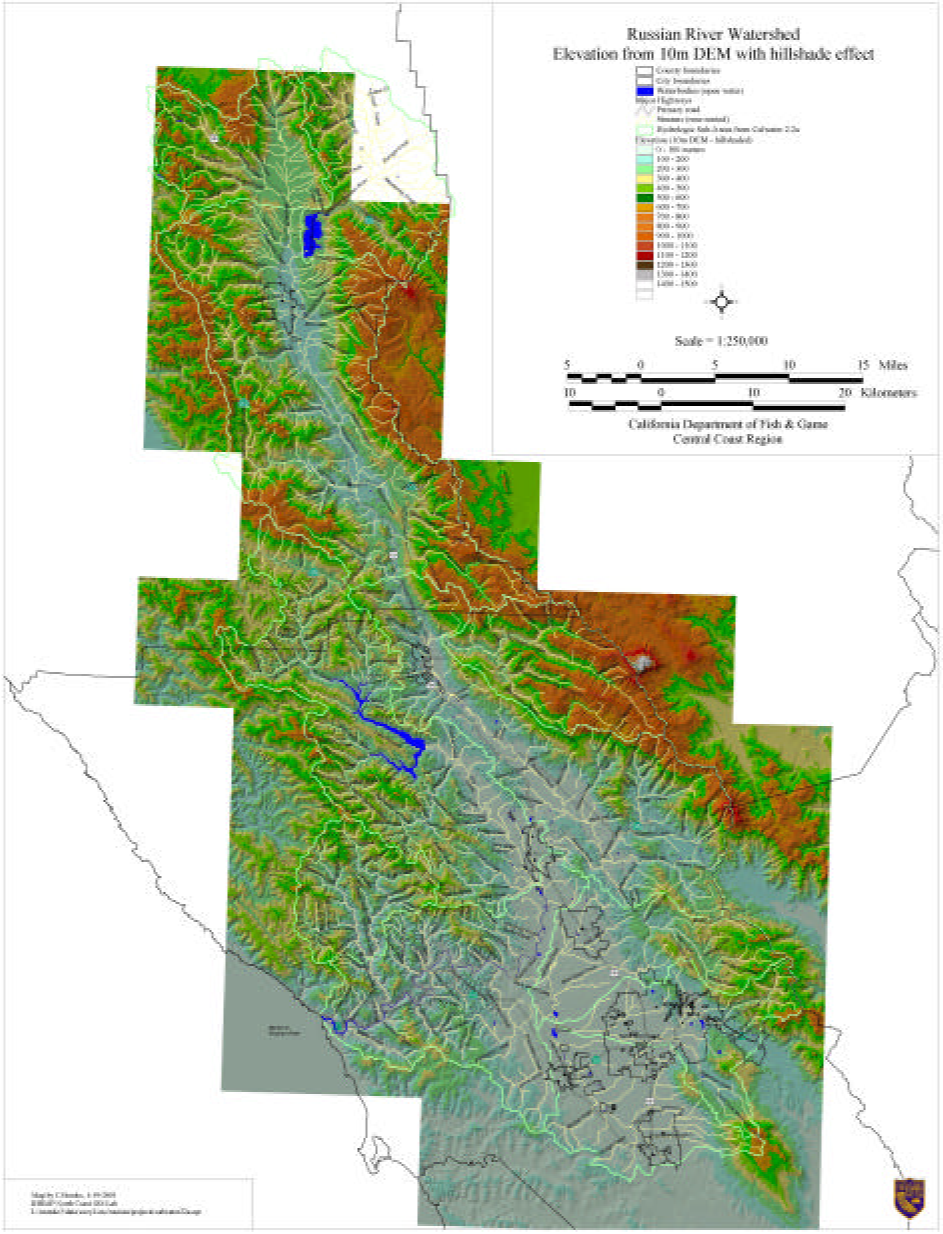
California Department of Fish and Game
2002 DRAFT
RUSSIAN RIVER BASIN FISHERIES RESTORATION PLAN



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Acknowledgements

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INTRODUCTION

> *"People are in competition with salmon in ways similar to the crowding of the wolf, the grizzly and the buffalo out of their historic habitats spanning thousands of years. West Coast coho-along with other Pacific salmon, steelhead and sea-run cutthroat trout, have an unbroken chain of evolution of 50 million years in the making. The coho of today have ancestors that once knew the shadow of the woolly mammoth and the scream of the sabertooth tiger. The West Coast has gone through ecological change and geologic cataclysm, but the salmon have persisted..until now." -Bill Bakke, Executive Director, Native Fish Society*

The protection of existing habitat and restoration of damaged habitat of the Russian River has to occur in concert with active development of the basin for human populations, and with cooperation of the human population, to be successful. To be successful, actions must be science based, timely, and realistic. Both short and long term solutions must be considered.

Recognizing that watersheds themselves are constantly evolving as a result of natural and unnatural processes, actions must focus on limiting factors specific to each watershed and life stage function. Recognizing that land use is constantly changing, plans for restoration and management of watersheds must be considered to be a "moving target" and therefore adaptable to the changing landscape. Recognizing that 95% of the nursery and spawning habitat occurs on private property, actions must be realistic in approach, and partnerships built to ensure support for recommendations and treatments. Recommended actions to benefit coho salmon populations must be focused on causes and not symptoms of land use problems, and promote a "stewardship" ethic to see that management recommendations and projects are carried out and maintained. The focus of this report is to identify and prioritize these actions to benefit coho salmon populations and their habitat

RESTORATION PLAN GOALS

The goals of this restoration plan are to: 1) identify and prioritize high priority or "Keystone" factors which in themselves may restore functionality to watershed systems or lifecycle patterns specifically for anadromous salmonids; 2) prioritize keystone management changes to be implemented by local, state and federal agencies and districts; 3) prioritize keystone projects to be considered for funding by local, state and federal funding organizations; 4) prioritize and encourage lower priority projects to be undertaken by private landowners that provide shorter term, but needed benefits; 5) encourage Demonstration projects which demonstrate fish-friendly techniques and Best Management Practices; 6) engage and support an active citizenry and local government in a partnership for restoration and "stewardship" in management.

WATERSHED BACKGROUND

DESCRIPTION OF WATERSHED

GEOGRAPHY

The Russian River Watershed contains 1,485 square miles of drainage area in Mendocino and Sonoma Counties, with a small portion of the watershed extending into Lake County (Figure 1). The mainstem, bordered to the west by the Coast Range, is approximately 110 miles long. From its headwaters in Redwood and Potter valleys north of Ukiah, the river flows 69 miles in a southeastward direction, makes a sharp turn to the west south of Healdsburg, and flows another 41 miles before emptying into the Pacific Ocean at Jenner.

The Russian River basin is roughly 110 miles long, and varies from 10 to 30 miles in width. Major tributaries to the Russian River include the East and West forks of the mainstem, Robinson Creek, Feliz Creek, Pieta Creek, Big Sulphur Creek, Dry Creek, Maacama Creek, Mark West Creek, and Austin Creek. There are approximately 240 named tributaries within the watershed and a multitude of small un-named streams both perennial and ephemeral. Most were once homes to the anadromous and warm water fish species native to the basin.

Highway 101 runs in a north/south direction, entering the Russian River basin from the northwest in the area of Forsythe Creek and continuing along the middle reach, crossing over the river as it turns westward north of Santa Rosa. Highway 20 runs along the East Fork and crosses the mainstem south of Redwood Valley. Highway 175 starts at Hopland and leads east up Dooley Creek and over the divide to Middletown in Lake County. The lower reach is bifurcated by Highway 116, which continues all the way to the mouth and intersects Highway 1.

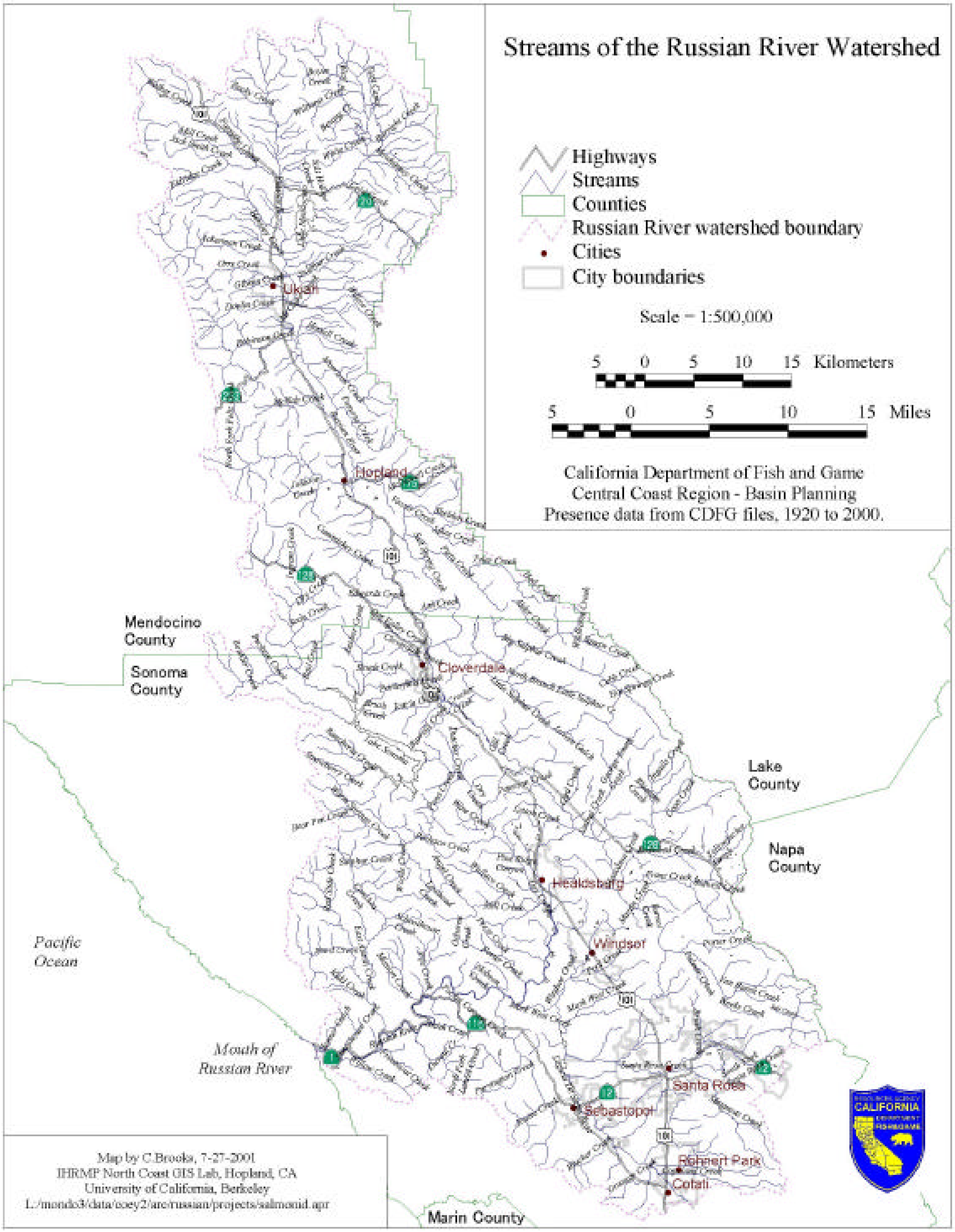


Figure 1. Streams of the Russian River watershed.

GEOLOGY

The Russian River is predominantly underlain by the Franciscan formation, a mélange of Jurassic-Cretaceous age, formed at the bottom of the Pacific Ocean over 100 million years ago. Franciscan sediments consist of a jumbled mass of muddy sandstones and cherts inter-layered with basalt lava flows-crumpled sea floor sediments that form the bulk of the Coast Range. The Franciscan lithology is very unstable and landslides are common throughout most mountain regions within the basin.

Elevations within the basin range from sea level at the mouth to 4,344 feet at the summit of Mt. Saint Helena in the Mayacamas Mountains to the east. Historic lava flow associated with Sonoma Mountain may have contributed to the isolation of the Russian River from the Petaluma and Sonoma Rivers (Hopkirk 1974). The river passes through a series of broad alluvial valleys and narrow bedrock constrictions along its course. Alluvial regions bordering the mainstem include the Ukiah and Hopland valleys in Mendocino County, and Alexander Valley and the Santa Rosa Plain in Sonoma County. The area within the basin consists of 85% hills and mountains and a mere 15% alluvial valleys (SEC 1996). Present drainage patterns in the Russian River region are similar to drainage patterns for the North Coast Ranges and are the result of Pleistocene down-faulting (Hopkirk 1974). Faulting in the North Coast Ranges follows northwest to southeast orientation, generally, and thus many streams (including the upper run of the Russian River) follow this orientation. With the onset of the Wisconsin glacial epoch, sea level changes combined with down-warping along the coast contributed to flow pattern changes as southeasterly flowing rivers of the area were redirected westward (Hopkirk 1974). Eventually the headwaters of the upper Russian River became the headwaters of the Eel, Navarro and Gualala river systems.

Perhaps the most striking character of the Russian River drainage is the sharp turn to the west that the mainstem takes near its confluence with Mark West Creek, where "After following for fifty miles its regular southeasterly course to Santa Rosa Valley, it turns away from this flat and uninterrupted alluvial plain which opens directly to San Francisco Bay, and flows westward to the ocean through twenty miles of rugged canyon, winding through a highland that varies from eight hundred to twelve hundred feet in elevation (Holway 1913)." Holway, in his 1913 paper, hypothesizes that a likely explanation for this is "that the transverse portion of the river from the open valley through the highland was antecedent to, and persisted through, the uplift which made the highland."

Historically, the waters of Clear Lake drained through two outflowing streams. Westward flows passed through Cold Creek into the Russian River, while Cache Creek drained the Eastern side of the Clear Lake Basin with flows eventually joining the Sacramento River. Flows from Cache Creek were eventually cut off by lava flows and water from Cache Creek joined with that from Cold Creek to flow into the Russian River (Hopkirk 1974). It is believed that within the past few centuries, however, a large landslide plugged the western Clear Lake outflow, isolating the lake from the Russian River basin (Alt 1975) and reestablished flows into Cache Creek through a sag in the lava flow near the mouth of Cache Creek. Present geology provides for the continued drainage of Clear Lake through its Eastern outlet. Historic flows from Clear Lake into both the Russian River and the Sacramento system explain why the fish assemblage in the Russian River today is so similar to that of the Sacramento system.

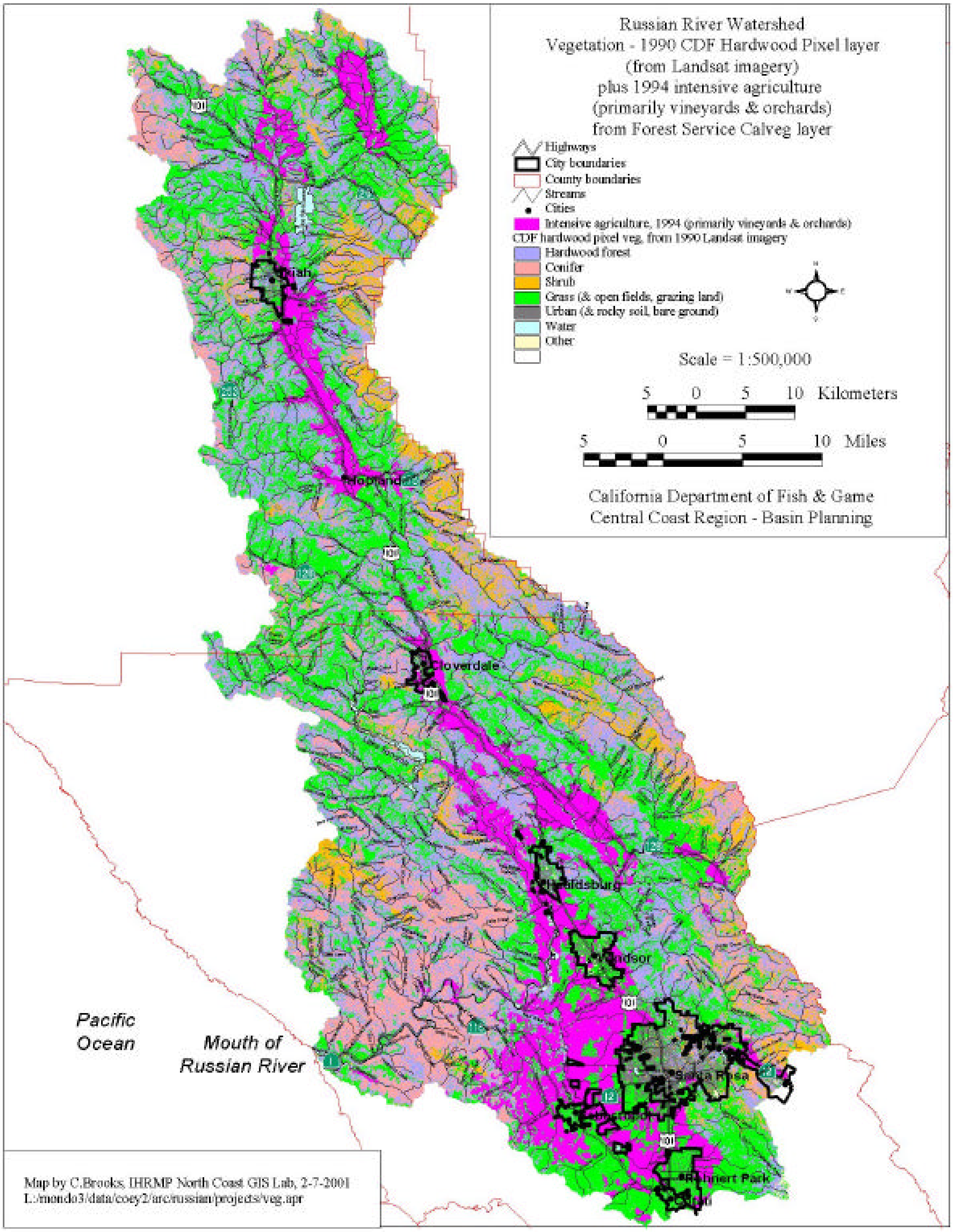
VEGETATION

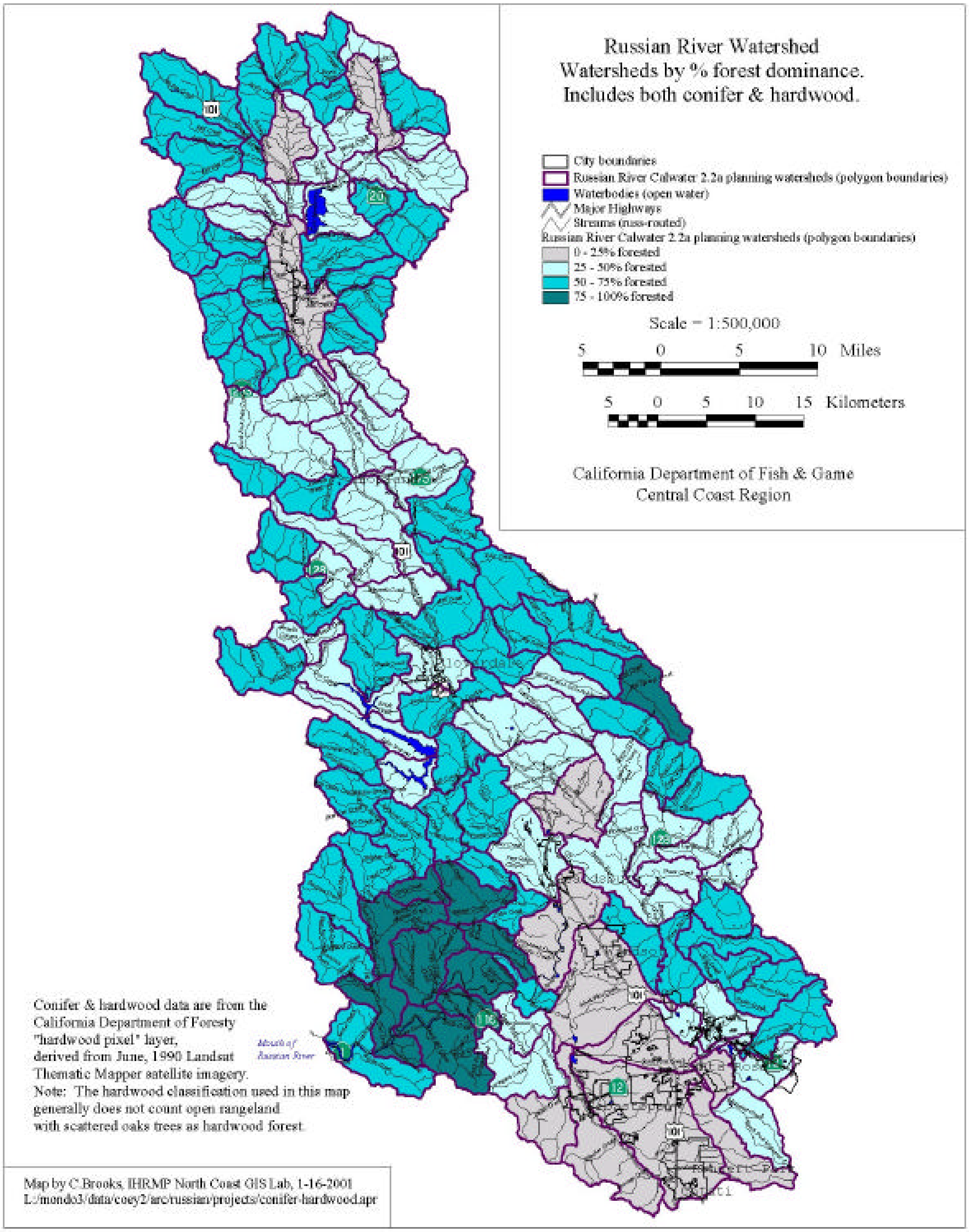
The vegetation within the system varies from mixed hardwood forests (oaks and bays) and many seral stages of chapparal (chamise and coyote bush), characteristic of the eastern foothills and upper inland basin area, to heavy forested coniferous (redwood and fir) regions with cooler wet underbrush species (ferns and huckleberry) characteristic of the western mountains. Mixed in between the foothills and lowland plains are riparian forests of alder, big leaf maple, cottonwood, willow, ash, and bay with an abundant diversity of underbrush species. The below figures depict landcover and the percentage of each watershed by forest dominance including coniferous and hardwoods.

CLIMATE AND HYDROLOGY

The Russian River region has a Mediterranean climate, characterized by warm summers and mild winters. The basin's fog-influenced coastal region, which extends 10 miles inland, typically has cool summers and abundant summer fog moisture. The drier interior region, on the other hand, experiences hot, dry summers with temperatures increasing to upwards of 100° F in the northeastern valleys most isolated from coastal influence. Winter temperatures can reach the low 20°s F, though snowfall is uncommon. Rainfall in the basin ranges from 22-80 inches, with a basin-wide average of 41 inches (SEC 1996). According to National Climatic Data Center Cooperative Weather Stations, the greatest average annual precipitation occurs at high elevations near Mount St. Helena and in the coastal mountains near Cazadero, while the least amount occurs in the southern Santa Rosa Plain (29.5 inches). From 1939 to 1971 the average precipitation in the Cazadero area was 75.8 inches and from 1971 to 1995 it was 67.5 inches. About 80% of the annual precipitation occurs as a result of pacific frontal storms from November through March (Swanson 1992), with maximum precipitation occurring between December and February. Approximately 95% of the basin's natural runoff occurs between November and April. Runoff is negligible between July and October, with many tributaries running dry in the lower reaches.

"Prior to 1908, the Russian River flowed unimpaired, tending to follow concurrent precipitation patterns. Winter flows were high, cycling with storm events, and summer flows were low or intermittent (SEC 1996)." Today, summer low flows are regulated by releases


Russian River Watershed
Vegetation - 1990 CDF Hardwood Pixel layer
(from Landsat imagery)
plus 1994 intensive agriculture
(primarily vineyards & orchards)
from Forest Service Calveg layer
Highways
City boundaries
County boundaries
Streams
Cities
Intensive agriculture, 1994 (primarily vineyards & orchards)
CDF hardwood pixel veg, from 1990 Landsat imagery
Hardwood forest
Conifer
Shrub
Grass (& open fields, grazing land)
Urban (& rocky soil, bare ground)
Water
Other
Scale = 1:500,000
5 0 5 10 Kilometers
5 0 5 10 Miles
California Department of Fish & Game
Central Coast Region - Basin Planning
Ukiah
Hopland
Cloverdale
Healdsburg
Windsor
Santa Rosa
Rohnert Park
101
Pacific Ocean
Mouth of Russian River
Map by C.Brooks, IHRMP North Coast GIS Lab, 2-7-2001
L:/mondo3/data/coey2/arc/russian/projects/veg.apr


Russian River Watershed
Watersheds by % forest dominance.
Includes both conifer & hardwood.
City boundaries
Russian River Calwater 2.2a planning watersheds (polygon boundaries)
Waterbodies (open water)
Major Highways
Streams (russ-routed)
Russian River Calwater 2.2a planning watersheds (polygon boundaries)
0 - 25% forested
25 - 50% forested
50 - 75% forested
75 - 100% forested
Scale = 1:500,000
5 0 5 10 Miles
5 0 5 10 15 Kilometers
California Department of Fish & Game
Central Coast Region
Conifer & hardwood data are from the
California Department of Foresty
"hardwood pixel" layer,
derived from June, 1990 Landsat
Thematic Mapper satellite imagery.
Note: The hardwood classification used in this map
generally does not count open rangeland
with scattered oaks trees as hardwood forest.
Mouth of Russian River
Map by C.Brooks, IHRMP North Coast GIS Lab, 1-16-2001
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101
20
128
116
12
1

from Coyote Dam and Warm Springs Dam. Minimum in-stream flow releases vary depending upon annual precipitation. Augmentation from the Potter Valley Project, which began in 1908 with completion in 1922, contributes 300 cfs to the river. Regulated flows from the two large reservoirs have altered river discharge characteristics. Summer flows, once extremely low to intermittent, are greatly augmented and peak winter flows are artificially low under all but the highest flows. The average annual runoff for the entire Russian River basin is approximately 1,600,000 acre-feet at Guerneville, on the lower river (SEC 1996).

A combination of soil types and steep topography within the Russian River watershed leads to low water intake rates, or retention capacity, which leads to high rates of runoff and serious erosion under major storm conditions. The result of these factors is a frequent occurrence of flooding. Flow frequency analysis indicates that major floods, ranging from approximately 89,000 to 100,000+ cfs (as measured at Jenner), will likely recur on 20 to 50+ year intervals, respectively. Historical evidence and flow records show that floods of this magnitude have occurred eight times since 1862. Floods with a range of 75,000 to 90,000 cfs can be expected to recur at approximately 10 to 20 year intervals, and floods equal to 60,000 cfs can be expected to recur on an average interval of 2.5 to 3 years (Trinity 1993). The largest flood on the Russian River occurred in 1862, as a result of precipitation at approximately 154% of normal. This was not only the largest flood recorded within the watershed, but also the largest flood on record in all of California, with flows estimated at more than 100,000 cfs (Trinity 1993).

RESOURCE USE

Historical Resource Use (See Appendix A for a more thorough historical overview.)

"One hundred and fifty years ago, the Russian River was the heart of a complex of interdependent ecological units. Well-developed flood plains, riparian forests, seasonal marshes, high-gradient woodland streams, oak grasslands, and coastal coniferous forests all worked interdependently to support highly productive fishery and wildlife habitats (SEC 1996)."

The history of resource use in the Russian River area began with the Pomo Indians, who occupied what we now call the Russian River basin for as long as 5,000 years prior to European settlement, living in numerous settlements of up to 1,000 people (Wilson 1990). These tribes altered their environment with the regular burning of oak woodlands and grasslands as a means of promoting new growth of their food sources and increasing wildlife habitat. The Native Americans called the Russian River Shabaikai or Misallaako, meaning "Long Snake." The Pomo Indians of the Ukiah Valley referred to the Russian River simply as "the River" (Wilson 1990).

In the late 1700's, the Spanish landed at Bodega Bay to find the river basin a virtual paradise, ripe for the development of suitable living conditions and a strong commerce. The Spanish were soon followed by the Russians who established colonies at Fort Ross and Bodega Bay, and utilized the lower Russian River for fur trapping, cultivating wheat and grazing cattle until 1840 (Ferguson 1923).

In the early 1800's the Spanish issued Rancho grants in "San Rosa" in order to limit Russia's encroachment into the Russian River Valley (Wilson 1990), and a Spanish petition for the Bodega grant named the river "Rio Russo." We have called it the "Russian River" ever since. Cattle and horse ranching soon became the dominant land use, as the lowland areas were converted from thick riparian forests to grasslands.

The arrival of many land-hungry "American" settlers soon decimated the Native Americans living in villages throughout the river valley (Wilson 1990). The discovery of gold in California in 1849 triggered the development of the Russian River valley, and the demand for wood and agricultural products escalated. Soon American settlers began to squat on Rancho lands, establishing homesteads in the valley and clearing the native vegetation of the river and uplands for cultivation.

At that time, the sheer size and density of the old growth redwood forests were almost unfathomable. The largest tree ever recorded was in the Russian River basin. In 1865 intensive logging in the lower watershed began with the establishment of milling yards in Guerneville (Schubert 1997). In 1876 the railroad was constructed for hauling lumber to outside markets and dramatically boosting the production of the timber industry (Stindt 1974). Two lines ran along the Russian River, the narrow gauge and the broad gauge (Figure 2). Small branch lines were also built fanning out from Duncan's Mills to Markham, Willow Creek, Azalea and up Kidd Creek and Kuhute Gulch in the Austin Creek watershed for hauling logs to Duncan Mills (Stindt 1974). The timber industry boom was short-lived, however, and in 1901 the last lumber mill in Guerneville closed, as the vast majority of harvestable redwoods had been removed (Clar 1984). During World War II, tractor logging of Douglas fir forests followed, to provide lumber for the ever-expanding urban population.

Consequently, Northwestern Railroad's freight business plummeted, and soon the same railways carried vacationers and weekend travelers from the ferry at Sausalito to popular destinations throughout the Lower Russian River from Rio Nido to Duncan's Mills. Small towns such as Monte Rio, the "Vacation Wonderland," developed around the turn of the century, and summer travel to the river for recreation and plentiful fishing boomed. The Lower Russian River continued to be a popular tourist destination through the early 1930s.

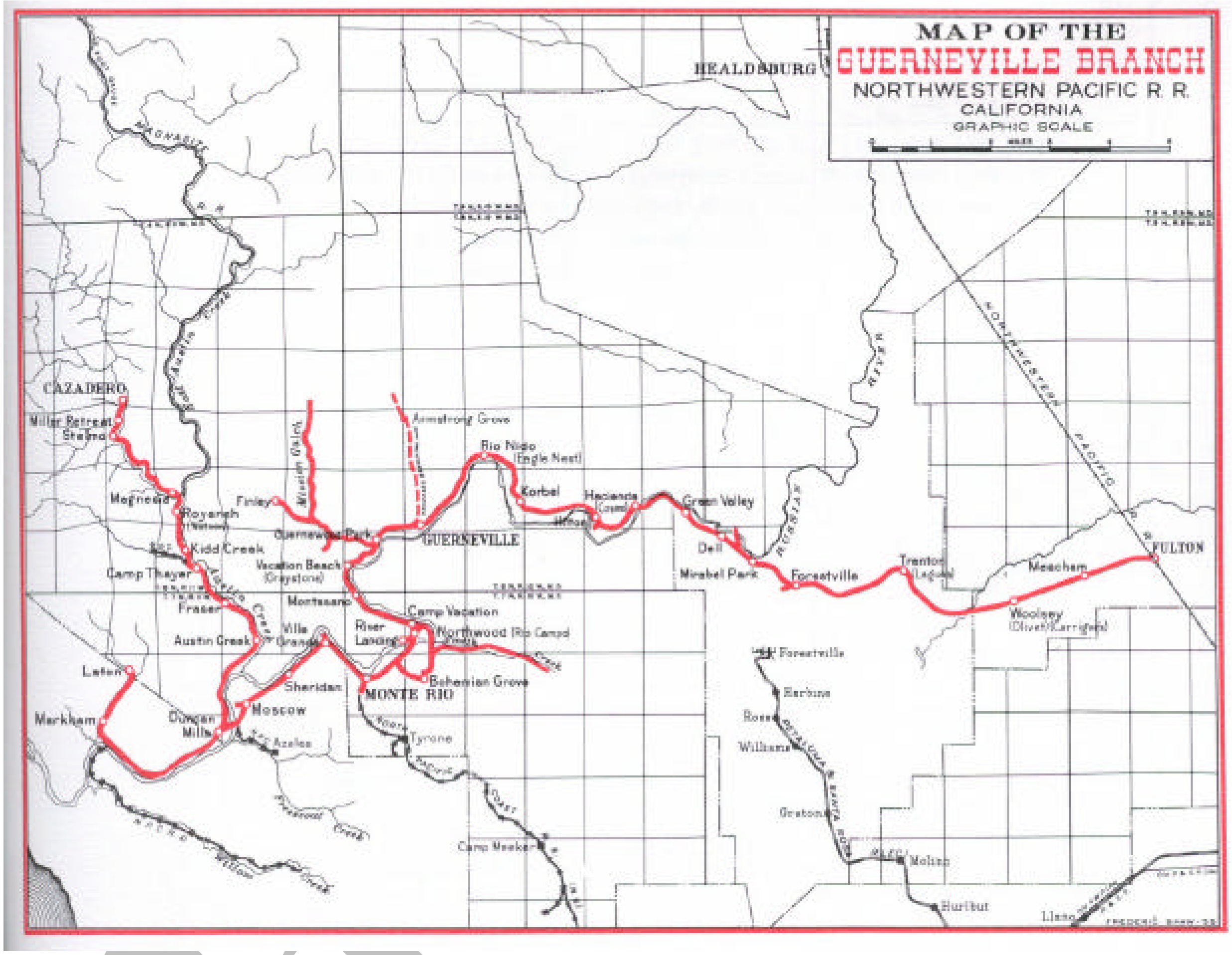


Figure 2. Map of the Guerneville branch of the NorthWestern Pacific Railroad depicting narrow gauge and the broad gauge lines, circa 1900.

Most of the land along the Russian River was already under cultivation by 1900 (SEC 1996) and this early agriculture focused mainly on the production of grapes, apples, hops and prunes. Farmers removed riparian vegetation and filled in sloughs and side channels in order to maximize their usable agricultural lands. These practices continued until the late 1940's when very few wetlands remained (SEC 1996). At that time, the river valley was leveled, creeks were channelized and, in an attempt at flood control, agricultural operations began removing small in-channel islands and gravel bars. In the 1950s, bank stabilization measures began in response to increased erosion. Ultimately, these practices resulted in mass channelization of the mainstem.

In the 1940's in-channel gravel extraction began and, in the years to follow, the production of sand and gravel was the principal mining industry from Healdsburg through Ukiah. Russian River gravels were used for concrete construction and roads from Santa Rosa to Ukiah and throughout the entire Bay Area. In response to demands for flood control and increased water supply, Coyote Dam was constructed on the East Fork of the Russian River in Ukiah in 1959, creating Lake Mendocino. In the 1970's, in-channel gravel mining slowed and operations moved to the adjacent terraces along the river. Warm Springs Dam, located on Dry Creek in Geyserville was completed in 1982, creating Lake Sonoma.

Current Resource Use

Today, the upper reaches of the Russian River flow south through southern Mendocino County and the towns of Redwood Valley, Calpella, Ukiah, and Hopland. This region consists of rural residential land, agriculture, and small towns. Populations of these cities have not changed dramatically over the last decade although predictions are that they will increase as the urban expansion from the Bay Area continues. According to the Mendocino County Planning Department (Jan. 2000), there are an estimated 14,961 residents in Ukiah and 60,615 residents in unincorporated communities throughout the county.

The river's middle reaches continue south, past Squaw Rock and over the Sonoma County line, opening up into wide a flood plain through Asti and Alexander Valleys, major vineyard producing regions. Here, the mainstream of the river passes through the cities of Cloverdale, Geyserville and Healdsburg, bypassing Windsor and Santa Rosa. The cities of Windsor and Santa Rosa have seen tremendous growth in recent years and will likely continue to grow where development is permitted. Turning west, the river's lower reach passes through the towns of Forestville, Rio Nido, Guerneville, and Monte Rio, reaching the ocean near the coastal town of Jenner. These towns have also seen an increase in population base while the number of buildings has remained virtually the same. This is primarily due to the conversion of vacation homes to year-round residences. According to 1998 figures from Sonoma County's Economic Development Board, populations for each city within the Russian River basin are as follows: Santa Rosa 136,100; Rohnert Park 39,550; Windsor 19,900; Healdsburg 9,900; Sebastopol 7,800; Cotati 6,700; Cloverdale 5,675; and unincorporated communities throughout Sonoma County 151,800.

The most densely populated area within the Russian River Watershed is the Santa Rosa Plains area, while the least populated area is the Guerneville sub-basin, which in 1990 had five unincorporated communities with a total of fewer than 10,000 residents (U.S. Census 1990). Overall, approximately 95-97% of the basin is held in private ownership (Figure 3). Urbanization and population densities throughout the Russian River watershed are increasing at an accelerated pace.

Urban and industrial uses are concentrated around cities in Mendocino and Sonoma Counties, with the largest concentration of land uses in the Santa Rosa plains, followed by

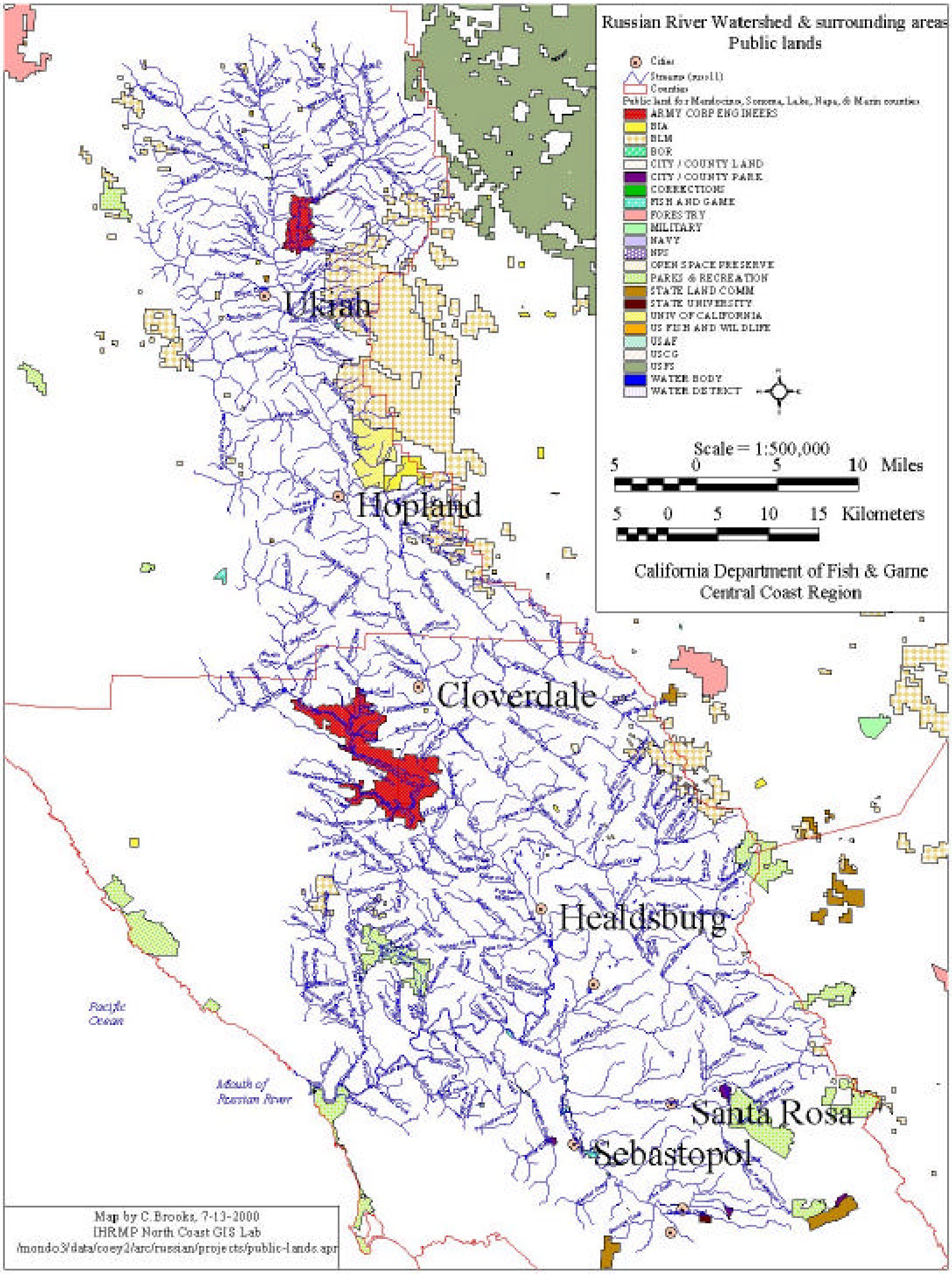


Figure 3. Russian River watershed and surrounding ownerships.

Ukiah and Cloverdale. Uses include high-technology industries, petroleum distribution plants, light manufacturing, wrecking and salvage yards, and industries related to construction. Santa Rosa is the chief commercial distribution center for the North Coast of California.

There are two major dams in the Russian River watershed: Coyote Dam and Warm Springs Dam. Coyote Dam, located on the East Fork Russian River in Ukiah, was completed in 1959, creating Lake Mendocino. Warm Springs Dam, located on Dry Creek in Geyserville was completed in 1982, creating Lake Sonoma. Both dams were designed to provide flood control, recreation, irrigation, and drinking water to Mendocino and Sonoma counties. The original estimated capacity behind Coyote Dam in 1985 was 88,447 acre feet (SCWA 1985, as cited in SEC 1996), while the original estimated capacity behind Warm Springs Dam was 381,000 acre feet (COE 1973, as cited in SEC 1996).

The Potter Valley Project was completed in 1922, when Scott Dam impounded Lake Pillsbury on the Eel River 12 miles upstream of Cape Horn Dam (DWR 1976, as cited in SEC 1996). Regulated flow between Scott and Cape Horn dams via Lake Pillsbury has since provided year-round diversion of Eel River water into the East Fork Russian River. This project increased the average summer base discharges in the Russian River dramatically, with summer flows generally exceeding 125 cfs (COE 1982). This diversion draws approximately 300 cfs from the Eel River and together with the natural rivers flow, supplies drinking water to about 500,000 people and a presently unknown amount of water for agricultural uses (RWQCB 1995, as cited in SEC 1996).

Other land uses such as timber harvest, agricultural production, livestock grazing, and gravel mining continues today, however the basin has been changed substantially through urban development (See Appendix B for more thorough discussion). Despite many years of intensive use, the peace and beauty of the Russian River still draw tourists from the Bay Area and elsewhere. Summer tourism associated with the recreational use of the river and profitable agriculture resources provide a critical economic base for Russian River communities.

Agriculture is still the dominant land use within the basin, with the recent trend being conversion of historic crop lands, livestock, dairy lands, and forest lands to vineyards. Some orchards remain, mostly in Ukiah and Sebastopol, though vineyards dominate the hills and valleys of the lower- and mid-river area. Current economic incentives threaten the replacement of the remaining orchards throughout Sonoma County, although pastureland and farmland for the cultivation of silage also remains in the open areas of the Santa Rosa Plains. Grazing of cattle and sheep is prevalent, particularly in Mendocino County, in areas of oak woodlands and coastal sage vegetation.

Inextricably linked to the variety of land uses within the basin are roads, dams, water diversions, and the development of cities with high density housing. Unfortunately, the end result of these activities is loss of riparian vegetation, reduced habitat complexity, accelerated erosion, urban runoff, augmented flows, elevated water temperatures, loss of spawning gravels, channel incision and widening, and other morphological changes to the river system. Each of these human activities has contributed to the cumulative decline of overall watershed quality and the basin-wide decline of salmonid populations.

"In the geologically brief time span since the mid-1800's, this system has been transformed from its natural condition and balance to what is now essentially a heavily controlled urban water conveyance. Today, only the undammed, most remote tributaries bear a semblance to the pristine conditions that once supported a self-sustaining, dynamic ecosystem." (SEC 1996).

FISHERIES RESOURCES

The Russian River and its estuary are known to support at least 46 species of fish (see Table 1-a, Resident and Anadromous Fishes of the Russian River System, and Table 1-b, Estuarine Fishes of the Russian River System). Of the various resident, anadromous, and estuarine fishes of the Russian River, 27 species are native to the drainage and one, the Russian River Tule Perch, is endemic to this drainage (Hopkirk 1980). The most common resident freshwater fishes in the Russian River are Sacramento sucker, hardhead, California roach, Sacramento pikeminnow (squawfish), smallmouth bass, and Russian River Tule Perch (see Table 1-a for a full listing).

The assemblage of native warmwater species in the Russian River is closely related to the fish population of the Sacramento River. The two rivers were probably connected in the past with the Russian flowing into San Francisco Bay, the two rivers meeting somewhere near the Farralon Islands when sea level was much lower, or through Clear Lake which now drains into the Sacramento, but has at times drained into the Russian.

The Russian River estuary (Table 1-b) supports a variable population of nearshore marine species, but the species most commonly found are staghorn sculpin, Pacific herring, topsmelt, surfsmelt, threespine stickleback, starry flounder, English sole, Pacific sanddab, and bay pipefish in the more saline waters. In the fresher waters near the surface or in the upper reaches of the estuary Sacramento sucker, western roach, and Sacramento pikeminnow are common. Steelhead smolts are sometime found in the estuary, but they seem to be primarily moving through on their migration to the ocean, in the fall winter and spring, rather than spending an extended time rearing in the estuary through the summer. In some years a small number of juvenile steelhead have been found rearing in the estuary in mid-summer.

Table 1-a lists the native and introduced fishes found or currently present in the system. Introductions of non-native fish to the Russian River include all of the catfishes (two species)

and bullheads (two species); all of the centrarchids (excepting the Sacramento Perch); all of the basses; all of the mosquito-fishes, and some of the minnows. Sacramento Perch is a California native species, however, the population present in the Russian River is presumed to be the result of introductions (USFWS 1995). These fish are all adapted to warmwater environments and dominate the mainstem, especially downstream from Cloverdale, and the lower reaches of some of the larger tributaries.

At least eight species of fish have been identified in the Russian River which are considered species of special concern by the California Department of Fish and Game. These include the following species: coho salmon (*Oncorhynchus kisutch*), pink salmon (*Oncorhynchus gorbuscha*), river lamprey (*Lampetra ayresi*), green sturgeon (*Acipenser medirostris*), California roach (*Hesperoleucus symmetricus*), hardhead (*Mylapharadon conocephalus)*, Sacramento perch (*Archoplites interruptus*), and the Russian River tule perch (*Hysterocarpus traski pomo*). Additionally, one species of invertebrate, the California freshwater shrimp (*Syncaris pacifica*) which is present in some tributaries of the Russian River, has been listed as endangered.

Table 1-a
Resident and Anadromous Fishes of the Russian River System

Family Petromyzontidae - Lampreys	
Lampetra ayresii (river lamprey)	Anadromous, Resident
Lampetra pacifica (Coastrange brook lamprey)	Resident, Native to Russian River
Lampetra tridentata (Pacific lamprey)	Anadromous, Resident
Family Acipenseridae - Sturgeons	
Acipenser medirostris (green sturgeon)	Anadromous, Native of Russian River
Acipenser transmontanus (white sturgeon)	Anadromous, Native of Russian River
Family Clupeidae - Herrings	
Alosa sapidissima (American shad)	Anadromous, Introduced
Family Salmonidae - Salmon and Trout	
Oncorhynchus gorbuscha (pink salmon)	Anadromous, Native of Russian River
Oncorhynchus kisutch (coho salmon)	Anadromous, Native of Russian River
Oncorhynchus tshawytscha (chinook salmon)	Anadromous, Native of Russian River
Oncorhynchus mykiss (steelhead/rainbow trout)	Anadromous, Resident, Native to Russian River
Family Cyprinidae - Minnows	
Carassius auranus (goldfish)	Resident, Introduced
Cyprinus carpio (carp)	Resident, Introduced
Hesperoleucus symmetricus (California roach)	Resident, Native to Russian River
Lavinia exilicauda (hitch)	Resident, Introduced?
Mylopharodon conocephalus (hardhead)	Resident, Native to Russian River
Orthodon microlepidotus (Sacramento blackfish)	Resident, Introduced?
Ptychocheilus grandis (Sacramento squawfish)	Resident, Native to Russian River
Family Catostomidae - Suckers	
Castostomus occidentalis (Sacramento sucker)	Resident, Native to Russian River
Family Ictaluridae - Catfishes	
Ictalurus catus (white catfish)	Resident, Introduced

Table 1-a
Resident and Anadromous Fishes of the Russian River System

Ictalurus melas (black bullhead)	Resident, Introduced?
Ictalurus nebulosus (brown bullhead)	Resident, Introduced
Ictalurus punctatus (channel catfish)	Resident, Introduced
Family Poeciliidae - Livebearers	
Gambusia affinis (mosquitofish)	Resident, Introduced
Family Gasterosteidae - Sticklebacks	
Gasterosteus aculeanus (threespine stickleback)	Anadromous, Native of Russian River
Family Cottidae - Sculpins	
Cottus aleuticus (Coastrange sculpin)	Resident, Native to Russian River
Cottus asper (prickly sculpin)	Resident, Native to Russian River
Cottus gulosus (riffle sculpin)	Resident, Native to Russian River
Family Serranidae - Sea basses	
Roccus saxatilis (striped bass)	Anadromous, Introduced
Family Centrarchidae - Sunfishes	
Archoplites interruptus (Sacramento perch)	Resident, Introduced?
Lepomis cyanellus (green sunfish)	Resident, Introduced
Lepomis macrochirus (bluegill)	Resident, Introduced
Lepomis microlophus (redear sunfish)	Resident, Introduced
Micropterus dolomieu (smallmouth bass)	Resident, Introduced
Pomoxis annularis (white crappie)	Resident, Introduced
Pomoxis nigromaculatus (black crappie)	Resident, Introduced
Family Embiotocidae - Surfperches	
Hysterocarpus traskii pomo (Russian River Tule perch)	Resident, Native to Russian River

Source: Hopkirk 1980

Table 1-b
Estuarine Fishes of the Russian River System

Family Clupeidae – Herrings	All listed fishes are native to the Russian River except the yellowfin goby
Clupea pallasii (Pacific herring)	
Family Engraulidae – Anchovies	
Engraulis mordax (northern anchovy)	
Family Osmeridae – Smelts	
Hypomesus pretiosus (surf smelt)	
Family Atherinidae – Silversides	
Atherinops affinis (topsmelt)	
Family Syngnathidae – Pipefishes	
Syncnathus leptorhynchus (bay pipefish)	
Family Cottidae – Sculpins	
Leptocottus armanus (staghorn sculpin)	
Family Embiotocidae – Surfperches	
Cymatogaster aggregata (Shiner surfperch)	
Family Grobiidae – Gobies	
Clevelandia ios (arrow goby)	
Acanthogobius flavimanus (yellowfin goby)	Introduced species
Eucyclogobius newberryi (tidewater goby)	
Family Pleuronectidae - Righteyed Flounder	
Platichthys stellatus (starry flounder)	

Source: Hopkirk 1980

Anadromous native species identified (historical or present) in the Russian River system include: chinook salmon (*Oncorhynchus tshawytscha*), coho salmon (*Oncorhynchus kisutch*), steelhead trout (*Oncorhynchus mykiss*), pink salmon (*Oncorhynchus gorbuscha*), pacific lamprey

(*Lampetra tridentata*), river lamprey (*Lampetra ayresi*), three-spined stickleback (*Gasterosteus aculeatus*), white sturgeon (*Acipenser transmontanus*), and green sturgeon (*Acipenser medirostris*). Both striped bass (*Morone saxatilis*) and American shad (*Alosa sapidissima*) are sportfish species also experiencing notable decline in the Russian River. American shad were introduced into California from the Atlantic Coast in 1871 and Striped bass were introduced in 1879. . The sturgeon and the striped bass are not known to spawn in the Russian River, but are probably Sacramento River fish which enter the lower Russian River to feed. Both species exhibit anadromous life histories, similar to salmon, thus it is not surprising that the decline of striped bass and American shad parallels that of salmonid fishes in the Russian River.

Historically, four anadromous salmonid species were native to the Russian River. These included chinook salmon, coho salmon, pink salmon, and steelhead trout (Moyle 1976a). Although no accurate counts exist, historically, each year the combined anadromous fish returns were in the tens of thousands. Since settlement of the Russian River Basin began in the 1850's, fish populations have declined. The impacts were noted as early as 1888, when the United States Bureau of Fish and Fisheries documented a decline in salmon populations (SEC 1996).

As the human population within the basin increased over time, pressure on the fisheries increased accordingly. Pink salmon became virtually extinct within the basin after 1955, while remaining salmonid populations in the Russian River plummeted, along with those in other river basins on the West Coast (Nehlsen et al. 1991). Currently, all three species of salmonids found in the Russian River, defined as the California Coastal Chinook Salmon, Central California Coast Coho Salmon, and Central California Coast Steelhead Trout are listed as "Threatened" species under the Endangered Species Act (ESA) by the National Marine Fisheries Service (NMFS 1997). A proposed listing for the coho salmon as state "Endangered" is currently under review by the State.

Salmon and Steelhead Populations

The following information regarding the historic status of salmonids within the Russian River Basin is taken largely from Steiner Environmental Consulting's 1996 report, *A History of the Salmonid Decline in the Russian River Basin*:

Chinook Salmon (*Oncorhynchus tshawytscha*)

The extent of naturally-occurring historic chinook salmon (also known as king salmon) in the Russian River is largely debated. Cannery records from before 1890 indicate that most salmon harvested were small, the largest of these weighing only about 20 pounds (SEC 1996). This is commonly thought to be too small to be chinook salmon, as the average size for chinook is commonly 16-20 pounds. Unfortunately, records from the early commercial harvest of the fish at the mouth of the Russian River are the only documented history.

Others, Shapovalov (1946, 1947, and 1955), Murphy (1945 and 1947), Pintler and Johnson (1956), Fry (1979) also stated there were few if any chinook in the Russian River. However, photographs of the early Native Americans show large fish being dried on racks and landowners maintain they have been caught since the turn of the century. Several other reports and communications claim chinook was a greater part of the Russian River's fauna. Lee and Baker (1975) stated chinook historically spawned in the upper drainage, and Jones (CDFG, personal communication) states chinook was regularly harvested by local tribes in Coyote Valley prior to construction of Coyote Dam. Nielsen (RREITF 1994) caught nine chinook in the estuary in 1992 and hypothesized natural production in the main river. More recently in 1999 and 2000 SCWA has observed downstream migration of chinook juveniles in their screw traps below Wholer Bridge upstream of the estuary, presumably moving to the estuary Figure 4 from SEC (1996) depicts the decline in salmon populations since the turn of the century. In a review of historic records SEC (1996) found that:

> "There are no chinook population estimates until the 1960's. Documented returns appear strongly associated with periods of sustained hatchery supplementation. Estimated chinook escapement in 1966 was 1,000 (CDFG 1966) and estimated escapement in 1982 was 500 (COE 1982). (Escapement is the number of adult fish successfully returning to a river system to spawn.) Heavy planting in Dry Creek during the 1980's did not result in establishment of a [large] run."

The Department of Fish and Game operates two hatchery installations under agreement with the USACOE as required mitigation efforts for the loss of spawning habitat due to the construction of the two reservoirs on the Russian River. The Warm Springs Salmon and Steelhead Hatchery is located on Dry Creek at the base of Lake Sonoma and The Coyote Valley Steelhead Facility is located in Ukiah at the base of Lake Mendocino. Returns to the hatchery may give some indication of the abundance of fish surviving ocean life and successfully moving into the river. Rise and fall in populations coast wide may in general reflect varying ocean productivity (Graph 1). Returns to Warm Springs from 1980 to 2001 ranged between 0 and 304 chinook, with the highest count in 1988 (Gunter 2001). Few chinook returned to Coyote Dam during the same time period (Gunter 2001).

Recent hatchery returns for Warm Springs Salmon and Steelhead Hatchery are shown in Table 2, while those for Coyote Valley Steelhead Facility are shown in Table 3. Figure 5 shows returns to Warm Springs Hatchery from 1980-2001. No chinook are currently spawned at WSH or CVFF due to concerns over genetic bottlenecking from too few fish. If runs exceed 100 spawning pairs, hatchery production may be resumed. In the 2000 - 2001 spawning season, all returning chinook salmon to either facility were relocated and released into the mainstem Russian River.

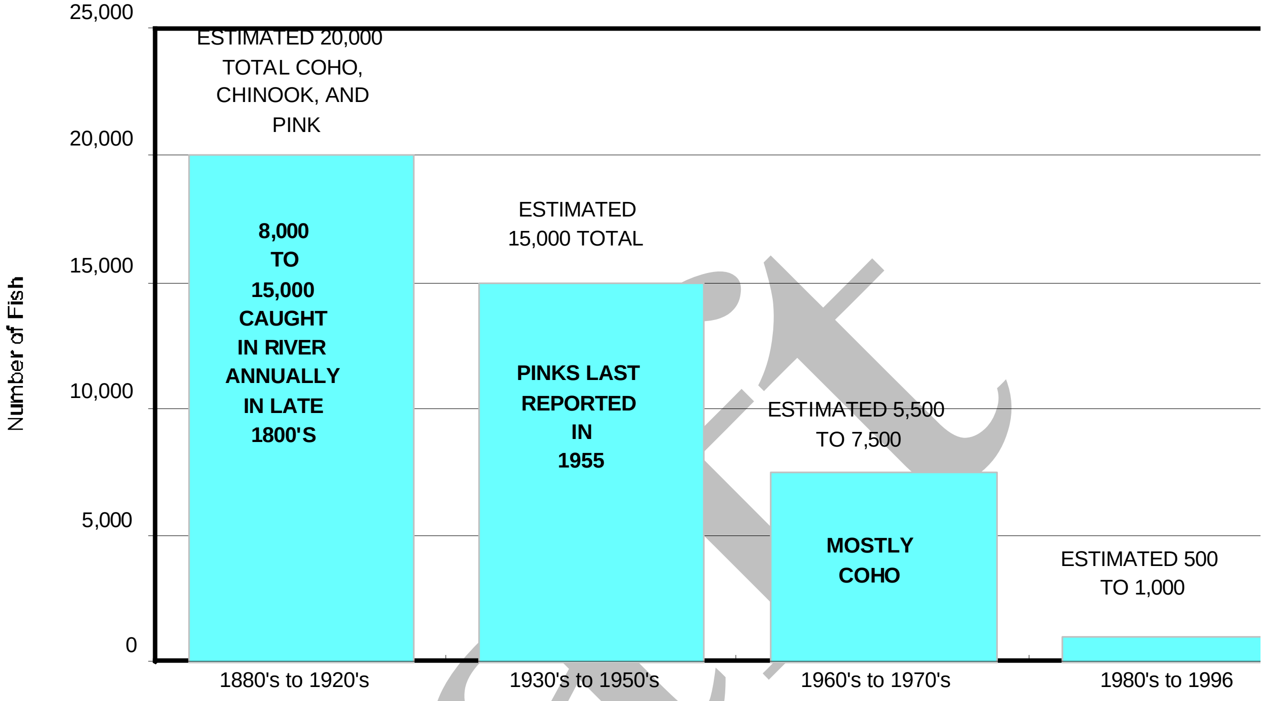


Figure 4: Hypothetical escapements to the Russian River for all species of salmon. [Estimates based on conservative expansion of U.S. Bureau of Fish and Fisheries (1888), Warm Springs Hatchery return numbers, and anecdotal CDFG reports.]

TABLE 2 -Warm Springs Hatchery

CHINOOK SALMON RETURNS (1980-2001)

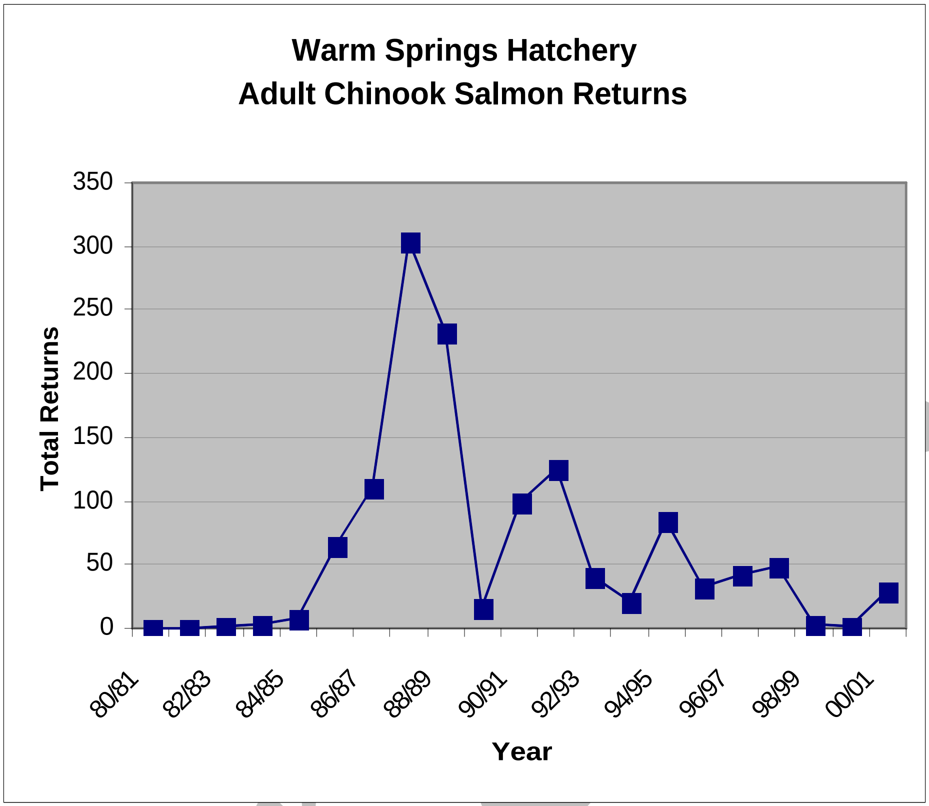
YEAR	MALE	FEMALE	GRILSE	TOTAL
80/81	0	0	0	0
81/82	0	0	0	0
82/83	1	0	0	1
83/84	2	1	1	4
84/85	7	1	0	8
85/86	65	0	0	65
86/87	50	25	36	111
87/88	176	4	124	304
88/89	151	61	21	233
89/90	8	6	3	17
90/91	67	0	32	99
91/92	77	46	2	125
92/93	15	22	3	40
93/94	8	0	13	21
94/95	59	9	17	85
95/96	18	12	3	33
96/97	25	11	7	43
97/98	16	14	19	49
98/99	1	0	3	4
99/00	2	0	0	2
00/01	21	5	3	29

TABLE 3 -COYOTE VALLEY STEELHEAD FACILITY

CHINOOK SALMON RETURNS (1992-2001)

YEAR	**MALE**	**FEMALE**	**GRILSE**	**TOTAL**
92/93	1	0	0	1
93/94	1	0	0	1
94/95	0	0	0	0
95/96	0	0	0	0
96/97	0	0	0	0
97/98	0	0	0	0
98/99	2	0	1	3
99/00	0	0	0	0
00/01	0	0	5	5

Figure 5



Although historic spawning distribution for chinook salmon is unknown, and returns to the hatchery have been dwindling, suitable spawning habitat exists today in the upper mainstem of the river and in the larger low gradient tributaries. White (SCWA, personal communication) counted approximately 300 chinook in 1999 and up to 1300 chinook in winter 2000 migrating through the fish ladder at the SCWA rubber dam near Wholer bridge. These recent runs have been spawning primarily in the mainstem Russian River above Asti, and in Dry Creek, and its tributaries, and Feliz and Forsythe Creeks (Coey 2000). Unfortunately, an accurate estimate of spawning distribution is unavailable due to low chinook escapements, variable water years, and irregular sampling effort. Interestingly, recent CDFG observations made during spawning surveys and preliminary genetic studies indicate that the recent returning chinook are unmarked, and are presumably naturally spawned fish. Further genetic studies should indicate whether these fish are wild Russian River natives, offspring from Dry Creek hatchery strays, or strays from other river systems. Like all other salmonids within the river, natural runs have declined over time.

With regard to the current operations at the Russian River facilities, existing procedures differ between coho and chinook. The present policy regarding salmon returns at WSH does not provide for spawning of wild adults due to concerns about the small returning population size and the risks for inbreeding depression. Therefore, returning wild or hatchery origin chinook salmon are not spawned, but are presently relocated to the Mendocino reach of the Russian River the mainstem Russian River at Comminsky Station respectively. If future runs exceed 100 spawning pairs, hatchery production may be resumed.

Coho Salmon (*Oncorhynchus kisutch*)

The extent of the naturally occurring coho populations is better known. In a review of historic records SEC (1996) found that:

> "Coho salmon (also known as silver salmon) were once so prevalent in the Russian River that they supported a commercial fishery (United States Bureau of Fish and Fisheries 1888). Cannery records give no mention of species, but fish weighed between eight and 20 pounds, suggesting coho were a large part of the catch. In 1888, 183,597 pounds of fish were caught near Duncan Mills for cannery and personal use (United States Bureau of Fish and Fisheries 1888). Assuming an average fish weight of 12 pounds, 15,300 fish were taken. Undoubtedly, many of these fish were coho. Since there is no indication of how many fish escaped capture and continued upstream, the cannery records by themselves may significantly underestimate salmon populations."

Coho once inhabited nearly all of the tributaries to the lower Russian (specifically the Guerneville, and Austin Creek sub-basins) and portions of the Warm Spring and Forsythe Creek sub-basins (Figure 6). Records from the early 1990s document sightings of juvenile coho in the West Fork, but there are no records of adult spawning (Jones, CDFG, personal communication).

While the distribution of coho within the system is better known, like chinook, early commercial records provide one of the few pictures of historic population size. Figure 4 from SEC (1996) depicts the decline in coho since the turn of the century. In 1975, Lee and Baker (1975) estimated Russian River coho escapement at 7,000. The COE (1982) estimated 1982 escapement at 5,000, and Dry Creek an estimated 300 fish before Warm Springs Dam was built. By the early 1990's, estimates of combined wild and hatchery coho numbers for the entire Russian basin were predicted to be under 1,000 (Cox, CDFG, personal communication).

Hatchery returns may give some indication of the abundance of fish successfully surviving ocean conditions and returning to spawn. Recent hatchery returns for coho salmon at Warm Springs Salmon and Steelhead Hatchery are shown in Table 4, while those for Coyote Valley Steelhead Facility are shown in Table 5. Figure 7 shows returns to Warm Springs Hatchery from 1980-2001..

Figure 6. Salmonid distribution in the Russian River watershed (presence data from DFG files 1920 to 2002).

Spawning of coho at either facility has ceased due to low numbers of returning adults, issues revolving around genetic integrity of existing stocks and inadequate genetic variability due to lack of an effective population size. Wild coho returning to WSH are currently relocated to tributaries of Dry Creek where suitable habitat occurs.

TABLE 4 - WARM SPRINGS SALMON AND STEELHEAD HATCHERY COHO SALMON RETURNS (1980-2001)

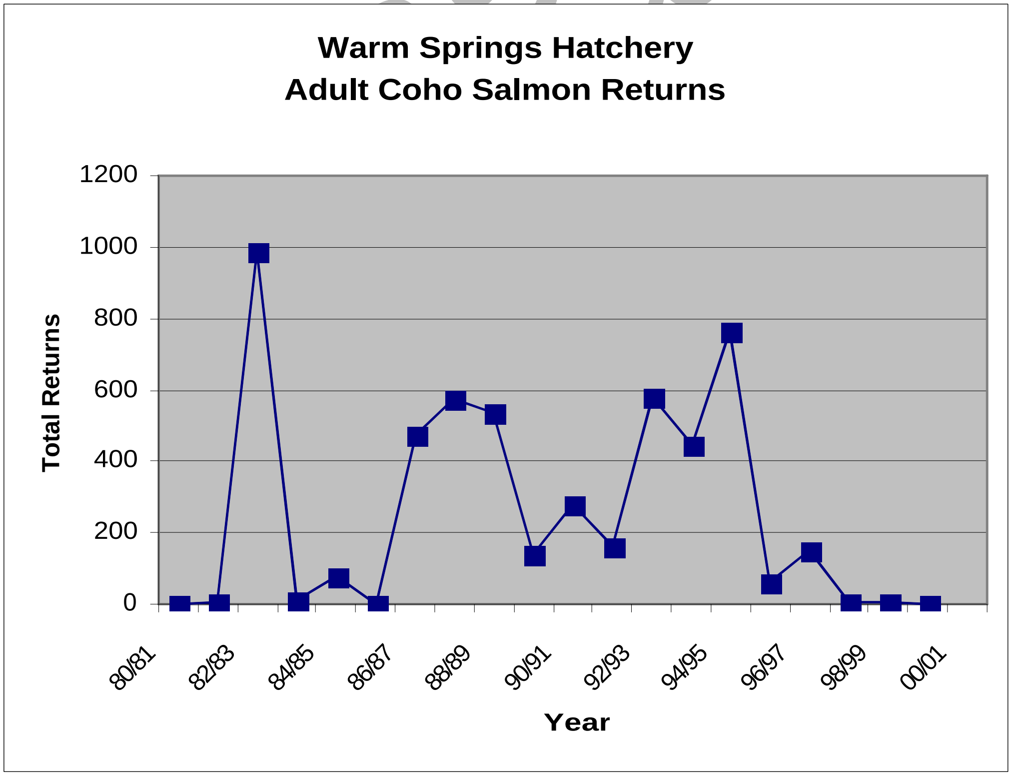
YEAR	MALE	FEMALE	GRILSE	TOTAL
80/81	0	0	0	0
81/82	2	2	0	4
82/83	515	277	194	986
83/84	0	1	8	9
84/85	32	44	0	76
85/86	0	0	0	0
86/87	139	5	328	472
87/88	164	155	257	576
88/89	219	139	176	534
89/90	35	35	70	140
90/91	100	87	90	277
91/92	53	20	89	162
92/93	250	113	215	578
93/94	110	62	277	449
94/95	310	392	63	765
95/96	13	13	36	62
96/97	68	68	12	148
97/98	1	3	0	4
98/99	2	1	5	8
99/00	1	0	0	1
00/01	N/A	N/A	N/A	N/A

TABLE 5 -COYOTE VALLEY STEELHEAD FACILITY

COHO SALMON RETURNS (1992-2001)

YEAR	MALE	FEMALE	GRILSE	TOTAL
92/93	0	0	0	1
93/94	5	2	1	8
94/95	0	1	0	1
95/96	0	0	0	0
96/97	1	1	0	2
97/98	0	0	0	0
98/99	0	0	0	0
99/00	0	0	0	0
00/01	0	0	0	0

Figure 7

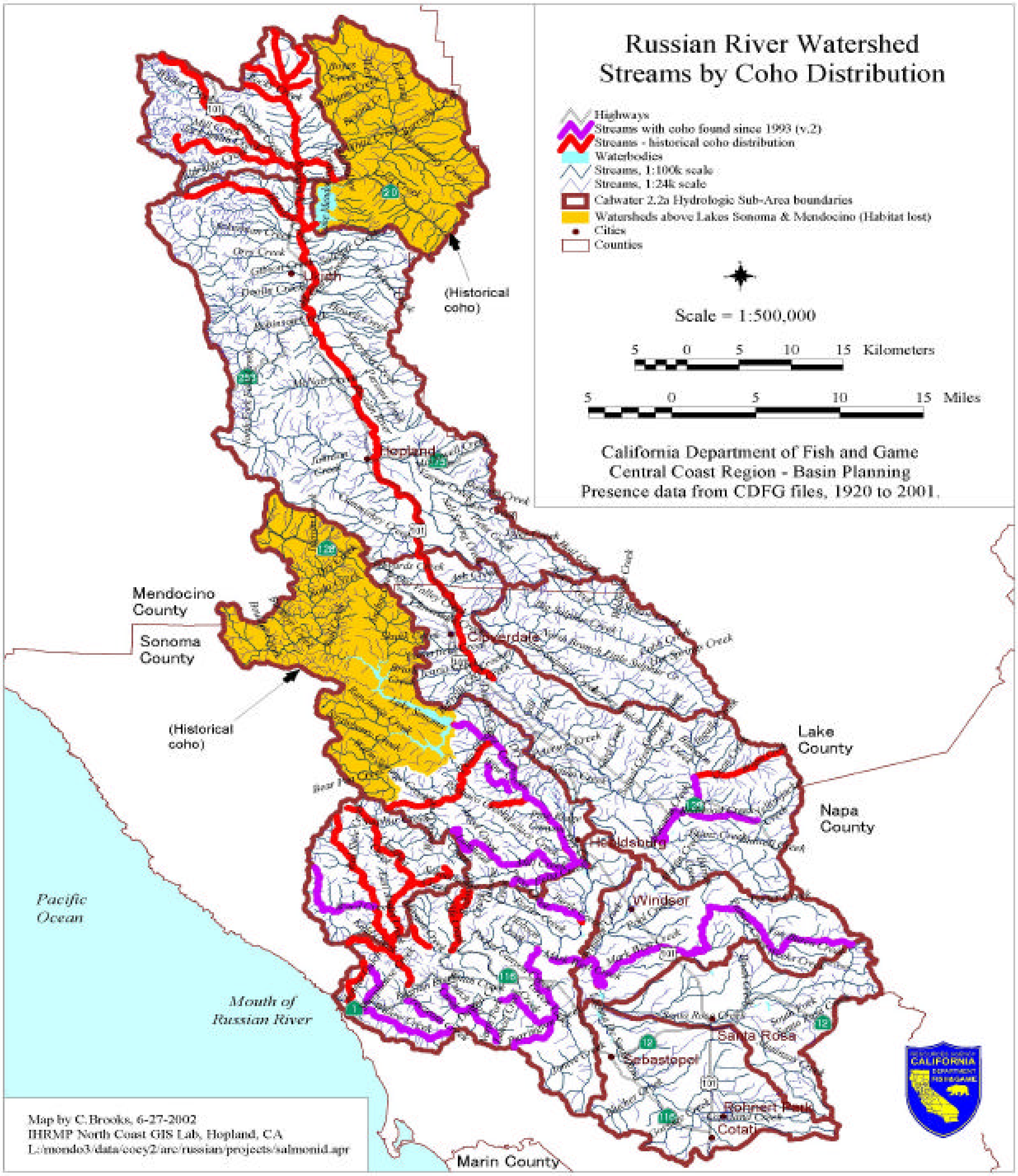


. No policy has been finalized with regard to spawning protocol for hatchery originating coho returns, however, at present, hatchery personnel have been directed to neither spawn nor kill any returning hatchery origin coho salmon. DFG is currently developing statewide policy and directives will be issued to hatchery personnel on a case by case basis if hatchery coho return to the facility until an approved policy is in place. However, a captive broodstock program is presently being drafted by CDFG with regard to recovery planning for coho salmon in the Russian River. It is proposed that continued genetic analysis will dictate the direction of future policy regarding spawning of any returning coho salmon to either facility. If runs exceed 100 spawning pairs, hatchery production may be resumed. Recent coho distribution (1994-2000) in the Russian River is also much reduced from historic range (compare Figure 8 to figure 6). Figure 8 also depicts the estimate of current range developed from recent, although limited sampling efforts (sampling conducted in 2001, found coho in only 3 of the 32 historic streams).

Pink Salmon (*Oncorhynchus gorbuscha*)

Pink salmon were also once found in the Russian basin, but their extent is debated even more than chinook. Numbers were also likely far less and were estimated to be functionally extinct (Nehlsen et al. 1991). In a review of historic records SEC (1996) found that:

> "The last spawning was documented in 1955. Only sporadic angler catches have been reported since then (Moyle 1976a; Coey, CDFG, personal communication). Prior to 1955, pink salmon returned in "good" numbers (various anecdotal accounts indicate this may have been in the hundreds) in 1949, 1951, and 1953 (Wilson 1954). The Russian River run represented the pink salmon's southernmost distribution (Moyle 1976a). No reason for decline or extirpation is presented in the literature, but the run probably was small, and cumulative watershed degradation resulted in conditions no longer favorable for continued existence."



8. Estimates of historic (1920-1994) and current (1994-2002) coho salmon range in the Russian River tributaries.

Steelhead *(Oncorhynchus mykiss)*

Information on steelhead is more extensive. In a review of the historical record SEC (1996) found that:

> "Prolific Russian River steelhead runs once ranked as the third largest in California behind the Klamath and Sacramento rivers (COE 1982). Early population estimates are lacking, but anecdotal evidence alludes to large steelhead runs throughout the entire Russian River drainage (Jones, CDFG, personal communication; Anonymous 1893). During the 1930's and on through the 1950's, the Russian River was renowned as one of the world's finest steelhead rivers. A healthy economy thrived on the sport fishing activity (COE 1982). Burghduff (1937) estimated the 1936 sport catch of steelhead at 15,000, and Christensen (1957) estimated the 1956/57 sport catch at 25,000. In 1957 there was an estimated 57,000 steelhead in the Russian River (Prolysts 1984)."

Steelhead utilize virtually every perennial and intermittent stream within the basin, and their distribution has not much changed, except where permanent barriers impede their migration (Figure 6). They have adapted to both the coniferous and hardwood-based systems, and even above barriers (both natural and man-made), "resident" steelhead or "rainbow trout" is found. Local human residents in the lower basin call these resident fish "mountain trout" due to the steep gradient in which they are found and the obstacles they have surmounted.

There have been no basin-wide population estimates of steelhead numbers since 1957, but their numbers have also declined. Figure 10 steelhead from SEC (1996) depicts their decline.

Since steelhead is not subject to ocean catch, little information exists coast wide, except where hatchery information exists. Hatchery efforts in the Russian River have largely been successful, and WSH has established an annual run. Since 1981, combined return numbers for Warm Springs and Coyote dams range between 333 and 10,310. Recent hatchery returns for steelhead at Warm Springs Salmon and Steelhead Hatchery are shown in Table 6, while those for Coyote Valley Steelhead Facility are shown in Table 7. Figure 11 shows steelhead returns for both facilities from 1980-2001 and Figure 12 shows smolt to adult survival rates. The large returns in 1995, is thought to be the result of improved ocean conditions, high rainfall, and large-scale hatchery plants at both Warm Springs Hatchery and Coyote Valley Fish Facility. Currently only the hatchery run is spawned at WSH and CVFF while wild fish are relocated to the tributaries.

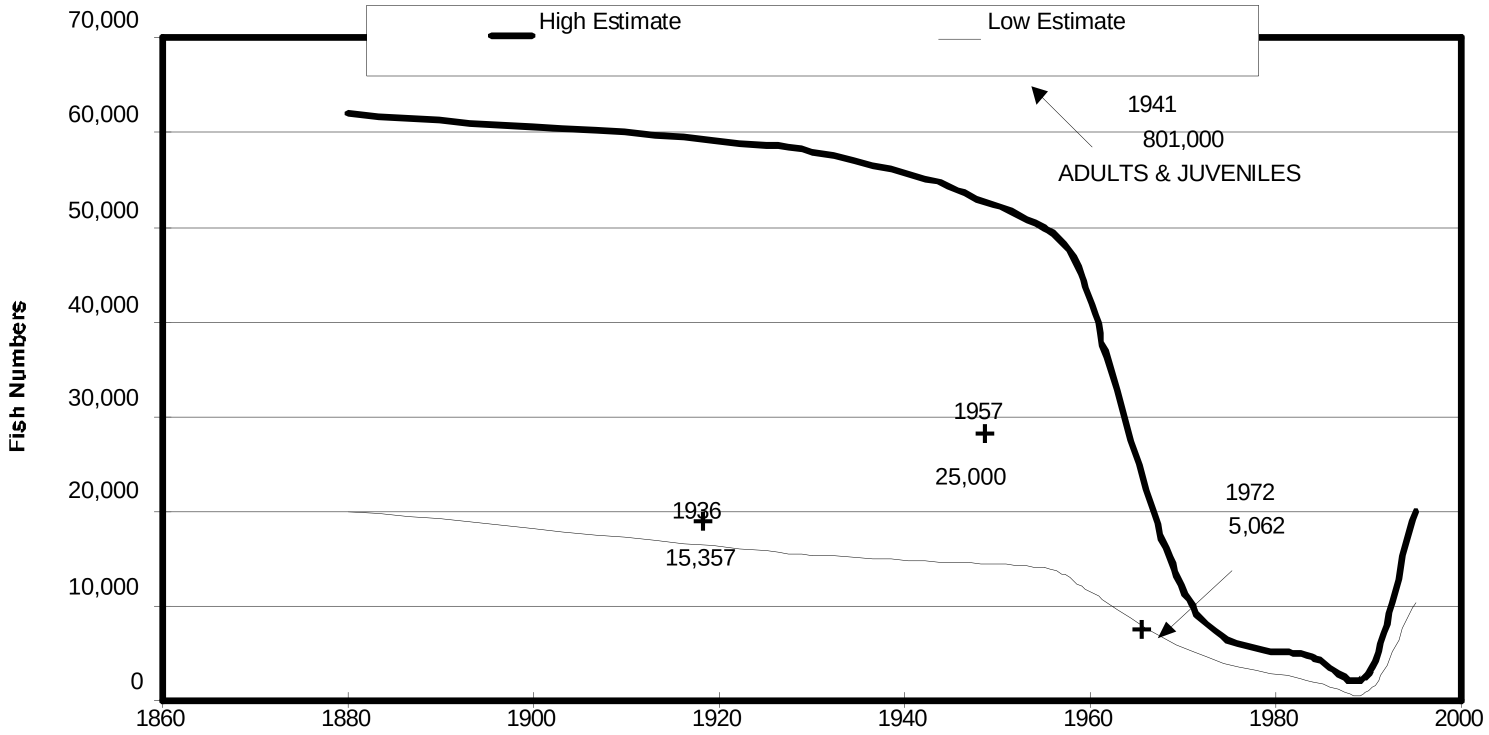


Figure 10 Hypothetical steelhead escapements to the Russian River. [Based on data from Coyote Valley Fish Facility, Warm Springs Hatchery, and estimates from CDFG personnel. All data points marked + from Prolysts (1984).]

TABLE 6 - WARM SPRINGS SALMON AND STEELHEAD HATCHERY STEELHEAD RETURNS (1980-2001

YEAR	**MALE**	**FEMALE**	**HP**	**TOTAL**
80/81	148	185		333
81/82	124	235		359
82/83	322	242		564
83/84	1039	923		1962
84/85	369	468		837
85/86	812	484	4	1300
86/87	519	696	36	1251
87/88	660	375	10	1045
88/89	453	421	17	891
89/90	428	260	15	703
90/91	239	181	3	423
91/92	750	834	7	1591
92/93	1378	1289	2	2669
93/94	856	895	9	1760
94/95	3561	4525	14	8100
95/96	2135	1958	12	4105
96/97	1729	1910	9	3648
97/98	656	687	1	1344
98/99	1219	1012	5	2236
99/00	1509	1794	11	3314
00/01	N/A	N/A	N/A	N/A

TABLE 7 -COYOTE VALLEY STEELHEAD FACILITY STEELHEAD RETURNS (1992-2001)

YEAR	MALE	FEMALE	HP	TOTAL
92/93	182	120	8	310
93/94	229	198	13	440
94/95	1147	1054	9	2210
95/96	1129	980	6	2115
96/97	1793	1934	8	3735
97/98	619	932	8	1559
98/99	793	798	5	1596
99/00	976	1292	2	2270
00/01	N/A	N/A	N/A	N/A

Figure 11

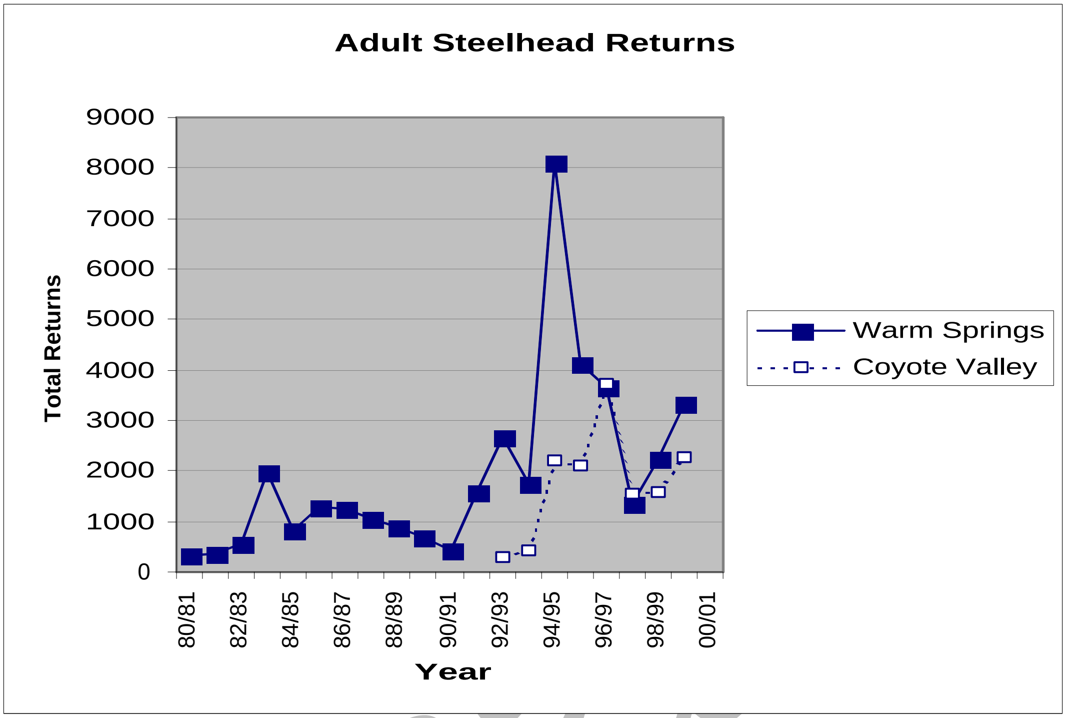
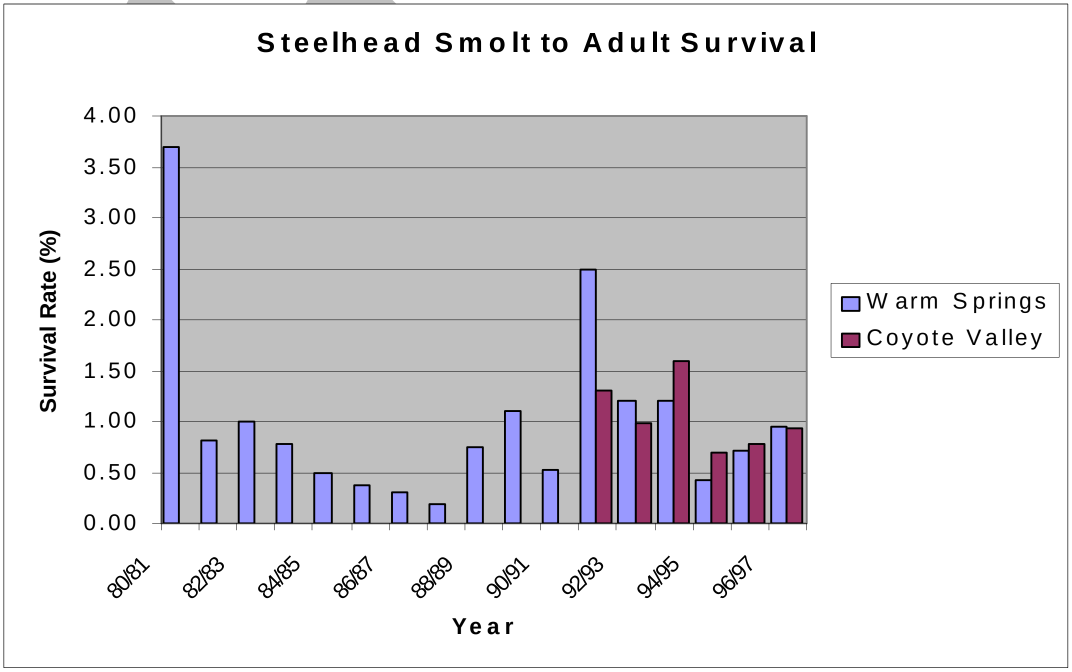


Figure 12



CVFF STEELHEAD EGGS TAKEN (1992-2000)

YEAR	CVFF - RUSSIAN RIVER
1992-93	530,000
1993-94	615,000
1994-95	460,000
1995-96	590,000
1996-97	582,000
1997-98	775,000
1998-99	535,000
1999-2000	510,000

Spawned fish are not selected for size. As of 1999 it has been the policy at both facilities to use broodstock originating only from the Russian River. Previous to the implementation of this policy, broodstock included Russian River origin as well as out of basin sources. Now the wild fish, commonly called "bluebacks", are kept separate from the other steelhead when held before release.

FISH HABITAT REQUIREMENTS

Every species has specific needs that must be filled in order for them to complete their lifecycle. For salmon and steelhead trout these needs include: good water quality with a high level of dissolved oxygen, adequate water temperatures, adequate flows, clean spawning gravels, complex instream and riparian habitat, sufficient food supply, access to spawning and rearing habitat, estuarine habitat (for residency prior to seaward migration), and barrier-free outmigration. Each of these elements is critical to the health and survival of the individual fish and the population as a whole.

ADULT MIGRATION

TIMING

Timing for upstream migration by adult salmonids is primarily dependent upon flows and temperature (Figure 13 and Table 13.1 (from SEC)), which are dependent upon rainfall and local climates. Coho prefer temperatures from 40° to 49° F for entering freshwater and steelhead prefers temperatures from 46° to 52° (Rich 1997). Peak river entry varies greatly along the

Pacific coast, as well as within California. NMFS (1997) during the review of listing pacific salmon, found that peak runoff and mean river temperature were important factors in determining river entry of pacific salmonids. These were also some of the variables used in determining different Evolutionarily Significant Units (ESU). This is because the run of fish that utilize a particular drainage has evolved over time with the set of conditions that makeup the geographical characterization. Generally, NMFS found that the farther south the river, the later cooler temperatures arrive, the later the peak flow occurs, and thus the later river entry occurs by fish in the winter. Thus the Russian, being within the central coast area, has a later run timing than many Northern California streams. Run timing also varies by species, with salmon generally entering the river earlier and steelhead later.

Chinook salmon enter the Russian River between August and January, and the bulk of chinook spawning takes place in November and December. Coho salmon enter the Russian River between November and January, with most spawning taking place in December. Steelhead may enter the Russian River between December and April, with most spawning taking place from January through March. Chinook and coho salmon die soon after they spawn. Steelhead, however, usually returns to the ocean after spawning (from February through as late as May), before repeating the upstream journey to their spawning grounds up to three or four times during their lifespan.

FLOWS

Adequate flow levels are required for upstream migration, for attraction into tributaries harboring suitable spawning habitat, and for outmigration during smoltification. Inadequate flows can physically restrict a fish’s ability to swim upstream. It has been reported that 7 inches

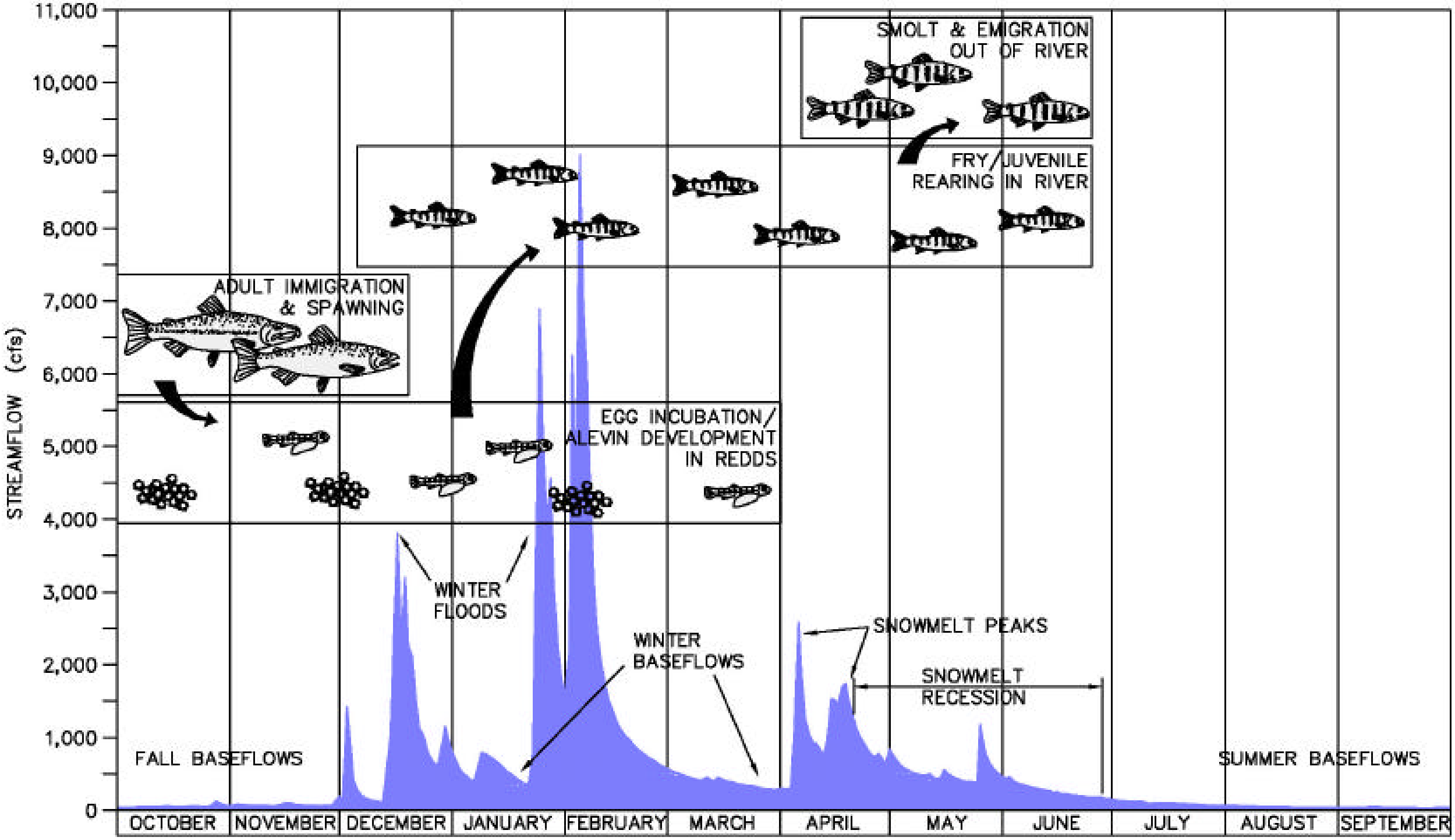


Figure 13 – Hypothetical correlation of salmonid life cycle to flows. Courtesy of The Lower Clear Creek Technical Workgroup (Bureau of Reclamation, 1999).

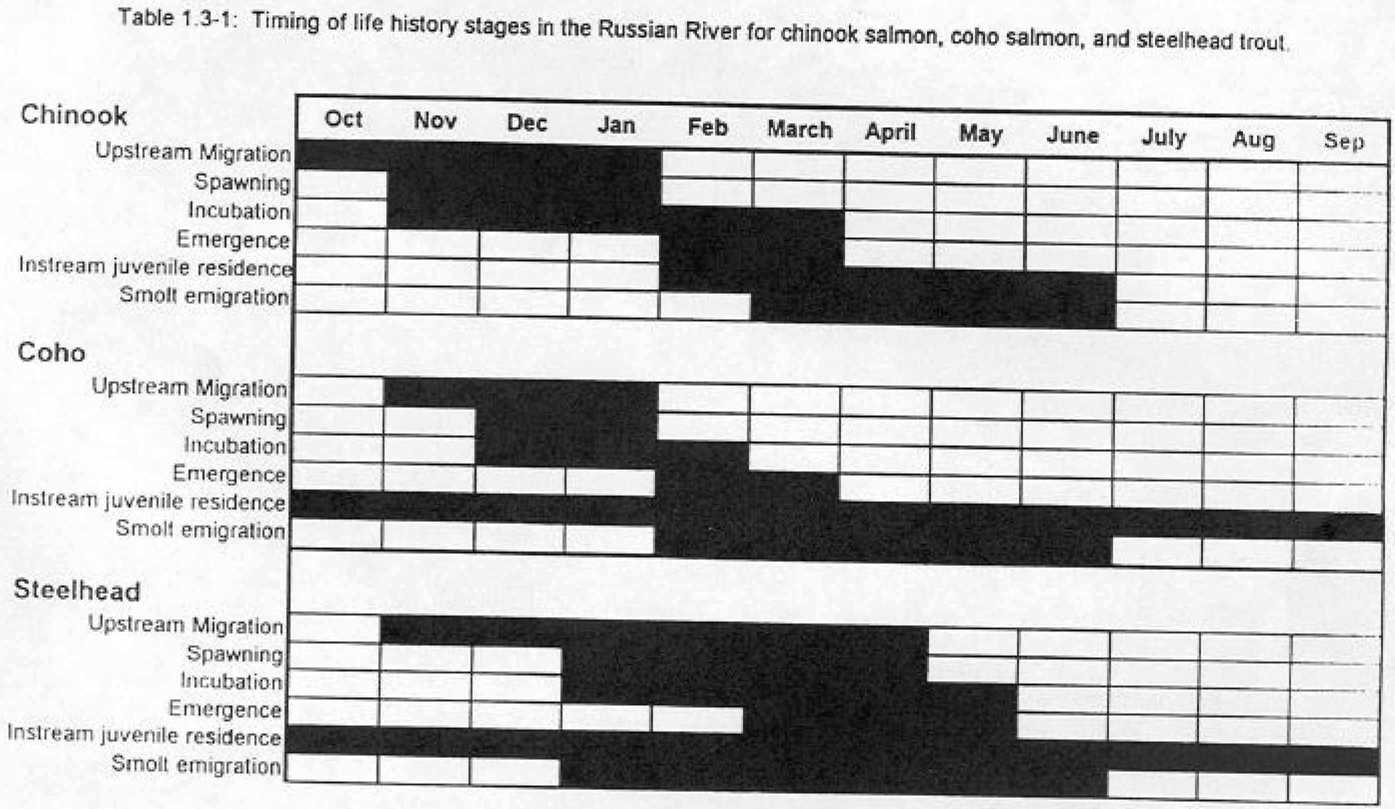


Table 1.3-1: Timing of life history stages in the Russian River for chinook salmon, coho salmon, and steelhead trout.

	Oct	Nov	Dec	Jan	Feb	March	April	May	June	July	Aug	Sep
Chinook												
Upstream Migration	■	■	■	■								
Spawning		■	■	■								
Incubation		■	■	■	■	■						
Emergence					■	■						
Instream juvenile residence					■	■	■	■	■			
Smolt emigration						■	■	■	■			
Coho												
Upstream Migration		■	■	■								
Spawning			■	■								
Incubation			■	■	■							
Emergence					■	■						
Instream juvenile residence	■	■	■	■	■	■	■	■	■	■	■	■
Smolt emigration					■	■	■	■	■			
Steelhead												
Upstream Migration		■	■	■	■	■	■					
Spawning				■	■	■	■					
Incubation				■	■	■	■					
Emergence						■	■	■				
Instream juvenile residence	■	■	■	■	■	■	■	■	■	■	■	■
Smolt emigration				■	■	■	■	■	■			

1.3-4

is the minimum depth required for the successful migration of adult steelhead (Barnhart 1986, as cited in McEwan 1996) and coho (Rich 1997).). Inadequate flows and low water levels also contribute to water quality problems during the hot summer months (as discussed in the Temperature and Flow section). Conversely, too much water from high water velocities could also restrict salmonids from swimming upstream. Steelhead prefer to migrate in velocities of less than 10 to 13 feet/second (ft/s)(Reiser and Bjornn 1979, as cited in McEwan 1996), while coho salmon prefer to migrate in velocities of less than 8 ft/s (Rich 1997). However, high winter flushing flows are necessary within the stream to maintain the channel and to move and clean gravels.

PASSAGE

Salmon and steelhead are powerful jumpers and can ascend many potential barriers as long as there is a pool of sufficient depth below the jump and a place of slow water to rest between a series of jumps. If a barrier is too high to jump or there is not a deep pool directly below it, salmon and steelhead will often repeatedly attempt to overcome it until they become exhausted or dies trying, when water velocity is too great or the amount of flow is too low, mortality can also occur.

Table 14 from Taylor (2000) displays minimum water depth requirements and recommended swimming and leaping abilities for several salmonid species and life stages commonly found in California.

Table 14 Depths and swim speeds adapted from NMFS (2000); Hunter and Moyle (1986).

Species or Lifestage	Minimum Water Depth	Prolonged Swimming Mode		Burst Swimming Mode		
		Maximum Swim speed	Time to Exhaustion	Maximum Swim Speed	Time to Exhaustion	Maximum Leap speed
Adult chinook, coho, and steelhead	1.0 feet	6.0 ft/sec	30 minutes	10.0 ft/sec	5.0 ft/sec	3.0 ft/sec
Coastal cutthroat trout and rainbow trout	0.5 feet	2.5 ft/sec	30 minutes	5.0 sec	5.0 sec	5.0 sec
Juvenile coho salmon and steelhead	0.5 feet	2.0 ft/sec	30 minutes	12 ft/sec	5 ft/sec	3 ft/sec

SPAWNING

SPAWNING GRAVEL SUPPLY

Clean, abundant gravel and cobble are essential in successful spawning. The transport and deposition of coarse substrates within a stream system determines the availability of sites suitable for salmonid spawning. The size and composition of substrate used for spawning is also important, and preference varies by species. Steelhead and coho salmon generally prefer substrate sizes of 0.5 to 6 inches dominated by 2- to 3-inch gravel, while chinook salmon require substrate from 0.5 to 10 inches dominated by 1- to 3-inch cobble (CDFG 1997). Unlike salmon, steelhead will spawn in relatively small pockets of gravel. Generally, spawning habitat is not thought to limit steelhead production.

SPAWNING HABITAT QUALITY

In order to keep eggs well oxygenated while they incubate in redds, gravels must be free of silt and fine sediments to allow the permeation of flowing water. Ideally, gravel and cobble should contain less than 5% sand and silt (McEwan et al 1996). Interestingly, studies have shown that the redd building activity itself generally cleans the redds of fines < 1 mm down to about 7%. However, when silts are mobilized again, they can quickly re-infiltrate clean gravels.

FLOW AND TEMPERATURE

Salmon and steelhead prefer at least seven inches of depth during spawning and a velocity of no greater than three feet per second (Rich 1997). Naturally, excessive flows can result in high velocities causing bed mobility. Redd scouring can occur interrupting the incubation process. This may occur naturally, normally through infrequent peak storm events. It may also occur artificially, through the construction of flood control projects which increase runoff peaks or discharge, or through dam releases.

Steelhead prefer temperatures from 46° to 52° F for spawning, while coho salmon prefer temperatures from 40° to 49° F (Rich 1997). Steelhead spawn in areas with water velocities ranging from .7 to 5.6 ft/s (Rich 1997) but prefer velocities of about 2 ft/s (Bovee 1978). Coho prefer to spawn in slightly lower water velocities, ranging from 0.7 to 3.0 ft/s (Rich 1997).

According to CDFG’s Habitat Restoration Manual (1997), chinook salmon generally spawn in water from one to three feet deep. However, spawning can occur in depths from 0.5 to greater than 20 feet deep. Other criteria include water velocities of 1 to 3 feet per second, [and] a gradient of 0.2 to 1.0 percent. Escape cover for spawning adults is also important. The location of spawning will vary from one year to another depending on the timing and amount of fall and winter rains. In drought years, spawning may occur in mainstem rivers, while during years of higher flows, spawning may occur in upper basin tributaries.

EMBRYO DEVELOPMENT

IN-GRAVEL

Salmon and steelhead eggs hatch in 50 to 60 days from the time the female deposits her eggs into a redd, depending on water temperature. They cannot develop properly without cold, well-aerated water. During egg incubating, a significant increase in water temperature or a decrease in the amount of dissolved oxygen in the water can be fatal to the eggs. In winter, steelhead egg mortality begins to occur at 56°F (McEwan et al 1996).

Once they are hatched, the tiny salmonids continue to live in the gravel as alevins for two to three weeks until their yolk sacs are absorbed. At this point, they emerge out of the gravel and enter the stream as fry to begin the freshwater rearing stage of their lifecycle. During the time the eggs and alevin spend in the gravel, they are very vulnerable to any changes in sediment delivery to the stream or streambed disruption. Abrupt changes in flow, initiation of bed movement, or stream siltation can destroy established redds by washing them out, or filling them in, respectively. Changes in flow can also impact redds by dessication or by causing changes in water quality

JUVENILE REARING

HABITAT AVAILABILITY

Salmonids need a variety of habitat types such as pools, riffles and flat waters to accommodate different life stage functions during their lifecycle (Figure 14). Deep pools provide depth for cool refugia especially where general water and air temperatures are high. Complex in-stream habitat is an absolute essential in the rearing and social structure of salmonids. Structure within pools creates microhabitats. Large and small woody debris, undercut banks, root wads, overhanging terrestrial vegetation, aquatic vegetation, boulders, and bedrock ledges all supply fish with shelter from predators, territorial niches, and eddies where fish can rest during high flows. Salmon and steelhead are aggressive, cannibalistic, and territorial creatures. For a large pool to be inhabited by numerous fish there must be sufficient complexity; that is, there must be plenty of cover so that each fish can preside over a different niche within the pool. Log cover structures provide rearing fry with protection from predation, rest from water velocity, and also divide territorial units to reduce density related competition.

Each species of salmonid has a unique lifecycle and habitat requirements. The general habitat requirements are outlined from CDFG's *California Salmonid Stream Habitat Restoration Manual* (Flosi et al 1998).

Chinook Salmon

Immediately after emergence, chinook fry are found in quiet water areas, along the stream bank, close to cover such as tree roots or logs. Juvenile chinook move into locations of higher velocity, either along the stream margin or in boulder runs away from the shore. Most chinook smolts migrate to the estuary or ocean in the spring. Some juveniles may remain in large pools with complex cover until they emigrate in the fall. In general, the healthier and larger the smolts are when entering the ocean (due to high quality water, habitat, and food sources), the more likely they will return as fully mature spawners.

Coho Salmon

Coho salmon have a more extended freshwater stage in their life history than chinook. Young coho spend their first year of life in the riverine environment prior to migrating to the ocean. Consequently, adequate cover, cool water, and sufficient food to sustain them through their fry and juvenile stages become critical habitat components. Juveniles are normally found in relatively slow current, shallow, quiet areas, usually associated with backwater pools, and dammed pools, but they are also found in side channels and along the quiet water margins of other types of habitats. In periods of high flows and cold water temperatures, juvenile coho shift to slow, deep pools, beaver ponds, or to side channels and backwater pools off the main stream. Under these conditions, the young fish are torpid and seek cover under rocks, tree roots, logs, debris, and in log jams.

During summer, preferred habitats are primary pools or backwater eddies in association with an undercut bank, submerged tree roots, or branches and logs. Boulder root wad combinations, large wood accumulations, whole trees, boulder clusters, and digger logs provide escape cover. Tree tops, branches, and other small woody debris provide especially good summer cover for coho.

Steelhead

Steelhead has more variable life histories than salmon. Although they generally remain in fresh water for two years prior to entering the ocean, some steelhead enter the ocean after one year in fresh water, some after three or more years, and some never leave fresh water. Those that stay longer in fresh water enter the ocean at a larger size, thus are more likely to return as fully mature spawners.

During their first summer, steelhead is generally found in relatively shallow areas, with cobble or boulder bottoms at the tails of pools, or in riffles less than 24 inches deep. In winter, they are found under large boulders in shallow riffles and quiet backwater areas. Preferred summer habitat of young-of-year (YOY) juveniles includes log accumulations, heads of pools, runs, and riffles. Large boulder substrate is important in runs and riffles. Surface turbulence or white water is also an important overhead cover feature in these areas. During winter, YOY steelhead is found in pools, or along stream margins containing debris, logs or boulders. Most cover structures, such as boulder clusters and root wads, provide both summer and winter rearing. Sometimes, turbulence and depth alone may be adequate sources of cover.

In large streams, 1+ fish also rear in glides and riffles with wood or boulder cover or in pocket water around boulders. Backwater pools, secondary channel pools and pocket water are winter habitat types that provide refuge during periods of high water.

Figure 15 depicts habitat preference by species and season. A wide diversity of habitat conditions and good habitat quality is necessary to sustain all 3 species in a particular stream.

Figure 14 - Level III and Level IV Habitat Types required by salmonid fishes for different life stage functions. ( ) are the standardized abbreviations adopted by DFG.

RIFFLE		
	Low Gradient Riffle	(LGR)
	High Gradient Riffle	(HGR)
	CASCADE	
	Cascade	(CAS)
	Bedrock Sheet	(BRS)
FLATWATER		
	Pocket Water	(POW)
	Glide	(GLD)
	Run	(RUN)
	Step Run	(SRN)
	Edgewater	(EDW)
Pools		
	MAIN CHANNEL POOL	
	Trench Pool	(TRP)
	Mid-Channel Pool	(MCP)
	Channel Confluence Pool	(CCP)
	Step Pool	(STP)
	SCOUR POOL	
	Corner Pool	(CRP)
	L. Scour Pool - Log Enhanced	(LSL)
	L. Scour Pool - Root Wad Enhanced	(LSR)
	L. Scour Pool - Bedrock Formed	(LSBk)
	L. Scour Pool - Boulder Formed	(LSBo)
	Plunge Pool	(PLP)
	BACKWATER POOLS	
	Secondary Channel Pool	(SCP)
	Backwater Pool - Boulder Formed	(BPB)
	Backwater Pool - Root Wad Formed	(BPR)
	Backwater Pool - Log Formed	(BPL)
	Dammed Pool	(DPL)

Figure 15 - Generalized habitat preferences from CDFG's *California Salmonid Stream Habitat Restoration Manual* (Flosi et al 1998).

Habitat Type

	SPRING	SUMMER	FALL	WINTER
STEELHEAD				
0+ REARING	EDW	ALL HABITAT TYPES	POW/BWP/SCP	
1+ REARING	LSP/RUN		POW/LSP/HGR	POW/BWP/SCP
SPAWNING	MCP/LGR/POW			MCP/LGR/POW
COHO				
JUVENILE REARING	BWP/LSP/DPL		ALL POOLS	MCP/BWP/SCP
SPAWNING				MCP/LGR/POW
CHINOOK				
JUVENILE REARING	MCP/BWP	MCP/LSP		
SPAWNING				MCP/LGR

According to CDFG's California Salmonid Stream Habitat Restoration Manual (1996?), the amount of effective cover and habitat complexity within a pool is easily as important, if not more important, than the size of the pool. The manual refers to a study conducted on five different Oregon streams, to determine the effectiveness of placing tree bundles of fir, alder, maple and myrtlewood in pools. Juvenile coho and steelhead populations in 16 pools were sampled before and after tree bundles were added. Originally, these pools were holding 12 percent of their summer coho population during the winter. The year after the tree bundles were added, however, these same pools contained 74 percent of their summer coho population during the winter sampling. The study also showed an increase in winter steelhead populations the year after tree bundles were added.

Large woody debris (LWD) has by far the largest influence on habitat diversity, and the influence that LWD has on the diversity of juvenile salmonid populations, has been documented by Reeves et al. (1993) and others. LWD has also been shown to be an important factor in collecting the substrate environment for benthic invertebrates that serve as food for rearing salmonids (Sedell et al. 1984, Sedell et al. 1988, and Bisson et al. 1987).

The relationship between large woody debris (LWD) and pool formation, and gravel retention is extremely important to salmonids and other aquatic life. The importance of large woody debris (LWD) in the development of a stream's morphology and biological productivity has been well documented over the last twenty years. LWD is generally recruited to streams during storms. During high flow events LWD scours pools which provide summertime habitat for developing fry and sort and retain gravel for spawning adults. Bilby (1984) and Rainville et al. (1985) found that in nearly 80 percent of the pools surveyed in small streams, LWD was the structural agent forming the pool or associated with the pools development. LWD also tends to collect small woody debris which serves as the primary food-base for insects (the primary food-base for developing salmonids). Thus, LWD influences the physical form of the channel, movement of sediment, retention of gravel, and composition of the biological community (Bilby and Ward, 1989).

TEMPERATURE AND FLOW

Cold water flows are essential to salmon and steelhead during each stage of their lifecycle. Salmonids prefer temperatures between 55° (12.8°C) to 60°F (15.6°C) (optimal temperatures may vary depending on life stage and stock characteristics). Colder water generally has a higher level of dissolved oxygen. As water temperatures increase, dissolved oxygen content lowers. As temperatures rise to high levels, salmonids lose their ability to breathe and become prone to lethargy, disease and death. In addition, reduction of flows reduces the habitat available within the stream channel.

WATER QUALITY

Good water quality is essential for both salmonids and the aquatic insects on which they feed. Water quality refers to a number of factors, including: temperature, turbidity (siltation), dissolved oxygen, pH, sediment, suspended material, settleable material, toxicity, pesticides, and chemical constituents.

FOOD SUPPLY

Salmonids need an adequate supply of food to survive. For the freshwater portion of their lives, especially during the critical juvenile years, food consists primarily of aquatic insects, or macro-invertebrates. These insects, including mayflies, caddisflies, midges, stoneflies, dragonflies and damselflies, are the larval or nymph stage of flying insects. These benthic macro-invertebrates inhabit the streambed, clinging to the bottom of rocks and debris, and feed on aquatic vegetation and bits of decaying leaves. They require good water quality, variable substrates, aquatic vegetation and an influx of leaves and other organic matter. Clearly, it is essential that riparian vegetation exists along the streambanks to deposit organic matter into the stream to feed the insects. Over evolutionary time, insects in different types of streams have developed a dependence on specific native riparian plants which occur naturally on those streams. Without the presence of these native plant species on the streambanks, the macro-invertebrates could not exist and salmonids could not survive through their juvenile years. Shifts from riparian habitats to constructed channels, and from native vegetation to alien species (such as Arundo donax or Giant Reed), reduces the food supply for salmonids.

RIPARIAN VEGETATION

Native vegetation plays a crucial role in the health and stability of a river system, and provides a critical link in the food chain for aquatic species. Riparian trees and under-story plants control erosion, help to reduce solar radiation and maintain low stream temperatures, contribute material to enhance fish cover and habitat, and provide nutrient input vital to aquatic systems.

Vegetation, particularly native plants with deep root systems, is the best protection against erosion. Roots of trees and under-story plants bind the soil particles together and armor the land, while the canopy of branches overhead disperses the raindrops as they strike the earth. Even dense grasses can provide protection against water and wind erosion. Also, vegetation along the riparian corridor acts as a filter to sediment entering the stream.

EMIGRATION

TIMING

Each salmonid species has developed their own timing pattern for emigration, or outmigration, to the ocean around seasonal flows and temperatures. Based on literature from other river systems, chinook move downstream from March to May (Reimers 1973; Moyle 1976a). For example, a regulated flow reach on the Eel River has a protracted chinook emigration due to unnaturally high and cool spring flows (SEC 1987). Chinook emigration in the Russian River may similarly be protracted due to regulated flows (SEC 1996). Once they reach the ocean, chinook spend between one and seven years there before returning to spawn. Most Russian River chinook, however, return to freshwater as two-to four-year-old adults.

Coho salmon generally spend one year after hatching in fresh water, with most emigration occurring in the spring. After reaching the ocean, coho spend between one and three years there before returning to freshwater to spawn. Most Russian River coho salmon spend two years in the ocean before returning (COE 1982, as cited in SEC 1996). In general, coho prefer depths of at least 2.4 inches, water velocities of 0.3 to 3.6 feet per second and temperatures of 44.6° to 52° F for outmigration (Rich 1997).

Most steelhead emigrate to the ocean between January and June, but some outmigration may occur during any significant runoff event (SEC 1996). Steelhead spend from one to three years in the ocean before returning to freshwater to spawn. In general, steelhead prefer depths of at least seven inches, velocities of 0.3 to 4.9 feet per second and temperatures of 48° to 58° F for outmigration (Rich 1997).

ESTUARY HABITAT

Sands deposited off the mouth of the Russian River, and moved inshore by wave action during the spring and summer historically closed the mouth of the river during periods of low flow, creating a closed estuary or lagoon. Like most estuaries along the northern coast of California, the pattern of closure varies from year to year, depending upon flow conditions and wave action. Prior to augmented flows in the Russian River, closure of the estuary to a productive lagoon system likely varied from year to year, depending upon flow conditions and wave action.

Pacific salmon have been shown to utilize estuaries in some part of their lifecycle, and much literature emphasizes the importance of estuaries in salmonid life history (Healey 1980, 1982; Cannon 1982; Kjelson et al. 1982; Meyers and Horton 1982; Pearce et al. 1982; Simenstad et al. 1982; McKeon 1985; Larson 1987; Mattole Restoration Council 1995). In general, estuaries provide abundant food for rearing fish, prepares them for chemical and temporal changes prior to seaward migration, and has been shown to be crucial to their life stage requirements (RNP 2000).

Much of the research and study regarding estuarine residency and salmonids has focused on chinook salmon. Healey (1982) states that of all Pacific salmon, "chinook are most dependent on estuarine habitat since members of all life history types feed and grow for some time in estuaries, and fry migrants appear totally dependent in the estuary to provide nursery habitat." Reimers (1973) found from scale analysis that the majority of returning adults had spent June-August as juveniles in the estuary before going seaward. Further, from data he concluded that juvenile chinook spending less than 3 months in an estuary habitat seldom returned to spawn. Anderson and Brown (1982) also found that juvenile chinook do not spend majority of rearing time in tributary or mainstem habitat, confirming the importance of the Redwood Creek estuary as the sole rearing place for chinook salmon there. McKeon (1985) compared Redwood Creek river reared to estuary reared juvenile chinook and determined that the estuary reared fish grew to a larger size. This larger size improves ocean survival and return (Reimers 1973). Hatchery efforts to bypass the estuarine phase in degraded estuary conditions were found to improve returns with wild populations (RNP 2000).

Coho salmon have been shown to utilize estuaries just prior to emigration. Healey (1982) found that coho as downstream migrants make use of inner and outer estuary areas. Parker (1971) and Myers (1980) also found estuarine usage by coho. More locally, Anderson (1992 and 1995) found some, although limited, use of estuary in the Redwood Creek system.

Steelhead has been shown to rear in estuaries throughout the summer as well (Amend et al. 1980). In Redwood Creek, the majority of steelhead spend their second year of life in the lower mainstem and estuary (Larson 1987; Anderson 1988). They also found that large numbers of different age classes and a large percentage of older, larger fish reside in the estuary in the summer and fall. Redwood Creek data confirms a similar relationship for river reared and estuary reared steelhead that McKeon (1985) found for chinook, begetting larger size for estuary reared steelhead (RNP 2000) . This larger size confers a survival advantage to the fish that reside in the estuary before returning seaward Reimers (1973).

DESCRIPTION OF THE SUB-BASINS

To get the big picture relative to past, present and potential fish production in a stream or stream system it is necessary to first understand the processes at work in the watershed. Geology, topography, precipitation, soils, vegetation, and land use comprise the makeup of a particular stream system and its watershed. A watershed is defined as the total land area draining to any point in a stream, as measured on a map, an aerial photo or other horizontal plane. A watershed can also be called a catchment area or drainage area. For purposes of this plan we will refer to the Russian River as the “basin”; large contiguous streams and their associated watersheds as “sub-basins”; and tributaries and their associated surrounding landmass as watersheds. Sub-watersheds are individual streams (tributaries to tributaries which may be perennial or intermittent) and their associated surrounding landmass. We will also discuss the estuary and the mainstem (with its’ geomorphologic reaches defined) as sub-basins.

For the purposes of mapping, Calwater 2.2a is the state standard watershed layer which has been utilized here (Figure 16). The California Watershed Map (CALWATER version 2.2) is a set of standardized watershed boundaries meeting standardized delineation criteria. The hierarchy of watershed designations consists of six levels of increasing specificity: Hydrologic Region (HR), Hydrologic Unit (HU), Hydrologic Area (HA), Hydrologic Sub-Area (HSA), Super Planning Watershed (SPWS), and Planning Watershed (PWS). The primary purpose of Calwater is the assignment of a single, unique code to a specific watershed. For the purposes of

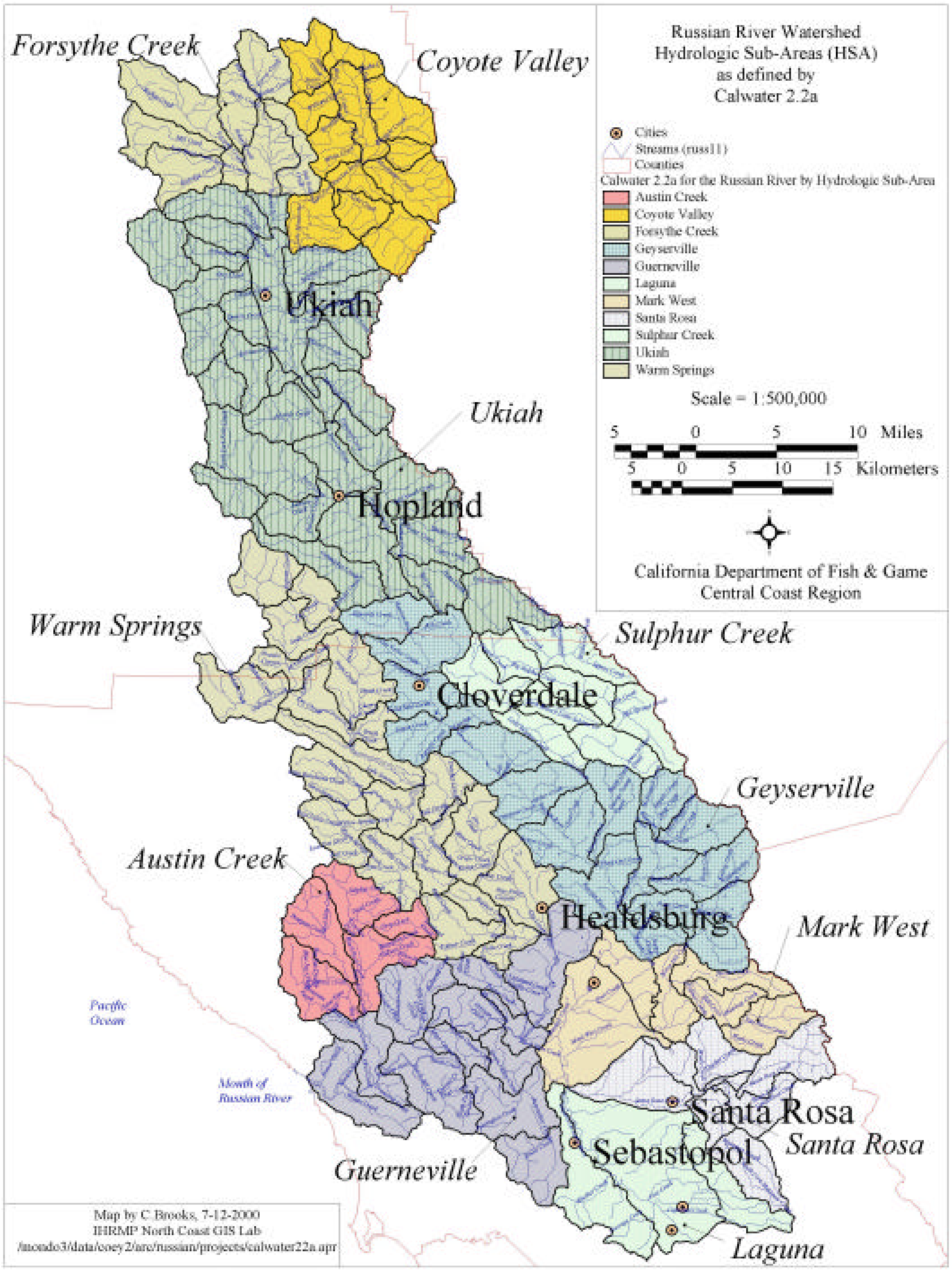


Figure 16. Russian River watershed Hydrologic Unit and the 11 Hydrologic Sub-Areas as classified by Cal-Watershed 2.2a.

this report we will be presenting data categorized by Hydrologic Unit or "basin" (eg. Russian River), Hydrologic Sub-Area or "sub-basin" (eg. Austin Creek), Super Planning Watershed or "watershed" (eg. East Austin), and Planning Watershed or "sub-watershed" (eg. Gilliam Creek).

The primary purposes for Calwater 2.2 include but are not limited to mapping, reporting, and statistical analysis of water resources, water supply, water quality, wild lands, agriculture, soils, forests, rangelands, fish habitat, wildlife habitat, and cross-referencing state and federal hydrologic unit or watershed codes and names. CALWATER boundaries were digitized on a 1:24,000-scale base and thus very accurately divide surface water features depicted on 1:100,000-scale Digital Line Graph hydrography (Richardson 1999). However, CALWATER delineations are primarily designed to be administrative reporting units, and the boundaries are not definitive topographic boundaries nor do they accurately define drainage area above a given point (as a portion of their definition includes nonphysical boundaries, particularly in valley floor and urbanized coastal regions). However, CALWATER boundaries do define fairly well differences in topography, gradient, climate and vegetation among the different HSA's within the Russian River System, and allow aggregation of PWS, for descriptive and comparison purposes.

ESTUARY

The estuarine portion of the Russian River extends from the river mouth to between Duncan's Mills and Austin Creek, approximately 6-7 miles upstream. According to the California Department of Water Resources (1964) tidal action has been documented as far as 10 miles upstream in Monte Rio (PWA 1994). In addition to local climate and precipitation, the estuary is affected by coastal and fluvial processes, including near shore wave climate, tides and river discharge. Historically, prior to major land use changes within the watershed, the mouth of the river was subject to periodic closure by the natural formation of a sand spit or barrier beach (PWA 1994). This barrier beach was, and continues to be, formed by the on-shore movement of sediment, previously discharged by the river at high flows, by the long, low-energy waves that hit the shore during low flow conditions (PWA 1994). Today, the river mouth is still subject to frequent closure under natural conditions, though it is breached regularly by the Sonoma County Water Agency (SCWA) for flood control purposes. Breaching for this purpose normally occurs in the fall, when river flow increases and the water rises in the lagoon behind the sand bar. The SCWA usually breaches the bar when the water level is between 7 and 8 feet on the gauge at Jenner; at higher levels there is a threat of flooding in homes along the river near the mouth. Prior to SCWA's artificial breaching, it was done by the Sonoma County Department of Public Works for many years.

When the mouth of the river is closed by the barrier beach, it forms a lagoon with salinity stratification as a result of limited mixing (PWA 1994). A comparison of river cross-section data collected by SCWA at river mile 2.1 and river mile 5.8 showed no long-term change in the riverbed of the estuary between 1971 and 1992. According to Philip Williams and Associates' *Russian River Estuary Study* (1994), SCWA's data, along with data collected during a 1992 bathymetric study, "imply that the massive sedimentation observed in other California coastal lagoons has not occurred in the Russian River, although the limited historic data is not conclusive."

One notable landmark within the estuary is Penny Island, a small island that exists in the center of the river approximately 3,000 feet upstream from the mouth. Penny Island has (persisted) in the same general location and form on historic maps since at least 1876 (PWA 1994).

MAINSTEM

For the purposes of this plan, the mainstem of the Russian River will be split into five geomorphic reaches as described in Philip Williams & Associates' document *Geomorphic and Hydrologic Conditions in the Russian River, California: Historic Trends and Existing Conditions* (1993).

1) Beginning at the mouth, the first reach is the Lower Reach, which is an alluvial reach extending *upstream* to river mile 23, at the Wohler Bridge crossing. The top 2 miles of this reach includes a bedrock stretch known as the Wohler Bridge Constriction. 2) This reach is followed by the Middle Reach, an alluvial reach extending up to river mile 46, upstream of the Sausal Creek confluence in Alexander Valley. This reach includes the Fitch Mountain Constriction, a 14-mile bedrock dominated stretch. 3) Next comes the Alexander Valley Reach, an alluvial stretch which extends upstream to river mile 63, at the Mendocino County border. 4) At this point, the Hopland Valley reach begins and extends to river mile 84.5, at the confluence with Morrison Creek south of Ukiah. The downstream portion of this alluvial reach includes 11 miles of bedrock-dominated channel known as the Squaw Rock Constriction and the upstream end of the Hopland Valley Reach includes the 5.5 mile bedrock stretch known as the Hopland Gage Constriction. 5) The final reach is the Ukiah Valley Reach, an alluvial reach which extends above Lake Mendocino near the headwaters of the Russian at river mile 96.

GUERNEVILLE

The Guerneville sub-basin, in the southwest end of the Russian River basin in Sonoma County, extends from the mouth of the river at the Pacific Ocean, upstream to Healdsburg and east to the outskirts of Sebastopol (Figure 18). Major tributaries include Green Valley Creek, Fife Creek, Hulbert Creek, Dutchbill Creek, and Willow Creek. Elevations range from approximately 4 feet to 2,900 feet in the hills above Willow Creek. The sub-basin is approximately 160 square miles, or 102,301 acres, and includes the towns of Jenner, Monte Rio,

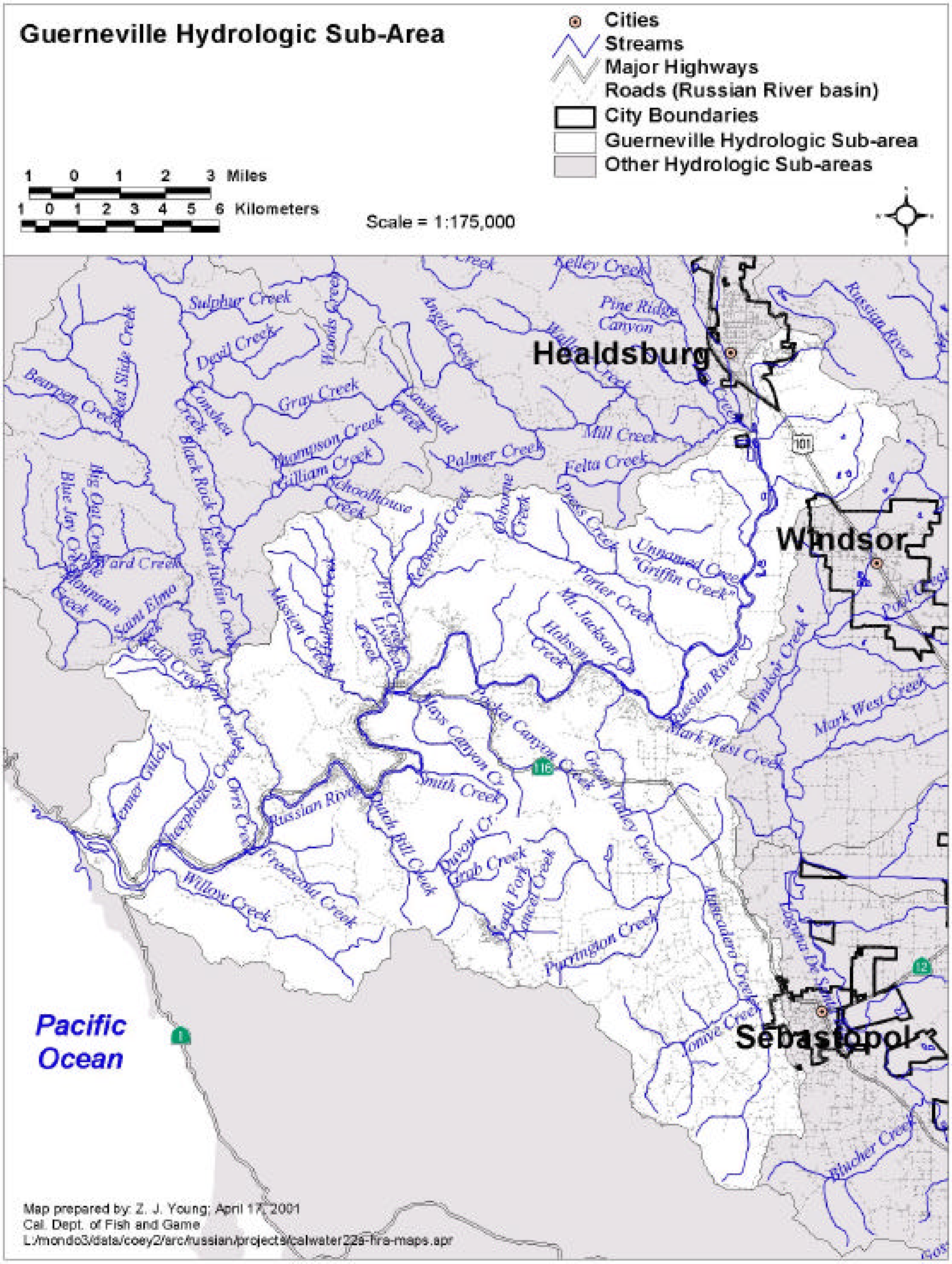


Figure 18. Guerneville Hydrologic sub-area.

Guerneville, Rio Nido, Forestville, Graton, and Occidental. Most of the sub-basin is privately owned, with approximately 805 acres of State Park land in the Fife Creek watershed (Armstrong Woods State Park) and (365) acres in the Willow Creek watershed.

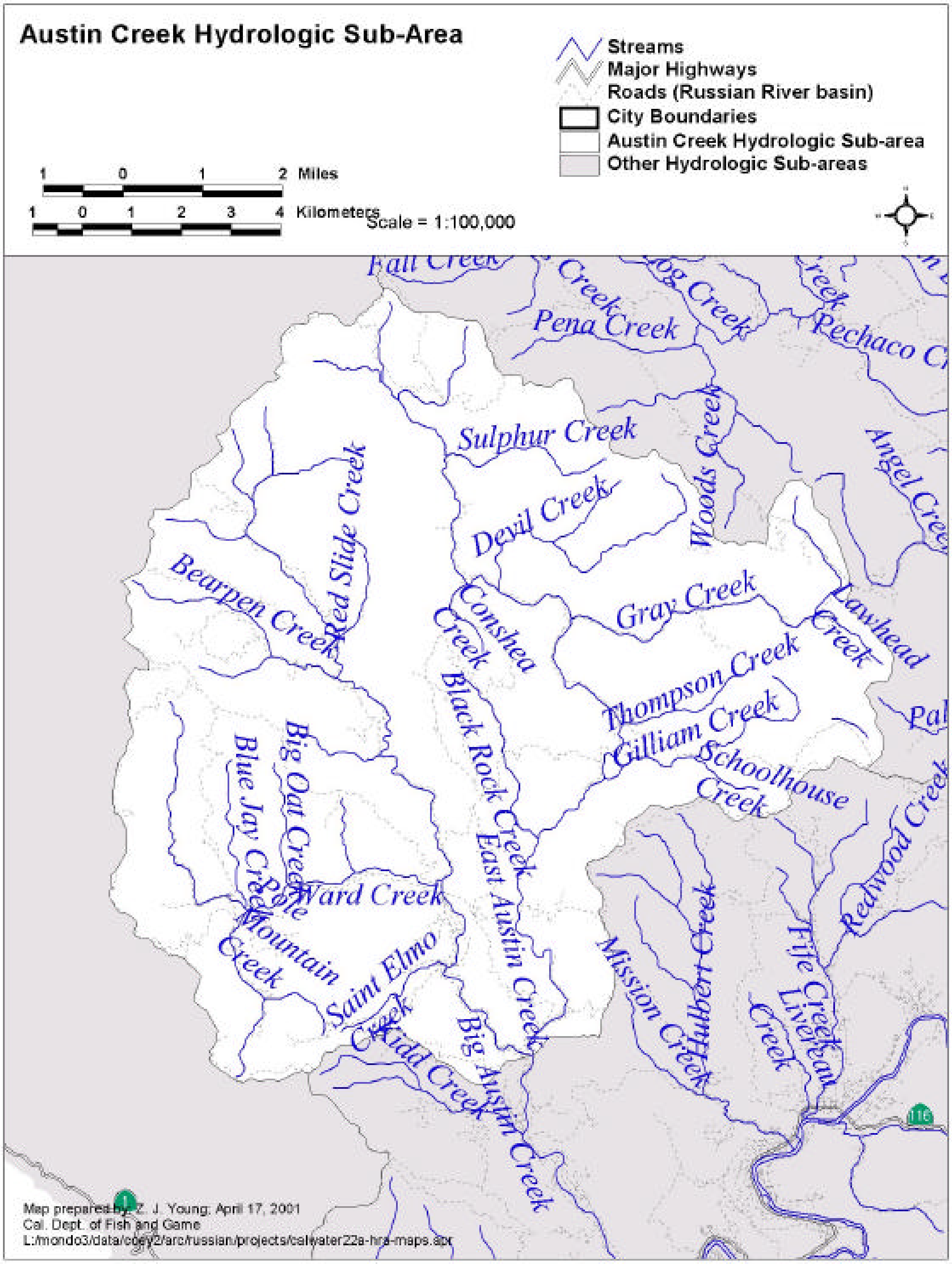
Features include gently sloping hills to the south and east with steeper slopes to the west. Redwood and Douglas Fir forest dominates the watershed, but there are zones of grassland and oak-woodland in the upper watershed and the coastal area is dominated by grassland. The lower reaches of the coastal streams within the basin contain marsh-like environments, which are subject to tidewater influence daily.

Land uses in the Guerneville sub-basin are consistent with the semi-rural setting, with vineyards and orchards located on the fertile floodplain terraces, and timber harvest operations in the mixed conifer forests closer to the coast. Livestock grazing is also a common practice on pasture lands in the coastal hills, and an abandoned hard rock mine is located on Redwood Creek, a tributary to Fife Creek. Tourism and viticulture is the chief economic base in the small towns of the lower river today. Most land use in the area is associated with vineyards, timber production, and the construction trade. Rural and residential development is scattered, with many houses concentrated throughout the narrow floodplain. Many properties are seasonally flooded and most were originally built as vacation homes for residents of the Bay Area. Dispersed commercial uses exist on isolated parcels.

A good deal of historic logging occurred within the sub-basin, particularly in the Willow Creek watershed, which was first logged in the 1860's. A sawmill was built around the lower meadow area later that decade. Narrow gauge rail was constructed in the stream channel and ran to the headwaters. It was used to push lumber uphill, while steam donkey engines were used for log extraction and to bring logs downhill. The rail system was later used to move finished lumber products over the top of the watershed to Bodega Bay for loading on schooners to San Francisco. In the 1950's and 1960's a second logging occurred, claiming much of the remaining old growth and any second growth trees that were large enough to be merchantable. The lower Willow Creek watershed is now part of the State Parks system, and a primitive campground exists on the southern edge of the valley. Mendocino Redwood Company owns most of the upper watershed and manages it for timber production.

AUSTIN CREEK

The Austin Creek sub-basin consists of the Austin Creek Watershed, with the major watersheds of Big Austin, East Austin and Ward Creeks (Figure 19). Numerous perennial and intermittent streams feed both the mainstem of Austin and these larger tributary systems. This watershed enters the Russian River downstream of the town of Cazadero, near Berry's Saw Mill, a currently operating sawmill built at the site of early mills of the timber heydays. The Austin Creek system drains a basin of 62 square miles, or 39,867 acres. Elevations range from about 20 feet at the mouth of Big Austin to 2,111 feet in the headwaters. Coniferous forest dominates the western portion of the watershed but there are zones of grasslands and oak woodlands in the upper eastern areas. The vegetation is mostly redwood forest, but other tree species include



Map prepared by: Z. J. Young; April 17, 2001
Cal. Dept. of Fish and Game
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Figure 19. Austin Creek hydrologic sub-area.

madrone, bay, alder, willow, and cypress. Many of the headwater areas are geologically unstable, and the basin has the highest average annual rainfall of any area within the Russian River region, 75.8 inches (National Climatic Data Center 1995).

The Austin Creek sub-basin has had an active land use history with timber harvest occurring from the late 1800s through the turn of the century and again after World War II. Logging has also occurred on a smaller scale in recent years. Evidence of the narrow gauge railroad, which ran from Cazadero to the headwaters of East Austin and Austin Creeks to mine magnetite is still intact on high terraces in East Austin Creek. Effects from these mines still linger as large gravel deposits in each stream below their source. A wild fire in the 1960s further contributed to unstable slopes and sediment erosion. Historically, many of the streamside residences were only occupied seasonally. Today, most residents live in the area year-round, though the rural communities within the Austin Creek sub-basin are not heavily populated. Major land uses in the Austin Creek sub-basin include timber production, gravel mining and rural development. The watershed is primarily privately owned, except for portions under California State Park System ownership. Much of the sub-basin is now protected from land use development as a part of Armstrong Woods State Park and Austin Creek State Recreation Areas (5,683 acres).

Two major watersheds comprise most of the basin with many small perennial tributaries. East Austin Creek and its tributaries drain a basin of approximately 38.9 square miles, and is a third order stream with approximately 13.1 miles of blue line stream. Much of the drainage is privately owned, with the lower 1.5 miles of East Austin Creek being populated by summer homes. Ward Creek and its tributaries drain a basin of approximately 13.8 square miles, is a third order stream and include approximately 7.3 miles of perennial stream. The vegetation is mixed, consisting of redwood, Douglas fir, California laurel, willow, oak, and blackberry. The watershed is entirely private land ownership and is primarily managed for timber production.

LAGUNA DE SANTA ROSA

The Laguna de Santa Rosa sub-basin, located in the southern end of the Russian River basin in Sonoma County, covers approximately 90 square miles, or 57,600 acres, and contains the Laguna de Santa Rosa and its tributaries (Figure 20). The largest tributaries are Santa Rosa Creek and Mark West Creeks which are discussed as separate sub-basins. Most of the Laguna de Santa Rosa sub-basin, not counting the Santa Rosa Creek and Mark West Creek watersheds, is a dry oak-savanna dominated area where the streams tend to go dry, or nearly so, in the summer. Streams in the southeast portion of the sub-basin that drain Sonoma Mountain have a very high sediment load that tends to drop out when the streams reach the valley floor. These streams probably meandered widely in their natural state, but are now mostly channelized through the urban areas of south Santa Rosa, Rohnert Park, and Cotati.

The Laguna de Santa Rosa lies in the lowest area of the Santa Rosa Plain, and forms an extensive wetland along its meandering 14 mile path from the communities of Rohnert Park and Cotati in the south to the Russian river in the north. During wet periods in the winter the Laguna

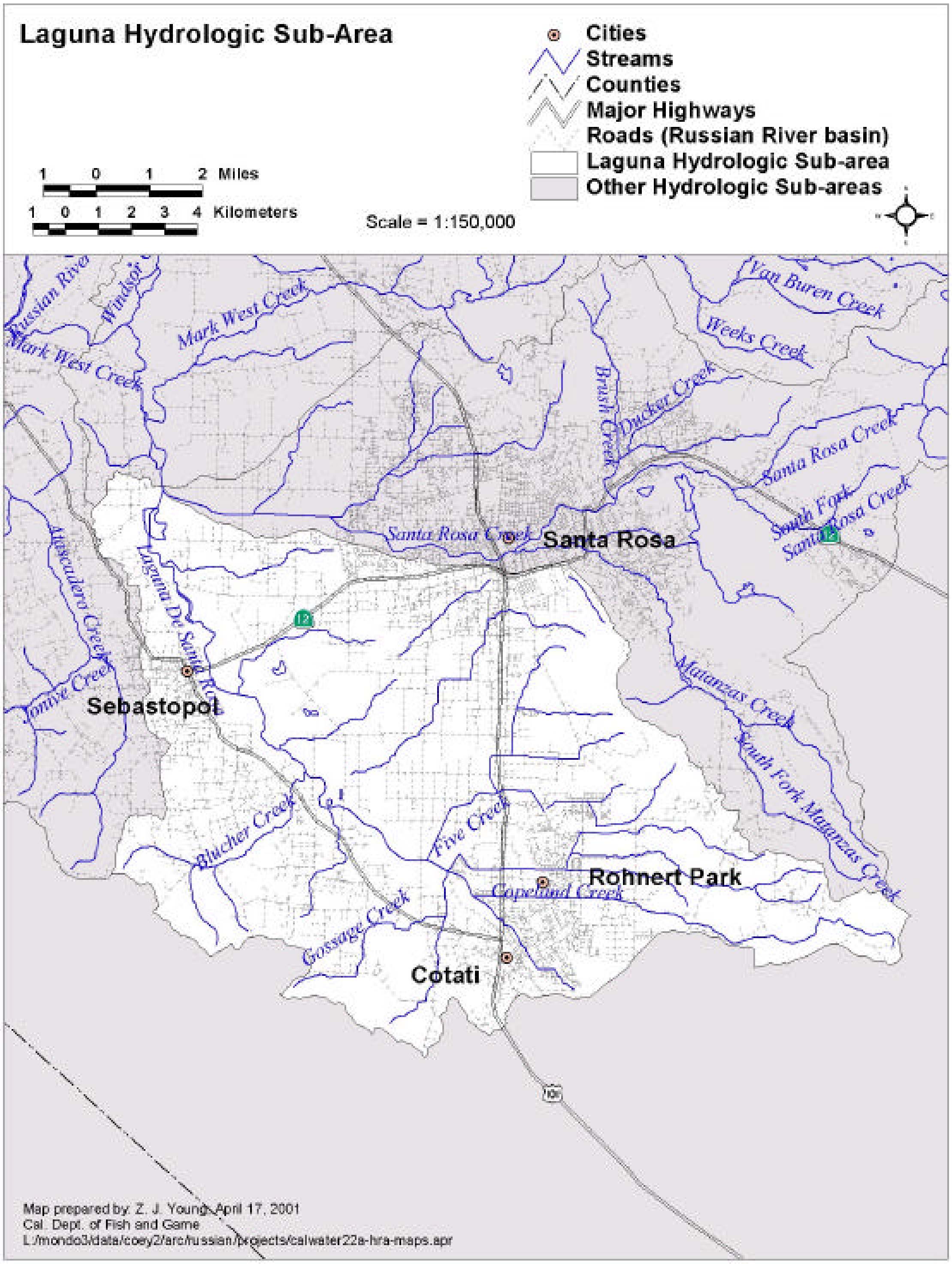

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Figure 20. Laguna de Santa Rosa hydrologic sub-area.

de Santa Rosa swells from its normally narrow channel to what looks like a chain of broad, shallow lakes from Highway 12 near the city of Sebastopol to River Road near the confluence with the Russian River. During a one-hundred year flood event these “lakes” could cover up to 7,000 acres and a holding capacity of 80,000 acre-feet of water (Peckham 1985). During flood events the Laguna de Santa actually experiences flow reversal as the Russian River floods into the Laguna. By late spring the “lakes” have generally drained and the Laguna de Santa Rosa has returned to its narrow meandering channel.

The Laguna wetlands were once an exceeding rich wildlife habitat. There are stories of large herds of elk**.** . A Pomo Indian woman related a story to her granddaughter how the Laguna was once so rich in elk that traffic from Santa Rosa into Sebastopol on roads spanning the Laguna would only be safe when the elk were herded off the road (Peckham 1985). While much of the wildlife habitat has been lost to agricultural development, the remaining wetlands and oak grasslands still provide habitat to a great diversity of wildlife. The Laguna provides critical habitat for migratory waterfowl, and is home for populations of mink, otter, badger, western pond turtle, herons, egrets, osprey, deer, fox, and many other species.

The Laguna plays a crucial role in flood control. In the floods of 1964, when the Laguna reached its full holding capacity, the high water in Guerneville was 14 feet lower than it would have been without the relief valve effect of the Laguna (Peckham 1985). Sonoma County Water Agency flood control engineers have also stated that the Laguna provides more flood control benefits than Lake Mendocino and Lake Sonoma combined.

Over time, farmlands began to encroach upon the Laguna. Trees were cut and wetlands were drained. In 1966 Sonoma County dredged a pilot channel from Sebastopol Road to one mile north of Guerneville Road. Land that was naturally too wet to farm until six or eight weeks after the winter could now be tilled earlier because of the drainage provided by the pilot channel. Over the years, development for agriculture and urban sprawl continued to threaten the fragile environment surrounding the wetlands, climaxing with the construction of The Santa Rosa Wastewater Treatment Facility in 1952.

In 1966 a channel was dredged from Highway 12 to one mile north of Guerneville Road. This was generally referred to as a flood control project, but was actually a drainage project. Land that was naturally too wet to farm until late in the spring could be tilled earlier because of the drainage provided by the channel. The last maintenance dredging of this drainage channel was done in the early 1980's. Since then the property containing the channel was turned over to the Department of Fish and Game and it is unlikely that there will ever again be any channel maintenance dredging.

Today much of the Laguna de Santa Rosa bottomlands are in agriculture. Further upstream in area of Rohnert Park and Cotati the Laguna de Santa Rosa has been channelized as a flood control channel. The most recent work was dredging and widening of the Channel near Stony Point Road in the 1990's to relieve flooding in western Rohnert Park.

Major tributaries to the Laguna de Santa Rosa, aside from Santa Rosa Creek and Mark West Creek which are discussed as separate sub-basins, are Blucher Creek and Copeland Creek. These are the only tributaries known to support populations of steelhead trout.

SANTA ROSA

The Santa Rosa hydrologic sub-basin is located in Sonoma County, in the southeastern portion of the Russian River watershed, and contains the city of Santa Rosa and outlying communities (Figure 21). This sub-basin contains Santa Rosa Creek and its many tributaries and covers an area of approximately 77.4 square miles, or 49,511.6 acres.

Santa Rosa Creek is a tributary to Laguna de Santa Rosa which flows into Mark West Creek. Major tributary watersheds include Mantanzas Creek and the North and South Forks of Santa Rosa Creek. Elevations range from about 59 feet at the mouth of the creek to 2100 feet in the headwaters. Santa Rosa Creek flows through a v-shaped canyon from its headwaters at Hood Mountain through a belt of rolling land before reaching the Santa Rosa Plain. Moving upstream, the creek is channelized for about seven miles from the Laguna de Santa Rosa to the Santa Rosa City Hall, then moves through an oak-woodland, and enters a mixed evergreen system in the upper watershed.

Santa Rosa is the most urbanized and densely populated city within the Russian River basin, divided by Highway 101 and Highway 12. The area has seen a long history of agricultural development followed by urban development. The Santa Rosa Wastewater Treatment Facility, located two miles west of the city of Santa Rosa, was constructed in 1952, to handle the bourgeoning domestic waste created by high-density residential and industrial expansion. The disposition of the discharge from this facility (now permitted under RWQCB) has fed controversy over growth, waste and water issues within the basin. In 1958 the Central Sonoma Watershed Project was drafted, as a flood control measure in the Santa Rosa Creek drainage. The plan included 6 floodwater detention structures having a combined capacity of 5960 acre-feet of water and 33.6 miles of channelized creek. Thus, Santa Rosa Creek, along with some of its tributaries, were permanently concreted into a trapezoidal channel, which now runs under the City Hall.

The Santa Rosa Creek watershed is owned primarily by private landowners although large portions are owned by the City of Santa Rosa and Sonoma County Regional Parks Department. The Santa Rosa Plains contains a large number of confined animal operations, including almost 100 dairies. Conversion of pasture and orchards to vineyards has increased significantly in the past decade. The primary land use today is urban development, although livestock grazing and vineyard development also occur. The upper basin is now protected from further development under the ownership of Hood Mountain Regional Park and the McCormick

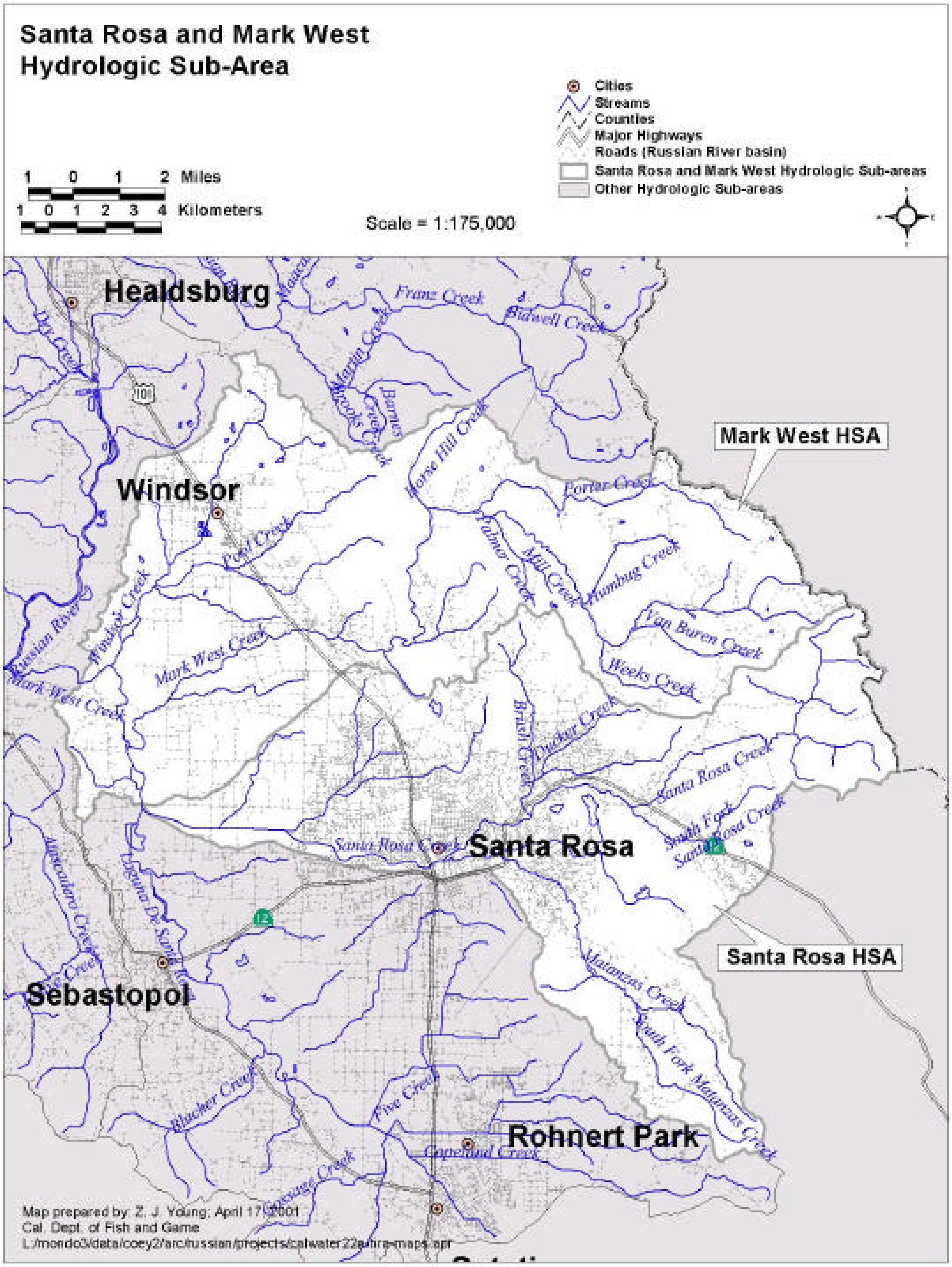

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Figure 21. Santa Rosa and Mark West hydrologic sub-areas.

Sanctuary.

Three major tributary watersheds comprise the basin. Matanzas Creek joins Santa Rosa Creek underneath the city at the constructed flood control channel which is a fish barrier to the entire stream. Together with its tributaries, Matanzas Creek drains a basin of approximately 8.2 square miles. Matanzas Creek is a second order stream and has approximately 9.2 miles of perennial stream, and several intermittent tributaries. Upstream of Matanzas Creek several miles Santa Rosa Creek splits creating the North and South Forks.

MARK WEST

The Mark West sub-basin contains Mark West Creek and its tributaries and includes the communities of Santa Rosa, Windsor and Mark West Springs (Figure 21). The sub-basin covers an area of approximately 86.3 square miles, or 55,247.2 acres, and includes the major tributary watersheds of Windsor Creek, Humbug Creek and Porter Creek. The Mark West system traverses Sonoma County in a general east to west direction, meets the Laguna De Santa Rosa, and flows into the Russian River at Mirabel Park, about eight miles east of Guerneville. Mark West Creek and its tributaries drain a basin of approximately 40 square miles. Mark West Creek is a fourth order stream and has approximately 27 miles of blue line stream. Elevations within the sub-basin range from about 40 feet at the mouth of Mark West Creek to 1800 feet in the headwaters.

The topography is mountainous in the headwaters, becoming a flat valley in the middle section and turning to low hills near the mouth. Most of the stream in the middle section is bordered by cultivated fields and housing developments. Where the Mark West sub-basin meets the Russian River, vegetation is dominated by typical redwood forest. Oaks, bays, redwoods, Douglas fir, maples, madrone, and manzanita characterize the vegetation near the headwaters. Riparian vegetation is composed of willow, oak, bay alder, maples, blackberry and a few redwoods.

WARM SPRINGS

The Warm Springs sub-basin drains an area of approximately 218 square miles, or 139,537.1 acres. It runs along the western edge of the Russian River basin in Sonoma County and contains the vast expanse of the Dry Creek watershed and Lake Sonoma, which now occupies the majority of the sub-basin watershed (Figure 22). Approximately 130 square miles of watershed is now above the lake. At maximum capacity Lake Sonoma is approximately 3600 acres and holds approximately 381,000 acre feet of water (personal communication, Ranger Mike Atchison, Lake Sonoma). This sub-basin is named after Warm Springs Dam, constructed in 1982, which impounds Lake Sonoma. Three hundred and nineteen feet tall and 3,000 feet long at the crest, Warm Springs Dam is the largest earthen structure in California and was also the last

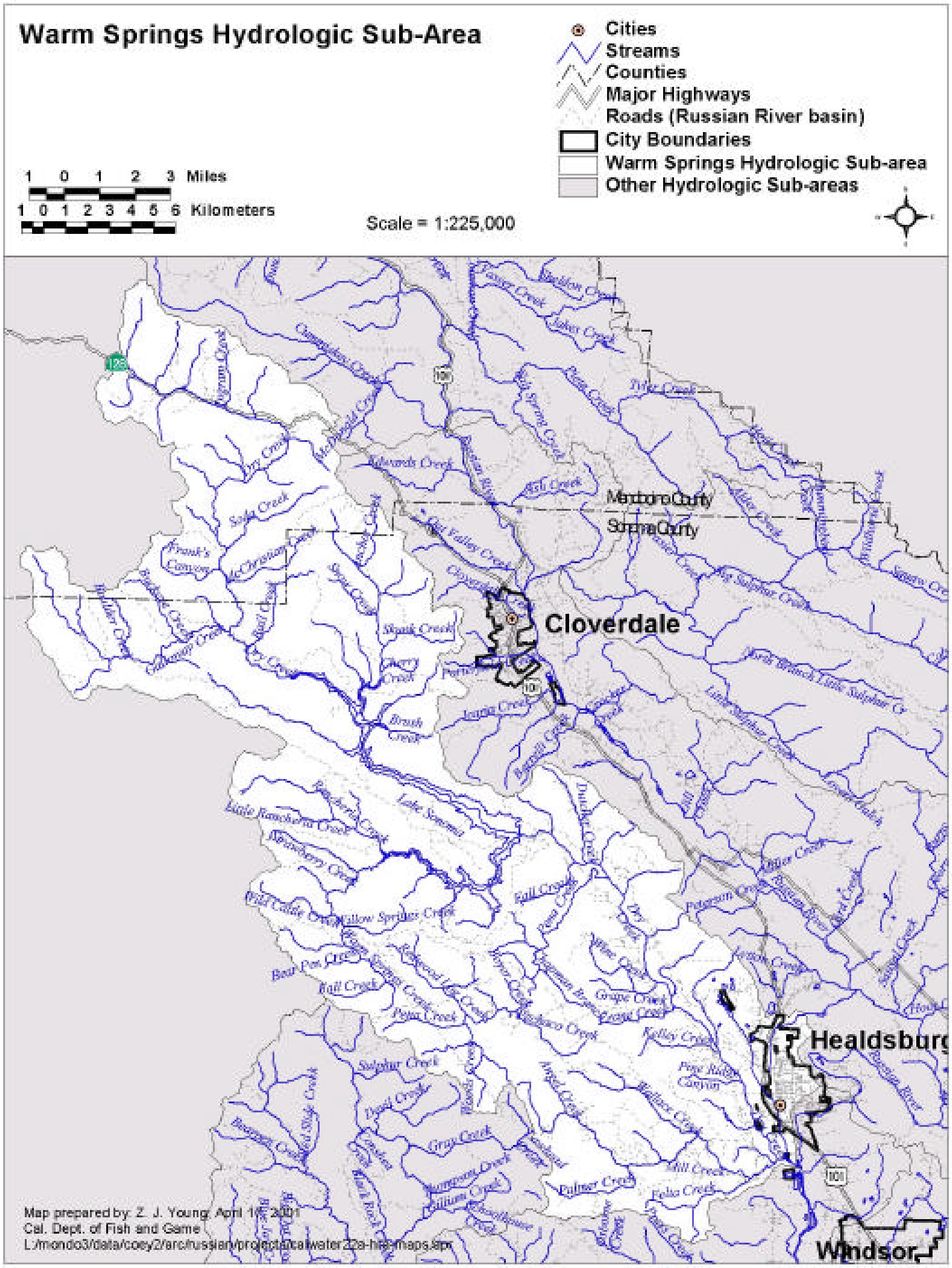

Figure 22. Warm Springs (Dry Creek) hydrologic sub-area.

major dam to be constructed in the last millennium.

The Dry Creek watershed has seen intense agricultural development since the turn of the century. Primary land uses today are vineyard cultivation, scattered rural development and grazing and recreation within the boundaries of Lake Sonoma. Some timber harvest still occurs within the basin, converting the uplands to steep agricultural steppes. Cherry, Warm Springs, and Gallaway Creeks are major tributary watersheds above the dam. Approximately 153 miles of potential salmonid habitat was lost from construction of the dam (Coey, 1999). Warm Springs Hatchery, operated by CDFG, was built in mitigation for lost habitat and fish runs on Dry Creek above the dam. Primary ownership is private, although the U.S. Army Corps of Engineers (USACE) owns and manages Lake Sonoma.

Major tributary watersheds within the Dry Creek watershed below the dam include Pena Creek and Mill Creek, as well as numerous perennial and intermittent tributaries. Pena Creek joins Dry Creek approximately 2.9 miles below the dam, in the southwestern expanse of the Warm Springs sub-basin, and remains as the major watershed within the Dry Creek sub-basin. Together with its major tributaries, which include Woods and Pechaco Creeks, the watershed drains an area of approximately 22.3 square miles. Pena Creek has 11.2 miles of perennial stream. Conifer forest dominates the upper watershed, but there are zones of grassland and oak-woodland in the lower watershed. The watershed is entirely privately owned and is managed for timber production, grazing, vineyard development and rural/residential development.

Mill Creek, the second largest tributary system, joins Dry Creek near its’ mouth at Healdsburg. Mill Creek, along with its tributaries Felta, Wallace and Palmer Creeks, drains a basin of approximately 24 square miles, and the system has a total of 29.0 miles of blue line stream. A series of earthen dams exist in the upper watershed at about 11 miles. Tan oak, alder, bay and redwood trees dominate the drainage area.

GEYSERVILLE

The Geyserville sub-basin, located in Sonoma County, drains approximately 207.8 square miles, or 133,006.2 acres, and includes the Alexander Valley Reach of the Russian River and the Maacama, Crocker, Gill and Gird Creek watersheds (Figure 23).

This area has seen intensive agricultural development in recent years, although timber harvest with clearing for grazing purposes was initiated early in the century. Vineyards dominate the landscape today where the Russian River mainstem flows through Alexander Valley. Grapevines are often planted close to the river’s edge, but where riparian vegetation remains it is dominated by thick stands of willows, with some cottonwoods and ash. Many small tributaries flow into this reach, most of which dry up seasonally in alluvial flats of the Russian River flood plain. Further upriver, many of the tributaries such as Gill, Gird and Crocker Creeks hold year-

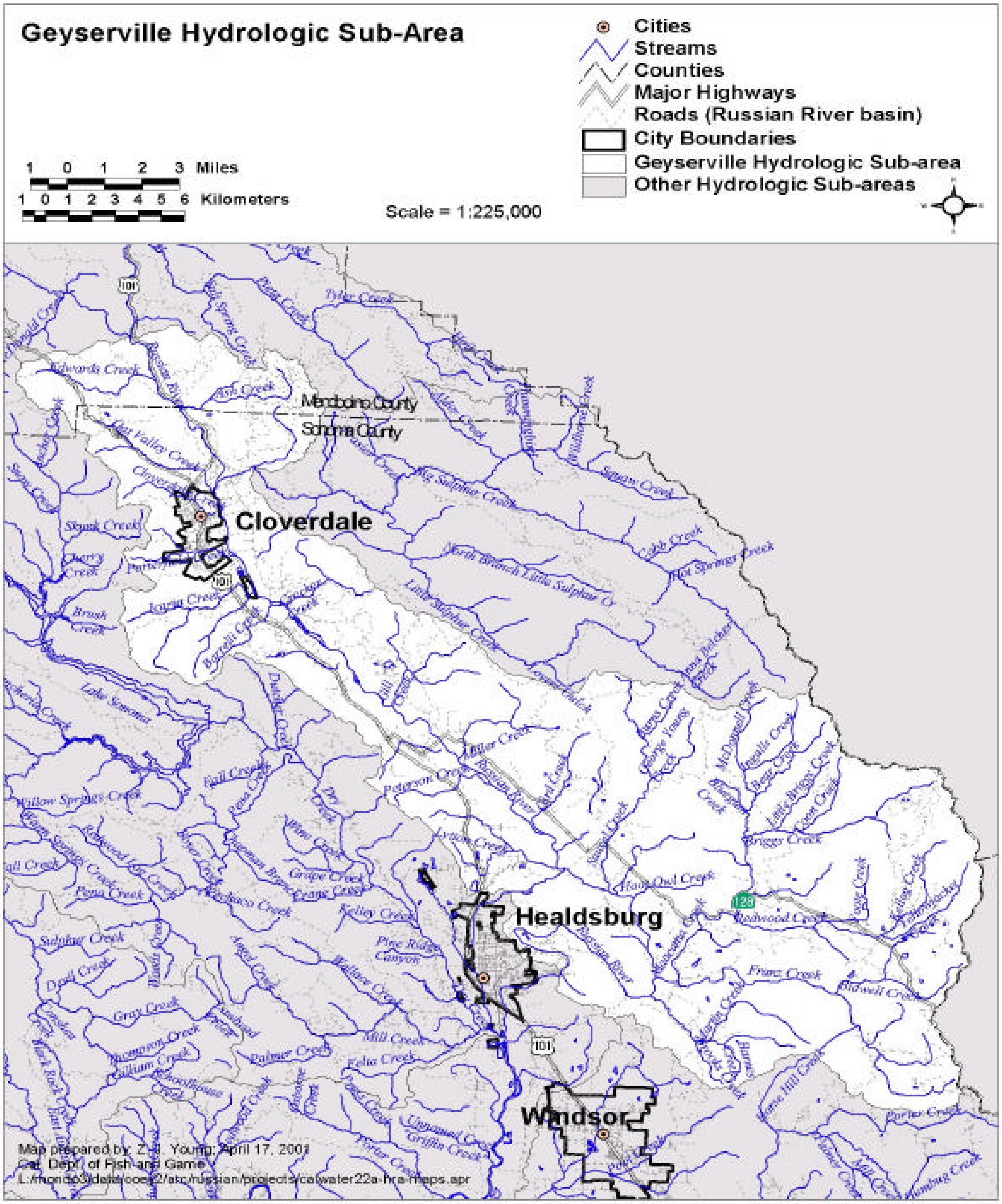

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Figure 23. Geyserville hydrologic sub-area.

round flows.

Major tributary watersheds within the sub-basin include Maacama, Gill and Crocker Creeks. Maacama Creek and its tributaries drain a basin of approximately 45 square miles. Major tributaries within the Maacama Creek watershed include Franz Creek and Briggs Creek. Elevations range from about 140 feet at the mouth of the creek to 3,060 feet in the headwaters. The upper section of the Maacama Creek watershed flows through a wide U-shaped canyon that is predominantly bedrock. At the top of this canyon the stream turns slowly north before splitting into the McDonnell and Briggs Creek watersheds. The Briggs Creek watershed and its tributaries occupy the north-eastern side of the upper basin, draining a basin of approximately 12.3 square miles. The mixed hardwood forests here are in excellent condition and few ownerships exist in this pristine sub-watershed. Much of the upper Maacama watershed is now under protection from further development under Sonoma County Open Space easements. In the lower section of the creek, the stream bed begins to widen for about 2.5 to 3 miles before narrowing and entering a steep-sided valley for approximately 1 mile. Near the mouth, the canyon opens up and the creek runs through a small valley to enter the Russian River. The watershed is dominated by oak grasslands, with the exception of the headwaters where vegetation consists mostly of grey pine and oaks. The riparian vegetation is generally abundant with alders and willows. Major land uses within the Maacama watershed are vineyard cultivation, cattle grazing and urban development.

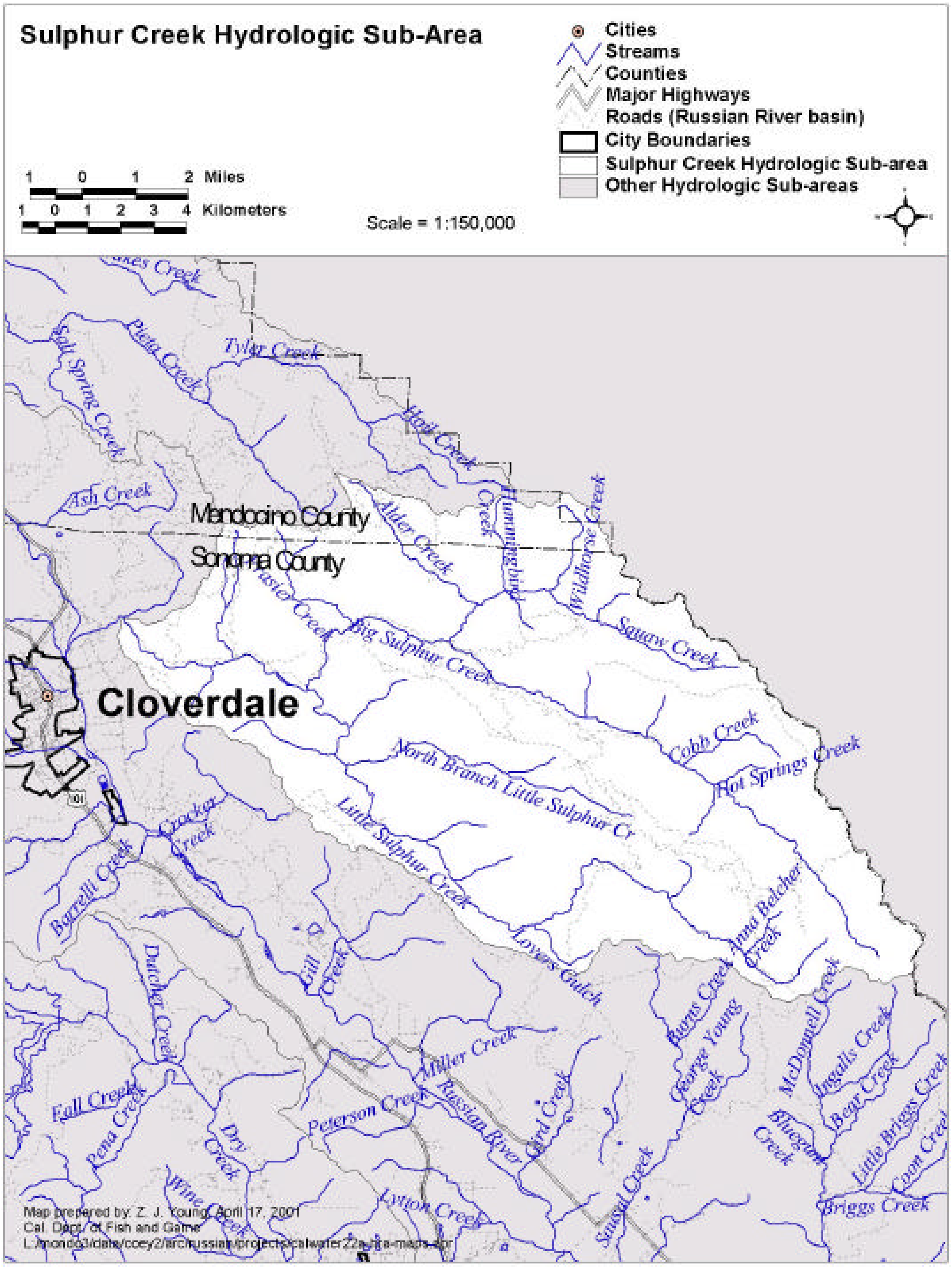
Crocker Creek and its tributaries drain a basin of approximately 3.3 square miles, is a second order stream and include approximately 12.25 miles of perennial stream. The stream flows through incised V-shaped canyons in the headwaters into an open lens shape at the mouth. Most of the land surrounding the upper reaches of the creek is managed as open grassland for livestock, and recreational use has been developed approximately ½ mile upstream from the Russian River. The predominant vegetation throughout the drainage consists of annual grasses, dogwood, buckeye, willow, live oak, California laurel, madrone, fir, and a few redwood trees.

Gill Creek and its tributaries drain a basin of approximately 7.43 square miles, is a second order stream and include approximately 3.75 miles of perennial stream. The watershed is privately owned and is managed for grazing and vineyard production.

SULPHUR CREEK

The Sulphur Creek sub-basin includes the Big Sulphur Creek watershed and covers approximately 82.3 square miles, or 52,655.3 acres (Figure 24). This sub-basin lies primarily within Sonoma County, with the headwaters of the upper tributaries extending into Lake County. The most well-known feature of the Sulphur Creek sub-basin is the Geysers Geothermal area in the headwaters portion of the watershed.

The sub-basin is comprised of 3 major tributary watersheds: Little Sulphur Creek, North Branch Little Sulphur Creek, and Squaw Creek. Little Sulphur Creek and its many perennial and



Sulphur Creek Hydrologic Sub-Area

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Figure 24. Sulphur Creek hydrologic sub-area.

intermittent tributaries (North Branch Little Sulphur, Lovers Gulch and Anna Belcher) drain a basin of approximately 43.9 square miles, is a third order stream and has approximately 16.6 miles of perennial stream. Elevations range from about 640 feet at the mouth of the creek to 2438 feet in the headwaters. Oak woodland dominates the watershed, but there are zones of mixed evergreen conifer forest in the upper watershed. The predominant upland vegetation throughout the watershed consists of annual grasses, buckeye, oak, California laurel, madrone, and Douglas fir, while the riparian corridor is dominated by alder and willow. The watershed is entirely privately owned and is managed for grazing and vineyard production, with scattered rural development.

North Branch Little Sulphur Creek and its tributaries drain a basin of approximately 8.6 square miles, is a third order stream and has approximately 5.4 miles of blue line stream. Elevations range from about 720 feet at the mouth of the creek to 2703 feet in the headwaters. Squaw Creek and its tributaries drain a basin of approximately 14.3 square miles, is a second order stream and include approximately 7.3 miles of blue line stream. Major tributaries include Alder, Hummingbird and Wildhorse. Elevations range from about 875 feet at the mouth of the creek to 3133 feet in the headwaters.

UKIAH

The Ukiah sub-basin contains the Ukiah Reach of the Russian River and its many tributaries (Figure 25). The sub-basin covers an area of approximately 312.9 square miles, or 200,238.9 acres. In the vicinity of Ukiah, orchards and vineyards are common with some light industrial activities and active timber mills. Gravel extraction activities have occurred near the confluence with major tributaries.

Major tributary watersheds include Pieta Creek, Feliz Creek, Robinson Creek, Ackerman Creek and Dooley Creek. Ackerman Creek and its tributaries drain a basin of approximately 22 square miles, is a third order stream, and the system has a total of 18 miles of perennial stream. Grassland and oak-woodland dominate most of the watershed but there are zones of Redwood and Douglas fir forest in the uppermost watershed areas, which are actively harvested for timber and grazing. Robinson Creek and its tributaries drain a basin of approximately 25.3 square miles with varying terrain, flowing through a U-shaped canyon. Robinson Creek is a third order stream and has approximately 9.8 miles of perennial stream. Feliz Creek is the largest tributary watershed in the Ukiah sub-basin. Dooley Creek and its tributaries drain a basin of approximately 13.2 square miles, and is a second order stream. Chaparral and oak woodland dominate the upper watershed, which flows through steep, narrow canyons. Downstream, Dooley Creek enters into a wide valley and joins McDowell Creek. The middle portion of the stream was channelized for almost a mile in the 1960's, for flood control and agricultural development. Prior to this, in the 1940s, the channel shows up on topographic maps as a braided perennial stream. Major land uses include vineyard development and reservoir construction.

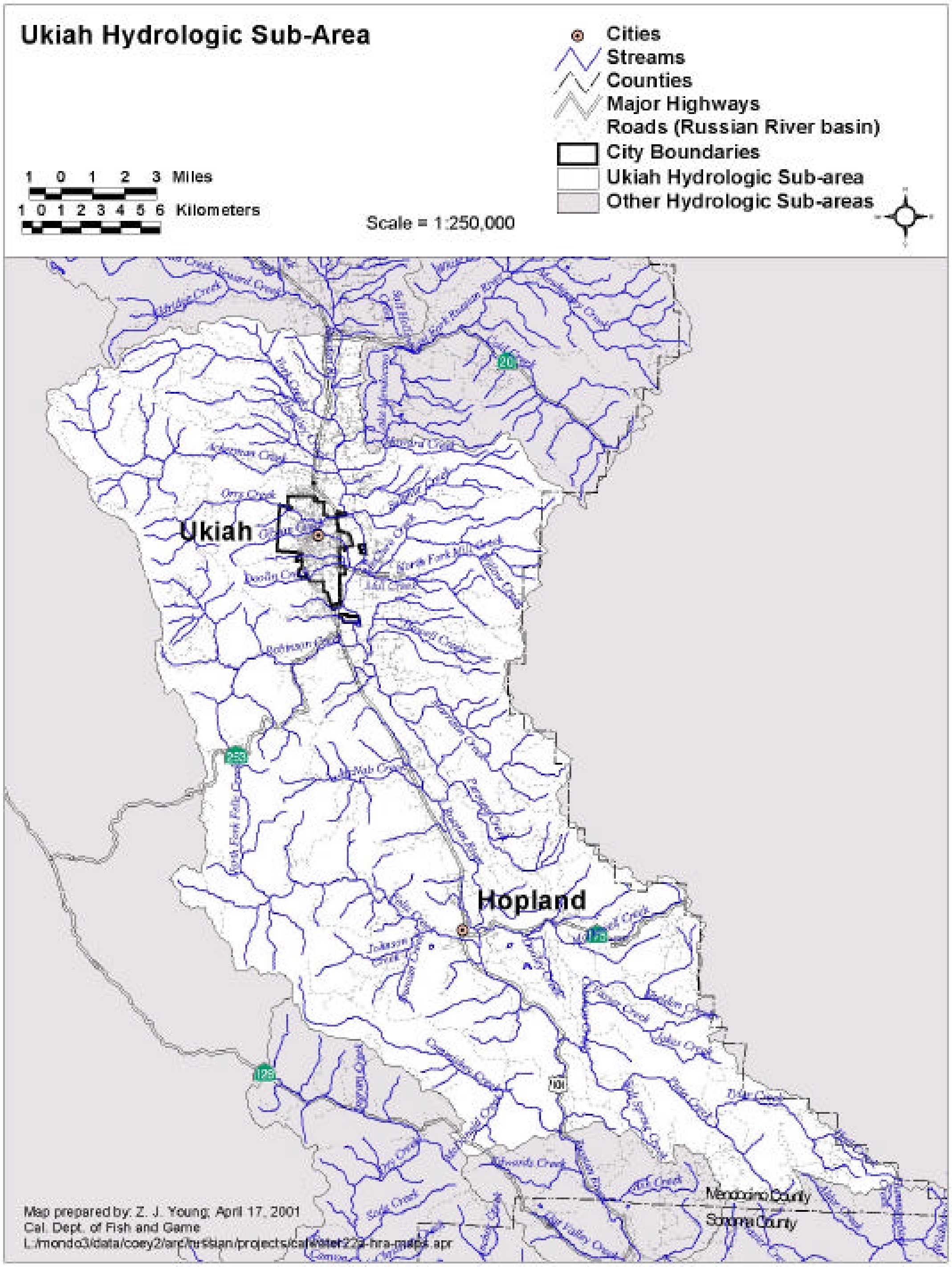

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Figure 25. Ukiah hydrologic sub-area.

The Pieta Creek watershed, situated in the Maacamas Mountains, drains 37.4 square miles. Elevations within the watershed range from around 460 feet at the confluence with the Russian River to 3,320 feet at Monument Peak in the headwaters. Most of the stream is characterized by steep, rugged slopes interspersed with a few small, narrow valleys. The vegetation is dominated primarily by chaparral, oak, madrone and grasslands. The Geysers-Calistoga Known Geothermal Resources Area includes about 10,000 acres of the Pieta Creek watershed, although the closest producing geothermal wells and power plants are about six miles away.

FORSYTHE CREEK

The Forsythe Creek sub-basin, in the northwestern portion of the Russian River watershed in Mendocino County, contains the Forsythe Creek drainage and the West Fork of the Russian River (Figure 26). The Forsythe Creek sub-basin drains approximately 84.3 square miles, or 53,966.2 acres, and is v-shaped in the narrow bedrock canyons of the headwaters and u-shaped in the wide alluvial valleys of the lower watershed. These streams flow predominantly through oak, bay and maple-covered rangelands with second growth redwoods in the upper headwaters of the drainage. The western edge of the sub-basin is roughly 50% redwood forest and 50% oak grassland, while the eastern edge is dominated by oak woodlands. Much of the central basin area is cultivated as vineyards or used for livestock grazing. Timber harvest is also a predominant land use with scattered rural homesteads. The majority of the Forsythe Creek sub-basin is privately owned, with much of the watershed being managed for timber production and livestock for the past 100 years or so.

Forsythe Creek and its tributaries drain a basin of approximately 47.7 square miles, is a fourth order stream and has approximately 13.6 miles of perennial stream. Major tributaries within Forsythe watershed are Mill Creek, Jack Smith and Eldridge Creeks. Elevations range from about 797 feet at the mouth of the creek to 2700 feet in the headwaters. Forsythe Creek flows through predominantly rangeland with oak, bay and maple, with second growth redwoods in the upper headwater drainage. The stream flows through a v-shaped basin in the headwaters and a u-shaped basin in the valley. Many manmade and several natural lakes occur throughout the basin.

The West Fork has its headwaters in a mountain forest with vegetation composed of pine, redwood and oak trees. For the most part, however, it flows through hills of range and pastureland for sheep and cattle, with scattered oak trees in areas. It begins in a v-shaped canyon, which widens gradually into a gentle u-shape valley as the gradient decreases. The channel is lens-shaped for the most part, with common stream side vegetation composed primarily of willow and grasses. Major tributaries include Mariposa, Corral, Fisher and Salt Hollow Creeks.

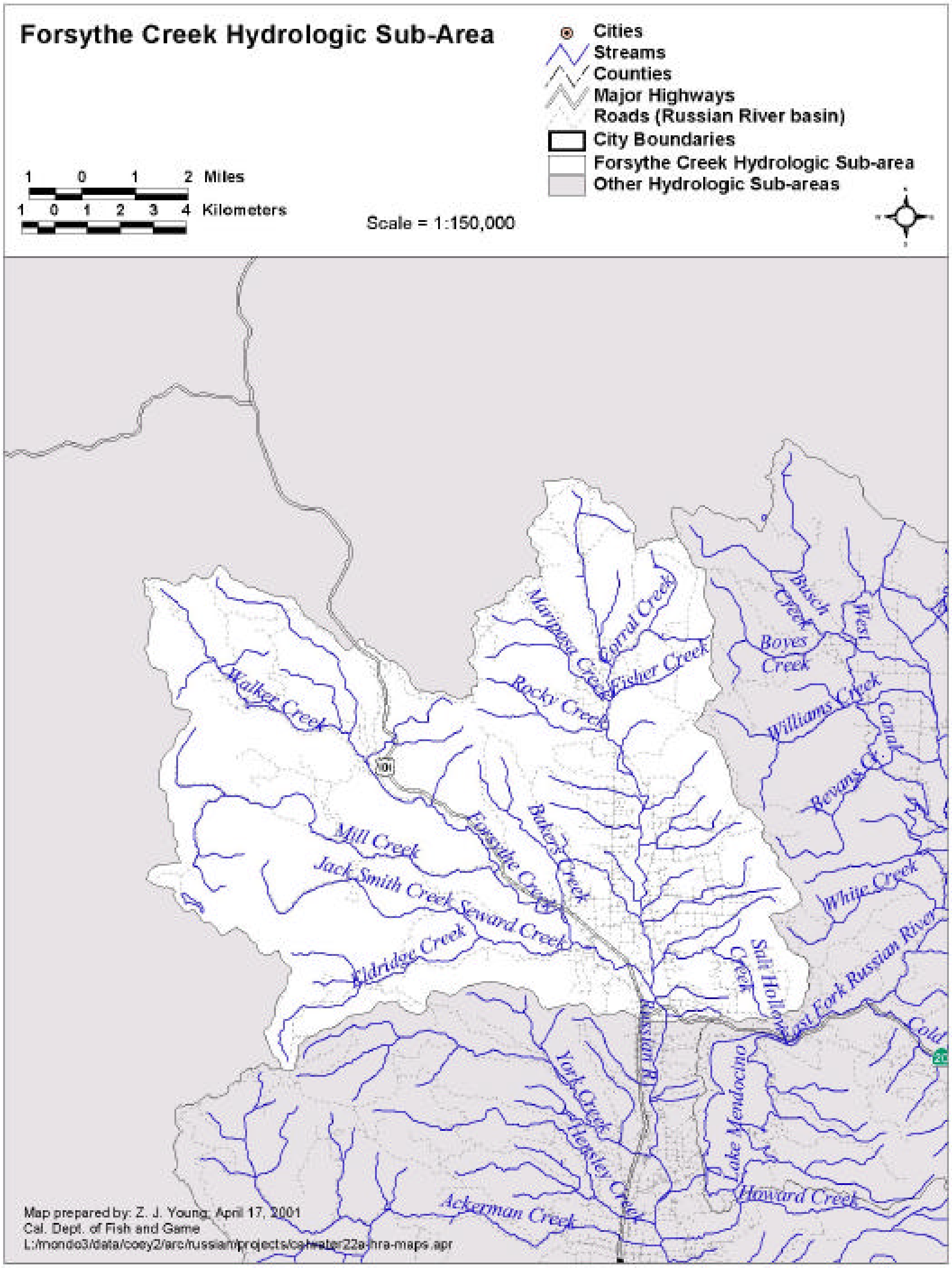


Figure 26. Forsythe Creek hydrologic sub-area.

COYOTE VALLEY

The Coyote Valley sub-basin, on the northeastern edge of the Russian River watershed in Mendocino County, contains the East Fork of the Russian River and all of its' tributaries, including Cold Creek, Mewhinney Creek and various smaller tributaries all of which are above Lake Mendocino (Figure 28). The sub-basin drains an area of approximately 105 square miles, or 67,012 acres. There is anecdotal evidence that, prior to the construction of Coyote Dam, the East Fork Russian River and its tributaries once contained some of the most viable steelhead habitat in the basin, with habitat for chinook salmon as well (SEC 1996). With the construction of Coyote Dam in 1959 by USACE, an estimated 90 miles of habitat was lost for salmonids. Recent estimates have estimated the figure to be closer to 143 miles of habitat lost (Coey 1999). In order to mitigate for the loss of steelhead spawning habitat above the dam, USACE constructed the Coyote Valley Steelhead Facility at the base of the dam in 1992. Lake Mendocino, behind the dam, is approximately 1922 acres at 100% capacity and has a maximum capacity of approximately 122,500 acre feet (Park Manager Steve Leonard, personal communication). Potter Valley above Lake Mendocino contains irrigated agriculture and pasture as the primary land uses.

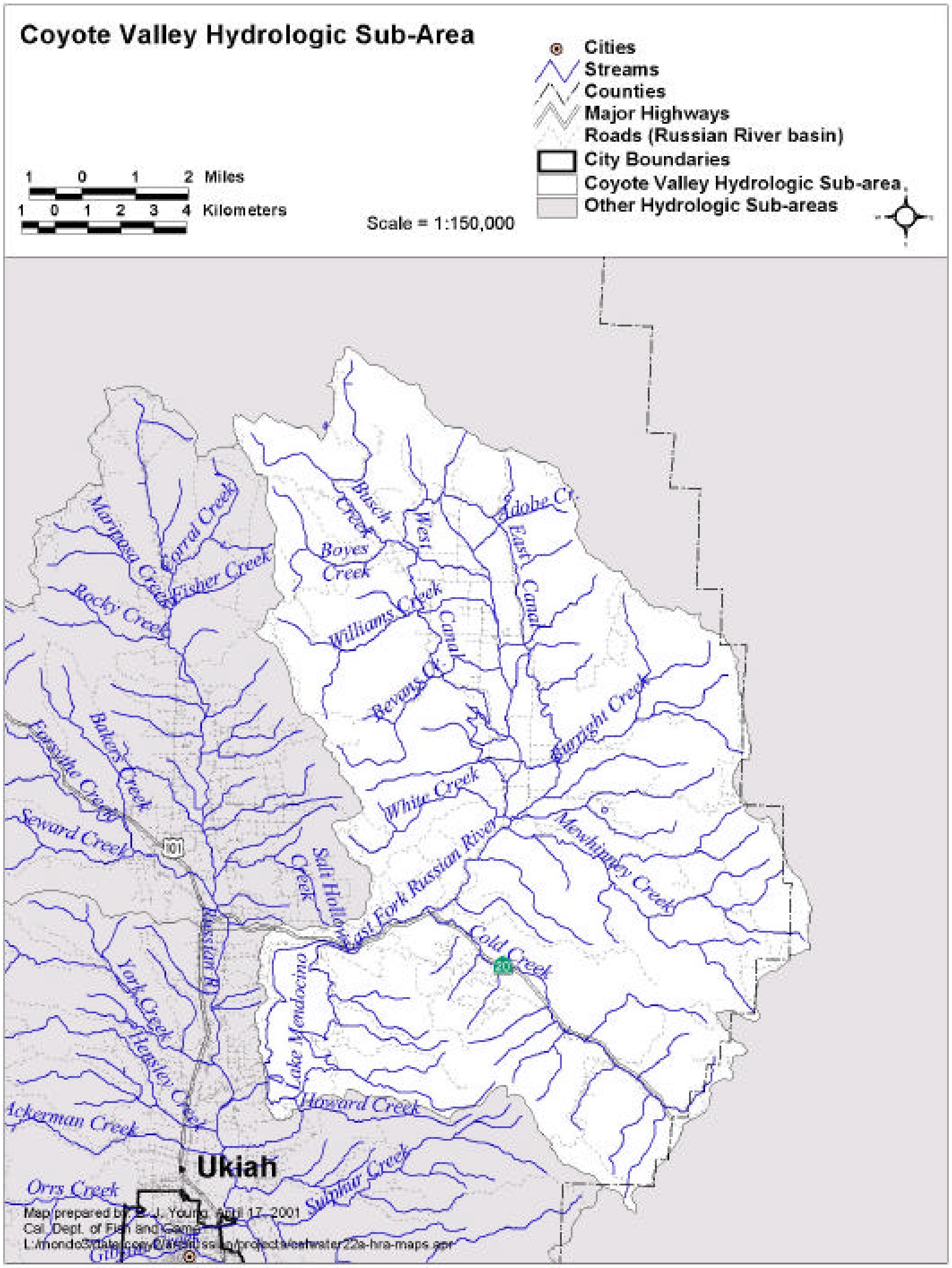


Figure 27. Coyote Valley hydrologic sub-area.

RECOMMENDED ACTIONS TO BENEFIT SALMON AND STEELHEAD

The focus of this section of the report is to identify and prioritize actions to benefit salmon and steelhead populations and their habitat. To be successful, actions must be science-based and focus on limiting factors specific to each life stage function. Both short and long term solutions must be considered. Long term solutions are preferred, but in light of the drastic decline in population numbers, some short term solutions are necessary. These solutions include both habitat restoration and population supplementation.

Restoration of habitat should focus on “Keystone” factors which in themselves may restore functionality to watershed systems or lifecycle patterns and should be considered high priority. Keystone factors may be in the form of projects or changes in management. Recommended actions to benefit coho salmon populations must be focused on causes and not symptoms of landuse problems to be successful. Recommended actions must also be realistic in approach considering the fact that 95% of the nursery and spawning habitat occurs on private property. Partnerships built to ensure support for recommendations and treatments, and a “stewardship” ethic to see that management recommendations and projects are carried out and maintained, are crucial to success. Recognizing that watersheds themselves are constantly evolving as a result of natural and unnatural processes, and that landuse is constantly changing, plans for restoration and management of watersheds must be considered “adaptive management” and therefore adaptable to the changing landscape.

Streams within the Russian River basin that have historically had coho salmon runs have been the focus of habitat restoration work and many are presently deemed suitable for coho utilization. However, even with restoration efforts in place, the coho population has not rebounded, presumably due to the severely depressed status of remaining runs and two decades of poor ocean conditions. Therefore, it is essential that actions are taken to protect residual runs of coho salmon, and that restoration efforts focus on measures to ensure their survival and ability to re-establish population numbers closer to historic levels.

To initiate recovery planning for coho salmon in the Russian River, the California Department of Fish and Game, the National Marine Fisheries Service, and the U. S. Army Corps of Engineers in cooperation with the Coho Recovery Workgroup are developing and implementing a captive broodstock program at Warm Springs Salmon and Steelhead Hatchery. The near term goal of this program is to prevent extirpation of coho salmon in the Russian River by re-establishing lost or declining stocks. This program entails “stock rescue”, and supplementing streams ready for utilization by coho salmon, with an eventual “sunset” of several lifecycles. Concurrently, habitat restoration will continue as well as outreach and coordination with landowners to ensure that landuse activities do not impact restored habitat. The long term goal of this program is to restore self-sustaining stocks in the Russian River, without reliance on hatchery supplementation.

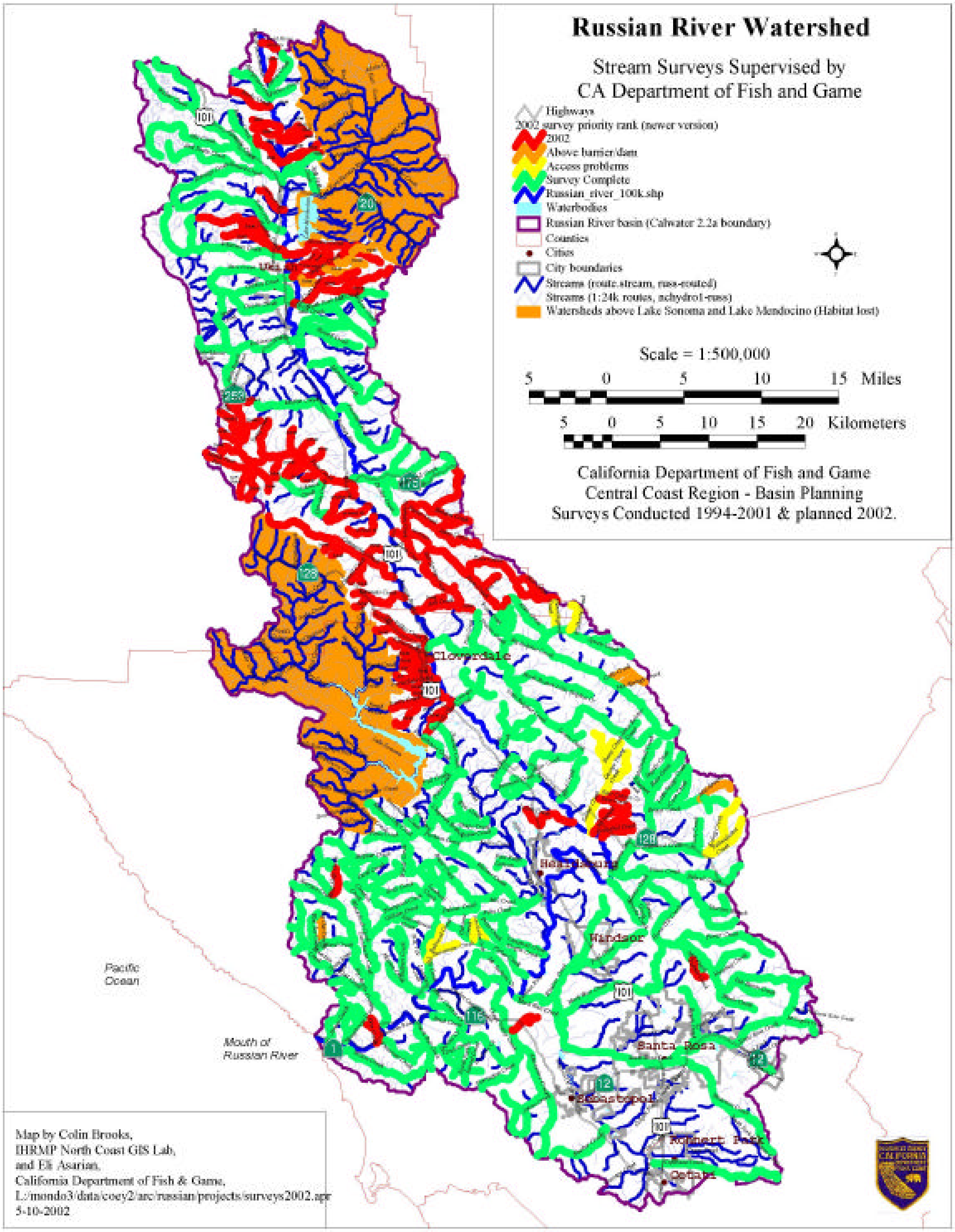
PRIORITIZATION STRATEGY

Recognizing that geology, climate, vegetation, and fish species distribution varies by sub-basin, watershed and sub-watershed, landuse condition and impacts thereof vary by sub-watershed. Thus, limiting factors to fish production and recommendations for change, restoration or enhancement must be identified at the sub-watershed level.

Salmonid fishes spend the majority of their lifecycle in the ocean. Transition from and to the ocean and the adult phase of the lifecycle is crucial to the existence of the population. Obviously, factors other than physical habitat may also limit production of juvenile salmonids in any given year. Biological factors such as disease, predation, and competition, or climatic factors such as oceanic conditions and food availability may account for much of the variation in salmonid production within any watershed. However, freshwater habitat is the resiliency in the cycle and provides the recruitment of individual offspring back into the adult population. It also is the portion that we have control over in comparison to ocean conditions.

Actions to restore or benefit freshwater habitat and the recruitment to the adult phase must start with the migration of adults back to the nursery. Proper water temperature, flow and quality as well as barrier free movement is needed for fish to migrate to the tributary nurseries. Specific requirements like escape cover and resting areas are also needed. Once fish reach these nursery areas, a suite of conditions must be suitable for successful spawning, and then likewise for rearing of offspring until the juveniles make their seaward transition.

Factors affecting each of these life stages must first be identified, and then the impacts assessed and prioritized in a timely manner, for a restoration plan to be successful in actually restoring conditions that will lead to naturally functioning watershed conditions with returning wild salmon and steelhead. Since 1994, CDFG, together with many local partners and volunteers has been conducting habitat inventory within the tributaries of the basin to identify limiting factors particular to each life stage and each sub-watershed. To date the inventory is comprised of approximately 180 streams comprising 750 miles (approximately 75% of the remaining steelhead habitat, and 100% percent of the known coho salmon habitat) in the basin (Figure 28). This effort spans 8 years, and almost 3 lifecycles of salmon (a sample size needed to develop minimally significant information). These inventories, together with other historical, physical, biological, as well as social-economic information form the basis for the prioritization strategy in the basin.



Map by Colin Brooks,
IHRMP North Coast GIS Lab,
and Eli Asarian,
California Department of Fish & Game,
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Figure 28. Completed (green), and proposed (red) habitat surveys in the Russian River basin 1994-2003.

METHODS

Watershed assessment requires the ability to access data and conduct analysis at multiple landscape scales. A watershed-level habitat inventory is designed to produce a thorough description of the basin, sub-basin and their contiguous streams and their associated tributaries, and individual streams and their associated surrounding landmass as watersheds**.** CDFG mapped stream habitat at the micro-level detailed scale to provide the basis for information to be utilized at various level scales for different purposes, and by different entities. For example, use by CDFG is for restoration planning and implementing projects at the stream reach and sub-watershed scale, and for establishing priorities and recommending funding on a sub-basin and basin scale (Figure 29). NMFS will utilize this information at the sub-basin and basin scale for Recovery Planning under the ESA which covers many river basins within each ESU. Whereas counties, may utilize the information at the jurisdictional scale to prioritize both environmental and community services resources.

Crews that conducted the inventory were trained in standardized habitat inventory methods and supervised by CDFG. The methodology utilized in the Russian River basin follows the procedures in the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 1998). Following completion of a desktop watershed information assessment, CDFG conducted in-field fish habitat inventories including: 1) stream channel typing; 2) habitat typing; and 3) biological surveys to describe fish habitat utilization and distribution of fish and other aquatic species basin-wide .

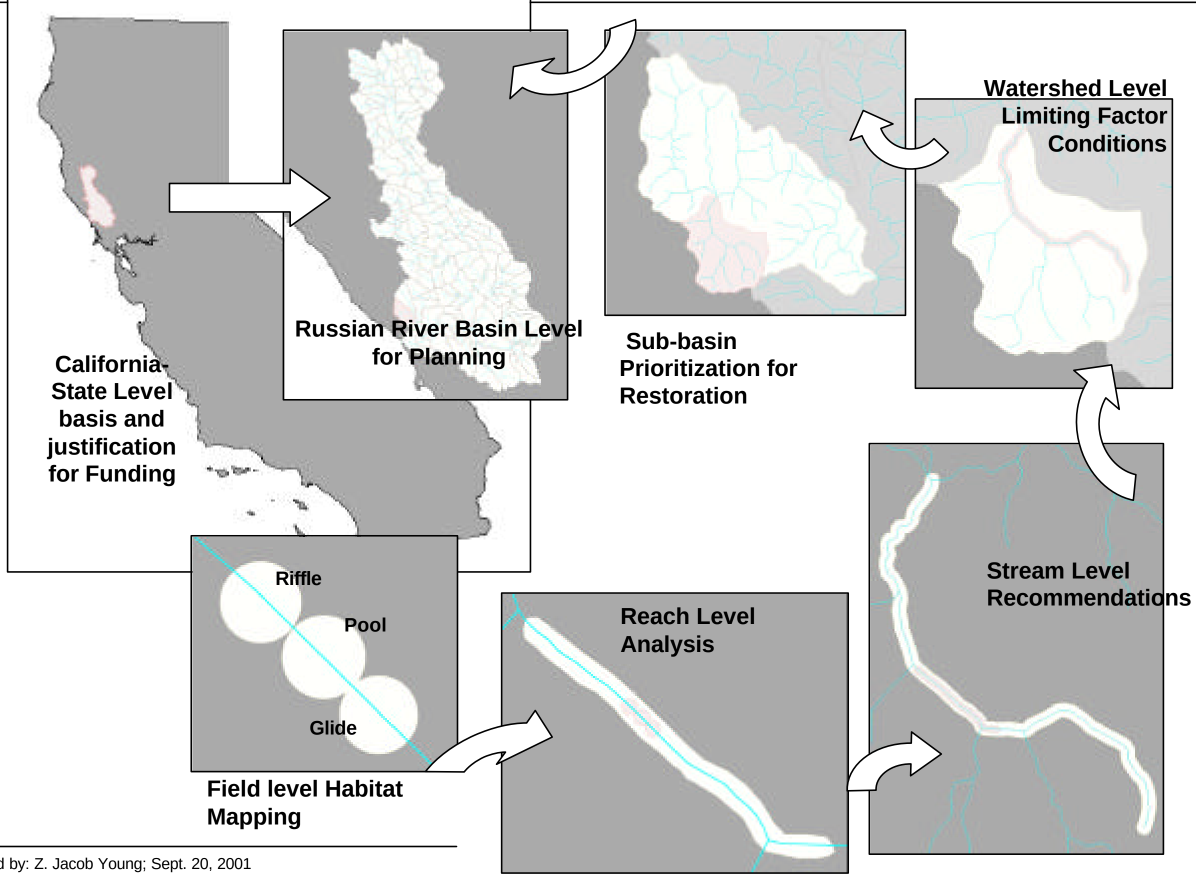
Stream channel typing describes relatively long reaches within a stream using eight morphological characteristics. Habitat typing describes the specific pool, flatwater, and riffle habitats within a stream. There are ten components to the habitat inventory: flow, temperatures, habitat type, embeddedness, shelter rating, substrate composition, canopy, bank composition, channel type, and biological inventory. CDFG classifies 100% of the habitat types along a stream, but quantifies habitat quality for approximately 30% of the habitat units utilizing a stratified random protocol. These are discussed in Appendix C. The information provided by habitat and channel typing, and biological information collected during spawning and juvenile rearing surveys, aids in determining if critical habitat needs of a target species are lacking, and if there are areas where improvements can be made.

Each surveyed stream has a written report that presents the information from the watershed overview, historical data, results of the habitat and biological inventories, and discussion and remediation of specific problems identified during the field survey. These tributary reports have been utilized by CDFG to analyze the need for habitat restoration in the basin. Appendix D provides a summary of the variables analyzed in the limiting factors analysis basinwide to date. Table 15 below describes some of the key variables analyzed during the limiting factors analysis.

Field Name	Description
HSA	Hydrologic Sub-Area (Calwater 2.2a).
Stream	Stream name.
Reach	Reach number.
Chan Type	Rosgen channel type classification.
Chan Len	Total length of all main channel habitat units (feet).
Low Water	Minimum surveyed water temperature (degrees Fahrenheit).
High Water	Maximum surveyed water temperature (degrees Fahrenheit).
% Pools	Percent of main channel, by length, composed of pools (habitat types 4.x, 5.x and 6.x). Includes dry (habitat type 7.0) and recorded but non-surveyed (habitat type 9.x) habitat units.
Pools 2ft	Percent of main channel pools (habitat types 4.x, 5.x and 6.x) greater than, or equal to, two feet deep.
Pools 3ft	Percent of main channel pools (habitat types 4.x, 5.x and 6.x) greater than, or equal to, three feet deep.
Pool Shelter Rating	Average shelter rating (ShelterValue x Cover) for main channel pools surveyed for in-stream shelter.
Embed (3+4)	Percentage of main channel pool tail outs, surveyed for embeddedness and containing suitable spawning substrate (not classified with pool tail embeddedness = 5), with an embeddedness classification of 3 or 3 (50% to 100% embeddedness).
Canopy	Average canopy density for habitat units surveyed for canopy cover. Average not weighted.
Conif	Average percent evergreen canopy for habitat units surveyed for canopy cover. Average not weighted.
Decid	Average percent deciduous canopy for habitat units surveyed for canopy cover. Average not weighted.

Table 15. Metadata for some key habitat variables averaged by stream reach within tributaries of the Russian River Basin to describe limiting factors and prioritize restoration. Data was collected from 1994-2002 (see Appendix E).

Watershed assessment requires the ability to access data and conduct analysis at multiple landscape scales. DFG mapped habitat at the micro-level detailed scale to provide the basis for information to be utilized at various level scales for different purposes, and by different entities. Use by DFG is for Restoration Planning and Implementation in cooperation with landowners.



Prepared by: Z. Jacob Young; Sept. 20, 2001

Figure 29. Watershed characterization and planning strategy for development of limiting factors to fish production, remedies and prioritization for funding.

CRITERIA

Habitat restoration/enhancement is typically recommended for the benefit of a particular species or species group. Therefore, the identified critical habitat needs must be keyed to the target species. Each life stage of the target species during freshwater residency needs to be identified, and the critical habitat needs ascertained prior to initiation of any habitat modification project. For example, typical life stages for steelhead trout in an inland environment include adult migration, spawning, year-round rearing and emigration. The concept that fish production is limited by a single factor or interactions between factors is fundamental to stream habitat management (Meehan 1991). Factors that considered to limit anadromous fish production include water temperature, pool depths, and shelter among others, and are discussed in detail in the next section titled "General Limiting Factors and Restorative Actions".

A "limiting factors analysis" provides a means to evaluate the status of key environmental factors that affect these life stages. This analysis is based on comparing measures of habitat components such as water temperature, pool depths, and shelter to a range of reference conditions determined from empirical studies and/or peer reviewed literature. If the measured component's condition does not fit within the range of the reference values, it may be viewed as a limiting factor. Once the critical limiting factors for the target species are identified, they can be defined in terms of habitat needs within the particular tributary or within specific "reaches" of the tributary in question.

CDFG has established "benchmarks" to define target habitat objectives established for north coast salmonid bearing streams. These benchmarks were adapted from the California Salmonid Stream Habitat Restoration Manual (Flosi, et al. 1998), and the Oregon Watershed Assessment Manual (OWEB, date) by Robert Coey, Associate Fish Biologist, CDFG, May 2000 and were utilized in establishing the condition and recommendations for each stream within the Russian River basin (Table 16).

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Within the first part of each sub-basin section of this report below, we describe the condition of the stream from data which were collected during the inventory process between 1994-2001, and prioritize the need to improve upon the suite of limiting factors specific to each life stage affected (eg. migratory problems translates to barrier removal). The number for each category describes the priority within the stream (ie. 1 = highest priority, 2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time). Where data gaps exist, the need for further inventory or monitoring has been identified.

Standard recommendations based on the "benchmarks" and tributary condition have been developed by CDFG (Appendix E). Within the second part of each sub-basin section of this report, we list the specific and general fish habitat improvement recommendations for each tributary, and prioritize their need based on the life stage affected. The Definition of each category of recommendations is also described in Appendix E.

As watersheds are dynamic and land-use ever-changing, these priorities may change with time and as restoration is initiated in each watershed. These issues and recommendations for management are discussed in detail in subsequent sections in this report.

Streams selected for re-introduction have been selected on the basis of having: 1) considered historical usage by coho; 2) coho presence in last 3 lifecycles but low numbers or missing year classes exist; 3) habitat conditions deemed suitable from the benchmark criteria, and 4) few landuse threats. Figure 6 depicts salmon and steelhead distribution.

Table 16 - California Department of Fish and Game Target Habitat Objectives established for North Coast Salmonid bearing Streams (tributary level).

Habitat Parameter	Undesirable	Desirable
POOLS-Primary pools*		
Pool Area (% total length)	<40	≥50
OR		
Pool Frequency (% compared to other habitats)	<40	≥50
Pool width (compared to low flow width)	<½	>½
Pool length (compared to low flow width)	<1	≥1
Residual Pool Depth		
1st order streams	<1.0'	>1.5'
2nd order streams	<1.5'	>2.0'
3rd order streams	<2.5'	>3.0'
RIFFLES		
Riffle length (% total length)	<10	15-30
Substrate	Sand/silt	Gravel/Sm. Cobble
Embeddedness	>50%	<25%
Length (habitat width vs. habitat length)	<1.5	>1.5
CANOPY		
Habitat Unit (non-pools)	<60	>80
Reach Average (% shade coverage)	<70	>80
Diversity (%coniferous vs. deciduous)	<30	≥50
SHELTER		
Complexity Value**	≤1	2-3
Coverage (% of habitat covered)	<40	≥40
Shelter Rating***(shelter value X % cover)	<80	>100
CHANNEL TYPE		
(Fish bearing reaches)	D, F1,2&6	B,C,E,G, F3-F5
HABITAT DIVERSITY	Species Specific (see appendix c)	
WATER TEMPERATURE		
chinook	>65	40-65
coho	>65	48-60
Steelhead	>70	40-65

Adapted From: California Salmonid Stream Habitat Restoration Manual (Flosi, et al. 1998), by Robert Coey, Associate Fish Biologist, CDFG, May 2000.

*Primary Pools- A primary pool is defined to have a maximum depth = stream order, occupy at least half the width of the low flow channel, and be as long as the low flow channel width.

**Instream Shelter Complexity Value-. This rating is a relative measure of the quantity and composition of the instream shelter within a habitat unit.

LIMITATIONS OF THE ASSESSMENT

This assessment provides useful and valuable information for generally characterizing, and summarizing the limiting factors in the basin for the tributaries inventoried. It is somewhat limited in the scope of the methodology to provide a "screening tool" for predicting the need to improve habitat within the tributaries inventoried. The period covers the last 3 lifecycles of the fish to date, but the baseline constructed in many cases covers the time period under which conditions, and populations of fish were already in severe decline. Where data are limited, working hypotheses are made to extrapolate information at the reach or sub-watershed scale.

- ?? Since the habitat protocol conducted during most years utilizes a random sampling protocol stratified by geomorphic reach, not all habitats were completely sampled. Thus, data is aggregated at the reach level and most data represents an average by reach, and not actual conditions of the length or period surveyed. Thus, reach factor values should not be interpreted to represent an individual stream section or property
- ?? Since the random sampling method allows data to represent the population of conditions that exist for the reach or stream, while presence of conditions describes the reach, absence of a particular condition cannot be assumed
- ?? The period covered during the survey effort covers a span of 8 years (1994-2001). Ideally, all streams would be evaluated during a similar time period, which of course is impossible. Therefore, conditions represented are that of the stream in that particular year. Concerns to this situation are:
    - o Habitat conditions described represent that stream in that particular year
    - o Flow, weather and landuse conditions vary widely over the time period covered
    - o Data represents conditions from an individual year surveyed, so cannot be statistically averaged over time
    - o Surveys were conducted by many different surveyors with individual bias (but training was provided and standardized protocols utilized)
    - o Large storm events can change conditions rapidly in stream systems, thus habitat type and quality is in constant flux, and has likely changed from the conditions observed during the survey*

* Since data was collected randomly, the % of pools/reach and other measured habitat variables should be within an acceptable range of the estimates we have provided to adequately represent conditions for the "stream" or even the "reach"

- ?? The protocols utilized were designed for watershed level analysis, and were not intended to be site specific. This allowed data to be collected quickly with accuracy, but precision in some measurement is lacking (eg. embeddedness).
- ?? While most protocols employ a quantitative measurement (pool depth) or categorical identifier (vegetation type), some employ qualitative estimates (dominance or %)

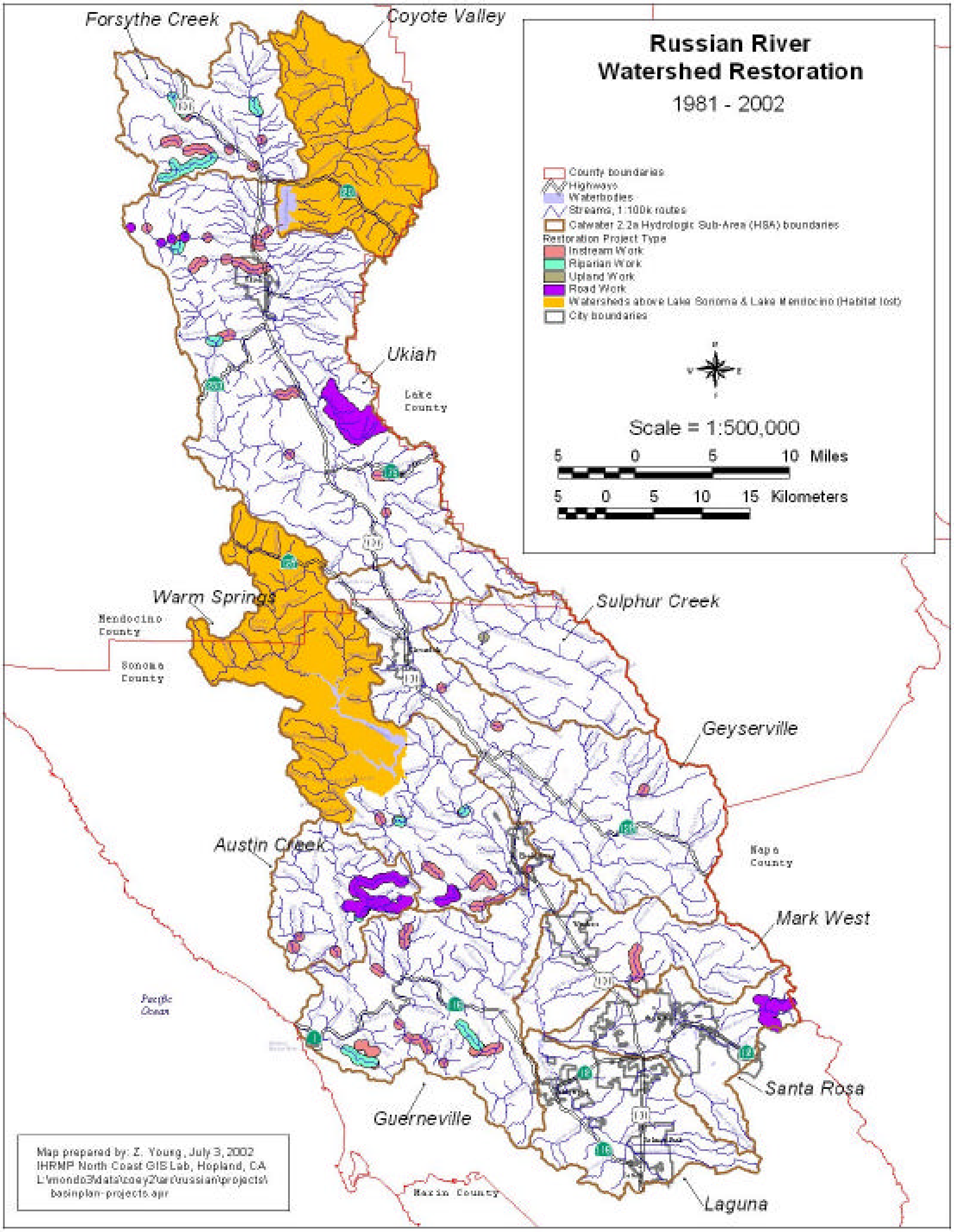
- Some data protocols were designed to be utilized as a screening tool only. For example, high embeddedness indicates sediment entering the stream but does not identify the source, delivery mechanism, nor the time period of entry
- Data from the 2001 survey effort are preliminary and are not available for inclusion in basin summary maps or stream inventory reports at the time of this report
- Annual monitoring of fish populations has not been conducted consistently throughout the basin, thus fish distribution information only allows a partial picture of actual conditions
- Annual monitoring of fish passage barriers has not been conducted consistently, nor at the full range of flows needed to assess the problem (however we feel that we paint a conservative picture)
- Most temperature information provided represents point locations measured systematically throughout the survey, but at different locations and on different days
- Temperature was collected during the survey period, and not necessarily during the critical summer months on every stream. When temperature thermograph devices (hobotemps or ryan tempmentors) were utilized throughout the summer months it is noted
- Annual monitoring of temperature has not been collected systematically throughout any stream nor throughout the basin (MWAT data is available through the RWQCB Basin Plan Amendment 2002, in progress)

IMPLEMENTATION OF RESTORATION PROJECTS AND PLANS

State and local funding entities should focus restoration dollars where information on “Keystone” factors exist. Keystone factors may be in the form of projects or changes in management. High priority management changes should only be funded with “restoration funds” if implementation by local, state and federal agencies and districts is unlikely. High priority projects should be the first considered for funding by local, state and federal funding organizations. Lower priority projects should be undertaken only when “keystone” restoration factors have been undertaken or considered to be non-feasible. Demonstration projects, which in themselves may not be “keystone” but demonstrate fish-friendly techniques or Best Management Practices (BMP), should be given high priority as well. BMPs to prevent the need for later restorative actions should always be encouraged and adopted into management strategies.

Significant efforts have already been taken towards implementing the recommendations in this plan and others, for fisheries and habitat restoration in the Russian River (as well as statewide). As noted earlier, habitat inventory reports developed using the methods discussed have been distributed to landowners, local, state and federal agencies, interest groups and private contractors, with tributary specific recommendations for habitat restoration. To date, almost 7 million has been spent on habitat restoration efforts alone by DFG. Appendix F summarizes the DFG funded projects by hydrologic sub-basin, stream and describes the project type, objective and DFG cost. Figures 30 and 31 display their general location in the basin.

No comprehensive database currently exists, but numerous other projects have been undertaken by other state and federal funding entities (such as NRCS, local RCD's, California Coastal Conservancy, California State and Regional Parks, Wildlife Conservation Board, NMFS, USACE, CDF, CCC, University of California, Americorps* Watershed Stewards Project and others), local entities (such as County Fish and Wildlife Advisory Boards, SCWA, Mendocino County Water Agency and others), local groups (Trout Unlimited, CalTrout, Friends of the Russian River, Russian River Property Owners Association, Russian River Watershed Council, Stewards of Slavianka, Landpaths and others) as well as numerous watershed groups and associations, private consultants, and private citizens and volunteers. The above is a only an example of the dedicated individuals and groups and is no way comprehensive nor exclusive. The efforts of these groups are to be acknowledged. The costshare funding provided by private landowners is also to be commended (and is continued to be encouraged). However, as with most human endeavors, while much has been accomplished, and more has been learned, much remains to be done.



Map prepared by: Z. Young, July 3, 2002
IHRMP North Coast GIS Lab, Hopland, CA
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Figure 30. Instream, upslope, road and riparian projects completed in the Russian River with DFG funds (1981-2002).

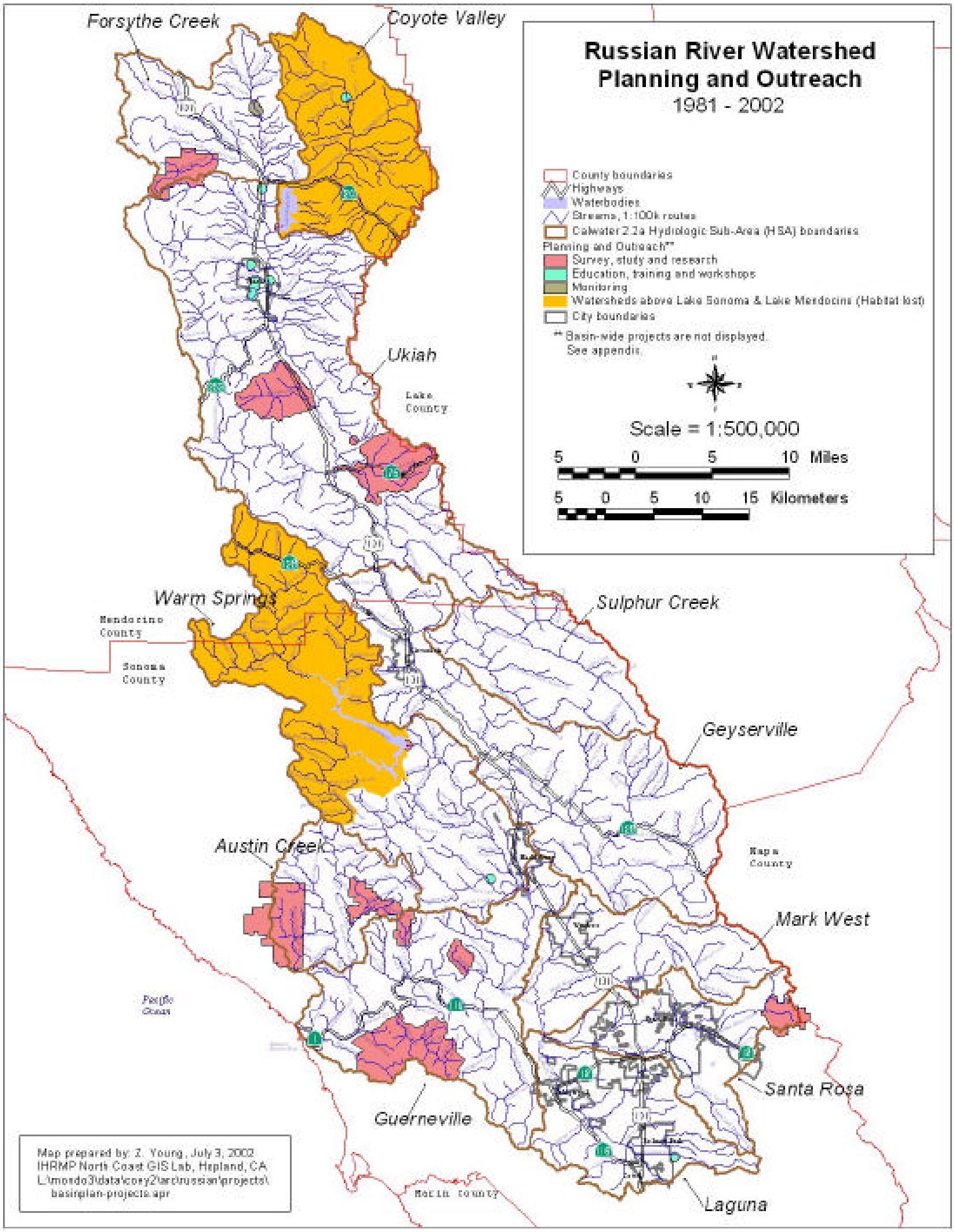

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Figure 31. Outreach, education, monitoring and planning projects completed in the Russian River basin with DFG funds (1997-2002).

GENERAL LIMITING FACTORS AND RESTORATIVE ACTIONS

LIMITING FACTOR: MIGRATION

Barriers to upstream migration include physical barriers (both natural and man-made), velocity and flow barriers, and temperature and chemical barriers. If a barrier is too high to jump or there is not a deep pool directly below it, salmon and steelhead will often repeatedly attempt to overcome it until they become exhausted or die trying, likewise, if water velocity is too great or the amount of flow is too low.

Debris jams brought on by natural storm events are one type of natural barrier. More recent study of these types of barriers has shown that debris jams typically float (providing passage underneath) at high flow, but occasionally they may become semi-permanent structures. This results when logs or other natural materials become jammed across the channel blocking the upward passage of fish and the downward movement of stream gravels. Resulting bed incision can occur downstream of the blockage (and/or bed aggradation upstream of the blockage) creating too high of a jump, or causing lack of depth to stage a jump. Again, these barriers are short-lived, as the debris eventually decays or becomes undermined and collapses. Bedrock or boulder constrictions, a series of high bedrock falls or rapids, or other extreme elevation changes generally greater than 6% (Flosi et al. 1998) can be permanent barriers which are complete barriers to migration or are accessible only during a specific range of flows. Man-made barriers can include dams, road crossings, culverts, grade control structures, and bridge abutments. Debris jams can also be man-induced through the dumping of slash or anthropogenic materials into stream channels. Even fish ladders, installed in an attempt to allow fish passage, may be barriers if they are too steep, have too great a velocity, do not provide proper attraction flows, or are not maintained.

Chemical or temperature barriers are usually caused by a point-source discharge, which makes conditions intolerable for breathing, swimming or feeding. Temperature barriers can occasionally be non-point source however, resulting from long sections of streams without stream canopy or resulting from natural geo-thermal activity.

Many existing culverts on federal, state, county, and private roads are barriers to anadromous adults, and more so to resident and juvenile salmonids whose smaller sizes significantly limit their leaping and swimming abilities to negotiate culverts (Taylor 2000). Even if stream crossings are eventually negotiated, excess energy expended by fish may result in their death prior to spawning, or reductions in viability of eggs and offspring.

Migrating fish concentrated in pools and stream reaches below stream crossings are also more vulnerable to predation by a variety of avian and mammalian species, as well as poaching by humans. Culverts which impede adult passage limit the distribution of spawning, often resulting in underseeded headwaters and superimposition of redds in lower stream reaches.

Typical passage problems (from Taylor 2000) created by undersized, improperly installed, or poorly maintained stream crossings are:

- Excessive drop at outlet (too high of entry leap required);
- Excessive velocities within culvert;
- Lack of depth within culvert;
- Excessive velocity or turbulence at culvert inlet; and
- Debris accumulation at culvert inlet or within culvert barrel.

Barriers may occur as temporal, partial or total depending upon flows and timing. Table 17 from Taylor (2000) defines the type of barriers, based on these variables.

Table 17 Definitions of barrier types and their potential impacts.

Barrier Category	**Definition**	**Potential Impacts**
Temporal	Impassable to all fish based on run timing and flow conditions	Delay in movement beyond the barrier for some period of time
Partial	Impassable to some fish at all times	Exclusion of certain species and lifestages from portions of a watershed
Total	Impassable to all fish at all times	Exclusion of all species from portions of a watershed

RECOMMENDED ACTIONS

In general, fish passage should be monitored and improved where possible. High gradient streams or streams containing some habitat types, may restrict access for migrating salmonids completely with geologic barriers. For example any "A" channel type; or streams with high gradient riffles, cascades or bedrock sheets as habitat types may limit fish passage especially in years with limited rainfall. Many of these natural type barriers have been identified during habitat inventories. Figure 32 depicts the impassable barriers in the watershed. As noted previously, some geologic barriers only restrict migration partially. Before any barrier modification of this type is undertaken, CDFG must be consulted to determine if modification of the barrier is desirable and to confirm the status of resident populations of fish in order to avoid impacting thegenetic integrity of existing native stocks.

Modification of log debris accumulations (LDA) is desirable, but must be done carefully, over time, to avoid excessive sediment loading in downstream reaches, and to preserve the larger beneficial scouring elements. LDA should only be modified if: the LDA is retaining sediment, and the biological inventory confirms it is creating a fish passage problem or the LDA is contributing to significant bank erosion.

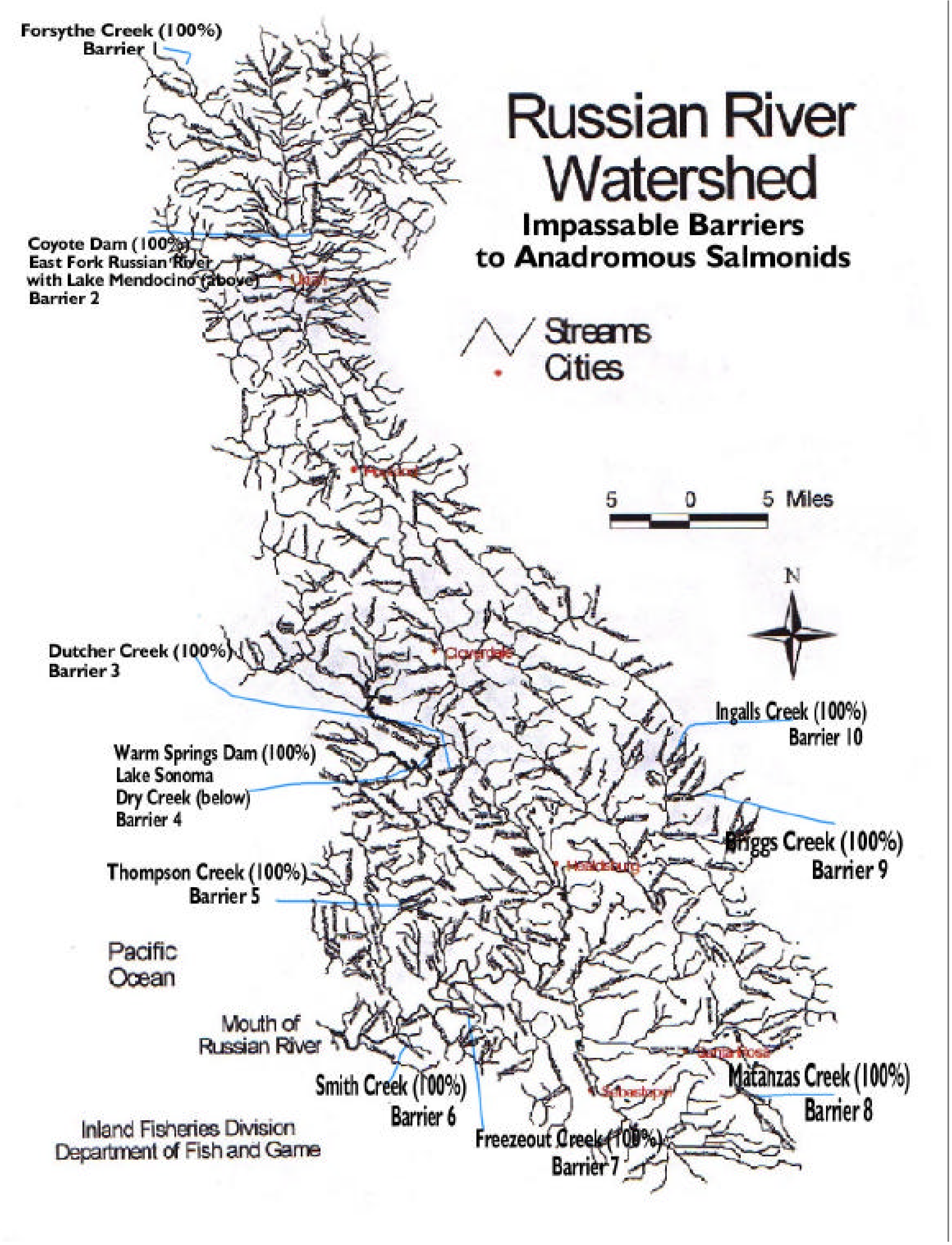

Figure 32. Locations of known natural barriers (except Lake Sonoma and Lake Mendocino) in the Russian River watershed.

NMFS Current guidelines for new culvert installation should provide unimpeded passage for both adult and juvenile salmonids. Existing culverts on fish bearing tributaries should be assessed for barrier potential following *Fish Passage Evaluation at Road Crossings (*Taylor 2000).

In 2001 and 2002, a basinwide assessment of all Sonoma and Mendocino County culverts in the Russian River basin (Figure 33) was completed under contract to DFG by Taylor and Associates utilizing the methods of Taylor (2000). A comprehensive prioritization remains to focus initial treatments at priority sites, having the best biological benefit to federally and state listed populations of anadromous salmonids. Taylors' methods were developed after existing protocols, Southeast Alaska (Leseveque et al. 1998), Washington (Bates 1999), Oregon (Robison et al. 1999), for inclusion in the CDFG manual under contract. Taylors protocols are consistent with recent National Marine Fisheries Service (NMFS) guidelines for salmonid passage at stream crossings (NMFS 2000). The primary objective of this protocol is to provide the user with detailed sections addressing:

1. consistent methods for collecting and analyzing data to evaluate passage of juvenile and adult salmonids at road/stream crossings;
2. a suite of ranking criteria (based on species diversity, severity of barrier, quality/quantity of potential habitat gains, and culvert condition and sizing) for prioritizing corrective treatments;
3. treatment options to provide unimpeded fish passage;
4. a list of available technical and financial resources; and
5. methods for post-project effectiveness monitoring.

Standardized methods for data collection and evaluation testing are needed to ensure that consistent fish passage evaluations of road crossings occur at a watershed-level across private, county, state and federal ownership. A comprehensive prioritization will focus initial treatments at priority sites, having the best biological benefit to federally and state listed populations of anadromous salmonids.

The following general guidelines for proper culvert installation are from Taylor (2000) and draw from design standards currently employed in Oregon and Washington, and are consistent with recent NMFS's guidelines:

> It is widely agreed that designing stream crossings to pass fish at all flows is impractical (NMFS 2000; Robison et al. 2000; SSHEAR 1998). Although anadromous salmonids typically migrate upstream during higher flows triggered by hydrologic events, it is presumed that migration is naturally delayed during larger flood events. Conversely, during low flow periods on many smaller streams, water depths within the channel can become impassable for both adult and juvenile salmonids. To identify the range of flows that stream crossings

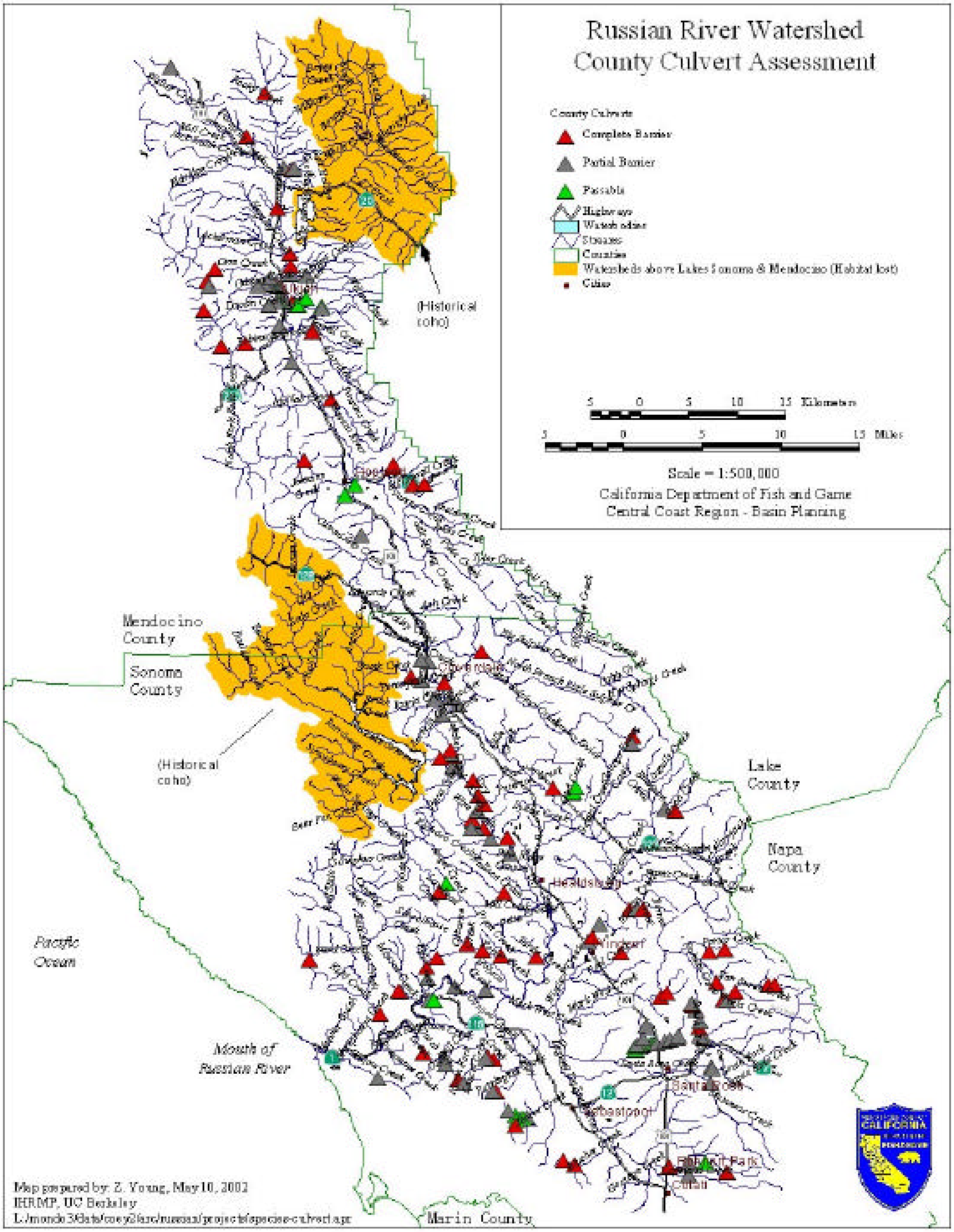

Figure 33. Assessment of county culverts and indication of their fish passability (red=none, green= passable, grey=partial).

should accommodate for fish passage, lower and upper flow limits have been defined specifically for streams within California (NMFS, 2000).

Site-specific characteristics of the crossing location should always be carefully reviewed prior to selecting the type of crossing to install. These characteristics include local geology, slope of natural channel, channel confinement, and extent of channel incision likely from removal of a perched culvert. Also, providing unimpeded passage for the salmonid species of concern or focus will often dictate design of a culvert upgrade or replacement. Bates et al. (1999) is recommended as an excellent reference to use when considering fish-friendly stream crossing installation options. Robison et al. (2000) provides a comprehensive review of the advantages and disadvantages of various treatment alternatives based on channel slope and confinement.

Order of Preferred Alternatives (Bates et al. 1999; Robison et al. 2000)

- Bridge
- Open bottom arch culverts
- Culvert set below stream grade (countersunk or embedded)
- Culvert set at grade with baffles installed to allow low-flow passage and reduction of velocities during higher migration flows.
- Culvert perched with outlet pool weirs and baffles throughout culvert. Entry jumps should never exceed 1.0 feet for adults or 0.5 feet for juveniles.

Design Criteria for Proper Sizing and Alignment

- Pass a 100-year storm flow at less than 100% of the culvert's height. This allows for passage of other watershed products (large wood and substrate) during extremely high flows.
- Culvert width sized at least equal to active channel width – OHW flow, about at line of annual vegetation growth. Should reduce constriction of flows at the inlet associated with fish migration.
- Avoid projecting culvert inlets.
- Align culvert with the general direction of upstream channel – avoid sharp bends in channel at approach to inlet.
- Avoid installing trash racks at culvert inlets.

NMFS *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2000) lists the following recommendations, in order of preference.

- Bridge – with no encroachment into the channel 100-year flood plain.
- Streambed simulation strategies – bottomless arch, embedded culverts, or ford.
- Non-embedded culverts – with less than a 0.5% slope.
- Baffled culvert or structure designed with a fishway –for slopes greater than 0.5%.

Because fish passage must be assessed across a multitude of watersheds and road system ownerships, consistent standardized methods are required for evaluation of habitat conditions. Assessing habitat conditions upstream and downstream of culvert locations should rely on habitat typing or fisheries surveys. When ranking culverts for treatment, both quality and quantity of upstream habitat should be considered so that limited restoration funds are spent to the greatest benefit of the fisheries resource.

DFG supports remediation of all passage issues at all County culvert identified in the Taylor assessment. Assessment of remaining city, state highway and private culverts is needed.

LIMITING FACTOR: GRAVEL QUALITY

Erosion is a natural process. Erosion provides gravel for spawning, substrate for macro-invertebrates, and initiates the process of scour and fill that leads to pools and riffles. Accelerated erosion is usually tied to human landuse impacts. Some common erosional processes, which are primarily determined by geology, vegetation patterns, and land use within a region, include surface erosion, channel erosion, some mass wasting, and debris torrents.

Surface erosion results from rain and surface runoff. Rates of erosion are influenced by the size and compaction of soil particles and by the protective cover of organic litter and plants, as well as by slope gradient and length, rainfall intensity, and soil infiltration rates. Surface erosion occurs at a far higher rate on sparsely vegetated lands as opposed to undisturbed forest lands. Sheet erosion is a type of surface erosion which occurs as a result of water runoff and tends to remove soil uniformly over an exposed area, in a non-channelized manner. Sheet erosion generally occurs on exposed soils and is of greater significance on low-gradient agricultural lands than on forested lands. (Weaver and Hagans, 1994)

Channelized erosion is also a form of surface erosion. It occurs in the form of rills and gullies when flows are concentrated due to topography, usually following heavy storms. A rill is a small channel formed by soil erosion. A rill that continues to erode and downcut becomes a gully. Rills and gullies are probably the most significant form of surface erosion in the Russian River basin and are enhanced when infiltration capacity is reduced. These channels become sediment transport corridors, increasing sediment loads as they move downslope and depositing them directly into the stream channel.

Mass wasting is the term given to large-scale erosional processes such as slumps, landslides and debris avalanches. Mass wasting episodes provide large quantities of sediment and organic matter to streams. Slumps, also called slope failure, are the downward and outward movement of rock or unconsolidated material. Slumps generally develop in deeply weathered soils, often in sedimentary geology like sandstones. Low soil permeability can increase the occurrence of slumping when heavy rains have saturated soils. Landslides generally occur on steep slopes where shallow non-cohesive soils overlay less permeable bedrock. Landslides, which are relatively dry soil masses, are often triggered when undercutting occurs, removing slope support.

Debris torrents, or debris flows, consist of thoroughly saturated soil masses. When a landslide enters a stream channel during a flood, it becomes a debris torrent–a deluge of water containing soil, rock, and organic debris. Debris torrents scour the stream channel as they move rapidly downstream and can severely alter fish habitat and stream characteristics.

Historically, mass wasting events, which occurred at intervals of decades to centuries, played a critical role in contributing large wood and coarse sediment to streams. In general, enough time lapsed between these events to allow natural erosion and aggradation processes to gradually modify the disturbed stream reaches, causing a succession of different habitat conditions for salmonids.

The majority of surface sediments that enter stream channels result from channelized erosion, like rilling and gullying, and from sheet erosion. However, even upslope activities contribute sediment to streams through the process of "routing", in which sediments in the watershed move to the lowest point, thus arriving in the stream. Whether sediments eroded from hillslopes arrive in a stream or not is dependent upon the "delivery" mechanism. Mechanisms for delivery are, ditches created by road building, redirected watercourses, gullies formed by poorly placed ditch relief culverts, plugged culverts resulting in diversion..

Though erosion occurs naturally in undisturbed systems, the percent of fine sediments is higher in watersheds where the geology, soils and precipitation or topography create conditions favorable for erosional processes (Duncan and Ward, 1985). Erosion can be drastically accelerated by many human activities including: urbanization, agricultural development, livestock grazing, road building, gravel mining, timber harvest, and removal of riparian vegetation. Accelerated erosion poses a severe threat to rivers and streams. Fine sediments are typically more abundant where land use activities such as road building expose soil to erosion and increase mass wasting (Cederholm ea al. 1981; Swanson et al 1987; Hicks et al. 1991)

In terms of accelerated erosion, road building is the most detrimental human activity. Erosion due to roads is a problem of major concern in the Russian River and in watersheds world-wide. Investigators examining erosion due to forest roads and logging in the Coast and Klamath Mountains of northwestern California found that roads were responsible for 61% of the soil volume displaced by erosion (McCashion and Rice 1983). The slopes at which most roads are built tend to inhibit the natural sheet dispersal of water, concentrating runoff and creating gullies and landslides. Networks of roads have created drastic changes in the natural drainage patterns of the watershed through increasing the amount of impervious surfaces and diverting water to follow roads rather than natural patterns. Furthermore, many road crossings are accompanied by culverts. Culverts can cause erosion by concentrating flow and have a tendency to fail, causing debris torrents.

Clearing and grading for urban and agricultural development also causes an influx of sediment into streams from erosion and often involves the diversion of drainage waters around projects, ultimately forming rills which cause gullies. In developed areas, extensive surfaces of impervious concrete and asphalt increase and concentrate runoff, causing accelerated flooding and stream bank erosion. Long-term grazing throughout the basin has compounded the situation, resulting in increased hillside erosion, more rapid runoff, compaction of soils, and preventing vegetation growth. Culverts and dams can hinder or stop sediment transport, which leads to channel incision and steep banks which then erode (discussed in next section).

Gravel quality or "embeddedness" refers to the degree to which larger substrate particles, like cobble and gravel, in the streambed are surrounded or covered by fine sediment.

Embeddedness is particularly important at pool tail-outs, at the upstream end of riffles, where spawning is most likely to occur. Spawning gravels are impacted when fine sediment (fines) fills the interstitial spaces in the framework of the gravel redd. Accumulations of fine sediments reduce intragravel water flow (permeability) which deliver oxygenated water to the young salmon in the redd and remove waste material out of the redd. Excessive accumulations can also impede fry emergence in extreme conditions. During the spawning process, salmon typically clean their redds down to about 7% fine sediments (< 1.00 mm) (Briggs 1954). McHenry et al (1994) found that when fine sediments (particles<0.85 mm) exceed 13% salmonid survival dropped drastically. When fine sediments (< 6.35 mm) exceed 30% of the substrate within a redd, salmon embryo survival drops considerably (Bjorn and Reiser, 1991; Marcus 1997).

Rearing habitat is degraded with the delivery of sediment when pools are filled or pool depth is reduced resulting in loss of cool water refugia that is important in the Russian River watershed where water temperatures frequently exceed standards that are protective of salmonids. Fish cover is impacted when large woody debris and other structures are buried, reducing habitat that is protects young salmonids from predators. Fine sediment that covers interstitial spaces in the gravel reduce the diversity of aquatic insects and other aquatic invertebrates that are critical food sources for salmonids.

<u>RECOMMENDED ACTIONS:</u>

CDFG and other state, local and federal agencies should support voluntary programs such as the NRCS Dairy Waste Program, Environmental Quality Incentive Program (EQIP), and Sotoyome Resource Conservation Districts' Fish Friendly

Farming Program which recommends BMP's for reducing sediment runoff from agricultural lands and practices through the use of BMP's for cover crops, drainage, road construction, riparian buffers, avoidance measures.

Habitat Inventory reports contain point-source descriptions of stream bank erosion. Implementation plans should prioritize them according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream. Where non-point problems persist, active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.

Maintenance on existing unimproved private and county roads should follow techniques outlined in "Handbook for Forest and Ranch Roads" by Weaver and Hagans, 1994. New construction on private roads should utilize techniques from this manual which reduce concentration of water on roads, and sediment transport from roads. For example, outsloping with rolling dips should be implemented wherever possible, natural drainage patterns should be reconnected, culverts should be upgraded to at least a 100-year flood event at all crossings, and critical dips installed over the hinge line at all stream crossings. Culvert installation should follow NMFS fish passage guidelines (NMFS 2000) and USACE stream crossing guidelines. Additional inventory of roads will be ongoing and therefore mapping of other sites is expected.

Sonoma and Mendocino Counties should adopt standards for unimproved road construction following techniques outlined in Weaver and Hagans, (1994). Training is needed for County Public Works to implement these fish friendly techniques.

Prior to funding and implementing watershed scale road improvements, road assessment should be conducted to: 1) catalog road construction history (relative to storm history) and identify potential sources of erosion and sediment production from aerial photos; 2) perform field road assessment and mapping utilizing DFG approved protocols for sediment inventory including: roads and landings, sources of erosion and sediment production on watershed roads, and erosion history and potential landslide evidence; 3) evaluate results of watershed assessment ranking treatment sites on a fishery priority basis (yd3 delivered to stream channels) basis and a cost/benefit ($spent/yd3 saved from stream channels) basis. Reports of assessments should include developed plans for specific treatments for high priority sites, and recommended treatments for secondary priority sites.

LIMITING FACTOR: GRAVEL QUANTITY

Changes created by humans within the watershed (like dams and urban development) can alter or disrupt the dynamic equilibrium of a river or stream by changing the watershed size, runoff rates, runoff timing or sediment transport processes, over very short time periods. The stream channel responds by compensating for the changes in the processes that maintain equilibrium.

For example, over time, dams can impound the sediments that ordinarily are transported downstream. Streamflow energy is dissipated through the movement of particles. Less particles to move equates to excess energy and the stream will erode the bed and banks downstream of the dam, eventually scouring out spawning gravels and causing channel incision. Instream gravel mining can greatly accelerate this process through removing existing bedload. Concentration of high flows due to urban development, road building and compaction of agricultural lands also increase run-off rates, causing excessive bed scour and channel incision. If channel incision continues it can expose underlying hardpan and bedrock, leaving streambeds devoid of spawning and rearing habitat.

Conversely, reduced run-off through alteration of flow quantity or accelerated bank erosion can reduce sediment transport, resulting in deposition. Both result in aggradation. Aggradation commonly results in lateral bank migration, increasing siltation and sub-surface flow. Channel stability is affected by these activities and affects every stage of the salmonid lifecycle. Unfortunately, these are common underlying problems in the Russian River system.

RECOMMENDED ACTIONS:

CDFG and other state, local and federal agencies should support voluntary programs such as the NRCS Dairy Waste Program, EQIP, and Sotoyome Resource Conservation Districts' Fish Friendly Farming Program which recommends BMP's for reducing accelerated runoff from agricultural lands and practices through the use of BMP's for cover crops, drainage, road construction, riparian buffers, avoidance measures.

Projects to offset channel incision, diminished gravel recruitment, gravel bed scour, bank erosion and riparian loss need to be developed on the mainstem and many tributary sections. Projects to increase spawning gravel are desirable where suitable spawning gravel is found on relatively few reaches, or crowding and/or superimposition of redds has been observed during winter surveys. Flosi et al. 1998 has specific structure recommendations for each channel type. Instream structures should only be considered in stream reaches suitable for habitat improvement structures. Project Implementation recommendations must be thoroughly reviewed before proceeding with instream structures to enhance spawning substrate. DFG and other agencies with jurisdiction should evaluate stream reaches located below permanent dams or other gravel supply restriction areas for potential to import spawning gravel.

Projects involving solely rip-rap as a treatment for bank erosion should be discouraged, except where structures are threatened. Bio-engineering techniques utilizing vegetative materials and limited rock should be encouraged whenever possible. The *California Department of Fish & Game Salmonid Stream Habitat Restoration Manual* (Flosi et al. 1998) and Water *Bioengineering Techniques for Watercourse Bank and Shoreline Protection* (H.M.Schiechtl and R.Stern), are good references for bio-engineering type projects.

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LIMITING FACTOR: Riparian Stability

Removing native vegetation from streambanks leads to increased erosion and vertical bank formation, which tends to create an ongoing cycle of erosion as vertical banks prevent the natural succession of riparian plant species. Removing vegetation in upslope areas can be equally detrimental. Timber harvest and hillside agriculture development can cause erosion of hillsides and streambanks through operation of heavy equipment in streams, tractor logging on steep slopes, clearing of riparian zones, and construction of roads. Riparian vegetation removal limits development of fish habitat by preventing large woody debris from entering the river, where it scours pools and creates shelter. Thin or young riparian corridors limit large woody debris recruitment, resulting in an unnaturally simplified river or stream without the substrate, structure, cover, and water quality necessary for salmonid habitat.

Naiman et al. (1992) reports that in Westside forests the amount of solar radiation reaching the stream channel is approximately 1-3% of the total incoming radiation for small streams and 10-25% for mid-order (3rd to 4th order) streams. Riparian canopy loss increases this dramatically resulting in elevated stream temperatures and diminished nutrient and macro-invertebrate inputs to the stream from the riparian zone. Removing riparian trees and undergrowth can also decrease water quality, as healthy riparian vegetation acts as a filter for sediment and runoff pollution.

Loss of riparian vegetation is a loss of habitat for wildlife, amphibians, invertebrates and fish which rely on these naturally lush areas for their survival. Removal of native vegetation from streambanks, either intentionally or as a side effect of other actions, leads to increased erosion and vertical bank formation. This leads to an ongoing cycle of erosion as vertical banks prevent the natural germination of riparian plant species. In the absence of established pioneer plant species, there is no successive replacement for the mature vegetation as it dies or is washed away. As bare banks continue to erode, channel incision and the accompanying drop in the water table may also separate mature riparian species from summer water. In an attempt to counteract the erosion caused by vegetation removal or loss, bank revetment structures are often installed, channelizing streambanks and further interrupting natural processes.

Invasive Non-Native Plants

Invasive plants are imported from other countries for ornamental landscaping, to provide erosion control on riverbanks, and for various other reasons. Non-native species often out-compete native species and may significantly alter the local environment. The lack of pests and consumers of non-native species are one reason for their advantage in a foreign environment. "Invasions of non-native species now constitute one of the biggest threats to native ecosystems. Unfortunately many of these species are still sold as ornamental plants and the general public is unaware of the problem.

Giant Reed

Invasive exotic plants also pose a serious threat to native riparian species. Amongst these, the plant causing the most disturbance along the mainstem of the Russian River is *Arundo donax*, the giant reed. *Arundo donax*, commonly known as giant reed, is a highly noxious weed species that has invaded riparian zones throughout the world. Once giant reed becomes established within an area, it continues to propagate at an incredible rate, taking over vast stretches of streambanks. In several river systems, giant reed has expanded from isolated clumps in the channel to a near monoculture within a ten year time frame (CRP 2000).

Giant reed suppresses the germination of all other seedlings, thereby eliminating entire populations of native plants in areas where the reed is left uncontrolled. As native plant species are replaced by *Arundo donax*, the once-complex riparian habitat becomes simplified into a vast stand of a single species that is not viable for native insects or wildlife. If this continues, "it is reasonable to expect reduced levels of diversity of a variety of other organisms, and significant modifications to the entire river ecosystem (CRP 2000).” The loss of native plant species has already had a direct effect on the diversity and abundance of terrestrial insect populations that depend upon native plants for their survival. These insects are a vital component of the diet of salmonids and other wildlife species, and play an important role as decomposers.

Pierce’s Disease

Pierce’s Disease is a lethal disease caused by the bacterium *Xylella fastidiosa*. Plants infected with the bacterium immediately manifest symptoms, which include drying of leaves and irregular maturation of bark. *Xylella fastidiosa* resides in the xylem of the plant and can remain localized in small sections of the plant. Propagation of the bacterium blocks water conduction channels (xylem) and kills the plant. The most common vector for *Xylella fastidiosa* in Northern California is the blue-green sharpshooter. Once the sharpshooter acquires the bacterium it is easily transferred through feeding patterns.

Pierce’s Disease has rapidly manifested itself throughout Napa County and has dramatically impacted viticulture within Napa County. A common response to both the actual and possible presence of the blue green sharpshooter in Sonoma and Mendocino counties has been increased removal of riparian vegetation in an attempt to eradicate sharpshooter habitat. Pierce’s Disease usually occurs within 300 feet of sharpshooter habitat (PDRHW 2000). Unfortunately, the majority of vineyards within the Russian River basin are located within 300 feet of the riparian zone.

Methods of containment for Pierce’s Disease have focused on restricting access of the blue-green sharpshooter. In addition to grape vines, hosts to the sharpshooter include a variety of native and non-native plant species. Native host species include: California Blackberry(*Rubus ursinus*), California Grape(*Vitis californica*), mugwort(*Artemisia douglasiana*), stinging nettle(*Urtica dioica)*, mulefat(*Baccharis salicifolia*), and blue elderberry(*Sambucus mexicana*). Non-native host species include: Himalayan Blackberry(*Rubus discolor*), periwinkle(*Vincus major*), and wild grape(*Vitis sp.).* Each of the above species’ is found commonly found in riparian corridors (PDRHW 2000).

Sudden Oak Death

Sudden Oak Death Sydrome (SODS), has recently been the cause of large numbers of dead Tanoak(*Lithocarpus densiflorus*), coast live oak(*Quercus agrifoia*) and black oak(*Quercus keloggii*) from Monterey County to Sonoma County. The suspected cause is a previously unknown species of *Phytophthora*, or water molds. There are sixty known species of *Phytophthora,* which were long thought to be fungi, but are more closely related to brown kelp.

Symptoms include dark brown cankers, seeping of a reddish brown viscous discharge, secondary predators of beetles and *Hypoxylon* can be found and then the foliage color turns from dark green to pale green and then brown.(McPherson 2000) Other species are now being found to be infected, but not being killed. These include *Quercus parvula*, *Rhododendron* from nursery stock, VIburnum and Vaccinium.

The implications of this potential epidemic are enormous, since oak trees figure significantly in 30% of California's landscape.(Pavlik et all, 1991) and prominently in the riparian zones of the Russian River.

RECOMMENDED ACTIONS:

Generally DFG recommends planting in riparian corridors when average reach canopy is below 80% or stream temperatures are above those preferable for the target species (see Temperature section). Alternatives such as excluding livestock from the riparian corridor except at controlled access points and the use of "riparian pastures," off-site watering devices, and other effective stock management techniques should be explored with livestock grazers and developed whenever possible. Habitat Inventory reports usually define where livestock are impacting the riparian zone.

When considering the removal of invasive plant species, control methods should: 1) address the way the plant spreads, either by seed or vegetatively; 2) include an evaluation of the extent of the invasion and plan for eradication; 3) Start at the upstream end of the watershed to avoid reinfestation; 4) include removal of single individual plants and small patches first, then the larger ones; 5) include proper disposal to avoid infesting another area; 6) Include control strategies for future years; 6) Incorporate erosion control measures and revegetation with native species, endemic to the watershed and planted in appropriate place to enhance survival rates.

The most common herbicide used to eradicate invasive plants is glyphosate, which includes Roundup and Rodeo. They have a low toxicity to humans. Triclopyr, a pyridine, is also used on woody and broadleaf plants and is almost non-toxic to birds and aquatic species. These chemicals should be used with caution, and follow guidelines on the label for timing and place of use.

The following is a list of the most common non-native plant species and control methods.

Species	Description	Habitat types	Growth mode	Control Mode
Giant Reed aka Arundo(*Arundo donax*)	Similar to bamboo; up to 35' tall	Riparian areas below 1000'	Rhizomes, stem or root fragments	Hand pulling, herbicide, cut off sunlight
Pampas Grass(*Cortaderia sellonana*)	6-13' tall with a hairy flower cluster on top	Disturbed areas, sandy areas, roadside	Seedlings from flowers	Cut prior to seeding, herbicide, hand pulling
German Ivy (*Delairea odorata*)	Perennial vine, shiny 5-6 pointed leaves, green to yellow foliage	Coastal forests, disturbed sites, riparian zones	Vegetatively only	Manual removal and complete eradication from the area
Scotch Broom(*Cytisus scoparius*) and French Broom(*Genista monspessulana*)	Perennial shrub 6-10' tall, yellow pea-like flower clusters	Mtn. Slopes, disturbed areas, clearcuts, riparian, grassland, etc	Prodigious seed production	Pulling by hand, herbicide, cutting, drying, and burning shrubs
Fennel (*Foeniculum vulgare*)	Perennial herb, 4-10' tall, anise scent, yellow flowers	Inland disturbed areas	Root crown and seed reproduction	Hand pulling and herbicides
Eucalyptus(*Eucalyptus globules*)	150-180' tall, aromatic, peeling bark	Groves or windbreaks in grassland habitats	Reproduction by seed and re-sprouting	Felling and treating stump avoids re-growth
English Ivy(*Hedra helix*)	Vines with deep green, leathery leaves	Forests near urban areas & disturbed riparian zones	Vegetative reproduction and by seed	Pruning vines and pulling roots
Blue Periwinkle(*Vinca major*)	Five petal, blue/purple flowers on a perennial vine	Mediterranean climate below 600' and in riparian zones	Vegetative reproduction	Hand removal or cut and spray with Roundup
Tamarisk/saltcedar(*Tamarisk gallica*)	Tree under 26' tall with small scale-like leaves	Disturbed sites with lots of water, riparian, pond sides, etc.	Reproduction by both vegetation and seed and cuttings	Cut shrub near bottom and apply Roundup

Recently, Circuit Rider Productions through funding with DFG and the Sonoma County Water Agency completed an assessment of Giant Reed infestation in the Russian River Basin (CRP 2002 Giant Reed). This included aerial mapping utilizing GIS, estimates of acreage infested, prioritized plans and cost estimates for control and restoration. The two reports "Assessment of Giant Reed and Restoration Planning: Russian River Tributaries" (CRP 2002) and Giant Reed (Arundo donax) in the Russian River Watershed: A Plan for Removal and Restoration (CRP 2000) provide a comprehensive watershed strategy. Estimates for control range from $10,000-$12,000/acre. The cost for removal basinwide within the riparian zone alone are estimated at $2.832 million dollars (CRP 2002). The results of these studies should be funded and implemented.

Recommended control methods vary by site conditions and locale and include:1)Removal of biomass and tarping of cut stems; 2) removal by hand or with small equipment on gravel bars; and 3) cutting stems and painting application of approved herbicides. In all cases continued maintenance to remove and treat re-sprouts is recommended for a minimum of three years.

Efforts to combat Pierce's Disease will have a substantial impact on the Russian River basin. The California Department of Fish and Game (CDFG) will be required to manage riparian habitat while maintaining viable vineyards. This is complicated by the presence of native and non-native riparian plants which act as alternate hosts for the sharpshooter and do not demonstrate visible symptoms. The majority of Pierce's Disease infections occur in the spring from overwintering blue-green sharpshooters.

The multi-agency/group Pierce’s Disease Task Force has developed draft recommendations for managing Pierce’s Disease and riparian corridors. The goal of a riparian vegetation management plan is replacement, not removal, of riparian plants thus maintaining suitable habitat for species found within the riparian zone. The recommended approach to decreasing the severity of Pierce’s disease is removal of specific riparian plants and replacement with native plant species that do not host the disease, thereby reducing the number of infected sharpshooters (PDRHW 2000). The replacement plants should mimic as closely as possible the ecological role of the removed plants. A transition zone at the edge of the riparian is recommended and long-term management is required. “The more the restoration follows the native vegetation patterns, the lower the restoration and maintenance cost, and the greater the success rate.”(PDRHW 2000).” Furthermore, it is recommended that new vineyards be installed at a distance greater than 300 feet from any riparian corridor. Opportunity also exists to expand the riparian corridor when vineyard or orchard replanting occurs in response to disease outbreaks and/or variety changes.

Initiation of a riparian vegetation management plan is only recommended after the presence of the blue-green sharpshooter has been detected. Landowners planning a revegetation project to combat Pierce’s disease may do so only under the guidance of CDFG. Preferred plant composition and structure of a given riparian zone varies according to location. See The Pierce’s Disease/Riparian Habitat Workgroup’s Information Manual: Riparian Vegetation Management for Pierce’s Disease in North Coast California Vineyards, 9/1/2000.

Presently with no known cure, control of SODS infestation is the only option. Preventing infested tree transportation and cleaning of wheels and feet that have been in infected areas are being presented as important steps. Public education is vitally important in this regard Clean-up of infected trees should preclude removing the trees from the affected area. Also, since the infestation is caused by a water mold, infected trees should be kept clear of all waterways to avoid transporting the disease. Burning the wood and leaving the wood to decompose on site are two methods of treating the infected trees after they are felled.(S.Swain, UCCE; May 2002 lecture, Occidental, Ca.). As the oaks die out, the question of restoration is going to be a vital one. Although we are not yet sure what types of restoration should be done in the previously affected area, new information is being gathered and tested daily.

In response to concerns over the mass conversion of oak woodland to vineyard, and the current lack of regulation guiding it, local regulatory policies are rapidly evolving to curtail hillslope erosion and protect habitat. The requirement of vineyard ordinances for farmers to register new vineyard developments with the county is one of the first ever legislative limits on agriculture in California (Merenlender 2000*). In 1991, Napa County passed an ordinance that required farmers to submit an erosion control plan and restricted new vineyards to a 35' setback from streams; 105' for slopes over 40% (Merenlender 2000*). In 1999 Napa was sued by Sierra Club for leaving review to discretion of agency reviewer, a huge loophole (Merenlender 2000*). In December 1999, Lake County passed an ordinance mandating that the clearing of more than 100 acres of native vegetation require the submission of an Environmental Impact Report (EIR).

Despite local efforts, however, in February 2000 the California Legislature passed legislation stating that vineyards are exempt from CEQA review (Merenlender 2000*).

In February 2000, after much debate between vineyard owners and environmental interests, Sonoma County passed a vineyard ordinance to control sedimentation caused by vineyard erosion. The ordinance identifies three levels of vineyards and seven types of "highly erosive" soils and provides corresponding requirements (Merenlender, 2000*). Level I vineyards are on slopes <15% (10% for highly erosive soils). They require a 25' setback from streams and a notice to the Agricultural Commissioner (Merenlender 2000*). Level II vineyards are of 15-30% slope and require a 50' stream setback and a certified erosion control plan prepared by any qualified person (Merenlender 2000*). Level III vineyards are on slopes of 30-50% and require a 50' stream setback and a certified erosion control plan prepared by any qualified professional (Merenlender 2000*). Planting on slopes greater than 50% is prohibited, with some exceptions. Replanting of previously established vineyard is treated differently. Mendocino County is currently developing a "grading ordinance" which may include agricultural practices.

LIMITING FACTOR: Water temperature

One of the most important factors in the overall health of salmonids and other aquatic life is water temperature. The ambient water temperature directly affects the body temperature and metabolism of fish and therefore influences feeding rates and growth, embryo and alevin development, timing for migration, spawning, and rearing. This is because water temperature has a direct relationship to the amount of oxygen that is dissolved in water. Dissolved Oxygen (DO) decreases when the water temperature increases. All life stages are impacted when DO is reduced, including eggs, alevins, and fry. This is because they are unable to regulate their own body temperatures. High water temperature is a serious concern, particularly with juvenile rearing which occurs in the summer. Poor temperature regimes can also adversely effect growth of juvenile coho salmon by decreasing size at smoltification (Holtby 1988).

Water temperature requirements are characterized in terms of "preferred", "optimum", or "tolerable". Preferred is what is preferred by a particular species and/or life stage. Optimum is the temperature that is the most beneficial for a species to thrive in for a particular activity such as spawning. Tolerable is used as a temperature range at which a species can survive.

The upper lethal temperature (at which death occurs in minutes) is 81?F-86?F (Jobling 1981). Juvenile salmonids begin to suffer significant stress at temperatures over 75?F (US EPA 1977; NCR1 WQCB 2000). Brett et al (1982) observed a significant alteration in food consumption at 72?F, and growth is reduced even at temperatures of 66?F MWAT (Sullivan et al. 2000; and US EPA 1977). Based on literature searches 60?F-62?F appear to be tolerable (Sullivan 2000; Welsh et al. 2001) for salmonids, while temperatures between 55?F and 60?F are preferred (Sullivan et al. 2001; Welsh et al. 2001).

.Elevated temperatures can indirect effects as well. Egg, fry, and/or adult mortality or reduced reproductive activity caused by high temperatures can lead to replacement of coldwater fish such as salmonids with warmwater fish such as cyprinids (carp, minnows). Water temperature also affects other aquatic life such as macro invertebrates. Warm water temperatures which suppress benthic organisms and the availability of that food source, combined with an increase in metabolic rates in fish may also result in high mortality.

Further, Hicks (2000) notes that there are warm water enhanced diseases such as Icthyophthiriasis and Columnaris Disease, which with temperatures exceeding 63?-64?F, serious infection and mortality are associated. At temperatures below 57?-59? F infections and mortality are often completely eliminated.

<u>RECOMMENDED ACTIONS</u>:

Riparian planting is needed along many sections of the mainstem to reduce stream temperatures and provide bank stability. DFG generally recommends riparian restoration planting where average canopy is below 80% and water temperature is over target by species (Flosi et al. 1998). Habitat Inventory reports summarize canopy measurements and needs but do not provide specific detailed project locations. Increase canopy by planting willow, alder, or native conifers along the surveyed stream banks where shade canopy is not at acceptable levels, or in reaches above the survey section when temperature impacts have originated upstream. Planting should be coordinated with bank stabilization and/or upslope erosion control projects. Species appropriate to the floodplain elevation and location in the watershed must be utilized. Circuit Rider Productions, "A Guide to Restoring Native Riparian Habitat in the Russian River Watershed," provides the best guide to riparian species and planting methods for the Russian River System.

The United States Environmental Protection Agency, in its *Draft Temperature Guidance, 2001,* advises that the "ultimate temperature criteria (standards) should be based on the thermal potential of the watershed. Thermal potential is defined as the estimated thermal regime achievable after all reversible anthropocentric (man-made) sources of heat are removed." The thermal potential should also include the addition of natural riparian corridors that existed historically and the replacement of water flow that has been altered as a result of extensive water diversions. Adequate monitoring is needed to determine the thermal potential.

LIMITING FACTOR: Water Quality

An important component of fish habitat is water quality. Historically, water quality standards have focused on drinking water and other beneficial uses of the human population. Since the listing of coho and chinook salmon and steelhead trout on the Federal Endangered Species list, more and more emphasis is being placed on standards that are protective of salmonids and other aquatic species. Non-point source (NPS) pollution from urban and agricultural runoff, roads, and leaking septic and sewage systems are the major source of pollutants affecting aquatic habitat. These pollutants include, oil and gas residues, chemicals, heavy metals, animal wastes, bacteria, pesticides and excessive sediment to our streams and rivers. Degrading water quality due to erosion, runoff from agricultural lands and urban areas, leaking septic tanks, and high mineral concentrations can adversely affect water quality. Pollutants of major concern for coho salmon and other fish species are sediment, nutrients, pesticides and thermal pollution that affects water temperature.

Sediment

The major human induced causes of sedimentation are unpaved roads that are improperly designed or maintained, land use activities such as vineyard and urban development that create unstable slopes, and removal of the riparian corridor along stream banks. In general, excessive sedimentation impacts the habitat required by salmonids rather than the direct physical health of the fish. Habitat is degraded when coarse and fine sediment fill in deep pools and embed or bury spawning gravels.

Nutrients

Nitrogen and phosphorus, necessary elements in sustaining the environment, may have deleterious effects on water quality, salmonids and all aquatic life. Inappropriate and excessive use of these chemicals combined with soil type, climatic conditions, and management practices will determine the extent nutrient loading into nearby streams. Nitrate nitrogen which is highly mobile, readily leaches into groundwater or moves from land to surface waters. Phosphates adhere to soil particles and moves to surface waters through the erosion process. Excessive loading of these nutrients into streams results in algal growths, causing swings in dissolved oxygen (DO) and pH, which are detrimental to salmonids and other aquatic life. The decompostion of prolific algal blooms causes a sharp decline in DO and directly reduces availability of oxygen for fish. Eutrophication also compromises the diversity and abundance of aquatic insects. Species that are especially intolerant to eutrophication are mayflies, stoneflies, caddisflies, and water-penny and riffle beetles that are important food sources for salmonids.

Dairies produce dairy waste which is the major cause of nutrient loading into surface waters. Dairy wastes produce toxic levels of ammonia. A release from a dairy waste retention pond into a stream may result in deleterious effects on salmonids and all aquatic life.

Pesticides and Herbicides

The term pesticide is a general term representing chemical substances used for pest control. Pesticides include insecticides, and fungicides, which when found in waterways or ingested can result in acute toxicity to animals and humans, from epidermal reaction, such as rashes, to nerve damage caused by organophosphates. Chemicals including organophosphates, carbamates, pyrethrins, chloronicotinyl insecticide and phthalimide are or may be toxic to wildlife, birds, bees and aquatic life, as well as toxic to humans. Herbicides are found in many forms and are utilized to control vegetation or weed growth. Fish and other aquatic species, including aquatic plants receive significant exposure to waterborn chemicals because they spend all or most of their lives in water. They absorb dissolved chemicals from the sediment and water and through ingestion with the food they eat. Pesticides are recognized as major stressors to fish as they cause lethal effects, impair reproduction, and reduce food sources. Chemical eradication of beneficial insects may ultimately cause pests to reinvade faster and even develop resistances, both of which may allow them to outcompete beneficial insects, ultimately causing more harm to an area. .

Contamination of waterways and water supplies from urban use of chemicals is a worldwide problem. Contributions of pesticides and herbicides from urban applications are from lawn, garden, and building treatments. These are introduced into local tributaries through runoff into storm drains. Although it is not required that home use of pesticides be reported, marketing data reveal a significant percentage overall pesticide sales are for home use. Pesticides are also transported through the watershed through aerial drift. As they volatilize, they are carried by the winds and precipitate out with rainfall. Irrigation water runoff is the primary source of pesticide loading into surface waters. Some pesticides are transported bound to sediment which enters streams through the erosion process. Others are water soluble and are transported through stormwater and irrigation runoff. Pesticides are also transported through the food web, which contribute significant sources of toxicity through the various trophic levels.

Pesticides and herbicides also find their way into rivers via agricultural, urban, and right-of-way applications. Agricultural applications include aerial and ground spraying of crops, and in soil treatment. In livestock operations, pesticides are used to control flies and other pests on the animals. Fumigation of soil and feed storage areas and application of pesticides in irrigation water also contribute to the mix. Drift through the air, groundwater infiltration, and runoff from stormwater or irrigation water allow migration of pesticides and herbicides into the watershed.

Right-of-way applications are those along roadsides, highways, and railways to control plant growth and around structures to control pests and molds. These wash into streams in storm runoff and since herbicides are very persistent in the environment, they are present in both surface waters and groundwater.

Environmental Estrogens

A general discussion on environmental estrogens is included in this report because these chemicals are of great environmental concern for all species. Environmental estrogens are also called endocrine-disruptors, ecoestrogens, environmental hormones, and phytoestrogens. Environmental estrogens are synthetic chemicals and natural plant compounds (phytoestrogens) that are suspected of disrupting the endocrine system. The endocrine system is the body’s communication system (glands, hormones, and cellular receptors) that control the body’s internal functions. The detrimental effects include reproductive and developmental problems caused by mimicking or blocking normal hormonal responses.

Natural estrogens are found in soybeans and other legumes, whole grains, and many fruits and vegetables. Synthetic estrogens are found in pesticides, chemicals used to manufacture plastics, pharmaceutical drugs, detergents and associated surfactants, and industrial chemicals.

Although effects of environmental estrogens in humans are highly controversial, effects on fish are no longer a suspicion. In the most widely publicized example, male fish exposed to municipal sewage sources had developed both female and male sex characteristics. It is hypothesized that certain chemicals that are produced when detergents and plastics breakdown are the causes.

Studies on fish as well as mammals, reptiles, and birds, indicate permanent effects including: abnormal blood hormone levels, reduced fertility, altered sexual behavior, modified immune system, feminization or males and masculinization of females, cancers of female and male reproductive tracts, malformed sexual organs, and altered bone density and structure

Urban and agricultural runoff, roads, and leaking septic and sewage systems contribute oil and gas residues, chemicals, heavy metals, animal wastes, bacteria, and excessive sediment to our streams. All of these compounds decrease water quality and lower levels of dissolved oxygen. Many heavy metals and chemical pollutants such as pesticides and PCBs, even in small quantities, can affect the gill tissues in fish. These pollutants can also have serious detrimental effects on egg viability and reproductive success. Studies on environmental estrogens in Europe have shown effects in salmonids that can block hormonal changes and response necessary for breeding, sexual maturation and transition to the seawater phase.

RECOMMENDED ACTIONS:

Today, the primary water quality problems in the Russian River are sediment and its effects on various life history stages of salmonids and temperature and dissolved oxygen and its effects on all life history stages of the cold water species. The Russian River is listed as an impaired water body for sediment on the Clean Water Act 303(d) list. The North Coast Regional Water Quality Control Board (NCRWQCB) will develop a technical Total Maximum Daily Load document by 2011. The NCRWQCB is currently initiating the process to amend its Basin Plan. It is proposing to add the RARE (rare and endangered species) beneficial use designation to the Russian River watershed, amend the narrative temperature objective to a numeric temperature objective, amend the narrative sediment objective to a general numeric sediment objective and develop a region wide (North Coast) sediment amendment that will incorporate the new Russian River sediment amendment. As of February, 2002, the Basin Plan amendment process is a NCRWQCB internal process where strategies are being developed and alternatives to those strategies are being analyzed. It is estimated that in Spring of 2002, the formal amendment process will begin. Public comment will be invited in the Fall of 2002.

Contamination of waterways and water supplies from urban use is a worldwide problem, and one easily avoided or reduced by education and management. Diagnosing a garden problem correctly is the first step in reducing reliance on chemicals for the urban garden keeper (Marcus et al 2001). Homeowners should consult “The House and Garden Audit: Protecting Your Family’s Health and Improving the Environment” by (Marcus et al 2001), which includes tips for monitoring the garden for insects or insect damage, examining insects and damage and keeping notes.

Symptoms of nutrient deficiency, too much or too little water, animal pests (such as gophers, birds and deer), diseases are often mistaken as insects as sources of damage. Reducing and controlling insects and diseases should include preventative measures, such as using healthy plants from the start, incorporating plants which attract beneficial insects and repel pests and using the least amount of toxic alternatives possible. The use of physical barriers, traps, baits and hand removal are effective on various types of pests, as well. Plant diseases consist of bacterial or viral infections, fungus and mildew and can be reduced by using proper watering methods and selecting plants which are appropriate for the area.

Dormant sprays, such as copper and fungicidal soaps, smother eggs and control pests. Botanical insecticides and insecticidal soaps are also methods of controlling pests, but avoid using rotenone and pyrethrins near creeks or where runoff occurs. Do not apply insecticides simply because insects are present, but instead consider non-insecticide control methods and consult a professional. Some pest damage should be considered acceptable.

Management of flora may be done naturally or chemically. No matter what, pest management should be performed using the least amount of insecticides, fungicides and other chemicals, as these methods kill a broad spectrum of insects, including those which are beneficial. Also, most conventional insecticides must remain on the plant to be effective. If conventional insecticides are to be used, recommended safety tips and all precautions should be followed.

The more natural method, Integrated Pest Management(IPM), which relies less upon the above mentioned chemicals and insecticides, include proper selection of floral species, balance of pests and beneficial insects, keeping flora in proper health and the acceptance of some pest damage as a naturally occurring part of the balance of nature.

CDFG and other state, local and federal agencies should support voluntary programs such as the NRCS, EQIP, and Dairy Waste Programs and Sotoyome Resource Conservation Districts' Fish Friendly Farming Program which recommends BMP's for reducing sediment, pesticide and herbicide uses, and for reducing runoff from agricultural lands through the use of riparian buffers and avoidance measures.

The study of benthic macro-invertebrate (BMI) communities in wadeable streams is a useful determinant of both acute and chronic water quality problems. CDFG believes studying BMI communities is the preferred method of water quality monitoring nationwide because BMIs are ubiquitous, relatively stationary, and the large diversity of BMI species provides a wide spectrum of responses to environmental stresses. Individual species live in stream bottoms for months to several years and each species is sensitive, to varying degrees, to water temperature, dissolved oxygen, sedimentation, scouring, nutrient enrichment and chemical and organic pollution. Several agencies in California have included BMI monitoring in their watershed planning efforts, including the Resource Conservation District, Department of Fish and Game, North Coast Regional Water Quality Control Board, Sonoma County Water Agency and the City of Santa Rosa.

DFG has been collecting macro-invertebrate samples in the Russian River since 1995 (see Appendix G for complete list). CDFG's Water Pollution Control Laboratory, which analyzed the samples, used the U.S. EPA's conceptual model for development of biocriteria to produce an Index of Biological Integrity for the Russian River Watershed (RRIBI). The methods for establishing this index are explained in *An Index of Biological Integrity for First to Third Order Russian River Tributary Streams,* CDFG 1998 and instructions for using the RRIBI are found in Appendix G. Streams sampled CDFG encourages the use of the RRIBI and supports Citizen Monitoring within the basin. Funding for citizen and agency training and sample collection to establish reference conditions on which to refine the RRIBI should continue.

Public assistance is encouraged in reporting of suspected violations and continued vigilance by CDFG and NCRWQCB is necessary. Studies to determine the presence and potential effects of environmental estrogens are needed.

LIMITING FACTOR: WATER QUANTITY

> Obviously rearing fish require summer flow. There are many small tributaries streams throughout California, however, which naturally have only intermittent flow in the summer months. Salmon and steelhead faced with reducing flows, must either move from shallow habitats like riffles to deeper ones like residual pools, or perish due to predation, high temperature, or standing when the stream goes dry. This is a natural occurrence, to which the fish population has adapted. Some streams with perennial (year-round) flow have become intermittent as a result of changes in the watershed, removal of riparian vegetation, or diversion of water. This has reduced the “carrying capacity” of many smaller streams to rear fish.

While salmonids may survive through periods of intermittent flow, new information indicates that juveniles may migrate within a stream to a much larger degree than previously thought (T. Roloeffs p.communication). When flows drop to a level which prevents intra-stream movements, the juvenile fish lose the ability to select better micro-habitats that offer better living conditions.

RECOMMENDED ACTIONS:

This document, as noted earlier, is intended to focus on the restorative actions for Russian River salmonid fish and their habitat, and therefore does not intend to deal with the complicated subject of adequate flow for fisheries. Flows necessary for rearing salmonids or suitable for migration is a much studied as well as a hotly debated topic. While past regulatory focus has been placed on so-called “minimum flow requirements”, more progressive study is being put into flow requirements that mimic natural patterns and fluctuations rather than focusing on a single target flow level.

To this end, DFG should encourage the North Coast Regional Water Quality Control Board (NCRWQCB) and the State Water Resources Control Board (SWRCB) to integrate life history requirements for salmonids and other aquatic life into the water rights permitting process. Water right permits should consider natural flow and water quantity/water quality requirements of the listed species. The NCRWQCB and SWRCB along with DFG and other agencies should obtain data and locations watershed-wide on water diversions, riparian water rights, water right permits, groundwater and well-water usage, and aquifer conditions in order to make safe and protective decisions on continued water quantity impacts on salmonids.

DFG wardens, should work directly with the SWRCB, NMFS, USFWS, and in investigating complaints of illegal water diversions and water right permit violations

Follow and give support to the U.S. Geological Survey (USGS) and Sonoma County Water Agency (SCWA) "Joint Groundwater Study".

Limiting Factor: Habitat Availability

Salmonids need a variety of habitat types such as pools, riffles and flatwaters to accommodate different life stage functions during their lifecycle (Figure 15). Pool habitats are required by most salmonids at one or more life stages (Spence et al. 1988). Provided that water quality is adequate, primary pools provide critical summer habitat for steelhead and coho salmon (Flosi et al. 1988; Nickelson et al 1991). Peterson et al. (1992) recommend a target condition for percentage area of the stream surface comprised of pools of 50% for Washington streams with gradients <3%. In California, Flosi et al. (1998) found that the better coho streams have 40% of habitat length in primary pools.

Complex instream habitat is an absolute essential in the rearing and social structure of salmonids. Structure within pools creates micro-habitats. Large and small woody debris, undercut banks, root wads, overhanging terrestrial vegetation, aquatic vegetation, boulders, and bedrock ledges all supply fish with shelter from predators, territorial niches, and eddies where fish can rest during high flows. Salmon and steelhead are aggressive, cannibalistic, and territorial creatures. For a large pool to be inhabited by numerous fish there must be sufficient complexity; that is, there must be plenty of cover so that each fish can preside over a different niche within the pool. Flosi et al (1998) recommends that a pool shelter rating of 100 (shelter value x percent of area covered) is desireable.

Log cover is often the principal component which provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density-related competition (Flosi et al. 1998). Large woody debris also serves to retain spawning gravels, creates slack water areas which provide opportunities for juveniles to feed on drift, and by providing essential cover from predators and freshets (Murphy and Meehan 1991). Underwater observations by Shirvell (1990) found that 99% of all coho salmon fry observed were occupying positons downstream of natural or artificial rootwads, during artificially created drought, normal and flood stream flows. Woody debris in streams also increases the frequency and diversity of pool types (Bilby and Ward, 1991).

Restorative Actions:

Habitat enhancement activities are generally the last activities to be considered in implementing watershed treatments. However, these relatively short lived projects are also often needed while bigger picture projects or management changes are being implemented. Funding entities should scrutinize proposals for habitat enhancement to make sure that causes of habitat degradation are being treated and not just symptoms. Otherwise habitat work may come undone through the disrupted hydrologic processes.

However, habitat enhancement projects often initiate landowner interest, and projects should be encouraged when the need is justified through habitat assessment, and the activity is well defined and designed whenever possible. Habitat Inventory reports summarize the need for habitat addition, and enhancement by geomorphic reach but do not detail specific locations.

In general, DFG recommends pool enhancement projects to be considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined as having a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. In third and fourth order streams, a primary pool must be at least three feet deep.

DFG recommends designing and engineering pool enhancement structures to increase the number of pools or deepen existing pools, where the banks are stable or in conjunction with stream bank armor to prevent erosion, when pool habitat is lacking (as described earlier). Flosi et al. (1998) includes specific structure recommendations for each channel type. Instream habitat improvement is only appropriate in stream reaches suitable for habitat improvement structures.

In streams or stream reaches where the shelter is lacking it is desirable to increase woody cover in the pool and flatwater habitat units, with complex, woody cover, especially where the material is locally available. In general, DFG recommends in streams or stream reaches where the mean pool shelter ratings are calculated to be less than 80 it is desirable to increase woody cover for shelter. Pools, which are too shallow to qualify as primary pools can often be enhanced by increasing scour with addition of LWD or boulders. Habitat types such as step runs and low gradient riffles can often be converted into pool habitat if pools are recommended. Project Implementation plans must be thoroughly reviewed before proceeding with a pool enhancement project. Cover structures should only be considered in stream reaches suitable for habitat improvement structures.

Barriers to Outmigration

Barriers to outmigration (or emigration) are usually in the form of flow barriers. Most upstream migration occurs from fall through early spring when, depending upon weather patterns, flows tend to be higher. Steelhead emigrating in the summer months can be faced with flows too shallow to swim through, particularly if summer dams have been installed.

RECOMMENDED ACTIONS:

There needs to be unhampered passage of juveniles downstream. Fish ladders and bypass structures need to be maintained to ensure that they are operating at peak efficiency when outmigration is occurring. Studies to elucidate the effect and the proliferation or loafing presence of warm-water predators need to be conducted. Timing of outmigration needs to be evaluated at a minimum. The Department should strongly oppose the construction of any onstream dams on the Russian River or its tributaries. Identify on-stream structures and encourage change-willing owners to switch to off-stream through cost shares for relocation, wells, crop buy-out, or easements.

SPECIFIC LIMITING FACTORS AND RESTORATIVE ACTIONS TO MAINSTEM RUSSIAN RIVER

The following details fish needs for the mainstem established through a limiting factors approach utilizing available information and data from DFG and many other agencies and sources.

Barriers to Upstream Migration

Principal concerns within the Russian River mainstem (particularly in the Lower River) are barriers to the upstream migration of fish from summer dams, presence of terrace pits which have potential for river capture and adult fish entrapment, water quality issues related to domestic discharge, and estuary conditions.

Both the Warm Springs and the Coyote Valley Dams completely block access to upstream spawning and rearing habitat for anadromous salmonids. In addition to these, there are also five smaller impoundments on the mainstem, and approximately 500 licensed or permitted dams on the tributaries to the Russian River (SEC 1996).

Summer dams are temporary structures placed across the stream to provide deep slow-moving bodies of water. Their main purpose is usually to provide for recreation although some also supply water. Historically the summer dams were typically installed just prior to Memorial Day and then removed just after Labor Day.

Summer Dams – Mainstem

The following is a list of the major summer dams on the main stem Russian River

1. Vacation Beach Dam- Operated by the Russian River Parks and Recreation District (RRPRD) for recreation. This dam includes a portable modified denil fish ladder designed to Department specifications. The dam is believed to have little impact on the migration of salmonids as the out migration is over before the dam is installed and only the earliest returning chinook salmon have entered the river by the time the dam is removed in late summer. Even with the fish ladder, the dam probably provides an impediment to the migration of American shad after the boards have been installed. Observations of the fish ladder when it was first installed demonstrated that American shad could pass through the ladder, but there is probably some delay. Because of changes in the river bed the ladder may not function as well now as it did when first installed.

2. Johnson's Beach Dam- Also operated by the RRPRD for recreation. This dam has a modified denil fish ladder. Fish passage issues are similar to those of the Vacation

Beach dam. Because the fish ladder at Johnson's Beach is positioned to function best when water is backed-up by the Vacation Beach dam, and because the Vacation Beach dam is normally installed 2 or 3 weeks after the Johnson's Beach dam, there has been a period from mid-May (when the Johnson's Beach dam has traditionally gone up) to mid-June when the Johnson's Beach dam has been more of an impediment to American shad. In the future it is likely that the Johnson's Beach dam won't go up before June 15.

3. Wohler Dam- Installed by the Sonoma County Water Agency (SCWA) to impound water to increase percolation to their Ranney wells which supply water to the City of Santa Rosa, other cities in southern Sonoma County, and portions of Marin County. This dam is an inflatable structure with modified denil fish ladders on each side of the river. The dam is usually inflated in early May and lowered in the fall just prior to the first major storm. As with the other summer dams, there is a concern that it may retard the downstream migration of steelhead and salmon smolts. In most years, it has no effect on the upstream migration of salmonids, except, possibly, for early returning chinook. chinook salmon do reach Warm Springs Hatchery upstream of Wohler dam when the dam is inflated and video cameras mounted in the fish ladders show chinook salmon moving through the ladders. In periods of drought the dam may be inflated during the winter when it could have a greater effect on migrating salmon and steelhead, but the ladders are well maintained and appear to easily pass these species. Wohler dam probably provide an impediment to American shad which are known for their reluctance to use most kings of fish ladder; there is probably a significant cumulative impact of Vacation Beach dam, Johnson's Beach dam, and Wohler dam on the shad migration after the dams go in.

Associated with Wohler dam is a large surface water diversion to a percolation pond. The diversion is equipped with two rotary drum screens designed to Department of Fish and Game specifications.

4. Healdsburg Dam- Installed by Sonoma County Regional Parks Department to provide recreation. The present dam at Healdsburg was constructed in 1953. As early as 1956 it was recognized that there was a problem with fish passage. The river bed downstream of the dam was degrading (i.e. lowering) and creating a drop on the downstream side of the dam's foundation. Eventually this drop reached 14 feet. Several times large rock was placed below the dam to protect the foundation and attempt to improve fish passage. The primary fish passage problems at Healdsburg are in the fall and spring when the flows are lower. In the fall and early winter adult chinook salmon and coho salmon are most likely to be affected. Steelhead trout enter the river later than the coho and chinook when the flow is often higher. The higher flows in mid-winter make it easier for the steelhead to get over the dam to reach the upper portions of the watershed, although there are probably periods of low flow when passage is difficult and the steelhead are delayed in their migration.

The dam has also created a total barrier to American shad, which enter the river to spawn in the spring and are completely blocked by Healdsburg Dam. Healdsburg dam has been the most serious fish passage problem on the Russian River.

During the summer of 2001 a fish ladder was constructed at Healdsburg Dam to help steelhead trout, coho salmon, chinook salmon and other fish species get over the dam as they migrate upstream to spawn. The fish ladder is a pool and weir structure, based on the design of the ladder at Ice Harbor Dam on the Snake River in the state of Washington. This design was chosen for its record of being able to successfully pass American shad which have been completely blocked by Healdsburg Dam for many years. The new ladder will allow the shad to pass the dam without having to jump, and will reopen the Alexander Valley area to spawning.

The fish ladder is designed to function only in the fall, winter, and spring when the spawning migrations occur and when the boards that form the dam are in the down position. In the summer, when the boards are raised to create the recreational pool, the fish ladder will not function for upstream fish passage, but will still facilitate safe downstream movement through the rocks below the dam. To ensure that the majority of migratory fish have passed the dam before the boards are raised and fish ladder is closed, the boards will be raised later in the year than they were in the past. The typical date of flashboard installation will change from about May 20 to June 26. By this date the majority of upstream movement by migrating salmon, steelhead, and American shad will have stopped.

5. Del Rio Woods Dam- Installed by the Del Rio Woods Homeowners Association to provide recreation. This is a gravel dam with a permanent sheetpile spillway structure. There is no fish ladder at Del Rio Wood, but the Corps of Engineers permit specifies that a fishway will be required at such time as a fishway is provided at Healdsburg dam; or the fish passage objective could be met by delaying installation under the boards go up at Healdsburg dam, which in the future will be June 26. Because Del Rio Woods is a gravel “push-up” dam that requires heavy equipment operation in the river to build and remove the dam, there have been concerns raised about water quality impacts.

6. Willow Water Company Dam- Constructed by the Willow Water District Company below the City of Ukiah, the structure was constructed of concrete and boulders with a small low flow channel. Rubble is added semi-annually to the base to retard undercutting of the 8 ft high drop. This dam represents a severe impediment to the migration of all salmonids in low flow years, and to early returning chinook in most years. Its effect on adult steelhead and outmigrating salmonids is unknown.

1.Mumford Dam- Located on the West Fork Russian River, this is a flashboard structure with a concrete sill which has been in use for over 40 years. The sill is now perched approximately 12 feet above the downstream channel bed. As with other full-spanning concrete structures in the river, downcutting has occurred downstream of the sill. This has resulted in a complete barrier to fish migration and adjacent bank erosion. An existing grant from DFG to SCWA proposes to build a step-pool fishway over the sill to restore fish passage and improve the hydrology and decrease bank erosion in close vicinity downstream. A new diversion structure proposed by the landowner will eliminate reliance on the use of flashboard which will significantly improve habitat upstream. The improvements are expected to be completed by April of 2003.

In the Russian River basin, it has been estimated that several hundred summer dams are installed annually(Chase et al. 2000). . Most existing types of summer dam are private ponds, which are typically constructed on relatively small streams for recreation or frost protection. Dam construction varies, but common types include manual placement of cobbles across streams, earthen-berms placed in stream or flashboard structures. The effects of summer dams on salmon and steelhead have the potential to adversely affect salmonid habitat by 1)reducing stream habitat diversity, 2) diminishing stream water quality, 3) enhancing the habitats of salmonid predators, and 4) blocking or restricting fish movements(NMFS, 2001)

Effects of summer dams on listed salmon and steelhead include the degradation of suitable habitat, decrease of cool, clear, running water, interrupting their freshwater life stages, decrease of clean gravel needed for eggs, decrease of alternating riffle, run, pool complexes with sufficient woody debris, boulders and undercut banks for shelter. Summer dams convert such natural stream habitats to artificial ponds that may extend thousands of yards.

The timing involved in the creation and removal of summer dams affects salmonids differently at different stages in their life cycles. For example, installing a dam in June may not adversely affect the reproductive stages of a particular salmonid, but it may negatively affect the outmigration stage of the same salmonid. Each of these structures impedes fish passage to some extent. Some are complete or nearly complete barriers to adults, which is why summer dams need to be dismantled at the end of summer to allow migration of adult salmonids. All are nearly complete barriers to juveniles, and early returning Chinook. Backwatering upstream of the structures makes downstream movement of outmigrating smolts less than ideal.

During the summer months, summer dams change stream flow patterns, reducing habitat diversity and water quality. Habitat upstream of the structures is usually severely altered, and favors introduced warm water predators. As an example, in mid-June 1984, CDFG planted 468 marked steelhead in a seasonal impoundment and only one was left at the end of the summer. In contrast, 326 rough fish, including suckers, sculpin, roach and tule perch were present at the end of the summer. In a similar sized are of the creek, but in a free-flowing part, 14 times as many steelhead per unit length and 93 times as many steelhead per stream surface area were found.(NMFS 2001).

During the installation and removal process, salmonids in the creeks are subject to direct physical disturbances and by temporary changes in stream flow. Developing embryos or alevins are vulnerable to crushing and being dug up, as well as being vulnerable to fine sediments which clog interstitial spaces and can smother developing embryos and fry. The impoundment of water impairs surface currents needed to transport dissolved oxygen to eggs and fry and transport metabolic waste products away from those lifestages.

Altered stream flows adversely affect salmonid habitats, as well. Reaches become dewatered, stranding fish along stream banks and/or causing them to become isolated in small pools or other marginal habitats, where they are now vulnerable to both desiccation and increased predation from birds or mammals. Also, higher mortality rates are the result of deteriorating water quality. Although all dams may affect the above mentioned conditions, flashboard dams pose a more serious condition, since they are quickly put in place and completely affect the total water flow by capturing all water flowing in. This instantaneous, yet temporary stoppage can have severe downstream effects. The removal of the flashboard can cause a different effect by instantaneously deluging the stream below with a flood of water, which can negatively impact habitat. In general, sudden changes in flow and water surface elevations have the potential to cause stranding of juvenile salmonids both upstream and downstream of the dam.(Cushman 1985)

<ins>RESTORATIVE ACTIONS</ins>:

There needs to be unhampered passage of adult spawners (both salmonids and American shad) trying to migrate upstream, as well as of juveniles downstream. The fish ladders on the Vacation Beach, Johnson's Beach, and Wohler dams need to be maintained to ensure that they are operating at peak efficiency. Proper maintenance of these ladders may include proper positioning of the portable ladders during installation to accommodate changes in the river. The Vacation Beach dam should be installed at the same time as, or prior to, the Johnson's Beach dam to ensure proper functioning of the Johnson's Beach dam. Studies to elucidate the effect on early returning chinook, outmigrating steelhead, and the proliferation or loafing presence of warmwater predators need to be conducted. Timing of operation needs to be evaluated at a minimum.

The Department should strongly oppose the construction of any new summer dams on the Russian River or it’s tributaries. A shift to off-stream reservoirs would eliminate much of the fish passage concerns, and reduce regulatory conflicts A Reliance on on-stream reservoirs necessitates building fish passage structures which are significant improvements, but still limit passage of adults and juveniles to a specific range of flows, necessitates maintenance, and does not restore the hydrology which initiates gravel movement.

DFG code Chapter 1600 regulates projects, “…That divert or obstruct the natural flow or substantially change the bed, channel, or bank of any river or stream or lake…”. Most summer dams are not reviewed or permitted due to regulations being ignored

Stream Crossings and Culverts

Where the highway strays from the river, there are numerous county-owned roads serving as main arteries to numerous private roads. In all reaches of the basin, large tributaries are paralleled with paved roads, and smaller canyons bear numerous small dirt and paved roads with thousands of culverts or fords at crossings.

There are five summer road crossings on the Russian River. They are all in Sonoma County and are located near Asti, at the Syar gravel plant in Healdsburg, at Oddfellows Road, at Guernewood Park, and just downstream from the Vacation Beach summer dam. Four of these crossings are placed in the stream by Sonoma County to provide more convenient access and to reduce travel distances during part of the year. The Syar crossing is part of their gravel haul road. The summer road crossings are constructed by pushing up a gravel approach to a bridge structure; the bridge structure is either temporary or permanent, and the approaches are taken out before the winter high water, or washed out by high water, then installed again the following year. Recent bar growth and river meandering upstream of the Asti summer road crossing suggests that river scour (instead of manual removal) in some years of the constructed gravel ramp may be leading to localized aggradation of the bed. This may be a partial contributor to lateral migration, movement of the low flow channel, and significant erosion upstream (Matt O’Connor, personal communication).

Several other summer crossings may be installed each year by gravel miners. These crossings usually involve the placement of several large culverts in the river with a gravel road bed constructed over them. Some of these crossings also use railroad flatcars as temporary bridges.

RESTORATIVE ACTIONS:

A fish passage assessment of all county culverts in the basin was completed in the summer of 2002 under contract to DFG using the methods of Taylor(2000). Length and quality of habitat upstream will be utlilized to establish priorities for improvement. DFG will work with each county to address these issues, and develop and secure funding. Remediation should follow the NMFS *Guidelines for Salmonid Passage at Stream Crossings* (NMFS 2000) with the following recommendations, in order of preference.

For replacement:

- Bridge – with no encroachment into the channel 100-year flood plain.
- Streambed simulation strategies – bottomless arch, embedded culverts, or ford.
- Non-embedded culverts – with less than a 0.5% slope.

For retrofits:

- Baffled culvert or structure designed with a fishway –for slopes greater than 0.5%.

Several push-up temporary crossings exist on the river. When temporary crossings have been constructed, fills from the constructed ramps need to be removed manually by heavy equipment from the floodplain. This will allow more natural movement of bedload and decrease chances of aggradation or lateral migration.

GRAVEL QUANTITY:

All substrate within a hydrologic system is subject to transport and deposition by flowing water. As water moves it carries gravel and sediment with it. The ability of a stream to transport sediment depends on the energy available to move particles downstream.. In any river system, small particles, like silt and clay, are generally transported out of the system while larger substrates, like sand, gravel and cobble, are deposited during erosional events from banks and gravel bars. Flows must be adequate to mobilize the bed of the stream and to recruit gravel from flood plain sources. The transport and deposition of coarse substrates (like gravel) within a stream is influenced by peak flow hydrology, channel gradient and channel morphology. Sediments erode naturally from the headwaters (source areas) to steep stream channels (transport reaches) which tend to winnow away sediments to flatter reaches (response reaches) where they are deposited.

Where the river is “filling in” it is aggrading, and where the river’s bed drops, it is degrading. Rivers may also be said to be aggrading for a period of time and then degrading for another. This is dependent largely upon climatic conditions; large rainfall events can transport sediments during wetter years and deposit sediments in drier years. Thus, most rivers have portions which are aggrading and portions which are degrading, depending upon the underlying geology, the climatic conditions, and the frequency of large disturbances. Under natural conditions, the influx of sediments into and the transport of sediments out of any given system (over the long term) occur at more or less equal rates, creating a balance known as “dynamic equilibrium”. Thus, at any point along the equilibrium curve, or at any particular location along its length, the river may be degrading or aggrading. Disturbance mechanisms (like landslides or drought) occur more or less at random, and represent the peaks or troughs in the equilibrium curve. Geologic time between disturbances tends to smooth the curve and the stream responds back towards its state of equilibrium.

Salmonids spawn in the active channel of a river or stream; the area of the channel that is the most dynamic. In degrading systems or reaches, such as the Ukiah reach, spawning gravel may be in short supply or non-existent. Shortages of suitable redd locations or gravel size decrease the productivity of any stream. It can also result in super-imposition of redds from both within and between species; as fish compete for redd space, resulting in one fish scouring out another’s eggs during the nest building process. In aggrading systems or reaches, like Asti and

Alexander Valley, spawning gravel may be highly mobile as the thalweig (deepest part) of the stream flip-flops from side to side of the channel. Redds may also become de-watered as flows drop below heavily aggraded bars.

RESTORATIVE ACTIONS:

To reduce bank erosion and improve conditions for migrating and spawning adult salmonids, flow schedules should be established which closely mimic natural flow regimes. This would re-establish sediment transport processes needed to offset channel incision and reduce erosion. Dam releases, which more closely mimic the natural rainfall hydrograph would improve migration, and provide sediment flushing flows. This would eliminate the extended "limb" of the hydrograph which increases bank erosion from saturation on Dry Creek and specific sections of the mainstem.

Individual Aggregate Resource Mining (ARM) plans exist for each County, but no agency or element monitors aggregate movement or replenishment on a watershed or "sediment budget" basis. A sediment budget needs to be developed for the river and a sustainable mining plan needs to be developed. County ARM's would then need to be modified to reflect source and replenishment issues and local jurisdiction.

Additionally, projects to offset channel incision, diminished gravel recruitment, gravel bed scour, bank erosion and riparian loss need to be developed on Dry Creek below Lake Sonoma and in the Ukiah reach of the mainstem below Lake Mendocino. Projects involving solely rip-rap as a treatment for bank erosion on steep banks should be discouraged, except where structures are threatened. Bio-engineering techniques utilizing vegetative materials and limited rock should be encouraged whenever possible.

RIPARIAN STABILITY

Historically, "Extensive areas once existed along the Russian River where the riparian was dominated by large trees, shrubs, and vines. These areas, connected by a riparian corridor, created wildlife habitat and contributed extensively to instream fish habitat. Fallen trees and root wads provided deep scour pools in the channel which, during the summer, were likely utilized by rearing steelhead and coho (SEC 1996)."

The removal of riparian vegetation has gone hand-in-hand with the development of the Russian River watershed and has been a consistent practice since European settlement of the basin in the late 1700s. Since that time, total riparian area in the Russian River basin has declined 70 to 90 percent (Circuit Riders 1994a). Many factors have been responsible for the direct removal of riparian vegetation, including timber harvest, grazing, road building, agricultural development, and urbanization.

Research conducted by Circuit Riders Productions (CRP), with funding from the Sonoma County Water Agency (SCWA), concluded that there are approximately 236 acres of *Arundo* along the mainstem of the Russian River, with the majority (142.5 acres) being concentrated in the Alexander Valley area (CRP 2000-date?). CRP's research clearly indicates that giant reed is having a detrimental impact on native plant and animal communities along the Russian River, significantly threatening the abundance and diversity of riparian plants and terrestrial insects.

According to Circuit Rider Productions (2000), "The giant reed invasion is of immediate concern in the Russian River watershed. Based on information from river systems in southern California and other riparian areas throughout the world, it is clear that giant reed may be one of the most serious impacts to the remaining riparian habitat in the Russian River system, having a direct impact on the salmonid fishery." If *Arundo donax* continues to spread throughout the watershed, the resulting impacts to the salmonid fishery and wildlife in general will be severe.

<u>RESTORATIVE ACTIONS:</u>

Riparian stability can only be reached through implementation of large scale river projects or through management for natural river processes. Solutions include: removal of onstream levees and construction of offset levees to increase floodplain and reduce floodcontrol maintenance, moving or raising structures in frequently flooded areas, adding floodplain level culverts to increase floodplain draining at culvert crossings, and purchase of riparian easements to allow floodplain flooding and stream meandering. Local bond measures could be developed to cost-share these activities with county and other funds. KREP program needs to be discussed.

Fund solutions identified in the Coastal Conservancies Draft Russian River Enhancement Plan to solve flooding, river capture of gravel pits, fish stranding, and erosion control issues on mainstem Russian River (Middle and Ukiah Reaches).

Biologists believe that the invasion of giant reed can be controlled, but only by using the correct measures. These measures include cutting down the reeds and either tarping the cut stems or applying herbicides to the stems in the fall. Complete removal of all roots and rhizomes can also be successful for reed infestations of gravel bars. Unlike seed-producing plants, giant reeds reproduce clonally, expanding where stands exist or colonizing new sites when plants are transported by water in high flow events. Therefore, guidelines for successful long-term removal of *Arundo donax* include: removing upstream stands first and moving downstream; prioritizing the removal of stands that are in or near the active channel and most likely to be transported by high flows; removing new stands before they become established, and; monitoring sites for at least three years after removal to eradicate any re-growth.

Temperature

Temperature is a primary water quality problem in the Russian River mainstem. The following paragraphs are a review of historical information on temperature in the Russian River basin, taken from Steiner Environmental Consulting’s 1996 document, *A History of the Salmonid Decline in the Russian River:*

> “Cool water release from Coyote Dam was intended to benefit salmonids in summer, but the influence diminishes below Hopland due to ambient warming as the water moves downstream (Hopkirk and Northen 1980; Prolysts 1984). Preferred temperatures for steelhead are between 13 and 21 C (Brown and Moyle 1981), for coho, 11.8 to 14.6 C (Laufle et al. 1986), and for chinook, 12 to 13 C (Brett 1952). Kubicek (1977) described effects of high temperature on juvenile salmonids. At temperatures above 20° C, salmonids suffer stress (decreased metabolic activity and utilization of food, reduced competitive ability, and increased vulnerability to predation and disease). Between 23 and 26 C, salmonids suffer chronic physiological stress. Temperatures sustained for 100 minutes above 28 C are lethal. Summer temperatures between Hopland and Cloverdale cause salmonid stress, and high temperatures prevent juvenile salmonids from utilizing the river below Cloverdale (Hopkirk and Northen 1980; Prolysts 1984; COE 1982). Mean daily temperatures reach 20 C at Healdsburg in late April and exceed 23 C by June 1. By June 1, even minimum temperatures at Healdsburg exceed 20 C, creating thermally stressful conditions for salmonids
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> “Stratified pools form when currents are too weak or inflow of cold water is too great to allow mixing of waters of contrasting temperatures (Nielson et al. 1994). In the Eel River at flows of 44 cfs, DWR (1976) found temperature differences of 11.1 C between surface and bottom waters in pool habitat 16.5 feet deep. DWR (1976) then found that when flows were increased to 83 cfs, stratification failed to occur, resulting in uniform water column temperatures of 27.8 C. The augmented summer flow regime in the Russian River after 1922 eliminated potential salmonid rearing habitat in marginal thermal reaches by maintaining flows at levels too high to allow pool stratification.”

Increased summer base flows have eliminated the formation of stratified pool habitat in the Lower River which now primarily harbors warmwater native and alien species, many of which prey on salmonids. In addition, man-made structures, for water diversion and transportation, may also cause some increase in water temperatures through slowing flows, and backflooding riffles where sub-gravular cooling could occur. The presence of few pool habitats may congregate warm-water species in large numbers. Congregations of large numbers of warm-water species have been observed from Healdsburg to Asti (Coey, personal communication). Sea-ward migratory juveniles must evade these congregations or be eaten. Therefore, high water temperatures are a serious concern, particularly during adult migration, egg incubation and juvenile rearing .

Temperature is particularly a problem from Cloverdale downstream, where the river is broad, shallow, has very few deep pools, and has little riparian cover. Summer water temperatures are at best in the mid- to high-70's, and frequently in the 80's. These temperatures are too high to support juvenile salmonids. Upstream in the Upper River, temperatures are generally lower and habitat conditions are more favorable with distinct pool-riffle complexes intact. Juvenile salmonids are frequently caught here and some small resident populations are known to exist by locals.

Restorative Actions:

Active restoration of the riparian zone should be employed. Reduced flows in the mainstem river could provide for sub-surface gravel cooling, and increased anadromous fish habitat. Cooler water should reduce the preference of some habitats by warmwater species and growth of warm-water species, many which prey upon salmonids.

Current data has been obtained from northern watersheds in the Pacific Northwest. Collection of site specific trend data for watersheds at the southern end of the geographic range, such as the Russian River watershed have been collected in recent years, however, literature on temperature requirements of Russian River salmonid species is very limited. DFG, the Sonoma County Water Agency, and the North Coast Regional Water Quality Control Board (NCRWQCB) have collected temperature data from the Russian River mainstem and tributaries and suspect that Russian River salmonids may have adapted to the warmer temperature regime of it’s southerly range.

Although the temperature requirements of Russian River salmonids have not yet been determined, we do know that this watershed may be in the “tolerable” temperature range and further increases will be detrimental to the cold water fishery. Water withdrawals, changes in flow, riparian removal and degradation, grazing by domestic livestock, and other land use activities are continuing to contribute to this temperature increases and fish mortality**.**
To establish more complete and meaningful temperature regime information, 24 hour monitoring during the summer warm water temperature period (July-September) should be conducted for 3 to 5 years on the mainstem as well as on many tributaries.

Currently, the NCRWQCB is evaluating available data and consulting with various agencies to determine a numeric water quality objective (standard) for the Russian River watershed that is protective of the federally listed salmonid species (coho and chinook salmon and steelhead trout). The NCRWQCB is currently initiating the process to amend the narrative temperature objective to a numeric temperature objective for the Russian River watershed. As of February, 2002, this NCRWQCB Basin Plan amendment process is internal where strategies are being developed and alternatives are being analyzed. A Russian River watershed temperature committee has been organized that includes staff from the NCRWQCB, DFG, Sonoma County Water Agency, Mendocino County Water Agency, and others to provide data and expertise for the development of the temperature objective amendment. Currently, the NCRWQC is drafting a staff report that will be peer reviewed beginning in the Fall of 2002.

LIMITING FACTOR: Water Quality

Turbidity and sediment run-off from agricultural lands and urban areas has an adverse impact on water quality, as well as stream bed conditions. In the past, the primary water quality problem in the Russian River and its tributaries has been high turbidity resulting from winter and spring runoff and erosion; persistent turbidity caused by the diversions of water from the Eel River basin; and high summer nutrient loading in the lower river caused by the discharge of sewage effluent. The discharge of untreated sewage effluent during the summer months was stopped in 1977, and as a result, nutrient loading has been reduced. However, discharge from the City of Santa Rosa waste treatment facility continues. In the 1970's, mainstem turbidity attributed to the Eel River diversion was considered to be a major issue for anglers, but was probably not a significant issue for the fish populations because the material was colloidal rather than suspended and not enough to deter fish migration. Changed operations at Coyote Dam, seems to have reduced this problem. Many parts of the watershed are on septic systems, many of which are very old. There are concerns that these old systems may be causing elevated nutrient loading of some streams. The process of sewer service to these areas has been slow, but progress has been made.

Better erosion control practices, increased awareness on the part of agricultural operators, the new Sonoma County vineyard development ordinance, and stronger enforcement efforts by the North Coast Regional Water Quality Control Board, Fish and Game, Sonoma County Code Enforcement, the City of Santa Rosa Environmental Crimes Unit, and the Sonoma County District Attorney's Office have reduced the magnitude of this problem.

RESTORATIVE ACTIONS:

Obtain data form the North Coast Regional Water Quality Control Board's (NCRWQCB) Surface Water Ambient Monitoring Program (SWAMP). In the Russian River Watershed, SWAMP will monitor at four long-term monitoring stations in the mainstem. Inorganic and organic water chemistry, Chlorophyll-a, nutrients, Total Organic Carbon, dissolved oxygen, water temperature, and vitellogenin will be monitored at these four stations. TMDL confirmation monitoring in the Laguna de Santa Rosa, expanded temperature monitoring throughout the watershed, and ground water quality assessment will also be implemented. Vitellogenin screening will indicate male fish exposure to environmental estrogens (endocrine disrupting compounds). SWAMP staff will work in partnership with DFG in collecting fish and preparing fish blood samples

Participate in the Sonoma Marin Animal Waste forum and support its recommendations and guidelines for manure management

Support the California Dairy Quality Assurance Program in cooperation with the UCCE and continue in the development of the Environmental Stewardship Certification Program for dairy facilities.

Integrate the California Coastal Commission's "Model Urban Runoff Program" in Russian River watershed communities

Encourage citizen water quality monitoring through the Sotoyome Resource Conservation District

Support Sotoyome Resource Conservation District's Fish Friendly Farming Program which recommends BMP's for reducing sediment, pesticide and herbicide pollution

Assist organizations and agencies in obtaining grant funding for water quality improvement activities and implementation projects in the watershed

Consider riparian buffer restoration a top priority in reducing erosion, providing filtering of chemicals and pesticides, providing shade for reduction in water temperatures and increasing dissolved oxygen

Gather and share data on pesticide use and effects on salmonids and aquatic life

Continue to fill data gaps by collecting trend data on the mainstem and tributaries, utilizing the NCRWQCB, DFG, Sonoma County Water Agency, Sotoyome Resource Conservation District, and other data.

Continue discussion within the Russian River Watershed Temperature Committee to develop the most protective temperature objective for the NCRWQCB Basin Plan amendment.

Continue habitat restoration projects that include pool development, use of large woody debris and other cover for salmonid rearing

Assess natural and current flow regimes

Collaborate with the State Water Resources Control Board, Division of Water Rights to evaluate the water rights permitting process and its effects on salmonids and macro invertebrates

Follow and provide comment to the NCRWQB's Russian River sediment objective amendment to the NCRWQCB's Basin Plan

Follow the NCRWQCB's regionwide sediment objective amendment to the NCRWQCB's Basin Plan (separate amendment process to the Russian River sediment amendment process)

Participate with the University of California Cooperative Extension staff in their education and outreach efforts

Continue landowner workshops in partnership with various agencies and organizations and the Russian River Watershed Council

LIMITING FACTOR: Water quantity

In the following paragraphs, Steiner (1996) documented the changes in flow regime within the basin, and the subsequent effects to the river system:

“Changes in flow and temperature resulting from dams and diversions have significantly impacted Russian River salmonid populations. Regulated flow coupled with gravel extraction has caused channel incision, channelization, diminished gravel recruitment, riparian encroachment, and habitat simplification.

> Mainstem Russian River flow regimes fall into four distinct time periods: prior to 1908, the river flowed unimpaired; from 1908 to 1922, there was seasonal augmentation from the Eel River; between 1922 and 1959, there was significant year-round augmentation from the Eel River; and after 1959, Coyote Dam further regulated and stabilized flows (COE 1982).
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> Prior to 1908, the Russian River flowed unimpaired, tending to follow concurrent precipitation patterns (Florsheim and Goodwin 1993). Winter flows were high, cycling with storm events, and summer flows were low or intermittent (McGlashan and Dean 1913). Domestic, municipal, and agricultural users withdrew water. Spot measurements taken in September 1905 showed discharges of 2.2 cubic feet per second (cfs) in the East Fork near Ukiah (McGlashan and Dean 1913). Estimated summer flows at Healdsburg were 10 to 15 cfs (Cox, CDFG, personal communication). Low summer flows could have resulted in high water temperatures, but the mainstem river contained many deep pools with lower layers cooled by intergravel flow. Salmonids survived summer by seeking refuge in these stratified pools, near springs and seeps, at sites of intergravel flow, and near cooler tributary inflow (Circuit Rider Productions 1994a).
>
> In 1907, Snow Mountain Water and Power Company completed Cape Horn Dam, forming Van Arsdale Reservoir on the Eel River. A tunnel from Van Arsdale Reservoir to the East Fork Russian River was finished in 1908, allowing water diversion for power production (COE 1982). Due to Van Arsdale Reservoir’s limited capacity, 700 acre feet, this diversion was primarily run-of-the river, and likely had little effect on flows other than prolonging spring flows in the East Fork Russian River. The duration and intensity of prolonged spring flows depended on snowpack in the Eel River Basin, but seldom extended through July. Continuous flow records from this period are lacking, but one spot discharge of 6.6 cfs was recorded near Cloverdale in August 1910, and 17 cfs was recorded near Healdsburg in August 1911 (McGlashan and Dean 1913). Historical unimpaired flows for the Eel River from 1911 to 1967 show, that on average, only 17 cfs was available for diversion during August (Anderson 1972). Undoubtedly, a large portion of these early diverted flows were used for irrigation and, hence, did not

significantly alter summer flow in the Russian River. Minor flow augmentation from the Eel River continued until 1922.

Completed in 1922, Scott Dam impounded Lake Pillsbury (original capacity 86,000 acre feet) 12 miles upstream of Cape Horn Dam (DWR 1976). Lake Pillsbury provided regulated flow between Scott and Cape Horn dams allowing year-round diversion of Eel River water into the East Fork Russian River (COE 1982). The average summer base discharges in the Russian River increased dramatically, with summer flows generally exceeding 125 cfs (COE 1982).

> The construction of Coyote Dam in 1959 significantly altered downstream flows. During the rainy season, storage for water supply and flood control dampens or eliminates discharge peaks, particularly in fall and early winter as the water supply pool is filling. This attenuation occurs again in the spring when incursion in the flood control pool is allowed to maximize water storage. After storm events, releases from the flood control pool generally sustain high flows for extended periods of time, unlike natural systems. Summer flows also increased significantly after completion of Coyote Dam. Lake Mendocino enabled maintenance of stable base flows regardless of diversion flows from the Eel River. Current base flows are set by order of the State Water Resources Control Board (D1610). The mainstem is used as a water conduit to supply downstream agricultural, domestic, and industrial needs; releases to satisfy demands are in addition to the base flow. Two hundred cfs is now the approximate mean summer flow at Healdsburg, compared with the historic unimpaired flows of 20 cfs or less. Coyote Dam's ability to further alter natural flows in the Russian River added to the growing problems of changed channel morphology, impeded migration, and compromised rearing habitat (COE 1982; Prolysts 1984; Florsheim and Goodwin 1993).   .
>
> In 1982, Warm Springs Dam was completed on Dry Creek, resulting in regulated flows and a loss of rearing habitat below the dam. Before Warm Springs Dam, summer flows in Dry Creek were between 1 and 5 cfs. Present summer flows are approximately 90 cfs at the confluence with the Russian River and significantly higher immediately below the dam."

Watershed restoration efforts must include the analysis of flow and water quantity conditions and requirements. Historically, water right permits have been granted with minimal consideration of aquatic habitat. Appendix B for a more thorough discussion of land use impacts.

RESTORATIVE ACTIONS:

. In response to concerns about potential impacts of water diversion and storage projects the Department and the National Marine Fisheries Service jointly developed Guidelines for Maintaining Instream Flows to Protect Fisheries Resources Downstream of Water Diversions in mid-California Coastal Streams (Draft Guidelines). These Draft Guidelines, originally released in May 2000, were based on life history and habitat requirements of salmonids. The State Water Resources Control Board also issued a Staff Report, Assessing Site Specific and Cumulative Impacts on Anadromous Fisheries Resources in Coastal Watersheds in Northern California, January 23, 2001 (SWRCB staff report), clarifying their evaluation process to be used for environmental review of projects proposing to divert water under an appropriative water right.

The SWRCB staff report and the Draft Guidelines concur that significant impacts can be avoided if the season of diversion is limited to December 15 through March 31, reservoirs are built off-stream, specific bypass flow are provided during the diversion season, and the natural hydrograph is protected to avoid cumulative impacts due to flow reduction in the watershed.

To reduce bank erosion and improve conditions for migrating and spawning adult salmonids, flow release schedules should be established which closely mimic natural flow regimes. This would re-establish sediment transport processes needed to offset channel incision and reduce erosion. Dam releases, which more closely mimic the natural rainfall hydrograph would improve migration, and provide sediment flushing flows. This would eliminate the extended “limb” of the hydrograph which increases bank erosion, inhibits migration, and may flush juvenile fish prematurely out of Dry Creek and the East Fork.

Reduced summer flows in the river could provide for sub-surface gravel cooling, and increased anadromous fish habitat. Cooler water should reduce the preference of some habitats by warmwater species and growth of warm-water species, many which prey upon salmonids. Reduced flows would also reduce the frequency of artificial breaching of the estuary, and is discussed later, could have a significant benefit to steelhead and chinook return.

Other actions in support of improvements to water quantity are:

Support the addition of a water resources component to the Sonoma County General Plan

Attend SCWA’s “Water Supply” workshops for discussion on watershed management, water supply, and groundwater/gravel mining

Fund GIS mapping of surface water diversions and ground water usage on coho tribs

Fund GIS mapping of hotspot, low flow conditions/water quantity conditions on coho tribs

SPECIFIC LIMITING FACTORS AND RESTORATIVE ACTIONS TO ESTUARY

Prior to augmented flows in the Russian River, closure of the estuary to a productive lagoon system likely varied from year to year, depending upon flow conditions and wave action. All pacific salmon have been shown to utilize estuaries in some part of their lifecycle, and much literature emphasizes the importance of estuaries in salmonid life history (Healey 1980,1982; Cannon 1982; Kjelson et al. 1982; Meyers and Horton 1982; Pearce et al. 1982; Simenstad et al. 1982; McKeon 1985;Larson 1987; Mattole Restoration Council 1995). In general, estuaries provide abundant food for rearing fish, prepare fish for chemical and temporal changes prior to seaward migration, and have been shown to be crucial to their life stage requirements (RNP 2000).

Seasonal bar closure has been a normal event on the Russian River as far back as any records indicates. In the 1930's a jetty was built for the purpose of providing a port of refuge for commercial fishermen and allowing free access to the river. The jetty lasted only a few years before it was partially destroyed by winter storms.

With augmented flows, spring closure is now relatively rare and probably coincides with drought years when there have been few high flows to move the sands away from the river mouth. More common today is closure in mid- to late-summer. The river is now opened in the summer or fall, for flood control purposes. Opening for this purpose is conducted when river flow starts to increase and the water rises in the lagoon behind the bar. The Sonoma County Department of Public Works usually opens the bar when the water level is between 7 and 8 feet on the gage at Jenner; due to the threat of flooding in homes along the river near the mouth

Although estuarine usage of salmonids in the Russian River has been poorly documented, salmonids have been found when sampling has been conducted. chinook salmon primarily utilize the mainstem, Dry Creek, and larger tributaries for spawning (Coey, personal communication 1988). Many other reports document chinook salmon usage although authors vary on the extent of usage (Steiner 1988). Since temperatures in the mainstem and many larger tributaries become too warm to sustain salmonids, it is likely these fish utilize the estuary for the summer portion of their lifecycle. Nielsen (RREITF 1994) caught 9 chinook in the estuary in 1992 and hypothesized natural production in the main river. More recently SCWA has observed downstream migration of chinook juveniles in their screw traps below Wholer Bridge upstream of the estuary, presumably moving to the estuary (Sean White, personal communication).
Steelhead have also been found rearing in the estuary (MSC 1997, 1998, 1999; Sean White P. communication 1998) when sampling has been conducted.

As noted in the previous section describing the estuary, the river mouth is artificially breached in the summer or fall for flood control purposes. The concern with opening of the bar is for the impact it may have on the lagoon as a nursery area for juvenile fishes and on wetland habitat, primarily in the lower portion of Willow Creek. At this time, the Russian River estuary is frequently breached and primarily managed for flood control. Frequent artificial breaching has been shown to result in flushing rearing juveniles out prematurely to sea (RNP 2000). Studies have shown that estuarine residency is crucial to the lifecycle of chinook salmon and can improve adult return rates, indicating that current management of the estuary likely has significant impacts on adult returns. It is argued that frequent breaching improves water quality, which is necessary to improve estuarine conditions for rearing fish. However, no data exists to determine if premature flushing of YOY steelhead and chinook occurs prior to conditions improving. Studies have shown that, while immediate short term impacts to water quality occur within a closed estuary, over time conditions improve to a highly productive food-rich environment (Steve Cannatta, personal communication). Improvements in water quality could be significantly offset by decreases in rearing time for chinook salmon and steelhead in the estuary.

In the past, the bar was artificially opened in the fall to “let the fish in”. Unfortunately, fish that are attracted to move into the river when the bar is breached often cannot move upstream because of low river flow and excessively high water temperatures. The bar is no longer opened for the purpose of letting fish in. Artificial breaching in the summer or fall, in combination with augmented flows from the Potter Valley and Lake Sonoma Projects, may also attract adult chinook into the estuary before flows in the river are adequate to pass fish over obstacles or before temperatures are low enough to be desirable, making chinook more susceptible to pinniped predation or stress due to entrapment. Similar circumstances arise when early chinook come into the river during breach events and become susceptible to poaching and fishermen on riffles, or cannot surmount fish ladders on on-river dams because of limited flows.

RESTORATIVE ACTIONS

The following details fish needs for the Estuary established through a limiting factors approach utilizing available information and data from DFG and many other agencies and sources.

The Department of Fish and Game, Corps of Engineers, Coastal Commission, State Lands Commission, and Department of Parks and Recreation have all expressed concerns to the County of Sonoma about opening the bar. The impacts of opening the bar need to be studied, and monitoring for fish species composition and distribution conducted before, during and after breaching. Sampling further upstream from existing sampling stations needs to be conducted as recent data indicate conditions may be more favorable for salmonids there (SCWA 2000). . The county will have to conduct environmental studies on the impact on biotic resources as well as the flood control benefits, and alternatives through the Section 7 consultation with NMFS and the USACE..A no-beach alternative needs to be evaluated, and sampling conducted to show whether chinook salmon utilize the estuary through the summer in a lagoon type environment

Other flood control measures need to be evaluated (other than breaching) in the Section 7 process. A reduction in flows from the Potter Valley project , which would improve conditions both in some reaches of the Russian and Eel River systems, may alleviate the need for frequent breaching of the estuary.

PREDATION BY PINNIPEDS

Harbor seals and sea lions (pinnipeds) have occasionally been observed taking adult salmon and steelhead as they migrate upstream, and it is likely they also prey on smolts attempting to emigrate to the ocean. It is important to understand that pinnipeds and salmonids evolved together in the Russian River system over thousands of years before human intervention; predation by pinnipeds has always occurred, even when salmonid populations were thriving. Pinniped predation on salmon and steelhead is likely only a minor factor compared to upslope watershed instability and instream habitat barriers.

Pinniped predation is, however, perceived by many anglers to be a major problem because they are so visible at the mouth of the river and, at times, very abundant. Although sea lions are singled out as the culprit with ocean sports fisherman, the majority of animals at the mouth of the Russian River are harbor seals. During the late winter, there are sometimes over 300 seals hauled out on the bar at the mouth of the river. Although harbor seals do enter freshwater and will swim up rivers to capture prey, river otters are frequently mistaken for seals or sea lions and are reported as far up river as Healdsburg.

RESTORATIVE ACTIONS

In 1993 a study was conducted in the Russian River estuary to determine the effects of artificial breaching of the river mouth on pinniped communities using the beach at the mouth as a haulout site. The results, which also covered the foraging patterns of these animals, were published in the *Russian River Estuary Study Pinniped Report*. The following information is taken from this report (Hanson, as cited in PWA 1994).

The pinniped species that use the sandbar at the mouth of the Russian River as a haulout are primarily harbor seals, which can be found at the site year-round, sometimes numbering in the hundreds. Sea lions can also be seen foraging in the ocean near the river mouth from December through June each year, though they rarely number more than five individuals and normally don’t come ashore at this site.

During the pinniped study, it was determined that normal foraging patterns inside the estuary include pursuit and capture during the upstream migrations of salmonids and lamprey. Seals are most successful at capturing prey when the fish are trapped or stressed, or when the breach is not opened and fish are forced to funnel through a shallow and narrow river mouth. Because of this, the breaching of the mouth may affect the salmonid capture rate for harbor seals.

Interestingly, seals were not observed foraging on prey flushed out from the river system immediately after artificial breaching occurred.

Scat samples from harbor seals taken before and after breaching showed flatfish, octopus and hake as the three most dominant prey items in samples from both periods, occurring in at least 30% of the samples. These findings coincide with findings from studies conducted in Oregon which concluded that the major diet of harbor seals, even when salmon and steelhead are present, consists primarily of bottom fish, squid, and lamprey. However, during the Russian River study, a shift in the amount of secondary prey items was noted depending on whether the river mouth was opened or closed. When the estuary was opened, lamprey, smelt and skate were found more frequently in the samples. During closed periods, hagfish, midshipmen, cusk-eel and salmonid remains occurred more frequently in the scat samples. Except for one scat sample, the salmonid skeletal remains contained in the scat were from smolt size fish. This strongly suggests that harbor seals preyed on salmonids completing their downstream migration, rather than beginning their upstream one . It also suggests that smolt should be a common prey item in scat collected during periods when the hatchery is releasing smolts and the estuary is closed. This was not the case. Although salmonid remains were found in 17% of samples collected during the closed period and only 5% of the samples during the open estuary period, this higher frequency of occurrence was not found following all hatchery releases. A very specific set of circumstances took place prior to the only collection day with a high frequency of scat containing smolt. Prior to that sampling day the hatchery released 36,000 smolt into the river, it rained, and the estuary was closed. These three factors combined to create a large flushing of smolt down the river at once, where they were trapped behind the sandbar at the river mouth. Occurrence of only one or two of these events did not trigger an increase in scat samples containing smolt remains at other times during the study.

The Russian River Estuary Study indicates that pinnipeds at the river mouth do not have a significant impact on salmonid populations. The study report concluded that: “Based on the findings of the scat analysis, this population of harbor seals appears to feed outside the estuary on slow-moving or schooling prey with minimal anti-predator defenses. Lamprey increased in importance in the diet [of harbor seals] as they migrated through the estuary, but other up-river migrants, including adult salmonids, did not constitute an important part of the harbor seal diet. Predation on migrating salmonid smolt may increase when large numbers of these fish are flushed down river and trapped inside the estuary, but it appears that an unusual set of conditions is needed to initiate heavy predation on smolt (Hanson, as cited in PWA 1994).” Therefore, no mitigation measures should occur to address the predation of salmonids by pinnipeds.

SPECIFIC LIMITING FACTORS AND RESTORATIVE ACTIONS TO ESTUARY 11 HYDROLOGIC SUB-BASINS

The following details the needs for each watershed by hydrologic sub-basin established through a limiting factors analysis utilizing habitat inventory and other data.

Guerneville

Major tributaries include Green Valley Creek, Fife Creek, Hulbert Creek, Dutchbill Creek, Freezeout Creek, Willow Creek, Jenner Creek and various smaller tributaries. These low gradient, meandering tributaries once harbored the bulk of the coho habitat within the Russian River basin (Figure 6). The combination of meandering streams with highly erodible soils, provided deep pools with overhanging vegetation, and cool water ideal for rearing coho. Ironically, it is this same set of conditions that make these streams so vulnerable to degradation. Many of these streams have severely down-cut as the process of meandering was halted by development of the flood plain. As vacation homes turned to year-round residences, many streams were levied and rip-rapped to control flooding and erosion. The process of scour and fill which maintained the pool-riffle complex has principally been replaced by bed and bank scour resulting in erosion and riparian loss. Lower Fife and Hulbert Creeks are now managed as flood control channels by Sonoma County, and are infrequently dredged, or are cleared by Public Works. Mission Creek harbors the bulk of steelhead habitat remaining in the Hulbert Creek watershed. Numerous stream crossings and roads threaten this habitat. FEMA has been actively identifying houses to raise or move from floodplains in Fife and Hulbert Creeks. Today, Green Valley Creek is the only known stream within the Russian River basin that continues to harbor a recorded, consistent coho run. Atascadero Creek mainstem has been severely impacted by channelization and agriculture, but Jonive and Redwood Creeks could harbor coho (habitat inventories are incomplete). Steps have been made in these watersheds to address priority fishery concerns (specifically barriers, livestock grazing, and sediment from eroding banks, canopy coverage, and pool enhancement). Sediment from roads and barriers at culverts continue to be at issue.

Freezeout and Willow Creek watersheds still harbor coho infrequently, and steps have been made in these watersheds to address priority fishery concerns (specifically livestock grazing, sediment from roads and gullies, canopy coverage, and pool enhancement). Summer habitat conditions in the Willow Creek marsh area are poor to non-existent for salmonids due to high water temperatures, but conditions upstream improve considerably. Currently this marsh is growing due to high sedimentation levels from upslope sources. This process should slow as up-slope sediment sources are controlled by landowners under DFG grants in Willow and Freezeout Creeks. Alternatives for channel adjustment between bridges 2 and 3 are being developed. This should include raising and widening bridge 2 or re-aligning the road to the east side of the creek and removing bridge 2.

Porter Creek harbors high quality steelhead habitat and has good potential for coho, but county roads have impacted spawning gravels. Several culvert barriers have also been identified and Sonoma County is considering upgrading them. Much work has been completed in Turtle Creek, and the creek is frequently visited for tours of demonstration projects. Occasionally coho are found in lower Turtle Creek. See Table 11 for limiting factors specific to the Guerneville sub-basin.

Name	Migration	Gravel Quality	Gravel Quantity Degraded	Gravel Quantity Aggraded	Riparian Stability	Water Temp.	Water Quality	Pool Shelter	Pool Number	Data Gaps	Comments
Atascadero Creek	1	2				3	4	5	6		
Baumert Creek	1										
Dutch Bill Creek	1	4					6	2	3	5	Passage
Duvoul Creek	1										
Fife Creek	3			1				2		4	Surface flow
Freezeout Creek		1			2						
Grab (Grub) Creek	1	4			2	3					
Green Valley Creek		1	2			5	7	3	4		
Harrison Creek	1	3	2								
Hobson Creek		2		1					3		
Hulbert Creek		1	2					3	4		
Jenner Gulch Creek		1				2		3			
Jonive Creek		1						2		3	Fish distribution
Lancel Creek	1	4			2	3		5			
Mays Canyon Creek		3		2					4	1	Surface flows
Mission Creek		1						2	3		
Mt. Jackson								1	2		
N. Fork Lancel Creek	1	4			2	3		5			
Pocket Canyon Creek		3		2				4			Surface flows
Porter Creek	1	2						3			
Press Creek	1	2									
Purrington Creek		2	3					1	4		
Redwood Creek				1	2		3				
Sheephouse Creek		1						2		3	Winter refugia
Smith Creek		2						3		1	fish dist. above falls
Turtle Creek						1		2	3		Alien fish species
Tyrone Gulch	1										
W. Branch Fife Creek				1				3	2		
Willow Creek	1	2		3		4		5		6	Passage

Table 11. Limiting factors specific to the Guerneville sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc.

* = limiting factor identified from existing historical information or data, but no priority exists at this time)

RESTORATIVE ACTIONS RECOMMENDED

- In Willow Creek, alternatives to channel adjustment between bridges 2 and 3 are being developed. This should include raising and widening bridge w or re-aligning the road to the east sided of the creek and removing bridge 2.
-
- Willow, Sheephouse, Freezeout and Green Valley Creeks have been identified for re-introduction of native coho utilizing a Captive Broodstock Program discussed in Appendix G. This program focuses on utilizing native wild stocks with a return to historically native coho streams. Remaining coho streams in this sub-basin require further habitat restoration to re-establish natural coho populations or before supplementation with the Captive Broodstock Program would be considered

  - Implement results of sediment source assessment on Freezeout and Willow Creeks.
  - Implement results of Willow Creek Channel reconstruction and address sedimentation at Bridge 2.
  - Conduct road assessment on Sheephouse, Hulbert, Mission, Fife, and Porter Creeks.
  - Implement record of Hulbert Creek sediment source survey.
  - Address numerous County Crossing barriers on Dutchbill and Porter Creeks.
  - Develop alternatives for restoration at Camp Meeker Dam.
  - Conduct habitat enhancement work on Jenner, Dutchbill, and Mission Creeks.
  - Replace/Remove remaining weirs on Fife Creek.

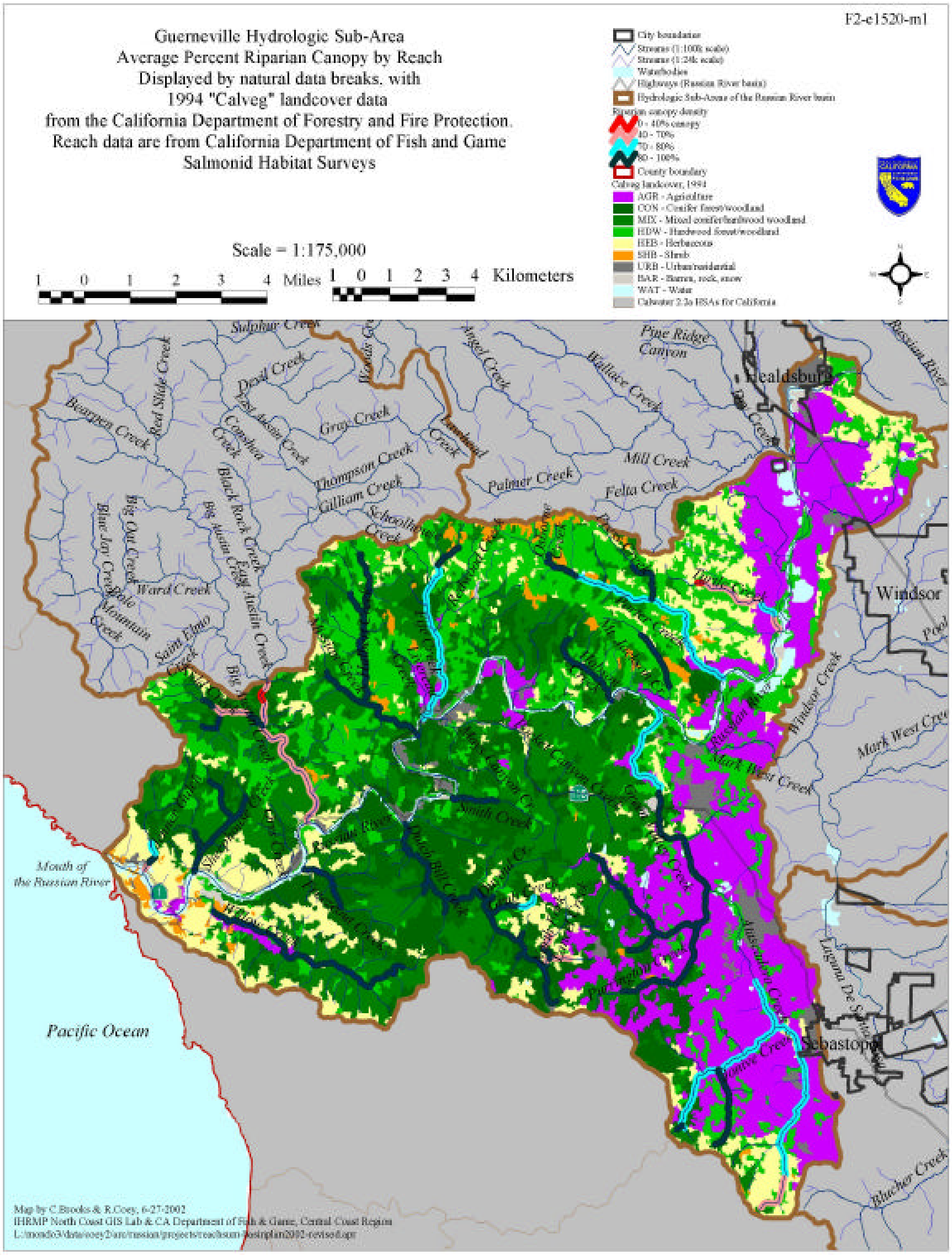
- A sediment source survey has been conducted in the State Park portion of Fife Creek. Road surveys on remaining private land are needed. Concrete weirs placed in the 1960's to halt channel degradation have been removed. Habitat improvement with natural structures is needed to complete the project adding large wood for complexity and constrictors for pool scour and gravel sorting.

- Jenner Creek has an active and interested community group. Work should focus on implementing DFG habitat improvement recommendations. Numerous pool enhancement projects have been undertaken in Sheephouse Creek through the addition of large wood by local landowners. Road sediment source surveys remain a priority.

See Table 12 for prioritized habitat recommendations specific to the Guerneville sub-basin.

Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Land-slide	Erosion	Shelter	Create Pools	Monitor	Comments
Atascadero Creek	1							2	4		3	Water quality
Baumert Creek	1											Culvert
Dutch Bill Creek	1				4			5	2	3	6	Culvert
Duvoul Creek	1											Culvert
Fife Creek	4								1	2	3	response of restoration
Freezeout Creek						1		2			3	Fencing
Green Valley Creek		4		2				5	1	3	6	Passage
Grub Creek (Grab)	1	3	2		4							Culvert
Harrison Creek	1			2	3							Culvert
Hobson						1		3		2		
Hulbert Creek				3	1			2	4	5		
Jenner Gulch		3			1		4	2	5			
Jonive Creek								1	2		3	Fish pops
Lancel Creek	1	3	2					4	5			Culvert
Mays Canyon Creek		3						2			1	Water
Mission Creek								1	2	3		
Mt. Jackson Creek									1	2		
N. Fork Lancel Creek	1	3	2					4	5			
Osbourne Creek					*	*		*				No access
Pocket Canyon Creek		3						2			1	Water
Porter Creek	1				2		3		4			Culvert
Press Creek	1				2							Culvert
Purrington Creek				3				2	1	4	5	clean-up
Redwood Creek				1			2				3	Water quality
Sheephouse Creek					1			2	3		4	x-sections & jams
Smith Creek								2	3		1	bio-sample above falls
Turtle Creek		1							2	3	4	Alien fish species
Tyrone Gulch	1											culvert
West Branch Fife Creek								3	2	1		
Willow Creek		3		2		1			4		5	fish pops

Table 12. Prioritized habitat recommendations specific to the Guerneville sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time)



F2-e1520-m1
Guerneville Hydrologic Sub-Area
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:175,000
1 0 1 2 3 4 Miles
1 0 1 2 3 4 Kilometers
City boundaries
Streams (1:100k scale)
Streams (1:24k scale)
Waterbodies
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Riparian canopy density
0 - 40% canopy
40 - 70%
70 - 80%
80 - 100%
County boundary
Calveg landcover, 1994
AGR - Agriculture
CON - Conifer forest/woodland
MIX - Mixed conifer/hardwood woodland
HDW - Hardwood forest/woodland
HEB - Herbaceous
SHB - Shrub
URB - Urban/residential
BAR - Barren, rock, snow
WAT - Water
Calwater 2.2a HSAs for California
N
W
E
S
Healdsburg
Windsor
Sebastopol
Pacific Ocean
Mouth of the Russian River
Russian River
Sulphur Creek
Devil Creek
Gray Creek
Thompson Creek
Gilliam Creek
Palmer Creek
Mill Creek
Felta Creek
Wallace Creek
Pine Ridge Canyon
Angel Creek
Buerreen Creek
Red Slide Creek
Big Oat Creek
Blue Jay Creek
Ward Creek
Black Rock Creek
East Austin Creek
Austin Creek
Saint Elmo Creek
Pole Mountain Creek
Schoolhouse Creek
Mark West Creek
Windsor Creek
Laguna De Santa Rosa
Atascadero Creek
Jonive Creek
Purrington Creek
Dutch Bill Creek
Hulbert Creek
Fife Creek
Green Valley Creek
Hobson Creek
Blucher Creek
Map by C.Brooks & R.Coey, 6-27-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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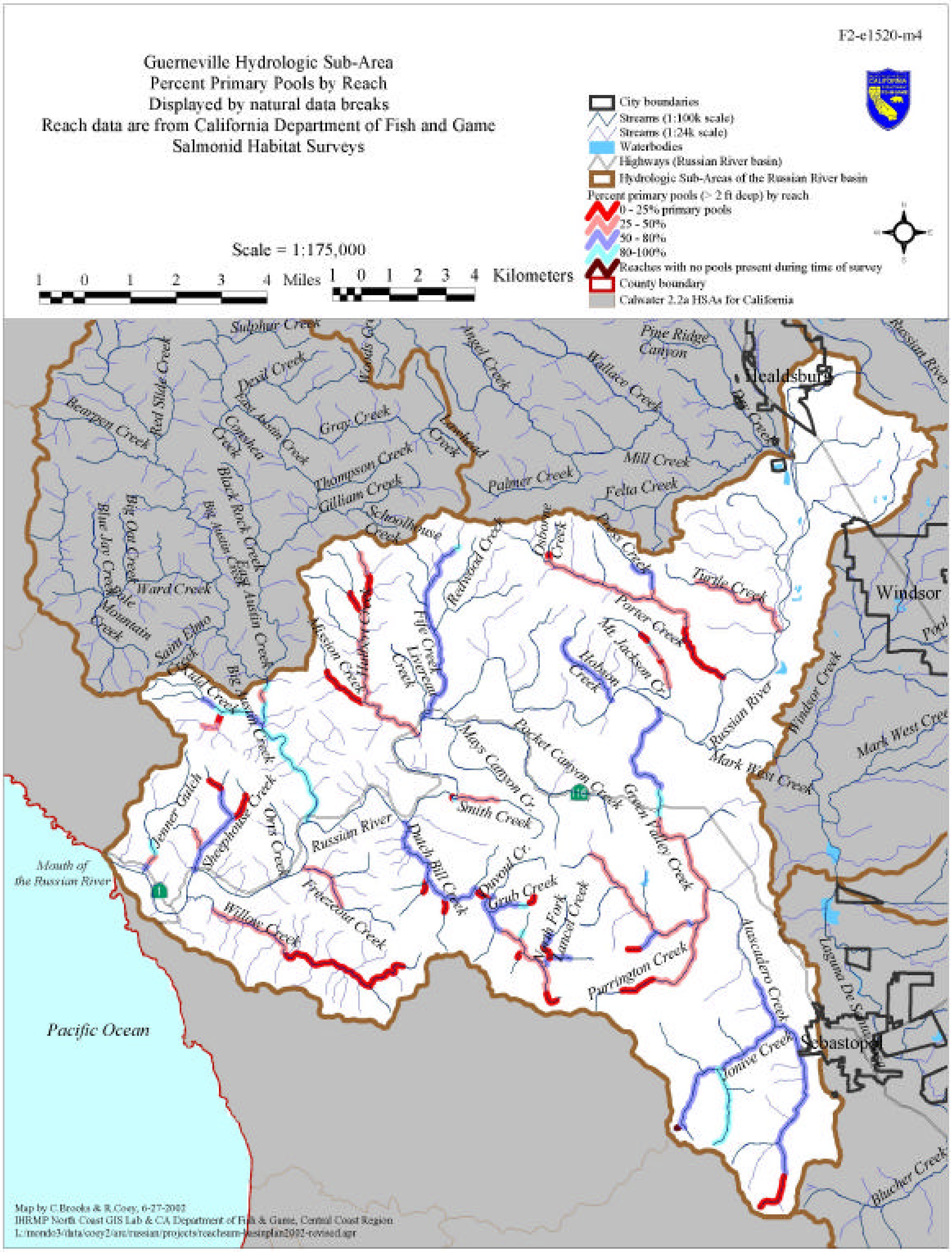

Guerneville Hydrologic Sub-Area
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C.Brooks & R.Coey, 6-27-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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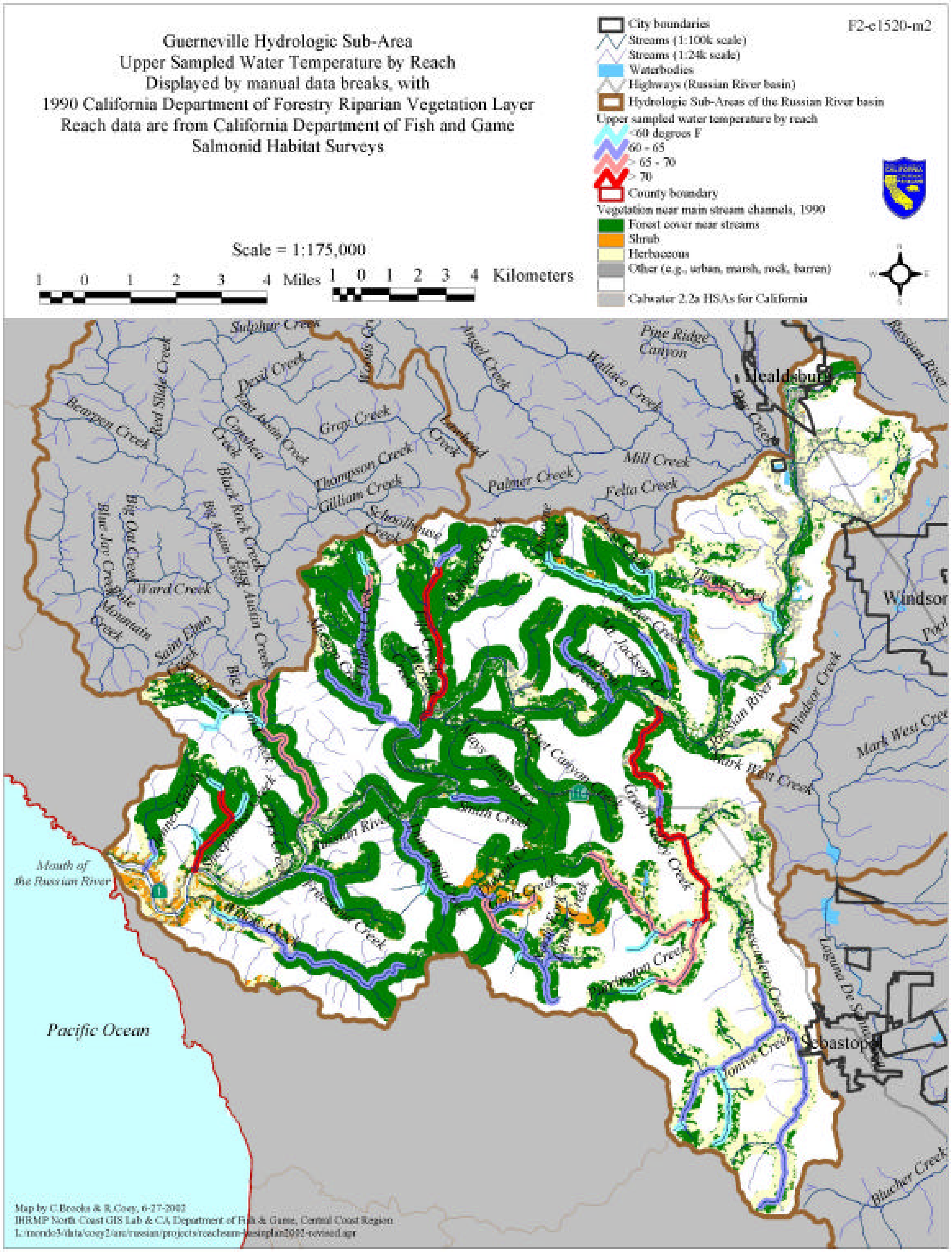
Guerneville Hydrologic Sub-Area
Upper Sampled Water Temperature by Reach
Displayed by manual data breaks, with
1990 California Department of Forestry Riparian Vegetation Layer
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
F2-e1520-m2
City boundaries
Streams (1:100k scale)
Streams (1:24k scale)
Waterbodies
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Upper sampled water temperature by reach
<60 degrees F
60 - 65
> 65 - 70
> 70
County boundary
Vegetation near main stream channels, 1990
Forest cover near streams
Shrub
Herbaceous
Other (e.g., urban, marsh, rock, barren)
Calwater 2.2a HSAs for California
Scale = 1:175,000
1 0 1 2 3 4 Miles
1 0 1 2 3 4 Kilometers
Sulphur Creek
Devil Creek
Gray Creek
Angel Creek
Wallace Creek
Pine Ridge Canyon
Healdsburg
Russian River
Mill Creek
Palmer Creek
Felta Creek
Thompson Creek
Gilliam Creek
Schoolhouse Creek
Red Slide Creek
Beaupon Creek
Big Oat Creek
Blue Jay Creek
Ward Creek
Black Rock Creek
East Austin Creek
Austin Creek
Saint Elmo Creek
Windsor
Windsor Creek
Mark West Creek
Green Valley Creek
Smith Creek
Russian River
Mouth of the Russian River
Pacific Ocean
Willow Creek
Purrington Creek
Atascadero Creek
Jonive Creek
Sebastopol
Laguna De Santa Rosa
Blucher Creek
Map by C.Brooks & R.Coey, 6-27-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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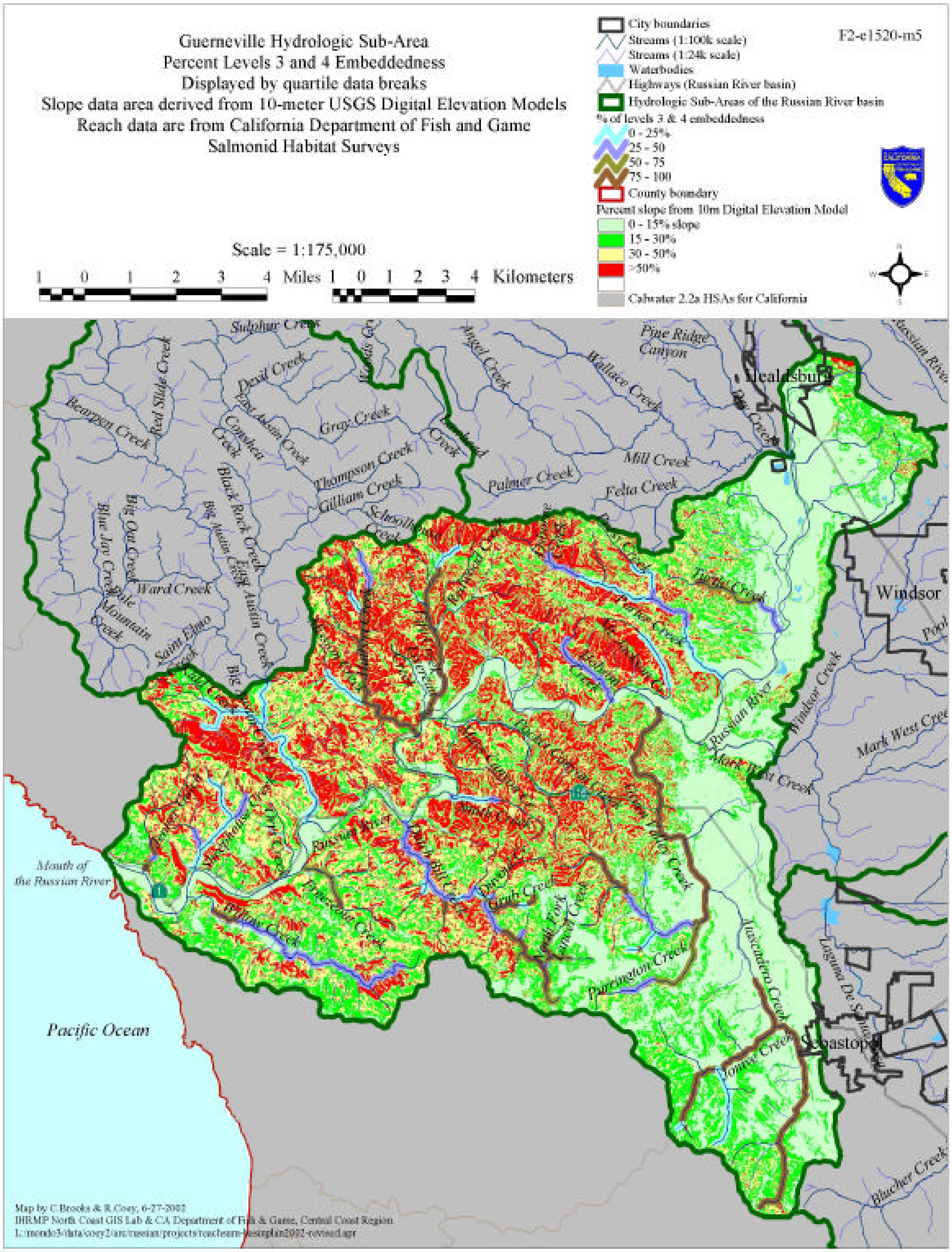

Guerneville Hydrologic Sub-Area
Percent Levels 3 and 4 Embeddedness
Displayed by quartile data breaks
Slope data area derived from 10-meter USGS Digital Elevation Models
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C.Brooks & R.Coey, 6-27-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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Austin Creek

Lower Austin Creek is highly aggraded and stream temperatures are warm. Spawning habitat is present but rearing habitat is in short supply and unsuitable. Upstream Austin Creek passes through a narrow canyon and here habitat value improves. The uppermost reaches of Austin Creek provide only fair habitat as a result of the high gravel load. Ward Creek, tributary to Big Austin Creek, and its tributaries serve as the primary source for steelhead and coho production in the west arm of this sub-basin. The deep forested canyons provide cool water and year round pools for over-summering fish. Frequent landslides provide adequate gravel although adjacent land use(primarily roads) increase sediment loading above natural conditions. Pole Mountain Creek has a significant partial barrier, near the mouth, that is occasionally worked on. Numerous roads across unstable slopes make the watershed prone to landslides. This sediment load impacts Pole Mountain and the lower three miles of Ward Creek. Saint Elmo and Big Oak Creeks have a natural bedrock waterfall that inhibits fish migration. Kidd Creek is severely aggregated and has many road crossings. Potential for coho is high in this low gradient heavily forested drainage, should restoration occur.

East Austin Creek and its tributaries are the principal refugia for steelhead in the Russian River system, because of the protected status of the State Park portion and limited land use access upstream. East Austin Creek harbors the highest quality steelhead, but upper east Austin Creek remains in degraded condition due to the failing riparian road which parallels the creek. Devil and Sulphur Creeks near the headwaters have some of the highest shelter values in the sub-basin. Thompson and Gillian both harbor good steelhead habitat, and coho historically. Thompson has a 40' waterfall shortly upstream from a confluence, although resident steelhead exist above. Gillian Creek watershed is crisscrossed with legacy logging roads. A large landslide exists half-way upstream which initiated as a result of un-maintained culverts on closed roads. The slide has been periodically a barrier for steelhead. Implementation of a DFG-funded road survey should address these conditions. Grey Creek meets all target habitat objectives except for embeddedness due to the degraded condition of the riparian road. Numerous wet crossings limit the road to seasonal use only. Recent improvements to the wet crossings and recently completed road drainage improvements and culvert upgrades will decrease sediment loading.

See Tributary Conditions (Table 13) below for limiting Factors specific to the Austin Creek sub-basin. Figures 34-37 describe average canopy, percent primary pools, water temperatures and embededdness by reach for the sub-basin. See Appendix E for further summary of some key habitat variables by reach for each stream and sub-basin. Data was collected from habitat data during 1994-2002 following the methods of Flosi et al. (1998). Map GIS data was compiled by HREC-IHRMP under contract to DFG.

Name	Migration	Gravel Quality	Gravel Quantity Degraded	Gravel Quantity Aggraded	Riparian Stability	Water Temp.	Water Quality	Pool Shelter	Pool Number	Data Gaps	Comments
Austin Creek		1		2		3					
Bearpen Creek		2				1		3	4		
Black Rock Creek		1				2		3	4		
Big Oat Creek	1										Waterfall
Blue Jay Creek		2				1		3	4		
Conshea Creek	1	2						4	3		Culvert
Devil Creek	1	3				2					Falls
East Austin Creek		1									
Gilliam Creek		1						3		2	Passage
Gray Creek	1	3				2		4			Culvert
Kidd Creek				*	*				*		In progress
Lawhead Creek	1	3				2		4			Culvert
Pole Mountain Creek	1	2				3		4	5	6	Falls/culvert
Red Slide Creek										1	Habitat Data
Saint Elmo Creek	1										Waterfall
Schoolhouse Creek	1	2						4	3		Culvert
Sulphur Creek		2				1					
Thompson Creek	1					2		3			Waterfall
Ward Creek		1				3		4	2	5	Log jams

Table 13. Limiting factors specific to the Austin sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc.
* = limiting factor identified from existing historical information or data, but no priority exists at this time)

RESTORATIVE ACTIONS RECOMMENDED

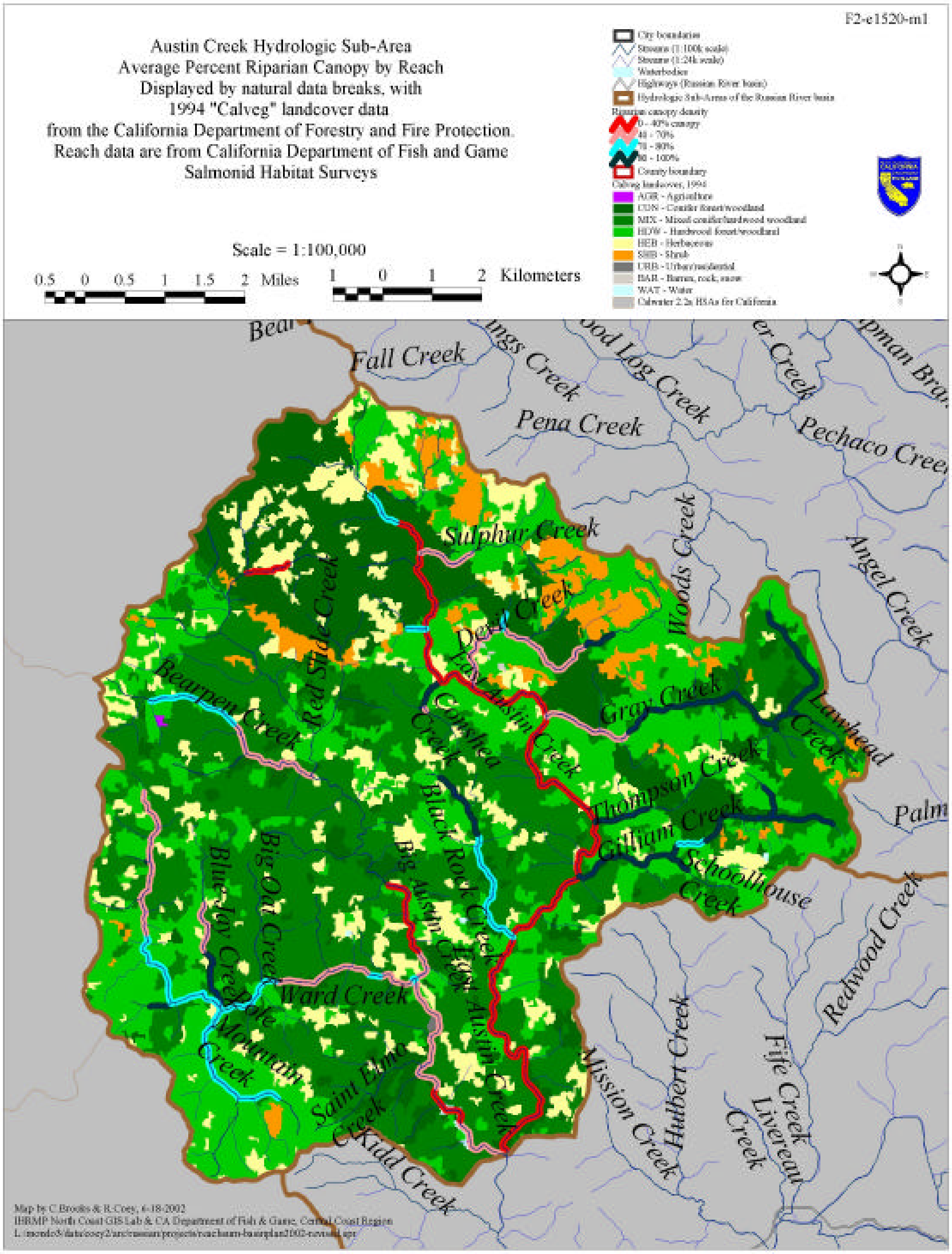
.

- Expand road sediment source surveys in Big Austin Creek.
- Implement sediment source treatments in Pole Mountain/Ward Creek.
- Monitor passage on Pole Mountain and Gillian Creek.
- Conduct sediment source surveys in Kidd Creek.
- Address culverts on un-named tributaries to lower Big Austin Creek.
- Implement sediment source treatments on upper east Austin Creek road.
- Survey Redslide Creek.
- Implement recommendations of sediment source surveys on Grey Creek and monitor crossings.
- Ward Creek has been identified for re-introduction of native coho utilizing a Captive broodstock Program discussed in Appendix G. Remaining coho streams require further habitat restoration to re-establish natural coho populations or before supplementation with the Captive Broodstock Program would be considered.

See Tributary Recommendations (Table 14) below for prioritized habitat recommendations specific to the Austin Creek sub-basin

Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Landslide	Erosion	Shelter	Create Pools	Monitor	Comments
Austin Creek		5		2	1		4	3				
Bearpen Creek		1			2		3		4			
Black Rock Creek		2					3	1	4	5	6	Log jams
Big Oat Creek												Natural barrier
Blue Jay Creek		1			2				3	4		
Conshea Creek	1							2	4	3		
Devil Creek	1	2						3			4	fish pops & macros
East Austin Creek						1	2				3	Fish pops
Gilliam Creek							2	1	4		3	Log jams/slide
Gray Creek	1	2						3	4			Culvert
Kidd Creek					*		*	*				In progress
Lawhead Creek	1	2						3	4			Culvert
Pole Mountain Creek	1	3				2			4	5	6	Culvert/falls
Red Slide Creek												Survey 2002
Saint Elmo Creek												Natural barrier
Schoolhouse Creek	1							2	4	3		Culvert
Sulphur Creek		1				2						
Thompson Creek		1							3			Natural barrier
Ward Creek		3				1		5	4	2	6	Log jams

Table 14. Prioritized habitat recommendations specific to the Austin sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time)



Austin Creek Hydrologic Sub-Area
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C.Brooks & R.Coey, 6-18-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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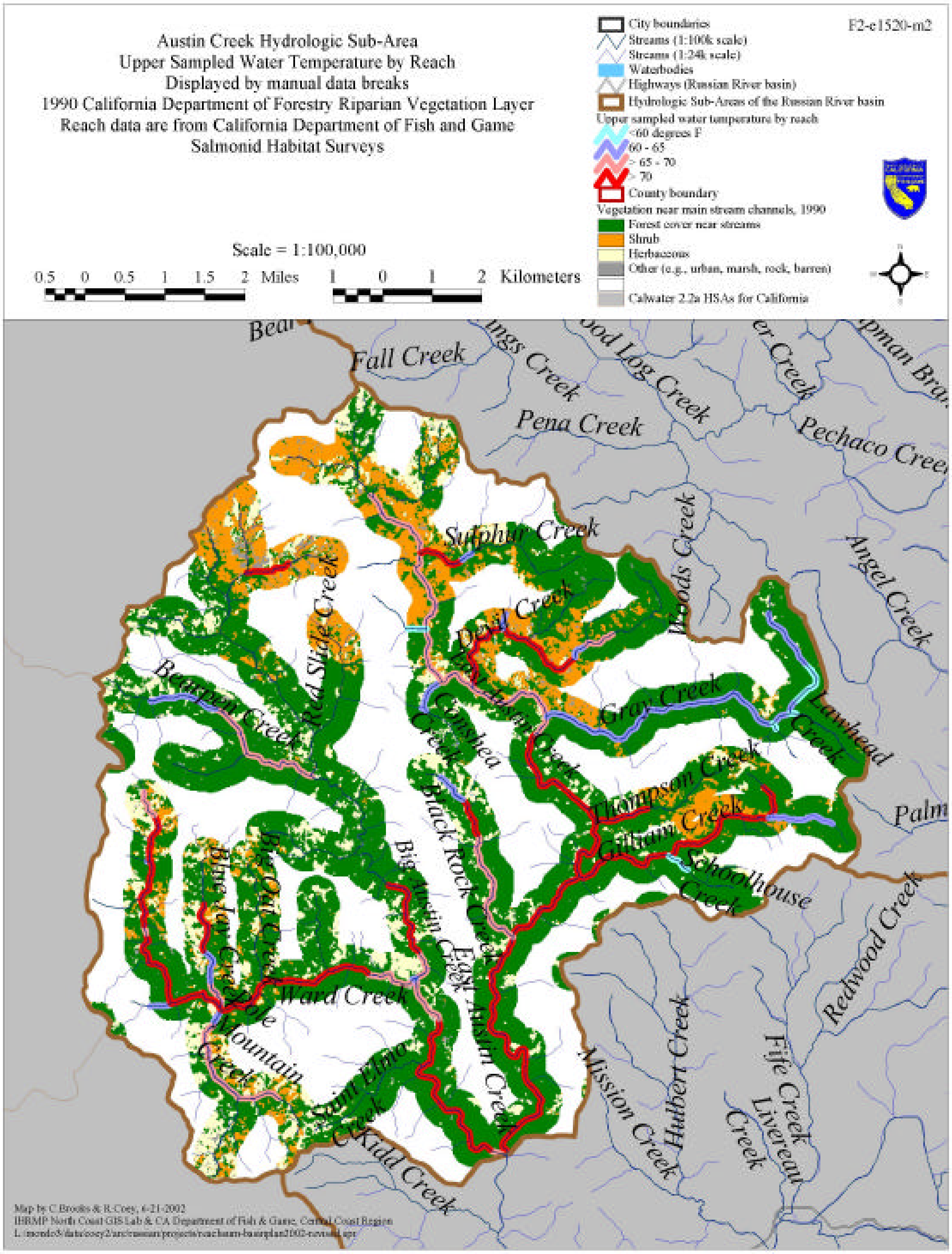

Map by C.Brooks & R.Coey, 6-21-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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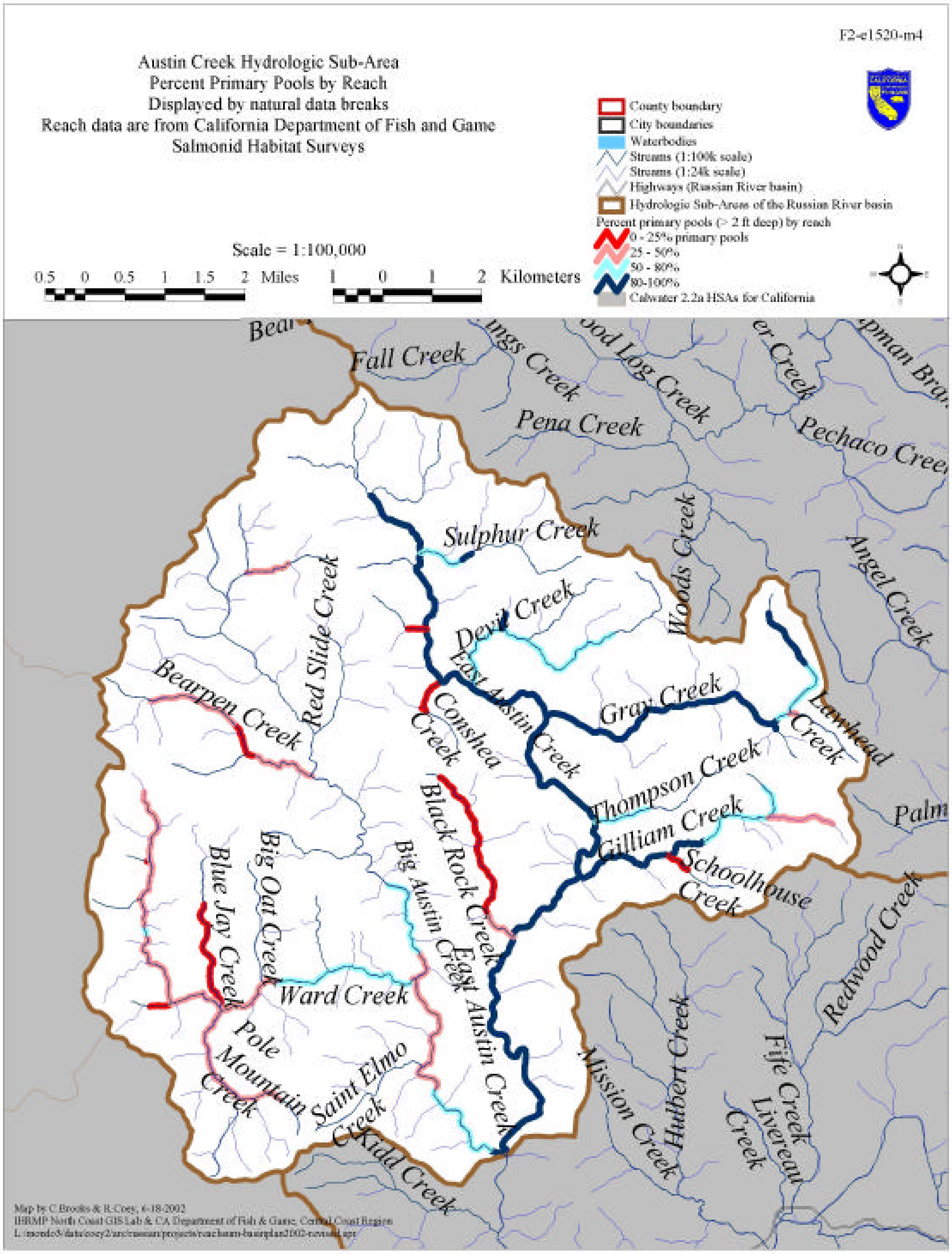

Austin Creek Hydrologic Sub-Area
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C.Brooks & R.Coey, 6-18-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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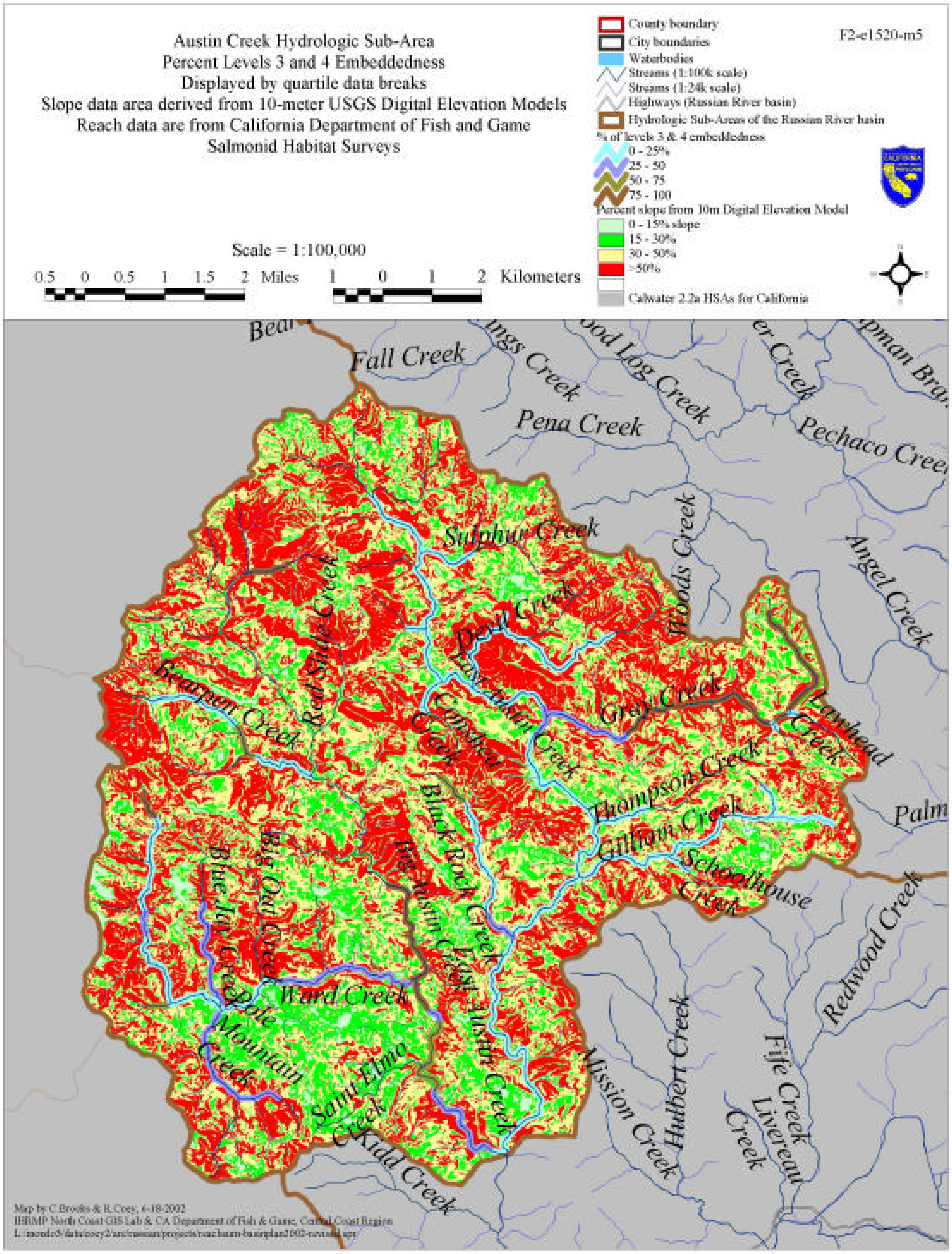
Austin Creek Hydrologic Sub-Area
Percent Levels 3 and 4 Embeddedness
Displayed by quartile data breaks
Slope data area derived from 10-meter USGS Digital Elevation Models
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:100,000
0.5 0 0.5 1 1.5 2 Miles
1 0 1 2 Kilometers
F2-e1520-m5
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
% of levels 3 & 4 embeddedness
0 - 25%
25 - 50
50 - 75
75 - 100
Percent slope from 10m Digital Elevation Model
0 - 15% slope
15 - 30%
30 - 50%
>50%
Calwater 2.2a HSAs for California
N
W
E
S
Bear
Fall Creek
ings Creek
ood Log Creek
er Creek
pman Bra
Pena Creek
Pechaco Cree
Sulphur Creek
Woods Creek
Angel Creek
Devil Creek
Red Slide Creek
Bearpen Creek
East Austin Creek
Gray Creek
Lawhead Creek
Conshea Creek
Thompson Creek
Black Rock Creek
Gilliam Creek
Palm
Schoolhouse Creek
Big Oat Creek
Blue Jay Creek
Big Austin Creek
Redwood Creek
Ward Creek
Pole Mountain Creek
East Austin Creek
Saint Elmo Creek
Kidd Creek
Mission Creek
Hulbert Creek
Fife Creek
Livereau Creek
Map by C.Brooks & R.Coey, 6-18-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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Laguna de Santa Rosa/Santa Rosa

The Laguna de Santa Rosa is a Clean Water Act Section 303(d) listed waterbody. The Laguna de Santa Rosa has a long history of water quality impacts. A 1954 DFG survey reported that effluent from the apple processing plant in Sebastopol was causing pollution in at the source and for some distance downstream "to a point lethal to fish" (Johnson 1954). In 1973, the summer flow of the Laguna was reported to be 53% wastewater. Grade "A" dairy cows were not permitted to drink from the waters there. A DFG survey conducted to evaluate the possible negative impacts from the discharge of wastewater to the Laguna from the Industrial Waste Disposal Site spray and leach fields found that: "although the industrial waste seepage has not yet significantly altered the ecosystem in the area of the flow, any further lowering of dissolved oxygen levels may result in a redistribution of key organisms (Rugg 1974)." The major polluters were four municipal sewer plants, dairies and industry. (Peckham 1985).

In recent times conflict has ensued between west county communities and the City of Santa Rosa over wastewater discharge in (Santa Rosa Creek and) the Laguna de Santa Rosa. Occasional violations of NPDES permits have escalated the issue. One example is when 750 million gallons of treated wastewater were released into the Laguna in 1985 by the City, contaminating the water supply for all of the communities downstream. Santa Rosa, like other upstream cities, is legally allowed to discharge effluent equal to 1% of the river's flow between October 1 and May 1, as long as the river is flowing at 1000 cubic feet per second or more. Because of this, winter floodwater flows into the Laguna were eventually mimicked on smaller scale by the floods of treated wastewater released into it.

Early urban development in the Russian River watershed resulted in raw, or minimally treated, sewage being discharged to various Russian River tributaries. Santa Rosa Creek was probably the worst case because of the large urban development in Santa Rosa. In 1958 the Central Sonoma Watershed Project was drafted, as a flood control measure in the Santa Rosa Creek drainage. The plan included 6 floodwater detention structures having a combined capacity of 5960 acre-feet of water and 33.6 miles of channelized creek. Thus, Santa Rosa Creek, along with some of its tributaries, was stripped of its riparian vegetation and concreted into a trapezoidal channel.

In the early 1970's the City of Santa Rosa built one of the first water reclamation and reuse facilities in the world. Treated wastewater coming out of this plant is certified for all uses except drinking. Most of the water is used for irrigation of crops in the Laguna de Santa Rosa area, but during the winter when irrigation demands are low water is discharged in lower Santa Rosa Creek at its confluence with the Laguna de Santa Rosa. At high flows, the effluent from the facility seems to have little effect on the fish life in Santa Rosa Creek. When flow drops, however, the bulk of the flow seems to be generated by the sewage plant effluent. The Laguna de Santa Rosa is now listed as an impaired waterbody on the Clean Water Act 303(d) list for nutrients and dissolved oxygen.

Since the early 1970's the primary issues with wastewater management have been public health concerns. The City's discharge permit allows a discharge of no more than 1% of the flow of the Russian River; but in certain dry years when there is insufficient flow in the river the City is unable to comply with that requirement. There were studies done in the 1980's to determine if there were any delays in fish migration caused by wastewater discharge to Santa Rosa Creek; none were detected. Since the advent of wastewater discharges the river below the Laguna Creek has become unusually un-fishable when in-river sport fishing for salmon or steelhead, due to water clarity.

Currently, the wastewater dilemma, including current pipeline and reduction in discharge levels, may be the biggest issue facing the Laguna. A pipeline is currently (2001) under construction which will take much of the reclaimed wastewater to The Geysers Geothermal Area for injection into the steamfield. Some water from this pipeline may also be diverted in Alexander Valley for agricultural irrigation.

See Tributary Conditions (Table 15) below for limiting factors specific to the Laguna/ Santa Rosa sub-basins. Figures 38-41 describe average canopy, percent primary pools, water temperatures and embededdness by reach for the sub-basin. See Appendix E for further summary of some key habitat variables by reach for each stream and sub-basin. Data was collected from habitat data during 1994-2002 following the methods of Flosi et al. (1998). Map GIS data was compiled by HREC-IHRMP under contract to DFG.

RESTORATIVE ACTIONS RECOMMENDED

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- •Restore the riparian corridor and floodplain on tributaries to the Laguna through riparian setbacks, conservation easements, and streambank stabilization techniques such as bio-engineering.
- •Restoration projects by SCWA, SSU, and the USACE Laguna Restoration should be supported and maintained.
- •Decreasing or eliminating wastewater discharge would improve upstream migration conditions in Laguna Creek and sport fishing on the lower river.
- •Conduct road assessments on larger ranches in watershed and implement recommendations.
- •Implement BMP's for road improvements on numerous smaller tracts of land throughout the watershed.
- •Implement Taylor recommendations for county road culvert passage issues.
- •Conduct habitat enhancement (address of LWD structures) along corridors adjacent to county roads.
- •Implement barrier modifications on south fork of Santa Rosa Creek.
- •Address sediment releases and catastrophic failure of private dam in the headwaters of the south fork (input PWA rec.).
- •Evaluate opportunity for habitat acquisitions between and within Hood Mountain and McCormick.
- •Complete road assessment surveys to include private property and implement records.

•Construct fish ladder on Matanzas and develop habitat enhancement projects Continue to focus on fish-related channel enhancement in lower Santa Rosa Creek.

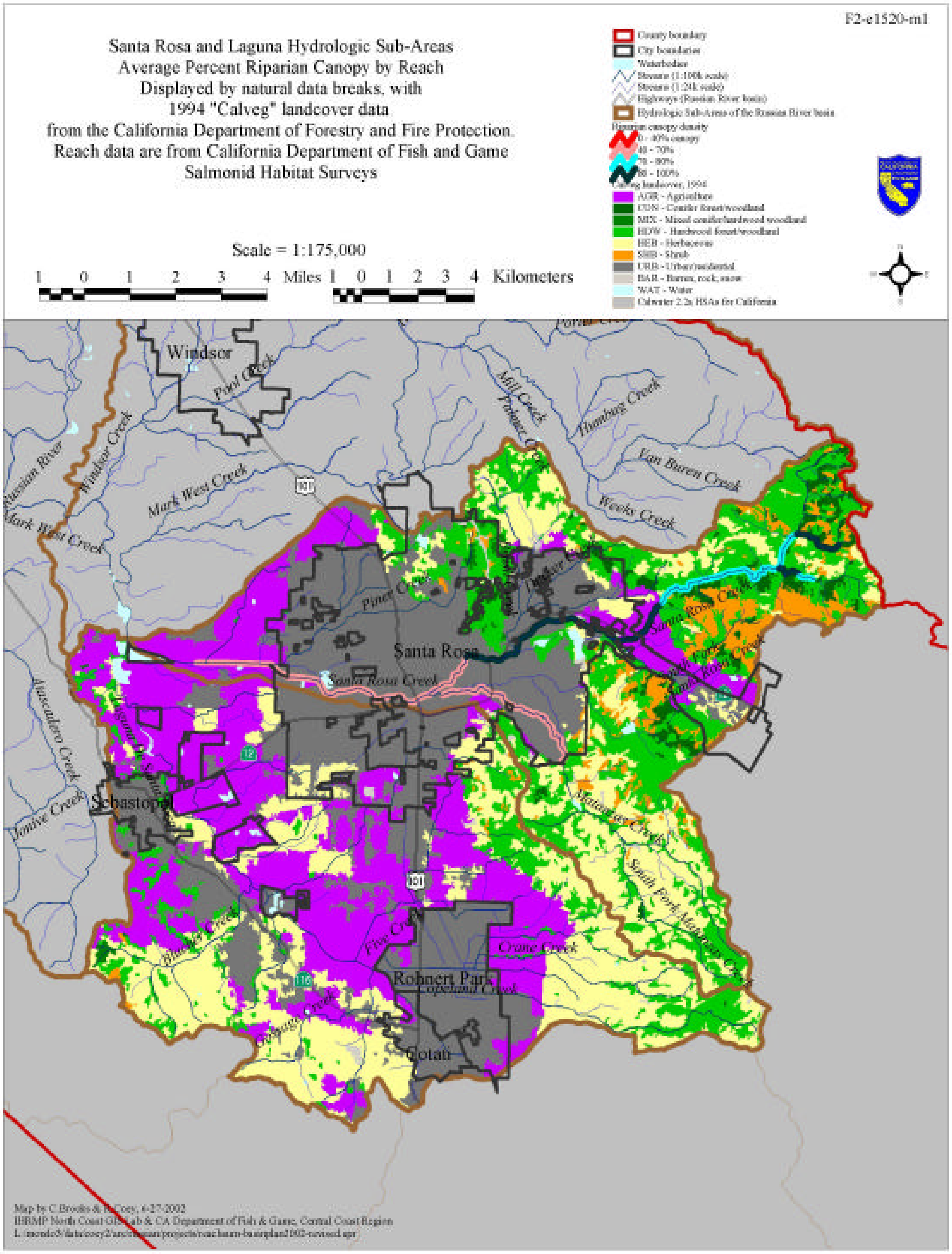
See Tributary Recommendations (Table 16) below for prioritized recommendations specific to the Laguna sub-basin

Name	Migration	Gravel Quality	Gravel Quantity		Riparian Stability	Water Temp.	Water Quality	Pool Shelter	Pool Number	Data Gaps	Comments
			Degraded	Aggraded							
Blucher Creek					*	*				1	
Copeland Creek		*			*	*				1	
Crane Creek					*	*				1	Habitat data
Ducker Creek		*			*	*	*			1	Habitat data
Five Creek						*				1	Habitat data
Gossage Creek						*				1	Habitat data
Hinebaugh Creek						*				1	Habitat data
Laguna de Santa Rosa	*				*	*	*				
Matanzes Creek	1	3				2		4		5	Passage
Rincon Creek (Brush Creek)		*			*	*		*		1	Habitat data
Santa Rosa Creek	1	3			4	2		6	7	8	fish dist.
SF Matanzas Creek		1						2	3		
SF Santa Rosa Creek	2	1									Waterfall

Table 15. Limiting factors specific to the Laguna/Santa Rosa sub-basins (1 = Highest priority, 2 = 2nd highest priority, etc. * = limiting factor identified from existing historical information or data, but no priority exists at this time)

Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Landslide	Erosion	Shelter	Create Pools	Monitor	Comments
Blucher Creek		*						*				
Copeland Creek		*			‘*			*				
Crane Creek		*						*				Survey 2003
Ducker Creek		*						*			*	Survey 2003
Five Creek		*										Survey 2003
Gossage Creek		*										Survey 2003
Hinebaugh Creek		*										Survey 2003
Laguna de Santa Rosa	‘*	*						*			*	Reduce discharge
Matanzas Creek	1	2						3	4		5	Passage
Rincon Creek (Brush Creek)		*						*	*			Survey 2003
Santa Rosa Creek	1	2	4			3		5	6	7	8	fish dist. & temps
SF Matanzas Creek								1	2	3		
SF Santa Rosa Creek							1	2				Natural falls

Table 16. Prioritized habitat recommendations specific to the Laguna/Santa Rosa sub-basins (1 = Highest priority, 2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time)



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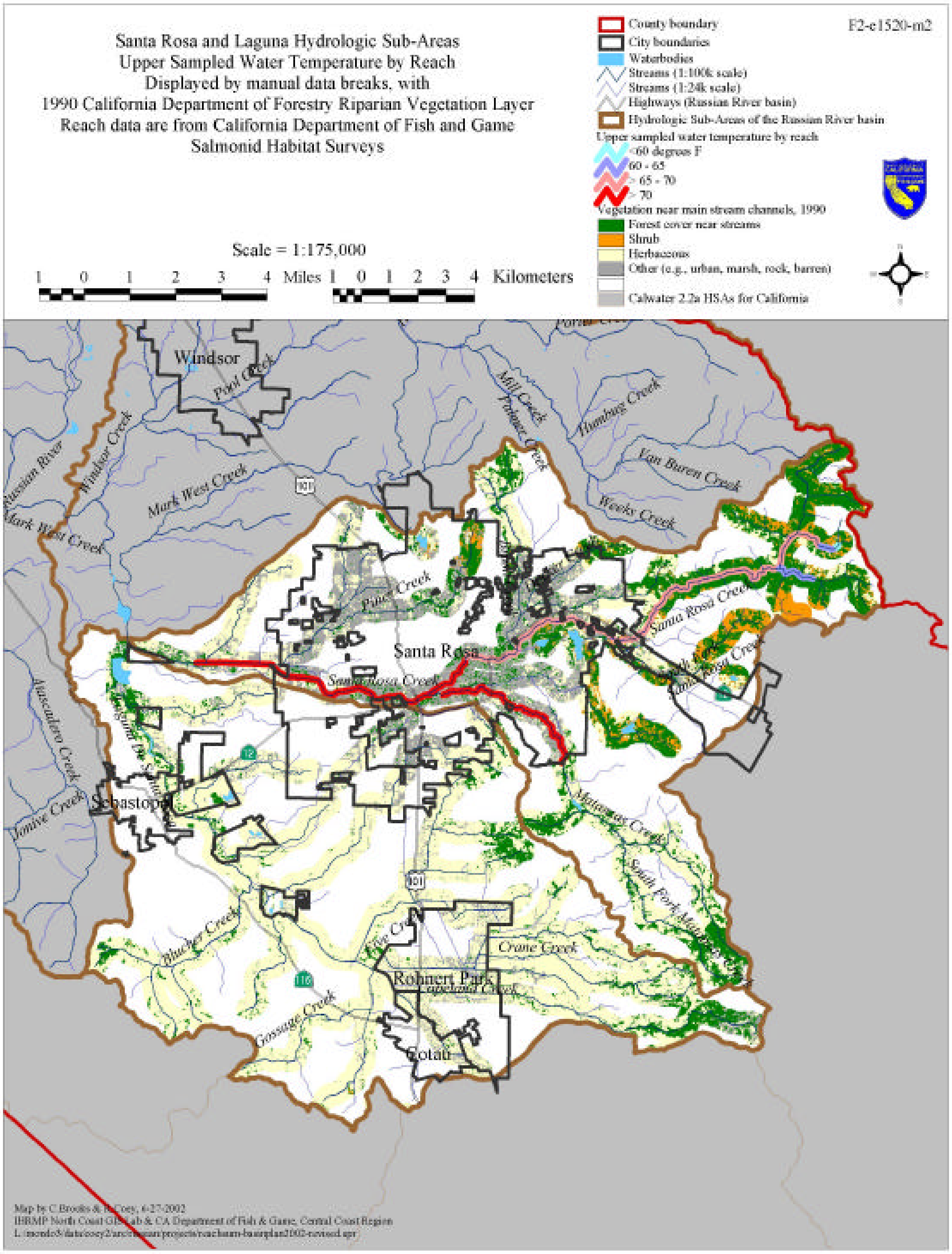
Santa Rosa and Laguna Hydrologic Sub-Areas
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

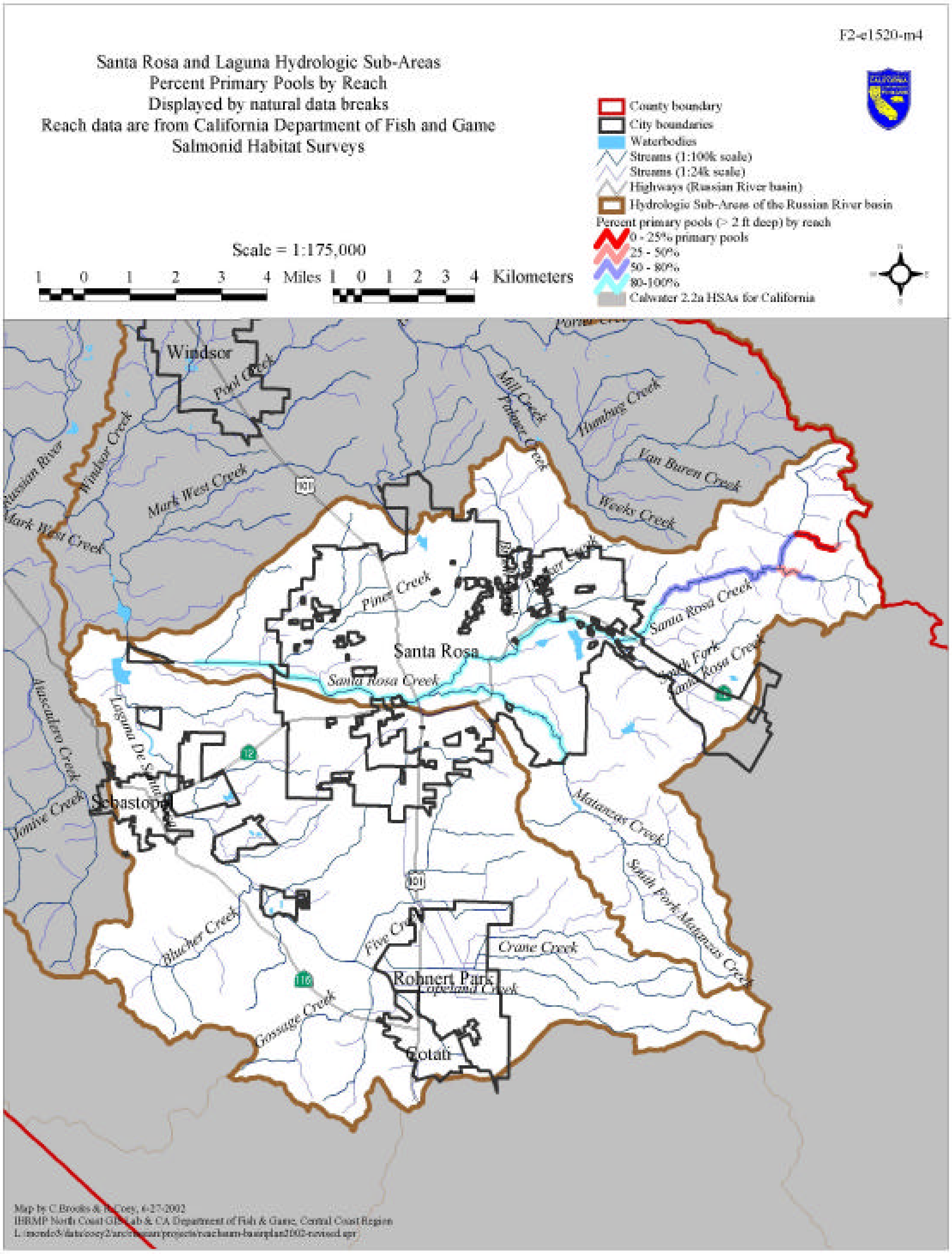
Scale = 1:175,000

Map by C.Brooks & R.Coey, 6-27-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
L:/mendo3/data/coey2/arc/russian/projects/reachaum-basinplan2002-revised.apr



Santa Rosa and Laguna Hydrologic Sub-Areas
Upper Sampled Water Temperature by Reach
Displayed by manual data breaks, with
1990 California Department of Forestry Riparian Vegetation Layer
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C.Brooks & R.Corey, 6-27-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
L:/mendo3/data/corey2/arc/russian/projects/reachsum-basinplan2002-revised.apr

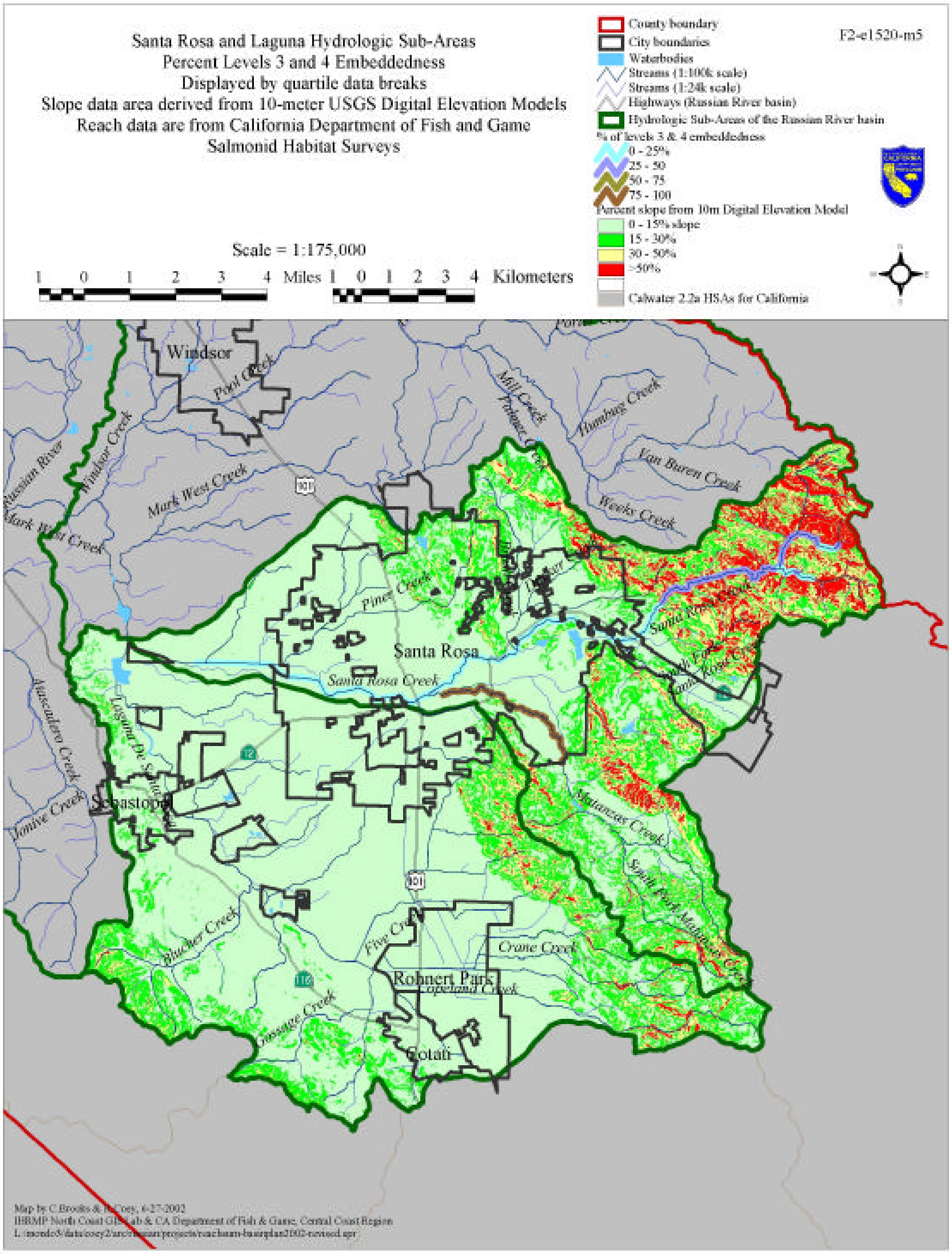


F2-e1520-m4

Santa Rosa and Laguna Hydrologic Sub-Areas
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Scale = 1:175,000

Map by C.Brooks & R.Corey, 6-27-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
L:/mendo3/data/corey2/arc/russian/projects/reachsum-basinplan2002-revised.apr



Map by C.Brooks & R.Coey, 6-27-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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Mark West

Historically, livestock operations were the dominant cause of water quality impacts, in this system, today Mark West Creek is impacted by non-point source inputs (stormwater runoff and agricultural operations) from the entrance of the Laguna de Santa Rosa downstream to the mouth. Agricultural runoff from animal operations and vineyards still have the potential to impact water quality, but at lower levels due to the City of Santa Rosa's water reclamation program, nitrogen reducing efforts, and the North Coast Regional Water Quality Control Board's non-point source control program.

Headwater areas of this sub-basin are in near pristine conditions, although near stream roads and development of riparian zones and floodplain areas limit habitat conditions and adult migration. A 1971 DFG survey found steelhead and coho salmon to be present in an abundance with estimates ranging from (2.5 to 20 miles of excellent habitat was estimated between 1965 and 1971). All previous and subsequent surveys, found a similar abundance of steelhead but no salmon until 2001 in Mark West Creek

See Tributary Conditions (Table 17) below for limiting factors specific to the Mark West sub-basins. Figures 42-45 describe average canopy, percent primary pools, water temperatures and embededdness by reach for the sub-basin. See Appendix E for further summary of some key habitat variables by reach for each stream and sub-basin. Data was collected from habitat data during 1994-2002 following the methods of Flosi et al. (1998). Map GIS data was compiled by HREC-IHRMP under contract to DFG.

Name	Migration	Gravel Quality	Gravel Quantity Degraded	Gravel Quantity Aggraded	Riparian Stability	Water Temp.	Water Quality	Pool Shelter	Pool Number	Data Gaps	Comments
Horse Hill Creek		2	5			1		3	4		
Humbug Creek	1					2		3			
John Gordon Creek										1	Habitat data
Mark West Creek		2			3	1	6	4	5		
Matanzes Creek	1	3				2		4		5	Passage
Mill Creek		1				2				3	Passage
Osborne Creek	1										Habitat data
Piner Creek										1	Habitat data
Palmer Creek		1									
Pool Creek		2	4			1	6		3	5	fish dist.
Porter Creek	1	2			3	4		6	7		
Press Creek			1								
Van Buren Creek	1	2	5					3	4		
Weeks Creek		2	5			1		3	4		
Windsor Creek		2	4			1	5		3	7	fish dist.

Table 17. Limiting factors specific to the Mark West sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = limiting factor identified from existing historical information or data, but no priority exists at this time)

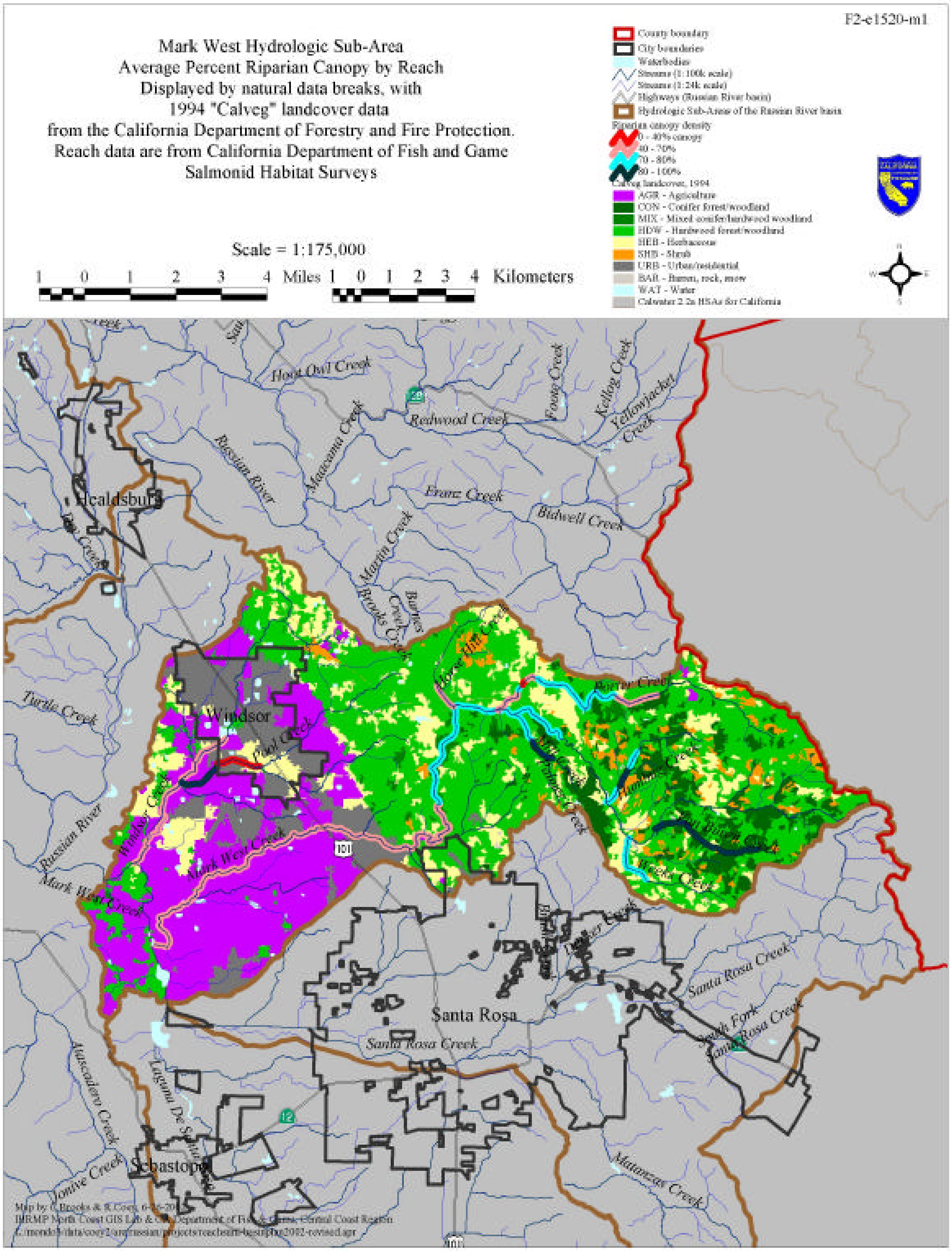
RESTORATIVE ACTIONS RECOMMENDED

- Increase canopy in Markwest and all tributaries to reduce water temperatures.
- Conduct road assessments on larger ranches in watershed and implement recommendations.
- Implement BMP's for road improvements on numerous smaller tracts of land throughout the watershed.
- Address barriers on Humbug, Van Buren, Mill, Porter, and Osborne Creeks.
- Implement Taylor recommendations for county road culvert passage issues.
- Obtain better fish utilization information on Windsor and Pool Creeks.
- Conduct habitat enhancement (address of LWD structures) along corridors adjacent to county roads.
- Pursue easements for riparian acquisition or setbacks along Mark West Creek.
- Complete road assessment surveys to include private property and implement records.
- Coho streams in this sub-basin require further habitat restoration before supplementation with the Captive Broodstock Program would be considered

See Tributary Recommendations (Table 18) below for prioritized recommendations specific to the Mark West Rosa sub-basin.

Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Landslide	Erosion	Shelter	Create Pools	Monitor	Comments
Horse Hill Creek		1		5				2	3	4		
Humbug Creek	1	2							3		4	fish pops
John Gordon Creek											1	Survey 2003
Mark West Creek		1	3				6	2	4	5		
Mill Creek		3			1			2			4	Culvert
Osborne Creek	1											Survey 2003
Palmer Creek					1							
Piner Creek		*						*				Survey 2003
Pool Creek		1		4				2		3	5	Fish distribution
Porter Creek	1	4	3		2				6	7	5	Channel
Press Creek				1								
Van Buren Creek	1			5				2	3	4		
Weeks Creek		1		5				2	3	4		
Windsor Creek		1		4				2		3	5	Fish distribution

Table 18. Prioritized habitat recommendations specific to the Mark West sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time)


F2-e1520-m1
Mark West Hydrologic Sub-Area
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:175,000
1 0 1 2 3 4 Miles
1 0 1 2 3 4 Kilometers
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Riparian canopy density
0 - 40% canopy
40 - 70%
70 - 80%
80 - 100%
Calveg landcover, 1994
AGR - Agriculture
CON - Conifer forest/woodland
MIX - Mixed conifer/hardwood woodland
HDW - Hardwood forest/woodland
HEB - Herbaceous
SHB - Shrub
URB - Urban/residential
BAR - Barren, rock, snow
WAT - Water
Calwater 2.2a HSAs for California
N
W
E
S
Hoot Owl Creek
Redwood Creek
Foote Creek
Kellog Creek
Yellowjacket Creek
Russian River
Maacama Creek
Franz Creek
Bidwell Creek
Healdsburg
Dry Creek
Martin Creek
Brooks Creek
Barnes Creek
Horse Hill Creek
Porter Creek
Turtle Creek
Windsor
Pool Creek
Windsor Creek
Russian River
Mark West Creek
Mark West Creek
Mark West Creek
Humbug Creek
Van Buren Creek
Weeks Creek
101
Santa Rosa Creek
Santa Rosa
Santa Rosa Creek
South Fork Santa Rosa Creek
Atascadero Creek
Laguna De Santa Rosa
Jonive Creek
Sebastopol
Matanzas Creek
12
101
Map by C. Brooks & S. Corey, 6-25-2002
IHRMP North Coast GIS Lab & Cal. Department of Fish & Game, Central Coast Region
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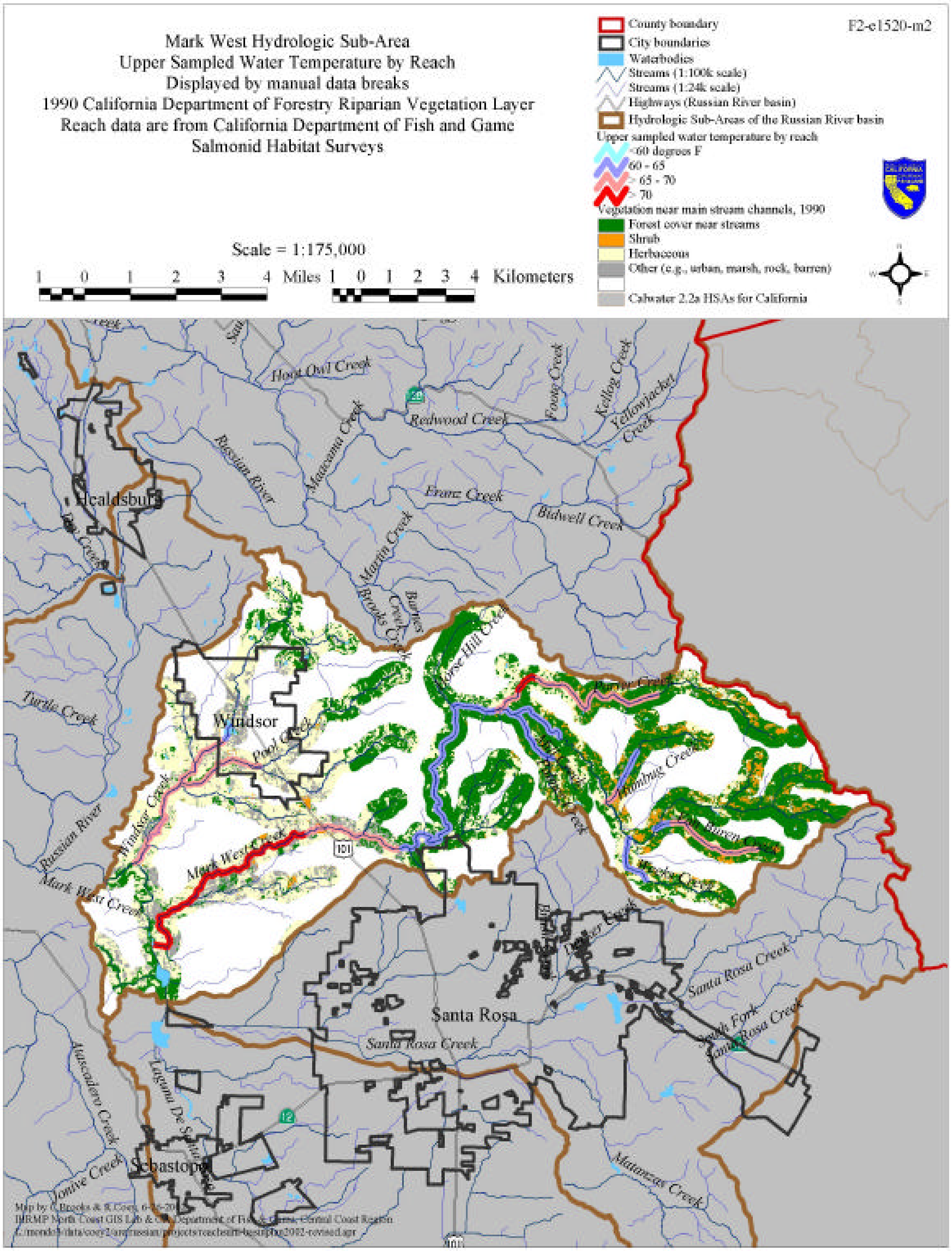
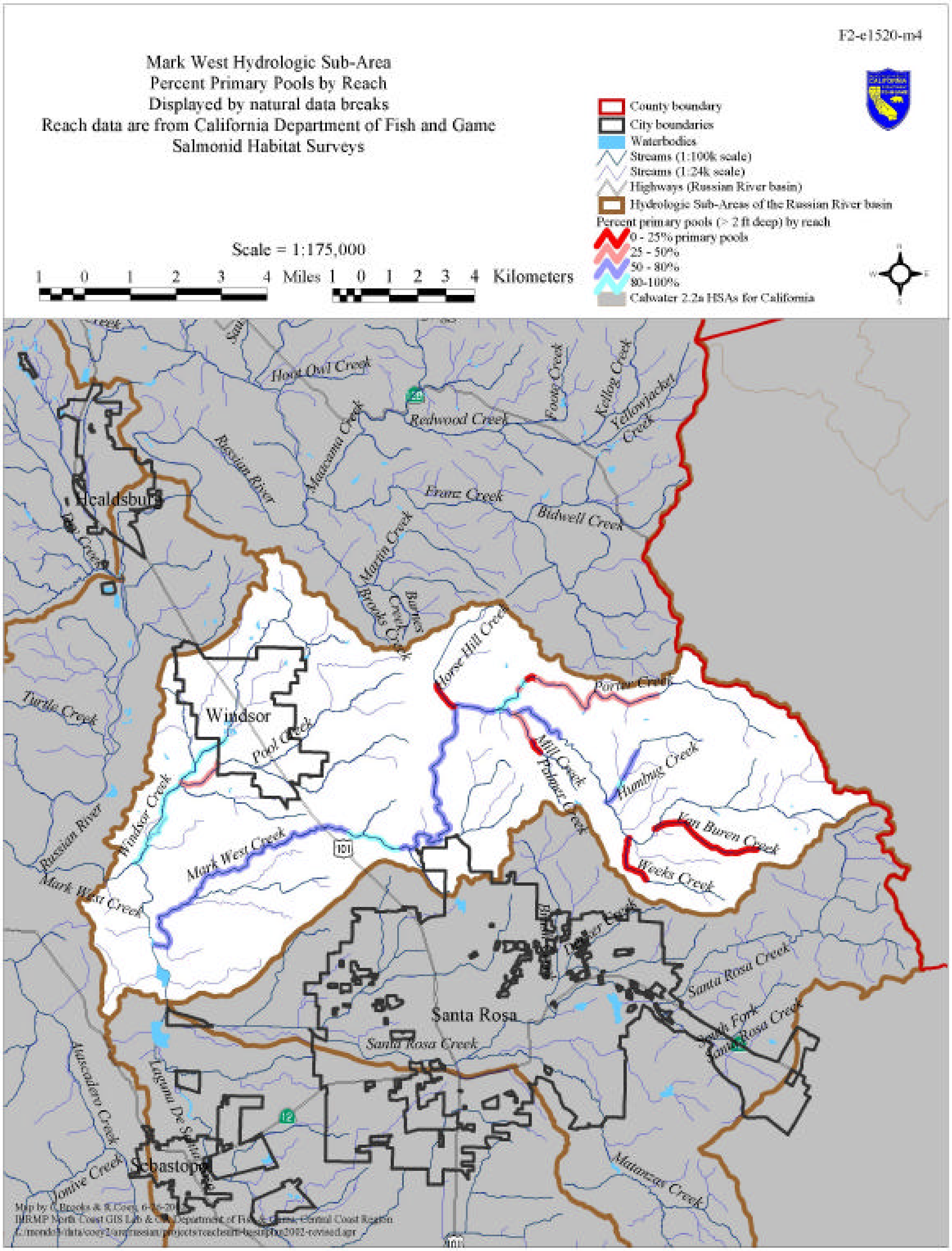
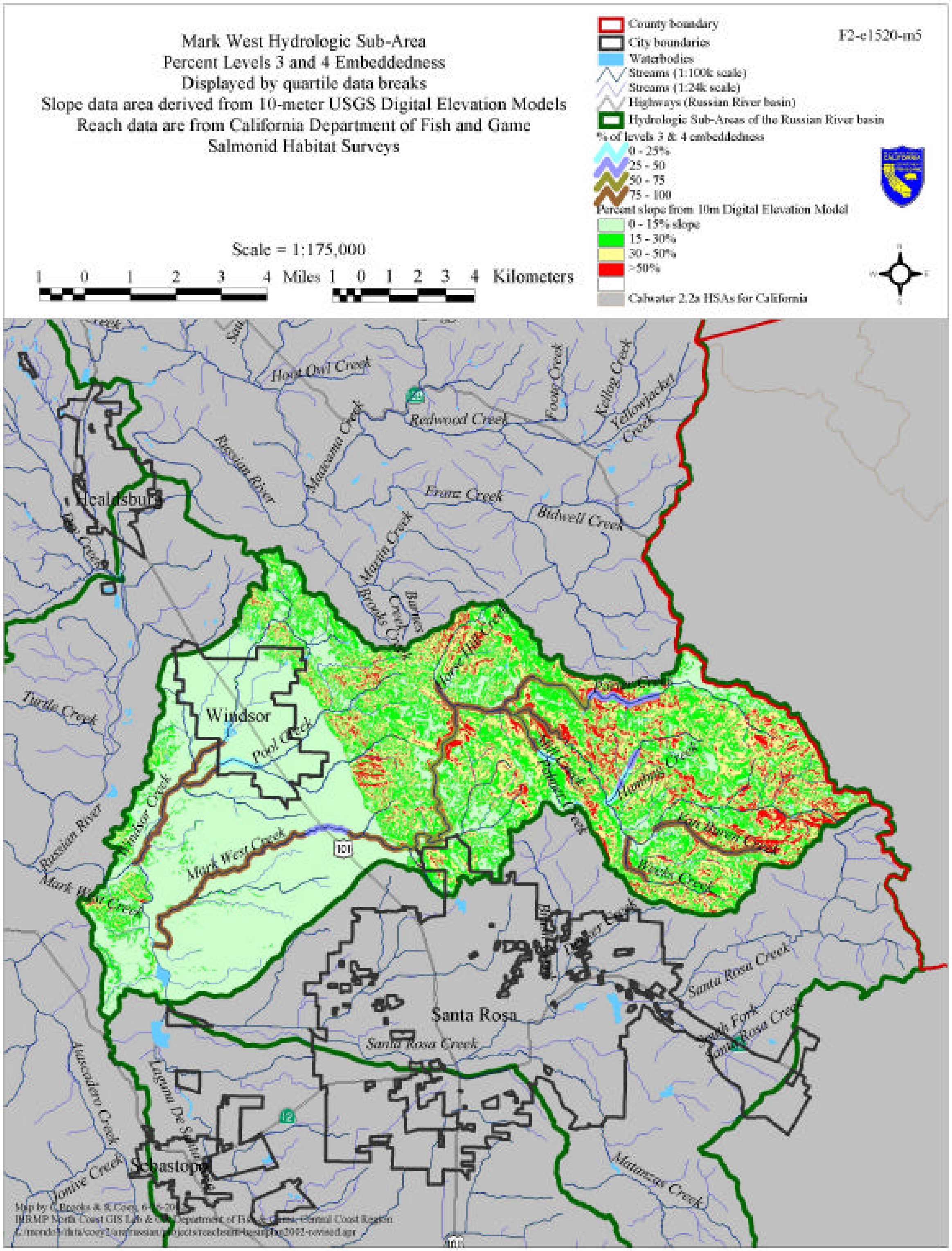


Mark West Hydrologic Sub-Area
Upper Sampled Water Temperature by Reach
Displayed by manual data breaks
1990 California Department of Forestry Riparian Vegetation Layer
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys


F2-e1520-m4
Mark West Hydrologic Sub-Area
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:175,000
1 0 1 2 3 4 Miles
1 0 1 2 3 4 Kilometers
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Percent primary pools (> 2 ft deep) by reach
0 - 25% primary pools
25 - 50%
50 - 80%
80-100%
Calwater 2.2a HSAs for California
Hoot Owl Creek
Redwood Creek
Foote Creek
Kellog Creek
Yellowjacket Creek
Russian River
Maacama Creek
Franz Creek
Bidwell Creek
Healdsburg
Dry Creek
Martin Creek
Brooks Creek
Barnes Creek
Horse Hill Creek
Porter Creek
Windsor
Pool Creek
Turtle Creek
Mill Creek
Pruitt Creek
Humbug Creek
Van Buren Creek
Weeks Creek
Windsor Creek
Mark West Creek
Russian River
Mark West Creek
101
Santa Rosa Creek
Santa Rosa
Santa Rosa Creek
South Fork Santa Rosa Creek
Atascadero Creek
Laguna De Santa Rosa
12
Sebastopol
Jonive Creek
Matanzas Creek
Map by G. Brooks & S. Cory, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
101


Mark West Hydrologic Sub-Area
Percent Levels 3 and 4 Embeddedness
Displayed by quartile data breaks
Slope data area derived from 10-meter USGS Digital Elevation Models
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:175,000
1 0 1 2 3 4 Miles
1 0 1 2 3 4 Kilometers
F2-e1520-m5
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
% of levels 3 & 4 embeddedness
0 - 25%
25 - 50
50 - 75
75 - 100
Percent slope from 10m Digital Elevation Model
0 - 15% slope
15 - 30%
30 - 50%
>50%
Calwater 2.2a HSAs for California
Hoot Owl Creek
Redwood Creek
Foote Creek
Kellog Creek
Yellowjacket Creek
Russian River
Maacama Creek
Franz Creek
Bidwell Creek
Healdsburg
Martin Creek
Brooks Creek
Barnes Creek
Horse Hill Creek
Porter Creek
Windsor
Pool Creek
Turtle Creek
Mill Creek
Humbug Creek
Windsor Creek
Mark West Creek
Van Buren Creek
Weeks Creek
101
Santa Rosa Creek
Santa Rosa
South Fork Santa Rosa Creek
Laguna De Santa Rosa
Atascadero Creek
Jonive Creek
Sebastopol
Matanzas Creek
12
128

Warm Springs (Dry Creek)

Cool water released from Warm Springs Dam keeps temperatures below 16 C, limiting warmwater fish intrusion into Dry Creek and creating favorable temperatures for salmonids. This positive effect is offset, though, by impacts to channel morphology from regulated flows. Before Warm Springs Dam, summer flows in Dry Creek were between 1 and 5 cfs. Temperatures are favorable for salmonid rearing, but lack of riffles, cover, and instream structure severely limits salmonid production in Dry Creek (City of Healdsburg 1996).

See Tributary Conditions (Table 19) below for limiting factors specific to the Warm Springs sub-basin.
Figures 46-49 describe average canopy, percent primary pools, water temperatures and embededdness by reach for the sub-basin. See Appendix E for further summary of some key habitat variables by reach for each stream and sub-basin. Data was collected from habitat data during 1994-2002 following the methods of Flosi et al. (1998). Map GIS data was compiled by HREC-IHRMP under contract to DFG.

Name	Migration	Gravel Quality	Gravel Quantity Degraded	Aggraded	Riparian Stability	Water Temp.	Water Quality	Pool Shelter	Pool Number	Data Gaps	Comments
Angel Creek		1						2			
Boyer Creek	1										Culvert
Chapman Branch	1	3		2				4			Log jams
Crane Creek				*	*						In progress
Dry Creek		3	1		2			4		5	fish distribution
Dutcher Creek	1	2	4					3	5		
Felta Creek		1				2		4	3		
Grape Creek		1	2		3			4			
Kelley Creek				1					3	2	Surface flows
Mill Creek	5	1	4					2	3		Passage
Palmer Creek		1									
Pechaco Creek		3			1	2		4	5		
Pena Creek	1	3			2	4		5	6		passage
Pine Ridge Canyon	1	3		2	4			5			Checkdams
Redwood Log (Canyon) Creek	1	3		2				4			Log jams
Redwood Log Creek	1	3	2					4			Log jams
Salt Creek			1		2			4	3		
Sweetwater Creek								1	2		
Wallace Creek		1						2	3		
Wine Creek	1	2	3			4		5	6		Culvert
Woods Creek	1	3				2		4	5		

Table 19. Limiting factors specific to the Warm Springs (Dry Creek) sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = limiting factor identified from existing historical information or data, but no priority exists at this time)

RESTORATIVE ACTIONS RECOMMENDED

•Flows in Dry Creek have been estimated to be too high for adequate juvenile rearing and rearing habitat is lacking due to lack of LWD through channel clearing and riparian loss. Addition of LWD to pool locations would improve rearing habitat.

•Mill and Felta Creeks have been identified for re-introduction of native coho utilizing a Captive broodstock Program discussed in Appendix G. Remaining coho streams in this sub-basin require further habitat restoration to re-establish natural coho populations or before supplementation with the Captive Broodstock Program would be considered. County maintained/owned culverts with low flow passage impaired identified so far: Wine Creek and Dutcher Creek (2 culverts).

•Lower Pena Creek would benefit from reduced bankfull width-to-depth ratio and increased riparian to improve vegetation. Mapping non-point source erosion is a priority in this sub-basin. Log-jams in the Chapman Branch need to be monitored for passage. Other passage issues in the Pena Creek watershed stem from log jams associated with natural constrictions.

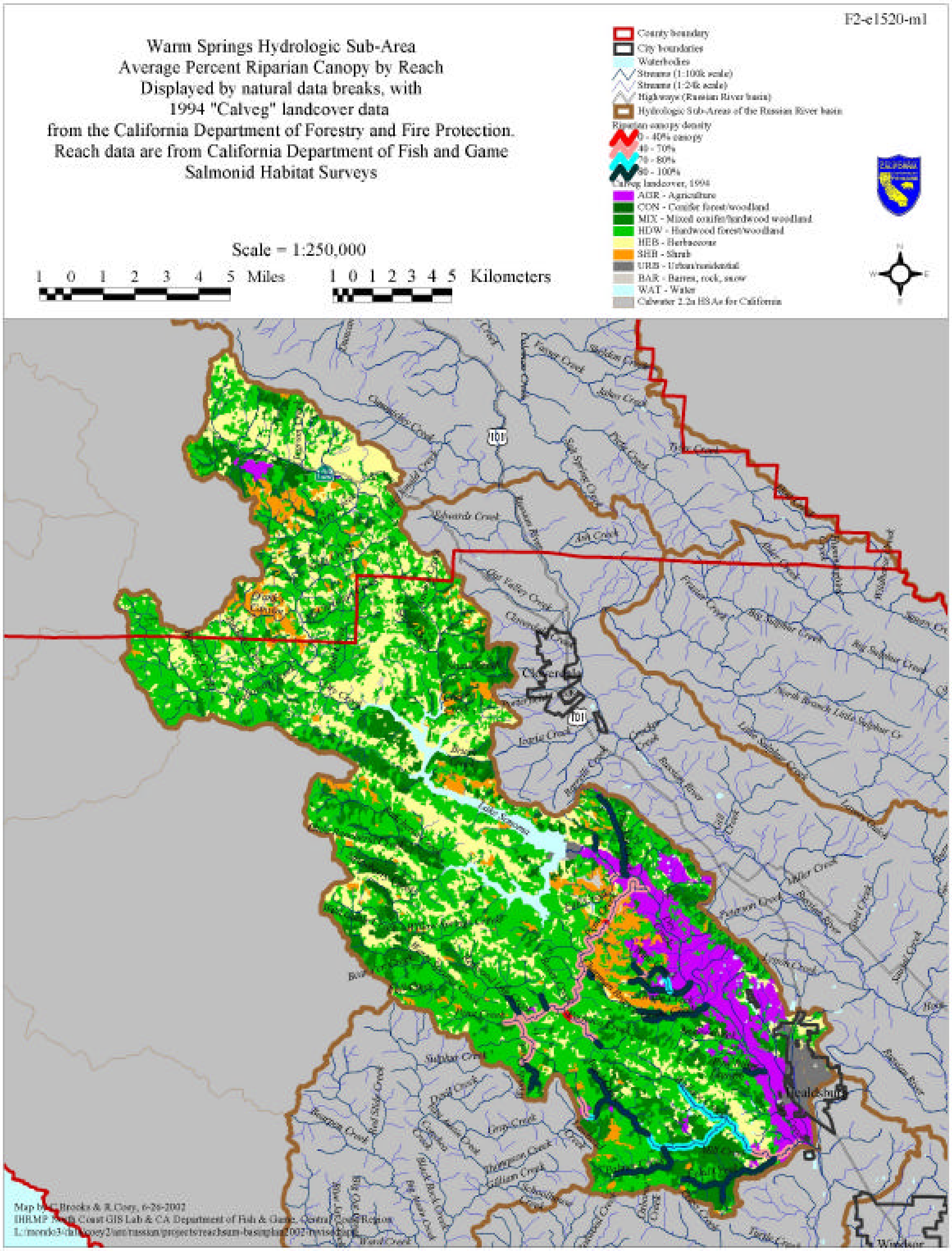
•The falls on lower Mill Creek and on lower Felta Creek need to be evaluated for passage periodically. Adjustment may be needed presently on Mill Creek.

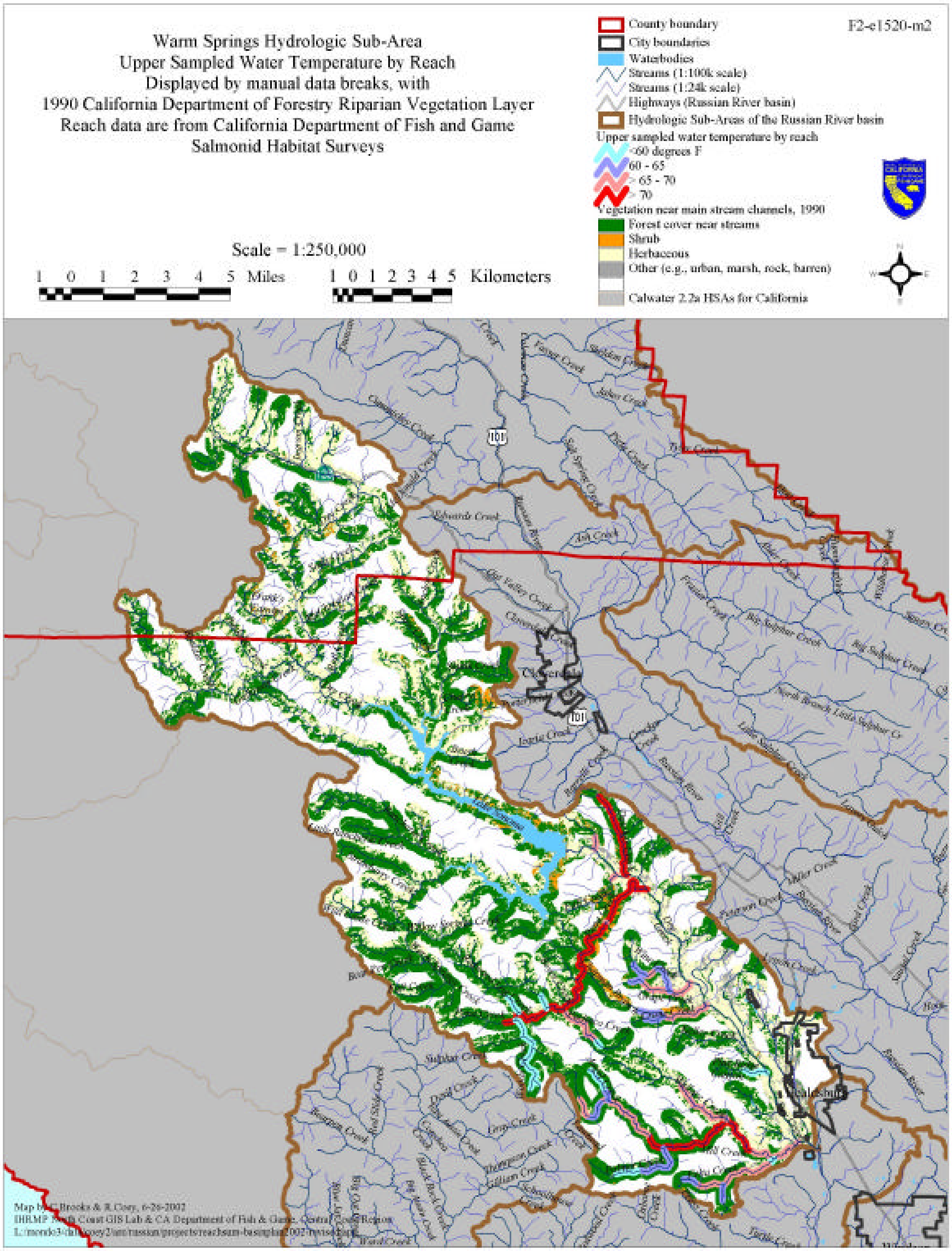
•Barriers by culverts exist on the smaller tributaries to Dry Creek. The recent culvert survey by Taylor should prioritize their remediation. Several large barriers exist on Dutcher Creek, which may make remediation problematic and prohibitibly expensive.

See Tributary Recommendations (Table 20) below for prioritized recommendations specific to the Warm Springs sub-basin.

Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Landslide	Erosion	Shelter	Create Pools	Monitor	Comments
Angel Creek					3		1	2	4			
Boyer Creek	1											Passage
Chapman Branch	1			2				3	4			Passage
Crane Creek												in progress
Dry Creek								2	3		1	flows
Dutcher Creek	1			4				2	3	5		passage
Fall Creek												Natural barrier
Felta Creek		2						1	4	3		
Grape Creek				3	1			2	4			
Kelley Creek					1	3	2					
Mill Creek	5			4				1	2	3	6	passage
Palmer Creek						1						
Pechaco Creek		2	1		3				4	5		
Pena Creek	1	5	2		3		4	6	7	8	9	passage
Pine Ridge Canyon	1				2			3	4			Check dams
Redwood Log (Canyon) Creek	1			2				3	4			Log jams
Redwood Log Creek	1				2	3						Log jams
Salt Creek								1	3	2		
Sweetwater Creek									1	2		
Wallace Creek					1			2	3	4		
Wine Creek	1	5		3	2			4	6	7		Culvert
Woods Creek		1					5	2	3	4		

Table 20. Prioritized habitat recommendations specific to the Dry Creek sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time)


F2-e1520-ml
Warm Springs Hydrologic Sub-Area
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:250,000
1 0 1 2 3 4 5 Miles
1 0 1 2 3 4 5 Kilometers
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Riparian canopy density
0 - 40% canopy
40 - 70%
70 - 80%
80 - 100%
Calveg landcover, 1994
AGR - Agriculture
CON - Conifer forest/woodland
MIX - Mixed conifer/hardwood woodland
HDW - Hardwood forest/woodland
HEB - Herbaceous
SHB - Shrub
URB - Urban/residential
BAR - Barren, rock, snow
WAT - Water
Calwater 2.2a HSAs for California
N
W
E
S
101
Cloverdale
Healdsburg
Windsor
Lake Sonoma
Dry Creek
Sulphur Creek
Big Sulphur Creek
Little Sulphur Creek
Pena Creek
Mill Creek
Map by C Brooks & R Cory, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region



Warm Springs Hydrologic Sub-Area
Upper Sampled Water Temperature by Reach
Displayed by manual data breaks, with
1990 California Department of Forestry Riparian Vegetation Layer
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C Brooks & R Cosy, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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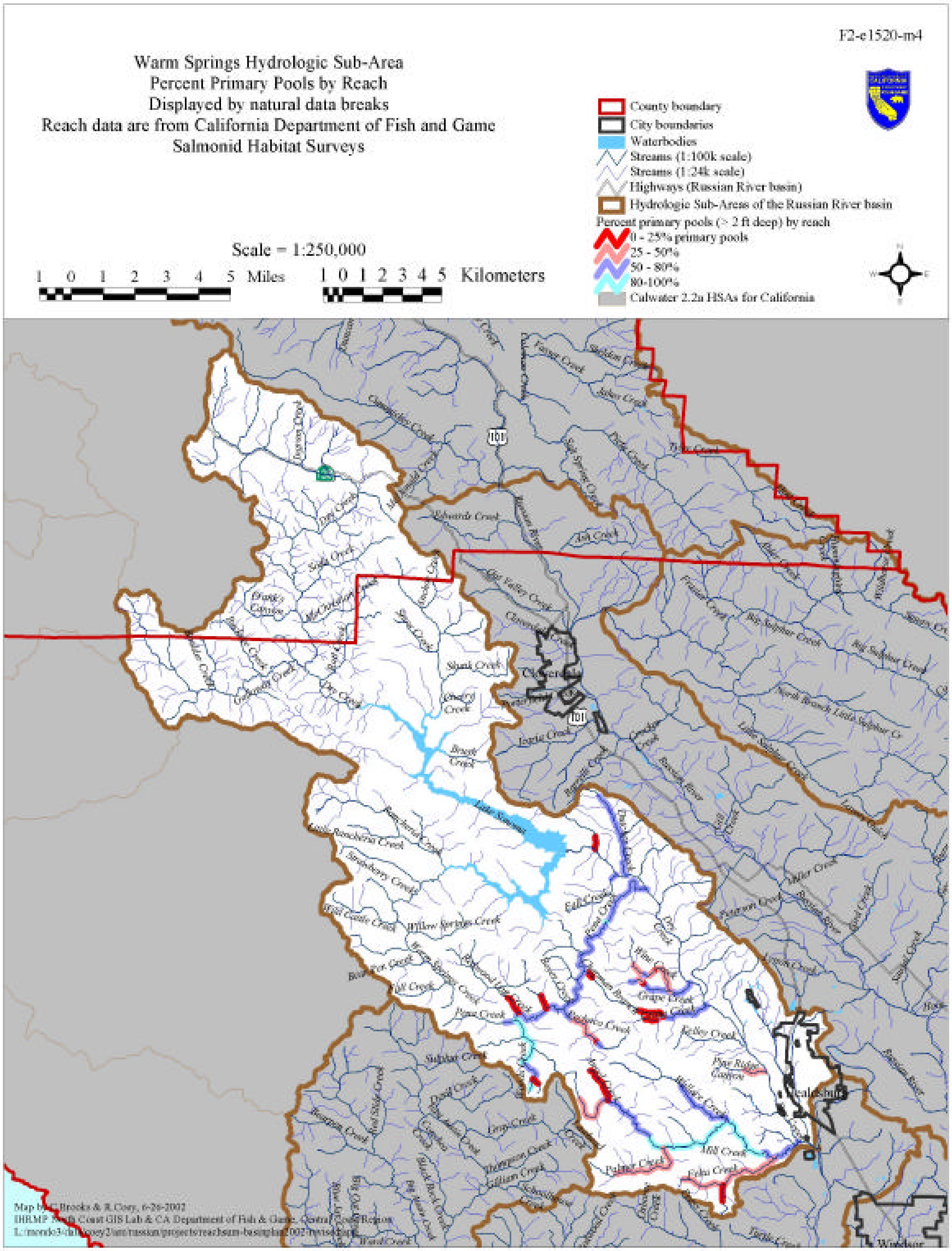

Warm Springs Hydrologic Sub-Area
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C Brooks & R Cosy, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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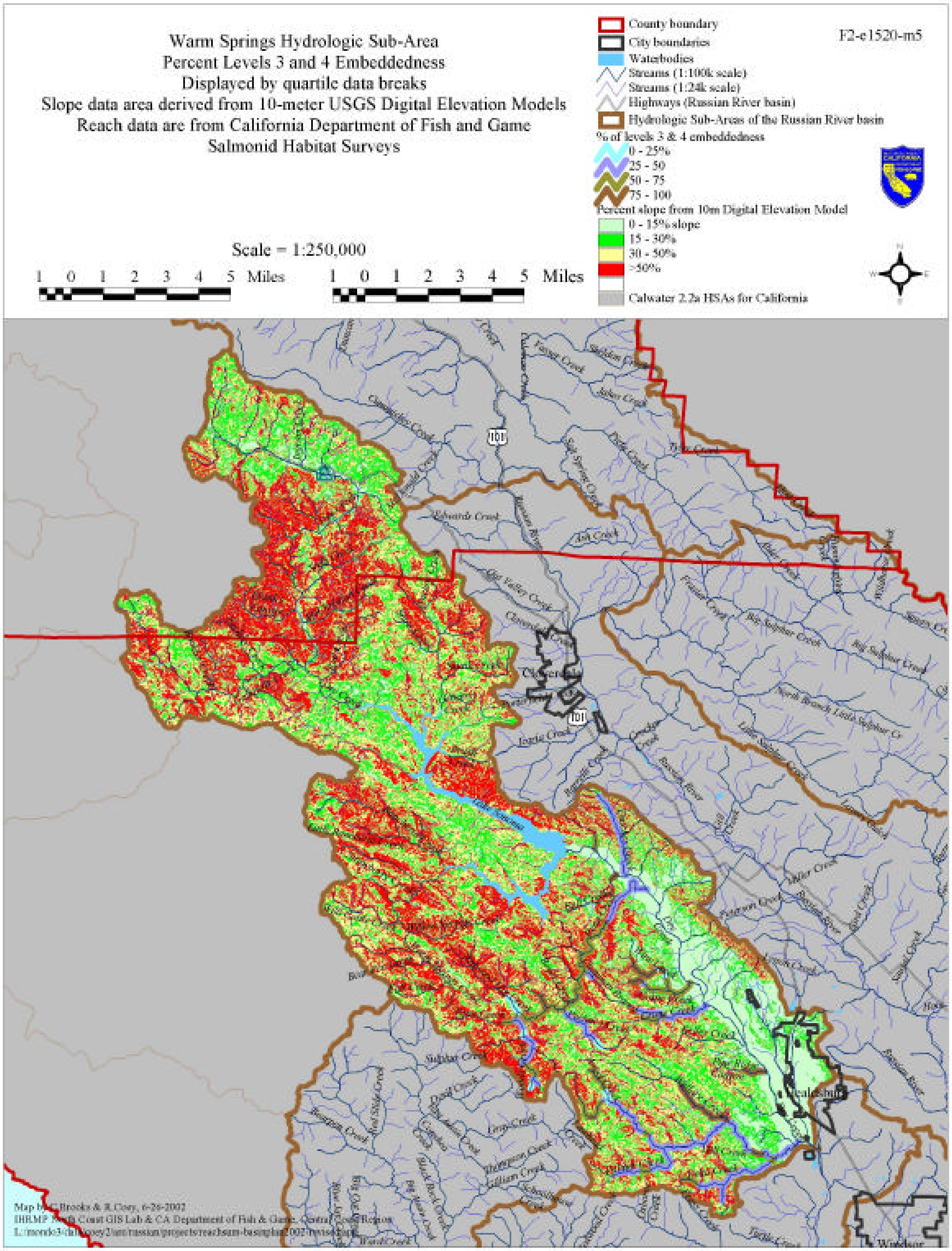

Warm Springs Hydrologic Sub-Area
Percent Levels 3 and 4 Embeddedness
Displayed by quartile data breaks
Slope data area derived from 10-meter USGS Digital Elevation Models
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:250,000
1 0 1 2 3 4 5 Miles
1 0 1 2 3 4 5 Miles
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
% of levels 3 & 4 embeddedness
0 - 25%
25 - 50
50 - 75
75 - 100
Percent slope from 10m Digital Elevation Model
0 - 15% slope
15 - 30%
30 - 50%
>50%
Calwater 2.2a HSAs for California
F2-e1520-m5
N
W
E
S
101
Cloverdale
Healdsburg
Windsor
Lake Sonoma
Map by C Brooks & R.Cory, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region

Geyserville

Maacama Creek proper for the most part is a warm water environment. The direction of flow and the wide valley which precludes closed canopy leads to warm temperatures which mainly harbor the native warm water species found in the mainstem Russian River. Only where the canyon narrows is it suitable rearing habitat with good spawning conditions. Upstream on McDonnell Creek conditions are similar, although its tributaries harbor excellent habitat with little land use and impacts. Briggs Creek and its tributaries harbor the principal refugia habitat for steelhead on the eastern side of the lower basin. The mixed hardwood forests here are in excellent condition and few ownerships exist in this large sub-basin. Several large tracts of land are in conservation easements. Spawning and rearing conditions for steelhead are excellent and occasionally salmon are observed by local landowners.

Franz Creek is also good habitat in the upper watershed but its tributaries, Redwood and Foote Creeks, have been impacted severely where adjacent land use has confined the streams and removed floodplains. North of Geyserville direct tributaries such as Gill, Gird and Crocker Creeks hold year round flows and abundant pools for harboring steelhead in headwater areas mainly. The unconfined valley areas of these tributaries have been developed for agriculture and flow is typically lacking. Habitat conditions vary based on slope and aspect in this hot and dry environment. Adjacent land use practices challenge salmon production even further and typically consist of livestock grazing and hillside vineyards.

Coho have been documented in Redwood, Briggs, and Maacama Creeks and are likely only native to the Maacama Creek watershed in the Geyserville sub-basin. Temperatures elsewhere are higher than optimal for coho, but preferable to steelhead. Many of the small direct tributaries to the Russian River have only recently been surveyed.

See Tributary Conditions (Table 21) below for limiting factors specific to the Geyserville sub-basin.
Figures 50-53 describe average canopy, percent primary pools, water temperatures and embededdness by reach for the sub-basin. See Appendix E for further summary of some key habitat variables by reach for each stream and sub-basin. Data was collected from habitat data during 1994-2002 following the methods of Flosi et al. (1998). Map GIS data was compiled by HREC-IHRMP under contract to DFG.

		Gravel	Gravel Quantity		Riparian	Water	Water	Pool	Pool	Data	
Name	Migration	Quality	Degraded	Aggraded	Stability	Temp.	Quality	Shelter	Number	Gaps	Comments
Ash Creek										1	Habitat data
Barnes Creek										1	Habitat data
Barrelli Creek										1	Habitat data
Bear Creek		2				1					
Bidwell Creek		5	2			1		3	4		
Bluegum Creek		2				1					
Briggs Creek		2				1					
Brooks Creek										1	Habitat data
Burns Creek										1	Habitat data
Cloverdale Creek		*			*	*		*	*		
Coon Creek	1	2									Culvert
Crocker Creek	1	2			3	4		5			Failed dam
Edwards Creek										1	Habitat data
Foote Creek											
Franz Creek	1	4			2	3		5	6		Vineyard fence
George Young Creek										1	Habitat data
Gill Creek	1	4			2	3		6	7		
Gird Creek					*						
Hoot Owl Creek					*						
Icaria Creek										1	Habitat data
Ingalls Creek											
Kellog Creek											No access
Little Briggs Creek	1	2									Culvert
Lytton Creek					1	2					
Maacama Creek		3			1	2		4			
Martin Creek										1	Habitat data
McDonnell Creek		3			1	2		4	5		
Miller Creek										1	Habitat data
Oat Valley Creek										1	Habitat data
Peterson Creek										1	Habitat data
Porterfield Creek										1	Habitat data
Redwood Creek		3			1	2		5	4		
Thornton Branch								1	2		
Sausal Creek											No access
Yellowjacket Creek											No Access

Table 21. Limiting factors specific to the Geyserville sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = limiting factor identified from existing historical information or data, but no priority exists at this time)

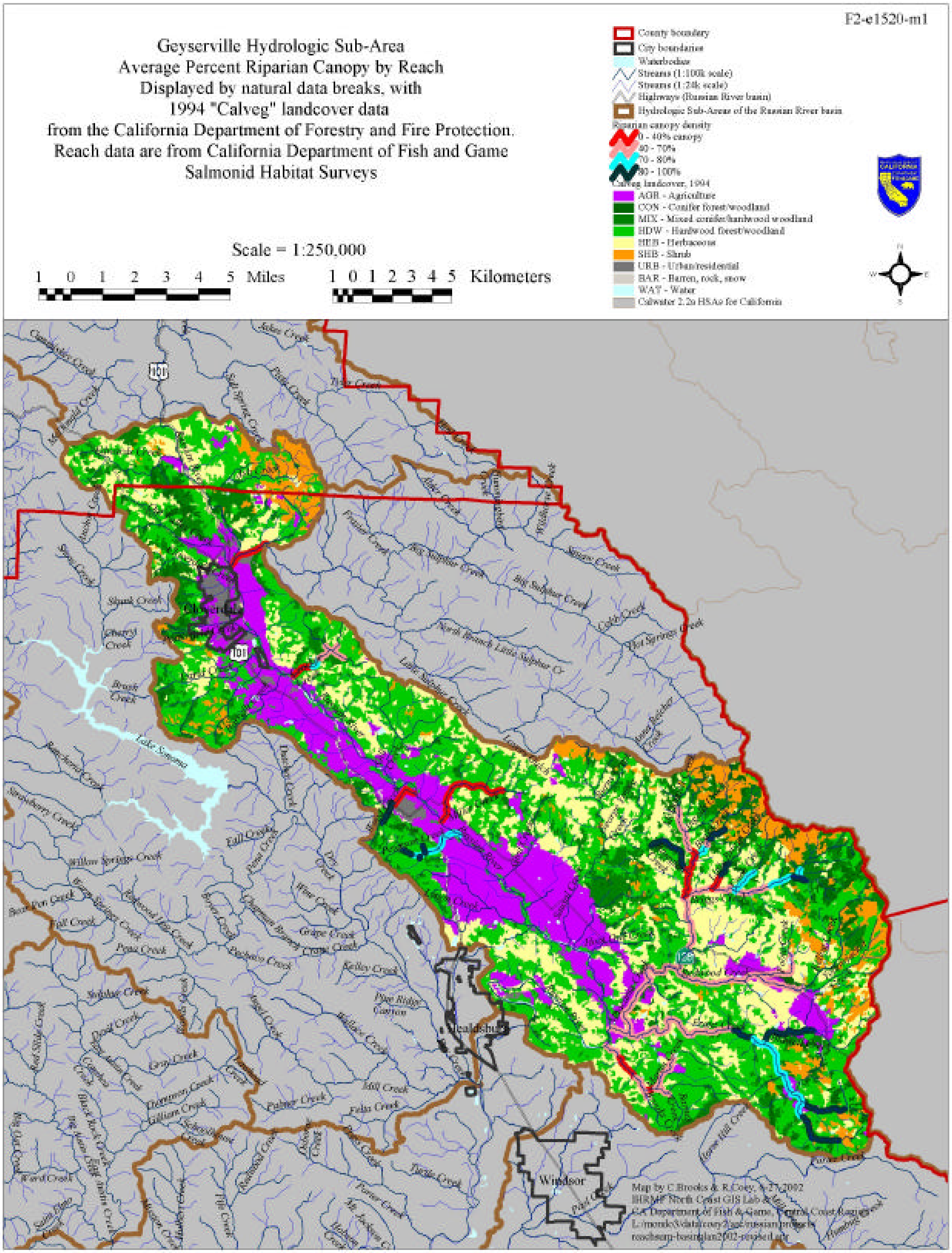
RESTORATIVE ACTIONS RECOMMENDED

•Livestock fencing would reduce sediment concerns in the Maacama Creek watershed on several tributary systems. Riparian improvements are also needed.
•Conservation easements along riparian zones connecting the Russian River to high quality protected habitat in the Briggs and McDonnel Creek watersheds should be considered.
•Upgrading culverts on Little Briggs and Coon Creeks are the highest priority in this sub-water shed.
•Redwood and Foote Creeks need riparian buffers. Livestock fencing is also needed in the headwater areas of Gill, Crocker, Foote and possibly Gird Creeks.
•Numerous direct tributaries north of Geyserville require habitat assessment for priorities to be established. These surveys are expected to be conducted in 2002 or 2003.
•Kellogg, Yellowjacket, and Sausal Creeks have not been surveyed due to un-cooperative ownerships.

See Tributary Recommendations (Table 22) below for prioritized recommendations specific to the Geyserville sub-basin.

Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Landslide	Erosion	Shelter	Create Pools	Monitor	Comments
Ash Creek												Survey 2002
Barnes Creek												In progress
Barrelli Creek												Survey 2002
Bear Creek		1						2			3	fish pops & macros
Bidwell Creek		1		2	5				3	4		
Bluegum Creek		1						2			3	fish pops & macros
Briggs Creek		1						2			3	fish pops & macros
Brooks Creek												In progress
Burns Creek												No access
Cloverdale Creek		*						*	*	*		
Coon Creek	1							1			2	fish pops & macros
Crocker Creek	1	4	3		5			2	6			
Foote Creek		3	1	5				2		4		
Franz Creek	1	3	2		5			4	6	7		
Gill Creek	1	3	2		4			5	6	7		
George Young Creek												No access
Gird Creek												In progress
Hoot Owl Creek												Survey 2003
Icaria Creek												Survey 2002
Ingalls Creek	1										2	Passage
Kellog Creek												No access
Little Briggs Creek	1										1	fish pops & macros
Lytton Creek												Survey 2003
Maacama Creek		2	1		3		4		5			
Martin Creek												In progress
McDonnell Creek		2	1					3	4	5		
Miller Creek												In progress
Oat Valley Creek												Survey 2002
Peterson Creek												In progress
Porterfield Creek												Survey 2002
Redwood Creek		1						2	4	3		
Sausal Creek												No access
Thornton Branch Creek									1	2		
Yellowjacket Creek												No access

Table 22. Prioritized habitat recommendations specific to the Geyserville sub-basin (1 = Highest priority2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time)



Geyserville Hydrologic Sub-Area
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C.Brooks & R.Coey, 5-27-2002
IHRMP North Coast GIS Lab &
CA Department of Fish & Game, Central Coast Region
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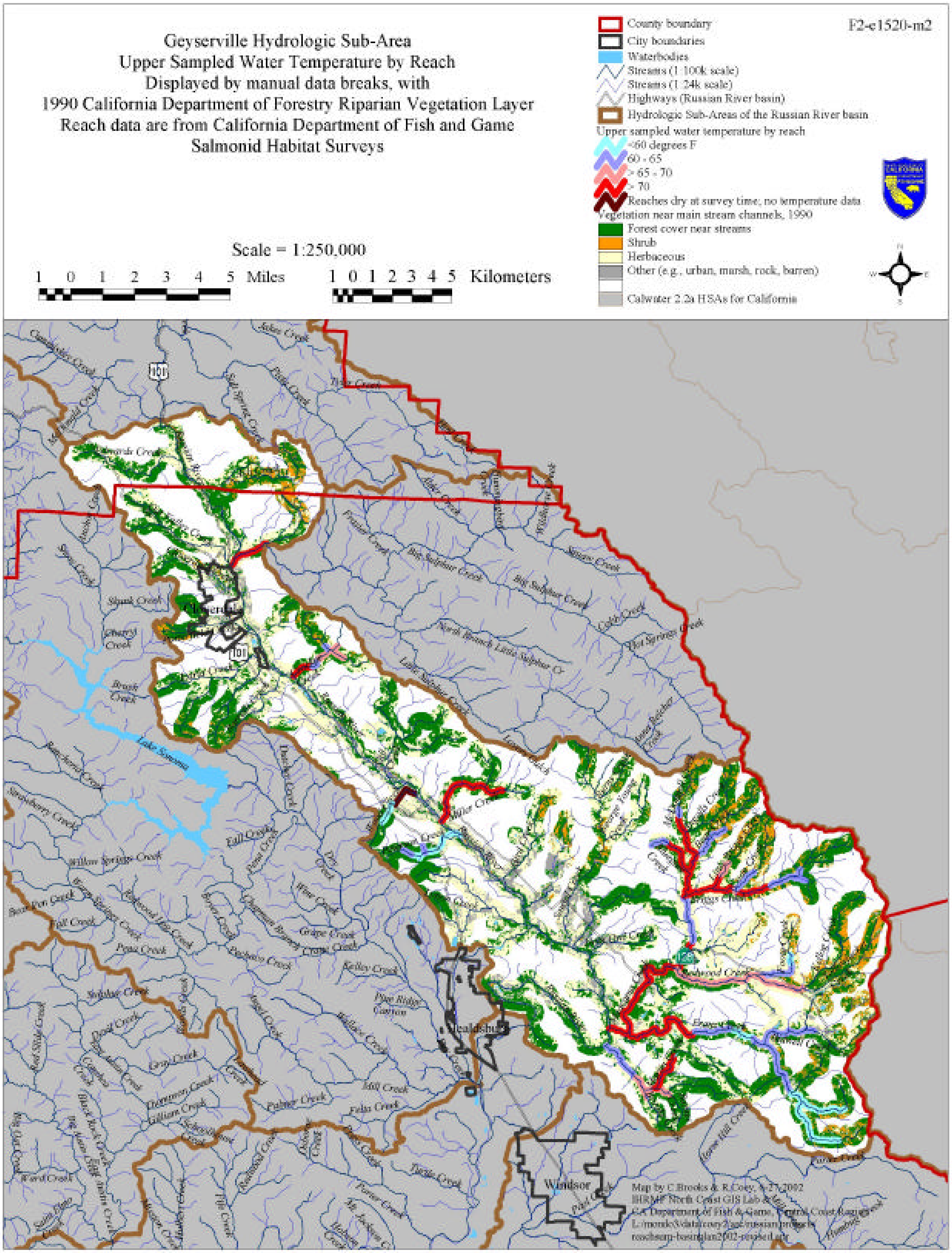
reachsum-basinplan2002-revised.apr


Geyserville Hydrologic Sub-Area
Upper Sampled Water Temperature by Reach
Displayed by manual data breaks, with
1990 California Department of Forestry Riparian Vegetation Layer
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:250,000
1 0 1 2 3 4 5 Miles
1 0 1 2 3 4 5 Kilometers
F2-e1520-m2
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Upper sampled water temperature by reach
<60 degrees F
60 - 65
> 65 - 70
> 70
Reaches dry at survey time; no temperature data
Vegetation near main stream channels, 1990
Forest cover near streams
Shrub
Herbaceous
Other (e.g., urban, marsh, rock, barren)
Calwater 2.2a HSAs for California
N
W
E
S
101
Geyserville
Healdsburg
Windsor
Lake Sonoma
Big Sulphur Creek
Little Sulphur Creek
North Branch Little Sulphur Cr
Hot Springs Creek
Squaw Creek
Foss Creek
Dry Creek
Pena Creek
Mill Creek
Felta Creek
Pool Creek
Map by C.Brooks & R.Coey, 5-27-2002
IHRMP North Coast GIS Lab &
CA Department of Fish & Game, Central Coast Region
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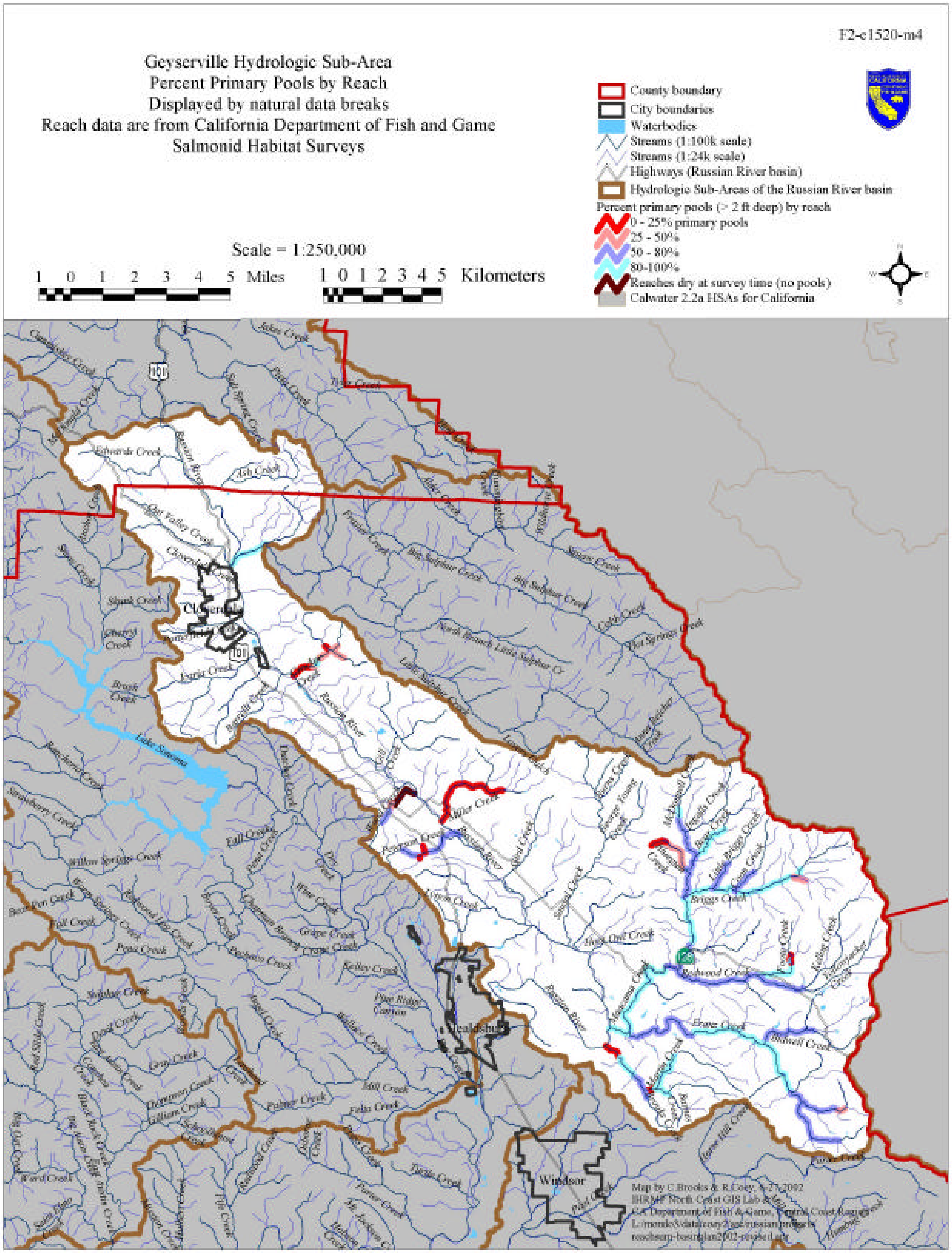
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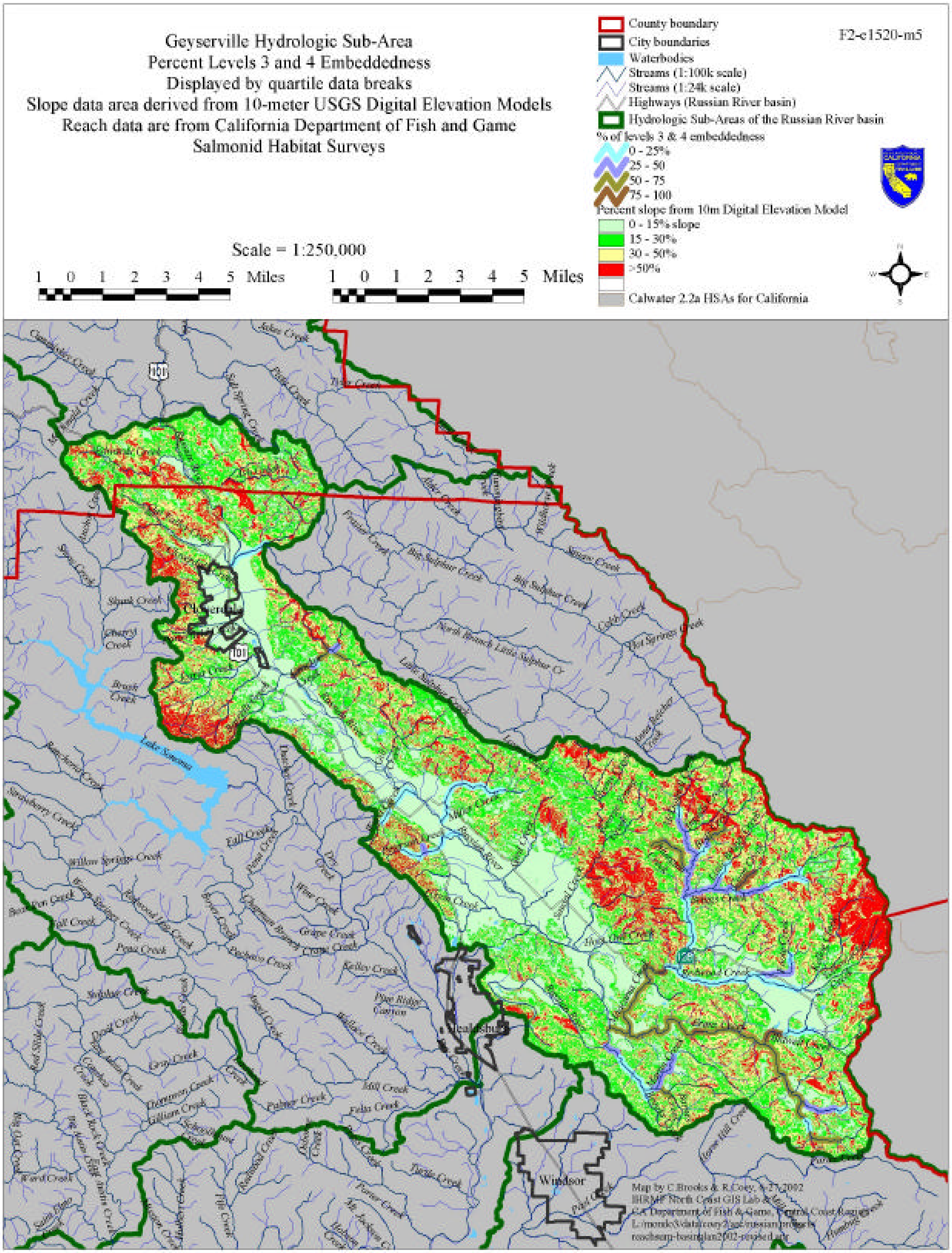
Geyserville Hydrologic Sub-Area
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Percent primary pools (> 2 ft deep) by reach
0 - 25% primary pools
25 - 50%
50 - 80%
80-100%
Reaches dry at survey time (no pools)
Calwater 2.2a HSAs for California
Scale = 1:250,000
1 0 1 2 3 4 5 Miles
1 0 1 2 3 4 5 Kilometers
N
W
E
S
Cloverdale
Healdsburg
Windsor
Lake Sonoma
101
Russian River
Big Sulphur Creek
Little Sulphur Creek
Sulphur Creek
Ash Creek
Edwards Creek
Oat Valley Creek
Cherry Creek
Brush Creek
Crocker Creek
Dutcher Creek
Miller Creek
Gill Creek
Peterson Creek
Redwood Creek
Briggs Creek
Little Briggs Creek
Franz Creek
Bidwell Creek
Maacama Creek
Kellogg Creek
Hot Springs Creek
Lyons Creek
Lytton Creek
Foote Creek
Pool Creek
Grape Creek
Wine Creek
Dry Creek
Pena Creek
Kelley Creek
Pine Ridge Canyon
Felta Creek
Mill Creek
Palmer Creek
Porter Creek
Mark West Creek
Map by C.Brooks & R.Coey, 5-27-2002
IHRMP North Coast GIS Lab &
CA Department of Fish & Game, Central Coast Region
reachsum-basinplan2002-revised.apr



Geyserville Hydrologic Sub-Area
Percent Levels 3 and 4 Embeddedness
Displayed by quartile data breaks
Slope data area derived from 10-meter USGS Digital Elevation Models
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C.Brooks & R.Coey, 5-27-2002
IHRMP North Coast GIS Lab &
CA Department of Fish & Game, Central Coast Region
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Sulphur Creek

Early California Department of Fish and Game files indicate that Big Sulphur Creek, the largest Creek in the Sulphur Creek sub-basin, has historically had limited salmonid suitability. This is primarily due to the high water temperatures in the stream, sometimes exceeding 80 degrees Fahrenheit, as a result of geothermal activity. Therefore, rearing conditions in Big Sulphur are very limited except between Squaw and Hotsprings Creeks. A large landslide in the middle reach periodically becomes a barrier. Conditions in this watershed are naturally geologically unstable. Land use in the upper watershed, including roads and livestock grazing, has contributed to the instability of the watershed and further limits salmonid presence.

Little Sulphur Creek, the largest tributary basin, on the contrary harbors some excellent steelhead habitat, although numerous natural partial barriers exist. Squaw Creek and its tributaries also harbor good steelhead habitat. A large landslide on Hummingbird Creek was a partial barrier for several years. Riparian zone loss from uncontrolled livestock grazing, non-point source sediment from roads, and geo-thermal development which modifies the natural temperature regime are the biggest factors limiting salmonid production in the watershed.

See Tributary Conditions (Table 23) below for limiting factors specific to the Sulphur Creek sub-basin. Figures 54-57 describe average canopy, percent primary pools, water temperatures and embededdness by reach for the sub-basin. See Appendix E for further summary of some key habitat variables by reach for each stream and sub-basin. Data was collected from habitat data during 1994-2002 following the methods of Flosi et al. (1998). Map GIS data was compiled by HREC-IHRMP under contract to DFG.

Name	Migration	Gravel Quality	Gravel Quantity		Riparian Stability	Water Temp.	Water Quality	Pool Shelter	Pool Number	Data Gaps	Comments
			Degraded	Aggraded							
Alder Creek	1										
Anna Belcher Creek	1	3				2		4			
Bear Canyon Creek											
Big Sulphur Creek	1					2		3	4		
Boggs Creek	1										
Cobb Creek	1										
Frasier Creek	1										
Hot Springs Creek	1										
Hummingbird Creek										1	Habitat data
Little Sulphur Creek	1	2									
Little Sulphur Creek, N Branch		2				1		3	4		
Lovers Gulch Creek	1	2						3	4		
Squaw Creek	1										
Wildhorse Creek	1									1	Habitat data

Table 23. Limiting factors specific to the Sulphur sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = limiting factor identified from existing historical information or data, but no priority exists at this time)

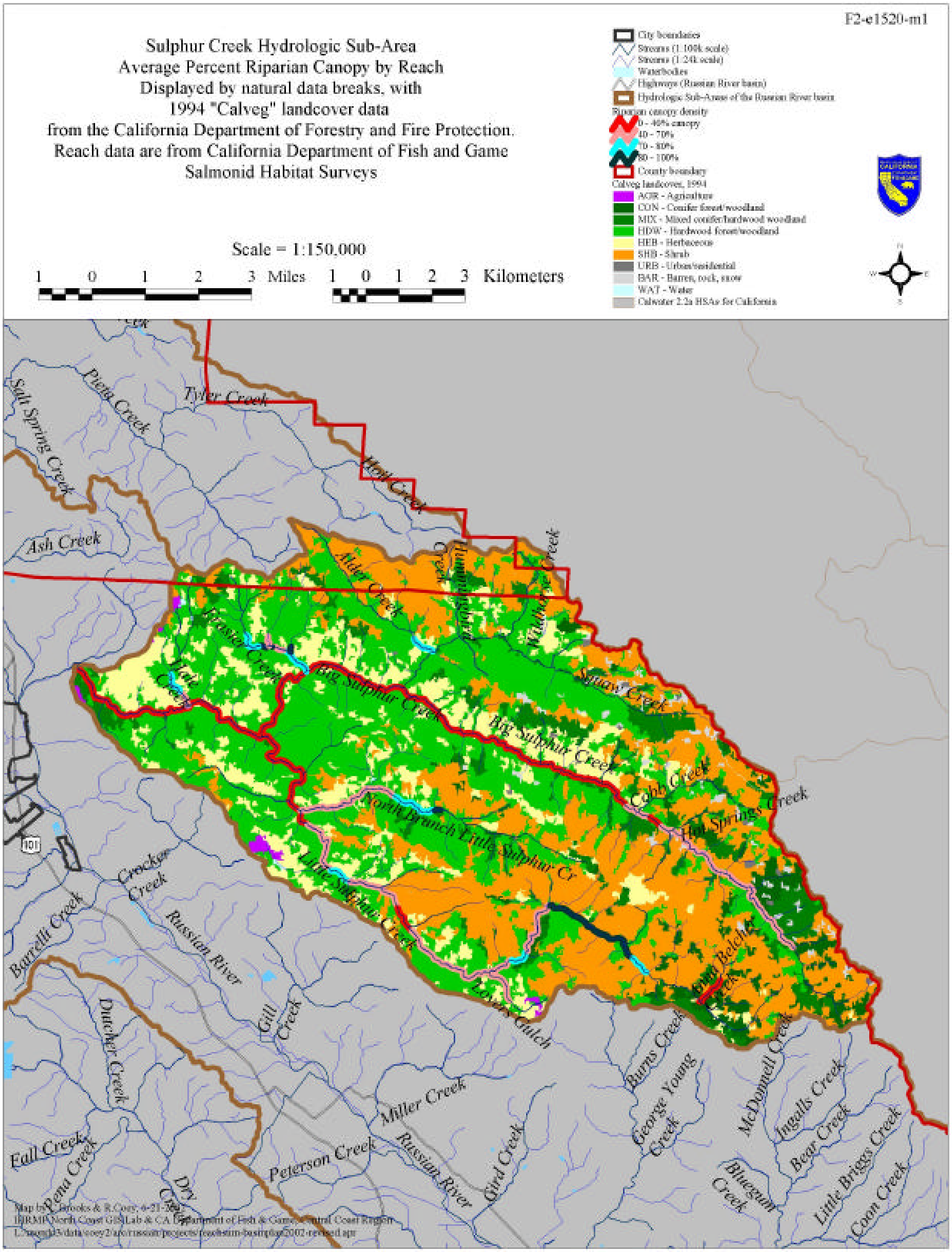
Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Landslide	Erosion	Shelter	Create Pools	Monitor	Comments
Alder Creek												
Anna Belcher Creek		1			2				3			
Bear Canyon												
Big Sulphur Creek	1	2	3				4				5	Passage
Boggs Creek												Natural Barrier
Cobb Creek												Natural barrier
Frasier Creek												Natural Barrier
Hot Springs Creek												Natural barrier
Hummingbird Creek												No access
Little Sulphur Creek		2	1		3				4	5	6	Passage
Lovers Gulch Creek		2	1		3				4	5		
N. Branch Little Sulphur Cr		1			2		3		4	5		
Squaw Creek		*	*		*		*					In progress
Wildhorse Creek	1	*	*		*	*	*					Passage/no access

Table 24. Prioritized habitat recommendations specific to the Sulphur Creek sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time)

RESTORATIVE ACTIONS RECOMMENDED

?? Alternatives to minimize livestock in the riparian corridor including exclusion fencing and off-stream water development should be explores in the Big Sulphur Creek watershed.
?? Landslide mapping and a sediment source survey of roads are priority concerns throughout. New roads should avoid steep slopes of this unstable region.
?? Natural barriers exist on Alder, Anna Belcher, Frasier, Lovers Gulch and Squaw and should not be modified as most contain resident populations of steelhead trout.
?? Barriers on Big Sulphur, Little Sulphur, Wildhorse and Hummingbird Creeks should be assessed by a fish passage specialist, and modified if necessary. Several of these partial barriers have been impacted by nearby road activities.
?? Riparian restoration is also needed, but is challenging in most of the watersheds where harsh summertime temperatures prevail. Riparian restoration would be most successful and should target the steep south and west facing tributaries, such as the squaw sub-watershed and the Little Sulphur and North Branch Creeks in the upper watershed areas.

See Tributary Recommendations (Table 24) above for prioritized recommendations specific to the Sulphur Creek sub-basin.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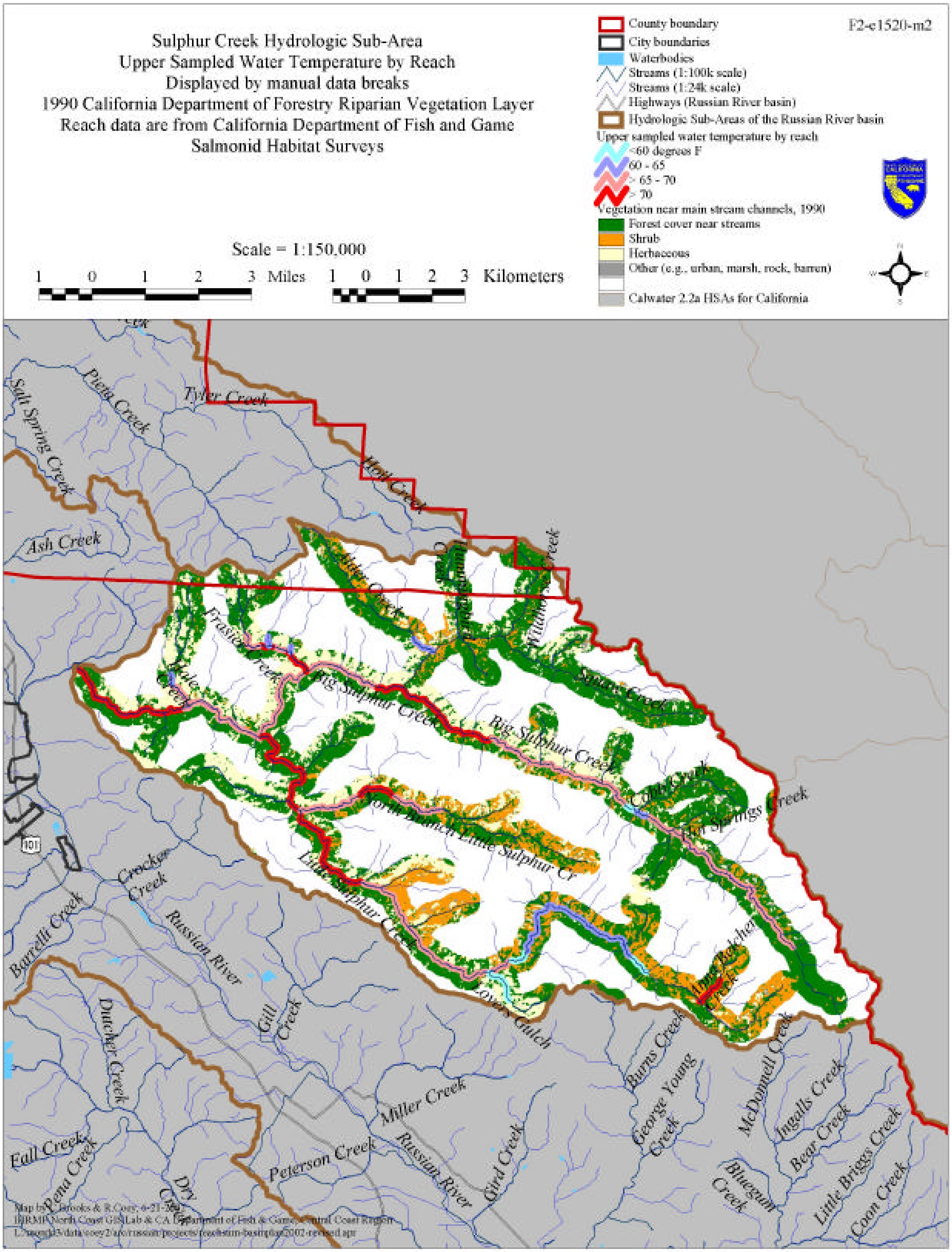
Sulphur Creek Hydrologic Sub-Area
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:150,000
1 0 1 2 3 Miles
1 0 1 2 3 Kilometers
City boundaries
Streams (1:100k scale)
Streams (1:24k scale)
Waterbodies
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Riparian canopy density
0 - 40% canopy
40 - 70%
70 - 80%
80 - 100%
County boundary
Calveg landcover, 1994
AGR - Agriculture
CON - Conifer forest/woodland
MIX - Mixed conifer/hardwood woodland
HDW - Hardwood forest/woodland
HEB - Herbaceous
SHB - Shrub
URB - Urban/residential
BAR - Barren, rock, snow
WAT - Water
Calwater 2.2a HSAs for California
N
W
E
S
Tyler Creek
Pieta Creek
Salt Spring Creek
Hoit Creek
Ash Creek
Alder Creek
Humming... Creek
Frasier Creek
Hale Creek
Big Sulphur Creek
Squaw Creek
Cobb Creek
Hot Springs Creek
North Branch Little Sulphur Cr
Little Sulphur Creek
Lovers Gulch
Crocker Creek
Russian River
Barrelli Creek
101
Ducker Creek
Gill Creek
Burns Creek
George Young Creek
McDonnell Creek
Ingalls Creek
Bear Creek
Little Briggs Creek
Coon Creek
Bluegum Creek
Gird Creek
Miller Creek
Peterson Creek
Fall Creek
Pena Creek
Dry Creek
Map by C. Brooks & R.Coey, 6-21-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region



Sulphur Creek Hydrologic Sub-Area
Upper Sampled Water Temperature by Reach
Displayed by manual data breaks
1990 California Department of Forestry Riparian Vegetation Layer
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C. Brooks & R.Cory, 6-21-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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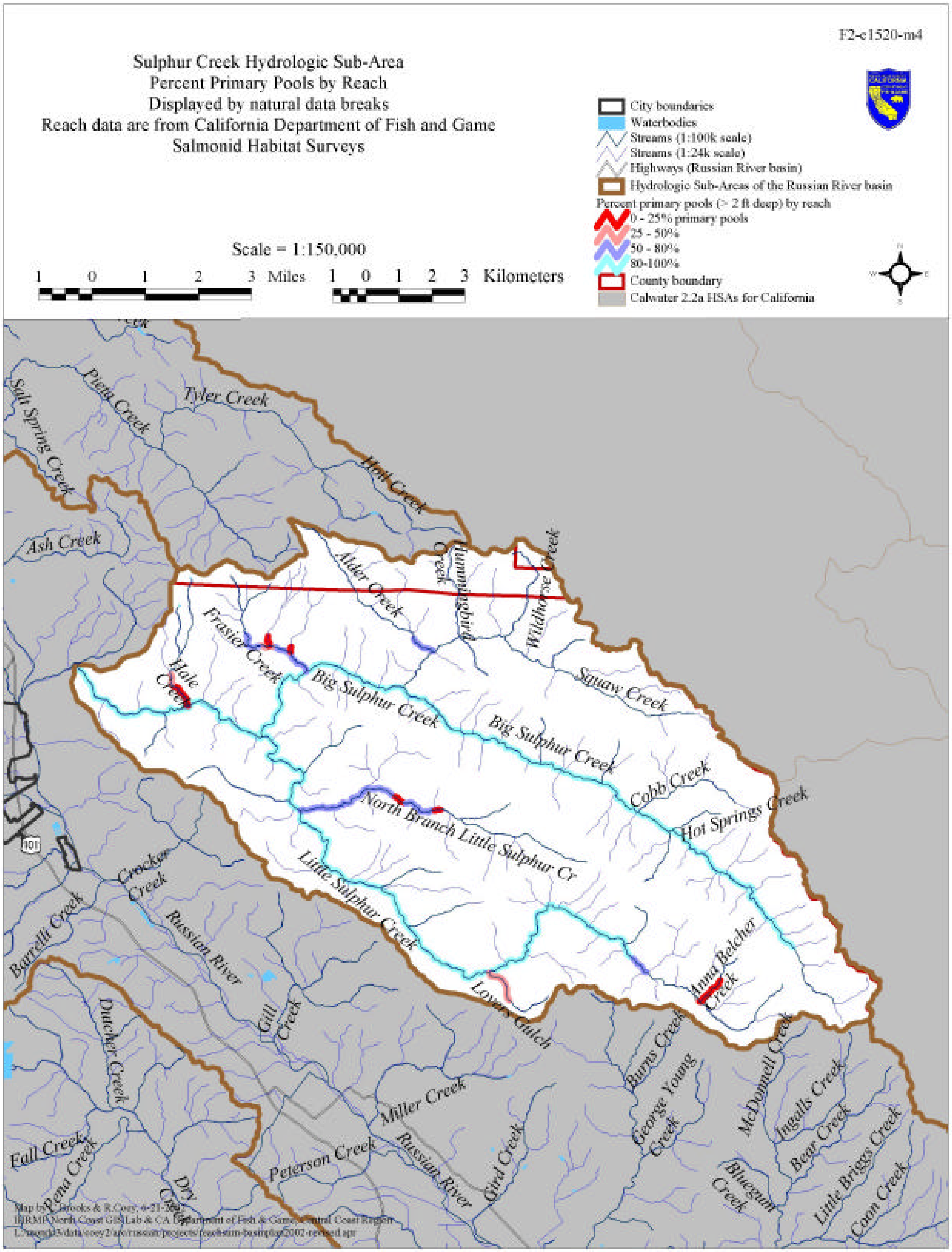
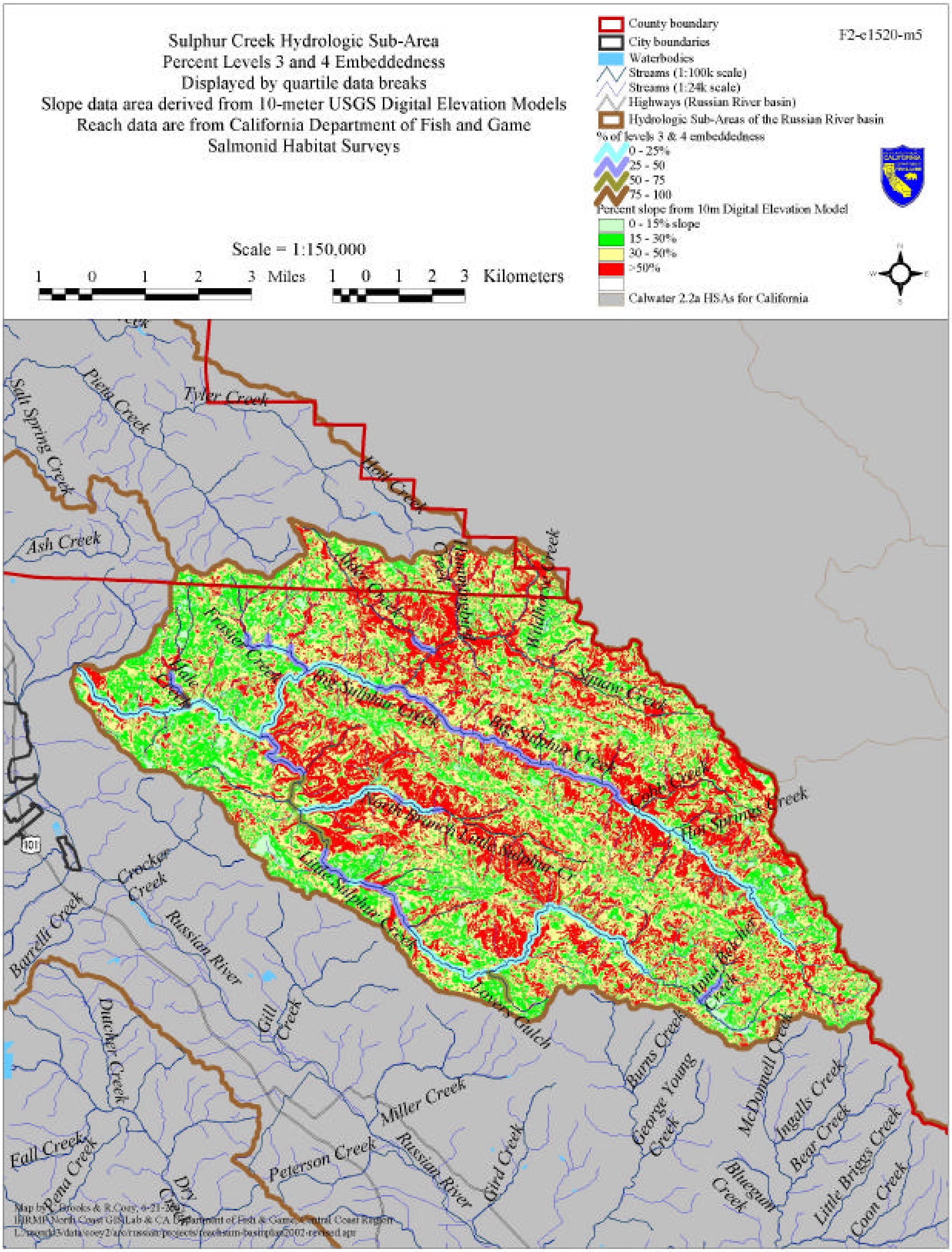


Sulphur Creek Hydrologic Sub-Area
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys



Sulphur Creek Hydrologic Sub-Area
Percent Levels 3 and 4 Embeddedness
Displayed by quartile data breaks
Slope data area derived from 10-meter USGS Digital Elevation Models
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

F2-e1520-m5

Map by C. Brooks & R.Coey, 6-21-2002
IHRMP, North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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Ukiah

Habitat conditions in the Ukiah sub-basin are highly variable for salmonids. Generally, the smaller tributaries and headwater portions of larger tributaries serve as the primary rearing and spawning areas of anadromous fish, while the larger tributaries serve as migration corridors and spawning areas for steelhead and occasionally chinook. Many direct tributaries currently go sub-surface in summer in the alluvial plains. Whether this is a natural occurrence or recent phenomena, as a result of human development, is unknown. Many of the direct tributaries have been channelized in the lower areas resulting in aggradation, loss of riparian, and dewatering (such as Dooley, McNab, Robinson, and Ackerman Creeks). Within the town of Ukiah most tributaries have been culverted, boxed, and/or paved over, with the adjoining floodplain removed or developed (such as Orrs, Gibson, and Doolin). Where development has occurred in headwater areas, these flood control channels have aggraded, resulting in frequent flooding and channel adjustment (such as Mill and Feliz Creeks). Together, these activities and channel conditions have contributed to migration and emigration issues in the Ukiah sub-basin in many tributaries. Upstream on each individual tributary, conditions almost universally improve, although embeddedness and temperature are still of concern throughout.

See Tributary Conditions (Table 25) below for limiting factors specific to the Ukiah sub-basin. Figures 59-62 describe average canopy, percent primary pools, water temperatures and embededdness by reach for the sub-basin. See Appendix E for further summary of some key habitat variables by reach for each stream and sub-basin. Data was collected from habitat data during 1994-2002 following the methods of Flosi et al. (1998). Map GIS data was compiled by HREC-IHRMP under contract to DFG.

Name	Migration	Gravel Quality	Gravel Quantity Degraded	Aggraded	Riparian Stability	Water Temp.	Water Quality	Pool Shelter	Pool Number	Data Gaps	Comments
Ackerman Creek		4		3	1	2		5	6		
Alder Creek		3			1	2		4			
Coleman Creek										1	Habitat data
Cummiskey Creek		*				*				1	Habitat data
Dooley Creek				1	2	3		5	4		
Doolin Creek	*				*			*	*		In progress
Duncan Creek											In progress
Feliz Creek	‘*			‘*	‘*	‘*		‘*		1	Habitat data
Gibson Creek	*				*	*		*	*	1	Habitat data
Hensely Creek	*				*	*		*	*	1	Habitat data
Hoil Creek										1	Habitat data
Howard Creek											Habitat data
Howell Creek		2				1		3	4		
Jakes Creek										1	Habitat data
Johnson Creek											
McClure Creek	*			‘*	‘*						In progress
McDonald Creek										1	Habitat data
McDowell Creek	2			1	3	4		6	5		
McNab Creek		3	1		2			4	5		
Mill Creek	*			*	*				*		In progress
Mohr/Mercer Creek		2				1		3	4		
Morrison Creek		*				*					In progress
North Fork Feliz Creek										1	Habitat data
North Fork Mill Creek											
Orrs Creek	5	2			3	1		4			
Parsons Creek		1			2	3		4			
Pieta Creek										1	Habitat data
Robinson Creek	5	2				1		3	4		
S. Branch Robinson Creek	1		‘*		‘*	‘*		‘*	‘*		In progress
Salt Springs Creek										1	Habitat data
Sheldon Creek										1	Habitat data
Sulphur Creek										1	Habitat data
Tyler Creek										1	Habitat data
Vasser Creek										1	Habitat data
Willow Creek										1	In progress
York Creek										1	In progress
Young Creek										1	Habitat data

Table 25. Limiting factors specific to the Ukiah sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc.

* = limiting factor identified from existing historical information or data, but no priority exists at this time)

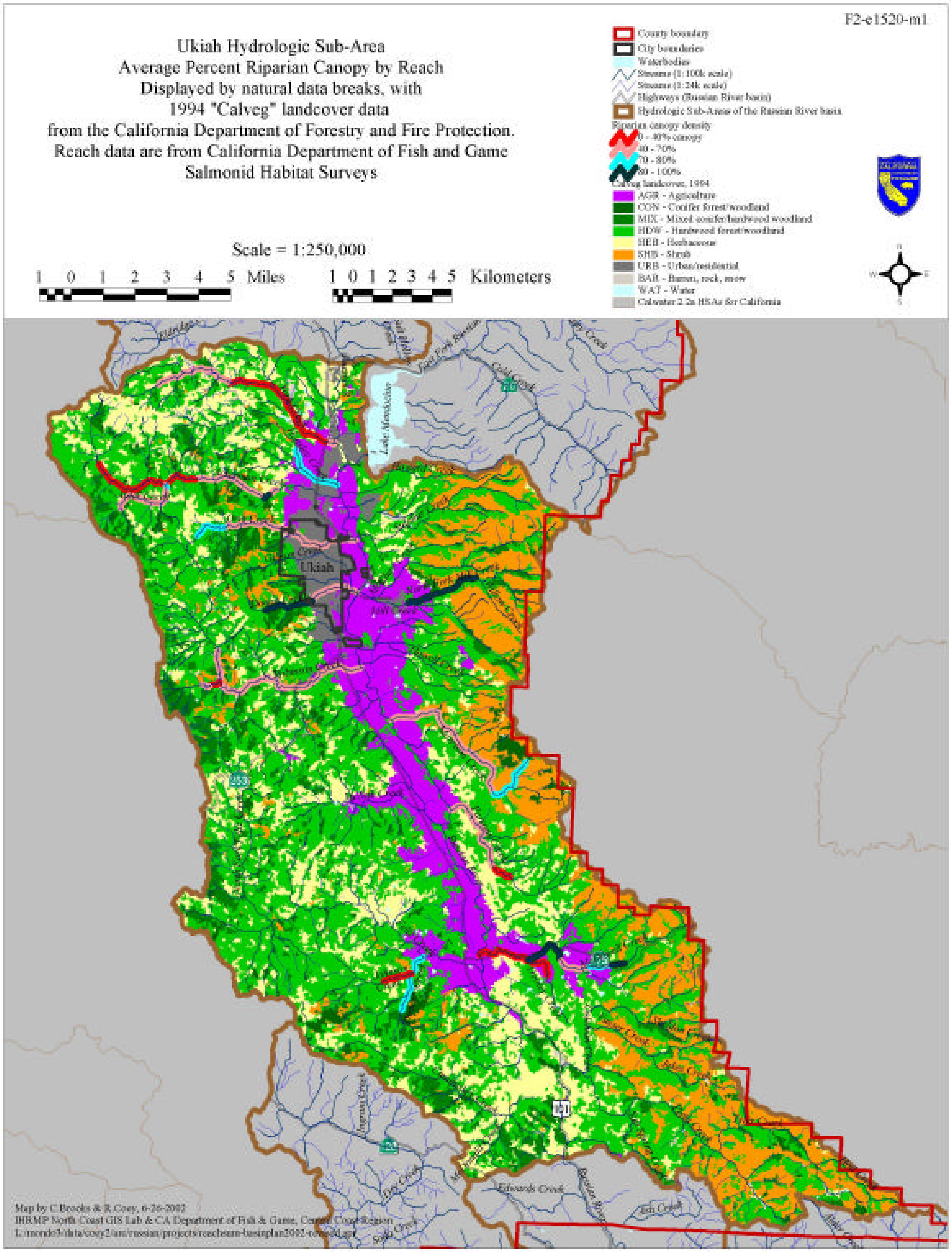
RESTORATIVE ACTIONS RECOMMENDED

- Improve passage at Willow Water District and Mumford Dams.
- Riparian restoration, riparian setbacks, conservation easements to improve protect riparian and restore floodplain processes are the priority needs to improve migration in many sub-basin tributaries.
- In some cases fishladders and resting cover is needed (City of Ukiah tributaries).
- The City of Ukiah’s redevelopment and corridor recommendations should be supported and implemented.
- Outreach with private landowners to complete habitat assessment to establish priorities in this sub-basin is a high priority.
- Instream habitat improvements as well as upslope mapping and restoration are needed in virtually every stream.
- No recent DFG surveys have been done on Pieta Creek, though a 1974 survey reported that juvenile steelhead were abundant in Pieta Creek, extending upstream to the headwaters. Habitat surveys are planned for 2002.

See Tributary Recommendations (Table 26) below for prioritized recommendations specific to the Ukiah sub-basin.

Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Landslide	Erosion	Shelter	Create Pools	Monitor	Comments
Ackerman Creek		2	1			3		4	5	6		
Alder Creek		2	1		3			4	5			
Coleman Creek												Survey 2002
Cummiskey Creek		‘*	‘*		‘*		‘*	‘*				survey 2002
Dooley Creek		3				1		2	5	4		
Doolin Creek	‘*	‘*				‘*		‘*	‘*	‘*		In progress
Duncan Creek												In progress
Feliz Creek	‘*	‘*	‘*		‘*			‘*	‘*			survey 2002
Gibson Creek	‘*	‘*				‘*		‘*	‘*	‘*		Survey 2002
Hensley Creek	‘*	‘*				‘*		‘*	‘*	‘*		Survey 2002
Hoil Creek												Survey 2002
Howard Creek												Survey 2003
Howell Creek		1						2	3			
Jakes Creek												Survey 2002
Johnson Creek												survey 2002
McClure Creek												In progress
McDonald Creek												Survey 2003
McDowell Creek	2	3		5				1	4	6		
McNab Creek		3			1	2		4	5	6		
Mill Creek												In progress
Mohr/Mercer Creek		1						2	3	4		
Morrison Creek		‘*	‘*		‘*							In progress
N. Fork Feliz Creek												Survey 2002
N. Fork Mill Creek												
Orrs Creek		1			4		2		3			Spawning gravels
Parsons Creek		3	2			1		4	5			
Pieta Creek		‘*	‘*		‘*		‘*					Survey 2002
Robinson Creek		1			2			3	4	5	6	Landowner outreach and survey upper
S. Branch Robinson Creek		‘*						‘*		‘*		In progress
Salt Spring Creek												Survey 2002
Sheldon Creek												Survey 2002
Sulphur Creek												Survey 2002
Tyler Creek												Survey 2002
Vasser Creek												Survey 2002
Willow Creek												In progress
York Creek												In progress
Young Creek												survey 2002

Table 26. Prioritized habitat recommendations specific to the Ukiah sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = need has been identified from existing historical information or data, but no priority exists at this time)


F2-e1520-m1
Ukiah Hydrologic Sub-Area
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:250,000
1 0 1 2 3 4 5 Miles
1 0 1 2 3 4 5 Kilometers
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Riparian canopy density
0 - 40% canopy
40 - 70%
70 - 80%
80 - 100%
Calveg landcover, 1994
AGR - Agriculture
CON - Conifer forest/woodland
MIX - Mixed conifer/hardwood woodland
HDW - Hardwood forest/woodland
HEB - Herbaceous
SHB - Shrub
URB - Urban/residential
BAR - Barren, rock, snow
WAT - Water
Calwater 2.2a HSAs for California
N
W
E
S
Ukiah
Lake Mendocino
Cold Creek
Mill Creek
Robinson Creek
Edwards Creek
Dry Creek
Map by C.Brooks & R.Coey, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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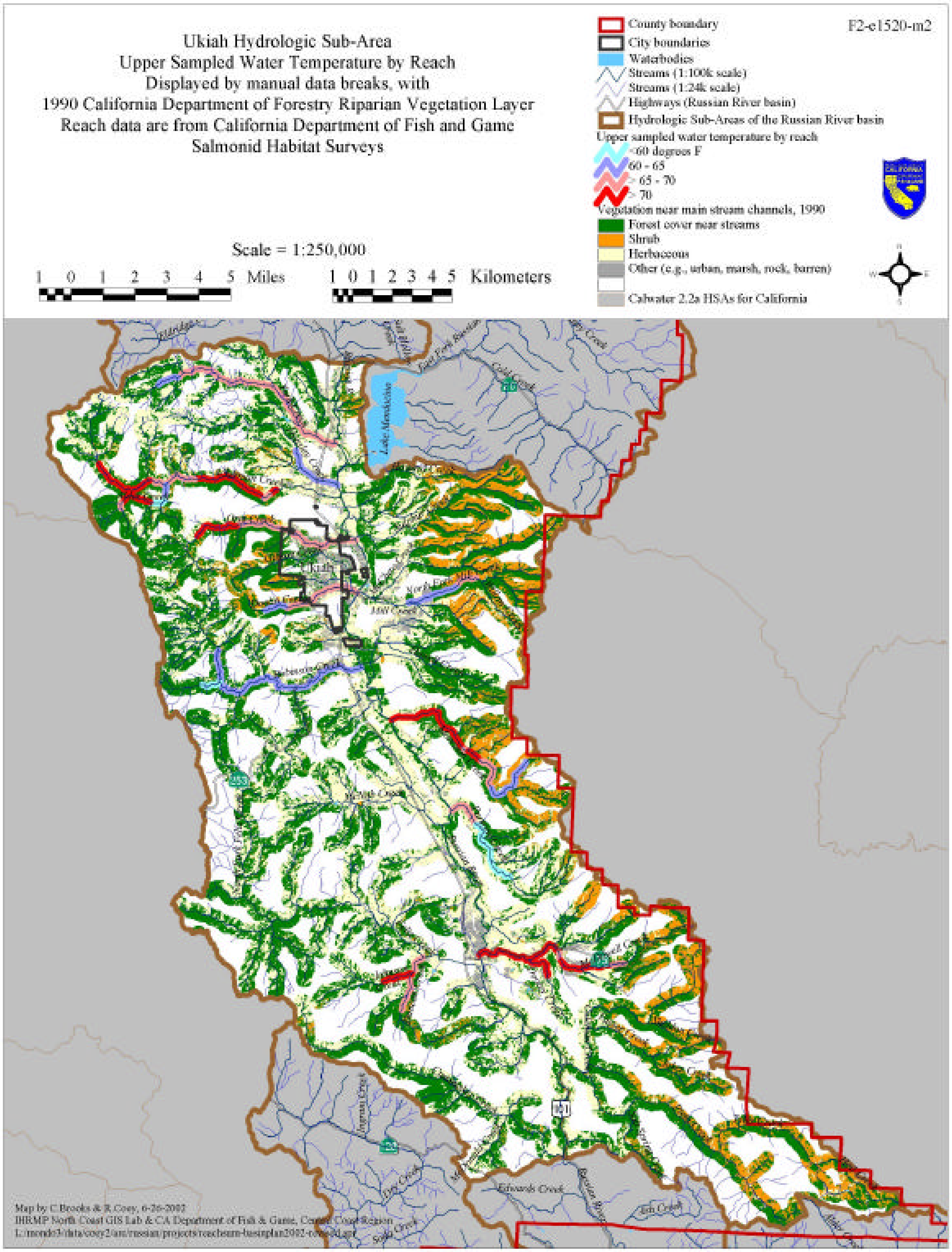
Ukiah Hydrologic Sub-Area
Upper Sampled Water Temperature by Reach
Displayed by manual data breaks, with
1990 California Department of Forestry Riparian Vegetation Layer
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:250,000
1 0 1 2 3 4 5 Miles
1 0 1 2 3 4 5 Kilometers
F2-e1520-m2
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
Upper sampled water temperature by reach
<60 degrees F
60 - 65
> 65 - 70
> 70
Vegetation near main stream channels, 1990
Forest cover near streams
Shrub
Herbaceous
Other (e.g., urban, marsh, rock, barren)
Calwater 2.2a HSAs for California
N
W
E
S
Lake Mendocino
Ukiah
Mill Creek
Edwards Creek
Map by C.Brooks & R.Coey, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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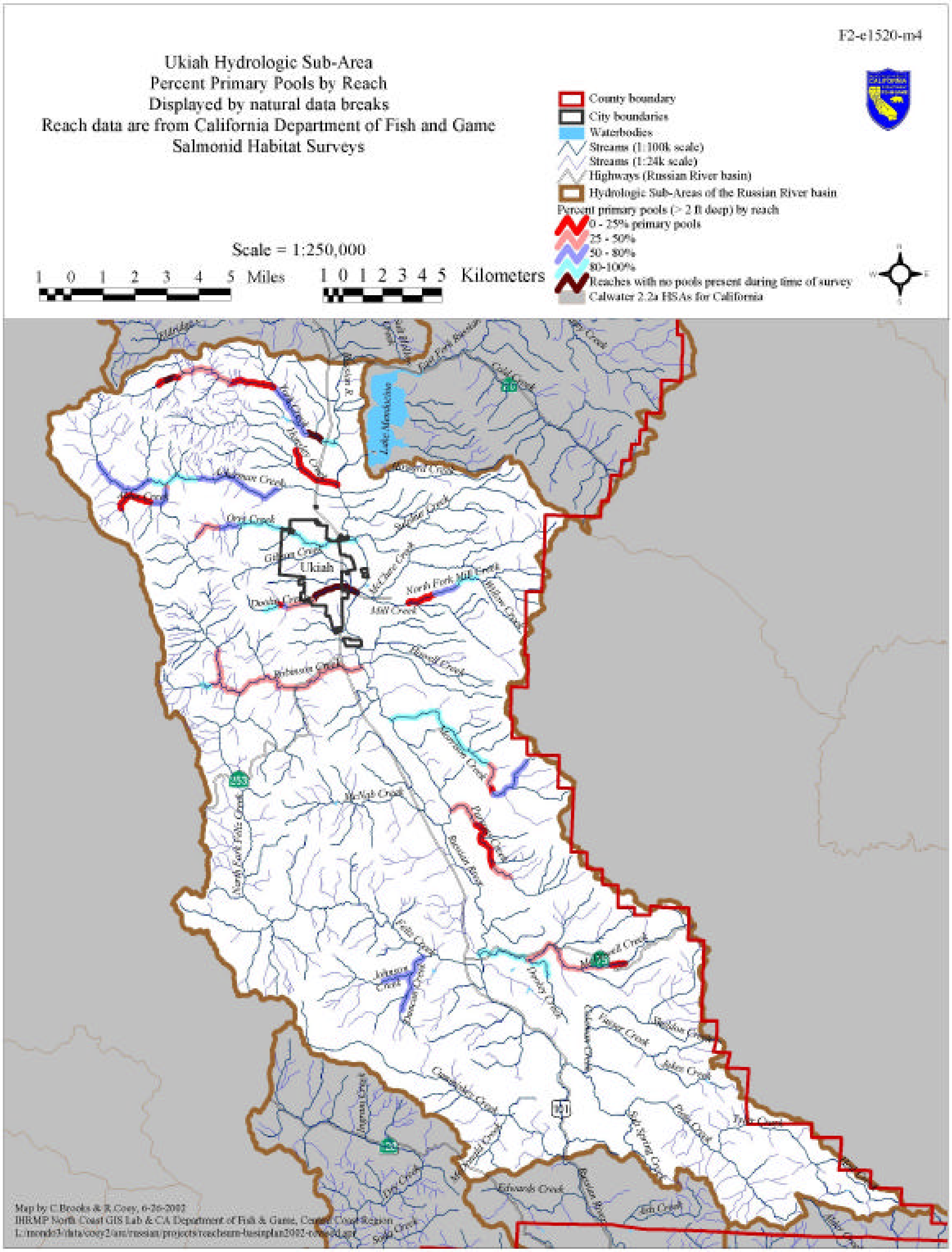

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Ukiah Hydrologic Sub-Area
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Scale = 1:250,000

Map by C.Brooks & R.Coey, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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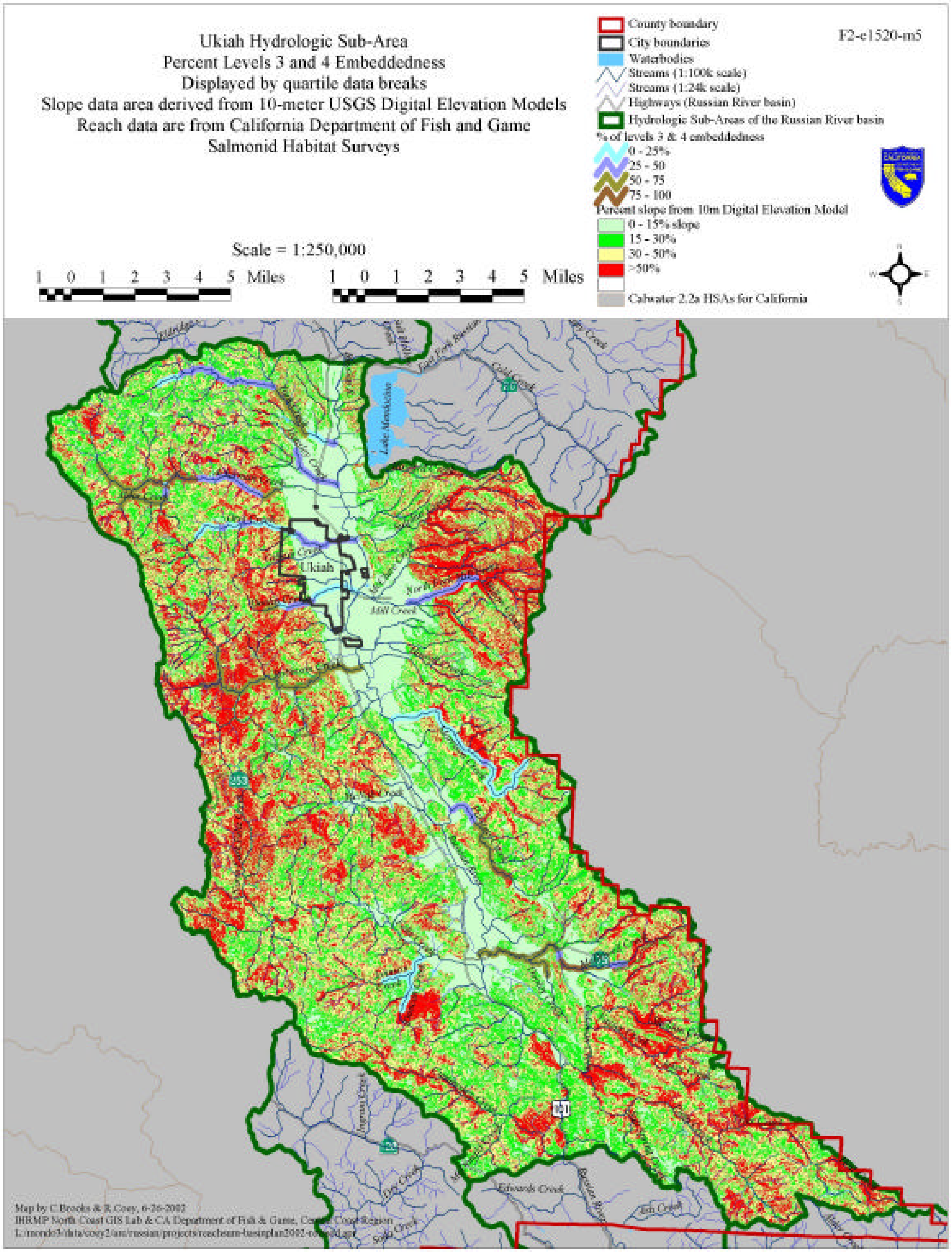

Ukiah Hydrologic Sub-Area
Percent Levels 3 and 4 Embeddedness
Displayed by quartile data breaks
Slope data area derived from 10-meter USGS Digital Elevation Models
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:250,000
1 0 1 2 3 4 5 Miles
1 0 1 2 3 4 5 Miles
F2-e1520-m5
County boundary
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
% of levels 3 & 4 embeddedness
0 - 25%
25 - 50
50 - 75
75 - 100
Percent slope from 10m Digital Elevation Model
0 - 15% slope
15 - 30%
30 - 50%
>50%
Calwater 2.2a HSAs for California
N
W
E
S
Lake Mendocino
Ukiah
Mill Creek
Cold Creek
Edwards Creek
Dry Creek
253
101
Map by C Brooks & R Coey, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region

Forsythe Creek

Several tributaries to the West Fork historically harbored coho salmon, but are mainly habitat for steelhead, although several of these now have on-stream reservoirs. Mumford Dam (a flash-board irrigation structure) currently limits migration to all but the highest flows due to channel down cutting at its base. Stocking of surplus adults above Mumford Dam from Warm Springs Hatchery has occurred above the dam since the mid 90's by the Cloverdale Casters and the Ukiah Rod and Gun club until 2000. NMFS and DFG currently limit population enhancement above Mumford Dam to wild fish arriving at CVFF. DFG and SCWA have funded a project to install jump pools and stabilization structures below Mumford Dam to facilitate fish passage and offset down cutting. This should be completed by 2003 at which time supplementation will be discontinued as wild runs will have access to an additional 14 miles of habitat.

No DFG habitat surveys have been conducted yet in the West Fork system. According to a 1966 DFG survey, the West Fork and most of its tributaries are limited in their utilization as nursery streams due to lack of flow in some sections during the summer.

Forsythe Creek has a natural rock falls located approximately 7.5 miles above the confluence with the Russian River which is a partial barrier to adult migration. Conditions within Forsythe Creek proper are poor to fair for salmonids in the lower and middle areas. Excess gravel mining, channel adjustments to the Coyote Dam, and floodplain impacts have exacerbated the unstable conditions of the soils and down cutting, which are prevalent. Over- steepening of banks has resulted in loss of riparian in most areas where little riparian exists anyway from adjacent land use. Current erosion control projects and future plans utilizing bio-engineering should improve habitat conditions in the tributaries where cool water and riparian exists. Sediment from roads is high. Portions of Eldridge and Jack Smith Creeks are excellent for salmonids.

A large on-stream reservoir exists on Walker Creek, and warm water surface release flows limit salmonid production. Other on-stream reservoirs exist on Mariposa and Salt Hollow Creeks. Channel down-cutting and riparian de-stabilization as a result of gravel mining in the mainstem Russian and on-stream reservoirs on tributaries is the main cause of habitat degradation in lower reaches of direct tributaries.

See Tributary Conditions (Table 27) below for limiting factors specific to the Forsythe sub-basin. Figures 63-66 describe average canopy, percent primary pools, water temperatures and embededdness by reach for the sub-basin. See Appendix E for further summary of some key habitat variables by reach for each stream and sub-basin. Data was collected from habitat data during 1994-2002 following the methods of Flosi et al. (1998). Map GIS data was compiled by HREC-IHRMP under contract to DFG.

Name	Migration	Gravel Quality	Gravel Quantity Degraded	Gravel Quantity Aggraded	Riparian Stability	Water Temp.	Water Quality	Pool Shelter	Pool Number	Data Gaps	Comments
Bakers Creek				2	1			4	3		
Corral Creek										1	Dry
Eldridge Creek		1				2		3	4		
Fisher Creek										1	Dry
Forsythe Creek	1	3	1		2	4		5	6	7	Passage/water quality
Jack Smith Creek		1			2	5		3	4		
Mariposa Creek	1									2	In progress
Mill Creek		2			3	1		4	5		
Rocky Creek										1	In progress
Salt Hollow Creek	1									1	
Seward Creek		2				1		3	4		
Walker Creek		2			3	1					
West Fork Russian River	1		2		3	4					

Table 27. Limiting factors specific to the Forsythe Creek sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc. * = limiting factor identified from existing historical information or data, but no priority exists at this time)

Stream Name	Barriers	Canopy	Fence	Gravel	Map Roads	Fix Roads	Landslide	Erosion	Shelter	Create Pools	Monitor	Comments
Bakers Creek							1		3	2		
Corral Creek												
Eldridge Creek		2				1			3	4		
Fisher Creek												
Forsythe Creek	1	5	2		4			3	6	7	8	Passage/water quality
Jack Smith	5				1			2	3	4		
Mariposa Creek	1											In progress
Mill Creek		1			3			2	4	5		
Rocky Creek												In progress
Salt Hollow Creek	1											
Seward Creek		1	2					3	4	5		
Walker Creek		3			4			2			1	Flows, Temp, veg
West Fork Russian River	1	4		3				2				

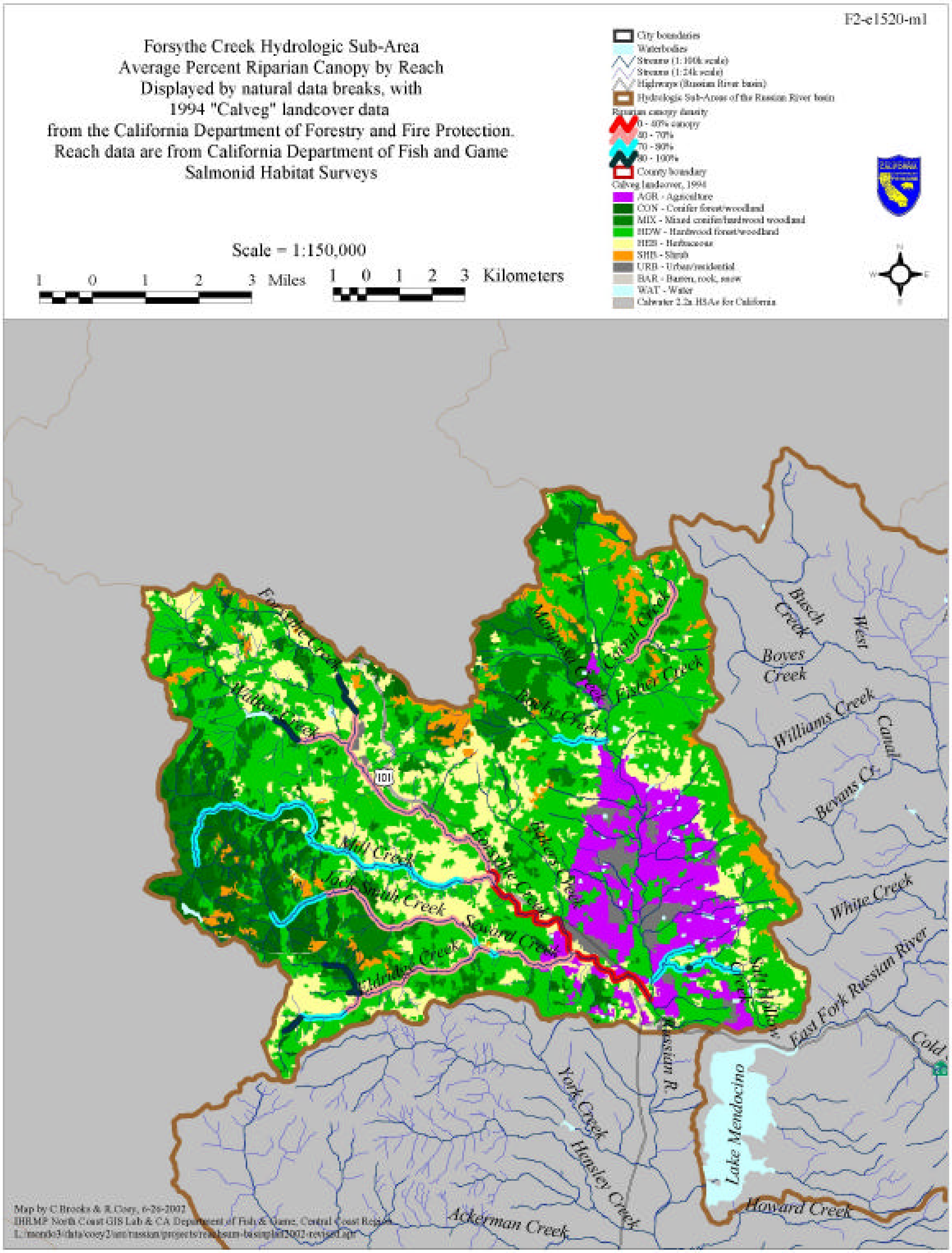
Table 28. Prioritized habitat recommendations specific to the Forsythe sub-basin (1 = Highest priority, 2 = 2nd highest priority, etc.

* = need has been identified from existing historical information or data, but no priority exists at this time)

RESTORATIVE ACTIONS RECOMMENDED

- Continue bio-engineering projects in the Forsythe Creek with adjacent landowners. Monitor cattle exclusion fencing.
- Initiate road assessment and landslide mapping in the Forsythe watershed.
- Implement recommendations of the Eldridge Creek Road Survey completed in 2000.
- Monitor passage and improvements at the barrier.
- Passage improvements are being considered on Mariposa Creek. Alternate passage should be explored and supported.
- Methods to release cooler flows out of Walker Dam should be explored.
- Surveys in the West Fork sub-watershed are needed before priorities are developed. Complete by 2003.
- Coho streams in this sub-basin require further habitat restoration to re-establish natural coho populations before supplementation with the Captive Broodstock Program would be considered.

See Tributary Recommendations (Table 28) above for prioritized recommendations specific to the Forsythe Creek sub-basin.



Forsythe Creek Hydrologic Sub-Area
Average Percent Riparian Canopy by Reach
Displayed by natural data breaks, with
1994 "Calveg" landcover data
from the California Department of Forestry and Fire Protection.
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C.Brooks & R.Coey, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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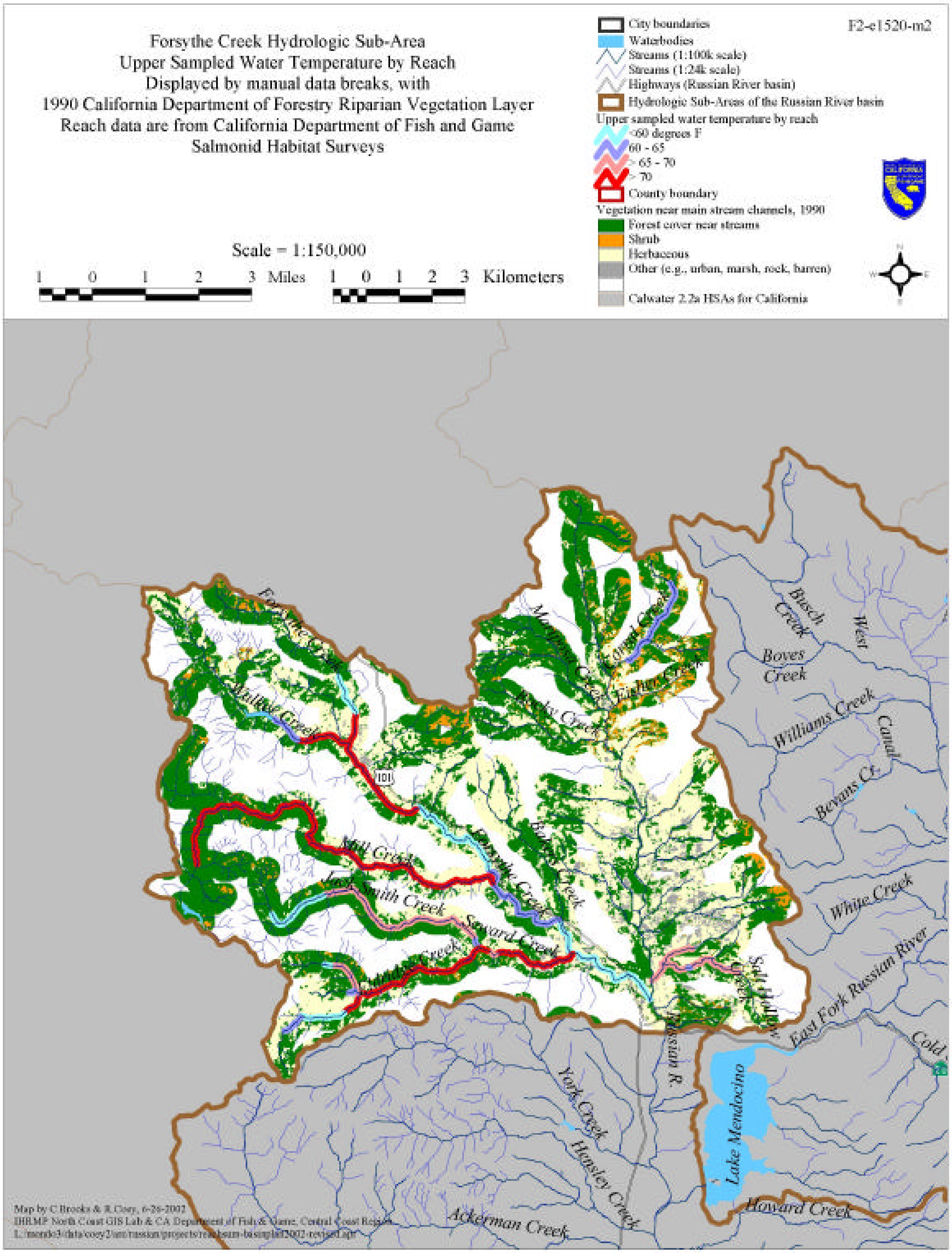

Forsythe Creek Hydrologic Sub-Area
Upper Sampled Water Temperature by Reach
Displayed by manual data breaks, with
1990 California Department of Forestry Riparian Vegetation Layer
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

Map by C Brooks & R Cory, 6-26-2002
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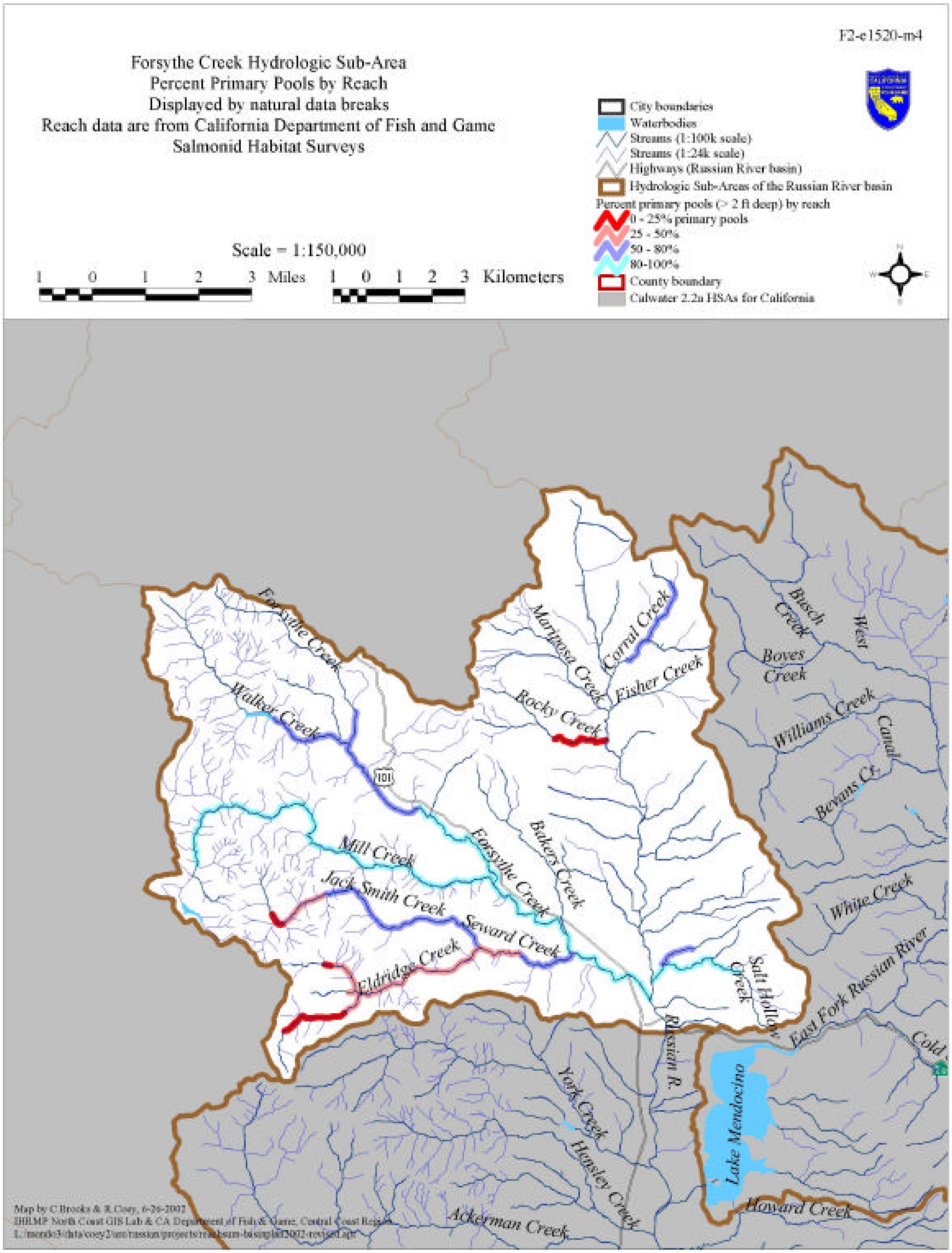

Forsythe Creek Hydrologic Sub-Area
Percent Primary Pools by Reach
Displayed by natural data breaks
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys

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Map by C Brooks & R Cosy, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region
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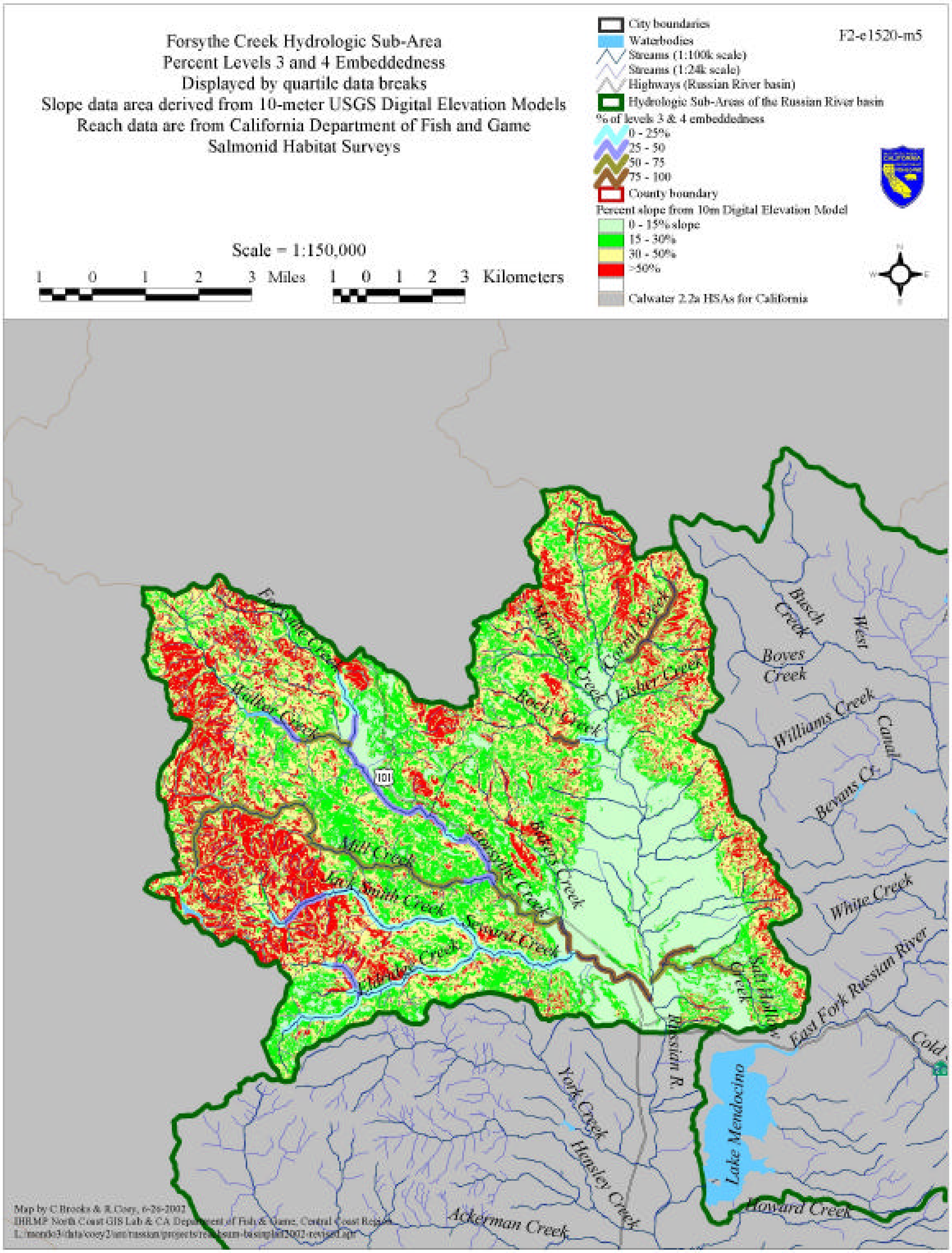
Forsythe Creek Hydrologic Sub-Area
Percent Levels 3 and 4 Embeddedness
Displayed by quartile data breaks
Slope data area derived from 10-meter USGS Digital Elevation Models
Reach data are from California Department of Fish and Game
Salmonid Habitat Surveys
Scale = 1:150,000
1 0 1 2 3 Miles
1 0 1 2 3 Kilometers
City boundaries
Waterbodies
Streams (1:100k scale)
Streams (1:24k scale)
Highways (Russian River basin)
Hydrologic Sub-Areas of the Russian River basin
% of levels 3 & 4 embeddedness
0 - 25%
25 - 50
50 - 75
75 - 100
County boundary
Percent slope from 10m Digital Elevation Model
0 - 15% slope
15 - 30%
30 - 50%
>50%
Calwater 2.2a HSAs for California
F2-e1520-m5
N
W
E
S
Forsythe Creek
Walker Creek
101
Mill Creek
Jack Smith Creek
Seward Creek
Eldridge Creek
Mariposa Creek
Corral Creek
Fisher Creek
Rocky Creek
Bakers Creek
Salt Hollow Creek
Russian R.
York Creek
Hensley Creek
Ackerman Creek
Howard Creek
Lake Mendocino
Busch Creek
West
Boyes Creek
Williams Creek
Canal
Bevans Cr.
White Creek
East Fork Russian River
Cold
Map by C Brooks & R Cosy, 6-26-2002
IHRMP North Coast GIS Lab & CA Department of Fish & Game, Central Coast Region

Coyote Valley

In order to mitigate for the loss of steelhead spawning habitat above the dam, the Army Corps of Engineers constructed the Coyote Valley Steelhead Facility at the base of the dam in 1992. USACE expanded the Warm Springs Hatchery to raise an additional 40,000 pounds of yearling steelhead to be imprinted at the Coyote Valley Facility and released in the East Fork of the Russian River. Numerous tributaries (154 miles est.) have been eliminated from coho, chinook, and steelhead usage as a result of the dam. Resident steelhead still utilize these historic anadromous streams. Conditions here range from poor to excellent.Habitat surveys have not been conducted by DFG on the streams within the Coyote Valley sub-basin in recent years and the few historic surveys have been limited to brief biological surveys.

Watershed size, channel incision, and over-steepened banks plague riparian stability in the remaining East Fork. A May 1983 DFG survey on the East Fork, conducted to determine existing fish species, found juvenile steelhead present in relatively low numbers. Even lower numbers of predatory fish species were present indicating the cold water habitat conditions limit their production. However, similar to Dry Creek, flows out of the dam are likely too high to develop rearing habitat predicted where the dam and flow regime was established.

RESTORATIVE ACTIONS RECOMMENDED

?? Fund feasibility engineering study of Park Steiner's Lake Mendocino Bypass Proposal.

?? Conduct outreach with the community and landowners of Potter Valley to develop a “safe harbor agreement” from the ESA to enable constriction of the bypass and cooperation of landowners in restoration of native steelhead and chinook habitat.

OTHER RECOMMENDED ACTIONS TO BENEFIT SALMON AND STEELHEAD

ROLE OF LOCAL GOVERNMENT

Projects and issues related to County Land Use Policies and Management Practices

Implement recommendations of Fishnet 4C Program report “Effects of County Land Use Policies and Management Practices on Anadromous Salmonids and Their Habitats” (Harris et al. 2001). Specifically:

1) Critical Fish Streams:

Develop county strategies for “prioritizing fishery protection and restoration actions within individual watersheds throughout the counties”. Close coordination between the different county departments, and with DFG, NMFS and the Russian River Watershed Council would be required

2) Coastal Zone Protections- "Extend coastal zone protection policies to non-coastal areas of the counties to include wetland and riparian protection, sensitive habitat protection and grading and erosion control".

3) Riparian buffers: "Establish riparian protection areas to protect stream function, wherein new development is prohibited". These areas should be defined based on geomorphic conditions, not vegetation or arbitrary distances, and should preclude roads, urban landscaping and any other type of development conditions from the zone. The meander belt width setback approach proposed by the "Fish Friendly Farming Program" would be the preferred method.

4) Bank stabilization: Promote "alternatives to conventional bank stabilization for public and private projects" (such as bio-engineering techniques, conservation easements for riparain buffers, and setback levees) and require evaluation of alternatives, and cumulative effects of new and existing bank hardening projects through the County permit process.

5) Grading and Erosion Control: "Develop grading and erosion control standards supported by ordinances to minimize sediment impacts to streams", which also minimizes winter grading. Compliance and enforcement programs would to be increased or developed.

6) Instream flows: Develop county programs to protect and increase instream flows for anadromous fish, working with water districts on conservation issues and conduct regional water management planning. Counties should also condition development which would divert or store surface water on the applicants having received appropriative rights from the SWRCB.

7) Watershed coordination: Counties should support and be active with multi-stakeholder groups (such as the Russian River Watershed Council) in working on watershed issues and landuse plan changes. Counties should identify, develop, fund or find funding to participate in these collaborative processes which assist community disclosure and support for county projects.

8) Resource/Development interactions: "Develop a program or policies for identifying especially unsuitable existing development, infrastructure and road segments affecting anadromous fish streams". The cities of Santa Rosa, Ukiah, Berkeley and Richmond could serve as models for developing solutions, alternatives and re-development plans and funding.

9) "Develop and adopt written standards for county road maintenance practices, under routine and emergency conditions. These standards should include guidelines for road maintenance and new construction that minimize sedimentation and runoff impacts and address storage and disposal of spoils, stream crossings, culvert diversion potential, fish passage and landslide and slope repair". The Five County Road Manual, ODOT Manual, California Stream Habitat Restoration Manual, and NFMS/DFG criteria for stream crossings should serve as reference documents for standard development and training.

10)Emergency Projects: Review and modify policy on how “storm-damage related road, culvert, and bank” work are treated under emergency conditions relative to effects on anadromous streams, and work with FEMA to alter existing conditions. Reduce dependency of maintenance or capitol improvement budgets on FEMA funding and instead create reserve budgets annually to treat emergencies correctly.

11) Spoil storage: “Establish adequate spoils storage sites throughout the counties” so that these do not become chronic sources of surface or fluvial erosion.

12) Channel and Riparian Corridor Clearing: Reduce native vegetation clearing, large woody debris and sediment removal adjacent to and in anadromous fish streams.

13) Adopt remaining recommendations of the Fishnet 4C Program Report, work with community, stakeholder groups, and state and federal agencies to ensure timeliness of implementation and technical support for permitting and funding.

Projects related to County Planning:

1) Assist Sonoma County Planning Dept. with GIS mapping of land ownership, roads, and culverts
2) GIS coverage of private roads and culverts
3) Fund "Urban stream coordinator" positions to work with the communities and cities to complete and implement Urban Creek Restoration Plans-model work after City of Santa Rosa and City of Ukiah Efforts
4) Identify locations and solutions for alternatives to in-stream and terrace mining

Projects/studies related to flood control:

1) In the remaining “natural” waterways/channels where the county has jurisdiction, flood control practices should be kept to a minimum, and only utilized when necessary as documented with monitored cross sections which show an unacceptable rise in the elevation in the 100 year flood height or as shown to significantly reduce flood capacity. In these channels, additional alternatives should be developed, such as: offset levees to increase floodplain and reduce flood-control maintenance, adding floodplain level culverts to increase floodplain draining at culvert crossings, active tree planting and irrigation to increase shading which will reduce growth of brushy and exotic species to increase capacity and add stability, and purchase of riparian easements to allow floodplain flooding and stream meandering. The county should contract with a hydrological consultant to develop and prioritize these alternatives in the channels they maintain. Bank stabilization projects at erosion sites should only utilize bio-engineering practices except where structures are threatened. The county should contract with a reputable bio-engineering consultant (there are several locally) to provide training for SCWA labor forces and

public works Dept. These recommendations are intended to improve sediment transport, encourage development of complex habitat, and reduce maintenance costs in the long term.

2) The “constructed flood control channels” should be managed or restored to improve hydrologic function where possible. This could include: removal of onstream levees and construction of offset levees to increase floodplain and reduce floodcontrol maintenance, moving or raising structures in frequently flooded areas, adding floodplain level culverts to increase floodplain draining at culvert crossings, and purchase of riparian easements to allow floodplain flooding and stream meandering. Local bond measures could be developed to cost-share these activities with county and other funds.

3) Alternatives for mitigation to unavoidable site specific impacts could also be discussed such as : the length of the streams modified through these activities could be mitigated for on streams where channel capacity is not an issue, through native re-vegetation efforts and floodplain easements in other coho drainages of the Russian River.

Projects related to County Public Works:

Road related actions:

-Provide training for Public Works road crews on fish-friendly road practices
-Identify and obtain easements or purchase spoil site locations for end-hauling ditch and slide spoils during winter preparation and maintenance (identified as a need by county road crews)
-Increase budget for county road maintenance crews (Identify sources of funding other than FEMA)
-Complete sediment source surveys on all County maintained roads to identify and quantify sediment sources and estimate sediment savings using DFG approved protocols
-Assist with DFG funded culvert assessment of remaining Sonoma and Mendocino County culverts-Russian River
-Implement Taylor Report recommendations when completed including:

County maintained/owned culverts with low flow passage impaired identified so far:
See Draft Taylor Report (January 2002)
Wine Creek
Dutcher Creek (2 culverts)
Dutchbill Creek at Market St.
Tribs to Dutchbill Creek:
    -Alder Creek
    -Lancel Creek
    -Grub Creek
        Tyrone Creek
Press Creek
Humbug Creek
"Indian Creek"-un-named tributary to Russian, Alexander Valley
Kidd Creek

County maintained/owned culverts with high flow passage impaired identified so far:
See Draft Taylor Report (January 2002)
Tyrone Gulch
Schoolhouse Creek

County maintained/owned culverts with all flows passage impaired identified so far:
    See Draft Taylor Report (January 2002)
Matanzas Creek

Other Specific:
-Implement recommendations of DFG funded Willow Creek Road Assessment on county road see Appleton Report (January 2002)
-Evaluate alternatives to Willow Creek bridging needs: Remove Willow Creek Bridge #2 and realign road on east side of creek.
-Complete sediment source survey on Sweetwater springs Rd (Sonoma County) and Walker Rd (Mendocino County) as a demonstration and training scenario for county staff to identify and quantify sediment sources and estimate sediment savings using DFG approved protocols
-Implement recommendations of these assessments when completed with oversight of an experienced contractor in fish friendly road techniques

ROLE OF REGULATORY EFFORTS

At present, flows in the Russian River are greatly augmented by diversion from the Eel River system, and augmentation of flows from Lake Sonoma; therefore, the flow is considerably higher during the summer than those flows that would occur naturally. These increased flows were speculated to result in increased natural production, but this has not occurred. Managed flows have caused habitat deterioration to such extent as to prevent any benefit which should result from increased flow.

Nursery habitat is presently almost non-existent in the lower mainstem, where warm slow moving water has eliminated riffle pool stratification, and has favored the proliferation and growth of native and introduced warm water species, many that prey on juvenile salmonids. Riffle/pool structure has been somewhat maintained in the upper mainstem but cold water stratification of deep pools has greatly diminished due to mixing of warmer surface waters. Cold water flows from Dry Creek in the summer may be too strong for adequate pool rearing, and winter flushing flows have been all but eliminated from the flow schedule (channel forming flows occur every 6 years instead of every 1.5). Flows in both Dry Creek and the upper mainstem in the winter are ramped down quickly to manage the flood pool, which contributes to bank sloughing, erosion and lack of mature riparian. Summer inspection of the two dam facilities reduces flows significantly (eliminates flows at the East Fork) stranding juvenile salmonids. Conversely, high flow releases conducted in the winter to test pipe vibration has been predicted to scour coho and steelhead redds in Dry Creek and keep spawners from entering the hatchery for up to a week (Royce Gunter, p. communication). Neither of the screens at either facility currently eliminate warm water fish stocked in either lake from entering the Russian River.

The rubber dam at Mirabel which is necessary for operation of the SCWA *Wholer facility* is constructed annually to provide water supply to the Mirabel pumping stations. Numerous studies have been conducted around this facility to evaluate the effects the activity has on river habitat, salmonid passage and the proliferation of warm water species. The rubber dam is often constructed during the late migration period out and frequently is utilized in the winter in dry years, although the structure has a fish ladder. The ladder is monitored by SCWA. Effects on juvenile migration and habitat are less known. Warm water predatory species such as the Sacramento Pike Minnow are known to congregate around artificial structures to feed on downstream migrants. Studies to observe this at this site behavior have been fruitless. Interestingly, very few fish at all have been observed using the Wohler "pool" indicating it's complete absence of fisheries utlilization (Dave Manning, p. communication). SCWA has also been conducting studies on the delay in outmigration caused by the backwatering of habitat and lack of attraction flows caused by the structure. Results of these studies are not yet available. The water intakes of the structure currently do not meet NMFS screening criteria and the approach velocities impinge juvenile fish on the existing screen.. Channel maintenance activities result in the removal of vegetation and regrading of gravel bars which reduces channel and habitat complexity. Removal of the structure often results in the stranding of juveniles. The infiltration ponds adjacent to the pumps trap juvenile salmonids and other fish and amphibians neccessitating fish rescue operations annually. Channel maintenance activities result in the removal of vegetation and regrading of gravel bars which reduces channel and habitat complexity. Removal of the structure often results in the stranding of juveniles (SCWA 2002).

The estuary is primarily managed for flood protection and is frequently breached to avoid impacts to adjacent development in what was once river floodplain. Flow augmentation has contributed to the summer time flooding problem in the estuary through increasing discharge beyond what was natural in the summer. Thus the natural breaching cycle has been altered, resulting in elevated water heights being deleterious to juvenile habitat when natural breaches occur in the estuary (Anderson 2001). Currently chinook, steelhead and potentially coho spawning still occurs in the upper Russian mainstem from Asti to Lake Mendocino and Mumford Dam. Adequate year-round nursery habitat is especially important to mainstem coho and steelhead spawners because these species spend at least one year in fresh water prior to migrating out to the ocean. Stable estuarine environments with adequate water quality, nutrients, cool water and space have been shown to increase condition and escapement of chinook and coho salmon and steelhead before migrating to sea.

The deterioration of habitat on the Russian River has occurred over many years and is the result of poor land-use practices involving urbanization, road building, mining, logging, grazing, channelization, agriculture, water diversion and augmentation and the clearing of riparian vegetation. Additionally, loss of habitat and river and estuary complexity and function has occurred due to the installation of the two flood control reservoirs : Lakes Sonoma and Mendocino. The interactions between humans' and salmonids' needs for the rivers resources will likely become increasingly complex.

Both regulatory and restorative measures are needed to protect and recover anadromous fish and their habitat. Currently Sonoma County Water Agency is involved in a Section 7 process to evaluate the effects of its operations. NMFS is scheduled to release a Biological Opinion on the activities in 2003.

Projects related to Section 7 consultation:

Problem: Improve migration

?? Operate dams to more closely mimic rainfall hydrograph to improve migration, and provide sediment flushing flows, but eliminate the extended “limb” of the hydrograph which increases bank erosion and impedes upstream fish migration.

Problem: Improve juvenile rearing for salmon and mainstem steelhead spawners

?? Identify and fund solutions to modify or eliminate summer breaching of the Russian River Estuary, with the goal of providing for longer estuary rearing of salmon and steelhead, and eliminating early adult chinook migration to appropriate migration period when river conditions are optimal. This two-fold goal could be accomplished through a series of management changes:
1) Reduce flows in the main river. This would also allow water levels to be maintained at 8.5 feet or higher, providing summertime through fall juvenile rearing in the estuary, until winter flows increased and the sand berm breached naturally or artificial breaching was required to reduce flooding of adjacent properties.
2) Alternatives to breaching such as acquiring property and relocating or raising adjacent facilities and residences, and above ground septic systems should be explored through FEMA funding. These solutions would extend estuarine closure further into the fall and possibly eliminate the need for breaching.
3) Explore other alternatives including pumping flood waters over the sand berm, or installing a bypass structure (buried pipe or culvert) through the berm during the summer months.

Problem: Reduce winter releases so that bank sloughing does not occur.

1) Dam releases: Manage winter flow releases to achieve channel forming flows every 1.5 years (or 2 events every 3 years). This would establish creation of diversity in channel morphology and habitat makeup. High flow releases would need to be combined with conservation easements or rights-of-way for riparian expansion, and other alternatives to acquire and expand floodplain. Adjust flow management to allow higher discharge on the ascending limb of the hydrograph when storm flows are entering the dam, to allow a slower rate of ramping on the descending limb. This would reduce the rate of bank sloughing that occurs during prolonged flood pool releases from the dam.

2) Reduce flows in the main river to improve habitat along the mainstem and reduce the frequency of breaching in the estuary. This would encourage pool/riffle complexity as well as cold water stratification in deeper pools..

3) Improve habitat and rearing complexity in Dry Creek. This could be accomplished by reducing flows in the summer through shifting dependency to offstream storage or piping needed water supply to Mirabel.

Problem: Avoid stranding of juveniles in summer during dam inspections, and scouring of redds in the winter.

1) Dam inspection impacts: Slow ramping rates to avoid stranding juveniles during inspections. Avoid critical timing of early emergence and summer high temperatures for inspection periods. Explore and fund other alternatives to slower the ramping rates.

2) Avoid high flow inspections during the incubation period. Coordinate with timing of flushing flows to promote channel and habitat formation.

3) Reduce ramping rates when removing the Mirabel rubber dam, by lowering it slowly.

Problem: Improve habitat condition within floodways, and reduce need for dredging and clearing through:

1) Tree-planting and irrigation program to reduce need for stream clearing along county maintained floodways (creeks).ie. provide shade which will out-compete brushier species which inhibit flood flows. Provides shade to cool streams to provide for enhanced salmonid habitat.

2) Identify and remediate upslope problems to reduce need for stream-dredging along county maintained floodways (creeks). Ie. identify and remediate sources of sediment and eliminate delivery mechanisms (dithches and gullies).

3)Identify and fund solutions to floodplain development of Fife and
Hulbert Creeks. Ie. move or raise houses instead of leveeing and rip-rapping.

Problem: Improve juvenile passage and reduce entrainment at Mirabel through:

1) Limit installation of rubber dam to non-migration periods of smolts and adults June through October-November (passage would not be needed for early chinook if estuary remains closed until naturally breached).

2) Provide attraction flows at Mirabel fish ladder to improve outmigration of smolts. Systematically lower the dam at Mirabel during the fall to improve the passability of salmonids or

flush them over the dam structure.

3) Bring fish screens at Mirabel and Wohler into compliance with NMFS criteria. Reduce approach velocities at the screens to avoid impingement of juveniles. Construct bypass to allow passive escape from infiltration ponds.

Problem: Improve juvenile mainstem habitat:

1) Eliminate channel maintenance activities at Mirabel and Wohler to provide for habitat complexity in the vicinity.

2) To offset losses of mainstem fisheries habitat for the backwatered distance upstream of Mirabel, mitigate through habitat restoration elsewhere (Mendocino reach) or through the purchase and creation of conservations easements in the riparian zone elsewhere (Dry Creek).

3) Screen discharges at the two dam sites for warm water fishes.
4) Reduce flows out of Lake Mendocino to improve stratification in the Mendocino reach deeper pools for juvenile fish.

ROLE OF HATCHERIES AND STOCK MANAGEMENT OPTIONS

Warm Springs Hatchery and The Coyote Valley Steelhead Facility should be utilized to enhance the size of the salmonid run in the Russian River and replenish lost runs to rehabilitated tributaries. With the advent of genetic analysis, much emphasis has been given to retention of wild genes and to the potential loss of genetic variability through stock integration and run suppression. If genetic analysis begins to pinpoint changes on a genetic level to salmonid runs in the Russian River, due to stock integrations, hatcheries may play a key role in reversing this loss of genetic variability.

The concerns of the biological community concerning loss of genetic diversity and the effects of hatchery fish on wild populations must be based on scientific evidence applicable specifically to the Russian River system. Genetic analysis which elucidates the specific difference between hatchery and wild fish in Dry Creek and the Russian River is necessary to determine the extent of interbreeding between hatchery / wild and previous out of basin transfers. In this interest it is necessary for genetic analysis to continue so that salmonid management in the Russian River system can be refined in a progressive manner that is based on sound scientific evidence.

Currently, studies are being undertaken to genetically differentiate between wild and hatchery origin stocks. Once completed, DFG would facilitate the implementation of a program to closely integrate wild fish into the hatchery component of the spawning run. In this capacity WSH would serve as genetic research center as well as a production facility for salmonids. A Hatchery Genetic Management Plan (HGMP) was prepared for steelhead production at both facilities on the Russian River in 2001, and is under review by NMFS. This document evaluates the existing risk to federally listed stocks as well as defines the future for additional or new programs. The objective of the HGMP is to maintain native stocks to the greatest extent possible and to maintain the widest possible genetic diversity. Many improvements identified during the development of the HGMP to reduce risk to listed steelhead have already been implemented by DFG at WSH and CVFF. An HGMP for coho salmon is currently under development which focues on the Captive Broodstock Program. These plans also recommend that anadromous facilities such as WSH and CVFF should be utilized for ongoing mitigation, research, broodstock development, and as refuges for increasing the contribution of wild fish to the spawning runs in the Russian River.

The National Marine Fisheries Service Conservation Hatchery Approach includes elements of hatchery operations that can be refined to produce fish that are genetically more similar to their wild counterparts. The theory behind this approach is that artificial propagation of fish can cause inadvertent selective processes to occur in the aquaculture stock, leading to decreased genetic fitness, poor adaptation to the wild environment and assorted physiological maladies. Specifically identified genetic issues include inbreeding, outbreeding and domestication selection. Identified physiological or behavioral changes that are indicated include loss of predator escape response, altered pigmentation, inability to make the transition between fresh and salt water, increased straying, higher incidence of returning jacks, and decreased disease resistance. Many of the recommended treatments seek to modify behavior and the resulting translation is that the behavioral changes will be manifested in genetic selection for wilder traits. Proponents of the conservation hatchery strategy subscribe to modifying hatchery operations to incorporate elements of the wild environment and measures to reduce inadvertent selective processes. It should be noted that at present there is no fully operational Conservation Hatchery, however, there are studies presently being conducted to collect data on this emerging proposition. Some aspects of the conservation strategy have already been adopted at WSH.

GENETIC CONSIDERATIONS

If it is determined through genetic analysis that the present stock of steelhead at both facilities differs greatly from that of wild stocks or fish found above unsurpassable barriers, there are many possible actions that may be taken. The following list is not exhaustive but summarizes suggestions for modifying present hatchery practices if it is determined that hatchery fish differ significantly from wild fish with regard to genetic analysis.

- establish a rigorous genetic monitoring program for hatchery and wild stocks
- establish genetic screening program for adult returns to prevent loss of gene variability and to prevent crossing of related adults
- embellish hatchery stock with wild genes by incorporating wild fish into hatchery program.

- employ a captive brood stock program at these facilities with fish from above barriers (steelhead) or with fish determined to be wild strains (i.e. the original Russian River Stock). This concept is presently under study by Sonoma State University under contract to DFG.

- transitionally phase out present hatchery stock if it is found that these fish are genetically depressed (exhibit low genetic diversity) and are significantly different than wild stock or original Russian River stock

Native Captive Brood stock Program

Restoration of native habitat in historic coho streams is a high priority of the California Department of Fish and Game. Streams within the Russian River basin that have historically had coho runs have been the focus of habitat restoration work and are presently deemed ready for the reintroduction of coho salmon. However, even with restoration efforts in place, the coho population has not rebounded presumably due to the severely depressed status of remaining runs. It is essential that residual runs of coho salmon be provided with measures to ensure their survival and ability to reestablish population numbers closer to historic levels.

Restoration efforts, which include hatchery operations should be undertaken that assist the recovery of the coho salmon run in these native streams. In the interest of initiating recovery planning for coho salmon in the Russian River, The National Marine Fisheries Service, The California Department of Fish and Game, and the U.S. Army Corps of Engineers began development of a captive broodstock program at Warm Spring Salmon and Steelhead Hatchery in 2001. The goal of this program is to prevent extirpation of coho salmon in the Russian River by reestablishing lost or declining stocks. The ultimate end goal of this program will be to restore self sustaining stocks of Coho salmon in the Russian River.

The benefits and criteria for use of captive broodstock technology are outlined in the National Marine Fisheries Service “Interim Standards for the use of Captive Propagation Technology in Recovery of Anadromous Salmonids Listed Under the Endangered Species Act” (1999). Conventional anadromous hatchery operations generally rely on returning wild or hatchery fish which were released as fry or fingerlings. Captive broodstock programs differ from conventional hatchery operations predominantly because they involve rearing fish in captivity for most or all of their life cycle. In addition, captive broodstock technology is generally employed if the imminent risk of extinction is high with the population in question, as the protective measures of fish culture can provide for higher survival rates. Equally, the generation of high numbers of progeny through captive broodstock technology, for supplementation into the wild, can provide for rapid increases in the abundance of depleted stocks.

In 2001, all 32 historic coho streams within the Russian River were sampled for coho juveniles (Figure 8). Coho juveniles were found in only 3 streams. DFG followed a capture protocol developed with and approved by NMFS to rescue and retain up to 50% of any wild coho remaining in intermittent pools which would otherwise be subject to dessication (up to 10 juveniles/pool for a total of 300 juveniles/year). Juveniles were captured from both the Russian River as well as other streams within the Central California ESU to broaden the genetic makeup of the broodstock population as was requested by the NMFS staff geneticist. Approximately 300 juveniles were captured and transported to WSH for rearing to adults. At the time of this report (July 2002) the fish are 1 year old, have been tagged and tissue samples taken, and less than 10% have been lost in the process. The fish will be held for 2 more years, and spawned as adults as per the genetic protocol. Offspring from this broodstock will be stocked in 5 (Willow, Freezeout, Sheephouse, Ward and Mill Creeks) streams (Figure 8). These were selected in the Russian River watershed due to:1) having documented missing at least several yearlclasses; 2) having suitable habitat for rearing coho or significant restoration efforts occurring; 3) having cooperative ownership where landuse threat is relatively low. Capture, rearing and outplanting is expected to occur for a minimum of 5 years. The program at this point is considered to be a “stock rescue” and will have an eventual ‘sunset’ of several life cycles after evaluation is made (discussed below).

It should be noted that in all cases an emphasis on utilizing and maintaining source stocks originating from the Russian River. Out of basin stocks have been collected as an alternative source if Russian River stocks are so severely depleted that a minimum number of suitable reproducing fish cannot be secured or identified. The initial captive breeding program has been a concerted effort by all involved agencies to improve the salmonid fishery resources of the Russian River watershed, and will ultimately address broad watershed issues which limit production of these fish in the wild. In addition, it is expected that this work will coincide with on-going habitat restoration efforts, and will provide a source for reestablishing runs in coho barren reaches which have been refurbished by restoration activities.

The full development of the program will require modification of existing facilities at Warm Springs Salmon and Steelhead Hatchery, and funding is actively being sought. However, the pilot program has already been undertaken without major modifications or interruption of present operations. The report **“**CALIFORNIA DEPT. OF FISH AND GAME , Russian River COHO SALMON SUPPLEMENTATION PLAN: A COLLABORATIVE EFFORT WITH THE NATIONAL MARINE FISHERIES SERVICE AND THE U.S. ARMY CORPS OF ENGINEERS (DFG 2001) describes possible scenarios for implementing components of this program . The Coho Recovery Workgroup, a local group of involved parties and responsible agencies has been formed and is developing the program in coordination with public input and scientific oversight.

AREAS/ISSUES PROPOSED FOR FURTHER STUDY

FUTURE RUSSIAN RIVER PLANNING

The highest DFG priority in the Russian River at present is to use elements of the Basin Planning Program to restore tributaries with unsuitable coho habitat, and to identify tributaries with suitable coho habitat. To lead to the recovery and re-establishment of salmonids, high priorities will be to: 1) monitor streams where suitable habitat occurs or is improving for natural recolonization by native wild coho; and, 2) plant coho in select tributaries that are presently undergoing habitat restoration, where more than two brood years are missing to re-establish lost runs in absence of natural re-colonization.

Where steelhead runs are completely absent, but habitat remains, an enhancement program should be installed to recover lost runs. Planting wild steelhead above barriers where suitable habitat occurs and no resident populations exist, or where barriers have been removed / improved will enhance the resource and in some cases have very little effect on other populations of fish.

The final recommendation is to find funding to establish an ongoing monitoring program to evaluate existing chinook distribution.

At present the California Department of Fish and Game takes tissue samples from all wild fish and hatchery fish in the Russian River. A random sample is selected from fish captured in the wild during routine fish surveys. Efforts are made to ensure that a representative sample is taken from each reach surveyed and reaches selected are representative of the habitat available on each tributary. In addition, efforts are made to collect tissues when possible from fish above barriers and also during winter carcass surveys. At present there is no funding for genetic analysis of these non-coho samples, thus samples are being stored at WSH. If funding were found, this information would be useful in managing salmonid stocks and have unlimited research value.

The Department of Fish and Game operates a genetic tissue archive located in Sacramento. At this facility, DNA aliquots and tissues are cataloged and placed in cold storage for the Sacramento Valley and the Winter Run chinook Program. At present, no such program exists on the Russian River, however, Warm Springs Hatchery serves as the cold storage location for Ocean Salmon Project tissue samples, Warm Springs Hatchery tissue samples and samples collected from Russian River salmonids

Russian River Research Recommendations Related to Hatchery Operations (General)

- Evaluation of system carrying capacity for each species
- Evaluate historic and present genetic structure of wild and hatchery populations of fish
- Radio telemetry study of smolt migration covering entire course of the Russian River and to evaluate length of esturine residency and survival of hatchery smolts
- Radio telemetry study of down stream migrant adult steelhead
- Brood stock evaluation and research to establish selection criteria

Genetic Sampling (Future Considerations and Research Recommendation)

- Broad Sampling across basin
- A comparable Genetic baseline for Russian River Salmonids
- Genetic assessment of hatchery runs
- Genetic assessment of wild runs
- Genetic comparison of fish from above barriers vs. hatchery and wild fish below barriers.
- Genetic comparison of fish from tributaries that have had very little stocking influence (ex. check database)
- Genetic comparison of multiple year returns to both hatcheries.
- Genetic comparison of RR fish to fish from nearest basins
- Genetic comparison of Lake Sonoma SH to the hatchery run (to identify divergence in the hatchery population)
- Genetic identification of local adaptations (if technology is available)
- Identification of closely related stocks
- A comparison of Stock Transfers (only over the course of hatchery operations) and present hatchery run to determine degree of integration and the influence of these stocks on the hatchery runs genetic make-up

EVALUATIVE MEASURES

The following is an excerpt from Collins (2002) and describes DFG' Project Evaluation Program. Each year the California Department of Fish and Game (DFG) evaluates at least 10% of coastal watershed restoration projects completed within the last three years following the procedures described in the California Salmonid Stream Restoration Manual, Part VIII, Project Monitoring and Evaluation (Flosi et al. 1998). Generally projects are selected for evaluation which have endured at least one but not more than three winter's high flow and high rainfall events. It is important that restoration treatments be monitored after such high flow/rain events have occurred to determine if the desired habitat condition has been met and maintained. Often, maintenance or modification is needed to make the treatments perform properly. Identifying such maintenance or modifications is part of the monitoring and evaluation protocol employed. Restoration projects are divided into the following three primary restoration objectives:

Restoration Objective Category	Treatment Description
1	**Fish passage improvement**
2	**Watershed and stream bank stability improvement**
3	**Stream improvement of rearing and/or spawning habitat**

Each year DFG's Fisheries Restoration Grants Program, through a request for proposal process, awards contracts to public and tribal agencies, non-profit organizations, and private entities to conduct specific watershed restoration work intended to directly or indirectly conserve, enhance, or restore anadromous fish habitat in California's coastal watersheds. These restoration projects are classified under the following project types:

Project Type	**Description**
	Fish Passage Improvement
FL	**Fish Ladder**
HB	**Instream Barrier Modification (including Fish Friendly Diversion Structures)**
SC	**Fish Screening of Diversions**
	Watershed and Stream Bank Stability Improvement
HR	**Riparian Restoration**
HS	**Instream Bank Stabilization**
HU	**Watershed Restoration (Upslope)**
	Stream Improvement of Rearing and/or Spawning Habitat
HI	**Instream Habitat Restoration**

The evaluation protocol used reviews and documents the physical effectiveness of individual habitat enhancement manipulations.. Although the evaluation protocol was primarily designed to assess instream and riparian treatments, it has also been used to assess and upland restoration treatments recently (primarily road decommissioning projects). The evaluation criteria and program is expected to be modified at the completion of the Effectiveness Monitoring Program described below.

DFG contract managers are responsible for completing annual evaluation of each funded project at completion and following the first winters storms. Project completion forms provide background information pertaining to the entire project or contract. This form assists in identifying what background information is available and its location. This form also serves to summarize pertinent stream information necessary for completion of the evaluation process. Project evaluations of each restoration project site are primarily based upon a subjective evaluation of both how well the treatment is meeting the habitat objectives for which it was built (function), and the present physical condition of the treatment (integrity). The criteria for these evaluations are summarized below:

	How Well Is Treatment Meeting Habitat Objective (Function)
1 (Excellent)	**Treatment is providing the habitat conditions as expected. Examples include: formation of a primary pool, spawning gravel retained, complex cover provided, sediment controlled, vigorous riparian growth achieved, etc.**

2 (Good)	**Treatment is meeting objectives and providing habitat but maximum pool depth is between 2.0 to 2.5 feet, shelter complexity is less than 3, spawning gravel is available but not abundant, or riparian growth is moderate.**
3 (Fair)	**Treatment is providing some habitat benefit that was not present before construction but it is achieving only partial expected benefits, or it may be providing some benefit but not the intended objective. Examples include: pool scour depth less than 2 feet, very little spawning gravel associated with structure, cover not complex, etc.**
4 (Poor)	**Very little habitat value exists as a result of the structure or treatment. Virtually no pool scour, shelter complexity less than 2, no gravel retained, etc.**
5 (Failed)	**Not visible. No value. Treatment is not meeting objective. Stranded out of stream channel with no possibility of providing low or high flow benefit.**

Condition of Treatment (Integrity)

1 (Excellent)	**Consider treatment condition only. Do not include functional aspects in this category. The treatment may not be functioning (stranded out of channel) but it may be in excellent structural condition.** **Treatment is intact and structurally sound.**
2 (Good)	**Treatment is intact and generally sound but some wear is evident. Pieces may have shifted slightly, erosion cloth visible, wire fence material visible, one or two anchor pins or cables loose but treatment still intact. Treatment is generally as designed.**
3 (Fair)	Treatment has been altered significantly but is still meeting about 50 percent of design criteria. Boulders or logs may have shifted, log weirs undercut, cables loose, etc.
4 (Poor)	**Treatment is visible but in a condition that is only about 25 percent of original design. Significant structural damage.**
5 (Failed)	**Complete structural failure. Not visible or remnants not in any form of designed configuration.**

DFG evaluated 95 separate project sites in 2001 from 24 different restoration projects implemented during Fiscal Year 1996/97 through 1999/00. At least 90% of treatments in each project type, except Instream Barrier Modification (HB) were rated as either excellent or good for both the function and integrity. Only 60% of the HB treatments were rated as either excellent or good. The percentage of treatments for each project type receiving ratings from excellent to failed are presented in the report: *Northern and Central Coastal CaliforniaWatershed Restoration Project Evaluation Reportfor State Fiscal Year 2001/2002 (DFG-Collins 2002).*

MONITORING

Restoration

Three types of restoration monitoring are widely recognized: implementation, effectiveness and validation monitoring (Collins 2002). Implementation monitoring is intended to document adherence to a contract or regulation (discussed above as Project Evaluation). Effectiveness monitoring is monitoring to document the status of resources and is most often associated with physical properties such as LWD or water quality. Validation monitoring is monitoring to document a biological response from management actions, such as a watershed restoration project. For example, validation monitoring could include measuring the number of salmon in a stream subjected to restoration treatments to determine if the restoration actions are resulting in greater salmon population size.

Although restoration monitoring has not been widely conducted in California, Dr. Richard Harris (University of California, Berkeley and Dr. Walter Duffy (Humboldt State University Foundation) are presently working with the California Department of Fish and Game to develop protocols for effectiveness and validation monitoring of restoration projects in California's coastal watersheds. Work was initiated in June of 2001, and will be completed in the spring of 2003. A draft report for the UCB project has been prepared and is presently in peer review (Harris et al. 2002 in review). That report includes a review of exemplary monitoring programs throughout the Pacific Northwest, recommendations for monitoring at different scales and a review of protocols for monitoring. A data management system that can be used to track monitoring and improve grant application procedures is also being created. A draft report for the HSU project is also in preparation.

The objectives of these projects are to:

1. Develop conceptual models for the relationships between: 1) watershed processes and anadromous salmonid habitat conditions, and 2) anadromous salmonid habitat conditions and salmon and steelhead abundance and distribution. These relationships may then be used to hypothesize the physical and biological responses of salmonid habitat and populations to restoration.

2. Review existing effectiveness and validation monitoring programs and approaches to determine if they produce data appropriate for inclusion in a restoration monitoring program for California.

3. Test measures identified under objective number 1 in watersheds located in coastal regions of

northern, central and southern California.

4. Produce an effectiveness and validation monitoring protocol manual.

The Grantees have completed objectives 1 and 2. During summer 2002, they will begin fieldwork to address objective 3 in the north coast region of California, with an expected completion (depending upon funding) of 2005. It is anticipated that manual will take the form of a revised chapter of the *California Salmonid Stream Habitat Restoration Manual; Part VIII Restoration Monitoring and Evaluation.* Below is a timeline for the expected work.

Fish Populations

At present there is no quantitative monitoring of adult returns or juvenile salmonid populations in the Russian River watershed. However, monitoring is proposed for the Coho Captive Broodstock Program, and is being developed by the Coho Recovery Workgroup. The goal will be to monitor interannual variation of coho populations in the Russian River watershed and support and evaluate artificial propagation programs working to maintain those populations. The following was adapted from a grant proposal from Hayes and McFarlane (2002). The specific objectives will be to:

1. Monitor stream movements, outmigration patterns, condition and development of juveniles relative to fluctuating environmental conditions and population densities in the pilot watersheds and a control.
2. Monitor return rates and survivorship of adult coho and steelhead to the Russian River watershed relative to fluctuating environmental conditions.
3. Collect base line genetic data on each year class of coho and steelhead in the Russian River.
4. Monitor differences between hatchery produced and natural run fish for the above objectives.
5. Enhance broodstock collection for the captive coho broodstock program.

Juvenile monitoring

After fish are released as fry in the 5 pilot streams, juveniles from both the stream and the broodstock will be sampled on a year round basis to monitor downstream fish migrant patterns, condition, summer survival and growth. During the spring a subset of both hatchery and natural run fish will have nonlethal gill biopsies taken to monitor developing Na /K -ATPase activity, which is indicative of smoltification (McCormick et al., 1998). ATPase samples will be collected according to protocols of McCormick (McCormick 1993). Downstream migrant traps will be placed at six different locations throughout the watershed . All fish captured will be handled according to the protocols of Williams et al. (1999). Data of fork length and mass will be collected on all individuals. Tissue samples for DNA analyses will also be collected from individuals. Starting in the fall of 2004, PIT tags will be inserted into a sub-sample of broodstock re-captured in the traps as out-migrants. PIT tags will be implanted according to protocols provided by Biomark (2000). Following 2 years in the ocean all returning re-captured broodstock adults (identified by fin clip) will be scanned for PIT tags to monitor growth and survival Monitoring of downstream migrant traps will continue for the duration of the project. The above tagging process will be repeated on each cohort of hatchery and natural run coho as they mature and smolt .

Adult Monitoring

A portable, temporary weir and fish trap will be needed on each pilot tributary to monitor adult return rates and survival of previously PIT tagged smolts. It will be necessary to install the weir during the late fall of 2004. Personnel will be required to monitor the fish trap (weir) on a daily basis and perform routine maintenance for the duration of the spawning run. All returning adults will be measured for length and weight, have scale and DNA (caudal fin clip) samples taken, scanned for PIT tags, marked with Floy tags and then released upstream of the trap. Broodstock candidates will also be selected throughout the spawning season and transported to the WSH hatchery. The genetic samples will be transported to the Santa Cruz NMFS genetics laboratory for processing. The results of these analyses allow future broodstock candidates to be spawned in pair-wise combinations that optimize genetic diversity, reduce homozygosity, and prevent the loss of rare alleles.

Spawning and carcass surveys will be conducted above the weir following DFG protocols (Flosi et al., 1998). Fish will be checked for Floy tags. The number of tagged and untagged fish observed will be used to evaluate the effectiveness of the weir at catching all returning adults.

Data from juvenile rearing studies, smolt outmigration and adult returns will also be used to evaluate the pilot broodstock program. The identification of beneficial environmental conditions for smolt migration will be useful to for the purposes of scheduling smolt planting times. The ability to identify genetic traits of broodstock prior to spawning and the ability to capture adults throughout the spawning season will provide for maximum genetic diversity of hatchery smolts and enable selection for a diverse group of fish that return over the entire spawning run. A subset of these smolts will be transported to the WSH captive broodstock facility where they will be reared to preserve coho stocks that might be impacted by unforeseen future environmental or anthropogenic events. The monitoring will also enable managers to anticipate the size of future returns and calculate in advance optimal production numbers for the broodstock program.

APPENDIX A

A BRIEF HISTORY OF THE RUSSIAN RIVER BASIN

HISTORICAL RESOURCE USE

Long before towns, steam plants and vineyards covered the landscape, the hills of the Russian River basin were home to thriving populations of cougar, elk, black tail deer and grizzly. Eagles, hawks, ducks and loons soared over hills covered with redwoods, oak and alder. Otters, whales and sea lions swam the coast line and the river ran thick with salmon and trout.

The history of resource use in the Russian River area began with the Pomo Indians, who occupied what we now call the Russian River basin for as long as 5,000 years prior to European settlement, living in numerous settlements of up to 1,000 people (Wilson 1990). These tribes altered their environment with the regular burning of oak woodlands and grasslands as a means of promoting new growth of their food sources and increasing habitat. The Native Americans called the Russian River Shabaikai or Misallaako, meaning "Long Snake." The Pomo Indians of the Ukiah Valley referred to the Russian River simply as "the River."

In 1775 Juan Francisco de Bodega y Cuadro of Spain landed at Bodega Bay to find the river basin a virtual paradise, with all of the desirable elements for a strong commerce already in place (Wilson 1990). Rich soils would soon support thriving crops of grapes, apples, prunes and hops. Basalt in the eastern hills would ultimately become paving stones in San Francisco. Ancient redwood trees grew in dense forests throughout the lower river basin, destined to become the lumber that built the city of San Francisco in the 1800s, and again after the devastating earthquake of 1906. The arrival of the Spanish, who called the Russian River the San Ygnacio River, forever altered the future of this pristine region.

The Spanish were soon followed by the Russians in 1808, led by Alexander Kuskoff of the Russian-American Co. This company, under the leadership of Alexander Baranov, turned to the south in search of more hospitable lands after Russian fur traders virtually decimated the otter populations in Alaska, taking an estimated 100,000 pelts within the last decade of the past century alone (Wilson 1990). The Russian settlers called the river Slavianka, or "Little Slavic Maiden." By 1811 they had established colonies at Fort Ross and Bodega Bay and had navigated up the river to the Geysers on Sulphur Creek. Kyrill Khlebnikov, a Russian traveler reporting on the countryside around Fort Ross in the early 1800s, noted that "among quadrupeds the most important are bears, lynx, ordinary wolves, and small ones which the Spanish called coyotes. They catch sturgeon in the Slavianka River when the channel is open

(Wilson 1990)." Russian settlers remained in the Russian River area until about 1840, fur trapping otter along the coast and the river, exploring the river basin and possibly cultivating the river valley for wheat and cattle grazing (Ferguson 1923).

In 1831, a Rancho grant was issued for Rafael Gomez at San Rosa in order to limit Russia's encroachment into the Russian River Valley (Wilson 1990). In an 1843 Spanish petition for the Bodega grant the name of the river appeared as Rio Russo, and we have called it the Russian River ever since. With the presence of the Spanish increasing, cattle and horse ranching became the dominant land use in the Russian River Valley during the rancho period from 1835 to 1846.

In 1837 a smallpox epidemic decimated the Native Americans living in villages throughout the river valley, leaving the area open to colonization by Mexican settlers (Ferguson 1923). The Russians abandoned their efforts to establish a colony in 1841 and sold their settlements to Captain Sutter, bringing more "Americans" into the region. During the Mexican-American war in 1846 (the same year the Bear Flag revolt occurred in Sonoma) California was declared a republic. In the years to follow, hostilities ensued between the Indians, Mexicans and newly-settled Americans in the Russian River Valley, escalating in 1847 when the Russian River saw the arrival of many land-hungry American settlers.

The discovery of gold in California in 1849 triggered the development of the river valley, as the demand for wood and agricultural products escalated. By 1851, a significant number of American settlers began to squat on Rancho lands, establishing homesteads in the valley and clearing the native vegetation of the river valley and uplands for cultivation. Guerneville was founded that same year. From 1855 to 1865 a major period of homesteading and agricultural development occurred in the fertile valleys along the river and Healdsburg was founded in 1856. During these years, numerous conflicts over land ownership between squatters and Rancho owners led the government to bring in a County sheriff with a posse, and ultimately the military, to settle land ownership disputes, resulting in the subdivision of Rancho lands.

In 1865 the intensive logging of the old growth redwoods in the lower watershed began with the establishment of milling yards in Guerneville. At that time, the sheer size and density of the old growth forests were almost unfathomable. The largest tree ever recorded was in the Russian River basin. This tree grew upon the west bank of Fife Creek just opposite of the town of Guerneville and was known to all of the early settlers as "the Monarch of the Forest." It was the tallest specimen of redwood, or any tree for that matter, that had ever been seen. It measured 45 feet in circumference at the base and was 367 feet and 8 inches tall (Schubert 19---). Though the exact fate of this tree is unknown, another of the largest trees, measuring 23 feet in diameter at the base and over three hundred feet in height, was felled by a man named William English and was manufactured into over 600,000 shingles, affording Mr. English labor for more than two years (Schubert 19–).

In 1876 the railroad was constructed to haul lumber from the mills in the lower river basin to outside markets, dramatically boosting the production of the timber industry. Two lines ran along the Russian River, the narrow gauge and the broad gauge. Small branch lines were also built fanning out from Duncan's Mills to Markham, Willow Creek, Azalea and up Kidd Creek and Kuhute Gulch in the Austin Creek watershed for hauling logs to Duncan Mills (Stindt 1974).

By 1901 the last lumber mill in Guerneville closed, as the vast majority of harvestable redwoods had been destroyed in a mere 36 years. Eventually, this legacy would be followed by the wholesale tractor logging of Douglas fir forests in the basin during World War II. As early as 1902 the California Agricultural Experiment Station noted watershed overgrazing and soil impacts from forest and brush land clearing (USDA 1950).

After Northwestern Railroad's freight business had plummeted due to the collapse of the timber industry, the same railways that had been constructed to haul timber from the river basin carried vacationers and weekend travelers from the ferry at Sausalito to popular destinations throughout the Lower Russian River, from Rio Nido to Duncan's Mills. Around the turn of the century, summer travel to vacationland along the river, originally fueled by an extensive ad campaign in 1894, was booming, particularly in the summer months (Stindt 1974). It was during this time that Monte Rio won the name "Vacation Wonderland." The Lower Russian River continued to be a popular tourist destination through the early 1930s.

As the population increased, the potential for agricultural development as an economic strength was realized. Most of the land along the Russian River was already under cultivation by 1900 (SEC 1996) and this early agriculture focused mainly on the cultivation of grapes, apples, hops and prunes. Farmers removed riparian vegetation and filled in sloughs and side channels in order to maximize their usable agricultural lands. These practices continued until the late 1940's when very few wetlands remained (SEC 1996). At that time, the river valley was leveled, creeks were channelized and, in an attempt at flood control, agricultural operations began removing small in-channel islands and gravel bars. These practices, along with vegetation removal, accelerated erosion. In the 1850s, bank stabilization measures began in response to increased erosion. As cultivated acreage increased, these practices resulted in mass channelization.

Early agriculture in the Russian River basin was focused mostly on the cultivation of grapes, apples, hops and prunes. Today, agriculture is still the dominant land use within the basin, the trend being conversion of historical croplands, livestock, dairy lands, and forestlands to vineyards. Some orchards remain, mostly in Ukiah and Sebastopol, though vineyards dominate the hills and valleys of the lower river area. Some pastureland and farmland for the cultivation of silage also remains in the open areas of the Santa Rosa Plains. Grazing of cattle and sheep is prevalent, particularly in the hardwood forest areas and coastal sage vegetation.

The first major change in flows within the Russian River occurred in 1908 when the

Eel River Tunnel and canal system was built to divert water into the East Fork via the Potter Valley powerhouse, causing the river to have perennial surface flow. Known as the Potter Valley Project, this diversion draws approximately 300 cfs from the Eel River, and together with the natural rivers flow, supplies drinking water to about 500,000 people and a presently unknown amount of water for agricultural uses (RWQCB 1995).

The alteration of the natural course and function of the Russian River continued, as in 1928 when a jetty was constructed at the mouth of the river from quarry rock blasted from Goat Rock on the headlands to keep the mouth open to the ocean year-round. This effort failed and today the County opens the closed lagoon periodically through the summer to offset backwater flooding of adjacent land uses. In 1938 levee construction for flood control was completed in Dry Creek and the Army Corps of Engineers (COE) and Sonoma County Flood Control and Water Agency recommended channel clearing of the mainstem of the Russian River and many tributaries, including Green Valley, Fife and Hulbert Creeks, as well as the construction of additional dams for flood control. The COE went on to conduct channel clearing and realignment in Alexander Valley in 1958.

In 1940 in-channel gravel extraction of the Russian River began. In the years to follow, the production of sand and gravel was the principal mining industry from Healdsburg through Ukiah. Russian River gravels were used for concrete construction and roads throughout the entire Bay Area. In 1970, in-channel gravel mining slowed and operations moved to the adjacent terraces along the river. During these same years, from 1940 to 1970, the majority of clearing and filling of the Russian River flood plain for agricultural lands occurred.

In 1922, Scott Dam was completed, impounding Lake Pillsbury on the Eel River 12 miles upstream of Cape Horn Dam (DWR 1976). Regulated flow between Scott and Cape Horn dams via Lake Pillsbury has since provided year-round diversion of Eel River water into the East Fork Russian River. This project increased the average summer base discharges in the Russian River dramatically, with summer flows generally exceeding 125 cfs (Figure 3.2-2) (COE 1982).

In response to demands for increased water supply and flood control, Coyote Dam was completed in 1959, creating Lake Mendocino and in 1982 Warm Springs Dam was constructed, creating Lake Sonoma. Together, these two dams blocked off a total of 235 square miles of the upper Russian River watershed.

Urban and industrial uses are concentrated around communities in both Mendocino and Sonoma Counties, the major ones being Ukiah, Cloverdale, Geyserville, Healdsburg, Windsor, Santa Rosa, Rohnert Park, Sebastopol and Guerneville. The Largest concentration of urban and industrial land uses is within the Santa Rosa plains, with Ukiah and Cloverdale being the next largest. Industrial uses include high-technology industries–like electronics manufacturing–petroleum distribution plants, light manufacturing, wrecking and salvage yards, and industries related to construction. Santa Rosa is the chief commercial distribution center for the North Coast.

Despite many years of intensive use, the peace and beauty of the Russian River still draw tourists from the Bay Area and elsewhere. Summer tourism associated with the recreational use of the river and profitable agriculture resources provide a critical economic base for Russian River communities.

The Russian River watershed is also becoming increasingly urbanized. The most densely populated area within the Russian River Watershed is the Santa Rosa Plains area, which includes six incorporated communities and over 200,000 residents (US Census, 1990). Growth in the Guerneville sub-basin has been sporadic, the 1990 census listing five unincorporated communities with a total of fewer than 10,000 residents. Overall, approximately 95-97% of the basin is held in private ownership.

APPENDIX B

HUMAN ACTIVITIES (LAND USE PRACTICES& FISHING) WITHIN THE RUSSIAN RIVER BASIN AND THE RESULTING IMPACTS UPON FISH

"One hundred and fifty years ago, the Russian River was the heart of a complex of interdependent ecological units. Well-developed floodplains, riparian forests, seasonal marshes, high-gradient woodland streams, oak grasslands, and coastal coniferous forests all worked interdependently to support highly productive fishery and wildlife habitats. In the geologically brief time span since the mid-1800's, this system has been transformed from its natural condition and balance to what is now essentially a heavily controlled urban water conveyance (SEC 1996)." Today, only the undammed, most remote tributaries bear semblance to the pristine conditions that once supported a self-sustaining, dynamic ecosystem.

Dams, habitat loss, augmented flow and temperature changes, gravel mining, introduced fish species, morphological changes and ocean conditions all have major negative impacts on salmonids in the Russian River. Other human activities such as agricultural practices, timber harvest, urbanization, unprotected water diversions, and fish harvest have also played a part in the basin-wide decline in native salmonid populations. "The changes in the Russian River basin present a classic case study of the modern anthropogenic impacts on interrelated ecological communities (SEC 1996)."

URBAN DEVELOPMENT

Urbanization has had an enormous effect on the Russian River watershed. To begin with, urban development encourages increased gravel harvest, road building, channelization, and water withdrawal. Clearing land for urban development causes an influx of sediment into streams. Buildings, roofs, concrete driveways, walkways and streets decrease absorption of water into the soil, increasing and concentrating runoff. This leads to an increase in flooding and streambank erosion.

In Steiner Environmental Consulting's 1996 report A History of the Salmonid Decline in the Russian River, Park Steiner sums up the effects of urban development as follows:

> Since 1900, human population in the Russian River basin has increased rapidly. In 1950, there were 65,000 people in the basin, while in 1980 there were 215,800 people. The California Census Bureau reported a population

increase of 282% in Sonoma County between 1965 and 1995 (Census Bureau 1998) (Merenlender 2000).. Estimates predict 346,000 people in the basin by 2000 (COE 1982). As the population in the basin expands, demand for gravel and water increases proportionately. As a consequence, stream channels are altered and habitat degraded, either directly or through cumulative negative impacts to the river system. As level and accessible building sites are exhausted, steeper and remote areas are brought into production. Utilization of these sites often increases levels of habitat disruption as people move into sensitive habitat areas. Stream pollution increases with higher human density, degrading water quality for both people and wildlife (Florsheim and Goodwin 1993). Tributaries suffer from channelization, rerouting, and pollution. As a result, many urbanized Russian River tributaries no longer support productive or self-sustaining salmonid populations.

ROAD BUILDING

In general, roads cause many serious problems for salmonids and may pose the greatest threat of urbanization to streams. The gradients at which most roads are built tend to inhibit the natural sheet dispersal of water, concentrating runoff and creating gullies and landslides. Bridges and streamside roads suppress the natural tendency for a river to meander by causing channelization, and road crossings at streams can act as sources of erosion and pollution, or as passage barriers. Erosion due to roads is a problem of serious concern in the Russian River and in watersheds world-wide. Paved and unpaved roads, along with road construction, are a major source of sediment into streams. Furthermore, road failures often cause landslides, particularly in steep areas. Roads also change the natural drainage patterns within the watershed. Runoff is increased where paved roads create impervious surfaces, and concentrated where water is diverted via road side drainage ditches.

Road crossings of any kind have the potential to block the downstream movement of stream substrate, which can lead to degradation downstream and aggredation upstream. Aggredation can lead to increased flooding, while degradation removes spawning gravels from streams. Also, many road crossings are accompanied by culverts. Culverts can cause erosion by concentrating flow and can hinder or prevent fish passage. All culverts have the potential for being fish passage problems and many are. They also have a tendency to give out, causing massive sedimentation episodes. There are an estimated 350 culverts on the Russian River and its tributaries within Sonoma County and an estimated 250 in Mendocino County (SOURCE??not SEC).

GRAVEL MINING

Gravel mining is known to be the second major cause (next to Coyote and Warm Springs Dams) of sediment deficit in the Russian River basin. Park Steiner, in Steiner Environmental Consulting's 1996 report A History of the Salmonid Decline in the Russian River Basin, does an excellent job of outlining the impacts of gravel mining as follows:

In the basin there are three gravel mining methods: in-channel, terrace or pit, and quarry mining. In-channel mining removes material directly from the stream channel. Gravel is often skimmed from bars or excavated directly from the channel. Terrace or pit mining removes gravel from historic or active flood plain deposits. The pits are separated from the river by alluvial separators. Some pits are up to 44 feet deeper than the adjacent river channel elevation (Gahagan and Bryant Associates, Inc. 1994). Quarry mining utilizes sites away from the stream, and has little effect on the stream channel. The greatest stream impact from quarries is demand for water, up to 20,000 gallons per day for washing and related activities(Florsheim and Goodwin 1993). From 1981 to 1990, 51 million tons of gravel were removed from the Russian River basin: 19 percent in-channel, 47 percent terrace, and 34 percent from quarries (EIP Associates 1994).

In-channel and terrace mining each have unique problems, but both remove gravel from a sediment-starved system, further decreasing sediment supply. Lake Mendocino blocks approximately 200,000 tons of sediment per year (SCWA 1985), and Warm Springs Dam blocks approximately 400,000 tons of sediment per year (COE 1973). In-channel mining removes gravel at rates significantly in excess of replenishment, hence contributing to channel incision. In the Mendocino Reach, an average of 100,000 tons of gravel per year were extracted in the 1980's and an average of 45,000 to 60,000 tons of gravel per year were extracted in the early 1990's. This rate of extraction led to a net sediment loss in the reach of 97,000 to 200,000 tons per year. Since the United States Army Corps of Engineers (COE) surveys conducted in the 1940's, the channel in the Mendocino Reach has degraded 10 to 18 feet (Florsheim and Goodwin 1993). In the Alexander Valley Reach, an average of 726,500 tons of gravel per year were extracted between 1982 and 1991. This extraction led to an average sediment loss in the reach of 630,000 tons per year. From 1991 to 1995, an average of 496,000 tons of gravel per year were extracted, leading to a sediment loss of 395,000 tons per year (Sonoma County, unpublished data). In the Middle Reach, an average of 164,000 tons per year were extracted. Natural recruitment there averages 128,000 tons per year, and the reach suffered a net sediment loss of 36,000 tons per year (EIP Associates 1994). Sustained overharvest as well as deep dredge mining of the channel in the

1960's and 1970's led to channel degradation of 10 to 20 feet in the Middle Reach channel since the 1940's (EIP Associates 1994).

Negative impacts from terrace (pit) mining are related less to removal of in-channel gravel and more to potential impacts from breaching. The large pits are separated from the river channel by alluvial separators which are non-engineered gravel banks. The bottom of the pits are well below river channel elevations. When the separator is breached, either quickly in one flood event or more slowly from bank erosion, the river channel can migrate into the pit, causing "capture". When this occurs, riverine habitat changes to lacustrine (lake-like) habitat as the river channel incorporates the pit. Pit capture can result in extreme downcutting both upstream and downstream. Many pits contain warm water predator fish species. As the separators breach and the river flows through the pits, warm water fish dominate the captured pit, impacting salmonid populations. Breached pits may also attract salmonids during spring emigration and trap them with no chance of survival once flows decline (Circuit Riders 1994a).

Sonoma County gravel demand from the Russian River through 2010 is projected to equal, if not exceed, current extraction rates. The low estimate for 1991 through 2010 is 75 million tons, 3.9 million tons per year. The moderate estimate is 109 million tons, 5.7 million tons per year. The high estimate is 171 million tons, 9.0 million tons per year (EIP Associates 1994). Natural replenishment from all sources is estimated at 484,000 tons per year, well below demand. Continued extraction at these rates will significantly exacerbate existing geomorphic problems.

In response to gravel mining concerns, both Sonoma and Mendocino counties have created gravel management plans. In 1994, Sonoma County implemented their Aggregate Resources Management Plan and accompanying Environmental Impact Report. This is a twenty-year plan which aims to monitor river cross sections and determine yearly sediment budgets based on actual replenishment (EIP Associates 1994). To prevent degradation of the river channel, mining in excess of measured replenishment would not be allowed; the only sediment available for mining would be that which the river deposits over a set baseline year.

Recently, Shamrock Materials was granted a ten-year permit to remove up to 131,000 tons per year from the Alexander Valley Reach. Several other ten-year permit applications are pending which, when added together, could far exceed the most recently monitored sediment deposition amounts (Sonoma County Water Agency, unpublished data). The Mendocino County plan for the Russian River [was never formally approved or adopted]. The draft discuss[ed] natural inputs, past extractions, projected extractions, and permitting processes (Slota, Mendocino County Water Agency, personal communication).

Decreased sediment supply causes shifts in a river's equilibrium that lead to channel changes. With a decreased sediment load, the ability of water to carry sediment is greater than the actual sediment supply. To compensate for this discrepancy, the "hungry" water picks up sediment from the channel. This constant scour causes the channel to downcut. Mainstem river downcutting causes bank erosion, tributary downcutting, and a drop in associated ground water levels. Anecdotal evidence claims the Russian River was an aggrading system in the 1930's (Circuit Rider Productions 1994b). Since the first Corps of Engineers surveys in 1940, reaches of the Russian River near Ukiah (Lake Mendocino Drive) have downcut approximately 20 feet and reaches in the Alexander Valley and Middle Reach have downcut from 12 to 20 feet (Florsheim and Goodwin 1993). These changes in bed elevation have undermined bridge supports and other structures. For example, the Highway 101 bridge in Healdsburg requires premature replacement due to extensive undermining of the bridge pilings caused by downcutting.

Tributary downcutting is a significant problem in the Russian River system. As mainstem channel elevation drops, tributary channels will increase velocity and scour, dropping their channel elevations (Florsheim and Goodwin 1993). Tributary downcutting causes the streams to widen, become shallower, and lose gravel substrate, decreasing fish habitat and passage (Circuit Rider Productions 1994b). Gravels necessary for salmonid spawning frequently scour out, leaving fewer sites of lesser quality. Forsythe Creek near Ukiah has downcut as much as 10 feet near the Highway 101 bridge since 1949. Extensive tributary downcutting necessitated the replacement of the Uva Drive Bridge in 1990 (Florsheim and Goodwin 1993). Lower Forsythe Creek now flows over clay substrate and has highly erodable vertical banks (COE 1982).

Feliz Creek, near Hopland, has downcut five feet since 1979 which has exposed buried pipelines (Florsheim and Goodwin 1993). Ackerman and Hensley creeks in Ukiah required major grade stabilization structures to protect upstream bridges.

As channels downcut and drop in elevation, the water table also drops. In the Middle Reach, the water table has dropped 5 to 10 feet coincident with channel incision of up to 20 feet (Florsheim and Goodwin 1993). Near Forsythe Creek, the water table level has also dropped coincident with a channel elevation drop of up to 10 feet (Florsheim and Goodwin 1993).

As rivers downcut, vertical banks are created. These banks occur along many reaches of the Russian River and are very susceptible to erosion (COE 1982; Florsheim and Goodwin 1993). The winter release schedule from Coyote Valley Dam may exacerbate the failure of these vertical, erodable banks. Coyote Dam operational procedures require sustained discharges up to 7,500 cfs for many days following storm events (COE 1986). The banks along much of the Russian River are composed of fine alluvium. During the extended high flow period, this porous soil saturates. When flows decline, the saturated banks are prone to mass failure causing significant erosion and land loss. Landowner response is to armor the banks, creating more channelization and compromising the remaining riparian habitat.

Channel incision causes an interruption between the active river channel and its associated flood plains (Circuit Riders 1994a). Vertical bank formation effectively cuts off natural floodplain function. In a “natural” situation, the floodplain acts to slow down water velocity and dissipate energy during high discharges. Floodplains also act as water retention features. Water from a floodplain is slowly returned to the channel, and retained water may create seasonal wetland habitat. Floodplains isolated from the river by channel incision are only inundated on very large flows; in most flow events they fail to slow water velocity or retain water, and hence, downriver flooding increases.

TIMBER HARVEST

Like so many other watersheds across the northwest, timber harvest has had a major influence on the Russian River basin. The lower river basin, including 20 miles

upstream of the mouth, was virtually stripped bare of redwoods around the turn of the century, and again after World War II (Clar 1984). Timber harvest also occurred throughout many tributary watersheds in the western hills of the basin. Unfortunately, the majority of these timber harvests occurred at a time when there was no real regulation.

The primary impact of logging to streams is erosion of hillsides and streambanks, agitated by using stream beds as roadways, operation of heavy equipment in streams, tractor logging on steep slopes, clearing of riparian zones and construction of logging roads. Erosion causes an influx of fine sediments into streams, embedding streambed gravels in silt and causing deposition in pools. This diminishes benthic invertebrate populations, a staple food source for salmonids and other species, and reduces spawning and rearing habitat. Riparian canopy loss, which is also associated with logging, elevates stream temperatures and decreases nutrient and invertebrate inputs to the stream from the riparian zone.

Conversion of native forestlands into pasturelands has had far-reaching effects throughout the basin. In A History of the Salmonid Decline in the Russian River, Park Steiner outlines the problem of habitat conversion as follows:

> **"Conversion", the harvesting of timber, burning what remained, and preventing re-growth through heavy grazing pressure, was and remains a commonly espoused and followed practice in the Russian River basin. For example, 90 percent of the Dry Creek watershed redwood and Douglas fir forests were transformed to other habitat types (COE 1973). This conversion to other vegetation types and the fragmentation of the remaining conifer forests likely reduced salmonid populations. Botkin et al. (1995) found that, in Oregon, steelhead and chinook populations were larger in conifer forests than in brush and grassland habitats. Furthermore, forest fragmentation statistically correlated with diminished steelhead and chinook populations. They concluded that forest conditions were a major factor controlling salmonid abundance. Habitat conversion will continue to impact salmonids as long as habitats are held at their altered successional levels.**

Though timber harvest in the Russian River watershed has been primarily focused on conifer forests, hardwood forests have not been entirely exempt. In the following paragraph, Park Steiner (1996) elaborates on the little-known practice of converting hardwood trees into coal to be used as fuel:

> **Entire stands of trees were removed and reduced to charcoal, then transported by rail to population centers in the San Francisco Bay Area. During a period believed to peak in**

> **the 1920's and 1930's, considerable pressure was put on oak and madrone forests in the hills between Cloverdale and Ukiah. Based on artifact and remnants recovered, one ranch north of Hopland owned by Malcomb King (personal communication) was the site of at least nine charcoal camps. Mr. King stated that he remembered the whole area being severely cut over. One ridge, Largo Ridge, was completely cleared of all madrones at least twice in his memory. The implications for impacts from hardwood harvest are similar to those for coniferous timber harvest. Roads and siltation, loss of riparian habitat, and changes in nutrient cycling all have the potential to cumulatively impact the fisheries resources.**
>
> **Today, timber harvest operations, mostly small-scale, by private landowners and timber companies continue in tributaries throughout the lower river basin. These operations are regulated by the California Department of Forestry (CDF). At the time this report was drafted, CDF was unable to provide a record of the total acreage of land within the Russian River watershed being affected by timber harvest operations. Current logging practices are greatly improved over past practices and the adverse effects on anadromous fish populations are not nearly as severe. Still, the effects of the earlier logging, road building, and grazing activities persist and will continue to affect our streams and salmonid resources for many decades.**

DAMS

In general, dams are extremely detrimental to salmonids for three reasons; 1) dams cut off access to valuable spawning habitat; 2) dams cause changes in flow and water temperatures, and; 3) dams impede sediment transport, often leading to significant morphological changes within the river system.

The two major dams within the Russian River watershed, Coyote Dam and Warm Springs Dam, have had a tremendous impact on the system. Both structures completely blocked upstream access to anadromous salmonids, denying them several miles of valuable spawning and rearing habitat. In *A History of the Salmonid Decline in the Russian River*, Park Steiner gives a detailed explanation of the impacts these dams have had on the Russian River system:

> **U.S. Army Corps of Engineers (COE) estimated that [Coyote Dam and Warm Springs Dam] blocked access to 86 to 169 miles of historically valuable spawning and rearing**

> **habitat, enough for about 8,000 to 14,000 steelhead adults and 100 coho adults.**
>
> **The areas blocked by these two dams historically were valuable habitat for steelhead and coho salmon. Before Coyote Dam, the East Fork Russian River and associated tributaries provided some of the best steelhead habitat in the entire basin and accounted for an "appreciable portion of the Russian River spawning" (USFWS 1948). Estimates of steelhead denied access to the area above Coyote Dam range from 2,213 to 7,685 fish per year (Prolysts 1984). According to the final environmental impact report prepared by the US Army Corps of Engineers (1973), Warm Springs Dam blocks access to spawning habitat for estimated populations of 6,000 steelhead and 100 coho.**

In addition to the two major dams in the Russian River basin, there are five smaller impoundments on the mainstem, and, according to unpublished data from the State Water Resources Control Board, 509 licensed or permitted small tributary dams (SEC 1996). Many of these smaller dams are also impeding the upstream migration of salmonids, cutting off valuable habitat in a system already lacking habitat due to degradation.

Healdsburg Recreational Dam, constructed in 1952, is one example of a small mainstem dam acting as a migration barrier. It blocks upstream salmonid migration at high and low flows and blocks all passage of American shad (SEC 1996). The Willow Water District Dam downstream is a partial barrier during early and late winter flows, and Mumford Dam in Redwood Valley is a nearly complete barrier to fourteen miles of the West Fork and many tributaries (SEC 1996).

Tributary dams in the Russian River basin are often responsible for the degradation of the most important salmonid habitat. Coho salmon and steelhead trout prefer smaller tributary streams over the mainstem for spawning and over-summer rearing. Historically, tributaries with perennial flow and healthy riparian vegetation supported significant populations of salmonids. Extensive tributary damming exists in the more populated areas of Sonoma and Mendocino counties, totaling over 500 within the basin. Most of these small tributary dams are private projects, often constructed without permits or application. The fisheries impacts of these structures are unknown, but many are likely to pose migration impediments during both adult and juvenile life stages. A Febraury 1995 aerial flight over Redwood Valley revealed dams and farm ponds on most tributaries to the West Fork Russian River, with many streams accommodating multiple dams (SEC 1996).

In addition to creating fish passage problems, these dams trap sediment, limiting recruitment of downstream spawning gravel. Furthermore, tributary dams and water

diversions reduce downstream flows and increase water temperatures. These alterations have serious detrimental impacts on juvenile steelhead and coho, who rely on cooler tributary streams with sufficient vegetative cover for spawning and summer rearing. Tributary systems are much smaller than the mainstem and therefore are much more sensitive to environmental changes. According to the COE (1982), the loss and degradation of tributary habitat is the primary factor limiting the recovery of the anadromous fishery in the Russian River (SEC 1996).

Problems caused by small tributary dams are magnified with larger dams. Inhibiting downstream sediment movement is a serious impact of Coyote Dam and Warm Springs Dam, which block approximately 200,000 and 400,000 tons of sediment per year, respectively (SEC 1996). Decreased downstream sediment transport causes loss of spawning gravels, along with a number of complex morphological problems downstream.

In A History of the Salmonid Decline in the Russian River (1996), Park Steiner details the changes in morphology and flow regime caused by dams and the subsequent effects of those changes as follows:

> "Naturally flowing rivers are dynamic systems prone to change. Rivers are constantly acting to achieve "dynamic equilibrium", a delicate balance between the flow of water, the sediment transported, and the form of the river. In attempting to reach equilibrium, a river will balance the flood flows and sediment supply by adjusting various features of the river channel, mainly slope, geometry, and roughness (Leopold et al. 1964). The dynamic equilibrium is delicate and any change in the flow or sediment load will initiate a change in the channel form. Sediment load is often reduced in regulated (dammed, diverted, controlled flow) rivers. Lack of sediment results in changes to the channel and flow characteristics (Florsheim and Goodwin 1993). Channel and flow changes often result in downcutting, channelization, fish passage problems, loss of habitat diversity, and decrease in fish populations (Moyle 1976a; Florsheim and Goodwin 1993).
>
> Prior to flow regulation, the aquatic and riparian habitats of the Russian River were quite different from present conditions. The river was shallower and wider, meandering across its alluvial valleys. These meanders created oxbows and side sloughs which, coupled with seasonal wetlands and backwater marshes, created seasonal habitats for waterfowl and for rearing steelhead and coho salmon (Florsheim and Goodwin 1993; Circuit Rider Productions 1994a).

> Changes in the flow regime and sediment transport have caused significant morphological changes in the Russian River channel (Florsheim and Goodwin 1993). Dams decrease flow fluctuations and cut off downstream sediment supply. Together, Coyote and Warm Springs dams are the primary source of the river's long-term sediment deficit, blocking transport of an estimated 600,000 tons of sediment per year (Sonoma County Water Agency 1985; COE 1973). Decreased sediment load initially causes the river to increase in depth, resulting in extensive bank erosion (Florsheim and Goodwin 1993).
>
> Loss of the 600,000 tons of sediment trapped annually behind the dams has caused a multitude of adverse morphological problems throughout the basin. Augmentation from the Potter Valley Project and the regulating force the two major dams have altered river discharge characteristics. Winter flow peaks are dampened under all but the highest flows. The discharge patterns from the two dams act to protract high water events. Summer flows are greatly augmented; once extremely low to intermittent, mean summer flows at Healdsburg are now approximately 200 cfs (EarthInfo 1994). "

DIVERSIONS

In the Russian River basin, water is regularly withdrawn by domestic, municipal, and agricultural users. Like dams, these diversions tend to decrease available habitat and increase water temperatures, by decreasing downstream flows. This adversely affects salmonids, particularly steelhead and coho which rely on tributary habitat for summer rearing.

Unscreened water diversions pose a more immediate danger to young salmonids, who can be killed if they are drawn into water pumps or become stuck against the pumps' screened intakes. California Department of Fish and Game policy states that all intakes pipes must be screened where salmonids are present. Criteria for screens require that they have a pressed wire mesh with openings of 5/32 inches or less and an approach velocity to that mesh of less than 0.33 feet per second (SEC 1996).

Despite these criteria, many Russian River water diversions remain unscreened or inadequately screened. According to unpublished data from the California Department of Fish and Game, a 1991 survey from Lake Mendocino Drive near Ukiah to the Highway 101 bridge south of Hopland found 63 pumped diversions; eight with proper screen size

but unacceptable approach velocities, 51 with improper screens, and four with no screens at all (SEC 1996).

Such unscreened or inadequately screened diversions pose the highest threat during the spring months, when the most juvenile salmonids are present in the river system. Fortunately, during this period pumping activity is generally low, dependant upon the weather, with the primary uses being frost protection and early irrigation. However, should a frost event occur or early irrigation be necessary, most pumps would run simultaneously, presenting a cumulative withdrawal of large proportions. Any juvenile outmigration occurring at this time could experience significant loss.

CHANNELIZATION

Over time, human-induced alterations of the river bed have caused geomorphic changes to the Russian River, including the straightening and narrowing of the riparian corridor. Early channel stabilization efforts, which began by the 1850s, were an attempt to increase the size and fix the location of land holdings, surveyed from the center of the active channel. Channelization continued in the years following for agricultural purposes and flood control efforts. The result has been a decrease in the natural sinuosity of the mainstem and many tributaries and an acceleration of riverbed incision due to in-channel mining activities. "Historic aerial photographs, topographic maps, surveyed cross-sections, longitudinal profiles and oral histories provide a detailed account of the evolution of the Russian River from a dynamic meandering river which migrated across its floodplain leaving remnant traces such as ox-bow lakes to the existing deeply incised and relatively narrow riparian area. In the past century, land use practices such as timber harvest, grazing, agriculture, dam construction, and gravel extraction have changed the erosion and sedimentation characteristics of the river, and dramatically affected dominant geomorphic processes and altered channel morphology (PWA 1993)."

Channelization of the mainstem and tributaries has had a negative impact on habitat complexity, increased bank erosion and led to channel incision, or downcutting. Incision in the mainstem of the river during the past century has been significant, with approximately 12 feet of degradation since 1934 at the Monte Rio Bridge (PWA 1993).

Channelization and downcutting can create fish migration problems by increasing the height of a given gradient change, particularly when combined with instream structures. Healdsburg Recreation Dam is a good example of one such migration impediment in the Russian River. By 1969, the river channel below the dam's concrete sill had scoured severely. By 1991, downcutting had created a 14-foot elevation change in the riverbed immediately upstream and downstream of the dam (Florsheim and Goodwin 1993, as cited in SEC 1996). Subsequently, the dam became a total upstream migration barrier during the summer base flow period and is an intermittent barrier to adult salmonids during winter flows. Willow Creek Diversion Dam in Ukiah has also become a

fish migration barrier under high and low flows due to downcutting immediately downstream, which has caused the channel elevation to drop 10 feet below the dam's concrete spillway (Florsheim and Goodwin 1993, as cited in SEC 1996).

Most tributaries within the Russian River watershed are channelized to varying degrees. The most significant channelization is associated with urban areas, where streams are often confined with concrete and boulder rip-rap to maintain streamside roads and properties. Doolin Creek in Ukiah is one of many creeks that has passage problems due to urban encroachment and channelization (SEC 1996). Rip-rap grade stabilization structures on Ackerman and Hensley creeks have both required modification with fish ladders in an attempt to improve salmonid access (SEC 1996). Because the entire Russian River watershed is one interconnected system, most problems with downcutting on tributaries are attributable to downcutting in the mainstem and a system-wide trend towards channel degradation.

GRAZING

Grazing has been a fairly common practice within the Russian River watershed, since it was settled by the Russians in the early 1800s (Wilson 1990). Lands were cleared by early settlers for the purpose of providing pastureland to support their livestock. Long-term grazing throughout the basin has resulted in increased hillside erosion, more rapid runoff, compaction of soils, and reduced bank storage of water to provide summer flow. The concentration of cattle within the riparian zone has resulted in the loss of riparian vegetation, warming of the water, erosion from bank failure, and reduction of water quality from algae growth, nutrient loading, and turbidity.

AGRICULTURE AND THE EXPANSION OF VINEYARDS

Agriculture has impacted the Russian River since the late nineteenth century and is still the dominant land use within the basin. From the beginning, many farmers and agricultural operations have practiced methods which have had a drastic effect on the watershed, such as removal of riparian vegetation, channel stabilization measures, diverting flows and decreasing water quality by releasing fertilizers and pesticides into the river. (See 'Riparian Vegetation' in the 'Limiting Factors' section for more details).

The current trend in agriculture in the Russian River basin is from croplands, livestock, dairy lands, and forestlands to vineyards, as the basin bears some of the best wine grape growing conditions in the world. The current California wine boom has been an economic blessing for many rural land owners. Statewide, wine grape acreage has approximately doubled since 1990 (CA Ag Stats Service 1999). Prior to 1990, Sonoma County had approximately 36,337 acres of vineyard. According to a GIS Analysis performed by Researchers at Hopland Research Extension Center (HREC), the past decade's unprecedented growth of approximately 11,663 acres of new vineyard have brought the total acreage to at least 48,000. This is 20% more than reported by county

Ag officials (Merenlender 2000).

New vineyards typically occur at higher elevations and on steeper slopes than earlier plantings, resulting in the recent conversion of approximately 9,505 acres of undeveloped land.. Between 1990 and 1997, at least 1,631 acres of dense hardwood forest, 278 acres of conifer, 367, acres of shrubland, and 7,229 acres of oak grassland savanna were converted to vineyards in Sonoma County (Merenlender 2000).

The upper Russian River Basin, in Mendocino County, has also seen significant growth of vineyard acreage. The GIS vineyard analysis conducted by HREC researchers was done at a county-level. It would aid in the Basin-planning process to have such studies done on a basin-wide level.

Vineyards require a large amount of water, and therefore directly impact salmonid habitat. Warmer water temps due to lower flow stresses salmonids and aids warm-water fishes such as the squawfish which feed on salmonid fry. Loss of wetlands, reduced flow, passage barriers and blockage of gravel recruitment due to small dams are chief impacts vineyards have on salmonid habitat. Sedimentation and removal of riparian vegetation are others.

Pierce's Disease

In the past, many wine grape growers have removed riparian vegetation in order to access water entitlements, maximize cultivated acreage, and eliminate food for potential pests. These days, particularly in the face of recent epidemics of Pierce's disease, it is becoming accepted among vineyard managers that leaving native riparian vegetation intact can actually be better for pest control. Growers are very concerned about the glassy-winged sharpshooter, an insect that spreads the bacterium Xylella fastidiosa, causing Pierce's Disease, which destroys vines by clogging the plant's water-conducting tissues.

Despite efforts to contain the sharpshooter in southern California, it has been surfacing recently in different locations throughout Northern and Central California; egg masses have been found in Napa and Sonoma counties (Cal. Ag. 2000). Governor Gray Davis has signed legislation providing $6.9 million to fight the glassy-winged sharpshooter, and an additional $6.9 million is expected next year. Congress is currently making $7.14 million available to protect California crops from the pest (Cal. Ag. 2000).

Efforts to fight Pierce's Disease will have a substantial impact to the Russian River basin. Because of the proximity of vineyards to creeks, growers, under the guidance of the California Department of Fish and Game (CDFG), will be put in the position of riparian habitat managers, as well as farmer. Several riparian plants, including some invasive non-natives, are alternate host plants for Pierce's disease, which means they are carriers who do not suffer the symptoms. Certain types of sharpshooters feed on plant

xylems, where the disease is carried, and become vectors, spreading it to nearby vineyards as the vines experience rapid springtime growth.

One approach to decreasing the severity of Pierce's disease is to remove specific riparian plants and replace them with native species of plants that do not host the disease, thereby reducing the number of infected sharpshooters in the spring (PDRHW 2000). The general strategy is to create a continuous overstory of non-host trees so that shrubs and perennials grow in shade, as some species of sharpshooters are attracted to plants growing actively, as in the sun. A transition zone at the edge of the riparian is also recommended and, of course, long-term management is required. It should be stressed that the goal is replacement, not removal, of riparian plants. "The more restoration departs form natural tendencies of the local restoration, the higher the restoration and maintenance cost, and the greater risk of failure (PDRHW 2000)." It should also be stressed that all landowners planning a revegetation project for Pierce's disease prevention may do so only under the guidance of CDFG. Preferred plant composition and structure of a given riparian zone will vary from place to place. For a list of host species and suitable replacements, and please contact CDFG [or see The Pierce's Disease/Riparian Habitat Workgroup's Information Manual: Riparian Vegetation Management for Pierce's Disease in North Coast California Vineyards.

Vineyard Ordinances

In response to concerns over the mass conversion of oak woodland to vineyard, and the current lack of regulation guiding it, local regulatory policies are rapidly evolving to curtail hillslope erosion and protect habitat. The requirement of vineyard ordinances for farmers to register new vineyard developments with the county is one of the first ever legislative limits on agriculture in California (Merenlender 2000*). In 1991, Napa County passed an ordinance that required farmers to submit an erosion control plan and restricted new vineyards to a 35' setback from streams; 105' for slopes over 40% (Merenlender 2000*). In 1999 Napa was sued by Sierra Club for leaving review to discretion of agency reviewer, a huge loophole (Merenlender 2000*). In December 1999, Lake County passed an ordinance mandating that the clearing of more than 100 acres of native vegetation require the submission of an Environmental Impact Report (EIR). Despite local efforts, however, in February 2000 the California Legislature passed legislation stating that vineyards are exempt from CEQA review (Merenlender 2000*).

In February 2000, after much debate between vineyard owners and environmental interests, Sonoma County passed a vineyard ordinance to control sedimentation caused by vineyard erosion. The ordinance identifies three levels of vineyards and seven types of "highly erosive" soils and provides corresponding requirements (Merenlender, 2000*). Level I vineyards are on slopes <15% (10% for highly erosive soils). They require a 25' setback from streams and a notice to the Agricultural Commissioner (Merenlender 2000*). Level II vineyards are of 15-30% slope and require a 50' stream setback and a certified erosion control plan prepared by any qualified person (Merenlender 2000*).

Level III vineyards are on slopes of 30-50% and require a 50' stream setback and a certified erosion control plan prepared by any qualified professional (Merenlender 2000*). Planting on slopes greater than 50% is prohibited, with some exceptions. Replanting of previously established vineyard is treated differently.

Mendocino County is currently developing a vineyard ordinance. Many of the tributaries of the Russian River flow through oak woodlands, one of the most biologically diverse and yet unprotected ecosystem types in California. From 1990-97, "Thousands of acres of native vegetation, including hardwood such as Valley Oak, Coast Live Oak, and Madrone… have been removed to establish new vineyards throughout coastal California without a systematic environmental review process prior to conversion (Merenlender, 2000*). Protection to oak woodlands equal to that of coniferous forests–timberlands are protected by the Forestry Protection Act (FPA) of 1973–is essential to salmonids, as they pass through both ecosystem types. Adina Merenlender, in her article Policy Analysis Related to the Conversion of Native Habitat to Vineyards, outlines these discrepancies as follows:

> **"Under the current Forest Practice Rules, salmon and steelhead are afforded some level of protection when they enter freshwater habitat located in a coniferous setting. In many cases, salmon continue their upstream migration past coastal conifer forests and ultimately complete their journey in a predominately oak woodland habitat type. This scenario is true for the Russian, Navarro, Eel, Klamath, Smith and Sacramento River systems. However, as the fish move from one forest type to another, the level of protection is not contiguous, resulting in only a minimal level of protection for a small portion of the overall habitat. For example, the lower part of the Russian River is surrounded by forestland where timber harvest and conversion in these watersheds are subject to the FPA. Whereas in the upper Russian River and its tributaries which run through oak woodland habitat, where environmental protection is limited to streambed alterations and water quality violations."**

As one of the least regulated land uses, vineyard expansion substantially affects the future face of riparian habitat in the Russian River watershed. Researchers at HREC are developing a Geographic Information System (GIS) model that will predict where vineyards are most likely to go in the near future, based on recent trends. The model uses a logistic regression analysis to quantify the correlation between geographic factors and vineyard development. The model may be used by planning agencies to assess future trends in vineyard expansion (Heaton 2000).

SPORT FISHING

Sportfishing has inevitably had an impact on the fishery resources within the Russian River Basin. Park Steiner explains this impact in A History of the Salmonid Decline in the Russian River Basin as follows:

“In-river sport fishing has directly impacted spawning and rearing salmonid populations. Throughout the twentieth century, the Russian River has been a popular angling stream. The winter steelhead run was internationally famous, and its proximity to the San Francisco Bay Area made the Russian River accessible to millions of people (Prolysts 1984). With the advent of improved transportation networks, angling popularity intensified, and local economies benefited from the recreational trade. As the number of anglers increased, however, steelhead populations decreased, escalating harvest pressure when fish numbers were low. Only limited catch data are available, but a declining trend is evident. From the 1930’s to the 1950’s, anglers caught many steelhead, more than 15,000 in 1936. Under exceptionally favorable conditions in 1957, they caught approximately 25,000. By 1971/72, however, angler harvest had dropped to approximately 5,000 fish. By the 1980’s, angler success had diminished to the point that fish derbies were no longer held in Mendocino County (Prolysts 1984).

Extremely low salmon and steelhead populations observed in the early 1990’s stimulated concern about angler harvest of adults in the Russian River and other North Coast streams. Concern was most strongly directed at the diminishing populations supported by natural spawning. Angler pressure has been shown to have a significant impact on already depressed salmonid populations. These small populations can sustain little or no harvest (Cramer et al. 1995). Annual harvest estimates for adult steelhead in California range from 12 to 56 percent of the species population, with greater proportions taken in more southerly watersheds. A higher proportion of small salmonid escapements are caught in California streams during low water years. On the Eel River, situations often occur where discharge is sufficient to attract adult salmonids upstream, but inadequate to allow passage into tributary streams (SEC, unpublished data). These fish concentrate in pools as they wait for high flows, making them easy targets for anglers. The same situation occurs on the Russian River. Concerns about overharvest contributed to the 1995 closure of the mainstem Eel River to fishing (CDFG 1994) but no similar action has been proposed for the Russian River.

> Juvenile salmonid populations are also affected by freshwater harvest. Substantial numbers of yearling steelhead are caught by anglers who call them “trout’. A study of the Big Sur River found that the majority of emigrating wild juvenile steelhead were caught before they made it downstream (Cramer et al. 1995). In the Russian River basin, tributary fishing is prohibited, yet harvest of “trout” (juvenile steelhead) remains a significant source of loss for some rearing steelhead populations. Tributaries in urban areas, such as Ukiah, are especially vulnerable as anglers are often uninformed or unconcerned about regulations.
>
> Ocean harvest is a significant source of salmonid loss (Cramer et al. 1995). In addition to targeted harvest, oceanic salmonids are taken unintentionally during harvest of other types of fish (bycatch), or are taken through high seas drift net fishing. Both bycatch and drift net fishing are suspected of affecting oceanic salmonid populations, but impacts are difficult to quantify (Higgins et al. 1992).”

SUMMARY OF LAND USE IMPACTS

Watersheds, and every species within those watersheds, are affected by nearly all human endeavors. Countless human activities impact salmonids, either directly or indirectly. Individually, the factors may not seem significant, but cumulatively they become severe . The Russian River basin has been impacted by humans in significant proportions for nearly 200 years. Clearly, the Russian River system has been too far altered to ever regain its natural form. Nevertheless, it will continuously seek equilibrium based on its current state of channelization, reduced sediment supply, and flow regulation.

The recovery of salmonids in the Russian River and in other watersheds throughout the North Coast requires a significant decrease in all of the aforementioned impacts. This will require community cooperation on a large scale to protect entire watersheds, not just streams or forests.

When considering the viability of any river system for salmonids and other species, it is essential that focus isn’t concentrated solely on the river, but that all planning occurs on a watershed scale. In the Russian River it is crucial to realize that, though all anadromous fish must navigate through the mainstem of the river, the vast majority of the usable salmonid habitat within the basin lies in the tributaries. Accessible and healthy tributaries are absolutely vital to the maintenance of healthy salmonid populations.

The survival of salmonids in the Russian River rests upon the reversal of practices that encourage riparian vegetation removal, erosion control, gravel extraction, sustained unnatural flows, and other alterations of the river's natural biological system, as well as the long term mitigation of the effects of these practices.

Appendix C

METHODS FOR DATA COLLECTION

An important part of any assessment includes becoming compiling and summarizing existing information such as maps, historical stream surveys, literature and file reports on sediment sources, hydrology, water appropriations and impoundments, timber and other resources, management practices, and jurisdictional boundaries (zoning or other restrictions). This provides basic information on past and present land and other natural resources management, and their potential effect on present and potential fish production. It also provides the guidelines for realistic planning, aids in identifying data gaps. DFG has conducted a historic reveiw of each tributary discussed to assemble this information.

Following completion of a preliminary watershed overview, CDFG has conducted fish habitat inventories including: 1) stream channel typing; 2) habitat typing; and 3) biological surveys to describe fish habitat utilization and distribution of fish and other aquatic species basin-wide .

Stream channel typing describes relatively long reaches within a stream using eight morphological characteristics. Habitat typing describes the specific pool, flatwater, and riffle habitats within a stream. The information provided by habitat and channel typing, and biological information collected during spawning surveys and/or juvenile rearing surveys aids in determining if critical habitat needs of a target species are lacking, and if there are areas where improvements can be made. The methodology utilized in the Russian River basin follows the procedures in the California Salmonid Stream Habitat Restoration Manual (Flosi et al. 1998), and is summarized below:

Physical Habitat Inventory

Channel typing is conducted according to the classification system developed and revised by David Rosgen (1996). Channel typing is conducted simultaneously with habitat typing and follows a standard procedure to record measurements and observations. There are five measured parameters used to determine channel type: 1) water slope gradient, 2) entrenchment, 3) width/depth ratio, 4) substrate composition, and 5) sinuosity. Channel typing is used to describe the way the channel handles sediment transport and to guide the suitability and type of fish habitat improvement.

The habitat typing procedure utilized is a standardized methodology originally developed by P. A. Bisson, et al. (1982) and later expanded by Trinity Fisheries Consulting on contract to CDFG. CDFG’s protocol classifies 100 percent of the wetted channel, and measures the habitat variables discussed below through a 10% random sampling protocol. A basin-level habitat inventory is designed to produce a thorough description of the stream's naturally occurring pool-riffle-run units. Habitat types are described according to location, orientation, and water flow.

There are eight components to the inventory: flow, temperatures, habitat type, embeddedness, shelter rating, substrate composition, canopy, and bank composition. Elements of each are briefly discussed below:

1. Flow:

Flow was measured in cubic feet per second (cfs) at the bottom of the stream survey reach using standard flow measuring equipment. Flows were also measured at major tributary confluences.

2. Temperatures:

Water and air temperatures, and time, are measured by crew members with hand held thermometers and recorded at each tenth unit typed. Temperatures are measured in Fahrenheit at the middle of the habitat unit and within one foot of the water surface.
Temperatures are also recorded using remote Temperature recorders which log temperature every two hours, 24 hours/day.

3. Habitat Type

Habitat typing uses the 24 habitat classification types defined by McCain and others (1988). Habitat units are numbered sequentially and assigned a type identification number selected from a standard list of 24 habitat types. Dewatered units are labeled "DRY". Maacama Creek habitat typing used standard basin level measurement criteria. These parameters require that the minimum length of a described habitat unit must be equal to or greater than the stream's mean wetted width. All unit lengths were measured, additionally, the first occurrence of each unit type and a randomly selected 10% subset of all units were completely sampled (length, mean width, mean depth, maximum depth and pool tail crest depth). All measurements were in feet to the nearest tenth.

5. Embeddedness:

The depth of embeddedness of the cobbles in pool tail-out reaches is ocularly estimated by the percent of the cobble that is surrounded or buried by fine sediment. The values recorded use the following ranges: 0 - 25% (value 1), 26 - 50% (value 2), 51 - 75% (value 3), 76 - 100% (value 4). Additionally, a rating of "not suitable" (NS) is assigned to tail-outs deemed unsuited for spawning due to inappropriate substrate particle size, having a bedrock tail-out, or other considerations.

5. Shelter Rating:

Instream shelter is composed of those elements within a stream channel that provide salmonids protection from predation, reduce water velocities so fish can rest and conserve energy, and allow separation of territorial units to reduce density related competition. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All shelter is then classified according to a list of nine shelter types. A standard qualitative shelter value of 0 (none), 1 (low), 2 (medium), or 3 (high) is assigned according to the complexity of the shelter. The shelter rating is calculated for each habitat unit by multiplying shelter value and percent covered. Thus, shelter ratings can range from 0-300, and are expressed as mean values by habitat types within a stream.

Value	Instream Shelter Complexity:
0	! No shelter.
1	! One to five boulders. ! Bare undercut bank or bedrock ledge. ! Single piece of large wood (>12" diameter and 6' long) defined as large woody debris (LWD).
2	! One or two pieces of (LWD) associated with any amount of small wood (<12" diameter) defined as small woody debris (SWD). ! Six or more boulders per 50 feet. ! Stable undercut bank lacking root mass. ! A single root wad lacking complexity. ! Branches in or near the water. ! Limited submersed vegetative fish cover. ! Bubble curtain.
3	Combinations of: ! LWD/boulders/root wads. ! Three or more pieces of LWD combined with SWD. ! Three or more boulders combined with LWD/SWD. ! Bubble curtain combined with LWD or boulders. ! Stable undercut bank with greater than 12" undercut, associated with root mass or LWD. ! Extensive submersed vegetative fish cover.

***Shelter Rating- The shelter rating is calculated for each habitat unit by multiplying shelter value and percent cover. Using an overhead view, a quantitative estimate of the percentage of the habitat unit covered is made. All cover is then classified according to a list of nine cover types. Thus, shelter ratings can range from 0-300, and are expressed as mean values by habitat types within a stream.

From: California Salmonid Stream Habitat Restoration Manual (Flosi, et al. 1998)

6. Substrate Composition:

Substrate composition ranges from silt/clay sized particles to boulders and bedrock elements. In all fully measured habitat units, dominant and sub-dominant substrate elements were ocularly estimated using a list of seven size classes.

8. Canopy:

Stream canopy density was estimated using a modified handheld spherical densiometer. Canopy cover relates to the amount of stream shaded from the sun. An estimate of the percentage of the habitat unit covered by canopy was made from the center of approximately every third unit in addition to every fully-described unit, giving an approximate 30% sub-sample. In addition, the area of canopy was estimated ocularly into percentages of evergreen or deciduous trees.

9. Bank Composition:

Bank composition elements recorded range from bedrock to bare soil, and vegetation components range from grass to trees. The dominant composition type and the dominant vegetation type of both the right and left banks for each fully measured unit were selected from the range on the habitat inventory form. Additionally, the percent of each bank covered by vegetation was estimated and recorded.

BIOLOGICAL INVENTORY

Biological sampling during stream inventory is used to determine fish species and their distribution in the stream. Biological inventory is conducted using one or more of three basic methods: 1) stream bank observation, 2) underwater observation, 3) electrofishing. These sampling techniques are discussed in the California Salmonid Stream Habitat Restoration Manual.

DATA ANALYSIS

Data from the habitat inventory form are entered into Habitat, a dBASE IV data entry program developed by Tim Curtis, Inland Fisheries Division, California Department of Fish and Game. The HABITAT program provides a fully automated summarization of the fish habitat inventory data. This program processes and summarizes the data, and produces the following tables and appendices:

- Riffle, flatwater, and pool habitat types
- Habitat types and measured parameters
- Pool types
- Maximum pool depths by habitat types
- Shelter by habitat types
- Dominant substrates by habitat types
- Vegetative cover and dominant bank composition
- Fish habitat elements by channel type “Reach

Each surveyed stream has a written report that presents the information from the watershed overview , a summary of the habitat inventory, results of biological surveys, and a listing of specific problems discovered during the field survey. data is presented in a form that includes both data summaries and graphic displays of the data. These tributary reports have been utilized by CDFG to analyze the need for habitat restoration in the basin.

The computerized stream habitat inventory reports are sent to CDFG headquarters in Sacramento, where a statewide file of stream habitat inventories is maintained. Paper copies and digital copies are sent to CDFG central coast region headquarters in Yountville where a region-wide file of stream habitat inventories is maintained, and are also at the Russian River basin planning office in Hopland. Paper copies are also made available to other agencies, groups and Landowners, both public and private, whose properties were accessed during data collection upon request.

Survey data is stored in the programs geographic Information system (GIS) utilizing ARCINFO software. Data can be viewed as overlays of stream maps by using the ARCVIEW program, which requires Windows and an IBM-compatible PC .

The base layer of information is a digitized representation of all blue line streams in the basin linked to a the tributary database**.** Maps were created from the “reachsum” GIS database of salmonid habitat data, summarized at the geomorphic reach level using the Rosgen classification of channel type. The database was built from data collected from in-stream salmonid habitat surveys done or supervised by the California Department of Fish & Game from 1994 to 2000.

Source:

DATABASE (reachsum-x.dbf) - A Russian River “reachsum” database of reach-level attribute data was originally created in June, 2000 by Bob Coey, California Department of Fish & Game (DFG) Russian River Basin Planner, using DFG Dbase IV program “reachsum.prg” add-on to the “Habitat” Dbase program (this add-on was written by Ken Bunzel in the mid-1990s). This initial database summarized the in-stream habitat data collected by DFG-supervised field crews from 1994 to 1997. The reachsum Dbase program took the 1994-1997 habitat surveys database files and summarized them at the Rosgen geomorphic reach level, as labeled by the field survey crews and recorded in the database files. The 1998 to 2000 habitat surveys database files were processed into a second “reachsum” database using a Microsoft Access 2000 program written by Zeb Young, a University of California GIS Analyst located at the Hopland Research & Extension Center. The 1994-1997 habitat surveys were also rerun through this new Microsoft Access Program. The Access 2000-based reachsum program takes into account the length of each habitat unit when calculating reach-level statistics, and also calculates additional useful reach-level information.

GIS LAYER (reachsum-dissolve.shp) - The salmonid habitat database files were also matched to a routed GIS layer of 1:100,000 streams (created by Mike Byrne at DFG in the mid-1990s, and revised by Colin Brooks and Zeb Young) using the Arc/Info dynamic segmentation process. Mike Byrne did the dynamic segmentation for most of the 1994 to 1997 salmonid habitat surveys. Colin Brooks, Jeff Opperman, Emily Heaton, and Zeb Young did the dynamic segmentation for the 1998 to 2000 data. The 1998 and 1999 surveys were calibrated using field maps to provide greater position accuracy of habitat units and channel type locations. Habitat surveys done during 2000 had approximately every 10th habitat unit location recorded with a Garmin GPS unit, and these data points were used to create a more precise calibration of the habitat surveys to the underlying GIS streams layer. Towards the end of the processing of the

2000 data, a more detailed 1:24,000 streams layer became available from the California Department of Forestry, and we started using that layer for dynamic segmentation. The habitat surveys were done from 1994 to 2000, with most surveys being done by the California Department of Fish & Game and Americorps field crews, and some (mostly in 1997) by the Sonoma County Water Agency. Habitat surveys are continuing in 2001, and these data will be added to the reachsum database and GIS layer when they become available, most likely in early 2002.

Level III and Level IV Habitat Types:

The three or four letter abbreviations in parentheses, (***), are the standardized abbreviations adopted by DFG. The three digit numbers in brackets, [*.*], are the standardized numbers adopted by DFG. The numbers in braces, {**}, are the numbers listed in the Pacific Southwest Region Habitat Typing Field Guide, USDA-USFS.

RIFFLE			
Low Gradient Riffle	(LGR)	[1.1]	{1}
High Gradient Riffle	(HGR)	[1.2]	{2}
CASCADE			
Cascade	(CAS)	[2.1]	{3}
Bedrock Sheet	(BRS)	[2.2]	{24}
FLATWATER			
Pocket Water	(POW)	[3.1]	{21}
Glide	(GLD)	[3.2]	{14}
Run	(RUN)	[3.3]	{15}
Step Run	(SRN)	[3.4]	{16}
Edgewater	(EDW)	[3.5]	{18}
Pools			
MAIN CHANNEL POOL			
Trench Pool	(TRP)	[4.1]	{8}
Mid-Channel Pool	(MCP)	[4.2]	{17}
Channel Confluence Pool	(CCP)	[4.3]	{19}
Step Pool	(STP)	[4.4]	{23}
SCOUR POOL			
Corner Pool	(CRP)	[5.1]	{22}
L. Scour Pool - Log Enhanced	(LSL)	[5.2]	{10}
L. Scour Pool - Root Wad Enhanced	(LSR)	[5.3]	{11}
L. Scour Pool - Bedrock Formed	(LSBk)	[5.4]	{12}
L. Scour Pool - Boulder Formed	(LSBo)	[5.5]	{20}
Plunge Pool	(PLP)	[5.6]	{9}
BACKWATER POOLS			
Secondary Channel Pool	(SCP)	[6.1]	{4}
Backwater Pool - Boulder Formed	(BPB)	[6.2]	{5}

Backwater Pool - Root Wad Formed	(BPR)	[6.3]	{6}
Backwater Pool - Log Formed	(BPL)	[6.4]	{7}
Dammed Pool	(DPL)	[6.5]	{13}
DRY STREAMBED	(DRY)	[7.0]	

From: California Salmonid Stream Habitat Restoration Manual (Flosi, et al. 1998)

Appendix D

INTERPRETING HABITAT INVENTORY DATA INTO RECOMMENDATIONS

At the end of every stream inventory report recommendations for fish habitat improvement are listed after an analysis of the channel and habitat tying data, the biological inventory, and a review of the comments. The recommendations generally fall into the subsequent categories.

1) Management as an anadromous, natural production stream versus enhancement through artificial propagation.

    a) Management as an anadromous, natural production stream includes all streams that currently support anadromous fish and all streams or stream reaches that are restorable to sustain anadromous fish. Naturally spawned salmonids provide the foundation of the Department's management program.

    b) In some cases cooperative fish production is desirable if the fish rearing facilities are linked to restoration goals and objectives approved by DFG. Hatchery enhancement programs are reviewed carefully by Regional and statewide personnel and must have specific purpose, need and scientific justification, as well as a five year management plan.

2) Design and engineer pool enhancement structures to increase the number of pools or deepen existing pools, where the banks are stable or in conjunction with stream bank armor to prevent erosion.

    a) In general, pool enhancement projects are considered when primary pools comprise less than 40% of the length of total stream habitat. In first and second order streams, a primary pool is defined as having a maximum depth of at least two feet, occupy at least half the width of the low flow channel, and be as long as the low flow channel width. In third and fourth order streams, a primary pool must be at least three feet deep.

    b) Part III, Stream Channel Type Descriptions and Structure Suitability, includes specific structure recommendations for each channel type. Instream habitat improvement is only appropriate in stream reaches suitable for habitat improvement structures.

    c) Table 2, Summary of Habitat Types and Measured Parameters, found in the stream inventory report lists the Level IV habitat types for the stream inventoried. Habitat types such as step runs and low gradient riffles can often be converted into pool habitat if pools are needed.

    d) Table 4, Summary of Maximum Pool Depths By Habitat Types, found in the stream inventory report lists the depth of the pools by habitat type. Pools that are too shallow to qualify as primary pools can often be enhanced by increasing scour.

e) Part VI, Project Planning and Organization, and Part VII, Project Implementation, must be thoroughly reviewed before proceeding with a pool enhancement project.

3) Increase woody cover in the pool and flatwater habitat units, with complex, woody cover, especially where the material is locally available.

    a) In streams or stream reaches where the mean pool shelter ratings are calculated to be less than 80 it is desirable to increase the amount of cover. Table 1, Summary of Riffle, Flatwater and Pool Habitat Types lists the mean shelter ratings for the Level II habitat types. Log and root wad cover structures in the pool and flatwater habitats are needed to improve both summer and winter salmonid habitat. Log cover structure provides rearing fry with protection from predation, rest from water velocity, and also divides territorial units to reduce density related competition. Table 5, Summary of Mean Percent Cover By Habitat Type identifies the type of cover by habitat type present.

    b) Part III, Stream Channel Type Descriptions and Structure Suitability, includes specific structure recommendations for each channel type. Cover structures should only be considered in stream reaches suitable for habitat improvement structures.

    c) Part VI, Project Planning and Organization, and Part VII, Project Implementation, must be thoroughly reviewed before proceeding with a cover enhancement project.

4) Increase canopy by planting willow, alder, or native conifers along the surveyed stream banks where shade canopy is not at acceptable levels, or in reaches above the survey section when temperature impacts have originated upstream. Planting must be coordinated with bank stabilization and/or upslope erosion control projects.

    a) Where summer water temperatures are above the acceptable range for salmonids (Appendix P) increasing the canopy is desirable. Water temperatures taken during the fish habitat inventory are found on Table 8, Fish Habitat Inventory Data Summary.

    b) In general, revegetation projects are considered when canopy density averages less than 80% in specific steam reaches or sub-areas. Canopy density, listed by the coniferous and deciduous components are found on Table 8.

    c) The mean percent right and left banks covered with vegetation are found on Table 7, Summary of Mean Percent Cover For The Entire Stream. Mean Percentage of Dominant Substrate and Dominant Vegetation are found on Table 9. Using these two tables, stream reaches can be identified where the dominant elements composing the structure of the stream banks is gravel/sand/silt/clay and riparian vegetation is lacking. These areas are good candidates for revegetation.

d) Part VII, Revegetation, has detailed instructions on techniques including willow sprigging and planting seedlings.

5) To establish more complete and meaningful temperature regime information, 24 hour monitoring during the summer warm water temperature period should be conducted for 3 to 5 years.

  a) This recommendation is made when limited water temperature data are available, but suggest that maximum temperatures are likely above the acceptable range for juvenile salmonids based upon temperatures taken during a summer survey or with temperature recording devices over one summer period. These streams or reaches are usually candidates for revegetation.

6) Inventory and map sources of stream bank erosion and prioritize them according to present and potential sediment yield. Identified sites should then be treated to reduce the amount of fine sediments entering the stream.

  a) Bank erosion sites are listed in the stream inventory report in Comments and Landmarks.

  b) Part VII, Watershed and Stream Bank Stability, details many techniques for treating stream bank erosion.

7) Active and potential sediment sources related to the road system need to be identified, mapped, and treated according to their potential for sediment yield to the stream and its tributaries.

  a) Sediment related to roads impact cobble embeddedness. These values are summarized in Table 8. Cobble embeddedness measured to be 25% or less, a rating of 1, is considered to indicate good spawning substrate for salmon and steelhead. Road systems have been attributed to as much as 70% of the sediment generated in a watershed. Part VI, Upslope Watershed Treatments, includes information on potential actions to identify and reduce upslope sediment.

8) Projects should be designed at suitable sites to trap and sort spawning gravel in order to expand redd site distribution in the stream.

  a) Projects to increase spawning gravel are desirable where suitable spawning gravel is found on relatively few reaches, or crowding and/or superimposition of redds has been observed during winter surveys.

  b) Table 6, Summary of Dominant Substrates By Habitat Type, summarizes the substrate in low gradient riffles. Where a large percentage of the low gradient riffles measured had substrate other than gravel or small cobble as the dominant substrate instream structures to trap and sort gravel may be considered.

   c) Part III, Stream Channel Type Descriptions and Structure Suitability, has specific structure recommendations are included for each channel type. Instream structures should only be considered in stream reaches suitable for habitat improvement structures.

   d) Part VI, Project Planning and Organization, and Part VII Project Implementation, must be thoroughly reviewed before proceeding with instream structures to enhance spawning substrate.

   e) For a stream reach located below a dam or other gravel supply restriction it may be desirable to import spawning gravel. Part VII, Placement of Imported Spawning Gravel, has recommendations for this treatment.

9) Modification of log debris accumulations is desirable, but must be done carefully, over time, to avoid excessive sediment loading in downstream reaches, and to preserve the larger beneficial scouring elements.

   a) Log debris accumulations (LDA's) are listed in the stream inventory report in the comments and landmarks section.

   b) Log debris accumulations should only be modified if: the LDA is retaining sediment, and the biological inventory confirms it is creating a fish passage problem or the LDA is contributing to significant bank erosion.

   c) Part VII, Fish Passage details methods for modifying fish passage.

10) Fish passage should be monitored and improved where possible.

   a) High gradient streams or streams containing some habitat types, may restrict access for migrating salmonids. For example any "A" channel type; or streams with high gradient riffles, cascades or bedrock sheets as habitat types may limit fish passage especially in years with limited rainfall. Good water temperature and flow regimes for rearing fish, must exist upstream for this to be a concern.

   b) In some streams selective barriers exist. For example the stream may have a barrier to coho but not steelhead. This must be confirmed with a biological inventory.

   c) Before any barrier modification of this type is undertaken, the DFG District Biologist must be consulted to determine if modification of the barrier is desirable and to confirm the status of resident stocks in order to avoid impacting the genetic integrity of existing or native stocks.

    d) Part VII, Waterfalls and Chutes, details methods for improving fish passage thorough these areas.

11) Culvert modification or replacement.

    a) Culverts, their type, dimensions, condition, and the height of the jump into the culvert are listed in the stream inventory report in Comments and Landmarks.

    b) Replacing a culvert with a bridge is desirable where a high jump into a culvert, and/or the velocity of the water going through the culvert, makes it a probable fish migration barrier under most flows.

    c) A culvert that is adequately sized, in good condition, and where the jump into the culvert for anadromous fish is less than one foot may benefit from the installation of baffles. Part VII, Culverts has several examples of baffle installation. Culverts should only have baffles installed after consulting with a qualified engineer.

    d) In some cases culverts have been installed too high to allow anadromous fish to jump into the culvert. If the culvert cannot be replaced with a bridge or with a new culvert below stream grade it may be desirable to construct a fishway. Part VII, Fishways, has examples of commonly used designs. Prior to construction of a fishway qualified engineer must design and engineer the project.

12) Alternatives to exclude livestock from the riparian corridor except at controlled access points should be explored with the grazier and developed if possible.

    a) Areas where livestock are impacting the riparian zone are listed in the stream inventory report in Comments and Landmarks.

    b) Part VII, Exclusionary Fencing, details some options for excluding livestock from riparian zones.

Key to Tributary Tables

Pname= primary stream name as specified by the usgs for each stream. This is utilized when the streams layer is digitized by teale data center.

Pnmcd= primary name code. Unique to every stream within standard digitized stream layers from teale. Used to distinguish between multiple named streams and for data linking to spatial layers.

Access=refers to whether there is a non-natural barrier on the stream (includes complete, partial and temporal barriers) or a natural barrier which has been enhanced by mans activities. Actual locations are in habitat inventory reports.

Fence=refers to whether fencing to control livestock or reduce deer herbivory is needed along a portion of the stream. Actual locations are noted in habitat inventory reports.

Canopy=refers to whether improvements to the riparian are desireable for the stream or as identified by reach within habitat inventory reports. Site specific improvements require further development. Need may be established by temperature or canopy measurements. For criteria see benchmarks.

Gravel=indicates that aggradation or degredation are at issue, and/or that embeddedness levels are high stream wide or as identified by reach within habitat inventory reports.
For criteria see benchmarks. Site locations and specific recommendations vary and may need further development.

Map roads= indicates that non-point source sediment inputs are present, usually indicated by high embeddedness and field observations of watershed roads. For criteria see benchmarks. Further assessment is usually needed to identify and prioritize problems utilizing dfg approved protocols.

Fix roads=indicates that a road assessment has been conducted to quantify potential and extent of sediment delivery, and priorities have been set for addressing remediation.. may also be that a specific road related problem (culvert, etc.) has been identified. Techniques to remediate should follow dfg reviewed protocols.

Erosion = indicates that point source in-channel erosion sources were noted (inner gorge scouring, lateral migration, frequent blow outs) during habitat inventory along with high embeddedness levels along the stream, within specific reaches, or as identified in field comment section within habitat inventory reports. For criteria see benchmarks. Site locations and specific recommendations vary and usually require site specific design.

Landslides= indicates the need for landslide mapping and/or that point source erosional sources were noted from habitat inventory, historical information or aerial photos, along with high embeddedness levels. For criteria see benchmarks.. site locations may be identified in field comment section within habitat inventory reports. Remediation is usually not recommended except where avoidance measures are planned

Shelter= indicates that complex shelter for rearing juveniles, or adult cover/resting structure is below target levels for the stream or as identified by reach within habitat inventory reports. For criteria see benchmarks. Site locations, structure type and cover type are specific to channel and vegetation types. Workplans require further development.

Pools= indicates that pool % or depth are below target levels for the stream or as identified by reach within habitat inventory reports. For criteria see benchmarks. Site locations, structure type, and scour type are specific to channel and vegetation types. Workplans require further development.

Monitor= indicates that further monitoring or assessment is needed to define priorities better or that key information exists in this watershed for managing resources in the future

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Austin Creek	Angels Creek	1	A2	330	61	61	2.1	100.0	0.0	105.0	0.0	73.3	63.3	36.7
Austin Creek	Austin Creek	1	F3	18874	59	67	29.9	87.7	49.2	26.5	24.2	54.8	64.9	35.1
Austin Creek	Austin Creek	2	F2	1563	63	66	20.8	50.0	37.5	35.0	16.7	35.9	56.3	43.8
Austin Creek	Austin Creek	3	F3	2220	65	67	12.3	100.0	16.7	41.0	0.0	60.9	61.1	38.9
Austin Creek	Austin Creek	4	F4	3523	66	72	38.1	57.6	18.2	23.9	40.6	58.8	17.1	82.9
Austin Creek	Austin Creek	5	D4	3403	72	75	32.0	66.7	27.8	48.8	38.9	30.3	47.5	52.5
Austin Creek	Austin Creek	6	D3	6257	62	74	49.6	45.7	11.4	26.5	65.8	47.1	69.3	30.7
Austin Creek	Austin Creek	7	F3	1153	65	68	58.2	29.4	17.6	16.3	35.3	54.3	62.0	18.0
Austin Creek	Austin Creek	8	F1	4536	62	69	51.6	44.1	16.2	19.4	77.5	69.3	77.8	22.2
Austin Creek	Austin Creek	9	B1	5772	63	76	48.0	62.9	22.6	15.2	88.7	35.4	81.8	18.2
Austin Creek	Bearpen Creek	1	F4	6328	64	70	30.9	28.6	3.6	38.4	24.1	57.0	92.7	7.3
Austin Creek	Bearpen Creek	2	F3	3032	63	66	53.7	25.0	7.5	39.4	51.2	69.8	69.5	30.5
Austin Creek	Bearpen Creek	3	F4	1766	62	66	50.2	32.3	19.4	23.6	18.8	74.0	80.7	19.3
Austin Creek	Bearpen Creek	4	F3	5094	63	65	19.7	45.5	3.0	30.0	5.7	74.2	95.0	5.0
Austin Creek	Big Austin Creek, Trib	1	F1	2969	68	72	38.1	50.0	29.2	23.7	83.3	35.5	90.0	10.0
Austin Creek	Black Rock Creek	1	F3	2554	60	66	25.9	47.8	8.7	26.0	33.3	74.5	60.8	39.2
Austin Creek	Black Rock Creek	2	F4	1245	58	68	24.2	30.8	15.4	18.8	30.8	74.9	50.3	49.8
Austin Creek	Black Rock Creek	3	F3	5484	58	67	26.9	23.3	6.7	25.6	24.5	76.7	69.4	30.6
Austin Creek	Black Rock Creek	4	F4	3030	58	73	17.8	20.8	4.2	17.5	8.7	80.5	60.3	39.7
Austin Creek	Black Rock Creek	5	F3	2575	59	64	29.5	5.7	0.0	29.6	64.7	91.1	97.0	3.0
Austin Creek	Blue Jay Creek	1	F3	1975	52	66	25.1	23.5	0.0	28.1	43.8	92.4	32.2	67.8
Austin Creek	Blue Jay Creek	2	B2	2339	52	63	30.1	25.0	10.0	31.9	35.0	87.0	80.2	19.8
Austin Creek	Blue Jay Creek	3	F3	3434	59	77	18.5	20.0	0.0	50.7	28.0	54.3	69.0	31.0
Austin Creek	Conshea Creek	1	F2	2538	57	63	10.0	22.2	11.1	96.1	0.0	81.0	84.3	15.7
Austin Creek	Devil Creek	1	F3	12053	57	71	18.2	72.0	18.0	91.0	0.0	67.1	54.6	43.8
Austin Creek	Devil Creek	2	A1	1223	57	60	17.3	66.7	33.3	151.7	0.0	70.0	12.5	87.5
Austin Creek	Devil Creek	3	F2	2095	56	67	26.8	73.3	26.7	157.9	0.0	92.5	42.5	57.5
Austin Creek	East Austin Creek	1	F4	12381	64	76	22.5	96.6	69.0	40.2	0.0	35.8	62.1	37.9
Austin Creek	East Austin Creek	2	F1	996	73	73	40.1	100.0	100.0	100.0	0.0	32.5	68.8	31.3
Austin Creek	East Austin Creek	3	B3	2816	68	73	23.4	100.0	66.7	60.0	0.0	26.9	36.8	63.2
Austin Creek	East Austin Creek	4	B1	18819	65	78	29.8	100.0	87.5	68.8	0.0	35.8	36.0	64.0
Austin Creek	East Austin Creek	5	G3	4753	60	78	34.2	100.0	71.4	114.6	0.0	39.8	27.9	64.0
Austin Creek	East Austin Creek	6	F1	2329	59	67	41.5	88.9	77.8	52.9	50.0	29.6	31.9	68.1
Austin Creek	East Austin Creek	7	F3	20969	57	68	20.8	93.6	55.3	112.9	2.2	30.1	49.9	50.1
Austin Creek	East Austin Creek	8	F2	2608	57	68	40.9	93.3	66.7	133.8	0.0	71.4	33.2	66.8
Austin Creek	East Austin Creek, Trib 1	1		1276	55	56	6.7	25.0	25.0	85.0	0.0	76.7	93.3	6.7
Austin Creek	Gilliam Creek	1	F3	8273	60	71	25.8	87.5	30.0	77.2	0.0	85.7	44.8	55.2
Austin Creek	Gilliam Creek	2	G1	1989	64	72	28.7	81.8	27.3	131.4	0.0	78.7	41.8	58.2
Austin Creek	Gilliam Creek	3	B2	7584	58	72	26.9	61.7	17.0	134.5	0.0	80.5	79.1	20.9
Austin Creek	Gray Creek	1	B2	6220	58	65	28.5	96.9	31.3	88.1	48.4	66.8	51.9	48.1

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Austin Creek	Gray Creek	2	B3	12092	57	65	27.9	87.0	27.8	88.8	98.1	82.4	58.5	41.5
Austin Creek	Gray Creek	3	F3	1920	51	60	19.5	57.1	0.0	101.4	100.0	92.9	83.3	16.7
Austin Creek	Gray Creek	4	G1	3335	51	58	12.9	60.0	20.0	106.5	100.0	97.7	81.1	18.9
Austin Creek	Gray Creek	5	F4	4249	57	60	14.0	87.5	25.0	59.7	100.0	81.6	82.7	12.7
Austin Creek	Gray Creek, Trib	1	B3	392	55	55	3.6	100.0	0.0	30.0	0.0	96.7	91.7	8.3
Austin Creek	Lawhead Creek	1	A2	402	57	57	6.0	50.0	0.0	60.0	0.0	99.0	97.0	3.0
Austin Creek	Pole Mountain Creek	1	F2	1230	58	62	35.3	50.0	4.5	18.9	47.6	78.3	37.4	62.6
Austin Creek	Pole Mountain Creek	2	F3	8783	58	68	21.1	34.3	8.6	37.1	29.0	75.2	58.4	41.6
Austin Creek	Schoolhouse Creek	1	F3	1629	58	58	4.0	0.0	0.0	101.7	0.0	82.9	53.6	46.4
Austin Creek	Sulphur Creek	1	F3	3186	57	72	18.5	72.7	36.4	132.7	0.0	46.7	31.2	68.8
Austin Creek	Sulphur Creek	2	B1	751	60	60	18.5	100.0	66.7	92.5	0.0	65.0	41.3	58.8
Austin Creek	Thompson Creek	1	B3	3653	59	71	29.9	60.9	21.7	95.5	0.0	81.5	61.5	38.5
Austin Creek	Ward Creek	1	C3	402	61	61	16.2	50.0	0.0	5.0	100.0	79.4	25.0	75.0
Austin Creek	Ward Creek	2	B2	2302	62	70	49.6	74.3	31.4	29.2	44.8	59.0	49.4	50.6
Austin Creek	Ward Creek	3	F3	1064	66	70	21.6	75.0	50.0	10.0	50.0	70.3	61.3	38.8
Austin Creek	Ward Creek	4	F2	7656	61	72	37.5	63.0	28.4	25.7	38.2	66.4	62.2	37.8
Austin Creek	Ward Creek	5	F3	15441	57	71	35.2	47.1	15.3	24.9	16.8	77.8	31.9	68.1
Austin Creek	Ward Creek	6	B2	628	67	70	28.2	57.1	0.0	16.0	42.9	62.3	69.7	30.3
Austin Creek	Ward Creek	7	F3	1319	58	77	21.1	45.5	9.1	17.2	30.0	50.8	71.5	28.5
Austin Creek	Ward Creek	8	F2	7136	60	76	24.2	43.8	6.8	31.6	22.5	64.7	61.9	37.2
Austin Creek	Ward Creek	9	B2	1879	62	66	9.7	41.7	0.0	35.0	90.9	69.1	75.6	24.4
Austin Creek	Ward Creek, Trib 1	1	F4	184	62	62	20.9	0.0	0.0	26.7	50.0	81.3	62.5	37.5
Austin Creek	Ward Creek, Trib 1	2	F3	1242	62	65	23.3	16.7	8.3	18.6	70.0	83.3	63.6	36.4
Austin Creek	Ward Creek, Trib 2	1		104	69	69	9.6	0.0	0.0	20.0	0.0	63.3	3.3	96.7
Austin Creek	Ward Creek, Trib 3	1		188	61	61	9.9	0.0	0.0	15.0	0.0	82.5	100.0	
Forsythe Creek	Butterfly Creek	1	F4	635	61	64	15.3	28.6	0.0	28.9	0.0	81.8	71.1	28.9
Forsythe Creek	Corral Creek	1	F1	10913	59	64	0.9	60.0	40.0	10.0	100.0	51.7	30.0	70.0
Forsythe Creek	Eldridge-Seward Creek	1	F4	7323	64	73	63.2	76.8	42.9	23.7	19.6	53.4	1.1	97.0
Forsythe Creek	Eldridge-Seward Creek	2	F2	2400	69	75	50.3	32.0	12.0	18.8	24.0	67.0	0.0	100.0
Forsythe Creek	Eldridge-Seward Creek	3	A2	972	61	69	40.7	46.2	15.4	12.3	7.7	77.4	0.0	100.0
Forsythe Creek	Eldridge-Seward Creek	4	F3	18594	52	71	32.4	47.4	15.6	24.6	18.5	69.5	7.4	91.9
Forsythe Creek	Eldridge-Seward Creek	5	A2	5012	56	56	4.5	23.1	0.0	36.2	15.4	75.9	3.3	96.7
Forsythe Creek	Eldridge-Seward Creek	6	B4	2290	58	65	10.8	23.5	5.9	18.3	11.8	95.1	19.5	80.5
Forsythe Creek	Forsythe Creek	1	F4	15371	50	59	32.8	96.6	49.2	22.6	76.3	25.5	9.6	89.3
Forsythe Creek	Forsythe Creek	2	F3	12308	50	60	26.3	97.5	65.0	16.4	55.3	30.6	20.8	79.2
Forsythe Creek	Forsythe Creek	3	B2	6065	51	59	27.9	100.0	70.0	16.6	40.0	46.1	44.6	55.4
Forsythe Creek	Forsythe Creek	4	A2	1938	51	59	44.4	100.0	57.1	41.8	0.0	41.9	54.1	45.9
Forsythe Creek	Forsythe Creek	5	B2	4634	51	54	25.8	100.0	54.5	31.8	28.6	52.2	43.2	56.8
Forsythe Creek	Forsythe Creek	6	F4	17731	47	73	27.2	79.3	43.1	31.3	37.9	40.5	24.4	74.2
Forsythe Creek	Forsythe Creek	7	A2	1551	57	57	0.0	0.0	0.0	0.0	0.0			

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Forsythe Creek	Jack Smith Creek	1	F3	1698	63	64	29.2	75.0	16.7	34.6	15.4	77.5	15.6	84.4
Forsythe Creek	Jack Smith Creek	2	F1	2864	64	68	24.8	56.3	18.8	18.3	12.5	54.7	7.1	92.9
Forsythe Creek	Jack Smith Creek	3	F4	17892	53	66	30.5	52.9	14.9	30.6	20.0	66.3	35.7	63.4
Forsythe Creek	Jack Smith Creek	4	G4	6778	52	55	27.5	47.9	10.4	47.6	31.9	71.3	64.4	35.6
Forsythe Creek	Jack Smith Creek	5	A4	2054	54	55	5.4	12.5	0.0	27.5	12.5	76.1	84.0	16.0
Forsythe Creek	Mill Creek	1	B4	1561	70	74	44.1	85.7	42.9	36.7	40.0	48.7	37.8	62.2
Forsythe Creek	Mill Creek	2	B2	1078	50	74	21.4	83.3	33.3	67.5	33.3	40.4	38.0	62.0
Forsythe Creek	Mill Creek	3	B3	43895	56	82	28.4	85.6	44.1	67.6	50.6	73.6	64.3	34.1
Forsythe Creek	Redwood Creek	1	B2	3985	59	66	19.3	26.1	2.2	29.0	37.0	91.5	69.7	30.3
Forsythe Creek	Redwood Creek	2	A2	485	56	59	27.2	22.2	0.0	29.4	22.2	86.7	67.5	32.5
Forsythe Creek	Rocky Creek	1	B3	2705			0.7	0.0	0.0	10.0	0.0	72.0	66.0	34.0
Forsythe Creek	Rocky Creek	2	A2	2014			4.2	0.0	0.0	15.0	100.0	78.0	51.0	49.0
Forsythe Creek	Salt Hollow Creek	1	F4	12341	58	70	9.8	87.1	32.3	22.9	60.0	72.8	64.2	35.8
Forsythe Creek	Salt Hollow Creek	2	F4	168	63	63	0.0	0.0	0.0	0.0	20.0			
Forsythe Creek	Salt Hollow Creek, North Fork	1	B6	4294	63	67	2.0	60.0	20.0	16.0	100.0	79.2	55.6	44.4
Forsythe Creek	Walker Creek	1	B4	5916	62	72	39.2	58.1	23.3	81.3	64.9	62.5	43.7	56.3
Forsythe Creek	Walker Creek	2	D4	3481	61	63	20.1	60.0	13.3	58.0	35.7	87.2	85.0	15.0
Geyserville	Barnes Creek	1	B3	3235	69	69	3.6	0.0	0.0	6.7	0.0	13.0	42.5	57.5
Geyserville	Barnes Creek	2	F3	2427	64	70	6.5	100.0	50.0	8.3	75.0	54.2	63.0	37.0
Geyserville	Bear Creek	1	B4	2362	59	61	22.3	84.6	23.1	48.1	7.7	72.4	62.0	38.0
Geyserville	Bear Creek	2	A2	765	59	64	30.3	100.0	50.0	95.0	0.0	80.0	61.4	38.6
Geyserville	Bear Creek	3	F4	1254	61	64	14.8	100.0	66.7	6.7	33.3	60.6	29.1	70.9
Geyserville	Bear Creek	4	B2	3349	56	62	27.1	95.0	45.0	44.5	55.0	83.1	62.0	38.0
Geyserville	Bidwell Creek	1	B3	4916	54	61	35.2	63.6	9.1	16.6	85.7	83.6	19.1	80.9
Geyserville	Bidwell Creek	2	B4	5167	54	61	54.8	70.3	18.9	17.6	24.3	81.8	22.7	77.3
Geyserville	Bluegum Creek	1	B4	1051	65	71	17.7	28.6	0.0	18.6	0.0	77.8	36.1	63.9
Geyserville	Bluegum Creek	2	F3	6836	60	78	20.1	25.4	1.7	24.1	52.5	87.4	57.0	43.0
Geyserville	Bluegum Creek	3	A6	3072	58	61	4.9	7.7	0.0	30.0	69.2	91.8	67.6	32.4
Geyserville	Briggs Creek	1	F3	15693	58	71	22.5	96.4	54.5	22.0	29.1	61.8	36.7	63.3
Geyserville	Briggs Creek	2	B2	6244	56	62	40.3	100.0	50.0	28.6	25.0	72.1	52.1	45.5
Geyserville	Brooks Creek	1	F6	3487	63	65	4.1	0.0	0.0	10.0	50.0	42.4	21.5	78.5
Geyserville	Brooks Creek	2	F3	5476	64	65	3.5	100.0	50.0	5.0	0.0	14.7	0.0	100.0
Geyserville	Brooks Creek	3	A3	4284	65	68	8.3	80.0	40.0	20.0	20.0	42.3	1.0	99.0
Geyserville	Coon Creek	1	F2	777	65	70	16.5	75.0	0.0	17.5	0.0	77.7	14.6	85.4
Geyserville	Coon Creek	2	B2	4028	60	65	61.6	60.5	20.9	27.4	75.6	77.4	72.8	27.2
Geyserville	Crocker Creek	1	F4	2890	63	71	10.8	0.0	0.0	24.0	77.8	37.1	43.8	56.2
Geyserville	Crocker Creek	2	F6	1864	64	71	30.6	23.1	7.7	76.9	60.0	22.1	54.4	45.6
Geyserville	Crocker Creek	3	B5	1136	64	64	18.3	50.0	16.7	44.2	33.3	79.4	41.3	58.8
Geyserville	Crocker Creek	4	A2	1399	62	62	87.1	100.0	0.0	105.0	0.0	80.0	25.0	75.0
Geyserville	Crocker Creek	5	B2	7202	61	68	28.6	26.7	6.7	42.6	53.8	70.0	34.9	65.1

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Geyserville	Crocker Creek, Trib 1	1	F3	1283	64	64	60.0	20.0	0.0	93.0	100.0	54.5	32.5	67.5
Geyserville	Crocker Creek, Trib 2	1	F5	1461	68	70	36.6	45.5	9.1	66.5	27.3	60.0	22.9	77.1
Geyserville	Foote Creek	1	F4	7590	54	60	3.4	83.3	0.0	16.7	50.0	47.8	0.0	100.0
Geyserville	Foote Creek	2	A2	1458	54	56	18.0	16.7	0.0	16.0	16.7	66.8	32.3	67.7
Geyserville	Franz Creek	1	F4	16155	62	71	15.6	73.7	26.3	24.8	68.4	53.5	29.6	68.5
Geyserville	Franz Creek	2	F2	1954	64	65	41.0	100.0	50.0	33.5	81.8	52.6	30.9	69.1
Geyserville	Franz Creek	3	F3	5136	57	65	33.9	100.0	55.0	15.0	70.0	56.3	33.9	66.1
Geyserville	Franz Creek	4	D3	3900	56	59	39.3	90.0	80.0	22.0	70.0	84.8	18.3	81.8
Geyserville	Franz Creek	5	F3	12655	49	62	32.6	84.0	42.0	22.4	53.1	71.8	22.9	77.1
Geyserville	Franz Creek	6	B3	5604	48	59	34.4	70.3	35.1	26.8	62.2	74.8	27.2	72.8
Geyserville	Franz Creek	7	G2	786	52	52	53.3	66.7	16.7	19.2	66.7	87.9	65.7	34.3
Geyserville	Franz Creek	8	B3	2378	52	52	17.2	55.6	11.1	22.8	25.0	89.2	53.5	46.5
Geyserville	Franz Creek	9	G1	5336	45	54	34.2	70.0	7.5	19.4	52.5	85.4	71.1	28.9
Geyserville	Little Briggs Creek	1	F4	2911	66	80	9.1	62.5	37.5	6.7	37.5	34.2	38.6	43.2
Geyserville	Little Briggs Creek	2	F2	2351	59	66	20.3	68.8	6.3	19.7	12.5	80.3	56.1	43.9
Geyserville	Maacama Creek	1	D4	20014	63	79	23.6	92.5	55.0	26.5	60.0	47.1	35.6	64.4
Geyserville	Maacama Creek	2	F4	1864	72	74	28.0	100.0	80.0	13.8	100.0	43.0	31.0	69.0
Geyserville	Maacama Creek	3	D4	7912	54	72	27.1	69.0	24.1	25.5	25.0	60.8	26.5	71.6
Geyserville	Maacama Creek	4	F4	8196	52	60	37.4	100.0	67.9	19.6	18.5	43.8	25.3	74.7
Geyserville	Martin Creek	1	F3	7955	0	76	13.5	84.0	36.0	10.4	50.0	56.9	36.4	63.6
Geyserville	McDonnell Creek	1	F4	10411	63	76	20.5	75.8	24.2	16.5	34.4	37.2	20.6	79.4
Geyserville	McDonnell Creek	2	F3	6170	60	76	16.3	56.5	21.7	16.5	43.5	66.3	59.8	38.8
Geyserville	McDonnell Creek	3	A2	884	61	61	3.9	100.0	0.0	40.0	0.0	63.8	87.5	12.5
Geyserville	Miller Creek	1	F3	15807	61	72	0.1	0.0	0.0	100.0	0.0	23.8	38.7	54.7
Geyserville	Peterson Creek	1	F3	5343	59	59	1.2	66.7	0.0	50.0	0.0	80.0	62.0	38.0
Geyserville	Peterson Creek	2	F4	7417	59	62	8.4	62.5	12.5	26.4	8.3	88.2	67.5	32.5
Geyserville	Redwood Creek	1	F3	10330	63	70	16.3	65.5	34.5	33.5	23.1	61.1	52.2	47.8
Geyserville	Redwood Creek	2	B3	13433	59	70	2.7	77.8	33.3	72.5	22.2	56.1	11.4	88.6
Geyserville	Thorton Branch	1	F3	5872	49	51	22.2	72.2	19.4	20.1	47.2	93.2	18.1	81.9
Geyserville	Thorton Branch	2	G2	1068	49	51	22.2	62.5	50.0	40.0	50.0	92.1	75.0	25.0
Geyserville	Thorton Branch	3	F3	1119	49	49	15.7	50.0	0.0	21.3	25.0	81.7	70.8	29.2
Geyserville	Wood Creek	1	F6	3647							0.0	5.0	20.0	80.0
Geyserville	Wood Creek	2	B5	1072	54	54	12.7	40.0	0.0	68.0	66.7	98.9		100.0
Geyserville	Wood Creek	3	F4	2898	54	55	10.0	58.3	0.0	25.5	18.2	94.0	29.8	70.2
Guerneville	Alder Creek	1	A2	988	61	61	3.0	100.0	0.0	16.0	50.0	95.0	77.9	22.1
Guerneville	Atascadero Creek	1	B6	13253	61	65	9.2	65.0	32.5	43.3	100.0	73.7	85.4	14.6
Guerneville	Atascadero Creek	2	B4	1263	60	62	27.8	6.3	0.0	46.0	87.5	69.2	100.0	
Guerneville	Baumert Springs Creek	1	B2	1023	56	57	22.9	8.3	8.3	13.9	58.3	94.4	67.2	32.8
Guerneville	Castellini Creek	1	C4	2578	50	50	10.3	54.5	0.0	40.5	9.1	100.0	48.8	51.3
Guerneville	Castellini Creek	2	B3	401	50	54	2.2	0.0	0.0	5.0	100.0	98.8	96.3	3.8

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Guerneville	Castellini Creek	3	A2	1135	54	54	7.5	16.7	0.0	16.7	20.0	99.6	93.1	6.9
Guerneville	Crawford Gulch Creek	1	A2	307	59	59	5.2	100.0	0.0	60.0	0.0	92.9	76.4	23.6
Guerneville	Dutch Bill Creek	1	F4	16253	59	64	18.8	67.9	30.2	25.0	36.5	88.9	48.0	52.0
Guerneville	Dutch Bill Creek	2	F3	1320	60	60	40.8	66.7	11.1	25.6	22.2	86.9	35.0	65.0
Guerneville	Dutch Bill Creek	3	F2	2825	60	62	20.8	80.0	60.0	35.0	40.0	82.1	52.1	47.9
Guerneville	Dutch Bill Creek	4	F3	1669	58	62	22.7	20.0	10.0	21.1	0.0	90.0	38.6	61.4
Guerneville	Dutch Bill Creek	5	F1	631	62	66	25.0	66.7	33.3	12.5	66.7	98.1	31.3	68.8
Guerneville	Dutch Bill Creek	6	F3	4694	58	66	40.8	72.2	33.3	24.1	44.4	89.1	45.0	55.0
Guerneville	Dutch Bill Creek	7	F2	10983	57	62	30.6	45.3	12.5	19.5	77.4	92.4	64.3	35.7
Guerneville	Dutch Bill Creek	8	G2	2027	60	60	18.4	22.2	11.1	16.4	66.7	87.4	81.9	18.1
Guerneville	Dutchbill Creek, Trib	1	A1	610	61	61	8.4	0.0	0.0	5.0	100.0	88.3	96.7	3.3
Guerneville	Duvoul Creek	1	B2	742	63	63	18.4	66.7	0.0	22.5	50.0	82.2	60.0	40.0
Guerneville	Fife Creek	1	F4	21345	0	76	9.2	63.5	13.5	44.4	80.8	70.8	83.4	16.6
Guerneville	Fife Creek	2	B2	1827	61	63	32.1	53.3	13.3	36.7	0.0	82.5	84.4	15.6
Guerneville	Fife Creek	3	B4	339	61	61	11.2	100.0	0.0	70.0	0.0	89.4	96.3	3.8
Guerneville	Fife Creek	23	B2B3	421	61	61	20.4	33.3	0.0	40.0	0.0	92.0	97.0	3.0
Guerneville	Freezeout Creek	1	F4	6250	57	64	31.9	30.8	7.7	26.9	57.6	80.1	32.7	67.3
Guerneville	Freezeout Creek	2	A2	608	57	57	27.0	33.3	0.0	13.3	100.0	86.0	65.8	34.2
Guerneville	Green Valley Creek	1	C4	12645	61	86	53.2	79.5	50.0	39.4	100.0	73.1	10.6	89.4
Guerneville	Green Valley Creek	2	F4	3041	61	64	31.3	93.3	60.0	38.3	100.0	86.0	0.4	99.6
Guerneville	Green Valley Creek	3	F3	15804	56	72	27.8	49.5	24.3	36.0	100.0	85.1	0.3	99.7
Guerneville	Green Valley Creek	4	B1	919	54	58	57.3	60.0	30.0	22.0	45.5	92.1		100.0
Guerneville	Green Valley Creek	5	B4	14066	54	70	30.1	43.3	12.5	40.8	42.7	85.9	4.8	94.6
Guerneville	Green Valley Creek	6	B6	5389	57	70	14.9	47.8	13.0	18.2	90.9	82.7	5.4	91.4
Guerneville	Griffin Creek	1	B4	2128	55	58	13.2	36.4	27.3	94.4	27.3	68.0		100.0
Guerneville	Griffin Creek	2	F4	2631	54	58	36.8	41.5	9.8	72.3	39.0	77.2	42.2	57.8
Guerneville	Griffin Creek	3	B4	7758	54	68	41.0	45.0	11.0	51.0	70.0	64.3	70.8	29.2
Guerneville	Griffin Creek	4	B1	507	61	61	15.6	33.3	33.3		100.0	13.3	91.3	8.8
Guerneville	Grub Creek	1	F2	4113	60	65	6.1	53.8	7.7	21.5	87.5	88.8	77.9	22.1
Guerneville	Grub Creek	2	G3	1116	70	70	1.6	100.0	0.0	5.0	0.0	76.0	25.0	75.0
Guerneville	Grub Creek	3	A2	978	66	70	0.8	0.0	0.0	10.0	100.0	73.5	42.0	58.0
Guerneville	Hobson Creek	1	F4	5388	56	61	7.7	60.0	6.7	91.4	35.7	88.9	70.9	29.1
Guerneville	Hobson Creek	2	G3	3296	56	61	6.4	60.0	20.0	43.9	33.3	94.2	77.0	23.0
Guerneville	Hulbert Creek	1	F4	28202	59	65	9.2	30.6	6.5	19.5	91.8	88.4	43.8	56.2
Guerneville	Hulbert Creek	2	G3	2504	60	66	12.3	7.1	0.0	37.1	76.9	91.8	61.3	38.7
Guerneville	Hulbert Creek	3	A3	1678	62	67	15.4	11.1	0.0	12.5	33.3	85.6	50.3	49.7
Guerneville	Hulbert Creek	4	G3	2453	59	59	8.1	50.0	12.5	26.0	37.5	91.1	84.6	15.4
Guerneville	Hulbert Creek, Trib	1	F4	2754	59	61	13.5	15.4	7.7	25.8	0.0	89.1	75.2	24.8
Guerneville	Jenner Gulch	1	F4	1081	58	60	30.8	66.7	0.0	15.2	80.0	55.0	7.5	92.5
Guerneville	Jenner Gulch	2	F3	589	58	60	57.0	50.0	12.5	31.3	60.0	81.8	1.7	98.3

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Guerneville	Jenner Gulch	3	B2	962	55	58	76.9	37.5	25.0	31.3	37.5	85.0	35.6	64.4
Guerneville	Jenner Gulch	4	A2	1424	58	60	6.6	100.0	25.0	20.0	100.0	77.1	85.0	15.0
Guerneville	Jonive Creek	1	F6	7820	58	63	61.0	68.5	35.2	38.4	100.0	79.4	84.3	10.0
Guerneville	Jonive Creek	2	B4	2872	53	60	62.1	56.9	22.4	42.0	93.1	86.6	65.6	34.4
Guerneville	Kidd Creek	1	B3	2882	50	54	19.1	71.4	0.0	18.9	0.0	89.3	84.3	15.7
Guerneville	Kidd Creek	2	F3	4065	50	58	29.5	81.5	29.6	37.1	11.5	70.0	66.4	33.6
Guerneville	Kidd Creek	3	B2	986	54	56	17.6	100.0	20.0	30.0	0.0	65.0	69.0	31.0
Guerneville	Kidd Creek	4	A2	1662	52	58	20.5	57.1	28.6	30.9	20.0	83.5	57.0	40.9
Guerneville	Lancel Creek	1	B2	1073	60	60	20.0	80.0	40.0	17.0	50.0	82.3	39.6	60.4
Guerneville	Lancel Creek	2	F3	2803	59	65	22.9	58.8	0.0	20.9	57.1	65.2	56.1	43.9
Guerneville	Lancel Creek, North Fork	1	F3	1878	61	62	4.8	20.0	0.0	14.0	80.0	86.5	73.5	26.5
Guerneville	Lancel Creek, North Fork	2	F6	1437	60	62	22.9	57.1	28.6	20.0	71.4	49.3	57.9	42.1
Guerneville	Mission Creek	1	F4	6086	60	61	5.5	20.0	0.0	21.5	13.3	81.9	80.4	19.6
Guerneville	Mount Jackson Creek	1	G3	3424	56	60	19.1	41.9	3.2	23.8	23.1	90.0	72.3	27.7
Guerneville	Mount Jackson Creek	2	A2	446	58	58	1.8	0.0	0.0	30.0	0.0	86.0	94.0	6.0
Guerneville	Mount Jackson Creek	3	G3	2206	58	59	12.7	41.2	11.8	10.0	13.3	84.8	98.2	1.8
Guerneville	Mount Jackson Creek	4	B3	477	60	60	7.8	100.0	0.0	5.0	0.0	95.0	100.0	0.0
Guerneville	Mount Jackson Creek	5	G3	1144	60	60	4.2	25.0	0.0	11.3	0.0	90.8	99.2	0.8
Guerneville	Osborne Creek	1	G3	873	50	50	5.7	0.0	0.0	8.3	33.3	84.4	61.3	38.8
Guerneville	Porter Creek	1	F4	8887	58	61	3.6	22.2	0.0	35.0	22.2	71.2	24.4	75.6
Guerneville	Porter Creek	2	F2	6581	56	61	3.2	40.0	0.0	12.8	50.0	79.6	30.0	70.0
Guerneville	Porter Creek	3	F4	9391	52	54	8.6	37.5	0.0	25.9	6.7	79.6	69.6	30.4
Guerneville	Porter Creek	4	B3	3948	52	56	23.9	44.0	16.0	21.8	44.0	85.2	58.5	41.5
Guerneville	Press Creek	1	E3	1420	53	54	21.4	40.0	10.0	28.1	40.0	90.7	70.9	29.1
Guerneville	Press Creek	2	G2	4004	50	53	6.2	62.5	12.5	40.0	25.0	88.1	88.9	11.1
Guerneville	Purrington Creek	1	G1	15072	56	66	32.9	43.0	9.6	25.6	72.4	90.4	5.3	94.4
Guerneville	Purrington Creek	2	F2	4299	50	58	11.5	13.6	0.0	38.9	45.5	90.7	30.3	69.7
Guerneville	Sexton Creek	1	F4	9369	55	59	3.2	85.7	7.1	33.2	8.3	94.0	49.2	50.8
Guerneville	Sheephouse Creek	1	F4	13473	55	71	25.5	60.9	17.3	72.3	19.8	94.4	50.4	48.9
Guerneville	Sheephouse Creek	2	B3	2378	56	57	6.6	14.3	0.0	50.5	14.3	93.8	96.9	3.1
Guerneville	Sheephouse Creek, East Fork	1	F4	3391	55	58	8.5	9.5	4.8	55.2	38.9	91.6	82.0	18.0
Guerneville	Sheephouse Creek, Southwest Trib	1	F4	3128	55	55	12.1	34.6	0.0	49.4	45.8	93.0	54.4	45.6
Guerneville	Smith Creek	1	F4	392	58	58	22.7	25.0	0.0	36.7	50.0	88.3	88.3	11.7
Guerneville	Smith Creek	2	A2	399	58	60	42.6	100.0	33.3	55.0	0.0	97.5	63.8	36.3
Guerneville	Smith Creek	3	F3	3420	56	60	21.9	41.7	12.5	39.4	20.8	94.4	80.0	20.0
Guerneville	Smith Creek	4	A3	589	54	60	44.5	50.0	25.0	31.0	33.3	95.9	91.3	8.8
Guerneville	Tyrone Gulch Creek	1	B2	723	59	59	17.4	25.0	0.0	47.5	0.0	95.0	71.3	28.8
Guerneville	Tyrone Gulch Creek	2	A3	917	59	59	24.4	16.7	0.0	18.3	16.7	93.8	56.3	43.8
Guerneville	Willow Creek	1	B5	3865	54	58	33.1	34.5	6.9	21.8	100.0	89.2	0.0	100.0
Guerneville	Willow Creek	2	B3	7773	56	60	28.9	46.3	18.5	32.3	46.0	89.4	2.6	97.4

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Guerneville	Willow Creek	3	F3	17820	54	60	26.2	22.9	1.2	47.8	39.1	91.7	28.5	71.5
Mark West	Horse Hill Creek	1	B4	2871			1.2	0.0	0.0	10.0	100.0	57.5	55.0	45.0
Mark West	Humbug Creek	1	F3	2527	62	66	45.2	54.5	13.6	24.5	9.1	79.8	4.5	95.5
Mark West	Humbug Creek	2	F1	1091	62	64	54.6	81.8	18.2	24.5	40.0	81.9	5.4	94.6
Mark West	Humbug Creek	3	F3	1580	62	64	39.4	75.0	16.7	29.5	9.1	80.6	1.1	98.9
Mark West	Humbug Creek	4	F2	1854	62	62	50.4	61.1	22.2	39.6	46.7	75.8	11.8	88.2
Mark West	Mark West Creek	1	F4	28229	62	73	47.3	79.3	45.7	43.4	79.0	60.0	20.5	79.5
Mark West	Mark West Creek	2	F2	5510	62	67	48.8	68.0	24.0	41.8	36.0	61.8	39.7	60.3
Mark West	Mark West Creek	3	B2	6870	60	68	34.0	88.9	44.4	41.2	81.0	58.6	55.9	44.1
Mark West	Mark West Creek	4	B3	13412	54	64	31.5	67.4	32.6	30.7	68.1	64.7	46.7	53.3
Mark West	Mark West Creek	5	C3	10856	55	63	37.5	63.0	28.3	43.3	67.4	75.5	19.1	80.9
Mark West	Mark West Creek	6	B1-2	16934	46	63	39.7	52.5	23.7	46.9	99.1	79.2	54.3	45.7
Mark West	Mill Creek	1	F2	4019	60	64	13.7	35.3	11.8	28.0	53.3	79.0	72.4	27.6
Mark West	Mill Creek	2	A4	1524	64	64	9.4	0.0	0.0	25.0	100.0	90.5	86.5	13.5
Mark West	Mill Creek	3	B1	105	62	62	0.0	0.0	0.0	0.0	40.0			
Mark West	Mill Creek	4	A4	1509	62	62	0.0	0.0	0.0	0.0	35.0			
Mark West	Pool Creek	1	B6	5672	66	66	1.9	50.0	0.0	70.0	100.0	89.2	23.3	76.7
Mark West	Pool Creek	2	F5	5200	68	68	0.0	0.0	0.0	0.0	70.0			
Mark West	Porter Creek	1	F5	3752	68	68	27.9	87.5	37.5	30.3	100.0	59.7	22.4	77.6
Mark West	Porter Creek	2	B3	766	68	74	10.7	50.0	0.0	7.5	100.0	71.9	35.0	65.0
Mark West	Porter Creek	3	F4	906	74	74	13.9	100.0	0.0	40.0	100.0	18.3	20.0	80.0
Mark West	Porter Creek	4	F2	1288	64	74	35.6	14.3	14.3	22.1	80.0	46.4	15.0	85.0
Mark West	Porter Creek	5	F3	8634	58	70	38.8	46.6	12.1	38.9	66.0	77.4	40.2	59.8
Mark West	Porter Creek	6	B1	3863	64	68	28.2	41.7	8.3	45.7	29.2	77.7	35.5	64.5
Mark West	Porter Creek	7	F3	5269	66	66	26.1	29.0	9.7	42.7	37.9	59.8	44.8	49.1
Mark West	Van Buren Creek	1	B2	2283	62	64	8.4	0.0	0.0	27.9	100.0	88.2	68.2	31.8
Mark West	Van Buren Creek	2	F2	10433	62	70	7.5	19.2	0.0	23.0	100.0	89.8	77.7	22.3
Mark West	Van Buren Creek	3	F4	1135	64	66	11.1	0.0	0.0	61.7	100.0	93.5	85.4	14.6
Mark West	Weeks Creek	1	F4	6263	60	60	3.4	20.0	20.0	52.4	100.0	72.5	42.5	57.5
Mark West	Windsor Creek	1	B4	20172	62	66	11.8	83.7	32.6	49.1	100.0	64.4	17.0	83.0
Mark West	Windsor Creek	2	F3	1500	64	64	0.0	0.0	0.0	0.0	0.0			
Santa Rosa	Matanzas Creek	1	F3	22218	62	78	41.7	84.9	60.2	47.7	98.9	64.3	29.8	70.2
Santa Rosa	Millington Creek	1	F2	2092	57	63	46.4	28.6	3.6	22.9	15.4	92.0	46.7	53.3
Santa Rosa	Millington Creek	2	B2	502	58	60	45.8	33.3	0.0	24.9	50.0	88.4	45.4	54.6
Santa Rosa	Millington Creek	3	F4	1363	60	61	27.2	63.6	18.2	26.0	16.7	71.9	50.5	49.5
Santa Rosa	Santa Rosa Creek	1	F4	35733	64	72	3.2	95.0	75.0	50.0	6.3	45.9	3.4	94.8
Santa Rosa	Santa Rosa Creek	2	C4	30493	61	70	18.4	97.4	49.4	22.8	9.6	83.6	4.4	95.0
Santa Rosa	Santa Rosa Creek	3	B2	25025	60	70	45.0	68.1	26.9	18.9	35.5	76.0	46.3	53.3
Santa Rosa	Santa Rosa Creek, North Fork	1	F1	3253	63	66	44.8	5.3	1.8	24.1	28.0	85.2	78.7	21.3
Santa Rosa	Santa Rosa Creek, North Fork	2	C3	1895	58	63	33.8	0.0	0.0	16.1	7.4	90.1	49.9	50.1

In-stream Habitat Summarized by Reach

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Santa Rosa	Santa Rosa Creek, North Fork	3	A1	206	58	58	44.2	33.3	0.0	22.7	50.0	93.6	42.8	57.3
Sulphur Creek	Alder Creek	1	G1	2908	56	60	40.0	75.0	27.8	38.8	40.0	75.5	78.7	21.3
Sulphur Creek	Anna Belcher Creek	1	B4	3306	62	71	9.7	23.1	7.7	20.0	33.3	30.5	74.3	25.7
Sulphur Creek	Big Sulphur Creek	1	F4	6169	65	80	23.1	85.7	57.1	11.0	0.0	14.8	72.7	27.3
Sulphur Creek	Big Sulphur Creek	2	F2	16593	60	74	9.9	100.0	100.0	13.0	0.0	4.4	84.7	15.3
Sulphur Creek	Big Sulphur Creek	3	F3	24497	62	70	12.7	100.0	100.0	7.1	21.1	10.0	75.4	24.6
Sulphur Creek	Big Sulphur Creek	4	F2	3970	69	70	4.9	100.0	66.7	11.7	0.0	7.5	83.3	16.7
Sulphur Creek	Big Sulphur Creek	5	F3	15045	68	76	10.2	100.0	87.5	8.0	44.4	33.6	62.6	37.4
Sulphur Creek	Big Sulphur Creek	6	F2	17670	54	70	19.3	94.9	53.8	9.5	42.9	29.0	63.1	36.9
Sulphur Creek	Big Sulphur Creek	7	A2	1271	54	58	20.9	100.0	100.0	10.0	0.0	55.0	80.0	20.0
Sulphur Creek	Big Sulphur Creek	8	B2	1596	58	64	19.2	100.0	100.0	20.0	0.0	50.0	59.2	24.2
Sulphur Creek	Big Sulphur Creek	9	A2	1554	64	69	13.1	100.0	100.0	23.3	0.0	40.0	60.0	40.0
Sulphur Creek	Big Sulphur Creek	10	A2	20506	44	69	14.8	100.0	89.3	22.0	10.0	59.6	69.2	29.6
Sulphur Creek	Frasier Creek	1	B2	3741	63	72	9.2	72.2	16.7	31.6	35.7	71.7	42.7	57.3
Sulphur Creek	Frasier Creek	2	A2	1370	63	68	10.1	60.0	0.0	69.0	0.0	63.8	57.5	42.5
Sulphur Creek	Frasier Creek	3	F3	1617	68	72	9.6	50.0	0.0	15.0	20.0	81.2	62.1	37.9
Sulphur Creek	Frasier Creek	4	A2	2574	60	68	15.0	54.5	13.6	14.8	50.0	79.4	62.9	37.1
Sulphur Creek	Hale Creek	1	B3	2204	63	66	7.4	0.0	0.0	6.9	87.5	54.7	78.9	15.8
Sulphur Creek	Hale Creek	2	A2	1356	62	66	16.4	6.7	0.0	15.4	46.2	79.0	77.0	23.0
Sulphur Creek	Hale Creek	3	B3	1053	63	63	3.9	33.3	0.0	11.7	50.0	73.0	80.0	20.0
Sulphur Creek	Little Sulphur Creek	1	F3	9012	65	78	30.3	97.1	71.4	20.2	48.4	33.5	62.9	36.6
Sulphur Creek	Little Sulphur Creek	2	C3	5707	66	80	24.0	84.2	68.4	20.3	73.7	19.4	30.0	66.9
Sulphur Creek	Little Sulphur Creek	3	B2	1514	66	71	50.9	100.0	77.8	11.7	55.6	12.1	7.9	92.1
Sulphur Creek	Little Sulphur Creek	4	G1	4615	68	72	50.6	97.2	91.7	20.0	54.5	45.1	42.1	57.9
Sulphur Creek	Little Sulphur Creek	5	F4	2635	69	75	31.4	100.0	83.3	18.6	41.7	40.8	17.2	82.8
Sulphur Creek	Little Sulphur Creek	6	B4	2550	69	77	33.8	92.9	71.4	28.8	41.7	71.0	19.0	81.0
Sulphur Creek	Little Sulphur Creek	7	B1	1499	68	78	33.1	100.0	60.0	14.5	22.2	66.3	35.8	64.2
Sulphur Creek	Little Sulphur Creek	8	B2	4896	62	70	41.5	97.7	60.5	21.8	34.5	58.3	40.3	59.7
Sulphur Creek	Little Sulphur Creek	9	F4	3108	63	68	49.8	100.0	84.2	29.2	38.9	31.5	59.6	40.4
Sulphur Creek	Little Sulphur Creek	10	B2	16595	0	70	29.2	100.0	86.1	33.8	23.4	45.5	47.5	51.5
Sulphur Creek	Little Sulphur Creek	11	A2	2761	55	59	32.9	100.0	77.3	26.1	18.2	71.4	50.8	49.2
Sulphur Creek	Little Sulphur Creek	12	B2	10475	52	60	11.7	100.0	69.2	19.2	5.9	67.0	73.8	26.2
Sulphur Creek	Little Sulphur Creek	13	F3	16863	48	60	21.9	94.2	50.0	26.5	23.8	87.5	15.5	83.4
Sulphur Creek	Little Sulphur Creek	14	F4	2314	46	51	14.3	57.1	0.0	30.0	0.0	71.0	7.3	92.8
Sulphur Creek	Little Sulphur Creek, North Branch	1	F4	7960	59	70	18.0	78.4	40.5	13.3	21.2	57.4	42.5	57.5
Sulphur Creek	Little Sulphur Creek, North Branch	2	B3	4426	66	74	18.9	61.9	23.8	43.3	15.0	63.0	39.0	61.0
Sulphur Creek	Little Sulphur Creek, North Branch	3	B2	1504	68	70	13.6	25.0	0.0	28.6	33.3	71.9	61.2	38.8
Sulphur Creek	Little Sulphur Creek, North Branch	4	F3	3546	61	70	13.7	52.9	17.6	14.8	25.0	71.7	24.6	75.4
Sulphur Creek	Little Sulphur Creek, North Branch	5	B2	401	64	67	18.2	0.0	0.0	10.0	50.0	95.0	15.0	85.0
Sulphur Creek	Lovers Gulch Creek	1	F3	4168	54	59	8.8	29.2	4.2	29.3	66.7	65.3	36.2	63.8

In-stream Habitat Summarized by Reach

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Ukiah	Ackerman Creek	1	F4	2796	64	77	44.8	66.7	10.0	30.5	67.9	66.5	2.1	97.9
Ukiah	Ackerman Creek	2	B3	1593	64	70	37.9	72.7	18.2	9.0	61.5	83.9		100.0
Ukiah	Ackerman Creek	3	F1	1995	64	73	35.3	55.6	16.7	25.4	44.4	64.7	1.2	98.8
Ukiah	Ackerman Creek	4	F3	9904	63	77	28.3	54.9	19.6	21.3	37.3	56.1	13.6	86.4
Ukiah	Ackerman Creek	5	F2	3840	52	66	11.9	91.7	75.0	17.5	76.9	36.6	27.9	72.1
Ukiah	Ackerman Creek	6	B3	11890	54	79	20.6	54.3	19.6	24.3	52.2	39.6	3.6	94.5
Ukiah	Ackerman Creek	7	F2	9034	58	82	28.0	65.6	25.0	16.3	61.5	64.2	17.8	82.2
Ukiah	Ackerman Creek	8	A2	602	67	67	6.8	0.0	0.0	11.7	100.0	90.4	39.2	60.8
Ukiah	Alder Creek	1	F4	401	51	62	16.2	100.0	50.0	20.0	0.0	60.9	28.0	72.0
Ukiah	Alder Creek	2	F1	829	51	62	21.4	50.0	25.0	38.3	100.0	73.3	41.1	58.9
Ukiah	Alder Creek	3	F4	1979	56	64	39.9	71.4	14.3	34.3	38.1	48.7	35.5	64.5
Ukiah	Alder Creek	4	G2	3092	53	58	32.6	60.7	14.3	70.8	75.0	52.6	63.8	36.2
Ukiah	Alder Creek	5	F6	6568	53	78	36.3	10.2	1.1	30.5	65.2	57.2	65.2	33.7
Ukiah	Alder Creek	6	G4	1228	64	69	51.1	10.0	5.0	17.2	60.0	62.4	55.0	45.0
Ukiah	Dooley Creek	1	B4	15335	59	79	11.4	87.2	20.5	14.3	51.4	26.4	0.0	98.1
Ukiah	Doolin Creek	1	F3	8803	66	66	0.0	0.0	0.0	0.0	30.0			
Ukiah	Doolin Creek	2	B3	4542	64	67	2.9	37.5	0.0	18.6	50.0	84.5	81.6	18.4
Ukiah	Doolin Creek	3	A2	724	64	64	11.2	80.0	40.0	6.3	0.0	84.2	65.8	34.2
Ukiah	Doolin Creek	4	G3	936	61	64	4.4	25.0	0.0	35.0	25.0	84.3	79.3	20.7
Ukiah	Doolin Creek	5	A2	2055	61	62	8.5	90.0	10.0	10.6	62.5	87.5	83.1	16.9
Ukiah	Duncan Creek	1	B3	14657	62	70	0.8	71.4	14.3	14.0	0.0	74.3	75.7	24.3
Ukiah	Hensley Creek	1	F4	10839	61	62	1.4	12.5	0.0	39.4	50.0	74.4	68.5	31.5
Ukiah	Johnson Creek	1	B3	4820	71	76	2.5	60.0	20.0	13.8	0.0	38.1	59.1	40.9
Ukiah	McDowell Creek	1	B4	6929	62	73	15.0	27.5	5.0	13.0	61.5	82.5	0.0	100.0
Ukiah	McDowell Creek	2	F4	1478	63	67	21.0	50.0	10.0	10.0	30.0	89.7	0.0	100.0
Ukiah	McDowell Creek	3	B4	5447	61	72	12.2	28.0	0.0	20.0	87.0	50.7	0.0	100.0
Ukiah	McDowell Creek	4	F4	4064	61	71	22.9	41.4	0.0	16.1	73.1	77.7	0.0	100.0
Ukiah	McDowell Creek	5	B2	2153	65	68	24.9	25.0	6.3	6.7	30.0	80.9	0.0	100.0
Ukiah	Mill Creek, North Fork	1	F3	5913	60	60	3.0	25.0	0.0	47.1	37.5	90.6	17.5	82.5
Ukiah	Mill Creek, North Fork	2	B2	5260	60	64	8.4	73.7	15.8	15.6	30.8	82.4	22.1	77.9
Ukiah	Mill Creek, North Fork	3	A2	4026	60	68	29.7	97.0	36.4	27.2	42.1	92.2	19.6	80.6
Ukiah	Mohr/Mercer Creek	1	F4	2080	34	34	1.9	50.0	50.0	65.0	100.0	31.7	23.3	76.7
Ukiah	Mohr/Mercer Creek	2	C3	1228	34	38	17.0	90.9	45.5	133.3	90.9	50.7	62.0	38.0
Ukiah	Morrison Creek	1	F3	16823	64	80	7.0	92.3	26.9	15.5	25.0	47.0	19.8	79.2
Ukiah	Morrison Creek	2	C3	1278	65	68	33.8	100.0	62.5	20.0	14.3	63.5	100.0	
Ukiah	Morrison Creek	3	B3	4025	67	72	17.9	83.3	16.7	12.0	9.1	42.4	32.5	67.5
Ukiah	Morrison Creek	4	B2	918	70	70	15.5	100.0	0.0	5.0	0.0	51.7	46.7	53.3
Ukiah	Morrison Creek	5	G2	1502	63	70	31.4	100.0	57.1	8.8	41.7	55.7	37.6	62.4
Ukiah	Morrison Creek	6	F2	5864	62	67	11.8	27.8	5.6	11.0	9.1	56.3	54.5	45.5
Ukiah	Morrison Creek	7	F3	1185	61	64	5.7	0.0	0.0	5.0	0.0	63.0	85.0	15.0

In-stream Habitat Summarized by Reach

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Ukiah	Morrison Creek	8	B3	10241	58	63	5.2	56.3	9.4	16.2	13.8	70.5	76.4	23.6
Ukiah	Orrs Creek	1	F4	14134	58	66	15.0	97.1	67.6	56.8	42.9	53.8	9.8	88.7
Ukiah	Orrs Creek	2	B3	8134	60	70	16.8	100.0	46.4	85.2	13.0	68.4	7.7	92.3
Ukiah	Orrs Creek	3	F2	2050	61	68	22.3	92.9	57.1	81.1	42.9	46.1	14.8	85.2
Ukiah	Orrs Creek	4	A2	2225	61	77	31.1	56.1	17.1	25.2	23.1	62.4	1.5	98.5
Ukiah	Orrs Creek	5	F4	1114	69	73	38.6	56.3	6.3	9.7	36.4	73.4	6.9	93.1
Ukiah	Orrs Creek	6	F3	5021	61	79	33.0	39.1	8.7	21.9	20.5	78.5	2.8	97.2
Ukiah	Parsons Creek	1	F2	6370	62	69	8.9	38.9	5.6	17.5	41.2	48.5	62.7	37.3
Ukiah	Parsons Creek	2	F4	9417	52	58	13.3	18.5	7.4	20.5	52.0	46.3	72.7	27.3
Ukiah	Parsons Creek	3	C3	3390	55	57	6.3	50.0	12.5	56.7	100.0	31.7	43.3	56.7
Ukiah	Robinson Creek	1	F4	11441	52	60	12.1	41.7	0.0	47.3	62.5	53.5	1.8	98.2
Ukiah	Robinson Creek	2	B3	5508	51	53	27.1	81.3	18.8	25.8	68.8	48.7	2.9	97.1
Ukiah	Robinson Creek	3	B1	1971	52	58	32.1	63.6	18.2	49.5	100.0	46.8	11.5	88.5
Ukiah	Robinson Creek	4	B2	3661	49	58	32.3	46.2	15.4	67.7	65.4	36.8	46.8	53.2
Ukiah	Robinson Creek	5	G2	1420	52	52	31.1	83.3	33.3	40.0	50.0	35.8	51.1	48.9
Ukiah	Robinson Creek	6	C4	2940	52	57	28.3	55.6	0.0	43.3	72.2	37.1	47.8	52.2
Ukiah	Robinson Creek	7	F3	1359	53	58	11.6	50.0	50.0	5.0	75.0	18.6	65.0	35.0
Ukiah	York Creek	1	C4	2380	63	70	29.0	100.0	60.0	11.7	40.0	48.0	5.3	94.7
Ukiah	York Creek	2	C3	3119	68	68	0.0	0.0	0.0	0.0	0.0		13.3	86.7
Ukiah	York Creek	3	F3	9761	66	70	2.3	80.0	0.0	5.0	60.0	27.7	35.0	65.0
Ukiah	York Creek	4	D2	3354	66	66	3.0	25.0	0.0	11.3	66.7	32.3	22.2	77.8
Ukiah	York Creek	5	F3	4813	63	68	4.7	12.5	0.0	8.6	50.0	29.6	35.0	65.0
Ukiah	York Creek	6	A2	298	65	70	28.2	33.3	33.3	35.0	0.0	42.5	20.0	80.0
Ukiah	York Creek	7	F3	10367	60	68	6.5	29.2	4.2	6.4	33.3	46.2	48.3	51.7
Ukiah	York Creek	8	B3	168	61	61	28.0	0.0	0.0	5.0	0.0	50.0	70.0	30.0
Ukiah	York Creek	9	F2	2116	61	61	0.0	0.0	0.0	0.0	20.0			
Ukiah	York Creek	10	B3	545	61	61	1.8	0.0	0.0	0.0	60.0	65.0	35.0	
Warm Springs	Angel Creek	1	F4	2046	58	65	23.2	9.1	4.5	99.1	21.7	85.0	84.1	15.9
Warm Springs	Angel Creek	2	A4	3367	56	59	11.3	16.7	0.0	52.3	75.0	91.1	82.8	17.2
Warm Springs	Chapman Branch	1	G3	1717			26.7	15.0	0.0	26.8	45.5	94.6	42.5	57.5
Warm Springs	Crane Creek	1	F4	10866	53	67	20.8	53.7	14.6	36.9	30.9	89.2	47.7	52.3
Warm Springs	Crane Creek	2	B4	959	52	62	17.9	33.3	0.0	22.2	44.4	95.4	78.3	21.7
Warm Springs	Crane Creek	3	G4	2025	57	60	17.1	20.0	0.0	29.7	57.1	92.7	71.5	28.5
Warm Springs	Dorman Canyon Creek	1	G3	399	60	63	13.0	0.0	0.0	40.0	66.7	91.5	62.8	37.2
Warm Springs	Dorman Canyon Creek	2	A5	666	60	60	28.7	33.3	16.7	22.5	60.0	95.7	91.4	8.6
Warm Springs	Dorman Canyon Creek	3	G4	4208	54	63	11.9	17.4	0.0	63.8	43.2	91.5	87.5	12.5
Warm Springs	Dutcher Creek	1	B4	13648	60	75	11.9	62.5	10.4	15.0	34.1	91.6	0.6	99.4
Warm Springs	Fall Creek	1	B1	1135	69	70	14.0	60.0	40.0	18.8	100.0	52.6		100.0
Warm Springs	Felta Creek	1	F4	1863	55	57	37.3	42.1	15.8	33.6	63.2	82.2	73.0	27.0
Warm Springs	Felta Creek	2	G2	2246	56	66	35.7	45.8	8.3	44.6	33.3	93.1	77.7	22.3

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Warm Springs	Felta Creek	3	F4	10020	59	70	40.4	36.8	12.0	48.9	26.1	81.3	70.5	29.5
Warm Springs	Felta Creek	4	B4	5897	58	70	32.6	26.6	7.4	56.3	42.1	82.5	73.8	26.2
Warm Springs	Felta Creek	5	A2	2810	62	65	12.4	31.3	6.3	40.0	56.3	88.9	89.1	10.9
Warm Springs	Grape Creek	1	F4	9517	60	68	48.5	71.1	19.3	42.3	65.7	82.8	36.8	63.2
Warm Springs	Grape Creek	2	G4	640	61	66	34.4	25.0	25.0	52.1	50.0	94.5	87.5	12.5
Warm Springs	Grape Creek	3	G3	1252	61	64	17.5	33.3	0.0	82.0	100.0	96.4	83.6	16.4
Warm Springs	Grape Creek	4	G6	523	64	64	31.2	62.5	25.0	63.6	83.3	98.2	69.3	30.7
Warm Springs	Mill Creek	1	F4	18111	53	69	15.0	72.2	22.2	51.5	29.6	51.0	26.8	73.2
Warm Springs	Mill Creek	2	B2	3220	62	67	28.2	88.2	70.6	56.9	88.2	66.4	40.5	59.5
Warm Springs	Mill Creek	3	F4	34599	60	74	19.0	88.9	41.9	47.9	45.1	73.7	53.6	45.9
Warm Springs	Mill Creek	4	F2	1845	62	66	19.4	62.5	12.5	92.9	71.4	80.9	63.1	36.9
Warm Springs	Mill Creek	5	F4	13761	59	66	22.9	71.3	28.7	56.5	46.4	82.3	52.5	47.5
Warm Springs	Mill Creek	6	F3	4255	57	62	25.7	44.4	13.9	53.3	72.2	89.3	71.8	28.2
Warm Springs	Mill Creek	7	F2	1164	61	62	22.0	28.6	14.3	58.1	78.6	77.2	69.0	31.0
Warm Springs	Mill Creek	8	G4	3945	62	67	26.2	26.9	19.2	48.9	52.0	61.9	82.7	17.3
Warm Springs	Palmer Creek	1	F4	3249	59	64	25.0	37.0	3.7	35.1	29.6	85.1	67.5	32.5
Warm Springs	Palmer Creek	2	F3	6152	56	63	39.6	47.5	19.7	55.9	39.3	87.0	55.0	45.0
Warm Springs	Palmer Creek	3	F2	2437	58	61	41.6	35.0	20.0	69.5	65.0	91.2	47.3	52.7
Warm Springs	Palmer Creek	4	F4	4802	52	59	33.3	45.5	3.6	52.3	47.3	87.8	71.4	28.6
Warm Springs	Pechaco Creek	1	F4	2857	53	67	13.7	62.5	12.5	50.7	37.5	31.8	23.8	76.2
Warm Springs	Pechaco Creek	2	F2	1151	67	67	31.0	42.9	14.3	76.3	50.0	70.0	13.2	86.8
Warm Springs	Pechaco Creek	3	F3	5140	50	67	32.3	27.3	3.0	14.8	38.5	62.9	31.2	68.8
Warm Springs	Pechaco Creek	4	G3	525	50	51	17.9	25.0	0.0	25.0	25.0	91.0	80.0	20.0
Warm Springs	Pechaco Creek	5	G2	475	50	51	45.5	75.0	0.0	35.0	0.0	90.0	72.5	27.5
Warm Springs	Pena Creek	1	F4	13618	64	78	17.2	77.1	31.4	46.9	47.1	50.4	41.8	56.0
Warm Springs	Pena Creek	2	F1	672	65	66	26.2	100.0	0.0	5.0	100.0	16.4	33.3	33.3
Warm Springs	Pena Creek	3	F4	36020	56	76	33.3	74.2	26.5	22.9	50.4	49.6	30.4	69.6
Warm Springs	Pine Ridge Canyon Creek	1	F6	400	52	52	0.0	0.0	0.0	0.0	0.0			
Warm Springs	Pine Ridge Canyon Creek	2	C4	3517	52	54	7.8	28.6	0.0	11.3	100.0	85.5	100.0	
Warm Springs	Redwood Log Creek	1	G3	3094	55	57	2.6	16.7	0.0	11.7	16.7	94.7	49.5	50.5
Warm Springs	Salt Creek	1	G4	2681	60	62	24.9	8.3	0.0	60.5	40.5	82.8	64.6	35.4
Warm Springs	Schoolhouse Creek	1	B4	2201	68	69	1.5	0.0	0.0	5.0	66.7	95.9	8.3	91.7
Warm Springs	Sweetwater Creek	1	B3	2316	52	54	15.2	21.1	0.0	40.0	100.0	88.6	29.8	70.2
Warm Springs	Wallace Creek	1	F4	7513	57	67	35.3	55.1	6.1	39.6	83.7	72.5	51.2	48.8
Warm Springs	Wine Creek	1	F4	3508	62	64	23.9	33.3	4.8	21.7	53.3	75.4	23.5	76.5
Warm Springs	Wine Creek	2	F3	907	63	63	42.0	50.0	12.5	37.5	25.0	95.6	87.8	12.2
Warm Springs	Wine Creek	3	B3	1749	63	64	21.8	28.6	0.0	30.0	100.0	97.4	79.5	20.5
Warm Springs	Wine Creek	4	B2	389	64	64	25.7	50.0	50.0	55.0	0.0	98.3	86.7	13.3
Warm Springs	Wine Creek	5	B1	346	64	64	6.9	0.0	0.0	5.0	100.0	95.0	60.0	40.0
Warm Springs	Wine Creek	6	B4	1884	60	67	29.4	34.8	13.0	56.6	100.0	93.2	49.3	50.7

In-stream Habitat Summarized by Reach

HSA	Stream	Reach	Chan Type	Chan Len	Low Water	High Water	% Pools	Pools 2ft	Pools 3ft	Pool Shelter Rating	Embed (3+4)	Canopy	Conif	Decid
Warm Springs	Wine Creek	7	G3	1011	60	62	55.4	62.5	25.0	60.0	80.0	69.7	53.0	47.0
Warm Springs	Wine Creek	8	G4	2295	60	61	26.2	42.9	4.8	55.5	88.9	92.5	76.6	23.4
Warm Springs	Woods Creek	1	B4	2622	52	54	22.0	81.8	54.5	49.0	33.3	67.2	12.8	87.3
Warm Springs	Woods Creek	2	B3	1241	52	53	35.9	100.0	12.5	10.0	25.0	57.6	6.0	94.0
Warm Springs	Woods Creek	3	F3	6812	50	54	29.6	87.2	21.3	52.1	46.5	66.8	11.9	86.6
Warm Springs	Woods Creek	4	B4	4036	50	51	14.2	68.4	21.1	55.0	68.4	84.5	53.1	46.9
Warm Springs	Woods Creek	5	A3	624	50	50	1.6	100.0	0.0	0.0	93.0	80.0	20.0	
Warm Springs	Woods Creek, Trib 3	1	G3	1107	50	50	3.8	25.0	0.0	5.0	50.0	93.7	49.2	50.8

Metadata for Habitat Features Summarized by Stream Reach

Field Name	Description
HSA	Hydrologic Sub-Area (Calwater 2.2a).
Stream	Stream name.
Reach	Reach number.
Chan Type	Rosgen channel type classification.
Chan Len	Total length of all main channel habitat units (feet).
Low Water	Minimum surveyed water temperature (degrees Fahrenheit).
High Water	Maximum surveyed water temperature (degrees Fahrenheit).
% Pools	Percent of main channel, by length, composed of pools (habitat types 4.x, 5.x and 6.x). Includes dry (habitat type 7.0) and recorded but non-surveyed (habitat type 9.x) habitat units.
Pools 2ft	Percent of main channel pools (habitat types 4.x, 5.x and 6.x) greater than, or equal to, two feet deep.
Pools 3ft	Percent of main channel pools (habitat types 4.x, 5.x and 6.x) greater than, or equal to, three feet deep.
Pool Shelter Rating	Average shelter rating (ShelterValue x Cover) for main channel pools surveyed for in-stream shelter.
Embed (3+4)	Percentage of main channel pool tail outs, surveyed for embeddedness and containing suitable spawning substrate (not classified with pool tail embeddedness = 5), with an embeddedness classification of 3 or 3 (50% to 100% embeddedness).
Canopy	Average canopy density for habitat units surveyed for canopy cover. Average not weighted.
Conif	Average percent evergreen canopy for habitat units surveyed for canopy cover. Average not weighted.
Decid	Average percent deciduous canopy for habitat units surveyed for canopy cover. Average not weighted.

Russian River Basin - DFG Funded Restoration Projects (1981-2002)

HSA	Project	Year	Purpose	Project Type	Cost
Austin Creek	Austin Creek State Recreation Area Watershed Improvement Project	2000 -	Reduce impacts to and restore salmonid habitat through implementation of site specific and prioritized erosion control and erosion prevention in the Austin Creek State Recreation Area, East Austin Creek watershed.	Road work	$ 213,680.00
Austin Creek	East Austin Creek Riparian Revegetation	1997 - 2000	Restore shade cover and future recruitment of woody debris to an approximate 2.5 mile section of East Austin Creek by re-establishing native plants in the riparian zone.	Riparian work	$ 26,760.00
Austin Creek	Gray Creek Road Sediment Reduction Project	2000 -	Decrease the amount of fine sediment in stream gravel and riffle habitat with the objective of increasing production of juvenile steelhead within Gray Creek by regrading roads and installing needed culverts for erosion control and storm proofing, in accordance with the recommendations outlined by Pacific Watershed Associates road assessment report of May 31, 1997.	Road work	$ 98,722.00
Austin Creek	Pole Mountain Creek Fisheries Project	1998 - 1998	Reduce sediment loads to Pole Mountain Creek spawning and rearing habitat coming from an active landslide on an unnamed seasonal tributary.	Instream work	$ 14,180.00
Austin Creek	Pole Mountain Creek Bank Stabilization Project #2	2000 -	Reduce sediment loads to Pole Mountain Creek: divert current from the toe of slide with two wing-deflectors; boulder rip-rap bank stabilization; create rootwad rearing habitat.	Instream work	$ 16,512.00
Austin Creek	Restoration of Instream Structural Elements, Austin Creek	1998 - 2000	Increase and improve salmonid habitat within a 0.3 mile reach of Austin Creek by designing and installing natural instream structures with revegetation, creating a highly visible community demonstration project.	Instream work	$ 50,201.00
Austin Creek	Ward Creek Barrier Modification & Erosion Control	1988 - 1990	Modify logjam barrier. Stabilize chronic slide into creek.	Instream work	$ 2,250.00

HSA	Project	Year	Purpose	Project Type	Cost
Forsythe Creek	Eldridge Creek Riparian Canopy Restoration Project	2001 -	Increase the riparian canopy protecting the creek; create demonstration site for landowners to see two different methods for protecting native riparian canopy from deer browse and antler rubbing; exclusionary fencing to protect natural regeneration of riparian zone.	Riparian work	$ 26,668.00
Forsythe Creek	Forsythe Creek Restoration Project	1991 - 1993	Improve spawning and nursery habitat for steelhead and Chinook by constructing boulder weirs and boulder group deflectors to collect spawning gravel and produce scour pools. Protect old alder trees by armoring roots with boulders. New trees planted.	Instream work	$ 10,000.00
Forsythe Creek	Forsythe Creek Riparian Restoration Proposal	2000 - 2002	Riparian restoration to stabilize and revegetate critical bare and vertical banks along Forsythe and Walker Creeks, on the property of the Golden Rule Church Association.	Riparian work	$ 59,990.03
Forsythe Creek	Forsythe Creek Streambank Stabilization & Habitat Enhancement	1996 - 1996	Stabilize 150+ feet of rapidly eroding streambank, reduce channel meander and sedimentation, create summer pool habitat and cover.	Instream work	$ 11,645.00
Forsythe Creek	Forsythe Creek Riparian Restoration Proposal	2001 - 2002	To stabilize and revegetate critical bare and vertical banks along Forsythe Creek using bioengineered structures.	Riparian work	$ 62,198.00
Forsythe Creek	Forsythe Creek Golden Rule Riparian Restoration	1999 - 2000	Stabilize and revegetate critical bare and vertical banks along Forsythe Creek.	Instream work	$ 102,830.81
Forsythe Creek	Forsythe Creek Riparian Tree Establishment	2001 - 2002	Reduce water temperatures through tree canopy establishment to improve summer rearing habitat for steelhead.	Riparian work	$ 10,458.00
Forsythe Creek	Jack Smith Creek Restoration Project #1	1991 - 1992	Modification of log barriers and potential log barriers on Jack Smith Creek.	Instream work	$ 11,862.14

HSA	Project	Year	Purpose	Project Type	Cost
Forsythe Creek	Mumford Dam Fish Passage and Riparian Restoration Project	2001 -	Provide fish passage over the Mumford Dam and restore 720 feet of adjacent stream bank. Passage will be facilitated through installation of a series of eight cross-vane weirs; adjacent stream banks will be regraded to a stable profile and stabilized with bioengineered structures, geotextile fabrics, native plantings and rock.	Instream work	$ 420,905.00
Forsythe Creek	West Fork Russian River Riparian Restoration Monitoring	2000 - 2002	Sites were treated with Bioengineering techniques to stabilize and revegetate streambanks of the West Fork Russian River beginning 44 feet downstream of the East Road Bridge as it crosses the West Fork Russian River.	Monitoring	$ 4,396.25
Forsythe Creek	West Fork Russian River Riparian Restoration 2000	2000 - 2000	To stabilize and revegetate barren riparian terraces along a 2415 foot section of the West Fork Russian River.	Riparian work	$ 10,000.00
Forsythe Creek	West Fork Russian River Riparian Restoration	1999 - 2000	Stabilize and revegetate all (1400 linear feet) of devegetated vertical banks in a 2380 foot section of the West Fork Russian River.	Instream work	$ 85,384.58
Geyserville	Crocker Creek Dam Removal Project	2001 -	Restore a fish passage to Crocker Creek and stabilize adjacent stream banks. Passage will be facilitated through removal of portions of the Crocker Creek Dam and the installation of a series of weirs; adjacent stream banks will be regraded to a stable profile and stabilized with bioengineered structures, geotextile fabrics, native plantings and rock.	Instream work	$ 323,554.00
Geyserville	Gill Creek Restoration Project	1998 - 1999	Through a series of deflectors, baffles, weirs and revetments along with revegetating, prevent further erosion, stabilize banks and footing as well as slow the water, creating new pools and improving existing rearing habitat on a section of Gill Creek.	Instream work	$ 26,229.00
Geyserville	Little Briggs Creek Enhancement Project #2	2000 - 2001	Enhance salmonid habitat in a 1900 foot section of Little Briggs Creek by installing fish habitat structures, stabilizing eroding banks, and improving the riparian corridor.	Instream work	$ 15,990.00

HSA	Project	Year	Purpose	Project Type	Cost
Guerneville	Dutch Bill Creek Watershed Road Assessment and GIS Mapping	2001 -	Inventory of ongoing and potential sediment sources throughout the watershed; prioritized list of cost-effective erosion prevention projects will be developed for future implementation.	Survey, study, research	$ 27,669.00
Guerneville	Dutch Bill Creek Fish Habitat Improvement Project #4	2001 -	Increase pool cover and frequency through the installation of 3 boulder clusters, 5 cover logs, 1 rock weir in riffle habitat.	Instream work	$ 17,034.00
Guerneville	Dutch Bill Creek Pool Habitat Project	2001 -	Create and enhance deep pools with the installation of 10 complex log structures and 7 rock weirs.	Instream work	$ 30,035.00
Guerneville	Dutch Bill Creek Pool Habitat Project	2000 - 2001	Project will lead to the improvement of steelhead and Coho salmon summer rearing habitat by creating deep pools.	Instream work	$ 12,565.00
Guerneville	Dutch Bill Creek Fish Habitat Improvement Project #3	1999 - 2000	Improve fish habitat in a reach of Dutch Bill Creek by increasing pool cover and frequency.	Instream work	$ 17,006.00
Guerneville	Fay Creek Pool Habitat Project	2001 -	Create deep pools and increase stream complexity by installing a total of 6 cover scour logs, 1 fish ladder modification, 10 rock weirs, 2 complex log structures and 5 rock check dams on three separate sites.	Instream work	$ 29,397.00
Guerneville	Fife Creek Check Dam Removal and Habitat Enhancement Project	2000 - 2002	Correct stream and habitat degradation by removing or modifying the concrete check dams that are most affecting natural channel processes and salmonid habitat as identified in the DFG Stream Inventory Report for Fife Creek (DFG 1998). Increase and improve anadromous fish habitat in Fife Creek by restoring the channel and installing stabilizing structures which lengthen summer flows, encourage pool formation, and provide instream woody cover.	Instream work	$ 170,534.00
Guerneville	Green Valley Creek Erosion Project - Gunsalves Property	2000 - 2001	To improve habitat for juvenile and adult salmonids by stabilizing and revegetating the streambanks.	Instream work	$ 3,288.00
Guerneville	Green Valley Creek Erosion Project B	2000 - 2001	Streambank stabilization to improve salmonid habitat. Will focus on repairing 30 feet of eroding streambank.	Instream work	$ 7,476.00

HSA	Project	Year	Purpose	Project Type	Cost
Guerneville	Green Valley Creek Fisheries Restoration Project #3	1995 - 1996	Armoring a severely eroded bank with rock rip rap and incorporating native vegetation to provide canopy for the stream.	Instream work	$ 6,000.00
Guerneville	Green Valley Creek Fisheries Restoration Project #2	1996 - 1996	To provide in-stream structure for salmonids and recruit spawning gravels.	Instream work	$ 3,000.00
Guerneville	Green Valley Creek Fisheries Restoration Project #1	1995 - 1996	Repair of a severely eroded bank and incorporate native willow vegetation as a means to increase canopy over the stream.	Riparian work	$ 6,000.00
Guerneville	Green Valley Creek Pool Habitat Project	2000 - 2000	Improve steelhead and Coho summer rearing habitat by creating deeper pools.	Instream work	$ 6,224.00
Guerneville	Green Valley Creek Fish Passage Improvement Project	1999 - 2001	To improve fish passage in a reach of Green Valley Creek through the removal of a concrete barrier, and the installation of jump pools.	Instream work	$ 6,540.00
Guerneville	Green Valley Creek Pool Habitat Improvement Project	1999 - 2001	Improve fish habitat in a reach of Green Valley Creek by increasing the number of pools.	Instream work	$ 6,826.00
Guerneville	Green Valley Creek Pool Enhancement Project	2000 - 2001	Improve summer and winter rearing habitat for steelhead and Coho salmon by increasing the number and depth of pools in 2 reaches of Green Valley Creek.	Instream work	$ 23,082.00
Guerneville	Green Valley Creek Pool Habitat Project	2001 - 2001	Create and enhance deep pools in order to improve steelhead and Coho salmon summer and winter rearing habitat.	Instream work	$ 6,141.00
Guerneville	Healdsburg War Memorial Dam Fish Ladder	2001 -	Enable upstream passage for migrating species.	Instream work	$ 1,930,897.00
Guerneville	Hobson Creek Sediment Source Assessment	2001 -	Complete an inventory along 14 miles of road system within the Hobson Creek watershed, that will identify and detail cost-effective erosion prevention and control projects that can be undertaken to reduce the risk of future erosion and sediment delivery into Hobson Creek and its tributaries.	Survey, study, research	$ 17,485.00
Guerneville	Mission Creek Pool Habitat Project	2001 - 2001	Create and enhance deep pools.	Instream work	$ 15,500.00

HSA	Project	Year	Purpose	Project Type	Cost
Guerneville	Riparian Restoration: Green Valley Creek	2001 -	Riparian corridor restoration to improve riparian habitat through expanded riparian plantings, removal and conversion of exotic vegetation, and long term stream bank stability with native woody plants.	Instream work	$ 25,301.00
Guerneville	Willow Creek Enhancement Project	2001 -	Improve eroding bank conditions and habitat for steelhead trout and Coho in Willow Creek by installing 3 simple and 12 complex boulder/log/rootwad structures, resloping the stream bank and stabilizing with plantings.	Instream work	$ -
Guerneville	Willow Creek Watershed Evaluation, Assessment, & Planning	2000 - 2002	Locate specific erosion control and habitat restoration sites, provide one or more design options per site with approximate budgets.	Survey, study, research	$ 23,392.80
Guerneville	Willow Creek Restoration Project '97-1	1998 - 1998	Reduce sediment load entering Willow Creek by installing 8 erosion control projects in gullies. Revegetate the stabilized area and install livestock exclusion fences.	Instream work, Riparian work and Road work	$ 59,960.00
Guerneville	Willow Creek Enhancement Project #3	2000 - 2001	Enhance salmonid habitat in a 3000 foot section of Willow Creek by constructing a fence and planting native species along both banks to limit cattle access, control erosion and increase canopy in the riparian zone.	Riparian work	$ 27,993.80
Laguna	1995 California Salmonid Restoration Conference	1994 - 1995	Funding for the 1995 California Salmonid Restoration Conference.	Education, training, workshops	$ 4,500.00
Laguna	1998 California Salmonid Restoration Conference	1997 - 1998	Improve the effectiveness of salmon, steelhead and trout fisheries restoration practitioners and contractors.	Education, training, workshops	$ 5,000.00
Mark West	Mark West Creek Stream Enhancement Project	2001 -	Decrease the amount of sediment entering the creek from eroding banks by applying bioengineering, and to improve juvenile Coho salmon and steelhead trout habitat by adding rootwad and logs for scour pools.	Instream work	$ 7,539.00

HSA	Project	Year	Purpose	Project Type	Cost
Santa Rosa	Santa Rosa Creek Watershed Erosion Control and Prevention Implementation A: McCormick Sanctuary	2000 - 2002	Implement erosion control and prevention plan for road network and other upland surfaces on McCormick Sanctuary which drain to steelhead-bearing headwaters of Santa Rosa Creek; phase two of two phase project.	Road work	$ 91,228.00
Santa Rosa	Santa Rosa Creek Headwaters Erosion and Prevention Implementation B: Hood Mountain Regional Park	2000 - 2002	Implement road erosion control and implementation plan developed by Pacific Watershed Associates for Santa Rosa Creek Headwaters, Hood Mountain Regional Park. It is anticipated that the implementation of this plan will prevent an estimated 5078 cubic yards from being delivered to Santa Rosa Creek, thereby improving Steelhead spawning and rearing habitat.	Road work	$ 76,176.62
Sulphur Creek	Big Sulphur Creek Slide Stabilization Project	1981 - 1982	Stabilize and revegetate streambank in the area known as Blue Slide on Big Sulphur Creek.	Upland work	$ -
Ukiah	Ackerman Creek Channel Enhancement Project 1	2000 - 2002	Improve juvenile steelhead trout habitat by replacing an undersized culvert with a bridge, fencing off livestock and replanting the riparian area with native species.	Instream work	$ 174,190.92
Ukiah	Ackerman Creek Road Sediment Control	2001 -	Sediment control treatments at four sites: remove/upgrade failed culverts, rock armor outlets, replace culvert with a bridge, install a cross drain culvert and remediate a large gully along the road.	Road work	$ 270,120.00
Ukiah	Ackerman Creek Barrier Blasting	1986 - 1990	Modify rock falls barriers on Ackerman Creek.	Instream work	$ 1,200.00
Ukiah	Ackerman Creek 8 Mile Bridge	2001 - 2002	Remove a fish passage barrier on Ackerman Creek, accomplished by replacing an undersized culvert with a bridge to facilitate improved fish passage. The increased sediment transport will improve flow conditions and possibly the number of pools.	Instream work	$ 125,694.00
Ukiah	Ackerman Creek Fish Ladder	1982 - 1984	Construct Denil-type fish ladder to provide improved passage to 3 miles of rearing habitat and 9 miles of spawning habitat.	Instream work	$ -

HSA	Project	Year	Purpose	Project Type	Cost
Ukiah	Alder Creek Livestock Exclusion Fencing and Riparian Enhancement Project	2001 -	Enhance salmonid habitat in a 3000 foot section of Alder Creek by constructing a fence along both banks to limit cattle access and plant native species, which would control erosion and increase canopy in the riparian zone.	Riparian work	$ 49,441.00
Ukiah	Coleman Creek - Salmon Access Restoration	1988 - 1990	Remove debris jam which impedes fish passage.	Instream work	$ 1,980.00
Ukiah	Dooley Creek Planning Proposal	1999 - 2001	Identify incoming sediment sources and prioritize and prescribe solutions.	Survey, study, research	$ 27,253.00
Ukiah	Feliz Creek Fishway Project	1986 - 1986	To provide upstream passage for steelhead and salmon: modify a dam and spillway and create a jump pool; blast a rock barrier and rubble chute.	Instream work	$ 8,500.00
Ukiah	Feliz Creek Dam Modification	1986 - 1990	Modification of a dam spillway on Feliz Creek.	Instream work	$ -
Ukiah	Hensley Creek Fishway Project	1986 - 1986	Design, construct and install a denil-type fish ladder to provide upstream passage for Chinook salmon and steelhead trout.	Instream work	$ -
Ukiah	Influences of riparian vegetation and landscape-scale variables on salmonid habitat in Mediterranean-climate, hardwood watersheds	2001 -	To understand relationships between land use, riparian corridors, large woody debris, and salmonid habitat in the Mediterranean climate, hardwood watersheds of coastal California. This study will utilize GIS, remote sensing, stream and riparian field surveys, and existing California Department of Fish and Game databases to explore key ecosystem processes that affect fish habitat in hardwood watersheds.	Survey, study, research	$ 170,792.00
Ukiah	McDowell Creek Stream Enhancement Project 2000	2000 - 2002	Improve 3780 feet of juvenile and adult steelhead trout habitat in McDowell Creek by utilizing erosion control/riparian enhancement techniques such as willow walls, willow revetments and brush mattresses.	Instream work	$ 82,709.65

HSA	Project	Year	Purpose	Project Type	Cost
Ukiah	McNab Creek Restoration Project	2000 -	To stabilize the stream banks in 5 sites and to improve the quality of fish habitat in 13 other sites. The results will reduce the amount of fine sediment entering the channel by stabilizing the banks. The 13 sites planned for boulder weirs will provide a mechanism to sort and store spawning gravels and to create scours for pool habitat.	Instream work	$ 48,609.48
Ukiah	McNab Ranch Road Erosion Assessment	2001 -	Develop a comprehensive assessment of sediment sources associated with the main road network within the McNab Creek Watershed and portions of the Feliz Creek and Robinson Creek Watersheds, and to develop site-specific plans for treating these sediment sources.	Survey, study, research	$ 27,444.00
Ukiah	Orr Creek Project #2 - Habitat Restoration	1990 - 1992	Improve salmonid nursery habitat, streambank stability and establish riparian vegetation in Orr Creek.	Instream work	$ 10,480.00
Ukiah	Orr Creek Habitat Enhancemt	1987 - 1989	Remove rock falls barriers on Orr Creek by drilling and blasting.	Instream work	$ 4,000.00
Ukiah	Orrs Creek Restoration Project	2000 -	Part of a comprehensive plan to restore the riparian vegetation and improve habitat quality in approximately four miles of Orrs Creek. These goals will be attained by implementing the following: barrier modification (2), boulder cluster placement to create thalweg and pools (6), toe stabilization at slide (1), digger log structures to create scour in homogenous habitats (2).	Instream work	$ 27,068.01
Ukiah	Parson's Creek Barrier Removal Project	1998 - 1998	Upgrade existing 60' cement slab ford crossing, which over the last 30 years has downcut below, creating a fish passage barrier. Install 5 grade control boulder weirs to gradually raise the elevation of the streambed to a level at or above the ford.	Road work	$ 10,648.00
Ukiah	Parsons Creek Watershed Restoration	2001 -	56 road sites will be treated through erosion prevention techniques including critical dips, CMP replacements, soil excavation, rolling dips, and outsloping, among others.	Road work	$ 223,443.00

HSA	Project	Year	Purpose	Project Type	Cost
Ukiah	Parsons Creek Riparian Corridor Restoration Project	2001 -	To restore the riparian corridor of Parsons Creek by excluding native and domestic herbivores, and by planting and irrigating woody riparian species. This will increase canopy cover for the creek, lower water temperature, stabilize stream banks, promote the deposition of fine sediment on the floodplain and, through time, contribute large woody debris to the stream.	Riparian work	$ 72,591.00
Ukiah	Parsons Creek Stream Restoration and Demonstration Project	1992 - 1993	To improve and restore steelhead habitat in Parsons Creek by fencing the stream from ungulate use and planting riparian vegetation for shade and streambank stabilization	Riparian work	$ 64,460.00
Ukiah	Robinson Creek Habitat Enhancement	1996 - 1996	Installation of temporary wildlife exclusionary fencing to restore riparian vegetation along a 1,200 foot section of Robinson Creek.	Riparian work	$ 9,800.00
Ukiah	Robinson Creek Access Improvement	1995 - 1996	Modification of rock impediments. Remove cement and rubble dam.	Instream work	$ 7,290.00
Ukiah	Robinson Creek Habitat Restoration	1992 - 1993	Install fencing to exclude ungulates along Robinson Creek.	Riparian work	$ 7,437.00
Ukiah	Robinson Creek Access Improvement Project	1989 - 1990	Modify rock falls barriers for fish access.	Instream work	$ 14,770.00
Ukiah	Russian River Spawning Habitat	2000 - 2001	Build spawning habitat and repair riparian zones for salmon and steelhead. The spawning habitat, approximately 100 yards long and 30 yards wide, will be located 100 yards from the confluence of the East and West Branches of the Russian River. This site is below Coyote Dam yet protected from the dramatic effects of water release. The riparian zone along both sides and upstream from the project are designated for stabilization.	Instream work	$ 26,882.84
Ukiah	Salmonids in the Classroom	1993 - 1994	Continue and expand the Salmonids in the Classroom program.	Education, training, workshops	$ 3,000.00

HSA	Project	Year	Purpose	Project Type	Cost
Warm Springs	Coordination of the Watershed Education Programs in three Salmon River Schools	1998 - 1999	Funding an skilled coordinator and support needed to continue and expand existing Salmon River water science and education programs.	Education, training, workshops	$ 13,871.00
Warm Springs	Felta Creek Stream Enhancement #1	1997 - 1997	Install 10 boulder weir structures to create pools and add cover to pools.	Instream work	$ 13,120.00
Warm Springs	Felta Creek Stream Enhancement Project 2	1998 - 1998	Improve 3,620 feet of juvenile Coho and steelhead habitat in Felta Creek.	Instream work	$ 9,227.00
Warm Springs	Grape Creek Enhancement Project #2	2000 - 2001	Enhance salmonid habitat in a 750 foot section of Grape Creek by increasing numbers and depths of pools, stabilizing eroding banks, decreasing channel incision and retaining spawning gravels.	Instream work	$ 10,470.00
Warm Springs	Grape Creek at Quivera Streambank Stabilization and Riparian Revegetation	2001 -	Stabilize and revegetate bare, eroded stream banks along Grape Creek utilizing Bioengineering techniques or rock and vegetation.	Riparian work	$ 78,598.00
Warm Springs	Irrigation for Restoration Projects	2001 -	Irrigate new and existing bioengineering restoration projects and native vegetation planting sites along streams. The irrigation system would be mobile so that many restoration sites could benefit. The restoration sites, when properly watered, will increase the chance of survival of plants and bioengineering sites which will provide shade to the stream and bank stability.	Riparian work	$ 15,165.00
Warm Springs	Mill Creek Stream Enhancement	1997 - 1999	Enhance Coho and steelhead habitat by constructing 8 log cover/scour structures and 3 boulder weirs and planting 3100 trees.	Instream work	$ 15,880.00
Warm Springs	Mill Creek Stream Enhancement #1	1997 - 1997	Install 11 complex and 6 simple log cover structures in pool habitats.	Instream work	$ 23,460.00

HSA	Project	Year	Purpose	Project Type	Cost
Warm Springs	Palmer Creek Sedimentation Reduction Project	1999 - 2002	Decrease the amount of sediment in stream gravel and riffle habitat with the objective of increasing production of juvenile steelhead within Palmer Creek. This will be accomplished by regrading roads and installing needed culverts for erosion control, and storm proofing in accordance with the recommendations outlined by Pacific Watershed Associates road assessment report of April 10, 1997.	Road work	$ 117,200.00
Warm Springs	Palmer Creek Stream Enhancement Project #1	1997 - 1999	Enhance 3000 feet of Coho and steelhead habitat on Palmer Creek by installing 7 cover/scour structures and planting 1500 native alder trees.	Instream work	$ 8,496.00
Warm Springs	Pena Creek Enhancement Project	2001 -	Improve juvenile Coho salmon and steelhead trout habitat in Pena Creek. This will be achieved by excluding livestock from the stream channel, installing bank stabilization structures, and replanting native plant species.	Instream work and Riparian work	$ 28,187.00
Warm Springs	Sonoma County Stream Enhancement Projects	1985 - 1986	Install instream structures to establish habitat and reduce erosion in Tannery Creek. Remove boulders from a jump pool on Felta Creek to improve fish passage. Modify log barriers in Flatridge and Buckeye Creeks. Stabilize bank of Fay Creek.	Instream work	$ 35,000.00
Coyote Valley and Warm Springs	Microsatellite Analysis of Russian River Steelhead	2001 -	Use microsatellite loci to examine genetic differentiation in Pacific steelhead populations above and below ten impassable barriers and among geographically distinct localities in the Russian River watershed.	Survey, study, research	$ 254,490.00
Forsythe Creek and Warm Springs	Fish Passage Projects - Redwood Log Creek, Schooner Gulch, Jack Smith Creek, Elk Creek, Woodman Creek, Rice Creek, Salmon Creek, Albion River, Gates Creek, Cook Creek	1984 - 1985	Improve fish passage in various streams.	Instream work	$ 65,600.00

HSA	Project	Year	Purpose	Project Type	Cost
Guerneville and Austin Creek	Sediment Source Inventory and Erosion Control Plan for ACSRA and ARSR	1998 - 1999	Field check existing erosion inventory data, perform data analysis, and prepare an implementation action plan for erosion control and prevention in the Austin Creek State Recreation Area and Armstrong Redwood State Reserve.	Survey, study, research	$ 9,064.00
Guerneville and Salmon Creek	Willow Creek Road Inventory	2000 - 2001	Conduct inventory to identify sediment sources and chronic non-point source erosion problems on the active and abandoned road network in the greater portions of Willow Creek and Freezeout Creek; log in database. The database will provide a reference of prioritized sites for correction, in the effort to minimize sediment contributions into the Russian River, a TMDL listed watershed for sediment.	Survey, study, research	$ 28,202.00
Ukiah and Coyote Valley	Salmon in the Classroom	1992 - 1993	Salmonid life history education program utilizing aquaria to hatch salmonid eggs.	Education, training, workshops	$ 3,000.00
Ukiah and Warm Springs	Fish Passage Projects - Gazos Creek, Ackerman Creek, Burger Creek, Redwood Log Creek, Mill Creek, North Fork Indian Creek, Indian Creek, Rose Creek, Elk Creek	1985 - 1985	Remove logjams, woody debris and install fishways in various streams.	Instream work and Riparian work	$ 64,850.00
Austin Creek, Gualala and Russian Gulch	Ward Creek/Gualala Watershed Inventory and Restoration Planning Project	2000 - 2002	Reduce impacts to and restore salmonid habitat through development of a site specific and prioritized plan for cost-effective erosion prevention, erosion control and habitat restoration in this 8,700-acre portion of the headwaters of Ward Creek and the South Fork Gualala River.	Survey, study, research	$ 100,995.00

HSA	Project	Year	Purpose	Project Type	Cost
Big River, Forsythe Creek and Ukiah	Eldridge Creek Road Assessment and Erosion Control Plan	1999 -	Conduct an inventory and assessment of the road and other sediment sources and prepare a plan to implement erosion control and prevention on the Greenfield Ranch portion of the Eldridge Creek Watershed. Additionally, an adjacent 144 acre parcel will be evaluated and assessed by the community and participating landowners in order to become familiarized with identifying trouble spots.	Survey, study, research	$ 28,547.00
Sonoma Creek, Napa River and Santa Rosa	Santa Rosa Creek Watershed Assessment and Planning	1998 - 1999	Identify, characterize and quantify upland sediment sources likely to impact fish bearing streams. Develop a plan of action outlining the appropriate cost effective restoration plans for restoration in the watershed.	Survey, study, research	$ 17,830.00
Basin Wide	Russian River Tributaries Stream Surveys	1997 - 1999	Conduct stream inventories; enter and edit data collected; write reports; make recommendations for fish habitat improvements in the streams.	Survey, study, research	$ 22,931.00
Basin Wide	Assessment of Giant Reed and Restoration Planning- Russian River Tributaries	2000 -	Identify giant reed populations in Russian River tributary streams, map and analyze data, generate acreage figures, estimate control and restoration costs, develop prioritized plan for control and restoration of invaded sites.	Survey, study, research	$ 47,170.00
Basin Wide	Road Crossing Inventory and Fish Passage Evaluation of Mendocino and Sonoma Counties' Road Systems	2001 -	Conduct an inventory of 250 county-maintained road crossings located within anadromous stream reaches of Russian River tributaries; assess adult and juvenile fish passage; develop a project-scheduling document for Mendocino and Sonoma Counties that will prioritize corrective treatments and provide site-specific guidelines for unimpeded fish passage.	Survey, study, research	$ 94,545.00
Basin Wide	Russian River Tributary Watershed Enhancement Program	2000 -	To provide facilitation of restoration efforts with private landowners on the Russian River Tributary Watersheds within our District through outreach, education and project coordination.	Organizational support	$ 96,003.00
Basin Wide	Russian River Stream Inventories	1995 - 1997	Conduct extensive stream inventories to determine the status of the fish and fish habitat in the basins and subbasin of the Russian River.	Survey, study, research	$ 23,330.00

Appendix G

CDFG's Water Pollution Control Laboratory, used the U.S. EPA's conceptual model for development of biocriteria to produce an Index of Biological Integrity for the Russian River Watershed (RRIBI). The methods for establishing this index are explained in *An Index of Biological Integrity for First to Third Order Russian River Tributary Streams*, CDFG 1998 and instructions for using the RRIBI .

Table – and the Biological metrics used in analyzing BMI samples are discussed in Table —. Benthic macroinvertebrate (BMI) were collected from 35 reaches within 21 tributary streams and the mainstem Russian River during the fall 1995 and spring 1996 and 1997 using the California Stream Bioassessment Procedure. A set of core biological metrics, commonly used for bioassessment of California streams were used to describe the BMI communities in the 35 reaches. Monitoring reaches within the first to third order streams classified as similar with different channel types having no influence on mean biological metric values. The biological metrics, Taxa Richness, EPT Taxa, Modified EPT Index, Shannon Diversity, Tolerance Value and Percent Dominant Taxa were chosen as the most appropriate to be included in producing the RRIBI. These six metrics were integrated into a single scoring criteria by producing a histogram of the values for each of the biological metrics and visually determining breaks in their distribution..

This approach of determining scoring criteria was more intuitive and probably most appropriate since the data was collected from streams that could have been moderately impaired and not actually representative of pristine reference conditions. Although there was no indication of strong seasonal variability in the BMI communities, it was recommend that the index period for the Russian River tributary streams be in the spring. It was also recommended that the RRIBI be considered preliminary and that data on more Russian River tributaries and the mainstem be collected to 1) test the effectiveness of this scoring criteria on other first to third order Russian River tributaries, 2) test the appropriateness of using other biological metrics, 3) evaluate the use of the RRIBI in other north coast California streams to test its effectiveness at assessing biological integrity of streams outside the Russian River watershed, and 4) produce an IBI for fourth order and larger stream reaches.

Table ---

Biological Metric	Visual Distribution Score		
	5	3	1
Taxa Richness	?36	35-26	<26
% Dom. Taxa	?14	15-39	>39
EPT Taxa	?19	18-12	<12
Mod EPT Index	?54	53-17	<17
Shannon Diversity	?3.0	2.9-2.3	<2.3
Tolerance Value	?3.0	3.1-4.6	>4.6

How to Use the Russian River Index of Biological Integrity

Obtain a sample of benthic macroinvertebrates following the state standard procedures (California Stream Bioassessment Procedures - May 1999 version). There must be at least three replicate samples collected at each monitoring location. The samples should be processed by a professional bioassessment laboratory using the Level 3 Taxonomic Effort. Determine the mean values for the six listed biological metrics, compare them to the values in the columns and add the scores listed in the column headings. The total score will be between a low of 6 and high of 30. Determine biotic condition of the monitoring location from the following categories:

Excellent	**Good**	**Fair**	**Poor**
30 - 24	**23 - 18**	**17 - 12**	**11 - 6**

Taken From DFG BIOASSESSMENT FACT SHEET - JUNE 8, 1999 REVISION

Table — BIOLOGICAL METRICS USED TO DESCRIBE BENTHIC MACROINVERTEBRATE (BMI) SAMPLES COLLECTED FOLLOWING THE CALIFORNIA STREAM BIOASSESSMENT PROCEDURE (CSBP).

Biological Metrics	**Description**	**Response to Impairment**
Richness Measures		
Taxa Richness	Total number of individual taxa	decrease
EPT Taxa	Number of taxa in the Ephemeroptera (mayfly), Plecoptera (stonefly) and Trichoptera (caddisfly) insect orders	decrease
Ephemeroptera Taxa	Number of mayfly taxa (genus or species)	decrease
Plecoptera Taxa	Number of stonefly taxa (genus or species)	decrease
Trichoptera Taxa	Number of caddisfly taxa (genus or species)	decrease
Composition Measures		
EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae	decrease
Sensitive EPT Index	Percent composition of mayfly, stonefly and caddisfly larvae with Tolerance Values of 0 through 3	decrease
Shannon Diversity Index	General measure of sample diversity that incorporates richness and evenness (Shannon and Weaver 1963)	decrease
Tolerance/Intolerance Measures		
Tolerance Value	Value between 0 and 10 weighted for abundance of individuals designated as pollution tolerant (higher values) and intolerant (lower values)	increase
Percent Intolerant Organisms	Percent of organisms in sample that are highly intolerant to impairment as indicated by a tolerance value of 0, 1 or 2	decrease
Percent Tolerant Organisms	Percent of organisms in sample that are highly tolerant to impairment as indicated by a tolerance value of 8, 9 or 10	increase

Percent Hydropsychidae	Percent of organisms in the caddisfly family Hydropsychidae	increase
Percent Baetidae	Percent of organisms in the mayfly family Baetidae	increase
Percent Dominant Taxa	Percent composition of the single most abundant taxon	increase
Functional Feeding Groups		
Percent Collectors	Percent of macrobenthos that collect or gather fine particulate matter	increase
Percent Filterers	Percent of macrobenthos that filter fine particulate matter	increase
Percent Scrapers (Grazers)	Percent of macrobenthos that graze upon periphyton	variable
Percent Predators	Percent of macrobenthos that feed on other organisms	variable
Percent Shredders	Percent of macrobenthos that shreds coarse particulate matter	decrease

The following summarizes macro-invertebrate data collected by stream and by year from 1995-2002. Samples to be collected in 2003 are proposed.

STREAM	SAMPLE SEASON	LAB ANALYSIS
Ackerman Creek	1/95,5/96	
Atascadero Creek	10/95,5/96	
Bidwell Creek	5/98	
Brush Creek	97	CITY OF SR
Fife Creek	5/98	CC
Foote Creek	5/97	CC
Gray Creek	5/97,5/98	CC
Green Valley Creek	6/95,10/95,5/96	DFG
Hulbert Creek	5/98	CC
Jonive Creek	10/95,5/96	
McNab Creek	5/98	CC
Mission Creek	5/98	CC
Parsons Creek	5/98	CC
Peterson Creek	97	CITY OF SR

Robinson Creek	5/97	
Sheephouse Creek	5/96	
Wallace Creek	10/96,5/96	DFG
Willow Creek	10/95,5/96,5/97	DFG
Alder Creek	10/95,5/96	
Angel Creek	10/95,5/96,5/97,5/98	DFG/CC
Dutch Bill Creek	5/98	CC
East Austin Creek	5/97,5/98	CC
Felta Creek	5/96,5/97,5/98	DFG/CC
Franz Creek	5/98	CC
Gilliam Creek	5/97	DFG/CC
Maacama Creek	5/98, 1/99	CC
Mark West Creek	10/95,4/96	CC
Mill Creek	10/95,5/96,5/97,5/98	DFG/CC
Palmer Creek	5/96,5/97,5/98	DFG/CC
Porter Creek	5/98, 6/99	CC
Purrington Creek	6/95,10/95	DFG
Ward Creek	5/97	
Bear Creek	5/97,5/98	DFG/CC
Bearpen Creek	5/97,5/98	DFG/CC
Blue Jay Creek	5/97,5/98	DFG/CC
Briggs Creek	5/97,5/98, 1/99	DFG/CC
Coon Creek	5/97,5/98	DFG/CC
Devil Creek	5/97	DFG
Little Briggs Creek	5/97,5/98	DFG/CC
Sulphur Creek	5/97	DFG
Thompson Creek	5/97,5/98	DFG/CC
Briggs	5/98	DFG
Dutch Bill	5/98, 5/99	DFG
Dutcher	6/99, 5/00	DFG
Fife	6/99	DFG
Foote	6/99	DFG
Franz	6/99	DFG
Gill	6/99	DFG
Jenner	6/99	DFG
Mc Dowell	6/99	DFG
Mc Nab	5/99	DFG
Pacheco	6/99	DFG
Parsons	5/99	DFG
Pena	6/99	DFG
S. Fork Gill	6/99	DFG
Wine	7/99	DFG
Woods	6/99	DFG
Howell	6/99, 5/00	DFG

Dooley	6/99	DFG
Crocker	6/99, 5/00	DFG
Grape	6/99, 5/00	DFG
Hulbert	6/99, 5/00	DFG
Jenner Gulch	6/99, 5/00	DFG
N. Fork Dooley	6/99, 5/00	DFG
Orr (mendocino Co.)	5/99, 5/00	DFG
Alder	5/00	DFG
Anna Belcher	5/00	DFG
Bakers	5/00	DFG
Crane	5/00	DFG
Eldridge	5/00	DFG
Forsyth	5/00	DFG
Hobson	5/00	DFG
Jack Smith	5/00	DFG
Little Sulphur	5/00	DFG
Lover's Gulch	5/00	DFG
Mill (which one?)	5/00	DFG
N. Branch Little	5/00	DFG
S.Fork Gill	5/00	DFG
Seward	5/00	DFG
Walker	5/00	DFG
York	6/02	DFG
Mill (talmage)	6/02	DFG
Doolin	6/02	DFG
Mariposa	6/02	DFG
Fisher (dry, no survey)	6/02	DFG
Corral (dry, No survey)	6/02	DFG
Gibson	6/02	DFG
Salt Hollow	6/02	DFG
Johnson	6/02	DFG
Duncan	6/02	DFG
Morrison	6/02	DFG
Hale	6/02	DFG
Frasier	6/02	DFG
Squaw	6/02	DFG
Big Sulphur	6/02	DFG
Mt. Jackson	6/02	DFG
Barnes (dry, no samples)	6/02	DFG
Brooks (dry, no samples)	6/02	DFG
Martin (dry, no samples)	6/02	DFG
Jonive	6/02	DFG
Sexton	6/02	DFG
Redwood (jonive)	6/02	DFG

Kidd	6/02	DFG
Miller (dry, no samples)	6/02	DFG
Gird (dry, no samples)	6/02	DFG
Peterson (dry, no samples)	6/02	DFG
Frasier trib 1	6/02	DFG
Frasier Trib 2	6/02	DFG
Gossage	03	
Blucher	03	
Copeland	03	
Mc Clure	03	
Castellini	03	
Clear	03	
Heath	03	
Hensley	03	
Lytton	03	
Rockey	03	
Young	03	
Edwards	03	
Ash	03	
Feliz NF	03	
Feliz SF	03	
Feliz Tribs	03	
Pieta	03	
Salt Sprigs	03	
Tyler	03	
Hoil	03	
Cummisky	03	
Howard	03	
Sulphur	03	
Coleman	03	
Salt Canyon	03	
Vasser	03	
Sheldon	03	
Jakes	03	
Oat Valley	03	
Cloverdale	03	
Porterfield	03	
Icaria	03	
Barrelli	03	
Orrs (sonoma co.)	03	
Redslide	03	
Palmer	03	
Hoot Owl	03	

Deer	03
Bear Canyon	03

LAB ANALYSIS: DFG = DFG WATER POLLUTION CONTROL LAB
CC = COSENTINO CONSULTING

“Work in Progress”

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