Troubled Water of the Sierra

By Kerri L. Timmer

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Sierra Nevada Alliance

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Sierra Nevada Alliance

The Sierra Nevada Alliance has been protecting and restoring Sierra land, water, wildlife and communities since 1993. The Alliance unites hundreds of individuals and conservation groups to protect Sierra resources. The Alliance is driven by a vision of a Sierra where natural and human communities coexist in harmony. A Sierra where residents and visitors alike understand and value the unique qualities of the range and protect the places they love.

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> — *History of the Sierra Nevada,* F. Farquhar (1965)

Everyone is familiar with the old adage: *whiskey's for drinkin'; water's for fightin' over*. Nowhere is this more true than in California and Nevada, where complicated systems of dams, reservoirs and aqueducts capture water and move it from where it falls to where people want it – such as for drinking, irrigating land or creating electricity. Water has inspired great passions in those who've tried to control it; and the Sierra Nevada is the source of much of the water people fight over in both California and Nevada.

Sierra waters are critical for the health and welfare of California and Northern Nevada. Almost all 24 major watersheds of the Sierra – those areas of land and water that capture precipitation and drain into a major river or lake – are polluted and impaired to some degree from 150 years of human activity. With future population growth sky rocketing and global warming raising temperatures in the Sierra and decreasing the amount of water stored in the snow pack, there is an urgent need for insightful planning for the future. The Sierra needs public participation in numerous resource management planning efforts and state and federal investment if we are to continue to provide ample clean water, diverse habitat, and prime recreation in the future. More importantly, the Sierra needs collaborative solutions and support, not more fighting.

Sierra Water Supports Agricultural and Residential Uses

The Sierra Nevada is made up of 24 major watersheds which provide up to 65% of California's developed water supply and almost all of Northern Nevada's. Thirteen of these watersheds supply water to the Central Valley Project which irrigates 3,000,000 acres of Central Valley farmland and supplies urban uses, power generation and recreational uses in other parts of the state too. The State Water Project, which supplies water to the San Joaquin Valley for irrigation and drinking water to the Bay Area and southern California, is built primarily on the Sierra's Feather and Kern River watersheds. Water from this conveyance system serves about two-thirds of California's population. In addition, 70% of California's annual water supply comes from local water projects – including water from 12 of the Sierra's 24 watersheds. The entire Reno, Carson City and Minden/Garderville areas of Nevada depend on Sierra waters.

Water is the #1 Resource Exported from the Sierra

It should be no surprise, then, that water is the leading exported commodity out of the Sierra Nevada – bypassing timber sales, agriculture and grazing, and tourism. The direct resource value of this water – for irrigation, municipal and hydroelectric use – is $1.3 billion a year based solely on the derived value of individual water rights. Add to that the revenues generated by value-added uses of that water, such as electricity generation, sale of water by downstream water districts, or water-based recreation, and the figure increases dramatically.

Middle Fork Stanislaus River; Courtesy of Tim Palmer

Sierra Water Supports Important Wildlife Habitat

This water is also critical to a wealth of California and Nevada plant and animal life. The Sierra is home to 50% of all plant species in California, and 400 species of birds, mammals, reptiles and amphibians. Forty native fish species live in the Sierra as well.

Recreation and Tourism Depend on Sierra Water

Finally, Sierra water is the basis of much of the recreational and tourism-related spending in the region. The Sierra has 50-60 million recreational visit days each year. Fishing and whitewater rafting are the two most significant uses of Sierra water. For some Sierra communities, these activities are the single most important driver fueling the local economy.

Sierra Waters are Significantly Polluted and Impaired

Many people assume that the high mountain watersheds of the Sierra Nevada are pure and pristine. But impacts from human activities remain a problem throughout the region. In fact, almost all Sierra watersheds have been rated by one governmental agency or scientific body as polluted and/or impaired to some degree.

For example, looking at the state's list of "impaired" waterbodies under section 303(d) of the federal Clean Water Act, 11 of the Sierra's 24 watersheds have at least one river or lake impaired by pollution. A scientific study of the Sierra Nevada ecosystem commissioned by Congress in 1993, titled the *Sierra Nevada Ecosystem Project Report* (or *SNEP Report)*, uses the presence of various important fish communities as one measure of relative watershed health. Under this measure, fewer than one-third of the Sierra's 24 watersheds received scores indicating "good" watershed quality. Another analysis in the *SNEP Report*, called Potential Aquatic Diversity Management Areas (or PADMAs), looks at species

Troubled Sierra Watersheds

WATERSHED	IMPACTED by POLLUTION [watershed 303(d) listed]	IMPACTED FISH COMNTIES [watershed IBI score-fair/poor]	NATIVE SPECIES UNSUSTAINABILITY [no PADMA in watershed]	LOW RESTORATION POTENTIAL [no Category 1 CUWA in watershed]
American		x		
Calaveras			x	x
Caliente		x	x	x
Carson	x	x		
Cosumnes				
Eagle Lake	x			
Feather	x	x		x
Honey Lake	x	x		
Kaweah		x		x
Kern				x
Kings				x
Merced		x		x
Mojave		n/a	x	x
Mokelumne		x		x
Mono Basin	x	x		
Owens	x	x		
San Joaquin		x		
Stanislaus		x		x
Truckee	x	x		
Tule		x		
Tuolumne	x			x
Upper Sacramento	x			
Walker	x	x		
Yuba	x	x		

Source: SWRCB and SNEP Report

diversity, degree of existing preservation and other factors to measure the potential of different watersheds for perpetuating native species. In this analysis three Sierra watersheds are considered to be in such poor health they don't contain a single PADMA site. And finally, using restoration potential as the measure, the State Water Resources Control Board shows only half of the Sierra's major watersheds as containing high priority areas for restoration under the California Unified Watershed Assessment Program.

Based on these four different assessments or measures of Sierra watershed health, the inescapable conclusion is that Sierra watersheds are in trouble.

Such degradation has negatively affected different species living in the watersheds of the Sierra. For example fewer than half the native fish species in the Sierra have secure populations, due to the impacts of watershed disturbance, construction of dams and diversions, alteration of stream channels and introduction of exotic fish species. And half of the 29 native amphibian species (salamanders, frogs and toads) are at risk of extinction due to severe population declines and limited distribution.

State and Federal Governments Have Not Adequately Invested in Sierra Water Protection

The Sierra Nevada as a whole is a neglected region in terms of state and federal investment in the protection and enhancement of natural resources. Outside of Lake Tahoe, the Sierra between 1996-2001 received only one percent of conservation dollars spent for conservation easements and land acquisition by the State of California. The same region was not specifically earmarked for any support in Proposition 40 – a state bond providing conservation resources. The proportion of federal Land and Water Conservation funds appropriated for California projects spent in the Sierra since 1968, excepting Lake Tahoe, is only 0.3%. All this neglect – despite the fact that the Sierra provides 65% of California's water, represents 20% of the land mass, and is home to half of California's plant species.

Population Growth and Climate Change Threaten Sierra Water

But that was then – and this is now. Two very significant drivers of change are arriving in the Sierra that will only make this bad situation more challenging – population growth and climate change.

The Sierra Nevada region's population grew a startling 130% between 1970 and 1990, compared to a rate of 49% for the state and only 22% for the nation as a whole. Areas within the watersheds of Eagle and Honey lakes and the Yuba, American, Truckee, Cosumnes, Calaveras, Merced and San Joaquin rivers stand to experience a whopping 100% to 500% growth between 1990 and 2020. Most of the rest of the westside watersheds are looking at between 60% and 100% population growth for the same time period. Population growth in the state is generally expected to double by 2040 – which will likely increase population in the foothill areas of the Sierra. Such growth in the past has called for the building of more roads and structures that reduce or fragment habitat, increase pollution into waterways, and introduce more non-native species into these newly disturbed areas. More dams and water diversions that block fish passage and destroy natural ecological systems could be another possibility. More urbanization with covered surfaces reduces the natural soil's ability to retain water and increases runoff.

An equal challenge to population growth, however, is climate change. The State Water Board is beginning to plan for a three-degree Celsius rise in temperature and a 1,500-foot rise in the snow level over the next 100 years. Different climate models show different rates of change, with two models used by the National Oceanic and Atmospheric Administration showing a two-degree Celsius rise in temperature in the next 25 years and a 4.5- to 6-degree change by the 2090s.

Leading scientists have already recorded effects of climate change on snowmelt. Studies by university researchers, for example, report that over roughly the past 50 years, snowmelt runoff in Northern California has been occurring earlier

Mokelumne River; Courtesy of Tim Palmer

in the water year and winter and springtime floods have increased due to rain-on-snow events. As an example of the magnitude of such change, over the past 100 years the percentage of total annual runoff occuring during the period of April through July has decreased by 25% in the Sacramento region and 10% in the Southern Sierra.[1] And the effects are accelerating. In the Yuba River, for example, the period of 1950 to 2001 saw proportionally more of the annual runoff occurring from November through February (37.5%). During the first half of the century, only 30.1% of annual runoff occurred that early. Conversely, less water came down in the usual runoff period of April to July over the past 50 years (42.1%) than did during the same timeframe in the first half of the century (51.2%).[2]

Basically, decreased spring and summer stream flow will make it harder to fill water storage reservoirs for the summer and fall, intensifying the already competing demands for water to meet agricultural, industry, urban and environmental uses. Warmer water temperatures will affect fish that rely on cold-water stream flows (salmon and steelhead for example). There are numerous impacts from ecosystems, to wind conditions, to flooding that will occur as climate change continues.

We Need to Plan Ahead to Protect Sierra Waters

Some people may choose to ignore the situation; others will argue that we should wait and see what happens – until it is too late to act. However, there are numerous resource management processes occurring in the Sierra that concerned citizens, elected officials and varied interests can engage in to plan ahead. Various plans govern the physical growth of the Sierra over 10-50 year increments. We can begin to address these drivers of change and ensure that we protect our natural environment and create sustainable communities for future generations.

There are some 45 hydropower relicensings occurring in the Sierra over the next 10 years. If these relicensing proponents choose collaborative decision-making processes, there will be opportunities to account for population growth and climate change – and balance water interests for the future. These relicensing plans will govern dam operation for 20-50 years.

County general plan updates, community specific plans and habitat conservation plans provide more opportunities to affect positive change. Of 29 rural counties, at least 18 have been advised to revisit and update their county general plan. At least 15 counties in the Sierra are scheduled to update their general plans in the near future. In addition, various cities and communities will be doing similar specific plans or community plans. Other Sierra communities may be asked to develop habitat conservation plans. All of these are opportunities to embrace a smart future.

There are also 14 collaborative, multi-stakeholder watershed groups in the Sierra and many are just now doing assessments on the detailed health of their watersheds and are planning restoration and protection projects for the Sierra. Clearly, all of the Sierra's 24 major watersheds need collaborative watershed groups. In addition, these groups need tools to account for population growth and climate change impacts in their watershed restoration and protection plans.

There are also Timber Harvest Plans occurring regularly throughout the Sierra. Sierra Pacific Industries is planning to clear-cut as much as 70% of its 1,500,000 acres in the Sierra Nevada. This strategy must be thoroughly scrutinized for its impacts on watersheds and water quality by the California Department of Forestry, California State Water Resources Control Board and in the permit approval process. The public must have input and there should be resources made available to allow adequate public participation.

Sierra Waters Require Better Protection and More Investment from State and Federal Governments

In short, Sierra waters are the lifeblood of California and much of Nevada. Almost every single watershed is already significantly troubled from 150 years of human activity. With doubling to quintupling population in certain areas of the Sierra and climate change shrinking the amount of water stored as snow, there is dire need for smart planning for the future. The Sierra needs diverse participation in future planning efforts from individuals, groups, and elected officials. The Sierra deserves significant state and federal investment if we are to continue to provide ample clean water, diverse habitat, and prime recreation in the future. We can meet these challenges, if we are smart, committed, and united in our dedication to protecting the headwaters of California and Nevada.

Chapter 1 Sierra Water is Invaluable

> *Water, in all its forms, is indeed the crowning glory of the Sierra. Whether in motion or at rest, the waters of the Sierra are a constant joy to the beholder. Above all, they are the Sierra's greatest contribution to human welfare.*
> — *History of the Sierra Nevada,* F. Farquhar (1965)

Just about everyone is familiar with the old adage: *whiskey's for drinkin'; water's for fightin' over*. Nowhere is this more true than in California, where a complicated system of dams, reservoirs and aqueducts captures and moves water from the northern part of the state – where 75% of the rain falls – to the central and southern parts of the state – where 80% of the demand exists.[3] Nevada is equally dependent on moving water from its area of origin – which sometimes is out of the state altogether – to the primary population centers in metropolitan Las Vegas and Reno-Sparks.

24 Major Watersheds Comprise the Sierra

The Sierra Nevada is made up of 24 major watersheds, according to Calwater, California's system of identifying and delineating watershed boundaries (see Figure 1.1). Running north to south, these include: Eagle Lake, Honey Lake, Upper Sacramento, Feather, Yuba, American, Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Mono Basin, Merced, San Joaquin, Kings, Kaweah, Tule, Kern, Caliente, and Mojave on the west side of the Sierra and Truckee, Carson, Walker, and Owens on the east side of the Sierra crest: together, these watersheds produce most of the water used by Californians and northern Nevadans for residential, industrial, agricultural, power generation and recreational needs.

Sierra streams provide 60% or more of the state's developed water supply.

Water that runs into rivers, lakes and manmade reservoirs is called *surface water* or *surface runoff*, while water that seeps into and stays in the ground is called *groundwater*. Sierran streams generate roughly 30% of California's total surface runoff, providing 20 million acre-feet of surface water each year through rainfall and snowmelt. The total for all California rivers and streams is about 71 million acre-feet.[4]

Much of the flow from Sierra rivers is captured and stored in lower-elevation reservoirs as part of the federal Central Valley Project, the State Water Project, or various local projects built to supply water to people throughout the state. As a result, Sierra streams provide the basis for an even higher proportion of the state's developed water supply – up to 65%.

Sierra Water Supports Agricultural and Residential Uses

Sierra reservoirs, along with the dams that create them and the canals and aqueducts that carry the water from place to place, are part of an extensive storage and conveyance system that moves millions of acre-feet of water[5] each year from its area of origin – primarily the Sierra, the North Coast, or the Colorado River – to other parts of the state. In fact, 75% of the state's precipitation falls in the northern half of the state, while 80% of the agricultural and urban demand for water comes from the central and southern parts of the state.[6]

> *A watershed is that area of land and water that captures precipitation and then drains into a particular body of water, such as a stream, river or lake. Watersheds come in all sizes, and smaller watersheds join to become larger watersheds.*

Federal, state and local governments and other entities have taken advantage of this anomaly by building major water development, storage and distribution projects to move the water from one part of the state to another. (See Appendix A for full list of federal, state and local dams and diversions). The two major water delivery systems are the federal Central Valley Project (CVP) and the State Water Project (SWP). Other projects, such as the Colorado River Aqueduct, and San Francisco and East Bay Aqueducts, were built by local water developers to meet their customers' needs.

SIERRA WATERSHEDS

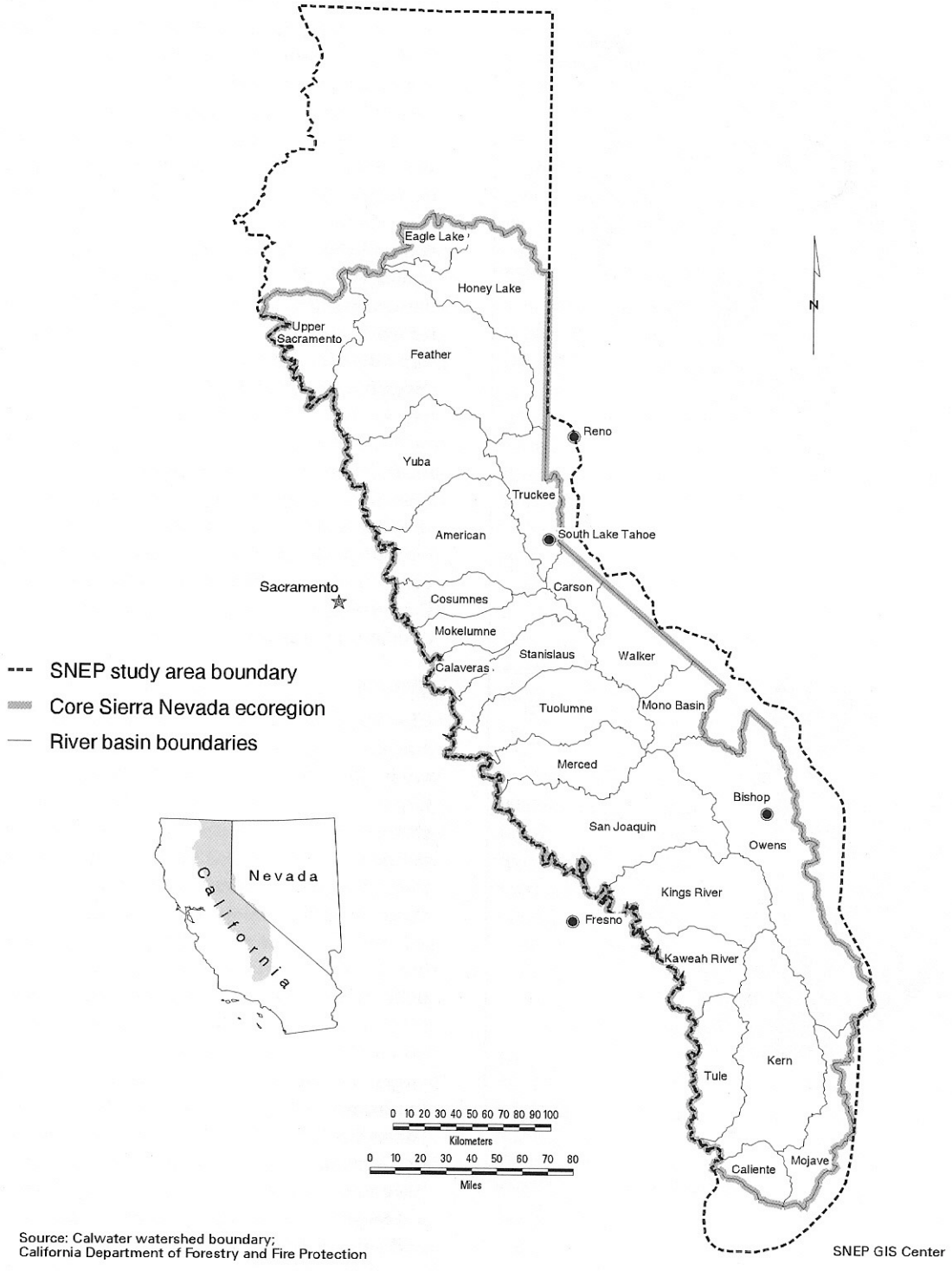

Figure 1.1

Central Valley Project Irrigates Prime Farmland

Congress authorized construction of the Central Valley Project in 1937 to provide irrigation water to farmland in California's Central Valley. The U.S. Bureau of Reclamation completed construction of the project in 1951. The system consists of 20 dams and reservoirs that can store up to 11,000,000 acre-feet of water, along with 11 power houses and three fish hatcheries. The federal dams and reservoirs (along with four combined state-federal reservoirs) deliver approximately 7,000,000 acre-feet of water total, with 95% going to irrigate 3,000,000 acres of farmland a year, and the rest (5%) to urban users, power generation and recreation.[7]

The Bureau of Reclamation and Army Corps of Engineers built major federal dams and diversions in 13 of the 24 Sierra watersheds to supply the CVP project and other federal water projects. (See Table 1.1)[8]

Table 1.1: Federal Water Projects in the Sierra

Sierra Watershed	Federal Dams/Reservoirs/Diversions
Sacramento	Shasta Dam & Reservoir Corning Canal Tehama/Colusa Canal
Yuba	Englebright Dam & Reservoir
American	Folsom Dam & Reservoir Nimbus Dam Folsom S Canal
Truckee	Stampede Dam & Reservoir Prosser Creek Dam & Reservoir Martis Creek Dam & Reservoir Boca Dam & Reservoir
Cosumnes	Jenkinson Lake Dam & Reservoir
Calaveras	New Hogan Dam & Reservoir
Stanislaus	New Melones Dam & Reservoir
San Joaquin	Eastman Lake Dam & Reservoir Hensley Lake Dam & Reservoir Friant Dam & Millerton Reservoir Madera Canal
Kings	Pine Flat Dam & Reservoir Friant-Kern Canal
Kaweah	Lake Kaweah Dam & Reservoir
Tule	Lake Success Dam & Reservoir
Kern	Lake Isabella Dam & Reservoir
Mojave	Mojave River Dam & Reservoir

Source: California Water Map (2001)

California's State Water Project Supplies the San Joaquin Valley, Bay Area and Southern California

In the Burns-Porter Act of 1960, California voters authorized a $1.75 billion bond issue to construct the State Water Project (SWP), consisting of dams, reservoirs, the California Aqueduct (to carry water over 400 miles from the Delta to southern California), levee improvements, the joint state-federal San Luis project, various drainage facilities and fish hatcheries. The SWP delivers approximately 3,000,000 acre-feet of water each year, with 30% going for irrigation, primarily in the San Joaquin Valley, and the balance used for residential, municipal and industrial use in the Bay Area and southern California.[9] Some 20 million Californians (approximately 2/3 of the state) get at least some of their water needs met through the SWP, via contracts with local water agencies.[10] The SWP facilities (excluding canals and the California Aqueduct) were built primarily in the Feather River and Kern River watersheds.[11]

The Bureau of Reclamation and Army Corps of Engineers built major federal dams and diversions in 13 of the 24 Sierra watersheds.

Table 1.2: State Water Projects in the Sierra

Sierra Watershed	State Dams/Reservoirs/Diversions
Feather	Antelope Lake Dam & Reservoir Lake Davis Dam & Reservoir Frenchman Lake Dam & Reservoir Oroville Dam & Reservoir
Kern	Kern Water Bank (underground storage)

Source: California Water Map (2001)

Nevada Water Projects Use Sierra Water for Agricultural and Community Needs

The state of Nevada suffers from a water imbalance similar to that of California. For one thing, Nevada only has one river located entirely within the state – the Humboldt River. The other major rivers, of which there are only five, originate in and/or drain to neighboring states. These include the Colorado, Snake, Truckee, Carson and Walker.

According to the Nevada Department of Conservation and Natural Resources, 40% of the annual yield calculated for Nevada's rivers and streams comes from water originating in adjoining states. Rivers with their headwaters in the California Sierra comprise a substantial portion of this amount, with water from the Colorado River making up the balance. As an example, the

In Nevada's three Sierra rivers – the Truckee, the Carson and the Walker – most of the water falls in the high alpine, California portions of the watersheds, whereas most of the demand exists across the state line in Nevada.

Colorado and Truckee rivers together provide drinking water to 85% of all Nevada residents (by supplying the urban areas of Las Vegas and Reno-Sparks).[12]

In Nevada's three Sierra rivers – the Truckee, the Carson and the Walker – most of the water falls in the high alpine, California portions of the watersheds, whereas most of the demand exists across the state line in Nevada. The two neighboring states signed the California-Nevada Interstate Compact in 1971 to codify water rights on the Truckee, Carson and Walker rivers. As a result of this agreement, 90% of the water from the Truckee and 80% of any additional or "future" yield from the Carson (in excess of water already required to satisfy existing uses) is allocated to Nevada.[13] Similarly in the Walker River watershed, it has been estimated that Nevada irrigation accounts for 90% of the total water used from this river system.[14]

Table 1.3: Water Projects Serving State of Nevada

Sierra Watershed	Dams/Reservoirs/Diversions Supplying Nevada
Truckee	Lake Tahoe Dam Donner Lake Dam Prosser Creek Dam & Reservoir Independence Lake Dam Stampede Dam & Reservoir Boca Reservoir Floriston Diversion Dam
Carson	Diamond Valley Irrigation Ditches 15 small reservoirs of 500 acre-ft or less capacity Heenan Lake
Walker	Bridgeport Reservoir Topaz Reservoir Diversion Canal Topaz Reservoir Poore Lake/Reservoir Upper Twin Lake Reservoir Lower Twin Lake Reservoir 3 small reservoirs of 500 acre-ft or less capacity Various irrigation diversion ditches

Source: NV Natural Resources Status Report (2002)

Local Water Projects Deliver 70% of California's Annual Water Supply

Some 600 cities and local water districts throughout the state have built their own storage and delivery facilities that account for about 70% of the California's annual water supply.[15] Dams, reservoirs and other facilities have been built with local funding in 12 of the Sierra's 24 major watersheds. (See Table 1.40).[16]

Table 1.4: Local Water Projects in the Sierra

Sierra Watershed	Local Dams/Reservoirs/Diversions
Sacramento	Box Canyon Dam & Reservoir
Feather	Mountain Meadows Dam & Reservoir Lake Almanor Dam & Reservoir Butt Valley Dam & Reservoir Bucks Lake Dam & Reservoir Paradise Dam & Reservoir Little Grass Valley Dam & Reservoir Sly Creek Dam & Reservoir Lake Wyandotte Dam & Reservoir
Yuba	Jackson Meadows Dam & Reservoir Bowman Lake Dam & Reservoir Spaulding Dam & Reservoir New Bullards Bar Dam & Reservoir Upper and Lower Scotts Flat Dams & Reservoirs Rollins Dam & Reservoir Camp Far West Dam & Reservoir
American	Sugar Pine Dam & Reservoir French Meadows Dam & Reservoir Hell-Hole Dam & Reservoir Loon Lake Dam & Reservoir Stumpy Meadow Dam & Reservoir Union Valley Dam & Reservoir Ice House Dam & Reservoir Chili Bar Dam & Reservoir
Mokelumne	Silver Lake Dam & Reservoir Lower Bear Lake Dam & Reservoir Salt Spring Dam & Reservoir Pardee Dam & Reservoir Camanche Dam & Reservoir Mokelumne Aqueduct
Stanislaus	Spicer Meadow Dam & Reservoir Donnells Dam & Reservoir Beardsley Lake Dam & Reservoir Lyons Dam & Reservoir Tulloch Dam & Reservoir

continued on next page

Table 1.4: con't:

Sierra Watershed	Local Dams/Reservoirs/Diversions
Tuolumne	Lake Lloyd Dam & Reservoir Lake Eleanor Dam & Reservoir Hetch Hetchy Dam & Reservoir Hetch Hetchy Aqueduct New Don Pedro Dam & Reservoir
Merced	New Exchequer Dam and Lake McClure Reservoir
Mono	Lee Vining Intake and Tunnel Grant Lake Dam & Reservoir
San Joaquin	Thomas A. Edison Lake Dam & Reservoir Florence Lake Dam & Reservoir Mammoth Pool Dam & Reservoir Huntington Lake Dam & Reservoir Shaver Lake Dam & Reservoir Bass Lake Dam & Reservoir
Kings	Courtright Dam & Reservoir Wishon Dam & Reservoir
Owens	Lake Crowley Dam & Reservoir Pleasant Valley Dam, Reservoir & Power Plants Lake Sabrina Dam & Reservoir South Lake Dam & Reservoir Tinemaha Dam & Reservoir Los Angeles Aqueduct No. and So. Haiwee Dams & Reservoirs Haiwee Power Plant

Source: California Water Map (2001)

Water is the #1 Resource Exported from the Sierra

According to statistics presented in the Sierra Nevada Ecosystem Project (SNEP) final report to Congress, water exported from the Sierra to other parts of the state accounts for 61% of the total monetary resource value of ecosystem commodities/services produced by the Sierra region. The direct resource value of this water – for irrigation, municipal and hydroelectric use – is $1.3 billion a year, based solely on the derived value of the individual water rights. Add to that the revenues generated by value-added uses of that water, such as electricity generation, sale of water by downstream water districts, or water-based recreation, and the figure increases dramatically.

Table 1.5: Resources Exported from the Sierra

Exported Commodities/Services[17]	Value (in millions)
Water	$1,300
Public/Private Timber	$ 320
Public/Private Agriculture & Grazing	$ 82
Public/Private Recreation & Tourism and New Residential	$ 475
TOTAL	$2,177

Source: SNEP Report (1996), v.i, Ch. 2

Sierra Water Supports Important Wildlife Habitat

In addition, water from the Sierra Nevada serves as the basis for important habitat that supports a wealth of plant and animal life, including humans. As a whole, the Sierra Nevada region contains more than 3,500 native plant species – that is 50% of all plant species found in California. Of that total, some 400 species are endemic to the Sierra, meaning they occur only in the Sierra Nevada region and not in other parts of the state.[18] The region is also home to 400 species of terrestrial vertebrates, including birds, mammals, reptiles and amphibians. Approximately 13 of those species are restricted only to the Sierra.[19]

Lest we forget the creatures that actually live in the lakes and streams – there are 40 native fish species and at least 30 introduced, or non-native, species living in the rivers, lakes and streams of the Sierra. Another 321 species of aquatic insects – the caddisflies and stoneflies – live in and around the waters of the Sierra, with 19% of the former and 25% of the latter categories found only in the Sierra and nowhere else in the state.[20]

Some 17% of the plant species, 21% of the vertebrate species, and, of course, all of the aquatic species depend on water and riparian habitat – that is, areas adjacent to streams, lakes, and other wetlands – for their survival. In addition, water and riparian areas in the Sierra provide food, nutrients and other necessary components to the larger ecosystem, not to mention providing buffer areas to minimize impacts of nearby land uses.[21]

Sierra Waters Provide Prime Recreation and a Strong Economy

Water is also the basis for many of the recreational and tourism-related values associated with the Sierra. People from all over California and Nevada as well the rest of the country and the world come to the Sierra Nevada for fun, relaxation and rejuvenation – to the tune of 50 to 60 million visits a year – making the Sierra a backyard playground of sorts for people from all over.[22]

Many of the visits revolve around water, either directly or indirectly. Direct water recreation includes fishing, motorized boating, swimming, rafting/kayaking/canoeing, gold panning, sailing and other activities that take place in or on the Sierra's many freshwater rivers and lakes, as well as winter activities such as skiing, skating or snowmobiling that occur on snow or ice. Other activities, such as golfing, rely heavily on Sierra water too, although more indirectly. A third category of water activity, including wildlife viewing, picnicking, camping, hiking, trail-riding, etc., focuses more on the aesthetic enjoyment of having water nearby.[23]

The SNEP Report identifies recreational fishing and whitewater rafting as the two most significant recreational uses of Sierra Nevada water.

In addition to the aesthetic values offered by Sierra water, the water-based recreational and tourism spending in the region contributes greatly to the local economies within the Sierra. Looking at recreation and tourism as a whole, a study by the Sierra Business Council titled *Sierra Nevada Wealth Index* reported that jobs supporting recreational and tourism activities (including retail and service jobs such as in hotels, restaurants, retail stores, gasoline service stations, outdoor recreation outfitters, agricultural and cultural tourism companies, and other types of businesses that sell products and services to travelers) account for 16% of the Sierra's annual estimated payroll value, as compared to only 3% of total payroll elsewhere in the state. For some Sierra counties, recreation/tourism is the single most important activity fueling the local economy.[24]

In terms of water-based recreation, the *SNEP Report* identifies recreational fishing and whitewater rafting as the two most significant recreational uses of Sierra Nevada water. Based on people's willingness to pay for these two activities, the annual value of water for recreational fishing and rafting in the Sierra is $250 million. Fishing alone accounts for close to $200 million, calculated using the US Forest Service's "travel cost" method [estimated value of a day of fishing – $18.96 – multiplied by the total number of fishing days]. Whitewater rafting, then, generates approximately $50 million a year. This calculation is based on the assumption that approximately two-thirds of the rafting trips are commercial trips, valued at $80 a day, and one-third are private trips with some kind of daily multiplier.[25]

The Sierra Nevada Ecosystem Project

The Sierra Nevada Ecosystem Project is a "scientific review of the remaining old growth in the national forests of the Sierra Nevada in California, and a study of the entire Sierra Nevada ecosystem by an independent panel of scientists, with expertise in diverse areas related to this issue." The project was authorized by Congress in 1993 to highlight what was known about the ecosystems of the Sierra and to provide professional judgment about what that information indicated for meeting the stated goal of "protecting the health and sustainability of the Sierra Nevada while providing resources to meet human needs."

A Science Team of 18 scientists and 19 special consultants, along with 107 additional authors or coauthors, analyzed primarily existing information and integrated this accumulated information into a four-volume report, the Sierra Nevada Ecosystem Project, or SNEP, report. A "key contacts" group of 70 people with diverse interests and responsibilities in the Sierra met with the Science Team to review progress and assist in the review of assessment, as well as helping plan for larger public meetings.

In addition to information, the report contains several models, some quantitative and some qualitative, illustrating different options that could lead to better management in the Sierra region.

— Summary of the Sierra Nevada Ecosystem Project Report

UC Davis Centers for Water and Wildland Resources

Chapter 2 California and Nevada Risk Losing Sierra Clean Water

While the watersheds of the Sierra Nevada are responsible for providing water to nearly two-thirds of California residents and four-fifths of Nevada residents – water that supports our plant and animal communities, makes California the nation's leading producer of food and fiber, and contributes to California's place as one of the top eight economies in the world[26] – we are at risk of losing much of this value to pollution and other human impacts.

Many people assume that the high mountain watersheds of the Sierra Nevada are pure and pristine. But impacts from early development – sometimes called "legacy" impacts – as well as the effects of more recent human activities, remain a problem throughout the region. The Sierra Nevada Ecosystem Project report, for example, points out that riparian areas are the most altered and impaired parts of the ecosystem in the Sierra.[27] Dams, ditches, flumes, roads and other structures have changed the shape, flow, temperature, and quality of our rivers and streams. Such manipulations of our streams for water supply, irrigation, transportation, hydropower, waste disposal, mining, flood control, timber harvest, recreation, and other uses has degraded watersheds throughout the state, but especially in the Sierra, according to the summary of the Sierra Nevada Ecosystem Project (SNEP) report.

Every Sierra watershed but one (the Cosumnes) has been identified by government agencies or other scientific sources as significantly impaired in some way. For example, looking at the state's list of "impaired" waterbodies under section 303(d) of the federal Clean Water Act, 11 of the Sierra's 24 watersheds have at least one river or lake impaired by pollution. In the *SNEP Report*'s Index of Biotic Integrity, which uses the presence of various important fish communities to measure relative watershed health, fewer than one-third of the Sierra's 24 watersheds received scores indicating "good" watershed quality. Another analysis in the *SNEP Report*, called Potential Aquatic Diversity Management Areas (or PADMAs), looks at species diversity, degree of existing preservation and other factors to measure the potential of different watersheds for perpetuating native species. In this analysis three Sierra watersheds are considered to be in such poor health they don't contain a single PADMA site. And using restoration potential as the measure, only half of the Sierra's major watersheds contain Category 1 (high priority) areas for restoration.

Based on these four different assessments or measures of Sierra watershed health, the inescapable conclusion is that Sierra watersheds are in trouble. Table 2.1 summarizes this. The following describes each assessment in more detail.

Clean Water Act Measures Pollution in Sierra Waters

Water quality indicators, such as the presence of pesticide residue, sediment, mercury, fecal coliform, and other substances, are used by the state to identify so-called "impaired" water bodies under Section 303(d) of the 1972 Clean Water Act. Under this federal law, states, territories and authorized tribes are required to use various water quality indicators to assess and identify any water bodies within their jurisdiction that do not meet current water quality standards, even after applying minimum required pollution control measures. These "impaired" water bodies are then prioritized by the state for development of action plans, called TMDLs or Total Maximum Daily Loads, designed to improve water quality by reducing the amount of pollutant(s) causing the impairment.

The State Water Resources Control Board (SWRCB) recently released its updated 2002 list of impaired waterbodies for California.[28] [For a summary of the SWRCB 2002 list, please see Appendix B.] The list includes the name of the water body, the pollutants or stressors that are impairing water quality, the estimated area affected by the pollutants (in acres or miles), the potential sources of those pollutants, and priority for completion of a TMDL.

Eleven of the 24 Sierra watersheds have at least one 303(d)-listed stream or reservoir. Together, those 11 watersheds contain 535 miles of impaired river or stream and 252,044 acres of impaired reservoir or lake. Primary stressors or pollutants include metals, nitrogen, phosphorous, sedimentation/siltation, salinity, chlorides, flow and/or habitat alterations, mercury and pathogens. Potential sources run the gamut from resource extraction to urban uses to recreation.

Eleven of the 24 Sierra watersheds have at least one 303(d)-listed stream or reservoir.

Table 2.2 presents a summary, by watershed, of the major pollutants or stressors in each watershed, the potential sources for those pollutants or

Table 2.1: Sierra Watershed Impairments

WATERSHED	POLLUTION IMPACTS [watershed is 303(d) listed]	IMPACTS ON FISH COMNTY [watershed IBI score is fair/poor]	NATIVE SPECIES UNSUSTAINABLE [no PADMA in watershed	RESTORATION POTENTIAL [no Category 1 CUWA in watershed]
American		x		
Calaveras			x	x
Caliente		x	x	x
Carson	x	x		
Cosumnes				
Eagle Lake	x			
Feather	x	x		x
Honey Lake	x	x		
Kaweah		x		x
Kern				x
Kings				x
Merced		x		x
Mojave		n/a	x	x
Mokelumne		x		x
Mono Basin	x	x		
Owens	x	x		
San Joaquin		x		
Stanislaus		x		x
Truckee	x	x		
Tule		x		
Tuolumne	x			x
Upper Sacramento		x		
Walker	x	x		
Yuba	x	x		

Source: SWRCB and SNEP Report

stressors, and the estimated number of miles and/or acres affected in each watershed. The SWRCB has prioritized the list, so not all of these waterbodies have active TMDL processes underway at this time.

Index Assesses Fishery Health

The *Sierra Nevada Ecosystem Project Report* uses another method for assessing the relative health of watersheds in the Sierra – biotic integrity. Biotic integrity is defined in Chapter 34 of the *SNEP Report* as: *the ability to support and maintain a balanced, integrated, adaptive community of organisms having a species composition, diversity, and functional organization comparable to that of the natural habitat of the region.*

Biotic integrity is measured by scoring a watershed on a finite number of factors, usually involving the condition of fish communities in the watershed, as an alternative to more complicated physical and chemical measures. The idea is that fish communities, as a whole, will respond to major changes in the environment, including both short-term degradation, such as a chemical spill, and longer-term impacts, such as changes in land use and development in the watershed. So presence or absence of certain fish species can serve as an indicator of relative watershed health or integrity.

Biotic integrity for the *SNEP Report* was determined using six primary measures, each scored on a scale of 1 to 5 (where 1 is low/poor and 5 is high/good). The primary measures included:

1. number of native fish, because native fish in the Sierra are highly adapted to the natural flow regimes, therefore, they are sensitive to flow changes resulting from dams and other streamflow modifications [Scoring: 1 = absent or rare or introduced where not native, 3 = present in much of native range, 5 = abundant in most of native range];

2. native fish assemblages, or groups of fish species living together, because co-existence of groups of species indicates a high-quality aquatic environment [Scoring: 1 = largely disrupted, 3 = present but scattered or containing exotic species, 5 = largely intact];

3. anadromous fish, such as salmon, steelhead, and lamprey, because these fish have to travel up and down a watershed to complete their

Table 2.2: Major Polluntants/Stressors in Sierra Watersheds

WATERSHED/ BODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCES	ESTIM. MILES	ESTIM. ACRES
CARSON	Metals, nitrogen, phosphorous, sodium	Mining, various modifications, human uses, natural sources, silviculture, atmospheric deposition, agriculture, grazing, erosion	46.3	164
EAGLE LAKE	Nitrogen, phosphorous, sedimentation/siltation	Agriculture, grazing, silviculture, urban uses, atmospheric deposition, internal nutrient cycling, natural sources	55.0	20,704
FEATHER	Copper, zinc	Mining	9.4	
HONEY LAKE	Arsenic, flow alterations, salinity/TDS/chlorides, metals, trace elements	Geothermal development, flow modification, natural sources, agriculture	58.0	21,011
MONO BASIN	Metals, nitrogen, phospherous, sedimentation/siltation, flow alterations	Mining, nonpoint source, grazing, urban uses, modifications, erosion, recreation, atmospheric deposition, internal nutrient cycling, natural sources	32.0	7,475
OWENS	Copper, metals, habitat alterations, nitrogen, phosphorous	Urban uses, natural sources, nonpoint source, agriculture, grazing, hydromodification, land development	160.0	1,729
TRUCKEE	Sedimentation/siltation, iron, nitrogen, phosphorous, nutrients, pathogens, salinity/TDS/chlorides, priority organics	Hydromodification, nonpoint source, natural sources, silviculture, modifications, atmospheric deposition, grazing, urban uses, erosion, recreation, land development, filling of wetlands	93.4	86,184
TUOLUMNE	Mercury	Resource extraction		11,056
UPPER SACRAMENTO	Mercury	Resource extraction	4.1	
WALKER	Pathogens, nitrogen, sedimentation/siltation	Grazing, urban uses, natural sources, recreation, upstream impoundment, modifications, erosion, atmospheric deposition, agriculture, nonpoint source	64.2	
YUBA	Mercury, copper, sedimentation, siltation, zinc	Resource extraction, mining	12.2	3,721
TOTALS			534.6	252,044

Source: SWRCB (2002), "Water Quality"

lifecycle, so their presence indicates that enough of the watershed is passable for them to survive [Scoring: 1 = absent or rare, 3 = present mainly below dams or uncommon, 5 = found in original range];

4. native ranid frogs (including foothill yellow-legged frog, mountain yellow-legged frog, and Cascade frog) because these frogs appear to be the amphibians most sensitive to environmental change, so their presence in a watershed indicates that relatively high-quality aquatic and riparian habitat exists in that watershed [Scoring: 1 = absent or rare, 3 = present, 5 = abundant and widely distributed];

5. trout, because non-native trout were introduced to many watersheds at higher elevations and they have become the dominant predators in many streams and lakes where they were introduced, so it is assumed that their introduction has had a negative effect on native aquatic biodiversity [Scoring: 1 = range greatly expanded/mixture of non-native and native species or range greatly reduced, 3 = range expanded but includes native species or range about the same but native populations reduced/exotics present, 5 = mostly native species in original range];

6. stream fish abundance, because watershed alterations can change not only the species composition but also the sheer number of fish present in a watershed [Scoring: 1 = substantially lower than presumed historic levels *or* abundant in originally fishless areas, 3 = somewhat lower overall than historic levels *or* present in fishless areas, 5 = about the same as or higher than historic levels].

The SNEP study also included a seventh "catch-all" category of "other analyses" that captured factors such as dams, reservoirs, diversions, roads, roads and streams, roadless areas, fishless areas and mean elevation within each watershed. These variables were expressed as a percentage of the watershed based on GIS analysis of square landscape units (pixels) within each watershed.

The Index of Biotic Integrity (IBI) scores by watershed indicate relative health based on these factors. According to the *SNEP Report*, a score of 80 to 100 indicates that aquatic communities in the watershed are in very good to excellent condition; 60 to 79 indicates good condition; 40 to 59 is considered fair, and a score below 40 indicates aquatic communities in poor condition.

The *SNEP Report* IBI assessed 100 different sub-basins in the Sierra. For purposes of this report, the Alliance has grouped the 100 sub-basins into the 24 major watersheds listed earlier in this report. [For more information, see Appendix C.] Scores for the individual sub-basins were averaged to come up with a single score for each of the 24 major watersheds, as follows.

Table 2.3: Aquatic Community Health

WATERSHED	IBI SCORE (AVE.G).
Upper Sacramento	76 - good
Eagle Lake	72 - good
Kern	67 - good
Calaveras	66.5 - good
Kings	62 - good
Tuolumne (tied)	60 - good
Cosumnes (tied)	60 - good
Carson	59 - fair
Merced	58.8 - fair
Truckee	58.4 - fair
Walker	57.7 - fair
Tule	57 - fair
Mokelumne	56 - fair
Kaweah	55 - fair
American	53 - fair
Honey Lake	50 - fair
Feather	49 - fair
Stanislaus	47 - fair
San Joaquin	46 - fair
Yuba	43 - fair
Owens	37 - poor
Mono	36 - poor
Caliente	32 - poor
Mojave	No information

Source: SNEP Report (1996), v. II, Ch. 34

Taken individually, a number of the sub-basins scored substantially higher or lower than what is reflected in the aggregated score for the whole watershed. For example, the highest IBI score of 93 was given to both Mill and Deer Creeks, two sub-basins of the Upper Sacramento watershed. But the Upper Sacramento watershed as a whole had an aggregated score of only 76. The lowest IBI score of 25 went to Yokohl Creek, a sub-basin of the Kaweah watershed which, as a whole, scored 55.

Although aggregating the scores may slightly skew some of the overall watershed results, such an exercise was useful to allow different watershed health assessments to be compared across the 24 major watersheds.

Taken separately, the IBI results show that: 7 of the 100 sub-basins had aquatic communities in very good to excellent condition; 36 were in good condition; 48 were in fair condition; and 9 exhibited aquatic communities in poor condition.

In general, watersheds or sub-basins with higher scores are likely to contain intact native fish and amphibian communities and be governed largely by natural processes. Areas with lower scores tended to be either: a.) drainages in the low- to middle-elevation portions of the Sierra with dams and diversions that have changed the fish populations, b.) those at higher elevations that have lost their frogs and have become dominated by non-native trout, or c.) small, low-elevation watersheds that have experienced extensive urbanization, agriculture, mining impacts, etc.[29]

For more information on the original IBI scoring, please see Appendix C.

Ability to Perpetuate Native Species in Sierra Watersheds

Chapter 57 in the *SNEP Report* (Potential Aquatic Diversity Management Areas) identifies aquatic ecosystems as among the most highly altered ecosystems in the Sierra Nevada. Alterations include: extensive development of dams and diversions to supply water and to generate power; watershed alterations through activities such as logging, grazing, road building, and mining; and widespread introduction of non-native species into Sierran lakes and streams. Impacts of these alterations include a decline in numbers of native aquatic species and increased isolation of species due to the breaking up of habitat by human uses.[30]

Using the Index of Biotic Integrity, specific species information, ownership data, existing protections, an "overall quality" rating[31], and other factors, the authors of this chapter identified 42 potential Aquatic Diversity Management Areas (ADMAs), or sub-basins, within 21 of the 24 major Sierra watersheds that seemed to have the highest potential for perpetuating native species in the future and that, together, contained a good representation of all aquatic habitat types found in the Sierra Nevada. Some might call these the Sierra's "last best places" in terms of watershed health and condition.

ADMA watersheds, by definition, are in reasonably good condition from a biotic integrity standpoint and contain a wide presentation of aquatic habitat types. They are large enough (50 km^2/19 mi^2) to allow most natural processes to function indefinitely and also large enough for most aquatic species to have a low probability of extinction. They have a flow regime with no dams or diversions that significantly alter the way the natural system operates. The waters within them are dominated by native species (approximately 75% of the fish found within a proposed ADMA should belong to native species, for example, with the exception of non-native trout) or are naturally fishless or can be reclaimed as fishless if introduced species can be eradicated. And, finally, they have other characteristics, such as unique species, scientific value, or resource values, that may override other considerations, such as size or natural function.[32]

For the full list of Potential ADMA watersheds from this chapter of the *SNEP Report*, please see Appendix D.

Table 2.4: Sierra Watersheds with No PADMAs

WATERSHED	LOWEST POTENTIAL FOR PERPETUAL NATIVE SPECIES [PADMA]
American	
Calaveras	x
Caliente	x
Carson	
Cosumnes	
Eagle Lake	
Feather	
Honey Lake	
Kaweah	
Kern	
Kings	
Merced	
Mojave	x
Mokelumne	
Mono Basin	
Owens	
San Joaquin	
Stanislaus	
Truckee	
Tule	
Tuolumne	
Upper Sacramento	
Walker	
Yuba	

Source: SNEP Report, v.II, Ch. 57

Assessment Process Evaluates Restoration Potential in Sierra Watersheds

The California Unified Watershed Assessment program (CUWA) was an effort to assess watersheds in California for restoration funding priority during Fiscal Year 1999-2000. Although the program is no longer in use and the information is somewhat dated, CUWA priority watersheds are discussed here to illustrate another system for assessing relative health of Sierra watersheds.

CUWA identified priority watersheds using the State Water Resources Control Board's 1998 list of impaired waterbodies – the 303(d) list – coupled with several other existing prioritization systems, including:

- ♦ US Department of Agriculture Geographic Priority Areas used in the Environmental Quality Incentives Program (EQIP);
- ♦ watersheds with high erosion potential related to wildfires, drawn from the California Department of Forestry's Wildfire Potential Database;
- ♦ areas with threatened or endangered aquatic species, as identified by the California Department of Fish & Game's databases;
- ♦ and areas with riparian corridor restoration needs, as determined from the multi-agency California Rivers Assessment.

Watersheds with much of their land falling within federal Wilderness Areas, those that contained federal or state Wild & Scenic rivers, or those composed of sizable amounts of public land giving no indications of water quality problems, were rated as having very good water quality.[33]

Table 2.5: Sierra Watersheds with No CUWA Priority Sites

WATERSHED	LOW RESTORATION POTENTIAL [no Category 1 CUWA]
American	
Calaveras	x
Caliente	x
Carson	
Cosumnes	
Eagle Lake	
Feather	x
Honey Lake	
Kaweah	x
Kern	x
Kings	x
Merced	x
Mojave	x
Mokelumne	x
Mono Basin	
Owens	
San Joaquin	
Stanislaus	x
Truckee	
Tule	
Tuolumne	x
Upper Sacramento	
Walker	
Yuba	

Source: CUWA Fact Sheet

According to the CUWA list, 13 of 24 Sierra watersheds contained at least one CUWA Category I Priority Watershed for restoration. Those 13 watersheds included the: American, Carson, Cosumnes, Eagle Lake, Honey Lake, Mono Basin, Owens, San Joaquin, Truckee, Tule, Upper Sacramento, Walker, and Yuba. Those with no CUWA Category 1 priority restoration sites – and therefore, presumably, a lower potential for restoration – are listed in table 2.5.

13 of 24 Sierra watersheds contained at least one Priority Watershed for restoration.

Sierra Watersheds "in Peril" – Still

> *California's economy derives enormous benefits from water diverted from the streams, rivers, and lakes of the Sierra Nevada. A major cost associated with these benefits has been deterioration of the biotic integrity and sustainability of the aquatic systems…. Aquatic and riparian habitats have been severely altered and continue to deteriorate, leading to the loss of native species, ecosystem functions, and services to human society.*
> — *SNEP Report*, vol. I, Ch. 8

No matter what the measure – whether presence of pollutants, health of the fishery, degree of disturbance/alteration, or restoration potential – Sierra watersheds are in decline and in need of protection and restoration. This is worrisome not only because we get the majority of our drinking water from the Sierra – as well as water for irrigation, power production and other human uses – but because so many species besides our own rely on water-based habitat for their survival.

And the decline is measurable. Of the 40 species of fish native to the Sierra Nevada, six are formally listed as threatened or endangered and 12 others are candidates for listing. Four other species are in decline in the Sierra but are more abundant elsewhere. In total, fewer than half of the native fish species in the Sierra have secure populations, due to the impacts of watershed disturbance, construction of dams and diversions, alteration of stream channels and introduction of exotic fish species that outcompete the native fish. Half of the 29 native amphibian species (salamanders, frogs and toads) are at risk of extinction due to severe

population declines and limited distribution. And of 67 different types of aquatic habitat identified in the Sierra, almost two-thirds (or 64%) have been found to be declining in quality and abundance, with many at risk of disappearing altogether. [34]

This problem is especially severe in the foothill areas around 3,000 feet in elevation and below. Land in the foothills is largely privately owned and provides easy access for development.[35] It is also this foothill band that is likely to see the most population growth in the next couple of decades,[36] meaning that even more pressure will be placed on riparian and aquatic habitats in the future.

The State Needs to Invest to Protect Sierra Watersheds

Despite the fact that a.) much of California and Nevada rely on Sierra water, and b.) the state and federal governments' own Sierra study, the Sierra Nevada Ecosystem Project, identifies riparian areas as some of the most degraded habitat types in the range – California has chosen not to invest conservation dollars in proportion to the region's obvious importance and need. For example, according to a report titled *Sierra Nevada Resource Investment Needs Assessment* by the Sierra Nevada Conservancy Working Group: between fiscal years 1996 and 2001, the Sierra (outside of Lake Tahoe) received only one percent of conservation dollars spent for conservation easements and land acquisition by the State of California; the Sierra was not specifically earmarked for any support (with the exception of Lake Tahoe) in Proposition 40, a $2.6 billion state bond measure approved in 2002 to provide conservation resources for California communities; and the proportion of all federal Land and Water Conservation funds appropriated for California projects spent in the Sierra (excluding Lake Tahoe) since 1968 is only 0.3%.[37]

In total, fewer than half of the native fish species in the Sierra have secure populations.

Funding requests to state and federal conservation grant programs regularly exceed the amount of money available. For example, in the most recent funding cycle for the 2003 Consolidated Watershed Protection and Non-point Source Pollution Control Grants Program , the Resources Agency received a total of 683 applications with funding requests totaling $863 million for a total available amount of only about $150 million.[38] Out of that total, only 15 projects based in the Sierra were invited back to submit full proposals[39].

This funding imbalance persists despite the fact that the Sierra Nevada makes up 20% of the land mass of the state, provides upwards of 60% of the water used by residents, farmers and businesses in the state, generates millions of recreation-based and tourism visitor days, and supports half of California's plant species.

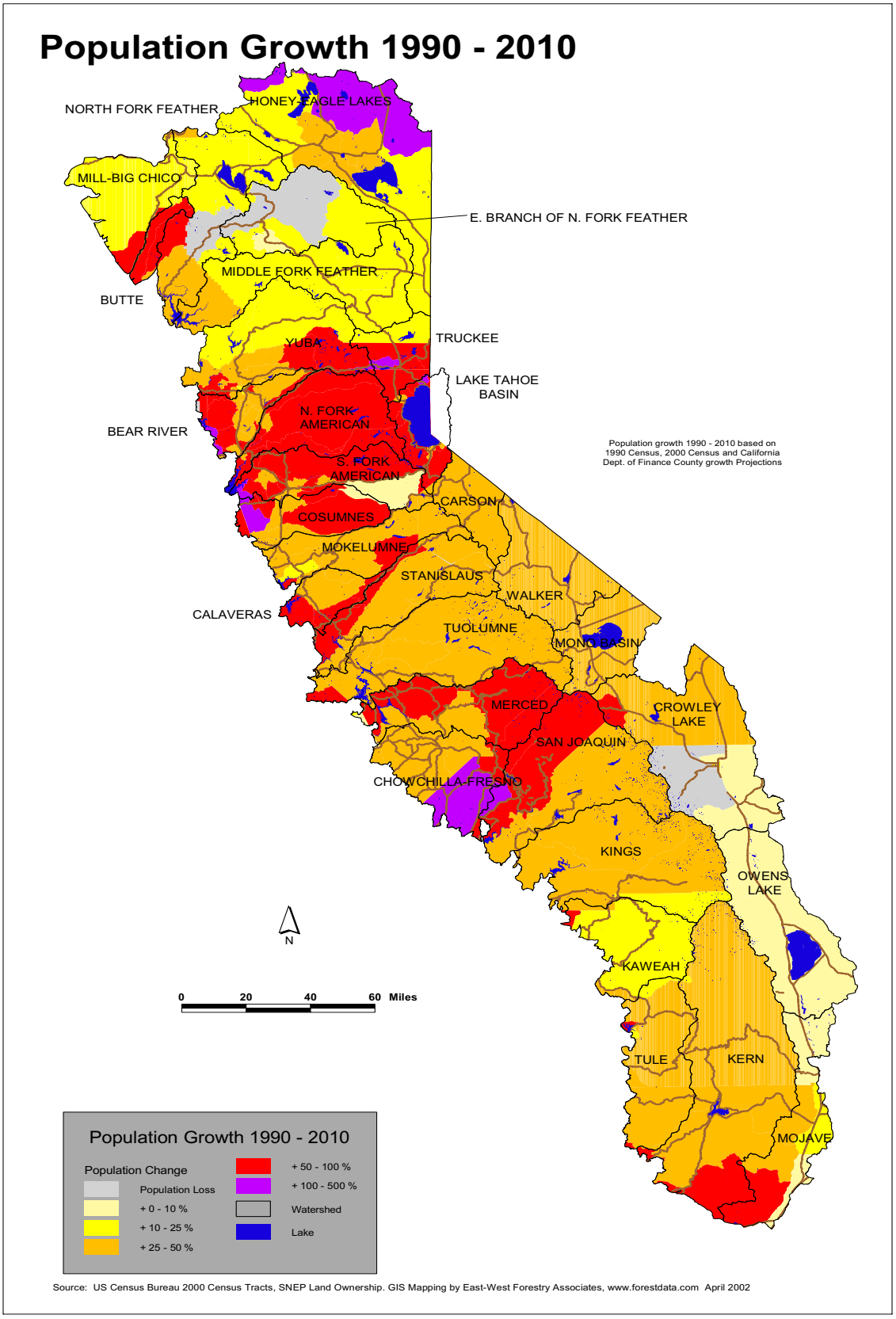
Population Growth 1990 - 2010
NORTH FORK FEATHER
HONEY-EAGLE LAKES
MILL-BIG CHICO
E. BRANCH OF N. FORK FEATHER
MIDDLE FORK FEATHER
BUTTE
YUBA
TRUCKEE
LAKE TAHOE BASIN
BEAR RIVER
N. FORK AMERICAN
S. FORK AMERICAN
Population growth 1990 - 2010 based on 1990 Census, 2000 Census and California Dept. of Finance County growth Projections
CARSON
COSUMNES
MOKELUMNE
STANISLAUS
WALKER
CALAVERAS
TUOLUMNE
MONO BASIN
MERCED
CROWLEY LAKE
SAN JOAQUIN
CHOWCHILLA-FRESNO
KINGS
OWENS LAKE
KAWEAH
TULE
KERN
MOJAVE
N
0 20 40 60 Miles
Population Growth 1990 - 2010
Population Change
Population Loss
+ 0 - 10 %
+ 10 - 25 %
+ 25 - 50 %
+ 50 - 100 %
+ 100 - 500 %
Watershed
Lake
Source: US Census Bureau 2000 Census Tracts, SNEP Land Ownership. GIS Mapping by East-West Forestry Associates, www.forestdata.com April 2002

Figure 3.1

Chapter 3 Population Growth & Climate Change Threaten Sierra Water

Over the past century, human activities have dramatically altered the natural landscape of California. Our historical legacy includes severe shrinkage and isolation of natural habitat, altered flows in streams and rivers, extensive introductions of non-native plants and animals, and pollution of the air, land, and water. As we enter the 21st century, a powerful new agent – global climate change – will increasing interact with the human pressures that continue to stress California's ecosystems. In the future, direct impacts generated by the state's rapidly growing human population will be intensified by the impacts of climate change.
— Confronting Climate Change in California: Ecological Impacts on The Golden State (as cited in The Potential Consequences of Climate Variability and Change), Field, et al (Sept. 2002)

As mentioned above, many of the watershed health issues facing the Sierra today are a result of past development and management decisions – *legacy* impacts, as they are called by some. Unfortunately, we have not yet figured out how to satisfactorily address legacy impacts, let alone develop workable guidelines for the growth and development that is happening right now. Nor does the Sierra receive its fair share in terms of financial investment to help address such issues.

These legacy problems and the impacts of current development on the water resources of the Sierra are only going to be compounded by additional threats, such as population growth and climate change, in the future.

Population Will Change our Communities

Without fail, just about every assessment of watershed health in the Sierra calls attention to the impacts of population growth on the watershed – including the effects of increasing urbanization and specific human uses, such as dam building, recreation, mining, timber harvest, and grazing. Statistics abound regarding projected population change: who's coming, what they are coming for, when they will arrive, where they will go, and why they are coming here.

According to the *SNEP Report*, the Sierra Nevada region grew at a startling 130% between 1970 and 1990, compared to a rate of 49% for the state and only 22% for the nation as a whole.[40]

From 1990 to 2000, 12 of the 20 counties comprising the Sierra grew at rates far exceeding the statewide average. Placer County led the way with close to a 44% change in population over the 10-year period. The state average was approximately 14%. Madera, Mono, Calaveras and El Dorado counties were not far behind, with population change rates of between 25% and 40%. Inyo County was the only one to experience a negative growth rate.[41]

According to the SNEP Report, the Sierra Nevada region grew at a startling 130% between 1970 and 1990, compared to a rate of 49% for the state and only 22% for the nation as a whole.

In terms of projected growth, a map titled *Population Growth 1990 – 2020*, produced by East-West Forestry Associates for a report on Sierra Nevada resource investment needs, uses 1990 and 2000 US Census Bureau data to calculate projected population changes throughout the Sierra (See Figure 3.1). Areas within the watersheds of Eagle and Honey lakes and the

Table 3.1: Percent Population Change 1990-2000

County	% Change 1990-2000
Alpine	8.5
Amador	**16.8**
Butte	11.6
Calaveras	**26.7**
El Dorado	**24.1**
Fresno	**19.8**
Inyo	-1.8
Kern	**21.4**
Lassen	**22.6**
Madera	**39.8**
Mariposa	**19.8**
Mono	**29.1**
Nevada	**17.2**
Placer	**43.8**
Plumas	5.5
Sierra	7.1
Tehama	12.9
Tulare	**18.0**
Tuolumne	12.5
Yuba	3.4

[boldface indicates counties with percent change exceeding 13.6% average for State of California]

Source: 2000 U.S. Census

Yuba, American, Truckee, Cosumnes, Calaveras, Merced, and San Joaquin rivers stand to experience a whopping 100% to 500% growth between 1990 and 2020. Most of the rest of the West-side watersheds are looking at between 60% and 100% population growth for the same time period, while most of the Upper Sacramento, Mokelumne, Kaweah, Carson, Walker, Mono, and upper Owens are likely to see between 25% and 50% growth. Areas within the Feather and lower Owens watersheds are expected to experience 0 to 25% growth, while a small portion of the upper Owens watershed is actually projected to experience a net population loss.[42]

The population of California is generally expected to more than double in the 50 years between 1990 and 2040. Much of this growth is expected to occur in the metropolitan areas, which will push existing boundaries out and likely increase population in the foothill areas of the Sierra. If the situation continues as it has over the last decade or so, land currently devoted to agriculture, grazing, private timber harvesting, open space and habitat will likely be converted to residential/commercial use to accommodate this growth. Estimates from the American Farmland Trust and the California Department of Forestry, for example, predict that between one and two million acres will be converted to urban use in the next decade.[43]

Looking at land conversion from another point of view, it took 1,741 square miles of land to support the human population of the Sierra in 1990. Under one possible population growth scenario, the amount of private land covered by human settlement could grow to 6,846 square miles, or nearly half of all private land in the region.[44]

Such growth in the past has resulted in the building of more roads and structures that reduce or fragment habitat, making it more difficult for certain species to survive. Pollutants are introduced into waterways, and invasive, non-native species gain a foothold in disturbed areas. More dams and water diversions block fish passage and destroy the natural functioning of ecological systems. And more intensive use of land for housing, grazing, timber harvesting and recreation can compact soils, impede water retention and increase the amount and force of runoff due to the increase in covered surfaces (roads, paved driveways, parking lots, structures).

In the absence of coordinated land use and environmental planning in the region, such conversions are likely to take place piecemeal and without consideration to cumulative impacts on the region, its residents and its resources.[45]

Global Climate Change Will Significantly Alter the Sierra

On the other side of the coin, few if any discussions of watershed health take into account potential impacts of climate change on the future of Sierra watersheds. As if growth and development aren't hard enough to deal with, now the Sierra is faced with the very real possibility of: changes in amount, location and timing of precipitation and snowmelt; reductions in overall water storage capacity to meet needs in the dry season; an increase in the number and severity of major storm events such as fires, floods and droughts; and much more. Sometimes referred to as "drivers of change," these forces have the potential in our lifetime to permanently alter the Sierra as we know it.

The Sierra Nevada would not be here for us to enjoy today were it not for climatic and geological forces that have acted on the area over millennia. But climate changes that used to happen in "geologic time" are increasingly being felt in the compressed timeframe of our own generation. This accelerated rate of change, due largely to human activities that transform the composition of the atmosphere and modify the land surface, is altering the face of our environment.

> *Greenhouse gases are accumulating in Earth's atmosphere as a result of human activities, causing surface air temperatures and subsurface ocean temperatures to rise. Temperatures are, in fact, rising. (Climate Change Science: An Analysis of Some Key Questions*, 2001)
> — National Research Council

Climate (defined as *the long-term statistical pattern of weather conditions over time*[46]) and water are inextricably linked, with average climatic conditions, such as temperature, precipitation, humidity, etc., determining basic water availability and yield. Water managers use historic records of climatic conditions to help shape current and future water planning. But such planning is based on one key assumption or principle – that the climate of the future will look like the climate of the past. We are beginning to see that this is clearly a flawed assumption.

For years skeptics have dismissed climate change, or "global warming." But in May 2001 the Bush Administration asked the National Research Council to review the work of the Intergovernmental Panel on Climate Change (IPCC), the premier international body on climate change, sponsored by the United Na-

tions. The National Research Council formed an expert panel to review the IPCC's findings. The panel released a report, titled *Climate Change Science: An Analysis of Some Key Questions*, confirming that: climate change is occurring – weather station records and ship-based observations indicate that global mean surface air temperature warmed between 0.7 and 1.5 degrees Fahrenheit during the 20th century; increasing greenhouse gas concentrations are the likely cause of the warming observed over the last 50 years; global warming could well have serious adverse impacts on our society and economy; and the IPCC Working Group report is an "admirable" summary of research and activities in climate science.[47]

Air temperature warmed between 0.7 and 1.5 degrees Fahrenheit during the 20th century.

Carbon dioxide is the primary "greenhouse," or heat-trapping gas produced through human activities such as transportation, industrial/commercial operations, electricity generation and residential activity.[48] Before the industrial revolution, carbon dioxide levels in the atmosphere remained steady for close to 10,000 years, as determined through research on tree rings, corals and ice core samples. Since 1750, however, CO^2 levels worldwide have risen 32%.[49] Although California's overall carbon dioxide emissions have actually decreased slightly from a peak in the late 1970s (due largely to power plants switching from fuel oil to natural gas), as the state's population grows, so will total carbon emissions. Estimates by the California Energy Commission, for example, predict that by 2010 total greenhouse gas emissions will increase approximately 15%, with fossil fuel combustion continuing to produce 85% of the total emissions. The balance comes from landfills (7%), agriculture (4%) and other unnamed sources (4%).[50]

General Impacts of Climate Change

Most researchers agree that such change will likely affect:

overall average temperature, with a projected increase of between 2.5 and 10.4 degrees Fahrenheit over the next century, based on computer modeling conducted at UC Santa Cruz[51];

the timing and amount of precipitation – including more precipitation in general, more precipitation falling at higher latitudes, especially in winter, and earlier spring runoff due to warmer winter temperatures, according to Dan Cayan and Noah Knowles, U.S. Geological Survey, Scripps Institute of Oceanography, and others;

form of precipitation – based on a study by researchers at the Lawrence Berkeley National Laboratory and the National Weather Service's California-Nevada River Forecast Center, higher temperatures and a higher percentage of rain versus snow will result in fewer days of below-freezing temperatures resulting in less snowpack coverage and, therefore, decreased water storage capacity[52]; in addition, the snowline will move up in elevation due to warmer temperatures, according to California's Chief Hydrologist (a general rule of thumb says that the elevation for snowline moves up the slope 500 feet for every one degree Celsius increase in temperature[53]);

number, extent and severity of extreme events, such as floods, droughts and wildfires, that affect life and property, the economy, and the survival of plant and animal species, according to a report by the U.S. Global Change Research Program[54]; and

water quality impacts, including a.) degradation due to salt water intrusion that may require more fresh water from the Sierra to dilute the salinity, and b.) changes to streamflow that can result in temperature increases that both affect wildlife as well as increasing the concentration of pollutants affecting drinking water.[55]

Predicted Impacts of Climate Change on the Sierra Nevada

Some of these predicted changes have already started manifesting in the Sierra. Studies by Michael Dettinger of the US Geological Survey, Dan Cayan of Scripps Institute of Oceanography US Geological Survey, and others, for example, report that over roughly the past 50 years, snowmelt runoff in Northern California has been occurring earlier in the water year and winter and springtime floods have increased due to rain-on-snow events.[56] As an example of the magnitude of such change, over the past 100 years the percentage of total annual runoff occuring during the period of April through July has decreased by 25% in the Sacramento region and 10% in the Southern Sierra.[56] And the effects are accelerating. In the Yuba River, for example, the period of 1950 to 2001 saw proportionally more of the annual runoff occurring earlier, from November through February (37.5%). During the first half of the century, only 30.1% of annual runoff occurred that early. Conversely, less water came down in the usual runoff period of April to July over the past 50 years (42.1%) than did during the same

timeframe in the first half of the century (51.2%). Future predictions show further reductions in spring runoff of 43% in the Sacramento region and 23% in the Southern Sierra by 2090.[57]

Because the various plant and animal communities in the Sierra are so sensitive to the availability of water, these climate change impacts – both current and predicted – can have extreme results in our region, such as:

decreased spring and summer stream flows that will make it harder to fill water storage reservoirs in the spring, thereby intensifying already-competing demands for water to meet agriculture, industry, urban and environmental uses, and causing a push for more dams and diversions in the mountains and foothills of the Sierra;

warmer water temperatures: that will affect habitat conditions for fish and wildlife species, such as salmon and steelhead, that rely on cold-water streamflow for their survival;

reduced inflow of fresh water into the Bay-Delta that will increase salinity in the Bay, leading to changes in water quality, circulation and the basic structure of the food web, thereby adversely impacting the Sierra's anadromous fish population that relies on the Bay for part of its lifecycle;

increasing winter rains that will intensify flooding and landslide hazards, causing increased sedimentation and other problems in Sierra watersheds, as well as impacts on life and property;

expanding grasslands that will encroach on existing Sierra foothill shrublands, changing the vegetation and habitat characteristics that different plant and animal species rely on for survival;

shifting of shrublands to higher-elevation areas of the Sierra, thereby reducing the amount of forested land and impacting species that are unable to move upslope due to existing and planned development or other human-caused limitations;

loss of important patches of unique habitat that often harbor special status species, such as Serpentine outcrops or vernal pools; some of these habitats are already so isolated they will not likely be able to migrate with the climate changes, and others simply will not have any place to migrate to;

changing wind conditions, combined with warmer, drier summers, that may lead to more catastrophic wildfires in the Sierra region;

increasing number of thunder and lightening storms (which form over land vs. sea and, therefore, pick up more acids and other pollutants), leading to more acid rain effects and increased clouding of Sierra lakes;

additional stresses to trees, resulting from temperature and precipitation changes, leading to more destructive or widespread pest infestations such as pine bark beetles.[58]

While ecosystems and individual species have been successfully adapting to climate change for millions of years, future changes will be taking place under far more limited or restricted conditions, due to human intervention, and at a much faster rate than ever before. This will make it harder and harder for different species, including our own, to adapt effectively.

In 2001, California's Department of Water Resources launched a new management directive on climate change, establishing a Joint Agency Climate Team with members from a number of state agencies, including: Resources Agency, CalEPA, Department of Transportation, Food and Agriculture, Trade and Commerce, and the Governor's Office of Planning and Research. This team is charged with developing initiatives to reduce carbon dioxide emissions (also called greenhouse gas emissions) and help the State adapt to potential impacts of climate change. The Department of Water Resources is also taking climate change into account in its current update of the State Water Plan. Due out next year, the plan is using climate change models that assume a three-degree Celsius rise in temperature to help evaluate future water needs and recommend policy changes to address climate change effects.[59]

Chapter 4 Planning Ahead to Protect Sierra Water

Given the impacts of historic and existing watershed abuses, along with natural climatic variability and the increasing pressures of population growth and global warming, it is clear that resource managers at all levels need to start preparing for new and different water quantity and quality scenarios.

Although it may seem overwhelming to try to deal with the impacts of population growth and climate change, the encouraging news is that there are processes in place where interested individuals can make a difference, including hydropower relicensing, community planning, watershed assessment and restoration work, timber harvest planning and fuel reduction work. Through these existing land and resource management efforts, concerned citizens can introduce concepts and bring relevant information to bear to protect the natural and community values in the face of climate change and population growth.

Hydropower Relicensings Offer Opportunities

The relicensing of dams in California offers a rare opportunity for conservation groups and the general public to work with project owners, the Federal Energy Regulatory Commission and state and federal resource agencies to reconsider appropriate operations and land management planning for hydropower facilities around the state.

When most dams were built and licensed half a century ago, little attention was paid to the environmental impacts of construction and operation; the focus at the time was almost exclusively on power production and irrigation. But with the re-authorization of these licenses that govern how the projects operate and under what conditions, there is an opportunity to offer new information that wasn't available when the projects were granted their original licenses.

The majority of California's hydropower dams (80%) are regulated through 30- to 50-year licenses

The vast majority of California's 300 hydropower dams (80%) are regulated through 30- to 50-year licenses issued by the Federal Energy Regulatory Commission (FERC). A 1986 amendment to the Federal Power Act, FERC's operating law, requires FERC to take a more balanced approach to dam licensing.[60] More specifically, the amendment requires FERC to give equal consideration to power generation, energy conservation, protection of fish and wildlife, protection of recreational opportunities, and preservation of general environmental quality.

This "equal consideration" mandate requires FERC to actively consult with federal, state and local resource agencies to assess the impact of the hydro project in question on the surrounding environment. FERC is also required to incorporate public input into the decision-making process. In its evaluation of environmental impacts, FERC is obligated to analyze potential environmental consequences and compare the potential consequences with those of alternatives to the suggested action.

This unprecedented entrée into the decision-making process of FERC offers a rare opportunity for Californians to improve dam project design and operations to reduce impacts on our rivers and enhance or restore fish and wildlife habitat and recreation opportunities that were previously lost.

The sheer number of relicensings coming up in the next decade is somewhat daunting. (See Figure 4.1) According to the California Hydropower Reform Coalition (CHRC),[61] about half of the facilities in the state (approximately 150) are scheduled to be relicensed in the next 15 years.

But by working with existing organizations to participate in relicensing proceedings and provide information and focus attention on the need for integrated watershed restoration, interested citizens can help ensure that dam licenses for the next 30 to 50 years restore rivers, while take population growth and climate change into account.

CHRC has compiled a list of relicensings taking place in California over the next 10 years or so(See Table 4.1). Approximately 45 different relicensing processes in or affecting the Sierra are currently underway or soon to start.

Approximately 45 different relicensing processes in or affecting the Sierra are currently underway or soon to start.

The relicensing process can take five or six years, starting well before the license expires and continuing through the scoping process, application

filing, baseline environmental studies, environmental analysis and review through a formal Environmental Impact Statement (EIS) or Environmental Assessment (EA), potential hearings, and finally, the decision, including any new conditions placed on the license. The time and resources needed to participate effectively in cooperative FERC proceedings can be daunting; but because each cooperative process is developed by the participants, strategies can be designed to address concerns such as resource inequities, information deficiencies and conflict resolution. The hard work is definitely worth it, however, when it results in more water in the river, better species protection, additional habitat enhancements, more effective fish passage, greater investment in recreation opportunities, etc. Unlike many protection or restoration activities, FERC relicensing successes are measurable in acre-feet or dollars, and they are codified as part of the project licensing requirements for the next 30 to 50 years.

In one such cooperative relicensing process on the Middle Fork Stanislaus River, for example, input from community-based organizations like the Central Sierra Environmental Resource Center, Friends of the River and Trout Unlimited will likely result in more than 10 times the amount of water left in the river during dry periods. In a similar process on the South Fork Stanislaus, public input will likely result in more than twice the amount of water in the river year-round. In addition, the project proponents, PG&E and Tridem, will likely contribute millions of dollars for new or improved recreational amenities, including new campgrounds, a restored sewer treatment plant, improved water

Table 4.1: Current or Upcoming FERC Relicensings In or Affecting the Sierra

LICENSE EXPIRES	FERC#	TITLE	RIVER
12/31/1995	2699	Angels	Angels Creek (Stanislaus)
2/28/2009	2175	Big Creek No 1 & 2	Big Creek, San Joaquin River
2/28/2009	67	Big Creek No 2A & 8	S Fk San Joaquin River
2/28/2009	120	Big Creek No 3	San Joaquin River
2/28/1999	2017	Big Creek No 4	San Joaquin River
2/28/2005	382	Borel	Kern River
7/31/2007	2155	Chili Bar	S Fk American River
4/30/1989	1354	Crane Valley	NF Willow Creek (San Joaquin)
10/11/2009	803	De Sabla	Butte Creek
12/31/2004	2005	Donnells & Beardsley	M Fk Stanislaus River
2/23/2002	184	El Dorado	S Fk American River
1/31/2007	2100	Feather River	Feather River
11/4/1932	2661	Hat Creek No 1 & 2	Hat Creek, Pit River
3/31/2009	2088	Kelly Ridge 1 & 2	Kelly Ridge Canal
4/30/2005	178	Kern Canyon	Kern River
4/30/1996	1930	Kern River No 1	Kern River
4/30/1996	2290	Kern River No 3	Kern River
3/27/2007	606	Kilarc & Cow Creek	Old Cow Creek, Cow Creek
3/31/1985	1988	Kings River	NF Kings River
2/28/2006	2082	Klamath	Klamath River
6/26/2004	11894	Lassen Lodge Project	SF Battle Creek
6/14/2000	372	Lower Tule	M Fork Tule River
11/30/1986	1390	Lundy	Lundy Creek
11/30/2007	2085	Mammoth Pool	San Joaquin River
9/28/2004	12027	Middle and South Forks Sacramento River Project	MF and SF Sacramento
9/30/1931	137	Mokelumne	Mokelumne, N. Fork Mok. & Bear
5/8/1996	2019	Murphys	Angels Creek (Stanislaus)
9/30/2003	2107	Poe	N Fork Feather River
3/31/2005	2174	Portal	Rancheria Creek, Big Creek
9/7/2004	12118	Robley Point Project	West Branch Feather River
9/30/1934	1962	Rock Creek - Cresta	North Fork Feather River
12/31/2004	2130	Stanislaus-Spring Gap	S Fk Stanislaus River
12/31/2004	2067	Tulloch	Stanislaus River
7/31/2007	2101	Upper American River	American River
10/31/2004	2105	Upper NF Feather River	N Fk Feather River
5/8/1996	11563	Upper Utica Reservoir	North Fork Stanislaus, Silver Creek
8/31/2003	2086	Vermillion Valley	Mono Creek
9/4/2004	12113	Willow Creek Project	Willow Creek

Source: California Hydopower Reform Coalition

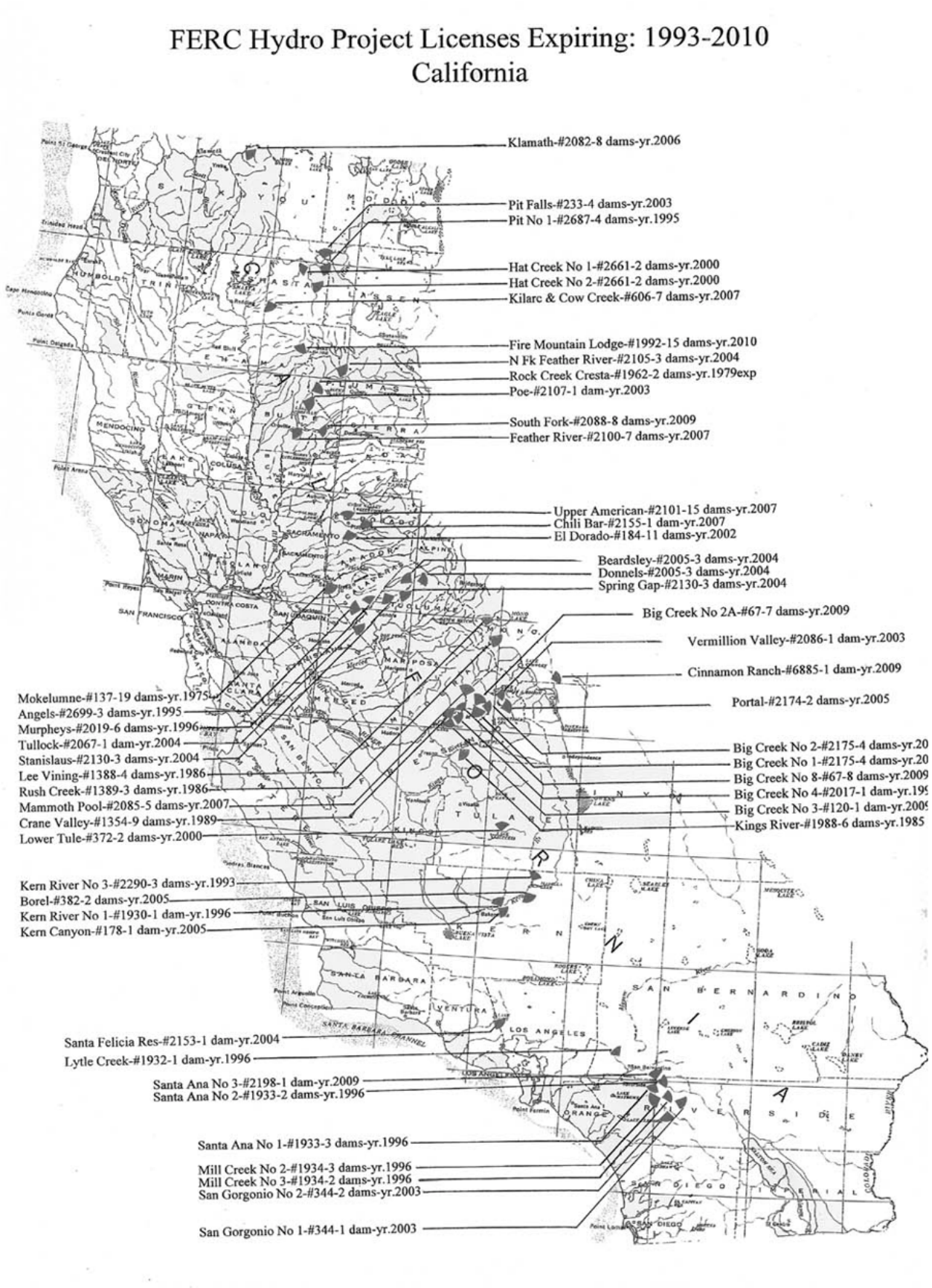

Figure 4.1: Expiring Licenses (California Hydropower Reform Coalition) www.calhrc.org

lines, rehabilitated trails and more. These improvements will be made in areas that get hundreds of thousands of visitors a year.[62]

Approximately 26 organizations in the Sierra have committed to working on relicensings, according to the California Hydropower Reform Coalition. That is a good start; but even more must work together to ensure that local voices are heard as part of the process.

An initial analysis by the Alliance shows that relicensings in Tehama, Plumas, Tuolumne, Madera, Calaveras, Stanislaus and Fresno counties have few resident environmental advocates to participate in relicensing proceedings.

An initial analysis by the Alliance shows that relicensings in Tehama, Plumas, Tuolumne, Madera, Calaveras, Stanislaus and Fresno counties have few resident environmental advocates to participate in relicensing proceedings. The state and national river conservation groups in the California Hydropower Reform Coalition provide experienced staff; but to be most effective, they need to be supported by local participants that reflect community concerns about operating conditions into the coming decades. Communities can't necessarily rely on agency and organizational allies to bring up the issues or information needs that are most important to them at the local, community level.

Community Planning Processes Present Additional Opportunities for Protection

> *Poor planning has… expressed itself in the pattern of structures on the Sierra Nevada landscape. More and more homes and businesses are being scattered across the countryside in a pattern of rural sprawl that could quadruple the portion of the landscape devoted to human settlement by the year 2040.*
> — *Planning for Prosperity*, Sierra Business Council (1997)

In the "Human Settlement, 1850-2040" chapter in the *SNEP Report*, author Tim Duane contends that most of the population growth in the Sierra during the period from 1970 to 1990 occurred in the unincorporated areas of Sierra Nevada counties, meaning that development "leapfrogged" over established communities and took root in areas outside the boundaries of existing services and infrastructure.[63]

People's desire to "live out in the woods" has resulted in the subdivision of large rural parcels into smaller residential lots across much of the Sierran landscape – especially in the foothill areas. Even in areas zoned for agriculture, large-lot residential development is often allowed. Such development breaks up the landscape and diminishes the non-commodity value of agricultural land as habitat and undeveloped space. This incremental construction of individual homesites has resulted in a pattern of low-density, land-intensive development that requires extensive investment to extend services and breaks up important habitat, open space and working landscapes.[64]

With the bulk of growth taking place in the unincorporated areas, county governments have the primary responsibility for regulating land use and guiding human settlement patterns in the Sierra. As a result, the county general plan[65] has taken on added significance, not only as the primary planning tool for individual counties, but also as arbiter of the collective growth of the region.

Unfortunately, one of the findings in the Sierra Business Council study was that most counties in the Sierra are not taking sufficient steps to address the issues brought up by population growth, not to mention climate change – "[m]any general plans in the Sierra Nevada contain vague and ambiguous language that creates confusion and interferes with plan implementation. Other general plans are so outdated that their usefulness is open to question."[66] As a result, rural sprawl is being allowed to further compromise the natural, social and economic assets of many communities in the region.

Of the 29 rural counties making up the Regional Council of Rural Counties (RCRC), at least 18 (or 62%) have been advised by the State that it is time to revisit and update their general plans.

Of the 29 rural counties making up the Regional Council of Rural Counties (RCRC), for example, at least 18 (or 62%) have been advised by the State that it is time to revisit and update their general plans.[67] Some of the RCRC member counties are outside of the Sierra; but most of the Sierra counties are included, so the statistics are representative of the situation in our region. Information from the Governor's Office of Planning and Research, including the "2001 Local Government Planning Survey" and a searchable database of California's 58 counties shows general plan status and planning horizons for the 15 Sierra counties. (See Table 4.2).[68]

In addition, various cities and community areas have their own general plans, sometimes called specific plans or community plans. For example, Alpine County is involved in an update of the Kirkwood Specific Plan, which calls for substantial

Table 4.2: General Plan Status in Sierra Counties

ENTITY	PLANNING HORIZON	COMMENTS
Alpine County	2009	Last updated in 1999
Amador County	2010	Various elements updated 1991 – 98.
Calaveras County	2016	Most mandatory elements updated in 1996; Housing in 2003; 20-yr horizon
El Dorado County	2022	An updated General Plan was adopted in 1996, with 15+-yr horizon; but the County was sued over the legality of the plan, and it was thrown out in court on grounds the county failed to adequately analyze effects of growth on traffic, water supply and quality of life. The legal matters remain unresolved.
Inyo County	2020	Major elements updated in 2001; anticipate 20-yr horizon
Madera County	2005-15	Most major elements updated in 1995
Mariposa County	2023	Update completed 2003; 20-yr horizon
Mono County	2020	Last updated 1993; Circulation and Land Use updated 1998 & 2000; 20-yr horizon
Nevada County	2005	Last updated 1995; 10-yr horizon
Placer County	2010	Updated most elements in 1994; Housing in 2000
Plumas County	1996-2011	Various updates between 1986 and 2001; overdue for update of many elements
Shasta County	2020	Last updated in 1998; approximately 20-yr horizon
Sierra County	2012	Last updated in 1996; 15-yr horizon
Tuolumne County	2020	A lawsuit was filed in 1997 challenging the legality of this general plan.
Yuba County	2016	Last updated in 1996; 20-yr horizon

Source: The California Planners 2001 Book of Lists

new growth in the area of the Kirkwood ski resort; and Placer County is involved in a similar effort with an update of the Martis Valley Community Plan, which also calls for substantial changes and new growth in Martis Valley, particularly around the Northstar ski resort. While General Plan regulations stipulate that incorporated cities and counties should review and update their general plans a minimum of every 10 years, one can see from the chart above that many counties are opting instead for 15- to 20-year horizons. Citizens can call for updates of their county and city plans. In addition, the state needs to spend more energy on enforcing the General Plan update regulations.

One bright spot on the horizon is the Governor's Office of Planning and Research, which is in the process of updating the state's General Plan Guidelines, the document outlining what should be included in general plans. This is the first major revision of this document in more than 25 years. Due to new requirements in the proposed revision, it is likely that many, if not most, cities and counties will need to revisit their general plans in the next three to five years to comply with new requirements.[69]

Concerned citizens should definitely gear up to be part of the process. General Plans, community specific plans and habitat conservation plans govern zoning, and zoning governs subdivision. If concerned citizens can put more effort into crafting strong local plan policies and appropriate zoning, they will go a long way toward reducing the need for individual project-by-project lawsuits. Some ideas concerned citizens may want to pursue for their local planning include[70]:

♦ holding off designation of lands for development unless they are needed within the next 10 years;

♦ redesignating current Rural Residential lands to Resource Lands (with 40-acre or even 80-acre minimum parcel size) unless such lands are contiguous to already developed land (such zoning changes are legal and are NOT considered a "taking"[71] as long as some economic use is allowed on the land, such as grazing; such zoning change is harder to do for brushlands);

♦ requiring a habitat conservation plan before opening up more land to development, since a county with protected lands can boast a stronger economy due to better tourism attraction, lower service costs and more interesting towns and cities;

♦ specific suggestions for new policy language or changes to the wording of existing policies.

In addition, concerned residents should monitor planning department decisions to ensure they are not in violation of local planning ordinances. There are opportunities to stop irresponsible projects and sometimes in this project revision process improve the general plan or community plan.

> *Land use patterns and change are determined by a wide array of governmental, environmental, economic and cultural factors. In the last twenty years in California, land use changes have been driven by a human population that has increased by 44%, a rapidly expanding economy, changes in the tax codes to favor sprawl, and poor land use planning at the local level. After 50 years of dramatic sprawl, California's metropolitan areas and farmlands now cut deeply into once-thriving natural ecosystems. Expanding acreage for agricultural, urban, industrial and transportation systems has caused declines in the spatial extent and connectivity of forests, wetlands, open space and wildlife habitat.*
> — Rebecca Shaw, "Ecological Impacts of a Changing Climate" (as cited in *The Potential Consequences of Climate Variability and Change)*

Watershed Planning and Restoration Efforts Provide Avenues for Change

There are 14 collaborative multi-stakeholder watershed groups in the Sierra and well over 70 conservation groups doing some form of watershed protection and restoration.

Within the Sierra's 24 major watersheds, at least 12 have watershed councils working for their protection. There are 14 collaborative multi-stakeholder watershed groups in the Sierra and well over 70 conservation groups doing some form of watershed protection and restoration. [See Appendix E]. A cursory survey of Sierra-based watershed assessment and restoration plans conducted in 1999 turned up some 250 different projects underway in the Sierra portions of 18 different counties throughout the state. Another study conducted by the Sierra Nevada Conservancy Working Group to quantify natural resource investment needs in the Sierra highlighted 38 specific watershed health projects that, if funded, would cover 565,367 acres and require between $24 and $32 million in funding. This was not meant to be a complete list, but rather an indication of the specific kinds of projects that could benefit from state funding.

In terms of number of groups working on watershed issues, the final report to the State Legislature on AB 2117, titled *Assessing the Need to Protect California's Watersheds: Working in Partnerships*, stated there were between 200 and 325 watershed "partnerships" (defined as groups representing diverse interests including agencies, landowners, environmentalists, and others) and more than 700 individual organizations that claim to be involved in some kind of watershed effort.

With all these watershed assessment and planning efforts underway in the Sierra, it is imperative that population and climate change be taken into account and strategies developed to address the changes that are coming. In addition, there are many watersheds in the Sierra that still lack a broad based effort for protection and restoration.

Timber Harvest Planning Can Protect Sierra Water

Sierra Pacific Industries (SPI) is said to be planning to clearcut as much as 70% of its 1,500,000 acres, much of which is in the Sierra Nevada, stretching from outside Yosemite National Park to the Oregon border.[72] SPI is generally known to be the largest timber company in California and the second-largest private landowner in the United States. The company has a 100-year logging plan to institute plantation forestry of even-aged tree farms for its entire ownership, with approximately 240,000 acres designated for actual clearcutting and 560,000 acres slated for "visual-retention" harvesting, which some call "virtual clearcutting." Visual retention harvesting methods leave four to eight trees per acre.[73]

The largest industrial land use in the Sierra is timber harvesting on private lands. Timber harvesting on private land is governed by the State of California through the state Forest Practice Rules and logging permits authorized by the California Department of Forestry and Fire Protection (CDF). Permit approval is based on a Timber Harvest Plan (THP) submitted by the landowner.

> *The California Forest Practice Rules are the most comprehensive set of guidelines for timber harvesting in the country. However, how adequately they address the public's concerns about the effects of timber harvesting is a matter of contention. Some say that the Forest Practice Rules, set by the nine-member Board of Forestry (composed of three timber industry representatives, one ranching*

industry representative, and five members of the general public) are seen by the timber industry as mere guidelines, not firm restrictions. In fact, the Registered Professional Foresters who write timber harvest plans can ask for exemptions to virtually any rule.
— Planning & Conservation League, A Report on Sierra Pacific Industries: Potential Consequences of SPI's Forestry Practices (August 2000*)*

Timber harvesting has lasting effects on watersheds in the Sierra. In the short term, the timber harvesting process can increase sedimentation in nearby streams and rivers. More medium-term impacts can include harm to water quality due to the use of pesticides and herbicides that can find their way into the same streams and rivers. Roads built to facilitate the harvest can cause longer-term damage if they are not properly constructed or maintained. And the continuing harvest patterns across the landscape can, over time, permanently impact the natural mix of plant and animal species due to habitat fragmentation or eradication.

Unfortunately, cumulative effects of individual THPs on biological and other resources of importance to the state are often not given appropriate consideration in the THP approval process, leading to negative impacts on wildlife, water quality, recreation and tourism. These issues go beyond the property owner's right to do what he wishes on his property. When the resources of the state are involved, citizens beyond the individual property owner have a right to weigh in.

The Forest Practice Rules do include the opportunity for public input as part of the THP review and permitting process, although the opportunity is fairly limited. Once a Registered Professional Forester (RPF) has prepared the timber harvest plan and submitted it to CDF for review, CDF is supposed to inform property owners within 300 feet of the plan boundary and provide written notification to all those who own land within 1,000 feet downstream of the proposed harvest. Notice is also supposed to be filed with the appropriate County Clerk and the local CDF Ranger Unit, as well as the Department of Fish & Game, the Regional Water Quality Control Board, the Department of Parks & Recreation, the county planning agency, and the Tahoe Regional Agency (if applicable). Other interested individuals can also request copies in writing.

These agencies and any individuals may supply written comments to the CDF Director; but they only have 15 days from the date of pre-harvest inspection or the date of filing if no inspection is required. A review team considers all information, including public comment, and makes a recommendation to the Director; but the Director, alone, decides whether the plan conforms to regulations.

The entire process can happen in as few as 45 days. Members of the public and adjacent landowners are not allowed to appeal THP approval by the Director to the Board of Forestry, the oversight body. If there is an appeal, it must be before the local Superior Court. County Boards of Supervisors, if their counties have special General Plan rules regarding timber harvesting, may appeal a THP approval directly to the Board of Forestry – another reason that involvement in the General Plan process can be crucial.

The sheer numbers of THP applications – from SPI and other timber companies such as Louisiana-Pacific, Georgia-Pacific, Pacific Lumber, Collins Pine, and numerous smaller individual companies – and the tight timeframe for review and comment make it difficult for concerned citizens to adequately review THPs and provide meaningful input. [Information on the THP process comes from a publication of the Planning and Conservation League, titled, *A Report on Sierra Pacific Industries: Potential Consequences of SPI's Forestry Practices* (August 2000).]

Chapter 5 Conclusion

Sierra lakes, streams and rivers are the lifeblood of California and Nevada providing a variety of recreation experiences, breathtaking scenery, abundant wildlife habitat and high-quality water for agriculture and communities. All but one major Sierra watershed are polluted and impaired from a legacy of human impacts. Given that, it is remarkable that there has been very little investment in protecting and restoring the quality of Sierra waters. And in this state of peril, population growth and climate change challenge our water delivery systems. Within twenty-five years, there is serious question that the region will be able to provide the same amount of quality water to California and Nevada.

The Sierra Nevada Alliance strongly encourages every community resident and decision maker to embrace these challenges and engage in the many resource management planning opportunities that will present themselves in the next ten years.

Individuals can:

♦ Get involved with local grassroots groups involved in planning. Some of the key local planning processes that need a voice for resource protection are community and general planning, hydropower relicensing, watershed planning, and timber harvest planning. Contact the Sierra Nevada Alliance for the Sierra based group nearest you.

♦ Support groups that are engaged in regional, state and national resource planning. These include the Sierra Nevada Alliance, California Hydropower Reform Coalition, Mono Lake Committee, Sierra Watch, Sierra Fund, Sierra Business Council, Planning and Conservation League, and Friends of the River.

Grassroots groups can:

♦ Engage in the important planning processes. These include general plan revisions, the creation of community plans, watershed planning, timber harvest plans and hydropower relicensing. Specifically, groups can:

♦ Ensure hydropower relicensing efforts in the Sierra Nevada are collaborative, involve local conservation representatives, and most importantly use adaptive management to account for different precipitation and flow regimes due to climate change.

♦ Make sure watershed planning optimizes naturally, sustainable absorptive functions of watersheds. These plans should (remove -)recognize groundwater's relationship to surface water, climate change impacts, and fish passage and forest health issues.

♦ Assure that general plans in Sierra communities take into account climate change, population growth, and altered hydrologic regime factors when assessing the availability, reliability, and management of consumptive and recreational water supplies.

♦ Reach out to regional, statewide and national groups for support for your efforts – including training, information, expert referrals, and access to funding.

♦ Stay abreast of population and climate change information. Incorporate the latest scientific information into planning efforts. Ensure that adaptive management can address the unknown specifics of the future – while not unraveling the process.

♦ Participate in a regional Environmental Water Caucus. The Sierra Nevada Alliance, in partnership with other groups, will be launching a Sierra Environmental Water Caucus. This caucus will coordinate local efforts and ensure that problems are not simply transferred elsewhere. The Caucus will also allow the region to coordinate and to engage on state and national water issues as a united voice for protection and restoration of Sierra resources. The Caucus will foster coordinated operation of Sierra water systems in the region and beyond for effective management of resources under a changed precipitation and hydrologic pattern.

Agriculture and Business can:

Accelerate water conservation efforts and implement new and current technologies for efficiency. Both direct and indirect costs of water will rise in inverse proportion to how these challenges are met. Water conservation must be part of every business plan.

City and County Staff and Elected Officers can:

Involve diverse, local stakeholders in local planning processes from the beginning, rather than plan and then ask for comment. Build a collaborative team from the start of the planning process that represents conservation interests, residents, business owners, land managers, agencies and everyone with a stake in the future.

State and Federal Agencies and Elected Officials must:

♦ Invest in the Sierra Nevada. The Sierra Nevada is California and Nevada's greatest water storage system. The Sierra contains half of our state's animal and plant species. The Sierra is the backyard playground for all of California and Northern Nevada. Clearly the Sierra deserves investment to maintain a supply of plentiful, high-quality water, a rich, diverse habitat for wildlife and an unequaled recreational environment.

♦ Establish a California Sierra Nevada Conservancy to manage conservation efforts in the region.

♦ Allocate needed funds to watershed restoration above the major dams and to the East side of the Sierra.

♦ Provide resources, research, and assistance so that local collaboratives, groups, and governments can address the future. Help local efforts lead on local issues.

♦ Expand the awareness of global warming and its natural, social and financial impacts on the Sierra and potential responses to it throughout the region and state. Consider creating a public policy research institute or a Governor's Council to evaluate climate change and impacts on the Sierra and water.

♦ Require future developments and general plans of all sizes to provide for a sustainable water supply. Require all general plans to be updated in light of population growth and climate change over the next ten years.

♦ Consider having County general plans incorporate NCCPs, THPs, species plans, and transportation plans.

♦ Prevent development on any wetlands and restore floodplains.

♦ Integrate water management among agencies and environmental organizations

Everyone must work to prevent a magnitude of climate change that can cause complete ecosystem failure and chaos. Every decrease in greenhouse gas emissions could help make the difference in having any snow in the Sierra in a hundred years. Incentives for energy conservation should be established by all levels of government. The nation should raise the amount of miles a car can go on a gallon of gas and develop zero pollution cars as soon as possible. California and Nevada should increase the amount of energy that comes from clean, renewable energy sources.

The Sierra Nevada Alliance acknowledges that this plan is broad—as is the challenge facing California and Nevada's water delivery system. To maintain a high quality of life, our states' need forward thinking, long term planning, committed investment and immediate action where there are answers.

The mission of the Sierra Nevada Alliance is to protect and restore the natural environment of the Sierra Nevada while ensuring healthy and sustainable communities. Our love of the Sierra is our motivation to meet the challenges ahead. We need to live in the "long" now. We invite you to join us!

ENDNOTES

[1] Wilkinson, Robert. *The Potential Consequences of Climate Variability and Change for California: A Report of the California Regional Assessment Group for the U.S. Global Change Research Program,* sponsored by the National Science Foundation (Santa Barbara, CA: University of California, Santa Barbara, September 2002), p. 4-1-41 to 4-1-42.

[2] "Global Climate Change and the Sierra," a presentation by Doug Osugi, Supervising Engineer, California Department of Water Resources, at August 2003 Sierra Nevada Alliance annual conference in Arnold, CA.

[3] *California Water Facts* (Sacramento, CA: Water Education Foundation, June 2002), p. 4.

[4] *Sierra Nevada Ecosystem Project, Final Report to Congress*, *vol. II, Assessments and Scientific Basis for Management Options* (Davis: University of California, Centers for Water and Wildland Resources, 1996), Ch. 30 ("Hydrology and Water Resources"), p. 855.

[5] An acre-foot of water is approximately 326,000 gallons, or the amount of water that would cover one acre – approximately the size of a football field – to a depth of one foot. [*California Water Facts*, p. 3.]

[6] *California Water Facts*, p. 4.

[7] *Layperson's Guide to California Water*, (Sacramento, CA: Water Education Foundation, Updated 2000), p. 9.

[8] "California Water Map" (Sacramento, CA: Water Education Foundation, 2001 [twelfth printing]).

[9] *Layperson's Guide to California Water,* p. 12.

[10] *California Water Facts*, p. 6.

[11] "California Water Map" (Sacramento, CA: Water Educaiton Foundation, 2001 [twelfth printing].

[12] *Nevada Natural Resources Status Report*, "Water Resources & Supply" (Carson City, NV: Nevada Department of Conservation & Natural Resources, August 2002). [http://dcnr.nv.gov/nrp01/env02.htm]

[13] Horton, Gary. *Truckee River Chronology: A Chronological History of Lake Tahoe and the Truckee River and Related Water Issues* (Carson City, NV: Nevada Division of Water Planning, Department of Conservation and Natural Resources, April 1997 [Seventh Update]), p. I-1; and Horton, Gary. *Carson River Chronology: A Chronological History of the Carson River and Related Water Issues* (Carson City, NV: Department of Conservation and Natural Resources, a publication in the Nevada Division of Water Planning's Nevada Water Basin Information and Chronology Series, April 1997 [First Update]), [n.p.] – as viewed on the Nevada Division of Water Planning's website: www.water.nv.gov.

[14] Horton, Gary. *Walker River Chronology: A Chronological History of the Walker River and Related Water Issues* (Carson City, NV: Department of Conservation and Natural Resources, a publication in the Nevada Division of Water Planning's Nevada Water Basin Information and Chronology Series, June 1996 [Fourth Update]), [n.p.] – as viewed on the Nevada Division of Water Planning's website: www.water.nv.gov.

[15] *California Water Facts*, p. 5.

[16] "California Water Map."

[17] *SNEP Report*, vol. I, Ch. 2, pp. 29-30.

[18] *SNEP Report*, vol. 1, Ch. 5, p. 77.

[19] *SNEP Report*, vol. 1, Ch. 5, p. 79.

[20] *SNEP Report*, vol. 1, Ch. 8, p. 125.

[21] *SNEP Report*, vol. I, Ch. 8, p. 129.

[22] *SNEP Report*, vol. II, Ch. 19, p. 557.

[23] Information on water-based recreation comes from preliminary draft work (June 20, 2003) on the 2003 State Water Plan Update, as viewed on the California Department of Water Resource's website: www.water.ca.gov

[24] *Sierra Nevada Wealth Index: Understanding and Tracking Our Region's Wealth* (Truckee, CA: Sierra Business Council, 1999-2000 Edition), pp. 64 and 11.

[25] *SNEP Report*, vol. III, Ch. 23, p. 1011.

[26] *California Water Facts*, p. 4.

[27] *SNEP Report*, vol. I, Ch. 8, p. 131.

[28] The full list can be found on the SWRCB website under *Water Quality* at www.swrcb.ca.gov/quality/html. Scroll down the page to "Surface Water – Monitoring/Assessment" to access the updated 303(d) list.

[29] *SNEP Report*, vol. II, Ch. 34, pp. 975-985.

[30] *SNEP Report*, vol. II, Ch. 57, p. 1493.
[31] Overall Quality Rating was on a scale of 1 to 3, with 1 indicating near-pristine condition with native biota largely intact; 2 indicating an altered watershed but one in fair to excellent condition and potentially restorable to a rating of 1; and 3 indicating a watershed that appeared natural and was important as a refuge for some native species, but was probably irreversibly altered, usually because of a large dam or urban area.
[32] *SNEP Report*, vol. II, Ch. 57, p. 1495.
[33] *California Unified Watershed Assessment Factsheet*, http://www.epa.gov/owow/udwa/uwafinal/ca_icon.html.
[34] *SNEP Report*, vol. I, Ch. 8, pp. 125-128.
[35] *SNEP Report*, vol. I, Ch. 8, pp. 128-129.
[36] *SNEP Report*, vol. I, Ch 5, Plate 2.2.
[37] *Sierra Nevada Resource Investment Needs Assessment* (Truckee, CA: Sierra Nevada Conservancy Working Group and Sierra Business Council, July 2002), p. iii.
[38] "Status of Consolidated Request for Proposal," a presentation by Barbara Evoy, Chief, Division of Financial Assistance, State Water Resources Control Board, to the Inaugural California Watershed Council Meeting, Sacramento, CA, August 28, 2003.
[39] Correspondence dated September 4, 2003, from Janet Cohen, Executive Director of the South Yuba River Citizens League, to Barbara Evoy, Chief, Division of Financial Assistance, State Water Resources Control Board.
[40] *SNEP Report*, vol. II, Ch. 11, p. 245.
[41] "Sierra Nevada Population Growth By County" (Source: 2000 U.S. Census), http://quickfacts.census.gov/qfd/states/06000.html.
[42] *Sierra Nevada Resource Investment Needs Assessment,* [n.p.].
[43] Wilkinson, *The Potential Consequences of Climate Variability and Change for California*, p. 6; see also original citation: Jensen, Deborah, et al. In Our Hands: *A Strategy for Conserving California's Biological Diversity* (University of California Press [n.l.], 1993).
[44] *SNEP Report*, vol. II, Ch. 11, p. 236.
[45] *SNEP Report*, vol. II, Ch. 11, pp. 235-6.
[46] Wilkinson, *The Potential Consequences of Climate Variability and Change for California*, p. 2-7.
[47] Wilkinson, *The Potential Consequences of Climate Variability and Change for California*, p. 2-11.
[48] Wilkinson, *The Potential Consequences of Climate Variability and Change for California*, p. 32.
[49] "California in a warming world," *University of California, Santa Cruz Review*, Summer 2001. http://www.ucsc.edu/news_events/review/summer.01/CAwarming.html; and Osugi, "Climate Change and California Water Resources."
[50] Wilkinson, *The Potential Consequences of Climate Variability and Change for California*, p. 32; see also original citation: California Energy Commission, "Historical and Forecasted Greenhouse Gas Emissions Inventories for California," Final Draft, September 30, 1997.
[51] "California in a warming world," [n.p.]
[52] Miller, Norman L., Kathy E. Bashford, Eric Strem, 2001. "Climate Change Sensitivity Study of California Hydrology: A Report to the California Energy Commission," LBNL Technical Report No. 49110, November 2001. Summary from NASA at: http://www.gsfc.nasa.gov/topstory/20020117califclimate.html, January 17, 2002.
[53] "Possible Effects of Global Warming on California Water or More Worries for the Water Engineer," a presentation by Maurice Roos, Chief Hydrologist for the California Department of Water Resources, at W.E.F. Water Law and Policy Briefing in San Diego, CA, July 2000.
[54] Gleick, Peter H. (Lead Author), 2000. *Water: The Potential Consequences of Climate Variability and Change for the Water Resources of the United States, The Report of the Water Sector Assessment Team of the National Assessment of the Potential Consequences of Climate Variability and Change*, U.S. Global Change Research Program, Pacific Institute for Studies in Development, Environment, and Security.
[55] Culled from a variety of sources outlined in Wilkinson, *The Potential Consequences of Climate Variability and Change for California*, pp. 4-1-35 – 4-1-103.
[56] Wilkinson, *The Potential Consequences of Climate Variability and Change for California*, p. 4-1-41.
[57] Osugi, "Climate Change and California Water Resources."
[58] Wilkinson, *The Potential Consequences of Climate Variability and Change for California*, pp. 4-2-7 – 4-2-8.
[59] Osugi, "Climate Change and California Water Resources."
[60] See Federal Power Act 16 U.S.C. 791-828c and its implementing regulations, 18 C.F.R. Parts 4 and 16.
[61] CHRC is a coalition of river conservation and recreation groups who work to protect, enhance, and restore California rivers adversely affected by hydropower operation using collaboration, scientific and legal expertise, and public involvement. The organization is located in Berkeley, CA. For more information, visit the CHRC website at www.calhrc.org or contact Steve Wald, Director, at 510-644-2900 x105 or swald@calhrc.org.

[62] Personal communication, dated August 20, 2003, with John Buckley, Executive Director of the Central Sierra Environmental Resource Center, a participant in relicensing projects on the Stanislaus River and other locations in the Central Sierra.

[63] *SNEP Report*, vol. II, Ch. 11, p. 251.

[64] *SNEP Report*, vol. II, Ch. 11, p. 273.

[65] Incorporated cities and counties in California are required by state law to adopt long-term plans, called "general plans," governing their physical development. These plans are supposed to be reviewed and updated at least every 10 years, although many counties have now gone to a 20-year planning horizon. Individual elements within a general plan may be updated separately. For more information, see the Governor's Office of Planning and Research at www.opr.ca.gov.

[66] *Planning for Prosperity: Building Successful Communities in the Sierra Nevada* (Truckee, CA: Sierra Business Council, 1997), p. 70.

[67] Personal communication, dated August 7, 2003, with John Mills of the Regional Council of Rural Counties' (RCRC) Watershed Program.

[68] "Planning Horizon for the General Plan," from *The California Planners' 2001 Book of Lists*, www.opr.ca.gov; and "General Plan Status Maps" from the California Planners Information Network (CALPIN), http://www.calpin.ca.gov/.

[69] Personal communication, John Mills.

[70] "Smart General Planning: How To," a presentation by Terry Watt, Principal of Terrell Planning Associates, and Bob Johnston, Professor, University of California, Davis, at Sierra Nevada Alliance annual conference in Arnold, CA, August 2003.

[71] "Takings" refers to the taking of private land by a public entity without just compensation. The so-called Takings Clause is from the Fifth Amendment to the U.S. Constitution: "Nor shall private property be taken for public use, without just compensation." While the Fifth Amendment already protects all property owners from government takings without just compensation, conservative activists have recently tried to expand the legal concept of what constitutes a government "takings" to include all situations where *potential* profits from natural resource extraction or commercial development on private lands are limited by land use regulations or other public interest laws. These are so-called "regulatory" takings (a term not found in the Constitution), in which advocates claim that government regulations prevent landowners and developers from using or enjoying their property and that government (taxpayers) should therefore compensate the "potential" value of the land lost due to regulation.

[72] "Proposed Ban on California Clearcuts Defeated, May Surface Again," *The Forestry Source* (Bethesda, MD: Society of American Foresters, Oct. 2000); and "Debate heats up about how to manage California's forests," Associated Press, November 26, 2001; and "Firm's stand changing on clear-cutting," by Stuart Leavenworth, *Sacramento Bee*, April 20, 2001, p. A3.

[73] "Debate heats up about how to manage California's forests"; and "Firm's stand changing on clear-cutting."

Appendix A: Major Dams, Reservoirs & Diversions in the Sierra

Sierra Watershed	Dams/Reservoirs/Diversions	Federal	State	Local
Eagle Lake				
Honey Lake				
Upper Sacramento	Shasta Dam & Reservoir	x		
	Corning Canal	x		
	Tehama/Colusa Canal	x		
	Box Canyon Dam & Reservoir			x
Feather	Antelope Lake Dam & Reservoir		x	
	Lake Davis Dam & Reservoir		x	
	Frenchman Lake Dam & Reservoir		x	
	Oroville Dam & Reservoir		x	
	Mountain Meadows Dam & Reservoir			x
	Lake Almanor Dam & Reservoir			x
	Butt Valley Dam & Reservoir			x
	Bucks Lake Dam & Reservoir			x
	Paradise Dam & Reservoir			x
	Little Grass Valley Dam & Reservoir			x
	Sly Creek Dam & Reservoir			x
	Lake Wyandotte Dam & Reservoir			x
Yuba	Englebright Dam & Reservoir	x		
	Jackson Meadows Dam & Reservoir			x
	Bowman Lake Dam & Reservoir			x
	Spaulding Dam & Reservoir			x
	New Bullards Bar Dam & Reservoir			x
	Upper and Lower Scotts Flat Dams & Reservoirs			x
	Rollins Dam & Reservoir			x
	Camp Far West Dam & Reservoir			x
American	Folsom Dam & Reservoir	x		
	Nimbus Dam	x		
	Folsom S Canal	x		
	Sugar Pine Dam & Reservoir			x
	French Meadows Dam & Reservoir			x
	Hell-Hole Dam & Reservoir			x
	Loon Lake Dam & Reservoir			x
	Stumpy Meadow Dam & Reservoir			x
	Union Valley Dam & Reservoir			x
	Ice House Dam & Reservoir			x
	Chili Bar Dam & Reservoir			x
Cosumnes	Jenkinson Lake Dam & Reservoir	x		
Mokelumne	Silver Lake Dam & Reservoir			x
	Lower Bear Lake Dam & Reservoir			x
	Salt Spring Dam & Reservoir			x
	Pardee Dam & Reservoir			x
	Camanche Dam & Reservoir			x
	Mokelumne Aqueduct			x
Calaveras	New Hogan Dam & Reservoir	x		
Stanislaus	New Melones Dam & Reservoir	x		
	Spicer Meadow Dam & Reservoir			x
	Donnells Dam & Reservoir			x
	Beardsley Lake Dam & Reservoir			x
	Lyons Dam & Reservoir			x
	Tulloch Dam & Reservoir			x

Sierra Watershed	Dams/Reservoirs/Diversions	Federal	State	Local
Tuolumne	Lake Lloyd Dam & Reservoir			x
	Lake Eleanor Dam & Reservoir			x
	Hetch Hetchy Dam & Reservoir			x
	Hetch Hetchy Aqueduct			x
	New Don Pedro Dam & Reservoir			x
Merced	New Exchequer Dam & Lake McClure Reservoir			x
San Joaquin	Eastman Lake Dam & Reservoir (Chowchilla River)	x		
	Hensley Lake Dam & Reservoir (Fresno River)	x		
	Friant Dam & Millerton Reservoir	x		
	Madera Canal	x		
	Thomas A. Edison Lake Dam & Reservoir			x
	Florence Lake Dam & Reservoir			x
	Mammoth Pool Dam & Reservoir			x
	Huntington Lake Dam & Reservoir			x
	Shaver Lake Dam & Reservoir			x
	Bass Lake Dam & Reservoir			x
Kings	Pine Flat Dam & Reservoir	x		
	Friant-Kern Canal	x		
	Courtright Dam & Reservoir			x
	Wishon Dam & Reservoir			x
Kaweah	Lake Kaweah Dam & Reservoir	x		
Tule	Lake Success Dam & Reservoir	x		
Kern	Lake Isabella Dam & Reservoir	x		
	Kern Water Bank (underground storage)		x	
Caliente				
Mojave	Mojave River Dam & Reservoir	x		
Truckee	Stampede Dam & Reservoir	x		x
	Prosser Creek Dam & Reservoir	x		x
	Martis Creek Dam & Reservoir	x		
	Boca Dam & Reservoir	x		x
	Lake Tahoe Dam			x
	Donner Lake Dam			x
	Independence Lake Dam			x
	Floriston Diversion Dam			x
Carson	Diamond Valley Irrigation Ditches			x
	15 small reservoirs of 500 acre-ft or less capacity			x
	Heenan Lake			x
Walker	Bridgeport Reservoir	x		x
	Topaz Reservoir Diversion Canal			x
	Topaz Reservoir	x		x
	Poore Lake/Reservoir			x
	Upper Twin Lake Reservoir			x
	Lower Twin Lake Reservoir			x
	3 small reservoirs of 500 acre-ft or less capacity			x
	Various irrigation diversion ditches			x
Mono Basin	Lee Vining Intake and Tunnel			x
	Grant Lake Dam & Reservoir			x
Owens	Lake Crowley Dam & Reservoir			x
	Pleasant Valley Dam, Reservoir & Power Plants			x
	Lake Sabrina Dam & Reservoir			x
	South Lake Dam & Reservoir			x
	Tinemaha Dam & Reservoir			x
	Los Angeles Aqueduct			x
	No. and So. Haiwee Dams & Reservoirs			x
	Haiwee Power Plant			x

Appendix B: Clean Water Act Section 303(d) List of Impaired Watersheds

[Source: 2002 Update of CWA 303(d) List, Approved by SWRCB February 4, 2003]

WATERSHED/ WATERBODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCE(S)	TMDL PRIORITY	EST MILES	EST ACRES
(1) AMERICAN					
(2) CALAVERAS					
(3) CALIENTE					
(4) CARSON					
Bryant Creek	Metals Acid Mine Drainage	Mine Tailings Inactive Mining Nonpoint Source	Low	5.2	
W. Fork Carson (headwaters to Woodfords)	Nitrogen Phosphorous Sodium	Silviculture Septic Tanks Habitat Modification Removal of Riparian Vegetation Streambank Modification/Destabilization Channel Erosion Erosion/Siltation Atmospheric Deposition Highway Maintenance & Runoff Natural Sources Recreation & Tourism (non-boating)	Low Low Low	18	
W. Fork Carson (Paynesville to State Line)	Pathogens	Pasture Grazing-Riparian, Upland Agriculture-storm runoff Agriculture-irrigation tailwater	Low	3.3	
W. Fork Carson (Woodfords to Paynesville)	Nitrogen Pathogens Sodium	Pasture Grazing-Riparian, Upland Range Grazing-Riparian, Upland Agriculture-storm runoff Agriculture-subsurface drainage Agriculture-irrigation tailwater Agriculture Return Flows Silviculture Wastewater-land disposal Septic Tanks Habitat Modification Removal of Riparian Vegetation Streambank Modification/Destabilization Channel Erosion Erosion/Siltation Atmospheric Deposition Highway Maintenance & Runoff Natural Sources Recreation & Tourism (non-boating)	Low Low Low		

WATERSHED/ WATERBODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCE(S)	TMDL PRIORITY	EST MILES	EST ACRES
Indian Creek	Habitat Alterations Pathogens	Agriculture Pasture Grazing-Riparian, Upland Agriculture-Irrigation tailwater Upstream Impoundment Flow Regulation/Modification Agricultural Water Diversion Grazing-Related Sources	Low Low	13	
Indian Creek Reservoir Wastewater	Phosphorous	Pasture Grazing-Riparian, Upland Flow Regulation/Modification Erosion/Siltation Internal Nutrient Cycling	High	164	
Leviathan Creek	Metals	Mine Tailings Acid Mind Drainage Inactive Mining Erosion/Siltation	Low	3.2	
(5) COSUMNES					
(6) EAGLE LAKE					
Eagle Lake	Nitrogen Phosphorous	Agriculture Grazing-Related Sources Silviculture Other Urban Runoff Highway/Road/Bridge Runoff Wastewater Septic Tanks Marinas & Rec Boating Atmospheric Deposition Internal Nutrient Cycling Sediment Resuspension Natural Sources Recreation & Tourism (non-boating) Nonpoint Source	Low Low		20704
Pine Creek	Sedimentation/Siltation	Grazing-Related Sources Silviculture Highway/Road/Bridge Construction Hydromodification Removal of Riparian Vegetation Streambank Modification/Destabilization Erosion/Siltation	Low	55	
(7) FEATHER					
Little Grizzly Creek	Copper Zinc	Mine Tailings	Med	9.4	

ATERSHED/ WATERBODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCE(S)	TMDL PRIORITY	EST MILES	EST ACRES
(8) HONEY LAKE					
Honey Lake	Arsenic Salinity/TDS/Chlorides	Geothermal Development Flow Regulation/Modification Natural Sources Nonpoint Source Agriculture Agricultural Return Flows Agricultural Water Diversion Sediment Resuspension	Low Low		57756
Honey Lake Area Wetlands	Metals	Agriculture Geothermal Development Natural Sources Nonpoint Source	Low		62590
Honey Lake Wildfowl Management Ponds	Flow alterations Metals Salinity/TDS/Chlorides Trace Elements	Agricultural Water Diversion Agriculture Geothermal Development Natural Sources Nurseries	Low Low Low Low		665
Susan River	Unknown Toxicity	Source Unknown	Low	58	
(9) KAWEAH					
(10) KERN					
(11) KINGS					
(12) MERCED					
(13) MOJAVE					
(14) MOKELUMNE					
(15) MONO BASIN					
Bodie Creek	Metals	Resource Extraction Mine Tailings Inactive Mining Nonpoint Source	Med	11	

WATERSHED/ WATERBODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCE(S)	TMDL PRIORITY	EST MILES	EST ACRES
Bridgeport Reservoir	Nitrogen Phospherous Sedimentation/Siltation	Grazing-Related Sources Pasture Grazing-Riparian, Upland Other Urban Runoff Highway/Road/Bridge Runoff Wastewater-land disposal Flow Regulation/Modification Removal of Riparian Vegetation Streambank Modification/Destabilization Channel Erosion Erosion/Siltation Marinas and Rec Boating Atmospheric Deposition Internal Nutrient Cycling Sediment Resuspension Natural Sources Recreational & Tourism (non-boating)	Med Med		2614
Crowley Lake	Nitrogen Phosphorous	Grazing-Related Sources Atmospheric Deposition Internal Nutrient Cycling Natural Sources Nonpoint Source Erosion/Siltation	Med Med		4861
Lee Vining Creek	Flow alterations	Flow Regulation/Modifications	Low	9	
Mill Creek	Flow alterations	Water Diversions	Low	12	
(16) OWENS					
Haiwee Reservoir	Copper	Other	High		1703
Mammoth Creek	Metals	Other Urban Runoff Natural Sources Nonpoint Source	Low	12	
Owens River (Long HA)	Habitat alterations	Agriculture Grazing-Related Sources Hydromodification Flow Regulation/Modification	Low	26	
Owens River (Lower)	Habitat alterations	Agriculture Hydromodification	Low	53	
Owens River (Upper)	Habitat alterations	Agriculture Hydromodification	Low	69	
Twin Lakes	Nitrogen Phosphorous	Agriculture Grazing-Related Sources Construction/Land Development Other Urban Runoff Atmospheric Deposition	Low Low		26

WATERSHED/ WATERBODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCE(S)	TMDL PRIORITY	EST MILES	EST ACRES
(17) SAN JOAQUIN					
(18) STANISLAUS					
(19) TRUCKEE					
Bear Creek	Sedimentation/Siltation	Hydromodification Nonpoint Source	Med	3	
Blackwood Creek	Iron Nitrogen Phospherous Sedimentation/Siltation	Erosion/Siltation Natural Sources Nonpoint Sources Silviculture Resource Extraction Hydromodification Streambank Modification/Destabilization Atmospheric Deposition Grazing-Related Sources	Low Low Low Med	5.9	
Bronco Creek	Sedimentation/Siltation	Silviculture Natural Sources Nonpoint Source	Med	1.3	
Cinder Cone Springs	Nutrients Salinity/TDS/Chlorides	Wastewater-land disposal	Med Med		1
Donner Lake	Priority Organics	Source Unknown	Low		819
Gray Creek	Sedimentation/Siltation	Silviculture Natural Sources Nonpoint Source	Med	2.8	
Heavenly Valley Creek (source to USFS boundary)	Chloride Phosphorous	Highway/Road/Bridge Runoff Atmospheric Deposition Natural Sources Source Unknown Erosion/Siltation Recreation & Tourism (non-boating)	Low Low	2	
Heavenly Valley Creek (USFS boundary to Trout Creek)	Chloride Sedimentation/Siltation	Highway/Road/Bridge Runoff Construction/Land Development Hydromodification Habitat Modification Atmospheric Deposition Natural Sources Nonpoint Source Source Unknown Recreation & Tourism (non-boating)	Low Low	1.4	

WATERSHED/ WATERBODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCE(S)	TMDL PRIORITY	EST MILES	EST ACRES
Squaw Creek	Sedimentation/Siltation	Construction/Land Development Other Urban Runoff Hydromodification Drainage/Filling of Wetlands Highway Maintenance & Runoff Natural Sources Recreation & Tourism (non-boating) Nonpoint Source	Med	5.8	
Lake Tahoe	Nitrogen Phospherous Sedimentation/Siltation	Grazing-Related Sources Silviculture Construction/Land Development Urban Runoff/Storm Sewers Urban Runoff-non-industrial permitted Other Urban Runoff Highway/Roads/Bridge Construction & Runoff Surface Runoff Urban Runoff-Erosion & Sedimentation Hydromodification Channelization Habitat Modification Removal of Riparian Vegetation Streambank Modification/Destabilization Drainage/Filling of Wetlands Channel Erosion Erosion/Siltation Marinas & Rec Boating Atmospheric Deposition Highway Maintenance & Runoff Internal Nutrient Cycling Sediment Resuspension Natural Sources Recreation & Tourism (non-boating) Golf course activities Groundwater Loadings Nonpoint source	Med Med Med		85364
Trout Creek (above Hwy 50)	Iron Nitrogen Pathogens Phosphorous	Urban Runoff-non-industrial permitted Erosion/Siltation Natural Sources Pasture Grazing-Riparian, Upland Atmospheric Deposition Source Unknown	Low Low Low Low	10	
Trout Creek (below Hwy 50)	Iron Nitrogen Pathogens Phosphorous	Urban Runoff-non-industrial permitted Erosion/Siltation Natural sources Atmospheric Deposition Pasture Grazing-Riparian Recreation & Tourism (non-boating) Transient encampments	Low Low Low Low	1	

WATERSHED/ WATERBODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCE(S)	TMDL PRIORITY	EST MILES	EST ACRES
Truckee River	Sedimentation/Siltation	Range Grazing-Riparian, Upland Silviculture Construction/Land Development Highway/Road/Bridge Construction Streamgank Modification/Destabilization Channel Erosion Erosion/Siltation Natural Sources Recreation & Tourism (non-boating) Snow skiing activities Nonpoint source	Med	39	
Truckee River, Upper (above Christmas Valley)	Iron Pathogens Phosphorous	Natural Sources Grazing-Related Sources Recreation & Tourism (non-boating) Silviculture	Low Low Low	4.5	
Truckee River, Upper (below Christmas Valley)	Iron Phosphorous	Erosion/Siltation Natural Sources Unknown Nonpoint Source Silviculture Construction/Land Development Hydromodification Channelization Removal or Riparian Vegetation Streambank Modification/Destabilization Atmospheric Deposition Highway Maintenance & Runoff	Low Low	11	
Ward Creek	Iron Nitrogen	Silviculture Other Urban Runoff Highway/Road/Bridge Runoff Channel Erosion Erosion/Siltation Natural Sources Atmospheric Deposition	Low Low	5.7	
(20) TULE					
(21) TUOLUMNE Don Pedro Lake	Mercury	Resource Extraction	Low		11056
(22) UPPER SACRAMENTO Little Deer Creek	Mercury	Resource Extraction	Low	4.1	

WATERSHED/ WATERBODY	POLLUTANT/ STRESSOR	POTENTIAL SOURCE(S)	TMDL PRIORITY	EST MILES	EST ACRES
(23) WALKER					
East Walker (above Bridgeport Reservoir)	Pathogens	Pasture Grazing-Riparian, Upland Other Urban Runoff Natural Sources Recreation & Tourism (non-boating)	Low	7.2	
East Walker (below Bridgeport Reservoir)	Nitrogen	Grazing-Related Sources Pasture Grazing-Riparian, Upland Range Grazing-Riparian, Upland Highway/Road/Bridge Runoff Upstream Impoundment Flow Regulation/Modification Streambank Modification/Destabilization Erosion/Siltation Atmospheric Deposition Natural Sources	Low	8	
West Walker River	Sedimentation/Siltation	Agriculture Pasture Grazing-Riparian, Upland Removal of Riparian Vegetation Streambank Modification/Destabilization Channel Erosion Erosion/Siltation Nonpoint Source	Low	49	
(24) YUBA					
Upper Bear River	Mercury	Resource Extraction	Med	10	
Camp Far West Reservoir	Mercury	Resource Extraction	Med		1945
Lake Combie	Mercury	Resource Extraction Abandoned mines	Med		362
Englebright Lake	Mercury	Resource Extraction Abandoned mines	Med		754
Humbug Creek	Copper Mercury Sedimentation/Siltation Zinc	Resource Extraction Abandoned mines	Low Low Low Low	2.2	
Scotts Flat Reservoir	Mercury	Resource Extraction	Med		660
Wolf Creek	Fecal Coliform	Agriculture Urban Runoff/Storm Sewers Recreation & Tourism (non-boating)	Low	23	

Appendix C: Index of Biotic Integrity for Sierra Nevada Watersheds

[Summarized from Appendix 34.1 in vol. 2 of the SNEP Report]

NAME	IBI	% DAMS	% DIVERSION	% ROADS	% ROAD/ STREAMS	% ROADLESS	% FISHLESS
AMERICAN							
S.Fk. American	40	1.40	2.58	19.90	9.76	28.9	38.9
M.Fk. American	47	0.82	1.23	15.67	5.02	45.2	69.2
N.Fk. American	73	1.44	0.93	17.04	7.66	47.8	42.1
	53						
CALAVERAS							
S.Fk. Calaveras	53	1.08	1.73	16.33	11.65	32.2	14.6
N.Fk. Calaveras	80	0.95	1.95	12.37	9.27	49.8	4.0
	67						
CALIENTE							
Tehachapi	32	0.09	0.40	12.33	10.31	52.1	0.0
	32						
CARSON							
L.W.Fk. Carson	52	0.00	0.95	7.98	4.39	65.5	0.0
Indian Cr.	56	4.14	0.00	6.73	5.59	59.3	0.0
E.Fk. Carson	64	0.95	0.52	2.77	2.83	89.5	26.7
U.W.Fk. Carson	64	3.04	0.49	8.16	4.98	71.3	8.2
	59						
COSUMNES							
Cosumnes	60	0.98	2.20	21.20	12.05	11.0	9.7
	60						
EAGLE LAKE							
Eagle Lk.	72	0.00	0.48	14.87	2.38	16.4	0.0
	72						
FEATHER							
N.Fk. Feather	40	0.59	0.80	14.36	5.73	33.4	0.0
N.Fk.E.Br. Feather	43	0.23	0.76	14.27	8.22	31.9	0.0
S.Fk. Feather	50	2.13	0.61	22.27	7.50	18.1	51.6
N.Fk.W.Br. Feather	50	0.82	2.80	14.86	7.04	29.6	0.0
M.Fk. Feather	63	0.27	0.53	13.98	6.64	39.3	12.3
	49						
HONEY LAKE							
Long Valley Cr.	40	0.07	0.58	11.29	3.32	40.1	0.0
Susan R.	60	0.75	0.38	12.43	5.35	30.5	0.0
	50						
KAWEAH							
Yokohl Creek	25	0.00	.95	6.95	3.14	43.7	0.0
M.Fk. Kaweah	60	0.00	0.04	0.65	0.30	97.4	99.3
N.Fk. Kaweah	64	0.34	1.21	6.20	2.09	78.9	70.7
S.Fk. Kaweah	72	0.00	1.65	4.06	1.52	83.3	45.7
	55						
KERN							
Mid. Kern	44	0.14	2.66	9.83	5.48	67.1	0.0
S.Fk. Kern	72	0.00	0.81	3.11	1.30	88.5	2.2
Kernville	76	0.00	1.45	9.21	5.25	69.5	0.0
N.Fk. Kern	76	0.00	0.15	3.10	0.82	87.7	35.4
	67						

NAME	IBI	% DAMS	% DIVERSION	% ROADS	% ROAD/ STREAMS	% ROADLESS	% FISHLESS
KINGS							
N.Fk. Kings	52	0.40	0.42	7.18	2.08	72.1	89.1
Lower Kings	53	0.32	0.83	10.34	6.71	54.2	0.0
Sycamore Cr.	68	0.00	1.77	11.35	5.71	53.9	10.2
S.Fk. Kings	76	0.08	0.14	2.84	1.03	88.8	74.9
	62						
MERCED							
Lower Merced	43	0.59	1.00	12.06	5.76	33.0	0.0
Yosemite	52	0.00	0.26	6.32	3.93	76.9	45.6
S.Fk. Merced	63	0.00	0.45	6.75	2.39	71.4	44.9
U. Yosemite	64	0.00	0.00	0.77	0.40	96.5	92.7
Mariposa	64	0.65	1.44	9.85	5.03	40.8	0.0
N.Fk. Merced	67	0.31	1.08	14.69	8.69	36.8	32.8
	59						
MOJAVE							
No information	n/a						
MOKELUMNE							
Sutter Cr.	48	1.46	2.75	15.70	14.25	16.0	0.0
Upper Mokelumne	64	0.93	0.89	15.43	8.61	42.8	64.4
	56						
MONO BASIN							
Mono	36	0.57	0.67	4.57	2.08	67.5	86.1
	36						
OWENS							
Upper Owens	36	0.21	0.61	5.33	3.43	76.0	30.1
Lower Owens	36	0.03	0.34	5.71	3.28	76.1	29.3
Mammoth Cr.	40	0.20	0.94	13.59	6.10	46.7	47.4
	37						
SAN JOAQUIN							
Daulton	30	1.05	1.64	8.75	5.48	42.3	0.0
N.Fk.San Joaquin	36	0.00	0.08	0.57	0.21	96.9	100.0
Huntington Lk.	40	1.16	1.41	11.96	5.31	52.1	82.4
Redinger	43	1.15	2.34	17.76	6.00	13.0	7.4
Mammoth Pool	43	0.38	0.29	5.11	2.12	79.5	82.1
Willow Cr.	47	0.89	1.22	17.95	5.63	36.9	50.3
Fresno R.	48	0.49	2.52	17.58	5.09	23.6	9.0
Finegold Cr.	48	0.55	1.74	15.25	7.19	29.0	0.6
E.Fk. Chowchilla	58	0.17	3.43	10.77	3.99	47.2	0.0
Willow Cr.	68	0.43	1.01	5.67	2.17	75.3	0.0
	46						
STANISLAUS							
L. Stanislaus	40	1.69	1.06	15.53	10.12	21.1	0.0
N.Fk. Stanislaus	43	1.41	0.66	16.66	8.93	41.0	76.3
Clark Fork	44	0.00	0.17	1.64	1.36	95.4	100.0
S.Fk. Stanislaus	53	1.08	0.76	15.33	9.96	42.1	69.7
M.Fk. Stanislaus	53	0.82	0.49	10.55	5.39	61.0	86.8
	47						

NAME	IBI	% DAMS	% DIVERSION	% ROADS	% ROAD/ STREAMS	% ROADLESS	% FISHLESS
TRUCKEE							
N. Tahoe	52	0.75	2.48	21.27	7.70	41.6	33.9
S. Tahoe	56	0.88	2.43	16.44	6.35	60.3	13.9
Little Truckee	60	0.41	0.67	15.62	7.30	23.6	10.4
L. Tahoe	60	0.29	1.78	0.09	0.17	0.0	0.0
Truckee	64	1.06	0.97	20.36	9.69	31.4	15.2
	58						
TULE							
5-Dog Cr.	40	0.00	2.35	12.64	7.67	11.9	0.0
Poso Cr.	52	0.00	2.43	10.89	5.29	44.7	0.0
N.Fk.M.Fk. Tule	56	0.00	0.57	5.93	1.34	83.4	80.0
Tule	60	0.11	1.69	10.09	4.88	57.0	27.5
Deer Cr.	68	0.00	3.27	8.24	3.84	66.0	0.0
White R.	68	0.00	0.71	13.02	5.38	28.7	0.0
	57						
TUOLUMNE							
U. Tuolumne	48	0.16	0.02	0.82	0.36	96.1	95.6
N.Lk. McClure	48	0.51	1.32	13.43	8.10	24.2	8.9
S.Lk. McClure	48	0.00	0.66	8.56	3.47	62.4	0.0
L. Tuolumne	56	1.37	1.34	15.50	9.06	24.4	0.9
Cherry Cr.	56	1.81	0.23	2.91	1.15	87.2	94.9
Mid. Tuolumne	60	0.00	0.64	11.02	3.47	61.3	90.9
S.Fk. Tuolumne	72	0.00	0.39	14.59	3.51	48.0	94.6
Clavey R.	92	0.43	0.85	20.32	8.87	26.2	60.9
	60						
UPR SACRAMENTO							
Big Chico Cr.	60	0.00	1.87	13.63	5.67	36.7	0.0
Paynes Cr.	60	0.00	0.00	8.43	2.33	59.5	0.0
Little Chico	67	1.39	1.39	10.33	1.39	21.3	0.0
Butte Cr.	67	0.75	2.33	16.81	7.00	30.6	0.0
Pine Cr.	80	0.00	0.57	3.21	1.60	78.0	0.0
Dye Cr.	80	0.00	0.10	12.20	1.43	31.5	0.0
Antelope Cr.	80	0.27	1.44	11.85	4.65	51.4	0.0
Deer Cr.	93	0.00	0.65	14.72	4.48	46.2	0.0
Mill Cr.	93	0.00	0.38	7.89	1.77	71.4	0.0
	76						
WALKER							
L.E.Fk. Walker	52	0.00	1.66	5.12	3.82	78.1	12.7
Slinkard Cr.	52	0.00	2.93	5.00	1.78	80.9	0.0
Desert Cr.	52	1.74	0.52	1.84	0.70	93.4	0.0
L.W. Walker	56	0.00	0.94	5.38	3.74	71.8	2.2
U.E.Fk. Walker	64	0.49	1.11	2.27	2.02	92.1	23.4
U.E.Fk. Walker (sic)	64	0.00	2.14	5.39	2.77	78.4	46.2
Upper W. Walker	64	0.34	0.51	4.32	3.22	83.0	47.0
	58						
YUBA							
South Yuba	30	3.13	1.88	15.30	6.50	39.8	63.9
Middle Yuba	33	0.92	1.59	17.83	6.04	28.3	46.0
U. Bear	47	1.23	1.61	30.03	17.15	3.1	17.2
Lower Dry Cr.	47	0.76	1.74	16.16	15.47	12.1	0.0
Upper Dry Cr.	47	2.68	1.88	18.42	10.30	15.5	0.0
Lower Yuba	47	2.09	1.74	16.76	11.14	21.1	0.0
N. Yuba	53	0.72	1.50	17.97	6.64	35.7	53.0
	43						

Appendix D: Potential Aquatic Diversity Management Area Watersheds

[from SNEP Report, vol. II, Chapter 57 - Potenital Aquatic Diversity Management Areas]

West-Side Drainages

Upper Sacramento
1. Antelope Creek
2. Dye Creek
3. Mill Creek
4. Pine Creek
5. Deer Creek
6. Big Chico Creek

Feather
7. Yellow Creek
8. M.F. Feather River

Yuba
9. Lavezolla Creek/Downey River

American
10. N.Fk. American
11. Rubicon River above Hell Hole
12. Jones Fork of Silver Fork
13. Rock Creek

Cosumnes
14. Entire drainage

Mokelumne
15. N.Fk Mokelumne

Stanislaus
16. N.Fk. Stanislaus
17. S.Fk. Stanislaus above Pinecrest Res.
18. Rose Creek

Tuolumne
19. Clavey River
20. S.Fk. Tuolumne

Merced
21. Entire drainage above McClure Res.

San Joaquin
22. Mariposa Creek above Mariposa Res.
23. E.Fk. Chowchilla
24. Finegold Creek

Kings
25. Rancheria Creek
26. S.Fk. & M.Fk. Kings

Kaweah
27. S.Fk. Kaweah

Tule
28. N.Fk. & M.Fk. Tule
29. Deer Creek

Kern
30. Kern above Isabella Re.
31. S.Fk. Kern
32. N.Fk. Kern

East-Side Drainages

Eagle Lake
33. Entire drainage, including Pine Creek

Honey Lake
34. Willow Creek

Truckee
35. Upper Little Truckee
36. Sagehen Creek

Carson
37. E.Fk. Carson

Walker
38. Buckeye Creek
39. West Walker drainage

Mono Basin
40. Mono Lake

Owens
41. Owens River above Crowley Res.
42. Convict Creek

Appendix E: Sierra Nevada Alliance Collaborative Watershed Group Directory

River systems are complex, as are the problems that affect them. Benefits from sound watershed management transcend individual ownerships and political boundaries. That is why we need multi-stakeholder watershed councils comprising a solid contingent of local citizens with specific concerns and experience in their own watersheds to help craft the solutions. Experience has shown that people with diverse viewpoints who voluntarily meet and work together as a planning team will find common ground as they interact with each other. Landowners, users, and resource managers learn to understand and respect each other's viewpoints.

The following is a directory of watershed councils which are locally organized, voluntary, non-regulatory groups established to assess the condition of the watershed and build a work plan to protect, restore and enhance the watershed. These are organizations (not processes) which involve a broad range of stakeholders in their watershed. Please note that conservation groups, agencies and other organizations also do very important restoration and protection. This directory only lists those groups however that reflect a broad range of stakeholders. [For a directory of conservation groups in the Sierra, please visit the Sierra Nevada Alliance member group directory at www.sierranevadaalliance.org]

Alpine Watershed Group

Joan Clayburgh, Interim Watershed Coordinator

PO Box 157
Markleeville, CA 96120

Watersheds: Carson, Mokelumne, Stanislaus, Truckee, Mokelumne, American (Silver Fork)
Region: Eastern Sierra
County: Alpine

Phone: 530-542-4546 Fax: 530 542 4570
Email: joan@sierranevadaaliance.org
Web: www.alpinecountyca.com/watershed/

Description: The Alpine Watershed Group works to preserve and enhance the natural system functions of Alpine County's watersheds for future generations. The group works by inspiring participation to collaborate, educate and proactively implement projects that benefit and steward the county's watersheds. The group is comprised of diverse stakeholders including ranchers, business owners, interested citizens, the Washoe Tribe, government agencies and districts and conservation groups. Current priority projects include conducting a hydro-geofluvial assessment and riparian survey of the Upper Carson river, creating a GIS Framework for the watershed, organizing an annual Markleeville Creek Day - a creek restoration and education event for the entire community, and determining restoration projects for the future. There are the headwaters of five watersheds in the county: Upper Carson, Upper Mokelumne, Upper Stanislaus, Upper Truckee, Upper Mokelumne, and Upper American (Silver Fork).

American River Watershed Group (North/Middle Fork)

Bonnie Bagwell, Executive Director

Watershed: American
Region: Central Sierra
County: Placer

Phone: 530-878-3622
Email: arwg@infostations.com

The North/Middle Fork American River Watershed Group (ARWG) is a collaborative forum that brings together public and private partners with a goal of working together to improve watershed health. The Group's mission is to sustain environmental and economic health within the American River Watershed and ensure public and firefighter safety. One focus of ARWG is to enhance watershed and habitat values and rehabilitate the forest ecosystem using a watershed based approach. ARWG is currently undertaking a watershed-wide sediment dynamics study that will allow us to prioritize areas of the watershed for future restoration efforts. Another focus has been to reduce the risk of catastrophic wildfire through collaborative planning and on-the-ground fuels reduction. ARWG spawned the Placer County Fire Safe Alliance that now works independently to further this aspect of the mission. A long-range goal is to create a system that will provide a market for what are currently underutilized forest products to landowners and managers in order to sustain long-term economic viability in our region.

Bear Creek Watershed Group

Gary Desselle, Watershed Coordinator
Shasta County RCD
6270 Parallel Rd
Anderson, CA 96007-4833

Watershed: Middle Sacramento
Region: Northern Sierra
County: Shasta

Phone: 530-365-7332 x 211 Fax: 530-365-7332 Email: gary@westernshastarcd.org
Web: www.westernshastarcd.org and http://wim.shastacollege.edu

Description: Bear Creek is in the south central part of Shasta County and is in the Cascade - Sierra Nevada interface. The watershed group, recently formed, will be collecting data on their watershed to assess it. The group participated in the first water quality monitoring day. Stakeholders include ranchers, residents, conservation groups, California Department of Fish & Game, US Fish & Wildlife Service, and the local timber companies. The group is also doing an assessment of anadramous fishery in Bear Creek. Last year the group did a Salmon redd survey and will be repeating the redd count this fall. They are not incorporated.

Big Chico Creek Watershed Alliance

Susan Strachen
602 Sycamore St
Chico, CA 95928

Watershed: Upper Sacramento
Region: Northern Sierra
County: Butte, Tehama

Phone: 530-894-8722 Fax: 530-899-5105 Email: bigchico@csuchico.edu
Web: www.buttecounty.net/waterandresource/watershed_groups.htm

Description: Big Chico Creek Watershed Alliance (BCCWA) is a collaborative of environmental agencies, ranchers, local businesses, and residents. The Alliance has produced a very comprehensive environmental conditions report which is available online at the address above. They have also completed a stakeholder survey and watershed management strategy. BCCWA was successful in helping M&T Ranch to relocate pumps that were drawing down water to such an extreme in Big Chico Creek that it was reversing the flow and causing fish kills during spawning.

Calaveras River Watershed Management Program

Kristin Coon, Administrative Technician
PO Box 846
San Andreas, CA 95249

Watershed: Calaveras
Region: Central Sierra
County: Calaveras

Phone: 209-754-3543 ext 29 Fax: 209-754-9620 Email: kristinc@ccwd.org
Web: www.ccwd.org

Description: The Calaveras County Water District (CCWD), in cooperation with Stockton East Water District (SEWD), initiated the Calaveras River Watershed Management Plan (CRWMP) in 2000. Phase I of the program was funded by a watershed grant from the State Water Resources Control Board and included a comprehensive field assessment of the watershed and formation of a stakeholder/technical advisory group. Phase I was completed in April 2002. Phase II of the CRWMP, which is currently underway, implements Baseline Water Quality Monitoring on the Calaveras River, as recommended in Phase I of the plan. Phase II is funded through a CALFED Proposition 13 grant. Sampling on the Calaveras began in late May 2003 and will continue for one year. Phase II also includes citizen monitoring training, which is scheduled to take place in the fall of 2003. CCWD hopes to obtain funding for Phase III of the CRWMP, which was submitted to the State Water Resources Control Board as a concept proposal on May 9, 2003.

Central Sierra Watershed Committee

Noreen MacDonald, Facilitator/Coordinator
PO Box 268
Oakhurst, CA 93644

Watershed: Merced
Region: Southern Sierra
County: Mariposa

Phone: 603-569-9912 Fax: 603-569-9915 Email: noreen@metrocast.net
Web: http://www.crcd.org/wtrshed.html

Description: Since 1997, the CSWC has met monthly with over 20 agencies and private citizens involved in Water Quality & Quantity issues. The goal is to coordinate efforts for identifying problem areas, and finding grants for study/planning and/or implementing solutions. Educational materials on water related subjects are regularly distributed through mailings and area newspapers.

Cherokee Watershed Alliance

Susan St Germaine, Coordinator
9985 Lott Rd
Durham, CA 95938

Watershed: Yuba
Region: Northern Sierra
County: Butte

Phone: 530-893-9039 Fax: 530-893-9039 Email: susansgm@saber.net

Description: The Cherokee Watershed Alliance is a collaborative, non-regulatory effort that involves the active participation of various social, economic, and environmental interests, both private and public, working together to achieve the enhancement of water quality and aquatic habitat in the Cherokee Watershed. The mission of the Cherokee Watershed Alliance is to foster partnerships that will contribute to the integrated long-term cultural, economic, and environmental health of the watershed through active community participation. The Cherokee Watershed is a place of natural beauty with rangeland, forest, mining, agricultural productivity, and environmental integrity whose stakeholders strive to integrate cultural, economic, and environmental health. Citizens, businesses, organizations, landowners, and government will collaborate to make informed, responsible decisions that will enhance and conserve the cultural, economic, and environmental qualities of the watershed for present and future generations.

Clavey River Ecosystem Project

Glenda Edwards
17860 Wards Ferry Rd
Sonora, CA 95370-8655

Watershed: Tuolumne
Region: Central Sierra
County: Tuolumne

Phone: 209-532-7110 Fax: 209-536-0876 Email: gedwards@inreach.com
Web: www.fs.fed.us/r5/stanislaus/watershed/crep/

Description: The Clavey River Ecosystem Project (CREP) was formed for the purpose of producing a scientifically credible assessment and analysis of the watershed of the Clavey River that would have wide support. CREP is comprised of interested stakeholders from a variety of backgrounds (ranching, logging, recreation, OHV, education, environmental and business). CREP participants recognize the value of working together to better understand the existing conditions of the Clavey River watershed. It is the intention of CREP participants to develop and use that understanding to recommend specific on-the-ground projects and potential management direction to help improve the health of the watershed.

Dry Creek Watershed Council

Gregg Bates
PO Box 1311
Roseville. CA 95678-8311

Watershed: Sacramento
Region: Central Sierra
County: Placer, Sacramento

Phone: 916-771-2013 Fax: 916-657-4721 Email: dcc@unlimited.net

Description: The Dry Creek Watershed Council works to protect and restore the watershed to enhance fish, wildlife, and other natural resources. The collaborative recognizes the rights and cultural heritage of landowners in the watershed. DCWC promotes recreational use of the watershed consistent with protection of private property and natural and cultural resources, cooperative partnerships among diverse stakeholders, education on the function and management of a healthy watershed, projects to protect and enhance the fishery and riparian corridors, and optimal passage of stormwater. Stakeholders include the Adelante High School, California Conservation Corps, California Department of Fish and Game, California Native Plant Society-Sacramento Valley Chapter, Central Valley Regional Water Quality Control Board, City of Roseville, Granite Bay Flycasters, Dry Creek Conservancy, Placer County Board of Supervisors, Placer County Department of Environmental Health, Placer County Fish and Game Commission, Placer County Flood Control District, Placer County Resource Conservation District, Rio Linda Elverta Recreation and Park District, Roseville Joint Union High School District, Sierra College, Sacramento County Board of Supervisors, Sacramento Urban Creeks Council, Sacramento Valley Open Space Conservancy, and U. S. Fish and Wildlife Service.

Friends of Deer Creek

John Vanderveen
132 Main St
Nevada City, CA 95959

Watershed: Yuba
Region: Central Sierra
County: Nevada

Phone: 530-265-6090 Fax: 530-265-3170 Email: friendsofdc@sbcglobal.net
Web: www.friendsofdeercreek.org

Description: Friends of Deer Creek (FoDC) is comprised of 50 volunteers doing water monitoring and 30-40 volunteers doing restoration. Stakeholders are land owners, businesses, public agencies and community members. Projects include monitoring, restoration, native plant restorations, storm drain measures of sediment load, and algal biomass measurements to resolve fish kills due to high water PH. FoDC was incorporated in September of 1999 by a small group of local citizens, out of a desire to protect this small creek nestled in the Sierra foothills. The group obtained Prop 204 funding early in 2000 to do baseline water quality monitoring, restore a segment of channelized creek, do storm water studies in Nevada City, and assist the local stakeholders in developing a Coordinated Resource Management Plan for the watershed. In 2003 FoDC was awarded a Prop 13 grant to continue its work. Under the new grant, sediment, algae, wetlands, and waste water will be studied and new restoration projects begun.

Friends of Squaw Creek

Ed Heneveld, Chairman
PO Box 2488
Olympic Valley, CA 96146

Watershed: Squaw Creek
Region: Tahoe
County: Placer

Phone: 530-583-1817 Fax: 530-583-1557 Email: heneveld@telis.org

Description: Friends of Squaw Creek (FOSC) is a grassroots organization in Squaw Valley comprised of landowners, businesses, jurisdictional agencies, and private citizens dedicated to enhancing the Squaw Creek watershed. FOSC's mission statement is to seek to provide a forum for facilitating and coordinating efforts to promote a naturally sustainable environment for the Squaw Creek watershed through education, communication, science, and community involvement. Goals of FOSC include promoting the creek's ecological system to perform its natural, physical, and biological function considering its uses and constraints. This will include improving communications within the community, improving fish and wildlife habitat, and educating the community on this watershed's ecology.

Kaweah-Tule Watershed Management Council

Cheryl Lane, Executive Director Tulare Co Farm Bureau
PO Box 748
Visalia, CA 93279

Watershed: Kaweah &Tule
Region: Southern Sierra
County: Tulare

Phone: 559-732-8301 Fax: 559-732-7029 Email: tcfb@tulcofb.org

Description: This is a collaborative of the farm bureau, building industry, pubic lands management, residents, conservation groups, local land trust, and the Tule Tribe. The group plans to reconvene after a year hiatus and hopes to hire a watershed coordinator. The organization has incorporated.

Little Chico Creek Watershed Group

Jean Hubbell, Co-founder
PO Box 9229
Chico, CA 95927-9229

Watershed: Upper Sacramento
Region: Northern Sierra
County: Butte, Glenn

Phone: 530-898-5684 Email: jhubbell@csuchico.edu
Web: www.buttecounty.net/waterandresource/watershed_groups.htm

Description: Little Chico Creek Watershed Group's (LCCWG) mission is to preserve, protect, restore and enhance the ecological integrity and economic vitality of the Little Chico Creek Watershed through the cooperative effort of private citizens and public agencies. We are a group of interested landowners, agency representatives and concerned citizens dedicated to the LCCWG mission. We pursue this mission by developing projects and studies that support it. A limited Existing Conditions Report with a stream survey, a fish survey, water quality data review and monitoring, land use and management plans review was completed in December 2002. A Steering Committee was formed in Fall 1998 and meets approximately twice per year. The meetings are open to the public.

Millerton Area Watershed Coalition

Steve Haze, Program Coordinator
PO Box 529
Prather, CA 93651

Watershed: San Joaquin
Region: Southern Sierra
County: Fresno and Madera

Phone: 559-855-5840 Fax: 559-855-3474 Email: sfcsteve@psnw.com
Web: http://www.sierrafoothill.org/watershed

Description: Since July 2002, the Millerton Area Watershed Coalition has been led by a Steering Committee representing landowners, residents and other stakeholders in the Millerton area of eastern Madera and Fresno counties. The group is operating under a grant from the CALFED Bay-Delta Program. The group is focused on the Millerton area watershed around the San Joaquin River in the foothills east of Fresno. This year the group will be conducting a comprehensive study of the watershed and will report back their findings to local government officials and CALFED at the end of 2003. This comprehensive assessment of the watershed will provide information to promote the protection and enhancement of the watershed including the economic and environmental well being of the communities within it and of the downstream users. State and Federal Agencies have taken on a non-regulatory role of providing technical resources as a part of the organization's watershed assessment program. Liaisons from the agencies have been appointed as members of a Technical Advisory Committee. The watershed encompasses the San Joaquin River drainage from Friant Dam for 26 miles up to Kerckhoff Dam.

Mono County Watershed Group

Greg Newbry, Senior Planner
PO Box 347
Mammoth Lakes, CA 93546

Watershed: Walker, Mono Basin, Owens
Region: Eastern Sierra
County: Mono

Phone: (760) 924-1811 Fax: 760-924-5458 Email: gnewbry@msn.com

Description: Mono County worked with the county Collaborative Planning Team (CPT) successfully and received two prop 13 grants enabling an effort towards the creation of watershed management plans. The CPT is an active body representing most of the state, federal and local agencies in Mono County. The purpose of the grants are to develop watershed management plans for three of the principal watersheds of Mono County: Upper Owens River Basin, Mono Basin and the West Walker basin. For each basin, the watershed management plans will be developed with input from a watershed council of landowners, agencies, and other local stakeholders, and will be based on an assessment of watershed conditions. The Group will also outline the role of a recently formed regional land trust, Eastern Sierra Land Trust, in watershed conservation and restoration (particularly as related to wetlands) within the basins and provide support for the land trust in this role.

Oakhurst River Parkway Partnership

Sandy Brinley, Human Resources Manager
PO Box 974
Oakhurst, CA 93544

Watershed: Merced
Region: Southern Sierra
County: Madera, Fresno

Phone: 559-683-7027 Fax: 559-683-0750 Email: sandyb@stcg.net

Description: The Oakhurst River Parkway is a 3 1/2 mile trail along three rivers in the Oakhurst basin. This is a volunteer, non profit organization developed to preserve the rivers in their Urban Area for future generations. They established Watchable Wildlife areas, provided river restoration and sponsored an annual River Clean-up Day. This is a grassroots organization with many community volunteers maintaining the project with fundraisers and donations. They received several grants for pedestrian bridges and river restoration. The community is proud of the Oakhurst River Parkway and in the new Madera County Area Plan for Oakhurst, a new land designation has been established to provide proper development along the river front area of the Fresno River.

South Fork American River Watershed Group

Mark Egbert
100 Forni Road #A
Placerville, CA 95667

Watershed: American
Region: Central Sierra
County: El Dorado

Phone: 530-295-5630 Fax: 530-295-5635 Email: Mark-Egbert@ca.nacdnet.org

The Georgetown Divide Resource Conservation District organized the first meeting of the South Fork American River Watershed Group (SFARWG) in November 2000 and the group continues to meet on a monthly basis. Participants represent a wide variety of interests including private landowners, government agencies, and non-profit organizations. The group's mission is to protect and improve the health and condition of the South Fork American River watershed through stewardship and education to a measurable extent. The group is working on a South Fork American River Watershed Stewardship Project to identify where specific on-the-ground projects in the watershed are needed to reduce the threat of catastrophic wildfire and to improve water quality of the South Fork American River. Under Proposition 204 funding the District has completed a "Watershed 2000" Program which achieved "on-the ground" restoration and protection of significant watershed areas in El Dorado County and increased community awareness and involvement with watershed issues. This project improved and protected portions of the North Fork Cosumnes River Watershed (NFCR), specifically within the subwatersheds of Camp Creek, Jenkinson Lake (a.k.a. Sly Park Reservoir), and Big Canyon Creek. Principle project components were the development of Community Defense Zones to protect watershed areas from the potential of catastrophic fire (2500+ acres to be treated), the closure and/or obliteration of secondary roads and trails (28+ linear miles), and public education programs.

Truckee River Watershed Council

Lisa Wallace, Executive Director
PO Box 8568
Truckee, CA 96162

Watershed: Truckee
Region: Tahoe Region
County: Placer

Phone: 530-550-8760 Fax: 530-550-8761 Email: lwallace@truckeeriverwc.org
Web: www.truckeeriverwc.org

Description: The Truckee River Watershed Council is composed of several different committees that each focus on different aspects of watershed restoration within the Middle Truckee River system. The focus of the Projects and Assessments Committee currently is the development of a coordinated watershed management strategy for the Middle Truckee River, identifying restoration projects throughout the watershed, and finding means of implementing restoration projects. The Truckee River Day Steering Committee focuses on putting on Truckee River Day, a one-day volunteer restoration effort that draws up to 800 participants. The Watershed Issues Forum provides a venue for informational presentations and discussions about local topics related to water quality and habitat. The Truckee River Aquatic Monitors collect benthic macroinvertebrates from local streams and identify the samples to assess water quality.

Upper Merced River Watershed Council

Holly Warner, Watershed Coordinator
P.O. Box 746
Mariposa, CA 95338

Watershed: Merced
Region: Southern Sierra
County: Mariposa

Phone: 209-966-2221 Fax: 209-221-2056 Email: watershed@sierratel.com
Web: www.sierratel.com/watershed

Description: The Upper Merced Watershed Council includes everyone who cares about the Merced River Watershed. Landowners, agency staff, outdoor enthusiasts, equestrians, and other interested citizens meet together to identify common concerns and carry out collaborative projects. Projects for 2003 include: Adoption of the South Fork Trail, Yellow Starthistle Removal in Merced Canyon, Educational Walks and Talks, and Citizen Water Monitoring.

Yuba Watershed Council

Lynn Campbell
132 Main Street
Nevada City, CA 95959

Watershed: Yuba and Bear
Region: Central Sierra
County: Nevada

Phone: 530-265-4860 Fax: 530-265-4860 Email: ywc@sbcglobal.net
Web: www.yubawatershedcouncil.org

Description: The Yuba Watershed Council works to protect the Yuba and Bear River watersheds and tributaries. The Yuba Watershed Council is a community forum of diverse stakeholders which is taking the initiative to: 1) Better appreciate the complex watershed relationships in the Yuba and Bear watersheds and their environments; 2) Protect, restore and enhance watershed resources where needed; and 3) Maintain a sustainable watershed resource base for future generations. Stakeholders include local, state, and federal agencies, conservation and environmental organizations, and neighborhood associations.

Appendix F: Annotated Bibliography

"Addressing the Need to Protect California's Watersheds: Working with Local Partnerships," Report to the Legislature as required by AB 2117, Chapter 735, Statutes of 2000, California Resources Agency and State Water Resources Control Board, April 2002.

> In November of 2000, State Secretary for Resources, Mary D. Nichols, and Chair of the State Water Resources Control Board, Art Baggett, began a study of watershed partnerships in California. The two agencies hired an expert consultant in watershed management, Dr. Sari Sommarstrom, to assist them in evaluating ten case studies of watershed partnerships. In August of 2001, Secretary Nichols and Chair Baggett formed the Joint Task Force on California Watershed Management, an interagency and stakeholder effort, to discuss the results of the ten case studies, to refine the findings, and to craft major recommendations to move the State in a new direction to protect and restore watersheds, lakes, rivers and estuaries in California. This report is the culminations of that study. The study was required by legislation signed by Governor Davis in September 2000 (AB 2117 (Wayne), Chapter 735, Statutes of 2000).

Associated Press, "Debate heats up about how to manage California's forests," November 26, 2001.

> This article discusses the debate in California about Sierra Pacific Industries' forest management plans and harvesting methods, including clearcutting. The article went out on the Associated Press Wire on November 26, 2001, and was accessed through the Forests.org archive on the organization's website at: www.forests.org.

"California in a warming world," *Santa Cruz Review* (Santa Cruz, CA: University of California, Santa Cruz, Summer 2001 – as viewed on the UC Santa Cruz website at: http://www.ucsc.edu/news_events/review/summer.01/CAwarming.html.)

> This article contains information on projections for average surface temperature increases over the next century and the likely impacts of such change on California. It looks specifically at one scientist, Lisa Sloan, associate professor of Earth sciences at University of California Santa Cruz, who is using regional computer modeling to address climate change on a more localized scale, rather than relying on global climate change models that address larger trends.

California Unified Watershed Assessment Factsheet, http://www.swrcb.calgov/watershed/wmi.

> In 1998, California developed an implemented the 1998 California Unified Watershed Assessment (UWA) in response to the Clean Water Action Plan released by President William Clinton and Vice-President Albert Gore on February 19, 1998. The UWA was a collaborative process between the State and the United States Environmental Protection Agency (USEPA) and was developed to guide allocation of new federal resources for watershed protection. Because the program has ended, additional information is not readily available.

California Water Facts (Sacramento, CA: Water Education Foundation, June 2002).

> This booklet, produced by the Water Education Foundation, was developed to help people identify the source of their water, realize the importance of water in a semi-arid state and understand the competition for our most precious resource. It contains information on precipitation, water use, water delivery, water projects, environmental protection alternative water sources, water trivia and water conservation tips.

"California Water Map" (Sacramento, CA: Water Education Foundation, 2001 [twelfth printing]).

> This poster presents a map of California's surface water system. It features natural and manmade water resources throughout the state, including the wild and scenic rivers system, the new Eastside and Los Vaqueros reservoirs and the Coastal Aqueduct, linking the central coast to the State Water Project. Water facilities are color-coded to indicate federal, state or locally-funded projects and the wild and scenic river systems. Map text explains the state, federal and local water projects; Bay-Delta issues; wild and scenic rivers; the Colorado River; and groundwater issues.

California Water Plan Update 2003 preliminary draft (June 20, 2003), California Department of Water Resources, as viewed on the California Department of Water Resource's website: www.water.ca.gov.

The Department of Water Resources has embarked on a fundamentally new approach, scope, and process for preparing the California Water Plan Update 2003 (Bulletin 160-03). The update will be California's plan or strategy to meet the State's future water needs, a useful reference and users' guide for water planners and decision makers, a living document integrating statewide and local planning initiatives, consistent with California Water Code requirements, and prepared with significant input from stakeholders. The 2003 update and previous updates can be viewed by visiting the California Water Plan web site at: www.WaterPlan.water.ca.gov.

Evoy, Barbara. "Status of Consolidated Request for Proposal," a presentation by Barbara Evoy, Chief, Division of Financial Assistance, State Water Resources Control Board, to the Inaugural California Watershed Council Meeting, Sacramento, CA, August 28, 2003.

This PowerPoint presentation, made by Barbara Evoy, Chief of the Division of Financial Assistance for the State Water Resources Control Board, at the August 28, 2003 Inaugural California Watershed Council Meeting, discussed the program goals, process and results of the first round of this year's Consolidated Grants Request for Proposals Program. This program, which resulted from legislative recommendations, is designed to consolidate the application and decision-making process for disbursing funding under California Resources Agency and California Environmental Protection Act's (CalEPA) competitive grant programs for watershed health (Proposition 13, Proposition 50, and Calfed funding).

Federal Power Act 16 U.S.C. 791-828c and its implementing regulations, 18 C.F.R. Parts 4 and 16.

The Federal Power Act (FPA) was adopted by Congress in 1920. It established the Federal Power Commission (FPC) as the regulatory agency for non-federal hydroelectric power production. As the FPC gradually took on responsibility for a wider range of national energy regulatory issues, it evolved into an independent federal agency called the Federal Energy Regulatory Commission (FERC). Today, FERC governs approximately 2,500 licenses for non-federal hydropower projects on both federal and non-federal lands. In 1935 and 1986, the FPA was amended in order to reflect issues arising with the growth of energy production in the United States. Most significantly for hydropower, the 1986 amendments require FERC to address concerns for fish and wildlife affected by hydroelectric facilities. These concerns must be given equal consideration when a hydropower project receives a new license. For more information on the Federal Power Act, visit the American Rivers website at: www.amrivers.org.

Gleick, Peter H. (Lead Author). *Water: The Potential Consequences of Climate Variability and Change for the Water Resources of the United States, The Report of the Water Sector Assessment Team of the National Assessment of the Potential Consequences of Climate Variability and Change* (Oakland, CA: U.S. Global Change Research Program, Pacific Institute for Studies in Development, Environment, and Security, September 2000).

The National Assessment of Potential Consequences of Climate Variability and Change for the United States (the "National Assessment") was designed to begin the complex process of assessing how to respond and adapt to an uncertain and changing climate. The National Assessment was called for by the 1990 Global Change Research Act (Public Law 101-6-6) and has been conducted under a plan approved by the National Science and Technology Council – the cabinet-level body of agencies responsible for scientific research in the U.S. government. The overall goal of the National Assessment is to analyze and evaluate what is known about the potential consequences of climate variability and change for the Nation in the context of other pressures on the public, the environment, and the Nation's resources. It is also addressing the question about why we should care about, and how we might effectively prepare for, climate variability and change.

Horton, Gary. *Carson River Chronology: A Chronological History of the Carson River and Related Water Issues* (Carson City, NV: Department of Conservation and Natural Resources, a publication in the Nevada Division of Water Planning's Nevada Water Basin Information and Chronology Series, April 1997 [First Update]) – as viewed on the Nevada Division of Water Planning's website: www.water.nv.gov.

This river chronology is intended to provide a background document and reference resource of the Carson River Basin. It is organized into several parts, including: (1) an introduction; (2) an overview of the basin and its geographic, hydrologic and socioeconomic characteristics; (3) a detailed chronology of the pre-twentieth century; (4) a detailed chronology of the twentieth century; (5) references; and (6) a river flow schematic diagram depicting important hydrologic features and U.S. Geological Survey stream flow gaging stations. The dates and happenings in this chronology represent our best knowledge of the sequence of important events pertaining to the Carson River Basin, the Carson River, the Carson River's East and West Forks and various tributaries, storage reservoirs, diversions, the Carson, Eagle and Dayton valleys, Lahontan Reservoir, Lahontan Valley and the Carson Sink and Desert, the Lahontan Valley wetlands, the Carson Lake and Pasture, the Newlands Irrigation Project, and related water supply, water quality and environmental issues.

Horton, Gary. *Truckee River Chronology: A Chronological History of Lake Tahoe and the Truckee River and Related Water Issues* (Carson City, NV: Nevada Division of Water Planning, Department of Conservation and Natural Resources, April 1997 [Seventh Update].

This river chronology is intended to provide a background document and reference resource of Lake Tahoe and the Truckee River Basins. It is organized into several parts, including: (1) an introduction; (2) an overview of the basin and its geographic, hydrologic and socioeconomic characteristics; (3) a detailed chronology of the pre-twentieth century; (4) a detailed chronology of the twentieth century; (5) references; and (6) river flow schematic diagrams depicting important hydrologic features and U.S. Geological Survey stream flow gaging stations of the Upper Truckee River Basin and the Lower Truckee River Basin. The dates and happenings in this chronology represent our best knowledge of the sequence of important events pertaining to the Truckee River Basin, Lake Tahoe and the Lake Tahoe Basin, the Truckee River, that river's tributaries, storage lakes, reservoirs, and diversions, Pyramid Lake, water diversions from the lower Truckee River at Derby Dam for the Newlands Irrigation Project, and related water supply, water quality, environmental and fishery issues.

Horton, Gary. *Walker River Chronology: A Chronological History of the Walker River and Related Water Issues* (Carson City, NV: Department of Conservation and Natural Resources, a publication in the Nevada Division of Water Planning's Nevada Water Basin Information and Chronology Series, June 1996 [Fourth Update]) – as viewed on the Nevada Division of Water Planning's website: www.water.nv.gov.

This river chronology is intended to provide a background document and reference resource of the Walker River Basin. It is organized into several parts, including: (1) an introduction; (2) an overview of the basin and its geographic, hydrologic and socioeconomic characteristics; (3) a detailed chronology of the pre-twentieth century; (4) a detailed chronology of the twentieth century; (5) references; and (6) a river flow schematic diagram depicting important hydrologic features and U.S. Geological Survey stream flow gaging stations. The dates and happenings in this chronology represent our best knowledge of the sequence of important events pertaining to the Walker River Basin, the Walker River, the East and West Walker rivers, and various tributaries, storage reservoirs and diversions, Walker Lake and related water supply, water quality and environmental issues.

Layperson's Guide to California Water (Sacramento, CA: Water Education Foundation, Updated 2000).

The Layperson's Guide to California Water is prepared and distributed by the Water Education Foundation as a public information tool. It is part of a series of guides which explore pertinent water issues in an objective, easy-to-understand manner. This guide contains information on the development of the state's water resources, the individual water projects in the state, flood management, groundwater, Delta issues, water quality, environmental issues and supply issues.

Leavenworth, Stuart. "Firm's stand changing on clear-cutting," *Sacramento Bee*, April 20, 2001.

This article addresses Sierra Pacific Industries' 100-year plan for managing its forest lands in California. The article, published on April 20, 2001, was accessed through the Sacramento Bee archives at the Bee's website: www.sacbee.com.

Miller, Norman L., Kathy E. Bashford, Eric Strem, 2001. "Climate Change Sensitivity Study of California Hydrology: A Report to the California Energy Commission," LBNL Technical Report No. 49110, November 2001 – as viewed in summary on NASA website at: http://www.gsfc.nasa.gov/topstory/20020117califclimate.html, January 17, 2002.

> In this study, Norman Miller and Kathy Bashford of Lawrence Berkeley National Laboratory and Eric Strem of the National Weather Service's California-Nevada River Forecast Center looked at two climate change scenarios projected out to the year 2100. Based on these scenarios, they determined how the smallest to largest expected changes in regional temperature and precipitation would affect streamflow throughout California. The two scenarios, both warmer and wetter than present day, were based on findings from the 2001 Intergovernmental Panel on Climate Change (IPCC) report. The report predicted temperature increases by as much as 9 degrees Fahrenheit with potential localized fluctuations in precipitation throughout the 21st century.

Nevada Natural Resources Status Report, "Water Resources & Supply." (Carson City, NV: Nevada Department of Conservation & Natural Resources, August 2002). [http://dcnr.nv.gov/nrp01/env02.htm]

> The Nevada Natural Resources Status Report was prepared by the Nevada Department of Conservation and Natural Resources as part of the agency's ongoing process to develop a Natural Resources Plan. The report gives a big picture view of the resources about which Nevadans care deeply: clean water and air; wildlife diversity; healthy aquatic, rangeland and forest ecosystems; outdoor recreation opportunities; and the natural beauty of wide-open desert and mountain wildlands. These are the essential elements of healthful, enjoyable, and productive communities. The focus of the report is the current state of these and other natural resources within the state.

Osugi, Doug. "Global Climate Change and the Sierra," a presentation by Doug Osugi, Supervising Engineer, California Department of Water Resources, at August 2003 Sierra Nevada Alliance annual conference in Arnold, CA.

> This PowerPoint presentation, made by Doug Osugi, Supervising Engineer with the California Department of Water Resources at the August 2003 Sierra Nevada Alliance annual conference, discusses the Department's policy on climate change, presents evidence of climate change, outlines climate change uncertainties, and identifies next steps for the State.

Planning for Prosperity: Building Successful Communities in the Sierra Nevada (Truckee, CA: Sierra Business Council, 1997).

> The Sierra Business Council (SBC) developed *Planning for Prosperity* to help communities plan wisely and effectively for their own future. The report includes chapters on: principles for sound development, principles for involving and serving business and the public, applying the principles with a landscape perspective, applying the principles in Placer County: A Case Study, findings and recommendations and conclusion. The report also contains the results of a voter survey as well as information on planning processes in the Sierra and suggested sources for more information.

"Planning Horizon for the General Plan," from *The California Planners' 2001 Book of Lists*, Governor's Office of Planning and Research at www.opr.ca.gov; and 68 "General Plan Status Maps," from the California Planners Information Network (CALPIN), http://www.calpin.ca.gov/.

> Each year, the Governor's Office of Planning and Research (OPR) conducts the Local Government Planning Survey to create a directory of California's planning agencies and to compile the latest information on local planning activities and special issues, which is published in the *California Planners' Book of Lists*. *The Book of Lists* contains practical information that is useful to local, regional, and state planners and resource managers, including directories of city and county planning agencies, Councils of Government, Local Agency Formation Commissions, CEQA judges, and selected State and federal agencies that interact with local planning agencies. It also contains a table summarizing the status of local general plans, including the dates these plans were last updated. Additionally, it identifies local jurisdictions that have adopted plans, programs, and ordinances that may serve as models or examples for other planning agencies.

"Proposed Ban on California Clearcuts Defeated, May Surface Again," *The Forestry Source* (Bethesda, MD: Society of American Foresters, Oct. 2000).

> This article addresses legislation proposed in 2000 by then-California Assembly member Fred Keeley to impose a moratorium on clearcutting in the Sierra Nevada for two years until a scientific panel could assess the environmental impacts of the forestry practice. The article first appeared in the October 2000 issue of *The Forestry Source* and was accessed through the Society of American Foresters' website at: www.safnet.org.

Roos, Maurice. "Possible Effects of Global Warming on California Water or More Worries for the Water Engineer," a presentation by Maurice Roos, Chief Hydrologist for the California Department of Water Resources, at July 2000 W.E.F. Water Law and Policy Briefing in San Diego, CA.

> This presentation, made by Maurice Roos, Chief Hydrologist for the California Department of Water Resources at the July 14, 2000 Water Education Foundation's Water Law and Policy Briefing in San Diego, discusses potential impacts of temperature change on water in the state. As Chief Hydrologist for the state, Roos also addresses the need to look at climate change, along with other factors, in decisions about water management and policy.

"Section 303(d) List of Water Quality Limited Segments," as viewed under "Surface Water – Monitoring/ Assessment" on the State Water Resources Control Board website at: www.swrcb.ca.gov/quality/html.

> Under Section 303(d) of the 1972 Clean Water Act, states, territories and authorized tribes are required to develop a list of water quality limited segments. These waters on the list do not meet water quality standards, even after point sources of pollution have installed the minimum required levels of pollution control technology. The law requires that these jurisdictions establish priority rankings for water on the lists and develop action plans, called Total Maximum Daily Loads (TMDL), to improve water quality. On July 25, 2003 USEPA gave final approval to California's 2002 Section 303(d) List of Water Quality Limited Segments. The list, broken down by State Water Resources Control Board Regions, identifies each segment by name and Calwater watershed number and contains information on the pollutant or stressors, potential sources, TMDL priority, estimated size of the area affected, and proposed TMDL completion date for each segment.

Sierra Nevada Ecosystem Project, Final Report to Congress, vol. I, Assessments and Scientific Basis for Management Options (Davis: University of California, Centers for Water and Wildland Resources, 1996).

> The Sierra Nevada Ecosystem Project (SNEP) study was conducted at the request of Congress (H.R. 5503) and was funded directly by congressional appropriation ((\$150,000) and by additional support (\$6.5 million) from the U.S. Department of Agriculture, Forest Service. The project was managed by the University of California Centers for Water and Wildland Resources under contract with the Forest Service Pacific Southwest Research Station. This volume offers a summary of the context for the study, the major findings from the assessments and case studies, and a presentation of alternative scenarios and their implications for the future health and sustainability of the ecosystem.
>
> Chapters cited:
> Chapter 2 – People and Resource Use
> Chapter 5 – Plants and Terrestrial Wildlife
> Chapter 8 – Watersheds and Aquatic Biodiversity

*Sierra Nevada Ecosystem Project, Final Report to Congress, vol. II, Assessment Summaries and Management Strategie*s (Davis: University of California, Centers for Water and Wildland Resources, 1996).

> This volume presents the detailed scientific assessments of historical, physical, biological, ecological, social, and institutional conditions in the Sierra Nevada, selected case studies, and details on the scientific bases of and methods used in scenarios compiled for the Sierra Nevada Ecosystem Project (SNEP). The chapters in volume II constitute, with few exceptions, assembly and evaluation of existing data from published and unpublished sources including expert opinion. Each chapter is authored and was prepared in response to direction from the science team and steering committee of SNEP.
>
> Chapters cited:
> Chapter 11 – Human Settlement, 1850-2040, Timothy P. Duane
> Chapter 19 – Recreation in the Sierra, Timothy P. Duane
> Chapter 30 – Hydrology and Water Resources, Richard Kattelmann
> Chapter 34 – Biotic Integrity of Watersheds, Peter B. Moyle, Paul J. Randall
> Chapter 57 – Potential Aquatic Diversity Management Areas, Peter B. Moyle

Sierra Nevada Ecosystem Project, Final Report to Congress, vol. III, Assessments, Commissioned Reports, and Background Information (Davis: University of California, Centers for Water and Wildland Resources, 1996).

Volume III presents commissioned background reports, reports received too late for inclusion in volume II, and other supplementary materials.

Chapter cited:
Chapter 23 – Economic Assessment of the Ecosystem, William C. Stewart

"Sierra Nevada Population Growth By County" (Source: 2000 U.S. Census), http://quickfacts.census.gov/qfd/states/06000.html.

QuickFacts provides quick, easy access to facts about people, business, and geography, based on the Census 2000 results. QuickFacts tables are summary profiles showing frequently requested data items from various Census Bureau programs. Profiles are available at the national, state, and county level. The data presented by QuickFacts is chosen to answer questions people frequently ask and also to demonstrate the wide variety of data available.

Sierra Nevada Resource Investment Needs Assessment (Truckee, CA: Sierra Nevada Conservancy Working Group and Sierra Business Council, July 2002).

The Sierra Nevada is a resource of regional, statewide, national and even global significance. However, as documented in various studies, this magnificent mountain region's unique resource values are undergoing rapid change. This *Sierra Nevada Resource Investment Needs Assessment* attempts to provide a starting point for assessing future investment to ensure the sustainability of key Sierra resources that are important to the region and to the state as a whole. The objective of this assessment is to: describe the Sierra Nevada's regional and statewide significance; identify forces that are causing change in the Sierra; discuss challenges and opportunities presented by these forces regarding protection of the Sierra's significant resources; and present ideas for conservation ,economic development and other investment programs and projects the state could support to help maintain the Sierra's key resources and, therefore, support the local and statewide communities that rely on those resources. The report also includes a list of 100 sample projects to illustrate the resource investment needs and type of work that could benefit from additional State support within the Sierra region.

Sierra Nevada Wealth Index: Understanding and Tracking Our Region's Wealth (Truckee, CA: Sierra Business Council, 1999-2000 Edition).

The Sierra Business Council (SBC) developed the *Sierra Nevada Wealth Index* to help business leaders and policy makers understand the assets that sustain our region. The Index describes the social, natural and financial capital which are the foundation of the Sierra Nevada's economy and thereby provides an integrated understanding of our region's wealth. The 1999-2000 edition of the *Sierra Nevada Wealth Index* is a refinement of the first edition published in 1996. The 1999-2000 edition includes a number of new indicators, more detailed data and analysis for each of the counties in our region, and many other changes in content and format which enhance the usefulness and quality of the publication.

Watt, Terry and Bob Johnston. "Smart General Planning: How To," a presentation by Terry Watt, Principal of Terrell Planning Associates, and Bob Johnston, Professor, University of California, Davis, at August 2003 Sierra Nevada Alliance annual conference in Arnold, CA.

This presentation, made by Terry Watt, principal of Terrell Planning Associates, and Bob Johnston, professor at the University of California Davis, at the August 2000 annual conference of the Sierra Nevada Alliance, addresses the basic elements of general plans in California, sample policies representing good planning, and recommendations for how citizens can get involved in the general planning process in their counties, cities or regional areas.

Wilkinson, Robert. *The Potential Consequences of Climate Variability and Change for California: A Report of the California Regional Assessment Group for the U.S. Global Change Research Program*, sponsored by the National Science Foundation (Santa Barbara, CA: University of California, Santa Barbara, September 2002).

> This assessment of the potential impacts of climate change and variability is a work in progress. It builds on important scientific research and analysis conducted over the past several decades which provides a valuable basis for the ongoing assessment. In addition to the outstanding university research institutions, national laboratories, and other research centers in the state, federal and state agencies have contributed significantly to our understanding of climate change and related topics. The information provided here is not intended to be an exhaustive compilation of all climate research, nor is it a comprehensive listing of all the possible consequences of climate change on California. Rather, it is an overview of potential implications of climate change for this important region, and a summary of what may be in store in the next century – based on what we know at this moment in time. These sketches will no doubt change as we learn more about the complicated nature of global climate and of the systems they impact.