may run concurrently with, sequential to, or as part of the CEQA review.
- County of Sonoma, Permit and Resource Management Division review.

Public Information, Education, and Outreach

Funding received in 2001 from Proposition 13, the Russian River Watershed Council, and the City of Santa Rosa was used by Stewards to develop two new public outreach programs in Willow Creek, the Willow Creek Watershed Education Program and the Citizen Action Team (CAT), and a large, two-sided, interpretive panel at Pomo Canyon Campground that provides important watershed information. The Willow Creek Education Program is a curriculum-based program for 6th-12th graders to learn about watershed values through hands-on activities. Students are introduced to the Willow Creek watershed first during a classroom visit by docents who prepare them for the concepts they will learn about during their site visit.

Stewards secured a contract with MRC to conduct the education program on their property, which is located near what is called the "Hunting Camp." Students learn about erosion and what land use practices and elements in the watershed cause erosion and sediment delivery to the stream, as well as how sediment in the creek affects fish and other aquatic life. They are shown how to assess the degree of sedimentation in the creek and how to evaluate the stream's health by assessing the macro-invertebrates that inhabit the creek.

Students also have the opportunity to work on restoration projects that affect healthy changes in the watershed using a service-learning model. They are encouraged to disseminate information about Willow Creek or their own watershed through presentations at community events. Finally, the goal is to provide time for reflection on the value of their work for the environment, for their community, and for themselves.

The CAT was formed simultaneously with the education program. CAT volunteers are trained to conduct water quality monitoring at three different locations in the watershed. They measure pH, dissolved oxygen, temperature, turbidity, conductivity, and ammonia. Baseline data is being collected at the 1st bridge, the confluence of Willow Creek and the Russian River, near Pomo Canyon Campground, at the 3rd bridge, and at the Hunting Camp bridge. A volunteer who is a professional with the Sonoma County Water Agency has assisted CAT members with standard operating procedures and equipment training.

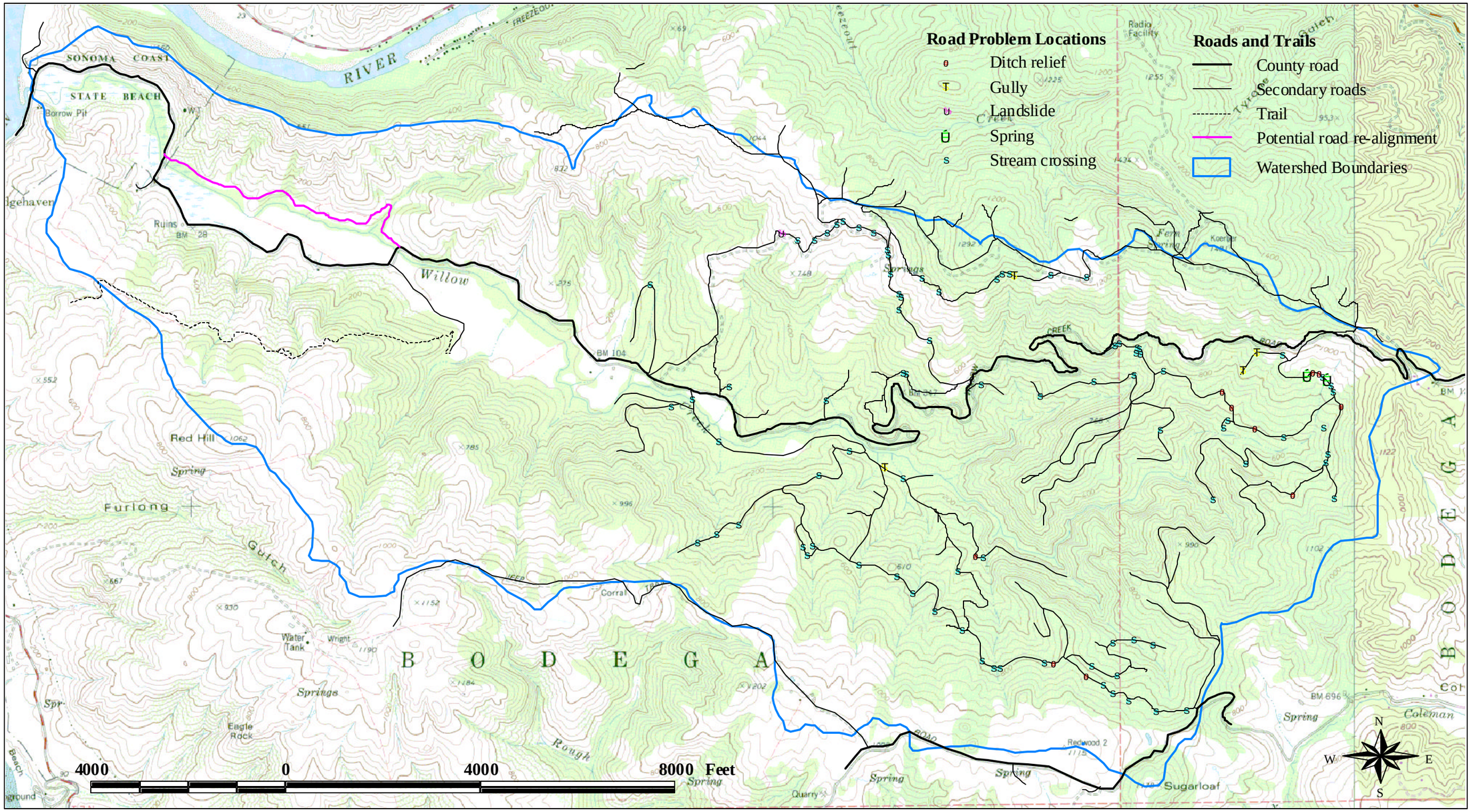
Stewards has developed a partnership with the Community Clean Water Institute (CCWI) in Occidental and with LandPaths in Santa Rosa. The goal of this partnership is to enhance training opportunities and to eliminate any duplication of efforts in providing monitoring in the lower Russian River watershed. The CAT will provide an essential volunteer service for all future

restoration efforts that require monitoring as a way to evaluate work being done through grant funding.

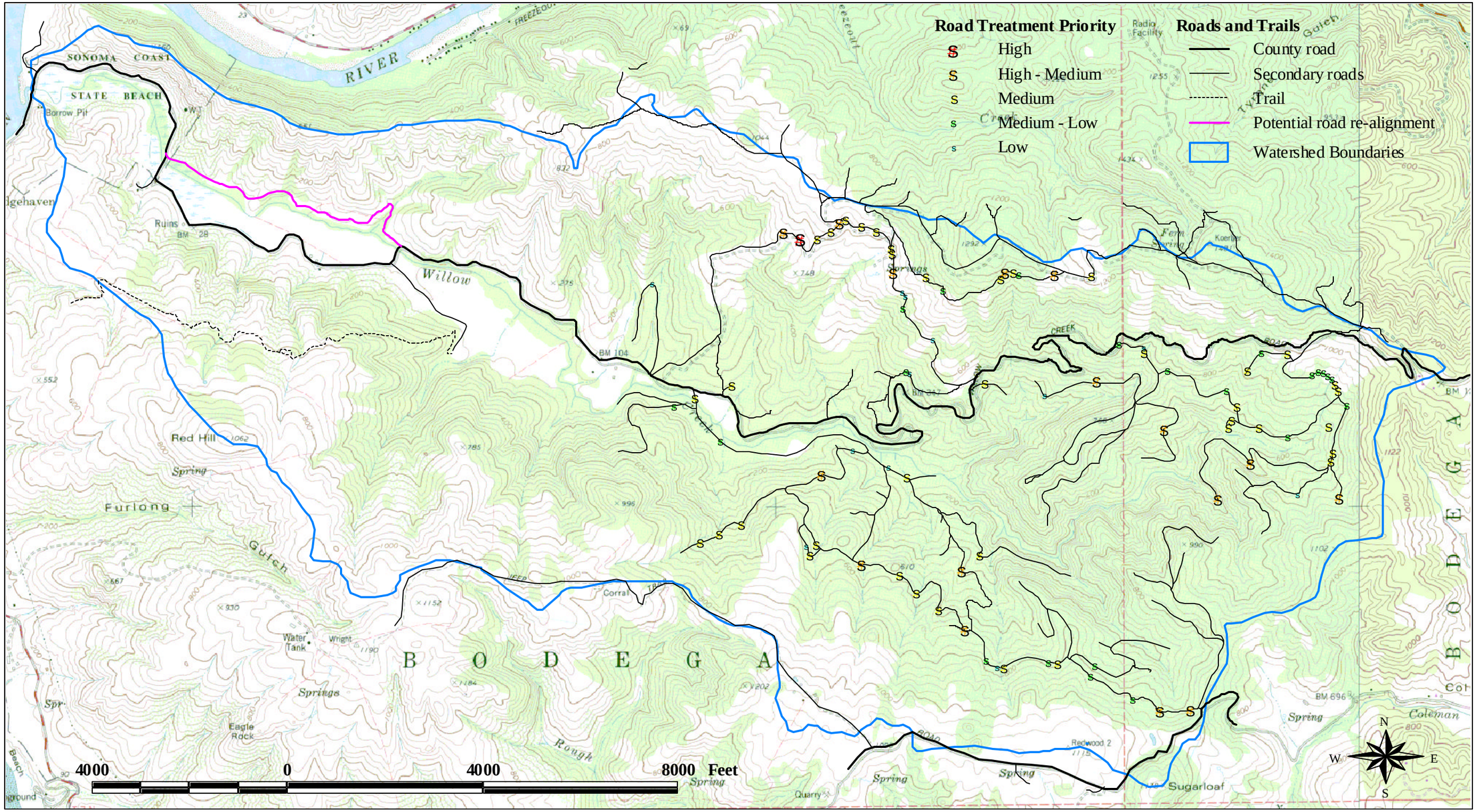
Implementation Strategy

In order to maintain the continuity that has occurred during the past three years as the *Willow Creek Watershed Management Plan* was being developed, the following is recommended:

- The Willow Creek Technical Advisory Committee (TAC) should continue to be available to evaluate and monitor watershed restoration activities as needed.
- Public comments will be heard and taken into consideration during restoration efforts.
- Any new reports developed for Willow Creek should be incorporated into the *Watershed Management Plan* and added to the list of existing documents.
- Copies of pertinent information regarding Willow Creek will to be kept by Stewards of the Coast and Redwoods. Stewards is responsible for keeping the *Watershed Management Plan* up-to-date and for making all information available on their website.
- Information pertaining to Willow Creek should be added to the Russian River Interactive Information System (RRIIS).
- Stewards will continue to support educational opportunities within the watershed, including docent-led programs for adults and school groups.
- The CAT will continue to monitor and work on restoration activities in the watershed.



Willow Creek Watershed Management Plan: Road Problem Locations	**Figure 8**



Willow Creek Watershed Management Plan: Priority Road Treatment Locations	**Figure 9**

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APPENDIX 1: 2004 PUBLIC COMMENTS

2004 Public Scoping Meeting and Public Comment

Compiled by Michele Luna, Executive Director
Stewards of the Coast and Redwoods

Through the process of developing a watershed plan for Willow Creek there have been opportunities for the public to provide input. The first public meeting was held on January 29, 2004. Approximately 35 participants used post-its to record their input on flips charts about a variety of watershed issues. A survey was also developed and it was publicized as being available on Stewards' website as another vehicle for public comment. A deadline of May 1, 2004 was given for returning the surveys. Six surveys were returned. The following is a summary derived from the raw data collected at the public meeting and the returned surveys with an indication as to who or how each issue will be followed-up with.

1. Land Use: Recreation and Public Access
   A. Hiking: All nine respondents were in favor of hiking trails in the Willow Creek watershed. There was concern expressed about keeping the area as "wild" as possible and limiting hiking access to a large loop trail. Creating a linkage to Coleman Valley Road was mentioned by two people.
   Refer to Sonoma Coast General Plan process.

   B. Biking: Of the fourteen comments that were received about biking in Willow Creek, seven were favorable and four were negative for this recreational activity. Two people wanted bikers to stay on the logging roads or the County road only. One person was very opposed to single track trails and noted damage caused by skidding on downhill trail sections, causing erosion. Two people used Annadel State Park has an example, one thought it was a good example to replicate as far as multi-use trails and another was opposed to this type of arrangement. Concern was expressed about Sudden Oak Death and being aware of the spread of this pathogen by way of hikers and bikers.
   Refer to Sonoma Coast General Plan process.

   C. Equestrian: There were fourteen varied comments regarding equestrian use. Four people were completely opposed and five noted limited use to only certain types of trails and stable land in the lower watershed. One person was interested in additional trails and more places to enter the area and park horse trailers. Another person suggested that users should ride in only and there be no parking lots for horse trailers. Areas of concern included compaction of soil and sudden oak death. Similar comments regarding Annadel State Park were noted, two to use Annadel as an example of good multi-use access, and the other to not let Willow Creek become like Annadel or Armstrong / Austin Creek.
   Refer to Sonoma Coast General Plan process.

   D. Birding: There were very few comments regarding birding and no one was opposed. A suggestion was made to review Louisiana Pacific and

MRC biological resource elements and NSO no take certificates contained in all past THP's.
Refer to Sonoma Coast General Plan process.

E. Fishing: There was consensus between three respondents not to allow fishing in Willow Creek. There was a suggestion to do annually data/stream surveys to determine if fish runs are improving.
Refer to Sonoma Coast General Plan process and address in Watershed Plan.

F. Camping: Eight people responded to this topic with two being opposed to any camping, two being in favor, and four being in favor of limited camping. Limitations included only allowing camping in State Park campgrounds and making them walk-in facilities.
Refer to Sonoma Coast General Plan process.

G. Other Land Use: Recreation and Public Access: The most prevalent comment had to do with dog access. Of the five people who commented, 3 wanted dogs allowed on leash, and two didn't want any dogs allowed. Three respondents requested no ATV access and there were suggestions made by a couple people about letting the land recover without any car and foot access. Conversely, other survey participants wanted there to be opportunities for low impact, low intensity recreational uses and both car and foot access. Suggested interpretive experiences included star gazing, wildflower walks and butterfly and dragonfly watching. One person wanted the property 1 mile east of the Poindexter Range to become State Park land (hunting camp). Finally, there was a comment about not allowing dumping.
Refer to Sonoma Coast General Plan process.

2. Land Use: Agriculture
   A. Timber Management: This topic was commented on by eight participants. Five of the respondents wanted a plan for some type of forest management. Thinning, rather then logging was suggested by most as a way address density issues and to create a healthier mature forest habitat. Repairing and/or decommissioning the old logging roads was also suggested. One person commented that the forest knows how to manage itself without our help.
   To be addressed in Watershed Plan

   B. Grazing: This topic was commented on by twelve participants with only one respondent completely against any type of grazing. Other respondents were open to limited grazing and the need for good management practices. It was noted by a couple people that the current practices need improvement in terms of cattle numbers and the need for additional fencing, especially to keep the cattle out of the creeks. Many respondents wanted a program established to reintroduce native grasses

and wildflowers. It was also noted by a couple people that well managed grasslands can reduce fire hazard. One person suggested introducing Elk. ***Refer to Sonoma Coast General Plan process and address in Watershed Plan.***

C. Other Land Uses: The two comments on this chart had to do with operating a native plant nursery and discontinuing the State Park shooting range and working on lead abatement.
Refer to Sonoma Coast General Plan process.

3, Land Use: Transportation

A. County Road: This was another popular topic for comments with seventeen people responding. Only two people were interested in keeping the road as a public access through to Coleman Valley Road. Many people wanted the county road either phased out all together, limited to only official use, or not paved and through to Occidental. Others wanted limited access for vehicle or bike traffic and some encouraged only access by way of hiking trails. Four respondents commented on 2nd bridge with two wanting it removed all together and two wanting it replaced, one with a causeway and the other with only a summer crossing.
Refer to Sonoma County Public Transportation and address in Watershed Plan.

B. Private Roads: There was one comment about offering expertise and assistance with private roads. ***Refer to Sonoma County Public Transportation.***

C. Parking: There were three parking comments, one to limit parking, two to improve and provide adequate parking. The other comments had to do with car access and the roads again. Three people said no cars, one said to keep roads primitive, and one to convert logging roads to hiking trails.
Refer to Sonoma Coast General Plan process.

D. Land Use: Transportation: Other
There was one comment about limiting the amount of traffic by not developing recreational uses.
Refer to Sonoma Coast General Plan process.

4. Natural Resources: Biological

A. Flora: Five of the eight respondents commented on removal of invasive plant species, some also indicated a need to propagate and encourage diversity of native plants. Protection for listed species populations was also mentioned. It was suggested that a map be developed to show the watershed's original vegetation and that the watershed be managed to re-establish natural or historic fire regimes.
Refer to Sonoma Coast General Plan process.

B. Fauna: A couple people responded to this topic. The need for adequate and intact habitat area and buffers for large fauna like bear and mountain lion was commented. The reintroduction of Elk was also notes as well as the introduction of beaver for stream channel formation.
Address in Watershed Plan.

C. Steelhead and coho: All five respondents wanted to work towards enhancing the fishery. A suggestion was made to enhance August, September, October flow of side tributaries (i.e. near Pomo Campground) with a ridge top pond with a 3-10 acre flow or recyclable 400 watt pump at 6 gpm. It was also suggested that a goal for achieving a certain number of steelhead and coho by 2020 be established. Another suggestion is to make Willow Creek a "coho refugia" with management as a wild resource to help seed other Russian River watersheds and hatch boxes. One person requested no fishing in Willow Creek.
Address in Watershed Plan.

D. Other Species of Concern: Comments included preserving all native species, not forgetting the upland areas, concern for the western pond turtle, and the use of fire as a historic management tool to benefit the watershed and biological components.
Refer to Sonoma Coast General Plan process and address some in Watershed Plan.

5. Natural Resources: Geological
   A. Erosion: There were four respondents who wanted to reduce erosion and suggested limiting vehicle access, the number of cattle and fencing to confine cattle. One person felt there was already a program in place to prevent erosion and limit sedimentation.
   Address in Watershed Plan.

   B. Sedimentation: Comments included continuing to work on sedimentation and repairing levees between 2nd and 3rd bridge to let the old channel to take over and allow flows under 2nd bridge. It was suggested that the increased level would allow cutting of the stream bed around 3rd bridge.
   Address in Watershed Plan.

   C. Other: Preserving the wonderful rock formations on the ridge and providing geologic interpretation along the trails were suggested.
   Refer to Sonoma Coast General Plan process.

6. Natural Resources: Hydrological
   A. Wetlands: It was suggested to make the wetlands a priority and that the cost of dredging would be much less expensive the using the public's money to build a new road from 2nd to 3rd bridge.
   Address in Watershed Plan.

B. Riparian corridor: Respondents wanted preservation, enhancement, maintenance and long-term monitoring of the native flora and fauna in riparian corridor.
Address in Watershed Plan.

C. Water Quality: A long-term monitoring and reporting project was suggested.
Address in Watershed Plan.

D. Other: Someone commented that they hoped the creek would cut a channel and the fish would come back since there is plenty of food (BMI's) available.
Address in Watershed Plan.

7. Cultural Resources
   A. Pre-historic: There was a question about what pre-historic and Native American history existed
   on the property. There were two suggestions for interpretive exhibits, two for an interpretive center, one for a gift shop and one opposed to a gift shop.
   Refer to Sonoma Coast General Plan process.

   B. Historic: It was suggested that there be a Pomo/Miwok demonstration village and native plant and basket exhibits. There was also interest in preserving the Ranches including the Brown/Mann Ranch as a historical point of interest.
   Refer to Sonoma Coast General Plan process.

8. Education and Outreach
   A. School Programs: Of the six respondents, five were very much in favor of continued and enhanced environmental and cultural educational opportunities. It was also suggested that providing opportunities for students to engage in maintenance projects was desirable. One person was concerned about busloads of students visiting the watershed on a regular basis.
   Refer to Sonoma Coast General Plan process and address some in Watershed Plan.

   B. Volunteerism and Monitoring: Respondents wanted there to be continued citizen participation and outreach opportunities in willow creek as a way to spread the good word and accomplish good projects. Relying on nonprofits is necessary with limited state park funds.
   Refer to Sonoma Coast General Plan process and address some in Watershed Plan.

10. Vision for Watershed in 2-5 Years

Respondents envision a watershed where the issue of fish passage has been addressed through the removal or replacement of the culverts near 2nd bridge.

There were suggestions to remove the bridges and to make a wet crossing at 2nd bridge. Restoring a stable stream channel was expressed, and a suggestion to introduce beaver as a way to control the Alder forest and reform the stream channel was offered as an interesting solution. Addressing sedimentation, especially in the upper watershed was also stressed. A number of respondents addressed the issue of removing and/or managing non-native plant species and planting native flora. Interest in designing and managing a multi-use trail system was encouraged and there was interest in discontinuing overnight camping in the watershed. It was also the vision of someone to implement a rating system to show progress over time as well as another suggestion to utilize one organization to coordinate all future planning and management with State Parks in the watershed.
Address in Watershed Plan.

11. Vision for Watershed in 10 Years

In ten years, respondents would like to see a watershed managed with sound ecological restoration and maintenance strategies. This might include taking inventories, studying what natural systems exist and then deciding what needs rehabilitation. Specifically the public wants restored habitat for fish populations, erosion areas fixed, and successfully managed invasive species.

In terms of recreational use there is a disparity of interests. Some people want Willow Creek to stay as wild as possible, with limited infrastructure for recreation. Some don't want overnight camping, others want only walk-in camping, and some would like to see the main road removed or at least not open for public use.

Conversely, some respondents would like to see uses that vary from only hiking to a coastal retreat and conference center. A number of people commented on trails. They want the old logging roads fixed and would like inter-connected trails that go inland to the coast. They want trail staging areas with adequate parking. Another identified need is trail signage so people don't get lost while hiking. Some would like to see picnic areas establised.

Public education was stressed by many. There is interest in having interpretive signage along the trails to identify flora. Respondents wanted there to be a large volunteer base to help with trails, restoration and interpretation efforts. There is also interest in having equestrian and mountain bike assistance units for safety and rescue.

One person wanted Off Road Vehicle (ORV) use and one definitely did not.
Address in Watershed Plan.

12. Vision for Watershed in 50 Years

Many of the same comments were mentioned for the 50 year vision; however the overall theme was more conservative in terms of uses. The following is a picture of what respondents envision Willow Creek to be like in 50 years.

The Willow Creek watershed is an oasis, free of development where the land is managed as a preserved natural resource area. After many years of land uses that included timber harvesting, grazing, and agriculture, the watershed has been restored to a balanced ecosystem as it was before native Californians were displaced. The area contains magnificent redwoods. Willow Creek no longer suffers from the affects of sedimentation, and is prime spawning and breeding habitat for salmonid species, including Coho salmon. Elk and deer can be seen grazing on the hillsides. Some areas are designated as reserves with no public access, and some areas are open for limited recreational uses. There is a well maintained, low impact loop trail open to hikers. There is a passive walk-in campground that has been a huge success. There are educational opportunities for park visitors as well as for school children. Willow Creek road has been redesigned so that it does not cause erosion and is a beautiful scenic drive for the public to enjoy while they witness 9 miles of a healthy watershed.
Address in Watershed Plan.

APPENDIX 2: 2005 PUBLIC COMMENTS

Summary of Public Scoping Meeting, February 9, 2005

Compiled by Michele Luna, Executive Director

The draft watershed plan was made available to the public on March 26, 2005, on the Stewards of the Coast and Redwood's website. The public meeting scheduled to hear input about the plan drew a crowd of 60 people. The agenda of the meeting included a welcome and review of the plan's purpose by Michele Luna, Executive Director of Stewards. Lauren Hammack from Prunuske Chatham, Inc. presented the vision and environmental concerns derived from both the public and the Technical Advisory Committee. A summary of restoration priorities determined by the TAC were also shared with those present. The public was given an opportunity to offer comments and ask questions, which are summarized below.

It was announced that the final Willow Creek Watershed Management Plan would be available after March 15th on the Stewards of the Coast and Redwood's website or available by mail upon request by calling (707) 869-9177 or emailing stewards@mcn.org.

The following questions and comments were addressed at the meeting.

1) NOAA Fisheries involvement?
2) Coho presence? 1995, How to reintroduce?
3) Include maps.
4) Add the Department of Forestry to the TAC.

It was determined that additional research is needed to address the following comments or questions.

1) Pomo historical use
2) THP history in late 20th Century
3) Long-term impacts of tourism from salmonid recovery
4) Concern regarding cultural resources and road work
5) Question regarding historic composition of riparian forest
6) Effect of alder forest on flyway?
7) Effect of summer tidal waters?
8) Relation of low flow?
9) Reasoning for moving the road
10) Roads – County road requirements
11) Legal "use" of road – requirements
12) Address Willow Creek estuary, especially regarding coho habitat, adaptive management section.
13) Alder forest – north of pond, potential adaptive management if channel forming processes are impeded by the forest.

Future action is required to address these issues:

1) Grazing plan for acquisition property – can be useful to enhance native species.
2) Gold Ridge RCD is interested in working the WC watershed.
3) Conversations w/ranchers regarding erosion control.
4) LandPaths will have public input re: 2005 road work.
5) Road improvements and retirement – LandPaths/MRC/DPR.