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Economic Assessment of the Ecosystem

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ABSTRACT

The Sierra Nevada region has supported a wide range of economic activities for more than 150 years. Timber harvesting, grazing, irrigated agriculture, and mineral extraction have occurred continuously since the Gold Rush of 1849. And even more significant from an economic viewpoint than these, is the extensive development of the streams and rivers of the Sierra Nevada-for hydropower, large irrigation project, and municipal water uses. Every human activity in the Sierra Nevada entails some degree of environmental alteration in the course of utilizing resources for individuals and business enterprises. The following economic assessment uses two complementary approaches to assess the human utilization of the Sierra Nevada ecosystem The first assesses the status of the regional economy based on employment and business enterprises. The second assesses the major resource-based sectors that directly impact the ecosystem.

The distribution of Sierran jobs between commodity-producing jobs and service- producing jobs) is the same now as it was in 1970. Diversification has occurred within each sector, the number of jobs has more than doubled, but the relative proportion of commodity and service jobs stayed constant. Recreation, timber, and agriculture are the three largest types of employment sectors directly dependent on the ecosystem From the perspective of gross revenues generated from natural resources, water is the most valuable commodity, followed by timber, livestock, and other agricultural products. Based on estimates of direct resource values as one input (not the total revenue produced by resource dependent activities), the Sierra Nevada ecosystem produces approximately $2.2 billion worth of commodities and services annually. Water accounts for more than 60% of that total value. Other commodities account for 20% as do services.

Public timber and private recreation are the largest net contributors of funds to county governments both in total dollars and as a percentage of their total value. Around 2% of all resource values are presently captured and reinvested into the ecosystem or local communities through taxation or revenue sharing arrangements. The declining status of some aspects of the Sierra Nevada ecosystem suggests that this level of reinvestment is insufficient to ensure sustainable utilization of the ecosystem.

The patterns of employment, commodity production, and services directly dependent on the Sierra Nevada ecosystem vary greatly across the range. Regions defined either by economic linkages or major vegetative types exhibit unique economic-ecosystem linkages. These variations complicate the application of many range-wide strategies but also create the basis for future opportunities involving the many stakeholders. The flow of economic values from the Sierra Nevada provides an empirical basis for assessing how different levels of government; producers and consumers; and employers and employees could be involved in new approaches.

Keywords (Economic Development; Federal lands; Forests and forestlands; Hydropower; Labor; Recreation; Resource Economics; Water Runoff; Wood and wood products)

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CHAPTER 1: INTRODUCTION TO THE ECONOMIC ASSESSMENT

The Sierra Nevada region has supported a wide range of economic activities for more than 150 years. Timber harvesting, grazing, irrigated agriculture, and mineral extraction have occurred continuously since the Gold Rush of 1849. And even more significant from an economic viewpoint than these, is the extensive development of the streams and rivers of the Sierra Nevada—for hydropower, large irrigation projects, and municipal water uses. The Sierra Nevada also supports an enormous amount of recreational activities ranging from developed recreational sites such as downhill ski resorts to millions of acres of wilderness. Over the past twenty five years, a considerable portion of the private land in the region has been converted from forests and ranches into residential areas for the roughly 300,000 people who have moved into the Sierra Nevada.

Every human activity in the Sierra Nevada entails some degree of environmental alteration in the course of utilizing resources for individuals and business enterprises. Many aspects of the ecosystem have exhibited considerable resiliency and recovery throughout the century and a half of widespread and often intensive resource use. Other aspects, however, have exhibited significant decline with minimal recovery. The goal of this assessment is to provide a common framework for assessing the major economic benefits and costs of existing uses of the Sierra Nevada. This allows for a more informed basis upon which future policies can be made.

The following economic assessment uses two complementary approaches to assess the human utilization of the Sierra Nevada ecosystem. The first assesses the status of the regional economy based on employment and business enterprises. The second assesses the major resource-based sectors that directly impacts the ecosystem.

The regional economic analysis (Chapter 2) is based on Census, employment, and business activity data sources collected at federal and state levels. The data are typically disaggregated to county and sometimes sub-county levels. Chapters 3 , 4 and 5 are devoted to assessing the major commodities and services directly based on the Sierra Nevada ecosystem. The major commodities are water, timber, forage, and other irrigated agriculture. In addition, estimates of the economic value of the ecosystem to the recreation industry and to local residences are presented. These two sectors are dealt with in greater detail elsewhere in the SNEP report (Duane 1996-a and 1996-b), but their inclusion here allows for direct comparison to the resource-based economic sectors. Many of the financial implications of resource use show up at the county level through a range of taxation and revenue sharing arrangements. These effects are the subject of Chapter 6. The concluding chapter provides an overview of the economic and financial trends of the various resource sectors.

Wherever possible we have tried to differentiate the direct value of an individual resource from the larger industry in which it is used. Timber stumpage values, forage values and the estimated value of the right to divert water are all lower than the final value of the wood products, livestock and agricultural crops to which they contribute. For recreational and residential-open space services, a 'rent' to the ecosystem of ten percent of total revenue was used.

For some resources such as timber stumpage, the value of the right to harvest specific commodities is set through open market bidding and accurately monitored for tax collection purposes. For resources such as private forage that are often used inside of integrated operations or bundled with other values, the value is based on the available rental rates or government estimates of value. The value of water rights are the most difficult to value because so few water rights are sold separately in California. Estimates are based on prices paid for alternative supplies such as pumped ground water for agriculture and municipal uses, and other sources of wholesale electricity for hydroelectric production. The value of non-consumptive uses accruing to recreationists, tourists, and new residents are always bundled with other benefits and have few direct market equivalencies. The lack of Sierra Nevada-specific willingness to pay (WTP) or contingent valuation methodology (CVM) studies required us to

estimate the values of these non-market uses as a fraction of total revenues, wages or taxes. No attempt was made to place a monetary value on the preservation and protection of ecosystems, species or any other aspect of biodiversity.

Resource Ownership and Management in the Sierra Nevada

The land base of the SNEP region is roughly two thirds federal and one third private. The total asset value of the Sierra Nevada is considerably less biased towards federal control than land ownership would suggest. For one, water rights are primarily controlled by private interests and all ownerships (including federal) are governed by state water law. Additionally, most improvements to residential, commercial, and agricultural lands are privately financed.

In addition to different rationales for setting prices and fees for different resources, the state and federal government take very different approaches to achieve similar goals. The state of California owns very little land within the Sierra Nevada. In most cases the state uses a regulatory framework while the federal government uses a planning framework to implement essentially comparable sets of laws developed to address social concerns and ensure long term ecological health of ecosystems. The two approaches have very different costs and levels of assurance that the overall goals will be met. In most cases the impact of state and federal approaches overlap because ecosystems rarely follow jurisdictional boundaries.

Aggregate analysis for the 20 million acre study area, or even the one to five million acre regions masks variations in local asset values of the Sierra Nevada. In many cases, 50% of a single resource value occurs on 10% or less of the total area. Broad scale resource based policies may be too strong in many areas but too weak in the most important 10% of the cases. Aggregate economic analysis can mask many of the public/private, state/federal, and regional/local variations that occur in a region the size of the Sierra Nevada. Regional assessments based on county groupings or ecological regions are presented where possible to allow for region-specific analyses of conditions and trends.

CHAPTER 2: REGIONAL ECONOMY OF THE SIERRA NEVADA

The following analysis of the regional economy of the Sierra Nevada and the diverse character of regions is based primarily on analyses of personal income, employment, and the types of firms operating within the Sierra Nevada. Long term trends are addressed through economic data aggregated at the county level. More detailed analyses of regions are based on community-level aggregations developed from economic data in the 1990 Census.

Many counties in the Sierra Nevada stretch from the Central Valley to the Sierra crest. Population in most counties is concentrated along the western foothills and in a few towns on the east side of the Sierra Nevada crest. National Forest and National Parks dominate land ownership in all parts of the Sierra Nevada except the western foothill region. Large cities such as Sacramento, Reno, and Fresno provide employment opportunities for Sierra Nevada residents willing to commute out of the region. The population of the Sierra Nevada has been grouped into 180 community aggregations for the SNEP assessment (Doak and Kusel 1996). These aggregations closely conform to the 160 unique ZIP codes used by the US Postal Service. Relatively long work commutes throughout the Sierra Nevada (average travel time ranges between 20 and 29 minutes most regions) and relatively high rates of residential mobility (more than one third of residents in 1990 have arrived in their county within the last five years) suggest that the many residents look beyond their local community for employment. The 180 community groupings are then combined in two complementary types of regions. The first is based on county boundaries, transportation networks and major urban centers. The second is based on three major vegetation zones—woodlands (foothill), conifer forests (Western Sierra Nevada), and the drier east side forests and shrublands (Eastern Sierra Nevada). Regional groupings of communities provide a more realistic view of the range of economic opportunities than individual community analyses. The major geographic attributes and the regional groupings are illustrated in the three maps below.

Total personal income rather than money income is used to address the growth non-wage income sources that now constitute more than half of all of personal income in the Sierra Nevada. The money income data reported by the Census significantly undercounts non-wage income as calculated by the Bureau of Economic Analysis (CCSCE 1996). In this analysis, the undercounting is corrected by allocating non-wage income to community level aggregations based on a linear transformation of the Census data. Most of the differences involves how non-interest based financial income and government-supplied health care are addressed. The Census methodology excludes these types of personal income such as Medicare because they do not involve direct cash payments. The Bureau of Economic Analysis reports personal income at a greater levels of aggregation and uses actual financial records and the full costs of government programs to calculate total personal income. The use of county level relationships on community aggregations may create errors for communities with very low and very high incomes. Employment data from the Census is used along with monthly employment data aggregated at the county level. Census employment data will overestimate the relative importance of part-time and seasonal employment because no correction is made for the number of hours per week or months per year the person is employed.

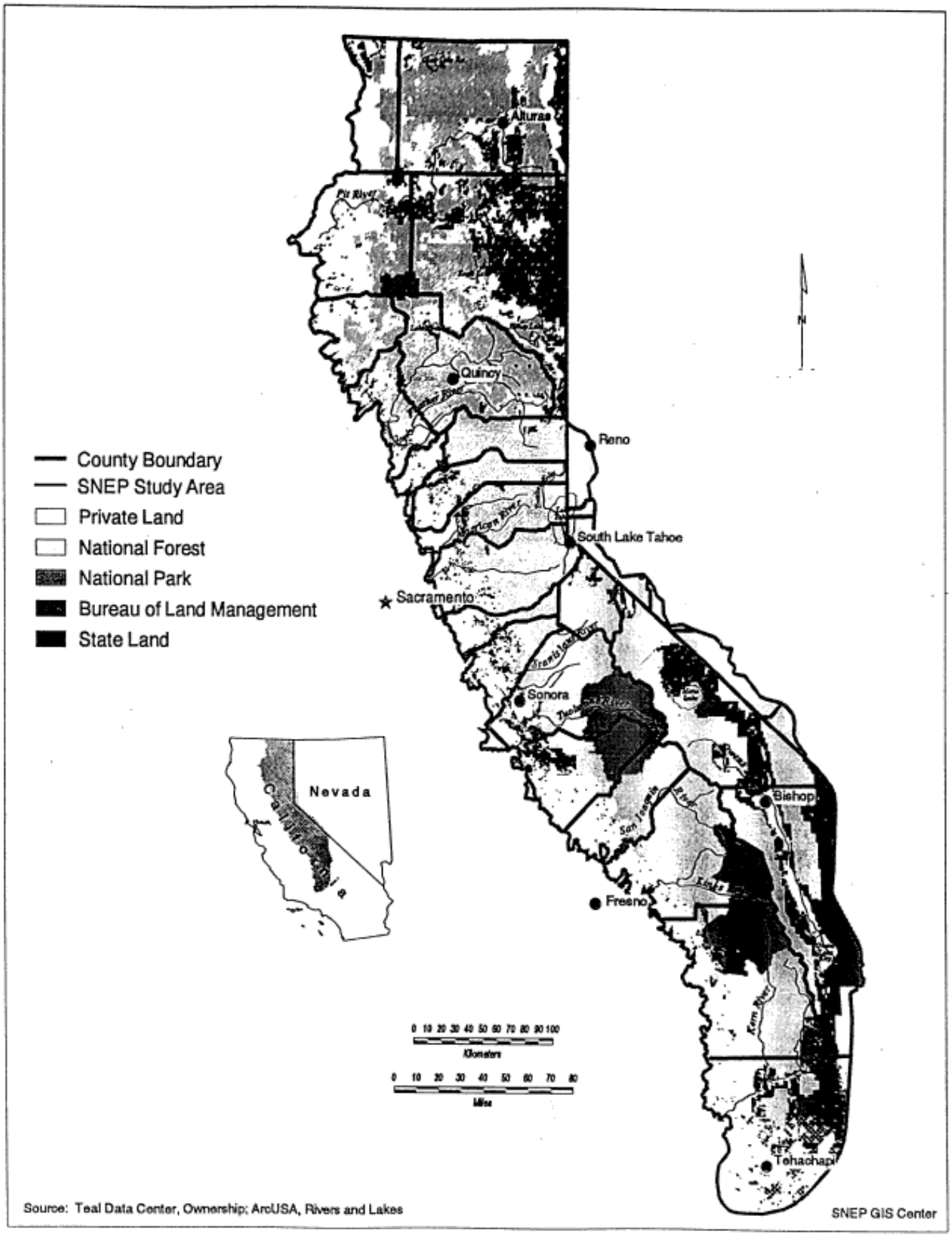

County Boundary
SNEP Study Area
Private Land
National Forest
National Park
Bureau of Land Management
State Land
Alturas
Quincy
Reno
South Lake Tahoe
Sacramento
Sonora
Bishop
Fresno
Tehachapi
Nevada
California
Kern River
0 10 20 30 40 50 60 70 80 90 100
Kilometers
0 10 20 30 40 50 60 70 80
Miles
Source: Teal Data Center, Ownership; ArcUSA, Rivers and Lakes
SNEP GIS Center

Figure 2.1

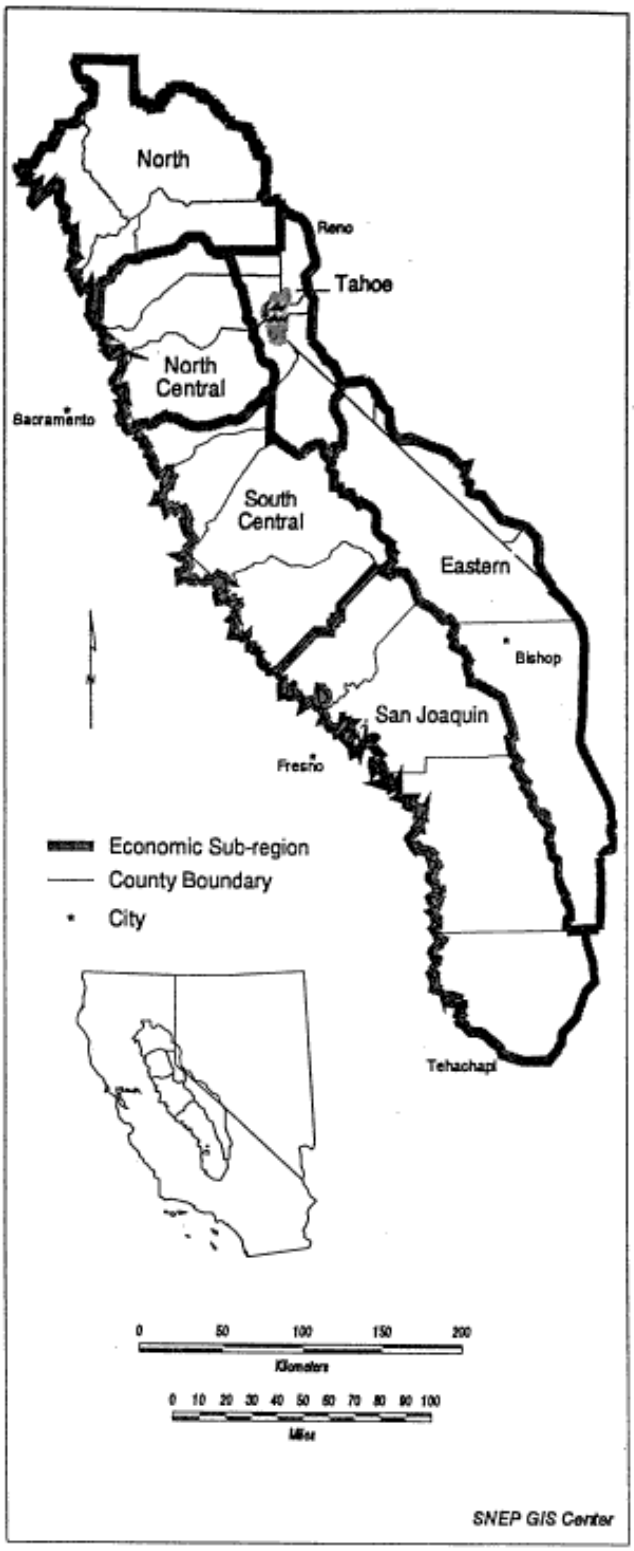

North
Reno
Tahoe
North Central
Sacramento
South Central
Eastern
Bishop
San Joaquin
Fresno
Tehachapi
Economic Sub-region
County Boundary
City
0 50 100 150 200
Kilometers
0 10 20 30 40 50 60 70 80 90 100
Miles
SNEP GIS Center

Figure 2.2

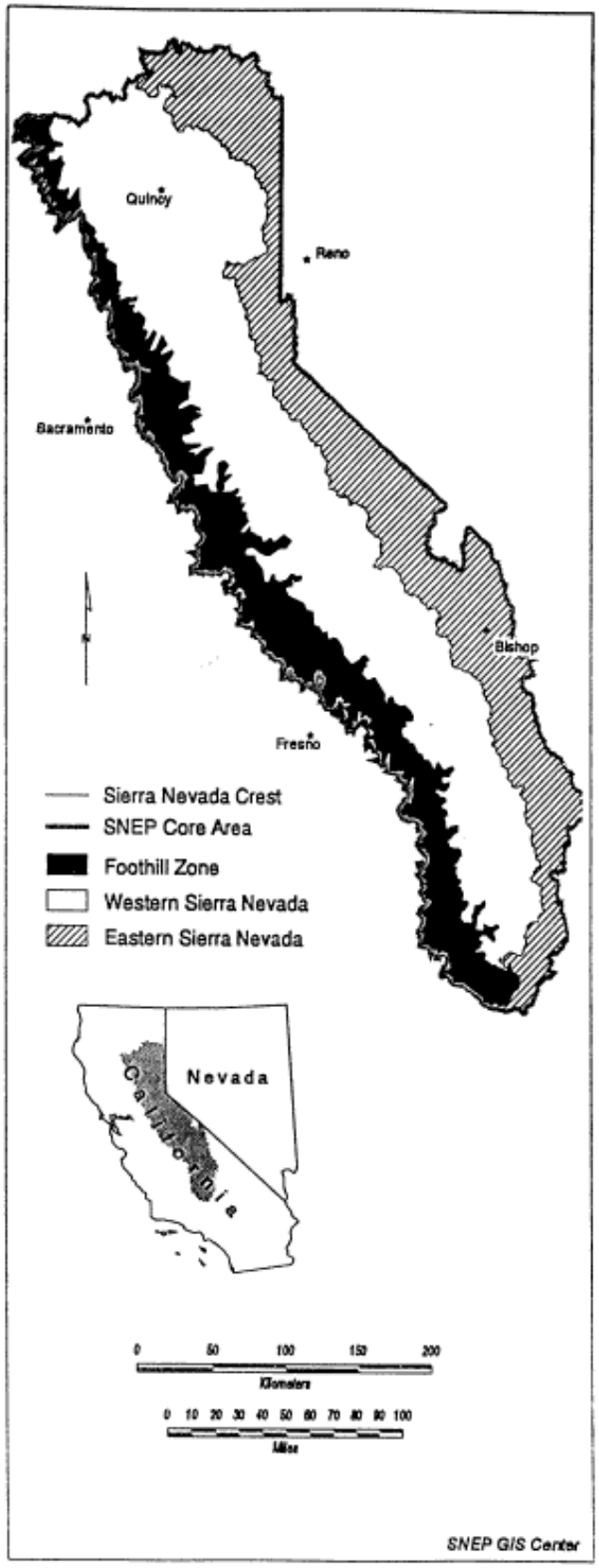

Quincy
Reno
Sacramento
Bishop
Fresno
Sierra Nevada Crest
SNEP Core Area
Foothill Zone
Western Sierra Nevada
Eastern Sierra Nevada
Nevada
California
0 50 100 150 200
Kilometers
0 10 20 30 40 50 60 70 80 90 100
Miles
SNEP GIS Center

Figure 2.3

Employment Patterns in Regions of the Sierra Nevada

The size and diversity of the Sierra Nevada requires regional analyses to complement Sierra-wide analysis. Six economic regions and three vegetative regions are when Census data are available. When county level data are used, the regional analysis must follow slightly different boundaries. The following table summarizes which counties are in economic regions.

Table 2.1: Counties and Economic Regions for Census-Based Analyses

Economic Region	Counties Fully Within Region	Counties Mainly Within Region	Counties Partly Within Region
North	Plumas, Sierra		Lassen, Butte, Yuba
North Central	Nevada, El Dorado	Placer	
Greater Tahoe	Alpine		Nevada, Placer, El Dorado, Douglas, Washoe
South Central	Amador, Calaveras, Tuolumne, Mariposa		
San Joaquin			Madera, Fresno, Tulare, Kern
East Side	Mono	Inyo	

The Greater Tahoe region is used when the community level data from the 1990 Census is available. Greater Tahoe includes portions of counties in the Tahoe Basin and Truckee River watershed, the Lake Tahoe shoreline communities in Nevada, and sparsely populated Alpine county. This region is separated because of the overwhelming influence of recreation and tourism and its difference from the western portions of the counties. When only county level data is available, the Nevada, Placer, and El Dorado county portions of the Greater Tahoe region are included in the North Central group. The South Central region includes Amador, Calaveras, Tuolumne and Mariposa counties. The San Joaquin region includes the Sierra Nevada portion of four populous counties—Madera, Fresno, Tulare, and Kern—that all have county seats in the San Joaquin Valley. These four counties are excluded when county level data analysis is conducted because 95% of the total population of these counties live in the San Joaquin Valley. All of Mono county and the Owens Valley portion of Inyo county make up the Eastern region. Alpine county is included in the East Side when only county level data is available.

In addition to the county based analysis, another analysis was conducted by grouping communities into three major vegetative regions. This allows for a more detailed analysis of the link between the ecosystems and economic condition. The foothill region includes communities from the Central Valley up to the start of the mixed conifer forests around the 3,000 foot elevation. The forest region includes all the communities within the mixed conifer and higher altitude forests on the west side of the Sierra Nevada. The thinly populated east side of the Plumas county is also included in the forest region. This is the largest region in size but has few residents because most of the land is federally owned. Finally, the Greater Tahoe region is combined with the East Side to form the Eastern vegetative region.

The following table summarizes the population distribution among the different regions based on the community aggregations. In every western region, most people live in the foothill rather than the forest region. This is even true in the North economic region because where the population in communities in the foothill portions of Yuba and Butte county outnumber the total population of the much larger Plumas and Sierra counties. This decreases the relative importance of forest related

ecosystem employment and revenue compared to the larger economy of the Sacramento and San Joaquin Valleys.

Table 2.2: Population of Total SNEP Area by Economic and Vegetative Regions

Region	Foothill	Forest	Eastern	Total	Pct of Total
North	84,000	44,000		128,000	20%
North Central	193,000	29,000		222,000	34%
South Central	98,000	30,000		128,000	20%
San Joaquin	68,000	9,000		77,000	12%
Greater Lake Tahoe			63,000	63,000	10%
East			28,000	28,000	4%
Total	443,000	112,000	91,000	646,000	
Pct. of Total	69%	17%	14%		

In many cases, data are only available on a county basis. In these circumstances, the regions include only the twelve counties where all or nearly all the population lives in the geographically defined Sierra Nevada region. Portions of Lassen, Butte, Yuba, Madera, Fresno, Tulare, and Kern counties in California; and Washoe and Douglas counties in Nevada are left out because more than 90% of the population lives outside of the SNEP region. The total population and counties within each county-based region are shown in Table 2.3.

Table 2.3: Population and Counties within County-Based Regions

County-based Region	1990 Population	Counties
North	23,300	Plumas, Sierra
North Central	383,400	Nevada, Placer, El Dorado
South Central	126,600	Amador, Calaveras, Tuolumne, Mariposa
East	29,700	Alpine, Mono, Inyo
Total	563,000	

Trends in Personal Income

Personal income levels across the Sierra Nevada have been far below state levels for decades. Over the past fifteen years personal incomes in the Sierra Nevada have followed two different patterns. Per capita income in the North Central region have rapidly approached the state levels while all other regions have remained at 80% of state levels. Placer county is now the only inland county in the state where personal income levels are above state levels (CCSCE 1996).

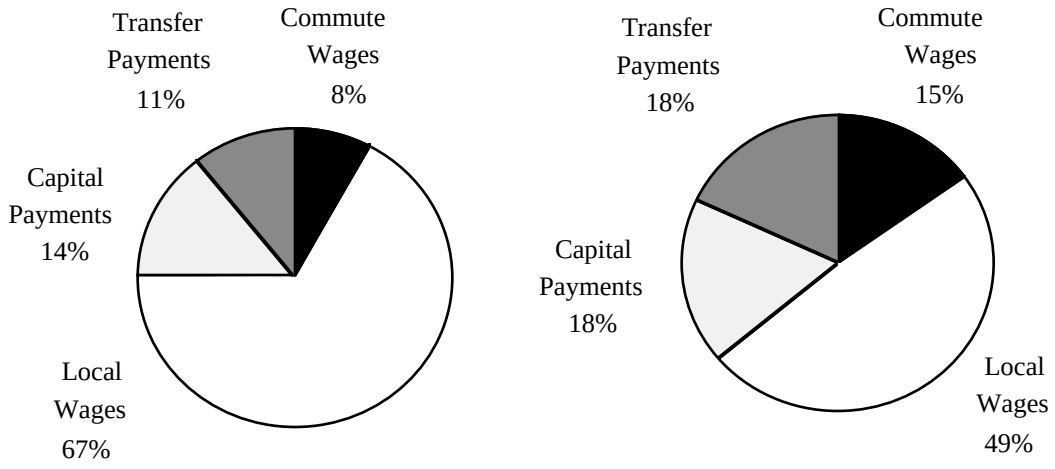
Table 2.4: Per Capita Incomes in Constant 1995 Dollars

Region	1980	1990	1995
California	$21,524	$23,675	$23,058
North	$17,166	$18,629	$18,767
North Central	$19,374	$22,932	$22,675
South Central	$16,870	$18,035	$17,751
East	$18,773	$19,978	$19,886

Source: CCSCE (1996); 1980 and 1990 are from Bureau of Economic Analysis; 1995 is CCSCE projection from 1993 data.

The composition of personal income in all counties has shifted away from local wage income because of relatively faster growth of commute wages, interest and dividends, and government transfer payments. The overall share of total personal income from local wages dropped from 67% in 1972 to 49% in 1992. A significant implication of this trend is that the local economic conditions are now less related to local economic conditions and more related to national and state economic conditions than they were twenty years ago. This shift has provided economic stability to the region where local employment sectors such as seasonal recreation and commodity production are highly variable. The major difference at a regional level is the importance of commute-based wages in the North Central region compared to the rest of the Sierra Nevada. In the early 1990s, commute-based wages constitute more than 30% of all wages in the North Central counties but less than 5% of all wages elsewhere in the Sierra Nevada.

Figure 2.4: Composition of Personal Income in the Sierra Nevada 1972 and 1992



Employment Patterns By Region

In addition to the changes in the overall sources of personal income, the types of jobs have also changed. The following table compares employment patterns from the 1970 and 1990 Census for the twelve counties fully within the SNEP boundary. The relative proportion of goods-producing and service-producing jobs remained constant over twenty years for the Sierra Nevada as a whole. Within the goods-producing sectors, agricultural and mining employment dropped and manufacturing employment increased. The most noticeable change in service-producing employment was a reduction in public administration employment (law enforcement, land management, environmental and programs) and an increase in high-wage service jobs in areas such as health, business, and legal services.

Table 2.5: Relative Size of Goods-Producing And Service-Producing Sectors
Remained Constant for Past 20 Years, 1970-1990

	Goods Producing				Service Producing			
Region 1970	Agr. & Mining	Manu-facturing	Const-ruction	Total Goods Producing	High Wage	Low Wage	Public Admin.	Total Service Producing
North	8%	19%	5%	32%	39%	24%	5%	68%
North Central	5%	9%	8%	22%	34%	34%	10%	78%
South Central	8%	13%	10%	31%	30%	28%	10%	68%
East	13%	4%	11%	28%	29%	36%	7%	72%
Total	7%	10%	9%	26%	33%	32%	10%	75%
	Goods Producing				Service Producing			
Region 1990	Agr. & Mining	Manu-facturing	Const-ruction	Total Goods Producing	High. Wage	Low Wage	Public Admin.	Total Service Producing
North	8%	14%	10%	32%	36%	27%	4%	67%
North Central	3%	13%	9%	25%	37%	32%	6%	75%
South Central	6%	11%	11%	27%	33%	31%	7%	71%
East	7%	3%	10%	20%	32%	37%	9%	78%
Total	4%	12%	10%	26%	36%	32%	6%	75%

Source: 1970 and 1990 Census.
Notes: Percentages may not add to 100 due to rounding. Census defined occupations are not adjusted for seasonal employment and will overstate the percentage of jobs in seasonal occupations.
Definition of Service Jobs: High Wage Service Jobs: Health, education, legal, finance, professional business services, transportation, communications. Low Wage Service Jobs: Retail, lodging, entertainment, business repairs.
Public Administration: Justice, police, prisons, environmental quality, housing.

The following table present the employment patterns for the whole SNEP region rather than just the counties mainly within the Sierra Nevada. Timber industry employment is separated out of total manufacturing employment with the use of county employment data. The local service sector includes many different job types with few jobs directly related to the ecosystem.

Table 2.6 : Major employment sectors - 1990

	Number of Workers	Local Services	Timber	Agr. & Mining	Travel	Public Admin.	Non timber Manuf.	Construction
Total	260,000	59%	4%	5%	8%	7%	6%	11%
North	44,000	61%	4%	6%	5%	8%	7%	9%
North Central	93,000	61%	3%	3%	5%	7%	9%	12%
South Central	46,000	57%	3%	6%	7%	8%	9%	11%
San Joaquin	29,000	58%	9%	7%	6%	9%	0%	10%
Greater Tahoe	35,000	51%	0%	2%	31%	4%	4%	9%
East Side	13,000	59%	0%	8%	13%	7%	3%	10%
Foothill	169,000	59%	3%	6%	5%	7%	8%	12%
Conifer	44,000	56%	8%	8%	8%	9%	2%	9%
Tahoe & East Side	48,000	53%	0%	6%	21%	6%	3%	11%

Source: 1990 Census and Employment Development Department.

Notes: Local Services - health, education, professional services, wholesale and retail trade, transportation, communications and public utilities; Timber - private sector employment in logging, sawmilling and remanufacturing. Private foresters and tree planters can not be separated from the larger agricultural category. USFS employees working on timber programs are included under Public Administration; Agriculture & Mining - agriculture is dominated by ranching, followed by irrigated agriculture and mining; Travel- hotels, motels, and recreational establishments; Public Administration: justice, police, prisons, environmental quality, housing; Non-timber manufacturing - electronics, metal fabrication, printing, food processing; Construction - residential and commercial construction.

Basic Income Analysis of Local and Regional Economies

One of the methods used to assess local economies is the economic base model based on the concept that economies can be understood by analyzing the amount of revenue coming into a region and how often it is spent and respent locally. The central assumption of the economic base model is tha all local income depends directly on basic money brought in via three sources. The first is wages associated with selling goods or services to residents or businesses outside the local economy. Basic wages account for less than a third of all local wages in Sierra Nevada communities. The second is the transfer of capital payments such as interest and dividends from the national economy to local households. And the third is the various types of government transfer payments including social security, medicare, and welfare. While economic base models can not produce the industry specific analyses available with IMPLAN or other regional input-output models, they can produce analyses for areas smaller than counties with publicly available data on personal income and employment. Many economic base models use only employment data and neglect the large and fast growing sources on income from capital payments (interest, dividends and rental income) as well as transfer payments (both cash payments and services). The difference between the money income of the Census and the total personal income used by the Bureau of Economic Analysis produces an even larger difference in the estimate of basic income because a significant portion of both capital payments and transfer payments are not recorded as money income. The following table illustrates the difference in the composition of basic income according to the more comprehensive BEA accounting methodolgy and the method used for the 1990 Census. The Department of Commerce will use the BEA methodolgy for the next Census to address the present inaccuracies. The more inclusive personal income method is used in this economic assessment and accentuates the relative importance of capital and transfer payments. The more detailed analysis of basic wages complements the total personal income analysis and should not be used as an alternative method of assessing the driving economic forces for local economies.

Table 2.7: Percentage of Basic Income by Bureau of Economic Analysis and Census Methodologies

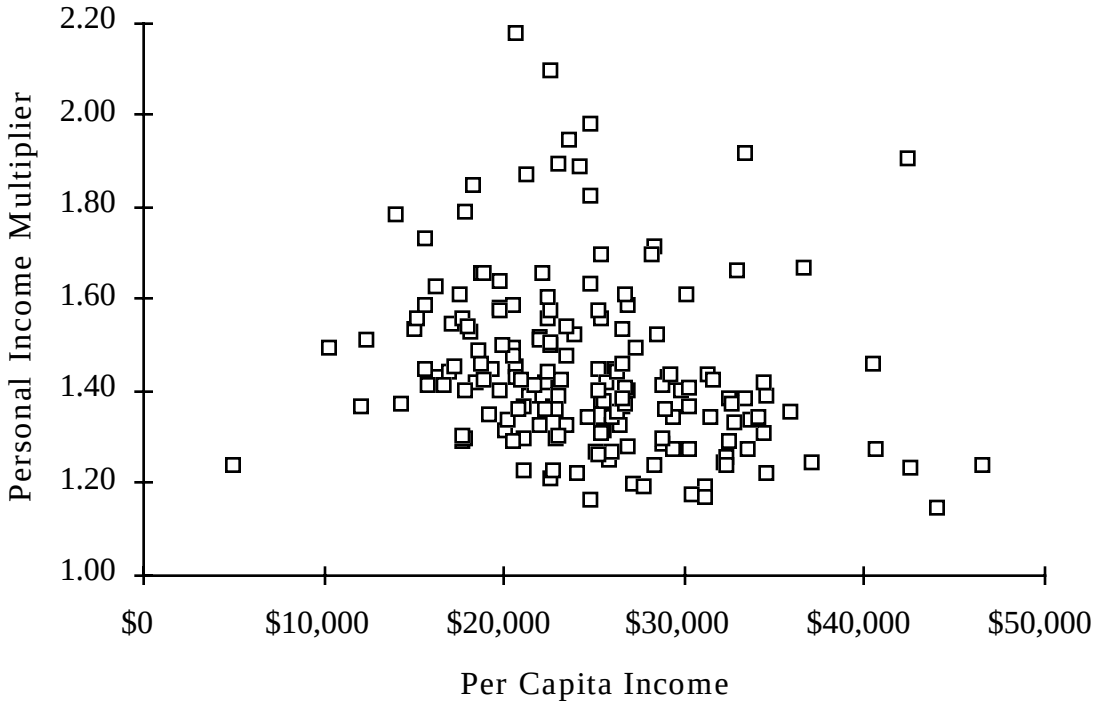
Income Source	BEA	Census
Wages	23%	40%
Capital Payments	64%	46%
Transfer Payments	13%	14%
Basic Income / Total Income	71%	58%

Regional Variations in Personal Income and Local Respending

Capital payments and transfer payments are correlated with the demographic make-up of the population and are relatively independent of local employment patterns. Capital payments in the form of interest, dividends, rental payments, and appreciation of other financial assets, go primarily to wealthier households and retirees with private pensions. Transfer payments are dominated by social security payments and associated health benefits. Welfare, Aid to Families with Dependent Children (AFDC), disability payments, and unemployment insurance constitute a small fraction of total transfer payments.

Basic wages are the most variable type of basic income and are closely related to the types of businesses in a region. The sources of personal income do not have a strong statistical relationship with local respending patterns. The average dollar brought into local economies led to a total spending of $1.45 — the original dollar plus 45 cents of additional respending within the local economy. While there is considerable variation in the local income multiplier among communities, there is no strong statistical relationship between the size of the income multiplier and the sources of basic income, regions, total income, or relative importance of resource-based employment. The only communities with much higher income multipliers were those along the major trans-Sierra highways and proximal to year round recreation centers. The average income multiplier of 1.45 is equivalent to a average employment multiplier of 1.6-2.0, due to the higher wages of 'basic' jobs compared to most local service jobs. This overall basic job multiplier is within the range of employment multipliers for Sierra counties calculated from the 1987 IMPLAN model (e.g. 1.65 for lumber and wood products, 1.47 for construction, 1.26 for hotels for Nevada county) (California Trade and Commerce Agency 1992). Not surprisingly, they are lower than the 1995 employment multipliers that cover state -wide rather than county-wide employment impacts (U. S. Department of Commerce 1995).

Figure 2.5: Local Income Multipliers for 180 SNEP Communities



Source: Author's calculation from 1990 Census money income corrected by Bureau of Economic Analysis personal income data.

The relationship between local economies and direct economic benefits of the ecosystem is apparent in basic wages. Even though all community economies are buffered from sector specific downturns through the increasingly diversified sources of personal income, the pattern of local jobs the most visible expression of local economic diversification. Basic jobs are those involved in producing goods or services for sale to non-local customers. Basic wages are only a portion of total wages but are a major source of the basic income that supports local or non-basic employment. The type and size of basic wages varies considerably between communities and tracks major employment changes. The following table is based on 1990 Census employment with wage corrections from employment and wage data in the County Business Patterns (1992).

Table 2.8: Sectoral Composition of Basic Wages in Economic and Vegetative Regions

	Pct of Total Pop-ulation	Timber	Agr.	Mining	Recreation	Fed Land Agencies	Const-ruction	Hi Wage Services	Other Manuf.	Other Public Admin.
Total	100%	11%	8%	3%	16%	4%	14%	15%	20%	10%
Economic Regions										
North	20%	13%	12%	2%	9%	7%	7%	20%	20%	10%
North Central	34%	9%	6%	1%	7%	4%	18%	15%	29%	10%
South Central	20%	11%	9%	7%	13%	4%	14%	10%	23%	10%
San Joaquin	13%	27%	11%	3%	8%	8%	11%	18%	0%	13%
Greater Tahoe	10%	0%	4%	1%	58%	1%	12%	11%	12%	1%
East	4%	0%	11%	8%	33%	5%	11%	12%	11%	8%
Vegetative Regions										
Foothill	68%	11%	8%	3%	8%	5%	15%	15%	26%	10%
Conifer	17%	24%	10%	3%	12%	5%	10%	18%	5%	13%
East & Tahoe	14%	0%	6%	3%	51%	1%	12%	12%	12%	4%

Source: 1990 Census.
Note: Census-based job classifications do not differentiate part-time from full time jobs.

Role of the Ecosystem in Local Employment

When the discrete sectors are grouped according to their linkage to the ecosystem, clear patterns emerge. The role of the ecosystem in stimulating the local economy has grown and diversified over decades. The growth of developed recreation and tourism sector has expanded the non-commodity based stimulus to the Sierra Nevada economy. The majority of basic wage income comes from jobs related to the metropolitan nature of the region. Basic wages (but not all basic income since the large captial and transfer payments are not included) are grouped into four different categories in the following table.

Table 2.9: Basic Wages by Direct and Indirect Links to Ecosystem

	Direct Ecosystem		Metropolitan or Indirect Ecosystem	
	Commodity	Services	Residents	Regional
Total	22%	20%	28%	30%
Economic Regions				
North	27%	16%	27%	30%
North Central	16%	11%	33%	39%
South Central	26%	17%	23%	34%
San Joaquin	42%	16%	29%	13%
Greater Tahoe	5%	59%	23%	13%
East	19%	38%	23%	19%
Vegetative Regions				
Foothill	22%	13%	30%	36%
Conifer	37%	17%	28%	18%
East & Tahoe	9%	52%	24%	16%

Commodity - Timber, agriculture and mining; Services - Recreation and tourism above location quotient; Residents - High wage services and new construction for residents above location quotient estimate of local population requirements; Regional - Non-timber manufacturing and federal and state employment not associated with land management agencies.

For the region as a whole, ecosystem-related wages constituted over 40% of all basic wages, split relatively equally between commodities and services. When the wage-based data is analyzed by economic or vegetative regions, each region exhibits its own unique pattern with no region following the Sierra-wide pattern. Commodity based wage income is greater than service based wage income in four of the six economic regions and two of the three vegetative regions.

At a Sierra Nevada wide scale, basic wages are well distributed among diverse sectors. The possibility of the whole region being sent into recession because of major changes in any one industry are minimal. When the analysis is conducted according to vegetative regions, the dominance of the metropolitan related manufacturing and construction sectors can be separated from the timber sector that dominates the conifer dominated landscapes of all the west-facing economic regions. The timber industry dominance is due to the lack of alternative basic sectors in the conifer region. Over 60% of timber related employment is in the foothills where the relative impact is less because of the larger absolute size of other sectors. Although recreation is the second most important sector on a Sierra wide basis, and the most important wage source outside of the foothills, its dominance at a regional level is limited to the Lake Tahoe and East Side communities.

Employment and Unemployment Patterns

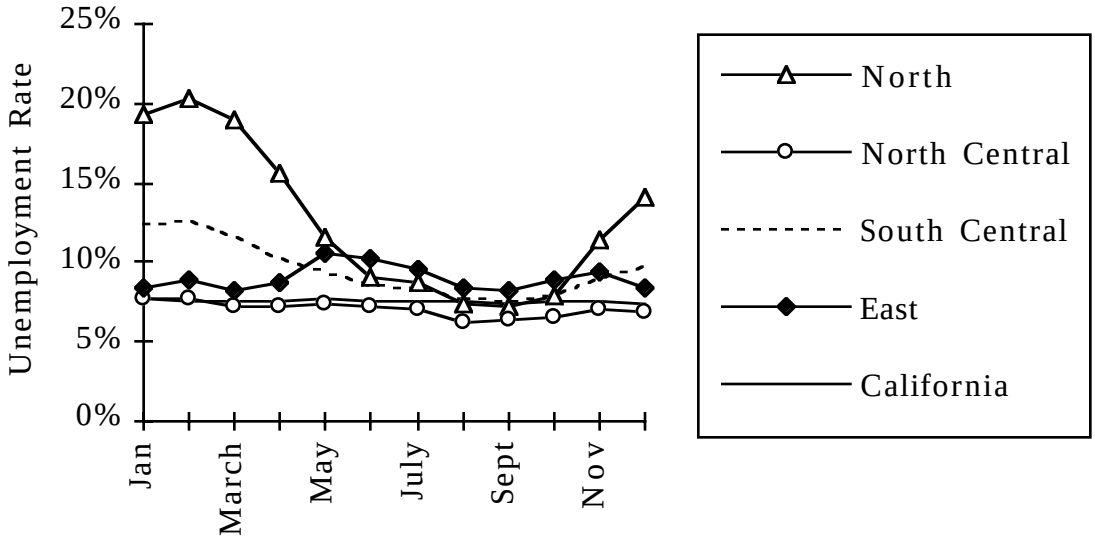
Over the past twenty years the number of jobs in the Sierra Nevada has grown faster than the overall population. Even with increasing rates of adult participation in the workforce, overall unemployment rates have dropped from what had been some of the highest rates in the state. However, with the exception of the three counties in the North Central region, unemployment rates within the SNEP region are still consistently above those of the state as whole. All the counties followed California into the recession of 1992 and 1993 and have since participated in an economic upswing.

The most significant aspect of the unemployment patterns within the Sierra Nevada is the marked seasonal unemployment patterns for all regions except the North Central region.

Diversification through the growth of less seasonal industries appears to be crucial for reducing unemployment throughout the region. Agriculture, timber, and tourism employment will remain major components of total employment, all seasonal in nature, but the regional patterns to date suggest that lower overall unemployment rates will only come with greater diversification of employment opportunities.

Figure 2.6 : Regional Unemployment Rates 1990-1995

Figure 2.7: Average Monthly Unemployment Rates 1990-1995



Conclusion

Ecosystems are linked to the regional economy in two primary ways. Direct linkages exist through jobs and firms that use commodities harvested from the ecosystem or provide services that require the unique ecosystem of the Sierra Nevada. Indirect linkages occur where the desirable environmental attributes attract commuters and retirees who choose to live in region when they could live elsewhere. Economic growth has occurred primarily in sectors indirectly linked to the ecosystem.

A significant change in the Sierra Nevada economy over the past twenty years has been the rapid expansion of personal income from sources other than local employment. Personal income from commuting, interest and dividends, and government transfer payments constituted 51% of total personal income in 1992 compared to 32% in 1972. Driven primarily by the movement of new residents into the Sierra Nevada, this change buffers the large variations in employment directly related to ecosystem commodities and services.

Over the past twenty years, the timber, ranching, agriculture, and mining sectors remained relatively stable while the rest of the economy doubled. Changes in commodity prices and governmental policies have had a relatively greater impact than the physical availability of natural resource for timber, agricultural, mining, and water diversion activities. Direct ecosystem commodity and service sectors remain large components of the Sierra Nevada and differentiate the Sierra Nevada from the rest of the state. Sustaining these sectors in a manner that does not reduce the overall value of the ecosystem to the regional economy requires considerations of tradeoffs between different sectors.

The number of local jobs is now than twice as large as it was when the integrated land management planning efforts were begun for the National Forests after the passage of the National Forests Management Act in 1976. This growth alone has substantially reduced the relative importance of natural resource based activities in local economies. Within the Sierra Nevada, major regional differences are large and no two regions have similar mixes of economic linkages to the ecosystem. This is true for regions based on county boundaries and adjacency to nearest metropolitan area and for regions following major vegetative boundaries.

CHAPTER 3: THE USE AND VALUE OF WATER FLOWS

The diversion of water for irrigation, residential, industrial, and power generation constitutes one of the most significant alterations of the Sierra Nevada ecosystem. Unlike gold mining, sheep grazing, and timber harvesting which have declined or stabilized during recent decades, the extent of water diversions has never declined and is greater now than at any time in history. Many ecological indicators related to water dependent resources are declining and show no sign of stabilizing. The ecological roles of water in different ecological systems are addressed in numerous other sections of the SNEP report.

The purpose of this chapter is to assess the economic benefits of different types of water diversions so that they can be considered alongside ecological and hydrologic assessments. The largest single revenue-generating use of water involves running water through turbines for hydropower. Of the water that is diverted from Sierra Nevada rivers and streams for consumptive uses, most goes to irrigated agriculture, with smaller volumes going to municipal uses and wetlands outside of the Sierra Nevada region. Estimates of economic values of water diverted for irrigation, municipal, and hydropower, suggest that water diversions represent the largest single commodity produced from the Sierra Nevada ecosystem. Additionally, economic values complementary to in-stream uses accrue through water dependent recreation activities such as fishing, white water rafting and wetland related uses. Declines in water quality and in-stream water quantity will have significant economic costs on these sectors.

Water's high value for diverted uses is predicated on its continued availability at its area of origin. History is replete with efforts to protect the headwaters of Sierra Nevada rivers and increase or alter their water yield. While the value of securing these source areas is accepted without contest, resource protection has been addressed through a reliance on legislative approaches rather than on market forces or economic policy. For example, the Sequoia National Forest was originally reserved from the public domain as part of the four million-acre Sierra Forest Reserve in 1893, in part because of heavy lobbying efforts by San Joaquin Valley agricultural interests concerned with threats to their water supply posed by upstream mining, grazing, and lumbering (Dilsaver and Tweed 1990). While the forest reserve strategy for protection of water resource was once politically viable, contemporary efforts are focused on preserving water quality for all of its beneficial uses through regulatory approaches. This approach is embodied in the Federal Water Pollution Control Act of 1972, amended 1977, and the Clean Water Act of 1987.

California's population is expected to double over the next forty years and will require considerable new water deliveries to urban areas. The development of the State Water Bank in the 1980s as well as other efforts of Southern California's urban water agencies to buy water rights elsewhere in the state suggest that existing water allocation patterns may change substantially. The possible expansion of the public trust doctrine to water resources outside of the Mono Lake basin is another potential change. These potential changes increase the need to assess existing patterns use for Sierra Nevada water resources.

Major Water Uses

Water diversions have been central to the economic development of the Sierra Nevada and California as a whole since the discovery of gold at Sutter's water-powered grain mill in 1848. The extensive infrastructure now controlling the distribution of water flowing from the Sierra Nevada includes two of the world's largest irrigation projects, nearly 500 reservoirs, and over one hundred hydroelectric generation facilities. The enormous investments in water moving infrastructure made over the past one hundred and fifty years highlight western water's peculiar distinction of having its greatest value at considerable distances from its area of occurrence. Water diversions have allowed for the residential and industrial growth in California's distant urban centers and made the Central

Valley the most productive agricultural region in the world. Coinciding with these investments in the reallocation of water, has been an enormous reduction in in-stream flows which support aquatic ecosystems, riparian plant communities and offer recreational and aesthetic opportunities on streams and rivers throughout the Sierra Nevada. Many of the ecological assessments in this report suggest that present land and water uses are responsible for the continued decline of many water-dependent ecosystems.

The annual unimpaired flow from the Sierra Nevada's nineteen major drainages is estimated by the Department of Water Resources at 20.8 million acre feet over the past 50 years. The following table presents the 50 year average of unimpaired runoff for the major river systems in the Sierra Nevada.

Table 3.1: Annual Unimpaired Flows for Major Sierra Nevada Rivers

Hydrologic Regions and Rivers	Unimpaired Flow Thousand Acre Feet (50 year average)
Sacramento Region (Sierra Portion)	
Feather	4,617
Yuba	2,389
American	2,736
San Joaquin Region	
Consumes	385
Mokelumne	747
Stanislaus	1,149
Tuolumne	1,882
Merced	966
San Joaquin	1,776
Tulare Lake Region	
Kings	1,669
Kaweah	444
Tule	145
Kern	716
South Lahontan Region	
Owens/Mono Basin	149
North Lahontan Region	
Truckee	409
Carson River, West Fork	75
Carson River, East Fork	264
West Walker River	185
East Walker River	115
Total	20,818

Based on Hydrologic Regions as defined by the California Department of Water Resources.

Water flowing from the Sierra Nevada is put to many uses across both California and Nevada. Based on water use and inter-regional transport data from the Department of Water Resources (Department of Water Resources 1994) , estimates of end uses were developed for all water running off the Sierra Nevada. Water use estimates include ground water basins that must ultimately be recharged by Sierra Nevada water as well as inter-basin transfers. Since the Department of Water Resources publishes water use estimates for regional basins rather than individual river basins, exact estimates

by river system were not completed. Within each of the six hydrologic regions covering parts of the Sierra Nevada, we estimated flows and use within the Sierra and non-Sierra portions. Inter-basin transfers from one region to another are referred to as exports and were calculated from the most recent California Water Plan Update (Department of Water Resources 1994) . Net, rather than gross volumes were used in the calculations. The figures are based on what are referred to as 1990 corrected water volumes and include corrections to address missing data.

The three major uses of water are irrigated agriculture, municipal and industrial uses in urban areas, and environmental uses as defined by DWR. A relatively small amount of water referred to as 'other' that is lost through evaporation or can not otherwise be accounted for are excluded in the following calculations. Environmental water use refers to "water demand based on water needs of managed fresh water wetlands, environmental in-stream flow needs, Delta outflow and Wild and Scenic rivers" (Department of Water Resources 1994). Environmental water use may all not be consumptive and may cover some amount of ground water recharge. Most of the environmental water use refers to flows of the Wild and Scenic section of the Feather River which ends up in Lake Oroville and can be diverted from there. Since some of this water may recharge wetlands that do not have legal water rights, the environmental water use ascribed to the Wild and Scenic portion of the Feather River may be more accurately considered to be used consumptively outside the Sierra Nevada region. For consistency, the volumes used here are reported as they are published by DWR. The calculated volume of water used is nearly identical to the unimpaired flow estimates for the major rivers. The three major geographic areas of use are: within the Sierra (SN); within the drainage of the river systems (IR);and exported (EX). Export water includes inter-basin water projects such as the State Water Project, Central Valley Project, Hetch Hetchy Aqueduct, and the Owens Valley Aqueduct.

Table 3.2: Water Use for DWR Hydrologic Regions in Sierra Nevada in Thousand Acre Feet

	Agriculture			Municipal			Environment		Total
DWR Region	SN	IR	EX	SN	IR	EX	SN	IR	
Sacramento	373	2,791	953	79	289	1,589	1,420	999	8,495
San Joaquin	21	3,552	983	43	181	575	554		5,909
Tulare Lake	20	3,585		5	95		34		3,739
S. Lahontan	147	16		15	12	437	128		755
N. Lahontan	460		580	31	3	40	17	550	1,681
Total	1,021	9,945	2,517	173	581	2,641	2,153	1,549	20,580

Note: SN - within Sierra Nevada; IR - within hydrologic region; EX - export across major watersheds. Sacramento Region excludes most of the Sacramento River and western tributaries.

Table 3.3: Water Use for DWR Hydrologic Regions in Sierra Nevada as a Percent of Total Flow

	Agriculture			Municipal			Environment		Total
DWR Region	SN	IR	EX	SN	IR	EX	SN	IR	
Sacramento	4%	33%	11%	1%	3%	19%	17%	12%	100%
San Joaquin	0%	60%	17%	1%	3%	10%	9%		100%
Tulare Lake	1%	96%		0%	3%		1%		100%
S. Lahontan	19%	2%		2%	2%	58%	17%		100%
N. Lahontan	27%		34%	2%	0%	2%	1%	33%	100%
Total	5%	48%	12%	1%	3%	13%	10%	8%	100%

Note: SN - within Sierra Nevada; IR - within hydrologic region; EX - export across major watersheds. Sacramento Region excludes most of the Sacramento River and western tributaries.

Water rights to Sierra Nevada water are predominantly controlled by downstream agricultural and urban users. In terms of total water use, agriculture accounts for 65% of the total use. Urban use is supplied mainly through inter-regional transfers to large coastal cities and accounts for 17% of total use. Environmental uses such as wetlands and riparian areas along Wild and Scenic Rivers accounts for the final 18%. Water use patterns vary considerably among hydrologic regions. West-facing rivers draining the central and southern portions of the Sierra Nevada are dominated by agricultural uses in the Central Valley. Rivers draining the northern and eastern portions of the Sierra Nevada provide considerably more water to distant urban users, wetlands, and local agricultural uses.

Although 100% of the water flows through the SNEP region, only 6% of total consumptive agricultural and urban uses is consumed within the region. On a region wide level, most water use in the Sierra also goes to agriculture but in many individual river basins, municipal use is greater. Nearly all agricultural water use in the Sierra Nevada occurs in the sparsely populated watersheds east of the Sierra Nevada crest.

Dams, Reservoirs and Other Diversions

The seasonal pattern of precipitation and runoff in the Sierra Nevada requires major diversions for uses that do not occur when runoff is highest. Water diversions in the Sierra Nevada range from stock ponds on small streams to the massive reservoirs just above the floor of the Central Valley. Most downstream water use is based on diversions from the 490 dams monitored by Department of Water Resources. Smaller diversions such as stock ponds and other structures storing less than 50 acre feet of water or less than 25 feet tall, are not monitored by the DWR.

Although thousands of reservoirs and miles of flumes criss-crossed the Sierra Nevada during the Nineteenth century (Beesley 1996 and Larson 1996) most of these structures no longer exist. Structures built in the twentieth century are much larger and alter much more of the total water flow. The present capacity of all the reservoirs in the Sierra Nevada is roughly equal to the total unimpaired flow of 20 million acre feet. The following figure illustrates the cumulative capacity of upstream and foothill reservoirs built during this century. Foothill reservoirs are defined as sites below an altitude of 3,000 feet. Sites for upstream reservoirs were selected earlier and primarily constructed between 1920 and 1960. They supply water for hydropower generation, municipal water uses, and smaller irrigation districts. In contrast, most of the large foothill reservoirs were built after 1950 with large public investments.

The construction of a series of large reservoirs in the foothills during the 1960s and 1970s more than doubled total reservoir capacity and altered the water flow patterns on a much larger scale than the previous systems of reservoirs. Very large reservoirs now account for more than 80% of total storage capacity. The ecological impacts of these reservoirs extend through the major river systems and the Bay-Delta ecosystems.

Figure 3.1: Cumulative Major Reservoir Capacity in the Sierra Nevada

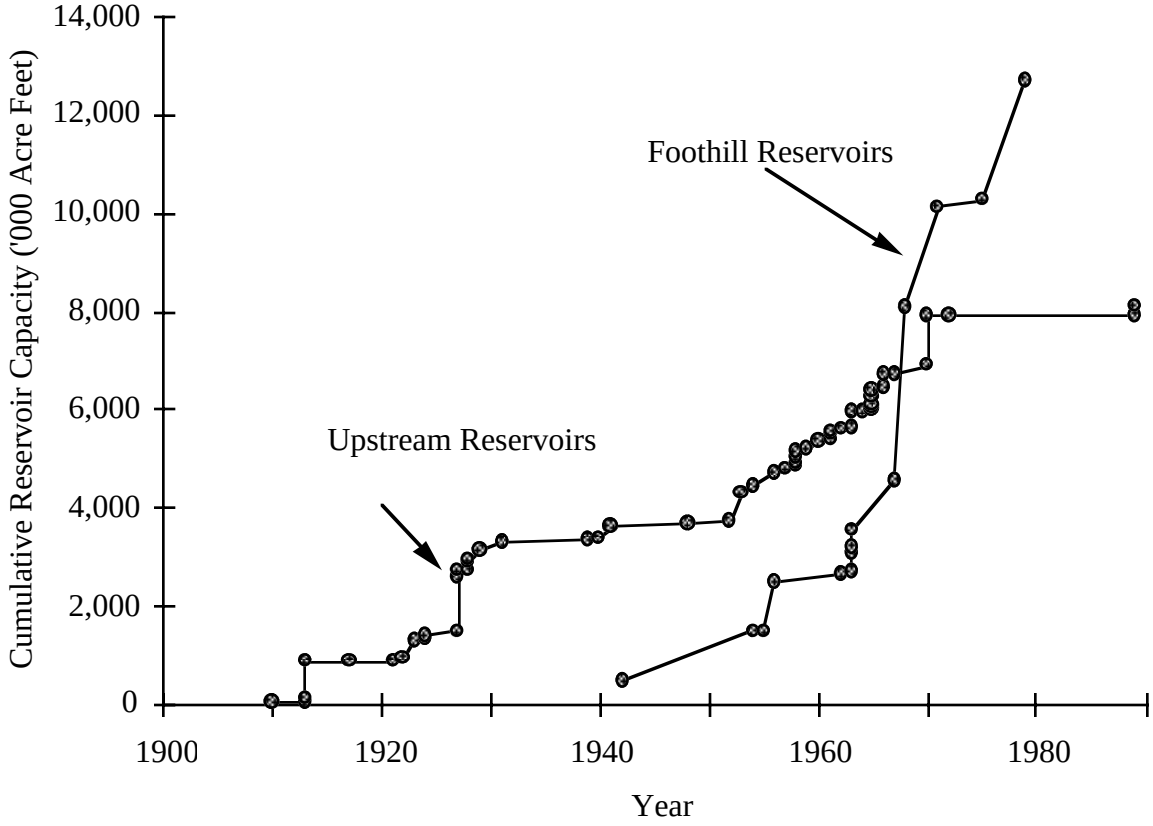


Table 3.4: Reservoir Capacity Relative to Annual Flow from West-Flowing Sierra Nevada Rivers

		Reservoir Capacity Thousand Acre Feet (TAF)			Reservoir Capacity as Percent of Unimpaired Flow		
Hydrologic Region	Unimpaired flow in TAF	Total	Upstream	Foothill	Total	Upstream	Foothill
Sacramento (Sierra only)	9,742	8,663	3,978	4,685	89%	41%	48%
San Joaquin	6,905	7,841	1,810	6,878	114%	26%	100%
Tulare Lake	2,974	2,044	901	1,143	69%	30%	38%
Total	19,621	18,548	6,689	12,706	95%	34%	65%

Note: The Sacramento-Sierra only region excludes the Sacramento River above Shasta Dam and all streams draining the west side of the Sacramento Valley. The South Lahontan and North Lahontan data are less accurate due to flows outside of the main river gauging stations and flow into Nevada.

The major ecological impacts of the foothill reservoirs have been the blockage of nearly every river and the retention of an enormous fraction of annual flow. Nearly all salmon and steelhead migration into the Sierra Nevada is blocked and downstream river flows in the Central Valley are significantly altered. Upstream reservoirs constitute less than half of the total reservoir capacity and have a different set of ecological impacts. In addition to flooding areas behind the dams, impeding fish and amphibian movement up the water course, they also drastically modify in-stream flows within

the Sierra Nevada itself. Approximately one third of total reservoir storage is not used on an annual basis so that it is available for flood storage.

Table 3.5: Reservoir Capacity by Year Constructed

Period	Number of Dams	Percent of Total Capacity
1850 -1900	57	<1%
1901-1950	198	22%
1951-1965	130	27%
1965-1993	105	50%

Source: DWR, Dam Safety Jurisdiction Data Base.

Table 3.6: Reservoir Capacity by Size Class

Dam Rank from Largest to Smallest	Size of Reservoirs in Acre Feet	Percent of Total Capacity
#1-#25	135,000 - 3,538,000	84%
#26-#50	48,000 - 135,000	10%
#51-#75	16,000 - 48,000	3%
remaining 425	20 - 16,000	3%

Source: DWR, Dam Safety Jurisdiction Data Base.

Foothill reservoirs exist on every river flowing from the Sierra Nevada except the Cosumnes. These reservoirs can store anywhere from 38% to 100% of total runoff of the river systems and have significantly reduced flows into downstream aquatic ecosystems. The main ecological impacts of foothill reservoirs within the region are that they stop nearly all salmon migration upstream, flood large areas of what was foothill riparian vegetation, and break the continuity of terrestrial riparian vegetation and habitats. Upstream reservoirs are more numerous, smaller, and are not on every tributary. Overall, they withhold a much smaller fraction of total runoff than the foothill reservoirs. Their ecological impacts within the region show up in both the reduced and seasonally altered downstream flows, and in the site specific flooding of upstream areas.

Any changes in reservoir management to improve the status of aquatic and riparian systems dependent on water flow will have to be implemented by the reservoir operators. Ownership of Sierra Nevada reservoirs is split among five major sets of organizations. Nearly all of the large foothill reservoirs are operated by federal, state, and local public agencies for the main purpose of irrigation. In contrast 67% of the volume of upstream reservoirs is operated by municipal water districts and power companies. The beneficiaries of the foothill reservoirs are primarily agricultural water users in the Central Valley while the beneficiaries of upstream reservoirs are primarily urban consumers of water and electric power. The institutional participants who must be involved in any plans to change water flows to address the serious declines in aquatic and riparian ecosystems will vary depending on the elevation and river system.

Table 3.7: Operators of Major Reservoirs

Operator	Whole Region		Foothill		Upstream	
	Acre Feet	Pct of Total	Acre Feet	Pct of Total	Acre Feet	Pct of Total
DWR	3,701	18%	3,538	28%	163	2%
Federal Agencies	7,317	35%	5,536	44%	1,781	22%
Irrigation Districts	3,816	18%	3,111	24%	705	9%
Municipal Water Districts	3,718	18%	521	4%	3,197	39%
Power Companies	2,276	11%	0	0%	2,276	28%
Total	20,828	100%	12,706	100%	8,122	100%

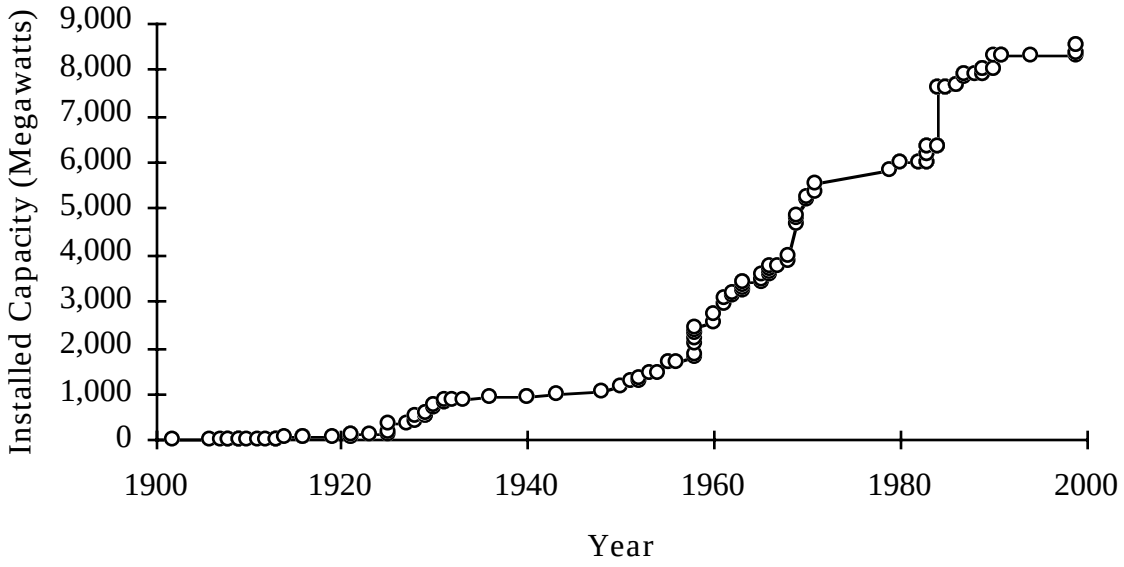
Source: DWR, Dam Safety Jurisdiction Data Base.

Hydropower Generation in the Sierra Nevada

Hydropower generation varies with California's precipitation and has constituted from 9 to 21% of total electric power generated in the state over the last decade. Precipitation and minimum in-stream flow requirements on natural water courses determine the maximum amount of water that can be diverted through turbines to generate electricity. The physical size of the turbines and the structures to store and release the spring runoff permitting year-round operation determine how much of this potential flow can be used to generate electricity.

The majority of hydroelectric plants in the Sierra Nevada were constructed in three distinct periods. The early projects were designed and built during the 1920s by engineers for private power companies. New construction technologies as well as increased public financing led to a enormous increase in hydroelectric capacity throughout the 1950s and 1960s. Finally, high energy prices and streamlined federal regulatory approval processes led to the applications for hundreds and the actual construction of 63 smaller hydroelectric projects since 1979. Relatively few plants have been completed since 1990 and the projected size of future plants is relatively small (California Energy Commission, 1992). The following figure illustrates the trend in hydroelectric capacity over this century.

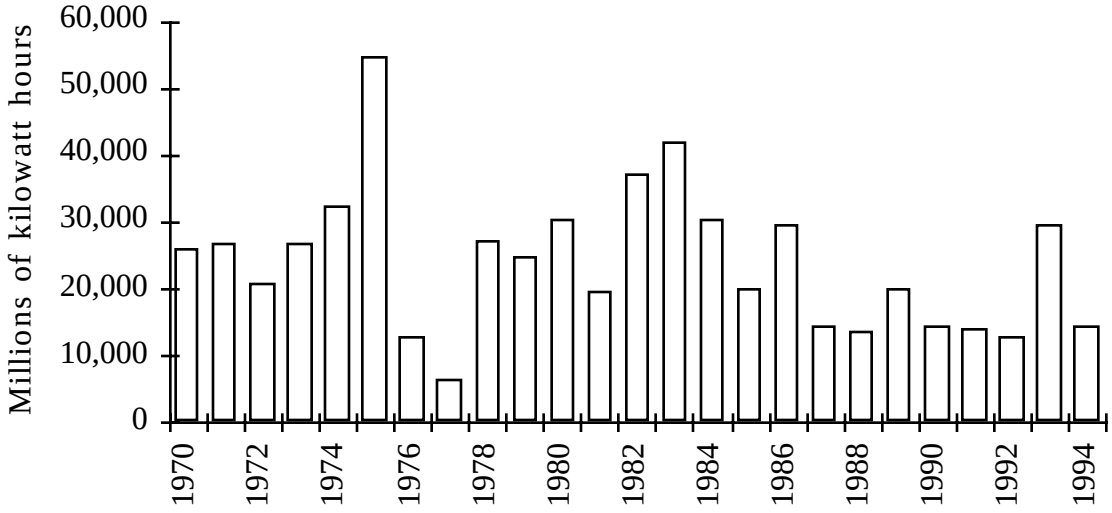
Figure 3.2: Hydropower Capacity in the Sierra Nevada



Sources: DWR 1994 and CEC 1992.
Note: the 1,000 MW Helms Canyon pump-storage facility (1984) is not dependent on diverting natural water flows.

Hydropower production trends over the past 24 years (1970-1994) illustrate the dominant importance of precipitation in overall production. In "wet" years such as 1975 and 1983, hydroelectric production reached 54.6 and 42 billion kWh respectively. During the most recent drought however, hydroelectric production fell, averaging less than 15 billion kWh per year between 1987 and 1992. This drop in production represents a decline in overall capacity utilization, since generating capacity had increased with the 63 new projects installed since 1979.

Figure 3.3: Hydropower Generation in the Sierra Nevada



Source: Federal Energy Regulatory Commission records

The location of the hydropower sites in the Sierra Nevada are identified in Figure 3.4. In addition, Table 3.8 lists the name, watershed, and other relevant information on the 124 hydropower sites identified within the SNEP boundary. The sources of original data and the methods used for the calculated values are described immediately after the table.

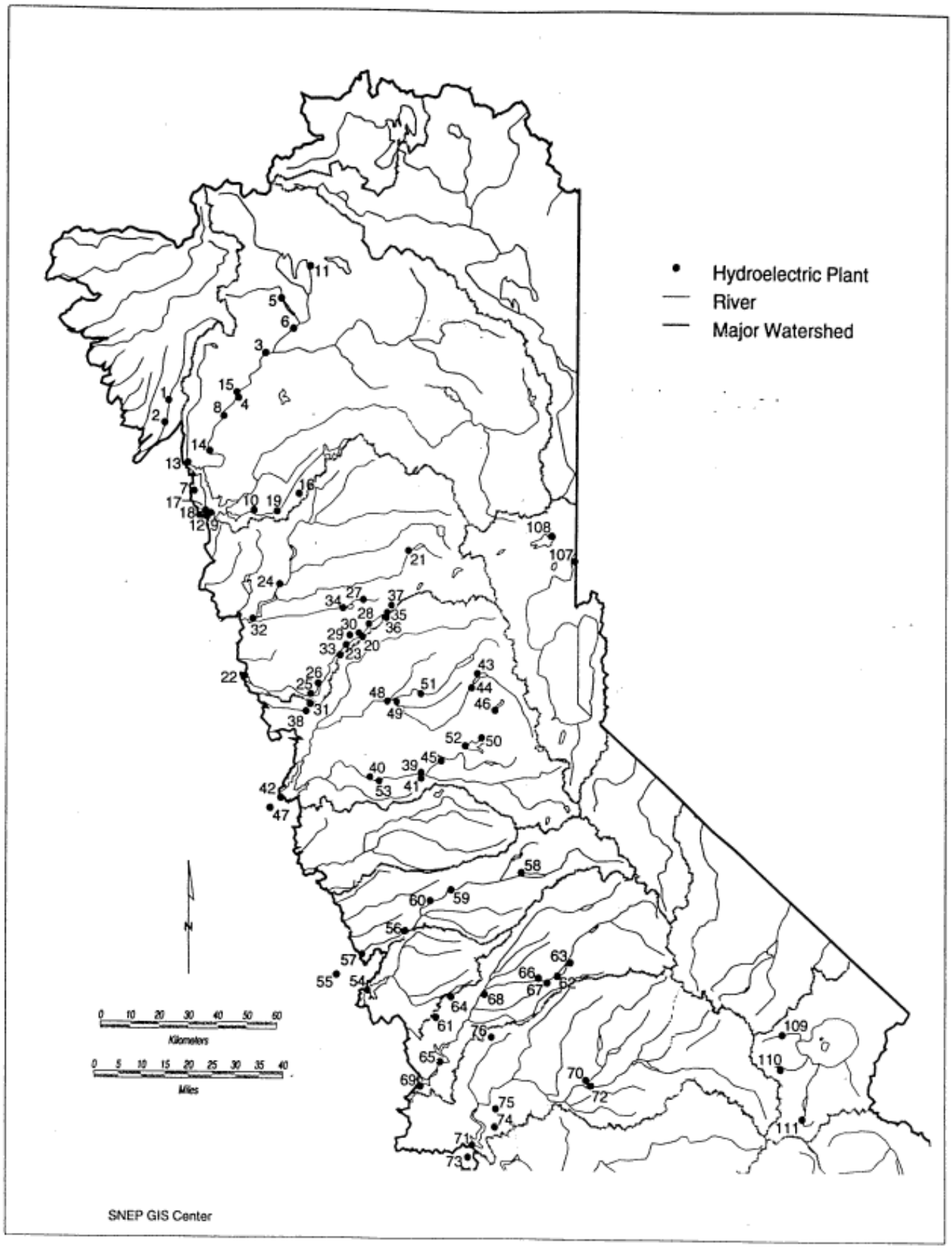

Hydroelectric Plant
River
Major Watershed
N
0 10 20 30 40 50 60
Kilometers
0 5 10 15 20 25 30 35 40
Miles
SNEP GIS Center

Figure: 3.4

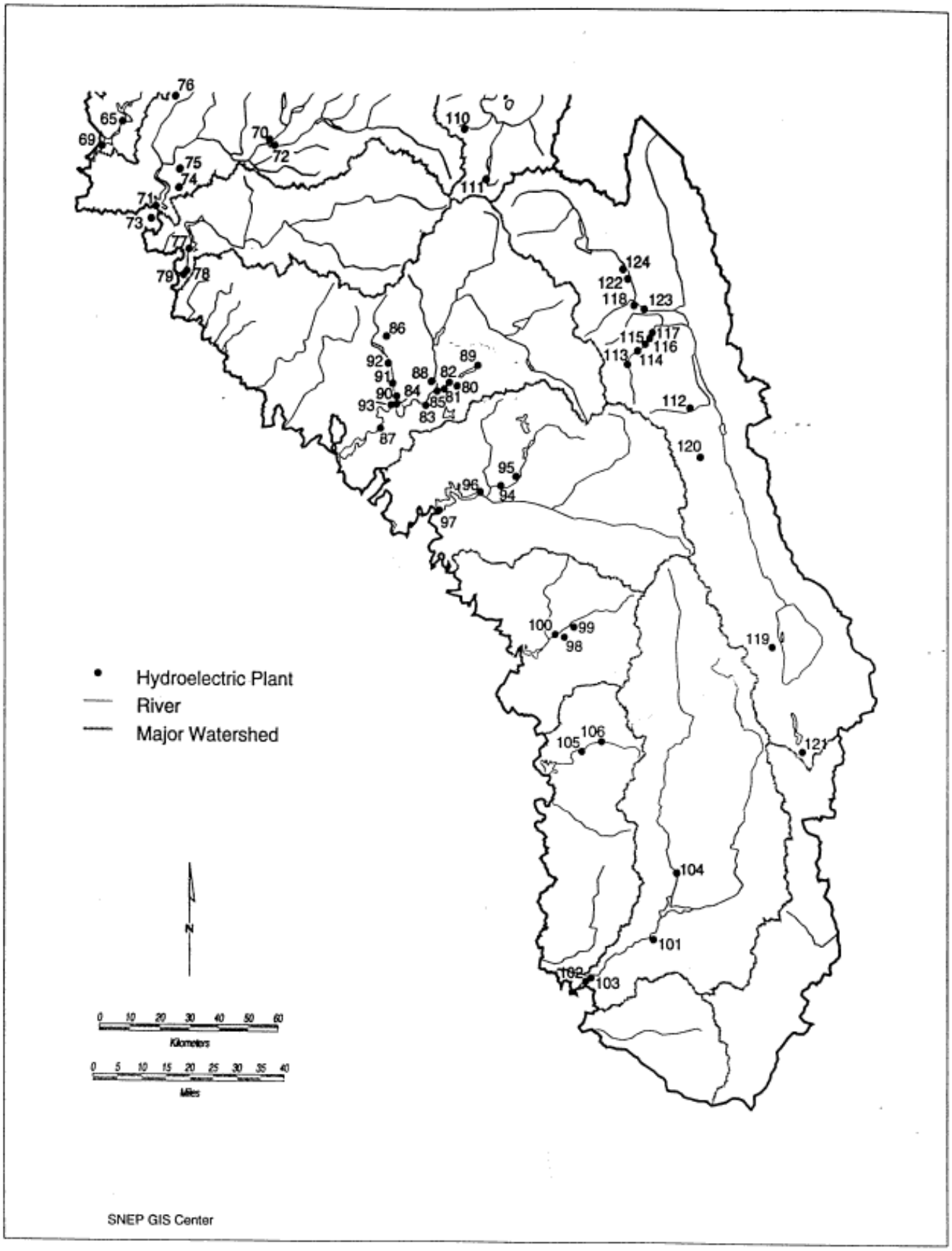

Hydroelectric Plant
River
Major Watershed
N
0 10 20 30 40 50 60
Kilometers
0 5 10 15 20 25 30 35 40
Miles
SNEP GIS Center

Figure: 3.4

Table 3.8 Hydropower Plants

Map Ref. # (a)	Powerplant Name	Watershed Name	Owner (b)	Completion Date (c)	Capacity MW	Yearly MWh Production (d)	Head (in feet)	Kwh per AF Water (e)	Value per AF (f)	Cumulative AF Value (g)
1	Centerville	Butte Creek	PG&E	1900	6.4	41,273	557	473	$12	$12
2	De Sabla	Butte Creek	PG&E	1963	18.5	125,825	1,545	1,313	$33	$45
3	Belden	Feather	PG&E	1969	125	408,545	770	655	$16	$102
4	Bucks Creek	Feather	PG&E	1928	77.8	245,915	2,558	2,174	$54	$129
5	Butt Valley	Feather	PG&E	1958	39.1	168,395	358	304	$8	$134
6	Caribou 2 (&1)	Feather	PG&E	1958	195	652,038	1,149	977	$24	$127
7	Coal Canyon	Feather	PG&E	1969	125	6,765	770	655	$16	$26
8	Cresta	Feather	PG&E	1928	77.8	358,218	2,558	2,174	$54	$75
9	Edward Hyatt	Feather	California	1958	39.1	1,875,552	358	304	$8	$10
10	Forbestown	Feather	OWID	1958	195	159,933	1,149	977	$24	$34
11	Hamilton Branch	Feather	PG&E	1921	2.4	24,522	410	349	$9	$143
12	Kelly Ridge	Feather	OWID	1963	10	69,751	668	568	$14	$17
13	Lime Saddle	Feather	PG&E	1906	1.6	10,322	462	393	$10	$20
14	Poe	Feather	PG&E	1958	142.8	628,760	477	405	$10	$20
15	Rock Creek	Feather	PG&E	1950	113.4	554,103	535	455	$11	$86
16	Sly Creek	Feather	OWID	1984	13	25,229	225	191	$5	$71
17	Thermalito	Feather	California	1968	115.1	267,354	102	87	$2	$2
18	Thermalito Div.	Feather	California	1987	3	18,333	74	63	$2	$2
19	Woodleaf	Feather	OWID	1963	55	263,091	1,495	1,271	$32	$66
20	Alta	Yuba-Bear	PG&E	1902	1	5,814	648	551	$14	$29
21	Bowman	Yuba-Bear	Nevada ID	1986	3.6	9,107	162	138	$3	$9
22	Camp Far West	Yuba-Bear	SMUD	1985	6.8	14,048	165	140	$4	$4
23	Chicago Park	Yuba-Bear	Nevada ID	1966	41.5	164,959	481	409	$10	$16
24	Colgate (New)	Yuba-Bear	Yuba CWA	1970	341	1,245,871	1,390	1,182	$30	$35
25	Combie Lake*	Yuba-Bear	Nevada ID	1984	1.5	3,479	70	60	$1	$5
26	Combie North	Yuba-Bear	Nevada ID	1988	0.33	592	40	34	$1	$6
27	Deer Creek	Yuba-Bear	PG&E	1908	4.6	25,242	837	711	$18	$21
28	Drum 1 & 2	Yuba-Bear	PG&E	1965	103.5	414,585	1,370	1,165	$29	$58
29	Dutch Flat 1	Yuba-Bear	PG&E	1943	23	83,784	643	547	$14	$29
30	Dutch Flat 2	Yuba-Bear	Nevada ID	1966	26	111,041	591	502	$13	$29
31	Halsey	Yuba-Bear	PG&E	1916	11	70,208	327	278	$7	$17

Table 3.8 Hydropower Plants

Map Ref. # (a)	Powerplant Name	Watershed Name	Owner (b)	Completion Date (c)	Capacity MW	Yearly MWh Production (d)	Head (in feet)	Kwh per AF Water (e)	Value per AF (f)	Cumulative AF Value (g)
32	Narrows	Yuba-Bear	PG&E	1970	64.9	271,271	240	204	$5	$5
33	Rollins	Yuba-Bear	Nevada ID	1980	11	61,596	215	183	$5	$10
34	Scott Flat	Yuba-Bear	Nevada ID	1984	0.9	2,839	140	119	$3	$3
35	Spaulding 1	Yuba-Bear	PG&E	1929	7	32,484	197	167	$4	$62
36	Spaulding 2	Yuba-Bear	PG&E	1929	4.4	13,228	344	292	$7	$28
37	Spaulding 3	Yuba-Bear	PG&E	1929	5.8	39,418	318	270	$7	$61
38	Wise	Yuba-Bear	PG&E	1970	14.7	98,999	519	441	$11	$28
39	Camino	American	SMUD	1968	150	381,757	1,061	902	$23	$50
40	Chili Bar	American	PG&E	1965	2.3	34,156	60	51	$1	$9
41	El Dorado	American	PG&E	1924	21	103,641	1,910	1,624	$41	$68
42	Folsom	American	USBR	1955	198.7	620,655	333	283	$7	$8
43	French Meadows	American	Placer CWA	1966	15.3	62,884	654	556	$14	$95
44	Hell Hole	American	Placer CWA	1983	0.5	2,316	359	305	$8	$18
45	Jaybird	American	SMUD	1961	139	539,510	1,530	1,301	$33	$82
46	Loon Lake	American	SMUD	1971	78	98,183	1,140	969	$24	$124
47	Nimbus	American	USBR	1955	13.5	63,937	43	37	$1	$1
48	Oxbow	American	Placer CWA	1966	6.57	31,124	89	76	$2	$10
49	Ralston	American	Placer CWA	1966	85	374,471	1,250	1,063	$27	$36
50	Robbs Peak	American	SMUD	1965	22	47,416	400	340	$9	$100
51	Stephenson LJ*	American	Placer CWA	1930	120	517,330	2,101	1,786	$45	$81
52	Union Valley	American	SMUD	1963	37	115,505	430	366	$9	$92
53	Whiterock	American	SMUD	1961	223	580,352	852	724	$18	$27
54	New Hogan	Calaveras	Modesto ID	1986	3.3	3,081	195	166	$4	$4
55	Camanche	Mokelumne	EDMUD	1983	11	20,192	107	91	$2	$2
56	Electra	Mokelumne	PG&E	1948	89.1	444,191	1,272	1,081	$27	$36
57	Pardee	Mokelumne	EDMUD	1930	29	89,232	327	278	$7	$9
58	Salt Springs	Mokelumne	PG&E	1931	44	220,283	2113	1796.05	$45	$114
59	Tiger Creek	Mokelumne	PG&E	1931	51	325,397	1,219	1,036	$26	$69
60	West Point	Mokelumne	PG&E	1931	13.6	95,888	312	265	$7	$43
61	Angels Camp	Stanislaus	PG&E	1940	1.4	7,013	444	377	$9	$25
62	Beardsley	Stanislaus	OSSJ	1958	11	59,775	264	224	$6	$21

Table 3.8 Hydropower Plants

Map Ref. # (a)	Powerplant Name	Watershed Name	Owner (b)	Completion Date (c)	Capacity MW	Yearly MWh Production (d)	Head (in feet)	Kwh per AF Water (e)	Value per AF (f)	Cumulative AF Value (g)
63	Donnels	Stanislaus	OSSJ	1958	67.5	317,865	1,484	1,261	$32	$70
64	Murphy's	Stanislaus	PG&E	1954	3.6	22,089	684	581	$15	$40
65	New Melones	Stanislaus	USBR	1979	300	393,829	583	496	$12	$16
66	Sand Bar	Stanislaus	TDP	1986	16.2	57,200	389	331	$8	$56
67	Spring Gap	Stanislaus	PG&E	1921	6	41,381	1,865	1,585	$40	$55
68	Stanislaus	Stanislaus	PG&E	1963	81.9	397,766	1,525	1,296	$32	$48
69	Tulloch	Stanislaus	OSSJ	1958	4.5	96,838	157	133	$3	$3
70	D R Holm	Tuolumne	HHWD	1960	135.9	739,491	2,481	2,109	$53	$67
71	Don Pedro	Tuolumne	Turlock ID	1970	179	545,833	530	451	$11	$14
72	Kirkwood R C	Tuolumne	HHWD	1936	50.3	568,117	1,450	1,233	$31	$71
73	La Grange	Tuolumne	Turlock ID	1924	3.9	15,728	119	101	$3	$3
74	Moccasin	Tuolumne	HHWD	1969	88	496,040	1,257	1,068	$27	$41
75	Moccasin L H	Tuolumne	HHWD	1987	3	7,579	76	65	$2	
76	Phoenix	Tuolumne	PG&E	1940	1.6	11,810	1,190	1,012	$25	$39
77	Exchequer	Merced	Merced ID	1970	89	289,581	464	394	$10	$12
78	McSwain	Merced	Merced ID	1967	10	36,623	56	48	$1	$2
79	Merced Falls	Merced	PG&E	1930	3.5	15,558	26	22	$1	$1
80	Big Creek 1	San Joaquin	SCE	1925	70	521,430	2,131	1,811	$45	$144
81	Big Creek 2	San Joaquin	SCE	1925	158	454,419	1,875	1,594	$40	$98
82	Big Creek 2A	San Joaquin	SCE	1928	95	390,537	2,418	2,055	$51	$110
83	Big Creek 3	San Joaquin	SCE	1970	147	844,733	827	703	$18	$43
84	Big Creek 4	San Joaquin	SCE	1951	92	450,573	416	354	$9	$26
85	Big Creek 8	San Joaquin	SCE	1929	58	327,943	713	606	$15	$58
86	Crane Valley	San Joaquin	PG&E	1919	1.1	3,345	128	109	$3	$66
87	Kerchoff 2	San Joaquin	PG&E	1983	173.7	409,058	792	673	$17	$17
88	Mammoth	San Joaquin	SCE	1960	149	610,219	1,100	935	$23	$67
89	Portal	San Joaquin	SCE	1956	10	51,608	230	196	$5	$148
90	San Joaquin 1A	San Joaquin	PG&E	1923	0.4	1,433	42	36	$1	$48
91	San Joaquin 2	San Joaquin	PG&E	1923	3.2	12,328	307	261	$7	$54
92	San Joaquin 3	San Joaquin	PG&E	1923	4.2	15,172	405	344	$9	$63
93	Wishon	San Joaquin	PG&E	1910	12.8	64,737	1,412	1,200	$30	$47

Table 3.8 Hydropower Plants

Map Ref. # (a)	Powerplant Name	Watershed Name	Owner (b)	Completion Date (c)	Capacity MW	Yearly MWh Production (d)	Head (in feet)	Kwh per AF Water (e)	Value per AF (f)	Cumulative AF Value (g)
94	Balch 1 & 2	Kings	PG&E	1958	139	603,190	2,389	2,031	$51	$76
95	Haas	Kings	PG&E	1958	135	492,366	2,444	2,077	$52	$128
96	Kings River	Kings	PG&E	1962	44.1	194,072	798	678	$17	$25
97	Pine Flat	Kings	KRCD	1983	165	197,499	386	328	$8	$8
98	Kaweah 1	Kaweah	SCE	1929	2.3	13,471	1,326	1,127	$28	$28
99	Kaweah 2	Kaweah	SCE	1929	1.8	12,462	367	312	$8	$24
100	Kaweah 3	Kaweah	SCE	1913	2.8	25,633	775	659	$16	$16
101	Borel	Kern	SCE	1932	12	65,869	261	222	$6	$30
102	Kern Canyon	Kern	PG&E	1921	8.5	68,144	264	224	$6	$6
103	Kern River	Kern	SCE	1930	24.8	184,629	877	745	$19	$24
104	Kern River 3	Kern	SCE	1921	32	174,132	821	698	$17	$47
105	Tule (lower)	Tule	SCE	1909	2	18,152	1,140	969	$24	$24
106	Tule River	Tule	PG&E	1914	6.4	25,362	1,544	1,312	$33	$57
107	Farad	Truckee	SPPC	1933	2.8	10,340	82	70	$2	$2
108	Stampede	Truckee	USBR	1987	3	6,683	183	156	$4	$4
109	Lundy	Mono Lake	SCE	1912	3	10,103	785	667	$17	$17
110	Poole	Mono Lake	SCE	1963	10	30,052	1,671	1,420	$36	$36
111	Rush Creek	Mono Lake	SCE	1916	8.4	49,081	1,807	1,536	$38	$38
112	Big Pine	Owens River	Los Angeles	1925	3.2	15,796	1,243	1,057	$26	$26
113	Bishop Cr. 2	Owens River	SCE	1911	2.3	43,739	953	810	$20	$76
114	Bishop Cr. 3	Owens River	SCE	1913	7.2	40,724	809	688	$17	$55
115	Bishop Cr. 4	Owens River	SCE	1909	7.4	52,951	1,112	945	$24	$38
116	Bishop Cr. 5	Owens River	SCE	1970	3.5	23,428	420	357	$9	$14
117	Bishop Cr. 6	Owens River	SCE	1913	1.6	12,865	260	221	$6	$6
118	Control Gorge	Owens River	Los Angeles	1952	37.5	151,812	780	663	$17	$18
119	Cottonwood 3	Owens River	Los Angeles	1909	1.5	6,252	1,267	1,077	$27	$27
120	Division Creek	Owens River	Los Angeles	1909	0.6	5,221	1,250	1,063	$27	$27
121	Haiwee	Owens River	Los Angeles	1927	5.6	27,791	193	164	$4	$4
122	Middle Gorge	Owens River	Los Angeles	1952	37.5	154,089	795	676	$17	$35
123	Pleasant Valley	Owens River	Los Angeles	1958	3.2	12,333	76	65	$2	$2
124	Upper Gorge	Owens River	Los Angeles	1953	110	142,012	872	741	$19	$54

Sources and Footnotes for Table 3.8: Hydropower Plants in the Sierra Nevada

Sources: DWR bulletin 160-93, Pp. 304-319; FERC 1970-94 unpublished yearly production data; and authors' calculations.

(a) These reference numbers are located on Figure 3.4 .

(b) These hydroelectric power plants account for 98 percent of hydroelectric power production in the Sierra Nevada based on natural flow. Helms Canyon power plant has been excluded since, despite its size, it is a net consumer of energy (by FERC accounts it has consumed on average 156,028 megawatt hours (mWh) of energy per year between 1984 and 1994. Helms Canyon is primarily a pump storage facility and does not rely on the normal flow of the river for power generation.

(c) SCE = Southern California Edison Co.
PG&E = Pacific Gas and Electric Co.
ID = Irrigation District
OWID = Oroville Wyondotte ID
SMUD = Sacramento Municipal Utility District
USBR = US Bureau of Reclamation -- Mid Pacific Region
CWA = County Water Agency
TDP = Tri-Dam Project
OSSJ = Oakdale South San Joaquin
EBMUD = East Bay Municipal Water District
SPPC = Sierra Pacific Power Co.
KRCD = Kings River Conservation District
HHWD = Hetch Hetchy Water District

(d) Year Installed are taken from Bulletin 160 of DWR except when FERC recorded production previous to those dates.

(e) Average yearly energy production for each plant is calculated from 1970-1994 FERC data. Where plants have been operating for less than that entire time, the average is calculated over the observed dates. The average yearly net value of energy generated is calculated by multiplying the energy generated at each plant (from the previous column) by $25 per megawatt hour (mWh). The net value of $25 per MWh of electricity was calculated as follows. In 1992, the value of a kilowatt hour (KWh) of electricity averaged around 3 cents (source: Public Utilities Commission, *Summary of Utilities Avoided Energy Prices*), from which 0.5 cents were subtracted per kWh for estimated average operating and maintenance costs (source: Energy Information Administration, 1992, *Electric Plant Cost and Power Production Expenses 1991*), to get a net value of 2.5 cents per kWh generated, or $25 per mWh.

(f) The kWh generated per acre foot (AF) of water diverted through turbines is calculated as follows. The engineering formula for measuring hydroelectric power generation is

$$Power(KWh) = \left(Flow(cfs) \times Head(feet) \times Efficiency\right) / 11.8$$

According to Dr. Calvin Warnick, (professor at the University of Idaho and author of "Hydropower Engineering"), the average efficiency of turbines in hydroelectric power plants in California is approximately 82-83 percent. Using the above formula yields a multiplier of 0.846 KWh of energy generated for every foot of head (drop).

(g) The net value of hydroelectric production per AF of diverted flow is calculated by multiplying the KWh generated (in the previous column, see footnote (g)) by 2.5 cents per KWh (see footnote (f)).

(h) The cumulative net value of hydroelectric power generated per AF of diverted water gives the value of diverting the water not only at the hydroelectric power plant listed, but also of diverting it at all hydroelectric power plants below that point along the tributary. This value can be translated as the potential hydroelectric value of runoff water originating from, or above, the given power plant (see Figure 3.8).

Actual Costs, Market Values and Estimated Economic Values of Water Diversions

The most explicit valuation of water flowing from Sierra Nevada rivers is for its non-consumptive use to generate electricity. Since there is a large market with many buyers and sellers for wholesale electric power, as well as an accepted methodology for comparing the opportunity costs of different types of electric power, the economic value of water used to produce hydropower can be calculated. The economic value of water diverted and consumed for agricultural and municipal uses is more difficult to estimate, since these uses are based on water rights that are not actively traded or independently valued. The following estimates are based on the limited market valuations and estimates of the total revenue benefits of using the water. The rapidly evolving area of inter-regional water marketing in California that began in earnest with the State Water Bank during the past drought will clarify economic values of water in California. In-stream water flows also create direct and indirect economic benefits to many recreational users. Fishing and white water rafting are the two most identifiable activities that directly benefit from in-stream water flows. In addition, a large fraction of boating, camping, hiking, and other dispersed recreational activity takes place near rivers and streams and indirectly benefits from in-stream water flows.

The high value of water diverted from its Sierra Nevada origin, is enshrined in the legal doctrine that has evolved to facilitate the transfer of use rights. The doctrine of prior appropriation—a system often described with the phrase "first in time, first in right"—allows acquisition of a water right simply by diverting it from its natural stream and applying it to a "beneficial use." The application of appropriative rights brought some semblance of order to the unprecedented manipulation of west side streams and rivers during the gold mining era of the mid-1800s. The extension of the appropriation doctrine into the 20th century reinforced the primacy of diverted water over in-stream water as a valued commodity. The enormous public investments in irrigation works and municipal supply lines throughout this century, formalized a system that values water if it can be moved out of the stream or river.

Values of Water for Hydropower Generation

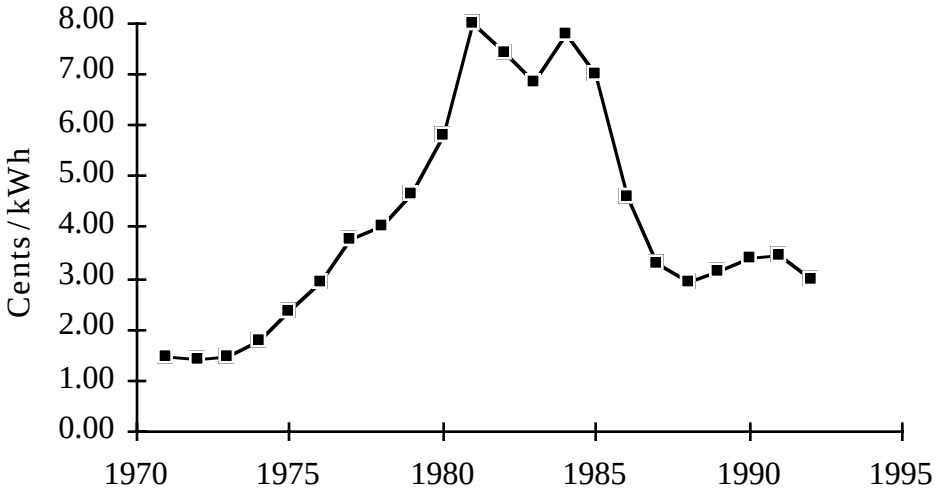
The economic value of water used to generate hydropower is unique in many respects. First, the total value of the output is only weakly correlated with the capital investment in hydropower plants because of highly variable rainfall, and fluctuations in region-wide wholesale electricity prices. Even with relatively low electricity prices and rainfall, significant revenues are produced. For example, the profit made by the City of San Francisco from the power generated as their drinking water exits Hetch Hetchy reservoir was over $30 million dollars in 1994 (Lucas 1995).

Nearly all the value goes to public utilities or corporations based in distant cities that own the hydropower plants. Property taxes paid to counties on hydropower facilities return a small fraction of the surplus value generated. With the exception of some small watershed restoration projects in the Feather River drainage, there is little reinvestment of hydropower revenues to restore or mitigate the environmental impacts. Even though water used for hydropower production is still available downstream and produces considerable revenue, hydropower water rights are often junior to irrigation rights. Water diversion schedules are rarely optimized to achieve the highest level of total hydropower and irrigation benefits.

Since most hydropower is produced by companies that also distribute it, a specific market price for hydropower does not exist. The California Energy Commission (CEC) estimates the value of hydropower by comparing it to the cost avoided by not having to use the next most expensive fuel—gas or oil-fired power plants. This essentially represents what electric utility providers are willing to pay for electricity on the open market. Avoided costs have ranged from as low as 1.4 cents per kWh in the early 1970's, to almost 8 cents per kWh in 1981, based on constant 1992 values (Figure 3.5). The present

availability of inexpensive power generated with natural gas suggests that the wholesale value of electrical power will not return to the levels of the early 1980s in the near future.

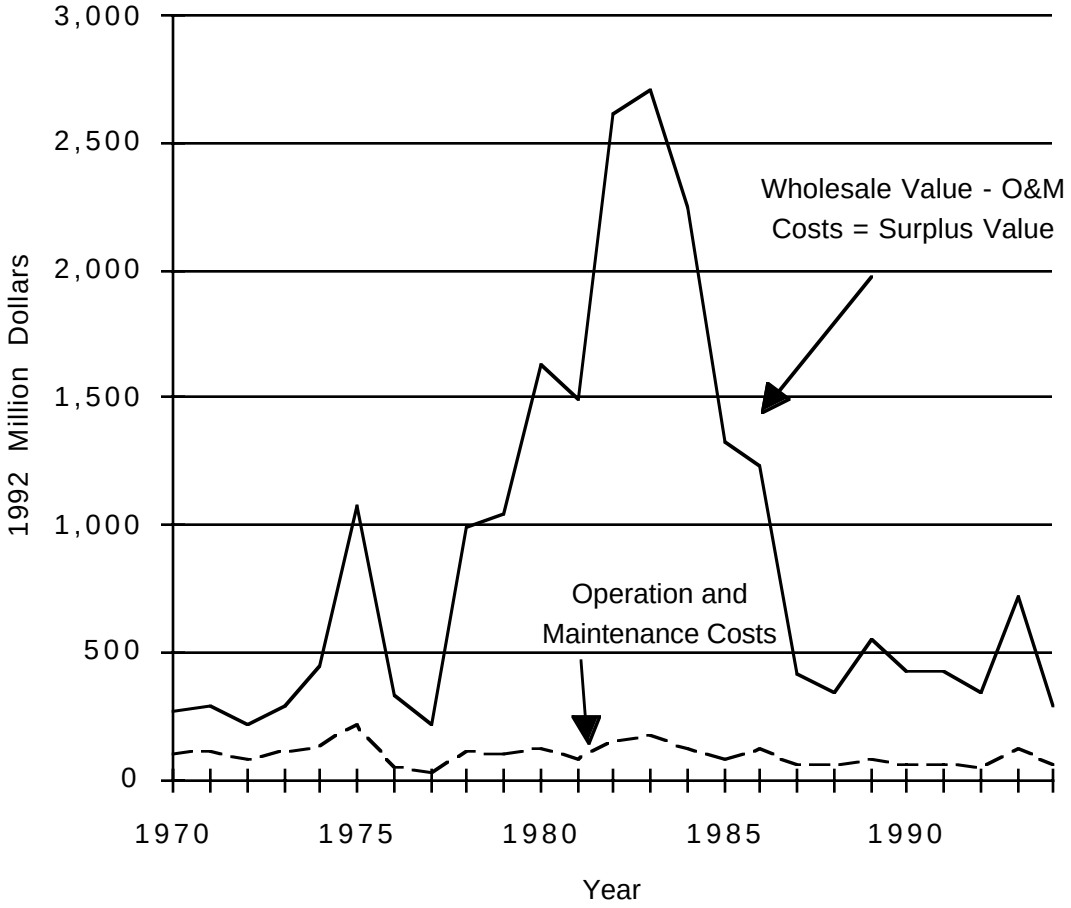
Figure 3.5: Avoided Costs of Not Having To Use Fossil Fuels



Sources: American Petroleum Institute before 1980, PUC from 1980. 1992 Dollars

The increased costs of oil and gas made hydropower production increasingly attractive up through 1983. The California Energy Commission and the Department of Water Resources promoted the development of new power plants, forecasting a doubling of energy prices in real terms by the year 2000 (CEC 1981; DWR 1979; DWR 1981) . Such predictions encouraged the industry to develop sites that may otherwise have remained undeveloped at then prevailing energy rates. Contrary to projections, energy prices fell after 1984 and many plants whose feasibility was based on the optimism of these forecasts may be unable to recover their initial investment costs.

Figure 3.6: Surplus Value from Hydropower Generation in the Sierra Nevada



Source: operating and maintenance costs derived from California Energy Commission data.
Note: 1973 value extrapolated from 1972 and 1974 values.

The surplus value of Sierra Nevada water from generating hydropower is large and highly variable (Figure 3.6). It has ranged from a low of $217 million in 1972 to a high of $2.7 billion in 1983 (all values in constant 1992 dollars). The average surplus value $914 million per year over the past 24-year period is considerably higher than the more conservative projection of $600 million per year based on present low wholesale electricity prices.

With essentially free water and very low operation and maintenance costs, hydropower is relatively inexpensive to produce once facilities have been built. Operating and maintenance costs for producing energy average around 0.5 cents per kWh (Energy Information Administration 1992). Surplus value is calculated as the revenues from sales of hydropower, minus operating and maintenance costs. Investment costs are not accounted for since these sunk costs have usually been written off during the early years of production.

Distribution of Hydropower Generation by River, Watersheds, and Power Plants

Within the Sierra Nevada and within each river basin, hydropower plants are not spread evenly. Based on the average power output per acre foot of total flow, the most developed river systems

are the tributaries of the Owens River on the east side and the San Joaquin River in the south. The degree of hydropower development is consistently high on most of the rivers in the central and northern Sierra Nevada. Figure 3.7 illustrates the power output pattern of sites with dots sized to plant output. Even for the most productive river basins such as the San Joaquin and Feather , most output is concentrated on a few reaches, or 'power tributaries.'

Table 3.10: Hydropower Value by River Basin

River Basin	Million Kilowatt Hours (1970-1994 average)	Million Dollars at 2.5¢/kWh	Unimpaired Flow in TAF	Power Value Per Acre foot
Butte Creek	167,098	$4.18	NA	NA
Feather	5,736,826	$143.42	4,617	$31
Yuba-Bear	2,668,565	$66.71	2,389	$28
American	3,573,237	$89.33	2,736	$33
Mokelumne	1,195,183	$29.88	747	$40
Calaveras	3,081	$0.08	NA	NA
Stanislaus	1,393,756	$34.84	1,149	$30
Tuolumne	2,384,598	$59.61	1,882	$32
Merced	341,762	$8.54	966	$9
San Joaquin	4,157,535	$103.94	1,776	$59
Kings	1,487,127	$37.18	1,669	$22
Kaweah	51,566	$1.29	444	$3
Tule	43,514	$1.09	145	$8
Kern	492,774	$12.32	716	$17
North Lahontan	17,023	$0.43	409	$1
South Lahontan	778,249	$19.46	149	$131
Total	24,491,894	$612.30	19,794	$31

Source: Hydropower production - FERC; Unimpaired Flow - DWR.
Notes: NA - not available.

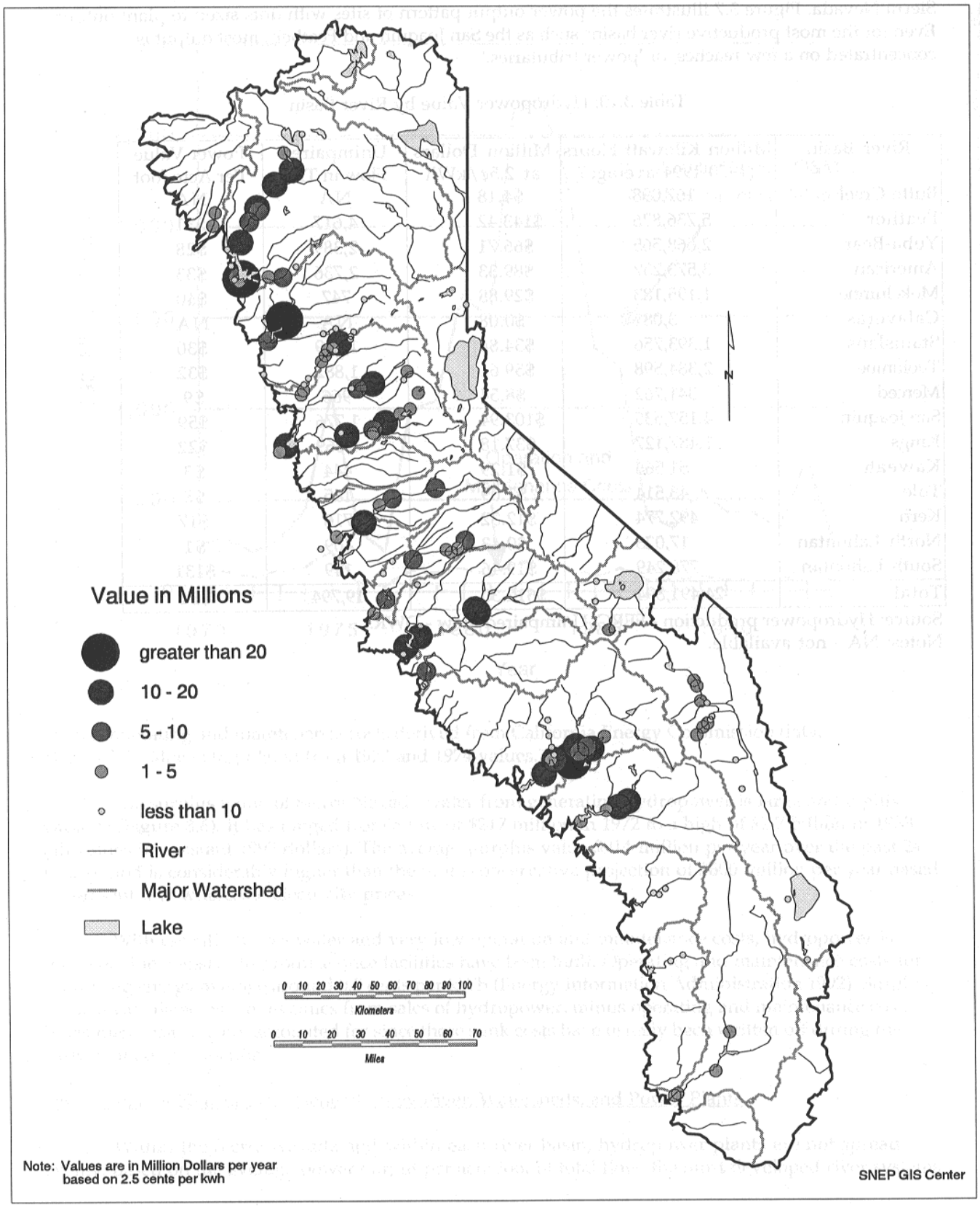

Value in Millions
greater than 20
10 - 20
5 - 10
1 - 5
less than 10
River
Major Watershed
Lake
0 10 20 30 40 50 60 70 80 90 100
Kilometers
0 10 20 30 40 50 60 70
Miles
N
Note: Values are in Million Dollars per year based on 2.5 cents per kwh
SNEP GIS Center

Figure 3.7

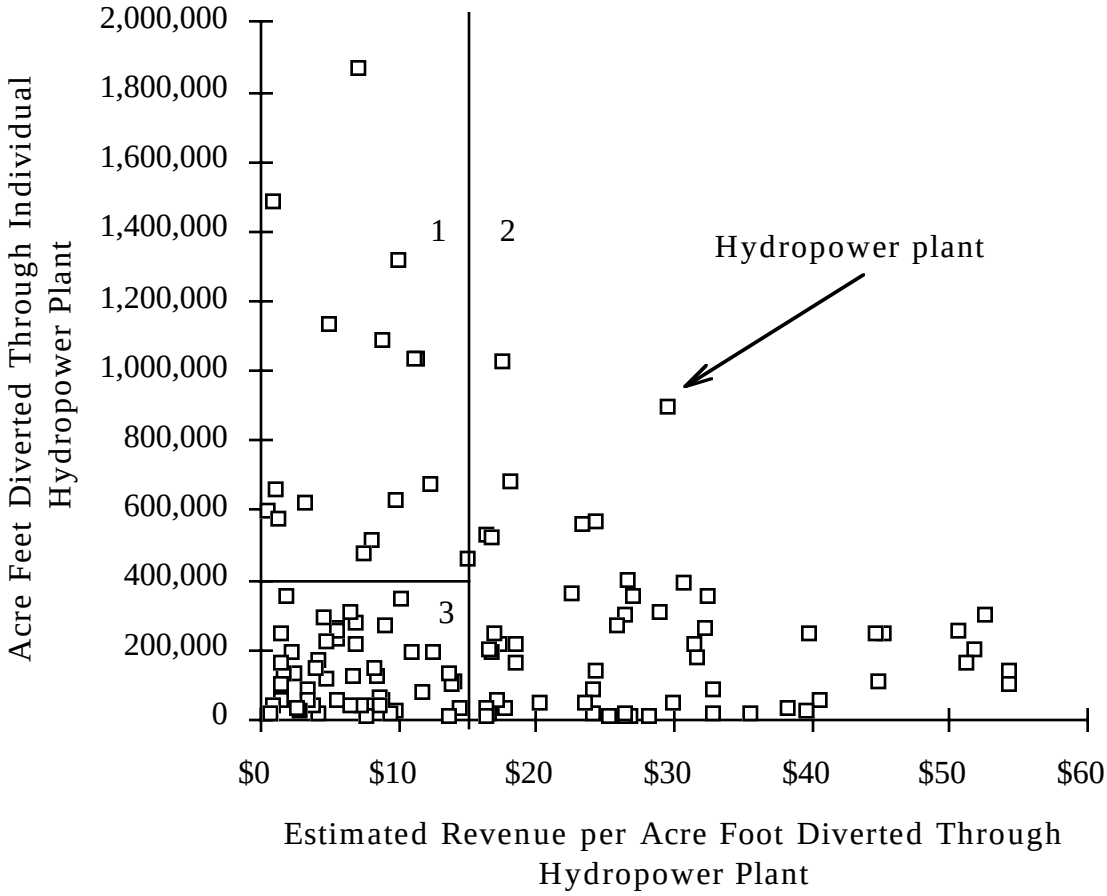
The possibility of increasing runoff to supply downstream hydropower turbines has been the focus of considerable research. Cloud seeding to increase precipitation, specific forest canopy patterns to delay the snowmelt, and vegetation removal to reduce evapo-transpiration from trees and other vegetation have all been suggested as means to increase the value of Sierra Nevada runoff (Romm et. al. 1988; Marvin 1996). Based on a methodology similar to that used by Romm and Ewing (1987), Figure 3.7 illustrates the potential hydropower value of one additional acre foot of runoff from each planning watershed in the Sierra Nevada study region. Watersheds immediately upstream of long vertical drop hydropower sites would produce very large revenues per acre foot while watersheds flowing directly into the foothill reservoirs would produce very little additional value.

The variation in the economic value derived from hydropower production is also apparent at the level of individual power plants. Across the whole Sierra Nevada, 40 million acre feet of water go through hydropower turbines in an average year. This is twice the total annual flow, since a considerable amount of water goes through a sequence of turbines. Overall, each acre foot diverted through turbines produces $15 of electric power valued at a wholesale power rate of 2.5 cents/kWh. Hydropower facilities typically associated with the large multipurpose dams in the Sierra Nevada produce nearly half the power because so much water is diverted through their turbines. Of the remaining 99 hydropower facilities, the half with large vertical drops divert the same amount of water as the sites with smaller vertical drops but produce more than five times as much power. The financial benefits for the less efficient sites are relatively small relative to the amount of water they divert from Sierra Nevada rivers. Figures3.8 and 3.9 illustrate the substantial variation in hydropower production in terms of location and plants.

Table 3.11: Hydropower Facility Typology

Figure 3.9 Reference	Type of Facility	Number of Facilities	Percent of total diversions	Percent of total power	Average $/AF	Total Value Million Dollars
1	Large multi-purpose	25	66%	47%	$11	$289
2	More efficient	49	18%	45%	$38	$276
3	Less efficient	50	16%	8%	$7	$47

Figure 3.9 : Volumes and Financial Efficiency of Hydropower plants



Note: the two large dams of the State Water Project (Oroville Dam and Thermalito) are not shown in the figure but are included in the calculations.

Hydropower in the Sierra Nevada is produced by both public entities and private corporations. Pacific Gas & Electric generates the most power of any single producer in the region (Table 3.3). Irrigation districts serving various communities in the Central Valley and the Sierra Nevada combine to make up the second largest type of institutional owner. Of the more distant urban water rights holders, Sacramento and San Francisco receive large hydropower benefits compared to the Los Angeles Department of Water and Power and the East Bay Municipal Utility District.

Table 3.12: Power Production by Institution

Institution	Pct of Total Power Production
Pacific Gas & Electric Co.	32%
Irrigation Districts	20%
Southern Calif. Edison Co.	18%
State Of California	9%
Hetch Hetchy Water and Power	8%
Sacramento MUD	7%
U.S. Bureau of Reclamation	4%
Los Angeles Dept. of Water and Power	2%
East Bay MUD	0.4%

calculated from FERC records

Values of Water for Direct Recreational Use and Indirect Recreational uses

The recreational value of in-stream water is difficult to measure because few direct fees are collected and the availability of the water is only one component of many recreational experiences. A large fraction of recreation in the Sierra Nevada is closely associated with lakes, rivers, and streams but it is difficult to assign a dollar value to the in-stream value. Based on estimates of the consumer value or willingness to pay for just two related activities—recreational fishing and white water rafting, the annual value is in excess of $250 million. Using the travel cost method, the Forest Service estimated the value of a day of fishing at $18.96 (McCollum 1990) . Based on the total number of fishing days estimated by the Forest Service on National Forests within the Sierra Nevada, the total economic value of recreational fishing in the Sierra Nevada is $146 million (Tripp and Rockland 1988) . The estimate of recreational fishing at reservoirs, lakes and rivers outside of National Forests could increase the overall economic value to over $200 million.

White water rafting is the second most significant recreational use of Sierra Nevada water with an estimated 849,000 visitor days per year on rivers within the Sierra Nevada (Department of Water Resources 1994) . Based on an average cost of commercial trips of $80/day and two thirds of the trips being commercial (George Wendt 1995), the recreational value is over 50 million dollars annually. Fishing and white water rafting are just two activities dependent on maintaining high quantities and high quality of the water bodies which comprise a critical component of the large recreational industry in the Sierra Nevada. The millions of dollars spent to maintain high water quality in the Lake Tahoe Basin is additional evidence of the importance of in-lake and in-stream flows.

Total Economic Benefits of Agricultural, Municipal, Hydropower and Recreation-related Water Uses

The lack of an active market among different users of diverted or in-stream water uses makes it impossible to place a single dollar value on water use for all sectors. A variety of alternative approaches are used to develop dollar values for different water uses. The marginal value of water for different uses is estimated using approaches similar to those reviewed in Boggess et. al. (1993). The primary approach uses a value based on the cost of alternative supplies purchased in the limited water markets. The value for environmental uses is based on the price paid in 1995 for water purchased under the CVPIA for use in wetlands throughout the region. Municipal water values are based on current costs for water supplies being purchased by growing metropolitan regions.

Different levels of subsidies for agricultural water supplies limits the usefulness of current delivery prices to estimate the value of water used for different crops. The values assigned to water used in agriculture in different agricultural regions are based on regional shadow values of ground water calculated in different regions as calculated by the Department of Water Resources (Farnam 1994), and

as a fraction of the total revenue per acre foot of water applied to the most common crops grown in different regions. A recent analysis of the crop-specific and region-specific revenues per acre foot of irrigation water (Sunding et. al. 1995) illustrates a range from $15 to $1,000 per acre foot for different crops grown with water diverted from Sierra Nevada rivers. The estimated values of water rights for different uses in different agriculutral regions are summarized in table 3.13.

Table 3.13 Farm Revenue per Acre Foot of Irrigation Water

Crop	Revenue per acre foot (AF) of water
Pasture	$15-$19
Rice	$44-$65
Field crops	$60-$140
Row crops	$176-$259
Vegetables	$451-$843
Orchards, Vineyards	$337-$940

Source : (Sunding et. al. 1995)

Table 3.14: Estimated Economic Value of Water Rights for Different Uses

Use and Location	$/acre foot	Rationale
Agriculture		
Sierra Nevada (SN)	$10	Irrigated pasture and hay make up 90% of irrigated acreage (Agricultural Commissioners Reports)
River Basin (IR)	$25	Earlier irrigation projects along Sacramento River and on east side grow medium value crops. Cost of ground water pumping vary from $30 to $100 depending on ground water basin (Farnam 1994)
Inter-basin export (EX)	$100	High value cotton and orchard crops are major consumers (Sunding et. al. 1995).
Municipal		
Sierra Nevada and River Basin (SN and IR)	$50	Urban suppliers charge from $400 to $700 per acre foot in these areas (Black + Veatch 1995)
Inter-basin export to coastal cities (EX)	$100	Southern California's Metropolitan Water District is purchasing new water rights of $150 to $175 per acre foot. Average urban water rates vary from $700 to $1,000 per acre foot in major coastal metropolitan areas (Black + Veatch 1995) .
Environment		
Riparian areas and wetlands (SN and IR)	$25	CVPIA and FWS purchase water at $25/AF for wetlands in Sacramento Valley (USBR 1995).

Based on the estimates in table 3.13, the water use volumes in table 3.14 can be converted into economic value of the water rights for different end users. Future evidence from direct water marketing or more detailed pricing analyses should be used to improve these initial estimates.

Table 3.15: Water Use in Thousand Acre Feet by Hydrologic Region and End Use

	Agriculture			Municipal			Environment		Hydro-power	Total Water Use
Region	SN	IR	EX	SN	IR	EX	SN	IR	see Note	
Sacramento	373	2,791	953	79	289	1,589	1,420	999	24,159	8,495
San Joaquin	21	3,552	983	43	181	575	554		12,641	5,909
Tulare Lake	20	3,585		5	95		34		2,251	3,739
S. Lahontan	147	16		15	12	437	128		1,186	755
N. Lahontan	460		580	31	3	40	17	550	163	1,681
Totals	1,021	9,945	2,517	173	581	2,641	2,153	1,549	40,400	20,580

Note: Water used for hydropower is temporarily diverted through turbines and is not a consumptive use as are the agriculture, municipal, and environmental end uses.

Table 3.16: Estimated Economic Water Value by Hydrologic Region and End Use

	Agriculture			Municipal			Environment		Hydro-power	Total Water Value
Est. Value / AF	$10	$25	$100	$50	$50	$100	$25	$25	NA	
Region	SN	IR	EX	SN	IR	EX	SN	IR	SN	
Sacramento	$4	$70	$95	$4	$14	$159	$36	$25	$299	$706
San Joaquin	<$1	$89	$98	$2	$9	$58	$14		$237	$507
Tulare Lake	<$1	$90		<$1	$5		$1		$52	$148
S. Lahontan	$1	<$1		$1	$1	$44	$3		$19	$70
N. Lahontan	$5		$58	$2	<$1	$4	<$1	$13	$5	$73
Totals	$10	$249	$252	$9	$29	$264	$54	$38	$612	$1,516

Legend : SN - within Sierra Nevada; IR - within hydrologic region; EX - inter-basin transfers.
Source: (California Department of Water Resources, 1994).
Note: The Sacramento region excludes the main Sacramento River and all western tributaries.

When the different economic value of water to various users is accounted for, the economic benefits are dominated by hydropower users (40%) and irrigated agriculture (34%). The economic value of municipal water use (20%) is proportionally greater than the volume used because of the high value to large metropolitan areas of a steady supply of high quality water. The extensive infrastructure to move water through hydropower turbines and out of natural drainage basins leads to three quarters of the economic value going to users who are not in the natural drainage basins of the rivers. Water uses allocated to environmental uses in Wild and Scenic rivers and in wetlands (including a small share for the Bay-Delta) accounts for a relatively small share of total water volume or value.

Conclusion

Large scale water diversions are the source of a considerable portion of the value produced by the Sierra Nevada ecosystem. Major reservoir capacity in the Sierra Nevada is now equal to the unimpaired flow of all the major rivers. In an average year, 40 million acre feet, double the unimpaired flow, is taken out of streams , run through hydropower turbines and returned. Nearly two thirds of the water diverted from Sierra Nevada rivers and streams goes to irrigated agricultural in the Central Valley. The remaining water diverted out of the rivers goes to municipal users and wetland habitats in the Central Valley.

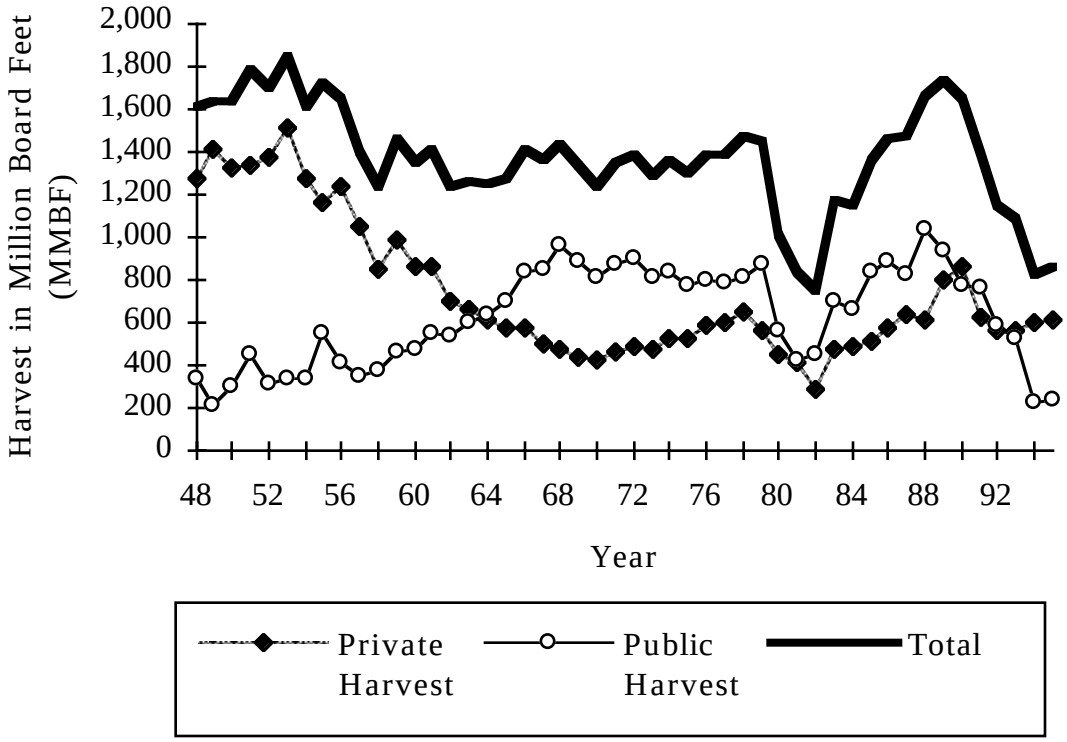
Water diversions are both a major source of economic value to the eventual users and the cause of much of the decline in fish populations and other water dependent populations and habitats. The estimated annual value of the right to divert water from the Sierra Nevada is approximately $1.5 billion. Hydropower, followed by irrigated agriculture and municipal uses in distant cities, are the three largest sources of economic value. Recreation associated with in-stream flows is also a major source of economic value.

The large economic benefits of water diversions and in-stream flows produce few direct payments, user fees, or taxes. The value of both diverted and in-stream water flows are not uniform across the Sierra Nevada. The non-random patterns of economic value and aquatic value suggests considerable scope for potential approaches to improve aquatic conditions dependent on more natural flows with limited reductions in the total economic value derived from Sierra Nevada water.

CHAPTER 4: FEDERAL AND PRIVATE TIMBER IN THE SIERRA NEVADA

Timber harvesting and management have been central facets of land use in the Sierra Nevada since 1850. The present timber resource base of the Sierra Nevada includes 2.4 million acres of private timber lands and 4.6 million acres of federal land on which commercial timber harvesting is allowed. In general, private timber lands are at lower elevations, have higher site quality, and have been harvested continuously since the Nineteenth Century. Much of the federal timberland is at higher altitude, often of lower site quality, and was not harvested, if at all, until after World War II. Since 1948 records of private and public timber harvests have followed two distinct patterns. Private harvests peaked in 1952 and have only recently begun to increase since a harvest nadir around 1970. Federal harvests climbed rapidly after World War II and stabilized at a plateau of 800 million board feet from 1966 until 1979. Large fluctuations in timber markets in the 1980s and the 1990s affected both public and private harvest levels. Policy changes for both federal and private lands during the 1990s has increased the variability in harvest levels and uncertainty over future harvest levels.

Figure 4.1: Private and Public Timber Harvests 1948-1995



Sources: USFS PNW and Zivnuska et. al. (1965) for 1948-1978, California State Board of Equalization 1978-1995.

Regional Forest Productivity

Two types of site productivity measurements are used for taxation of private lands and forest planning on federal lands respectively. Region-wide comparisons of site productivity are difficult because neither measurement is available for all forested acres within each county. If harvest levels are assumed to be proportional to site productivity, then the long term harvest averages provides a measurement of forest productivity in the Sierra Nevada. The most productive forests in the Sierra

Nevada are those in the central Sierra Nevada. Forests in both the northern and southern ends of the Sierra Nevada have lower site quality and considerably lower harvests per total commercial forest acre levels. A comparison of average harvest levels from 1948 to 1977 and 1978 to 1994 shows a slight drop in the average harvest per acre as the harvest pattern shifted from old growth to young growth stands.

Table 4.1: Total County Harvest per Acre of Total Commercial Forests 1948-1977 and 78-94

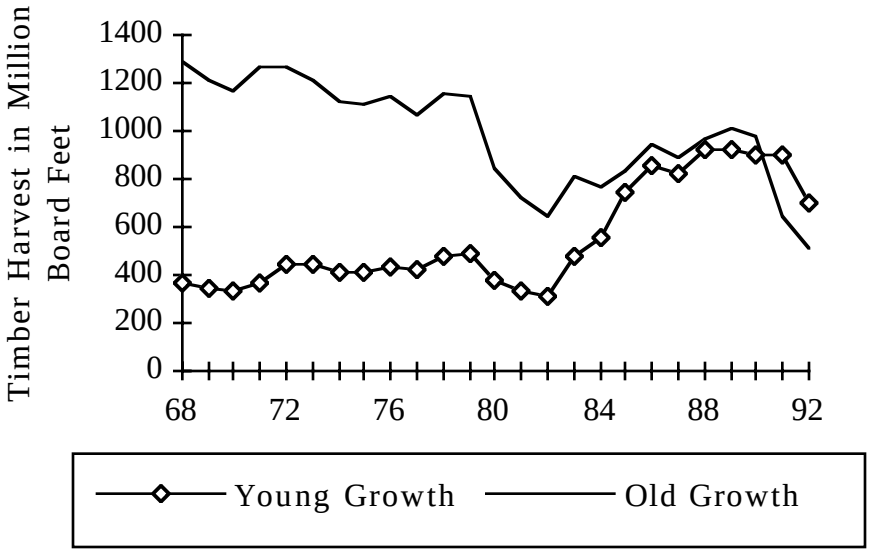
Major Timber Producing Counties	Board Feet / Acre 1948-1977	Board Feet / Acre 1978-1994
Lassen	221	147
Plumas	200	175
Sierra	202	206
Butte	246	209
Yuba	508	276
Nevada	223	152
Placer	252	222
El Dorado	391	351
Amador	358	461
Calaveras	433	346
Tuolumne	296	244
Mariposa	80	163
Madera	236	201
Fresno	237	210

Source: harvest - USFS PNW and California Board of Equalization; commercial forest acreage (1985) - USFS PNW.

Harvest Composition

From an economic perspective , the two most significant changes in timber harvests in the Sierra Nevada over the past two decades have been the increase in the harvest of young or second growth timber and the increasing prices for what had traditionally been considered lower grade timber. After 1982, the level of young growth harvests more than doubled while old growth harvests have steadily declined. Most of the timber harvest from private land now consists of young growth trees. Restrictions on old growth harvests on federal lands have also increased the relative importance of young growth harvests. Compared to other regions of California, the Sierra Nevada is less dependent on old growth harvests and has more acres of mature young growth forests which can produce sustainable harvests.

Figure 4.2: Young and Old Growth Harvests in the Sierra Nevada, 1968-1992



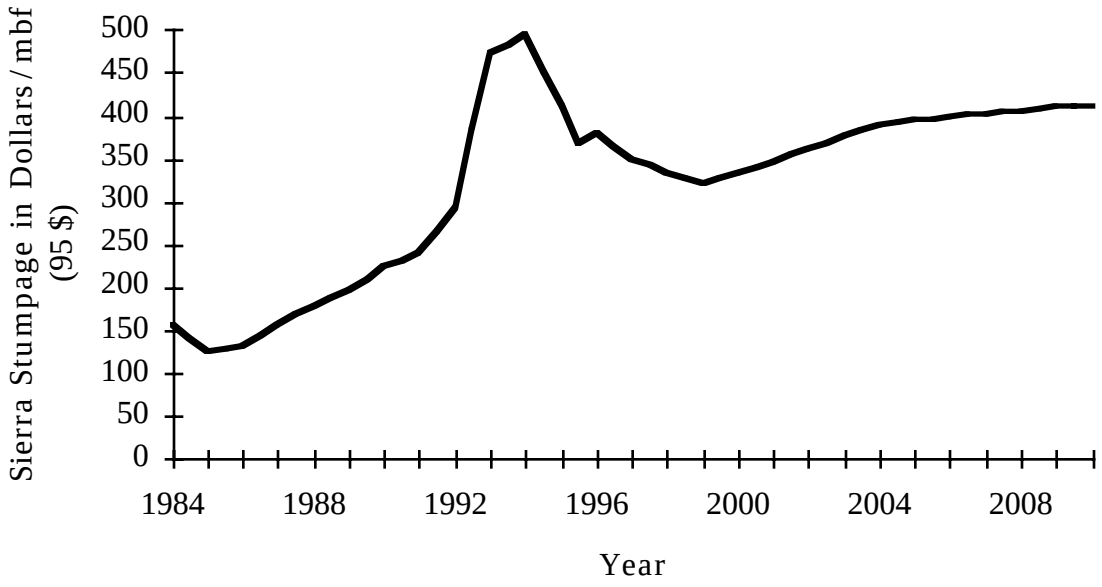
Source: USFS PNW.

Young growth, fire and disease salvage, and firs have consistently receive lower prices than old growth, green trees, and pines but the gap has narrowed. These relative values have changed in recent years as producers and consumers have responded to constraints on the supply of higher quality stumpage. Lower quality stumpage received 43% of the value of higher quality stumpage on average between 1978 and 1988 . Since 1995, lower quality stumpage has received an average of 61% of higher quality stumpage (California State Board of Equalization Various Years-a). This increase in the relative value of lower value trees may have significant impacts on the priorities for timber management. In particular, many types of multi-product sales that previously had been considered as uneconomical may be viable if the lower value products receive higher prices.

Revenue Flows from Timber

Total revenue from timber harvests have not been proportional to harvests due to the pattern of stumpage prices over the past ten years. Since the California State Board of Equalization began publishing summaries of stumpage prices by county and species, average Sierra Nevada stumpage rates rose steadily from 1985 to 1992 and then escalated very rapidly between 1992 and 1994. California State Board of Equalization values for 1995 and 1996 as well as long term price trends used by some timber industry consultants (Rinehart 1995) suggest that prices are dropping and will return to the price trajectory of the 1985-1992 period. Projections of revenue based on the high stumpage prices received in the early 1990s will significantly overstate probable revenues over the next decade if these prices follow the projected path suggested by recent stumpage prices.

Figure 4.3 : Price Trend and Projections for Sierra Stumpage, 1984-2010



Sources: California State Board of Equalization 1984-1996 and Rinehart and Associates for timber price projections 1996-2010. Prices in constant 1995 dollars.

Total Harvest Value

The doubling of stumpage prices from the 1980s to the 1990s led to a large increase in the total harvest value from the Sierra Nevada over the past decade. In the 1990s, the value of private timber harvests surpassed the value of public timber harvests for the first time in more than three decades . County revenues from the Forest Service revenue sharing stayed relatively stable until 1994 when very low volumes and lower prices combined to reduce overall public harvest value to its lowest level in a decade. The average value of all public and private stumpage over 1984 to 1994 period was 318 million dollars (1995 dollars).

Table 4.2: Stumpage Value in Million 1995 Dollars

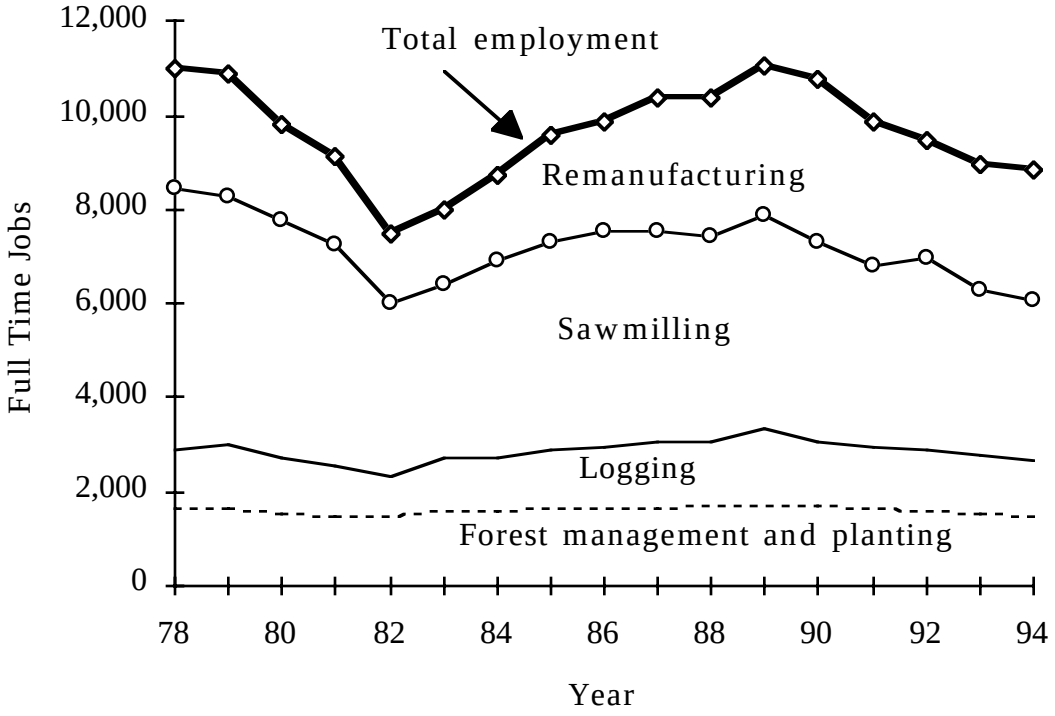
Year	Public Harvests	Private Harvests	Total Harvests
1984	109	77	185
1985	104	69	173
1986	128	83	211
1987	158	105	263
1988	186	135	322
1989	171	178	349
1990	167	212	379
1991	186	177	362
1992	146	193	339
1993	186	326	513
1994	96	310	406

Source: California State Board of Equalization

Employment

Direct employment in timber management and harvesting in the Sierra Nevada reflects a combination of changing harvest levels, increases in labor productivity, and changes in the types of wood products produced in the Sierra Nevada region. Since the low point of harvests and employment in 1982, overall employment rose rapidly until 1990 and has since declined. Most of the employment growth has occurred in the remanufacturing sector. Increased labor productivity in the logging and sawmill sectors slowed the increase in job creation during the increasing harvest levels during the latter half of the 1980s.

Figure 4.4: Total public and private sector jobs in timber industry



Source: Employment Development Department. Forest management and employment estimated from U.S. Forest Service employment records and timber industry case studies.

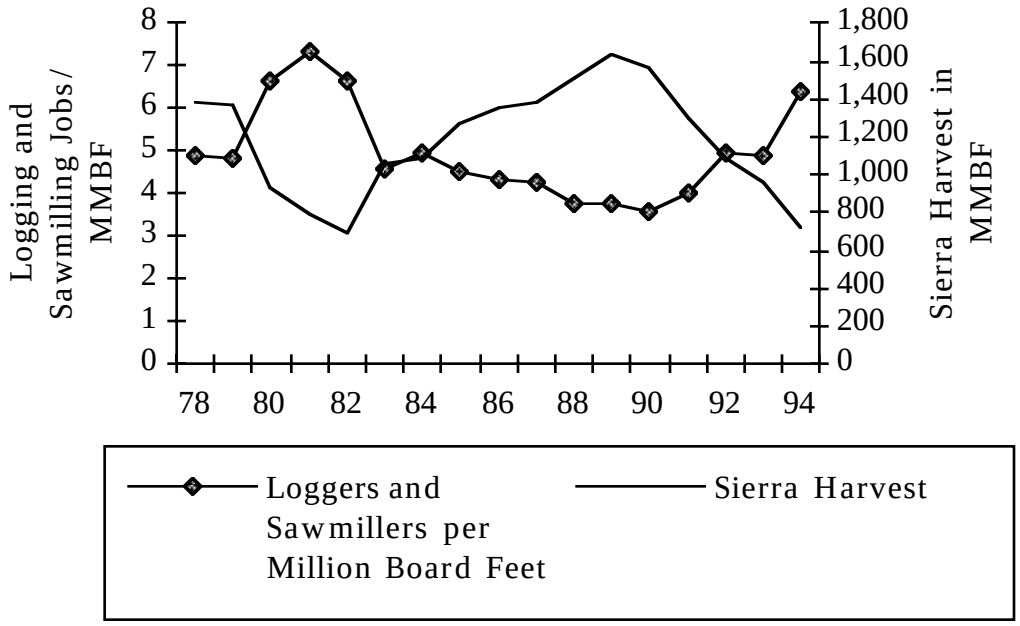
During the 1990s, sawmills went through a period of consolidation similar to that which occurred after the 1982 recession. Sawmills constructed on optimistic projections of continuing high Forest Service harvests of the late 1980s increased capacity above actual harvest levels and led to the closure of a number of older mills. From 1987 to 1992, milling capacity dropped by 7% while the number of mills dropped by 43% (from 38 to 22). Since 1992 there has been further consolidation owing to declining federal harvests as well as technological change in sawmilling. Employment associated with timber harvesting has historically been a large portion of total Sierra Nevada manufacturing employment. Employment derived from Sierra Nevada timber resources is of two principal types: employment directly tied to resource extraction, mainly logging and sawmilling, and employment tied to wood products remanufacturing. The first type is by necessity based in the region where the trees grow; the second is often located closer to transportation networks and final demand.

Timber employment in the SNEP region accounts for less than 5% of total employment in all but three counties—Amador, Plumas and Sierra. Regionally, timber employment as a percentage of all employment decreased from 3.4% to 2.6% for the counties totally within the Sierra Nevada during the 1978 to 1994 period. For the twelve counties fully within the SNEP region, timber employment dropped from 63% of all manufacturing employment in the Sierra Nevada in 1978 to only 29% in 1993 (U. S. Bureau of the Census 1980; U. S. Bureau of the Census 1995).

Contrary to standard assumptions, timber industry employment has not varied linearly with timber harvest levels. An analysis of data covering the past fifteen years suggests three reasons for the differences. First, labor productivity is increasing due to new technology and smaller logs. Second, short term rigidities in sawmill staffing reduce layoffs as long as sawmills stay open. And finally, market-led rather than raw material-led changes in wood remanufacturing employment represent the majority of the net changes in timber industry employment.

The following figure illustrates a long term decline in labor requirements and an inverse relationship of labor requirements and harvest levels in the Sierra Nevada. Over time, 1 to 1.5 loggers are required per million board feet of timber harvest in the Sierra Nevada. The number of sawmillers pre million board feet dropped to 2.5 in 1990 and climbed to over 5 during periods of very low harvest levels. Industry wide adoption of more efficient sawmilling technology and consolidation within the industry will most probably drive long term labor requirements towards the level achieved during 1989 and 1990.

Figure 4.5: Labor Requirements and Timber Harvest Levels in the Sierra Nevada



Sources: Employment - Employment Development Department; Harvest - California State Board of Equalization.

Employment in the wood remanufacturing sector has grown consistently over the past fifteen years and now employs more workers in the Sierra Nevada and Central Valley than logging and sawmilling combined. Many of these jobs are in counties outside the Sierra Nevada and the operations are not dependent on raw material from the Sierra Nevada and can purchase supplies from across the western United States and Canada. In 1992, approximately 50% of lumber arriving at remanufacturing

facilities in the Central Valley was from California, 40% from Oregon, and the balance came from other regions (Stewart 1993). As timber harvests dropped in the 1990s, wood remanufacturing employment was buoyed up by overall market demand and did not shrink as much as employment in logging and sawmilling.

Regional Employment Patterns

The following tables present timber related employment in four regions of the Sierra Nevada. Logging and sawmilling employment is relatively evenly spread among the four regions while remanufacturing employment is concentrated in only two regions. The lack of employment diversification within the timber sectors in the North and South Central regions will limit the potential to maintain or increase the number of jobs in the timber industry.

Table 4.3: Logging and Sawmilling Employment in the Sierra Nevada, 1978-1994

Year	North	North Central	South Central	San Joaquin	Total
78	1,701	1,631	1,503	1,976	6,811
79	1,518	1,575	1,560	1,970	6,623
80	1,578	1,509	1,314	1,844	6,245
81	1,383	1,514	1,095	1,783	5,775
82	1,243	1,129	933	1,256	4,561
83	1,547	1,046	932	1,326	4,851
84	1,618	1,279	1,127	1,308	5,332
85	1,499	1,435	1,240	1,547	5,721
86	1,641	1,446	1,444	1,344	5,875
87	1,692	1,594	1,369	1,243	5,898
88	1,692	1,626	1,256	1,167	5,741
89	1,802	1,734	1,411	1,246	6,193
90	1,715	1,667	1,171	1,059	5,612
91	1,424	1,394	1,320	1,069	5,207
92	1,439	1,384	1,359	1,213	5,395
93	1,414	1,248	1,300	770	4,732
94	1,424	1,109	1,438	601	4,572

Source: Employment Development Department. North includes Plumas, Sierra and Lasssen.

Table 4.4: Remanufacturing Employment in the Sierra Nevada, 1978-1994

Year	North	North Central	South Central	San Joaquin	Total
78	225	578	52	1,677	2,532
79	194	647	85	1,710	2,636
80	182	416	39	1,398	2,035
81	147	374	29	1,325	1,875
82	104	284	34	1,039	1,461
83	117	362	46	1,066	1,591
84	130	447	55	1,204	1,836
85	110	513	69	1,538	2,230
86	110	546	60	1,631	2,347
87	120	716	113	1,912	2,861
88	100	766	131	1,973	2,970
89	86	904	186	1,988	3,164
90	80	1,180	238	2,001	3,499
91	71	1,033	86	1,826	3,016
92	67	686	78	1,692	2,523
93	39	689	69	1,913	2,710
94	37	732	54	1,952	2,775

Source: Employment Development Department. North includes Plumas, Sierra and Lasssen.

Employment Projections

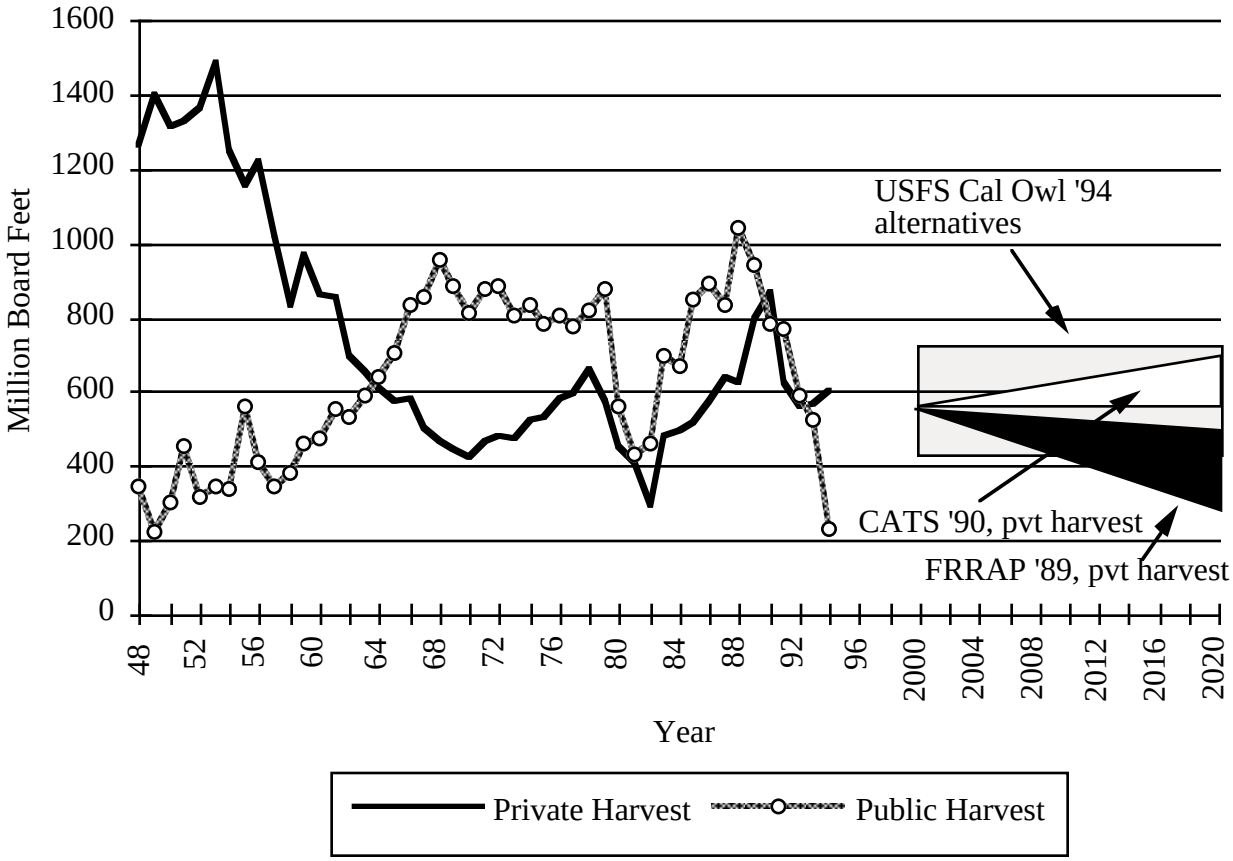
Employment in the timber industry will depends on total harvest levels as well as the business decisions of individual businesses regarding consolidation, new investment, and product diversification. If capacity utilization returns to high levels achieved during 1989 and 1990, the logging and sawmilling jobs per million board feet of harvest will probably decline to less than four jobs per million board feet, rather than six or seven jobs per million board feet experienced during the low harvests of 1993 and 1994. Employment in the remanufacturing sector is concentrated in the regions closer to transportation networks and final markets. An expansion in remanufacturing employment in regions and communities that have been more dependent on logging and sawmilling jobs requires new investment in retooling sawmills or adding new production facilities.

Public and Private Harvest Projections

Recent published projection of future harvest levels vary widely because they use slightly different forest growth computer models and very different policy assumptions. The figure below compares three sets of projections with historic harvest levels. The historic harvests cover the counties from Lassen to Kern. The federal harvest projections are from the 1995 draft California Spotted Owl Environmental Impact Statement (EIS) (USDA Forest Service 1995). The final EIS will be published in 1996 and was not available for this analysis. The different Forest Service harvest levels are primarily a function of how much land is taken out of the existing timber base and managed for non-commodity values. The CATS projections were made by Krumland and McKillop (1990) for private forest lands in the California. They assume nearly all non-industrial owners would harvest their inventory based on a price response function common to larger industrial owners. Their estimate is the top of the white triangle. The bottom side of the white triangle is simply a constant harvest level from the baseline. The Forest and Rangelands Resources Assessment Program (FRRAP) estimate was based on a forest growth model that was more conservative than the one used by Krumland and McKillop as well as an analysis of actual harvest rates by ownership class. A major difference is their assumption that non-industrial owners will continue to harvest at the low rates they documented during the 1970s and 1980s.

The lower edge of the black triangle is the harvest estimate and the upper edge is the growth estimate. The lower estimate would be more realistic if private timber land owners increasingly valued forest for their non-timber values as opposed to their harvest value. It is apparent that all the estimates are strongly influenced by institutional assumptions regarding the timber and non-timber values to the decision making institutions. Different assumptions result in estimates of plus or minus 50% over the median estimates for both public and private timber harvests.

Figure 4.6: Historic and Projected Sierra Nevada Timber Harvests



Sources: Historic harvests - USFS PNW, Zivnuska et. al., California State Board of Equalization; Projected harvests - Krumland and McKillop (1990), Forest and Rangeland Resources Assessment Program (CDF 1988), and USFS (1995).

Costs of Forest Service Ecosystem Management

Since 1991, the Forest Service shifted towards methods of forest management designed to provide more attention to non-timber attributes of the forests such as wildlife habitat, riparian zones, and old growth stands. Overall employment for the National Forests in the Sierra Nevada increased slightly even though timber harvests declined. Based on Forest Service employment classifications, the most significant employment shifts have been the reduction in new road building (civil works) and reduction in the timber operations staff within the broader forestry and fire protection category. Staffing levels are now more closely tied to the total land area that is managed than timber output. The Plumas National Forest, for example has historically been the major timber producing forest in the Sierra Nevada and is the lowest staffing per forested acre or timber output. It was the only National Forest to have a significant decline in total staff between 1986 and 1994.

Table 4.5: Forest Service Staffing Patterns by National Forest

National Forest	1986	1994
Eldorado	274	339
Inyo	166	170
Plumas	415	350
Sequoia	275	274
Sierra	329	341
Stanislaus	307	338
Tahoe	318	321
LTBMU	86	94
Region Office	412	514
Sierra Forests	2,170	2,227
Sierra share of Regional Office staff	171	231
All Sierra	2,341	2,458
Total Region	5,635	5,478

Table 4.6: Forest Service Staffing Patterns by Job Type

Staffing	1986	1994
Total Region 5 Employees	5,635	5,478
Ecosystem Scientists	5%	7%
Forestry and Fire Protection	50%	49%
Range	1%	1%
Civil Works	11%	7%
Organizational (includes recreation)	34%	36%

Source: Region 5 Employment Records, USDA Forest Service.

Cost Accounting for Federal Timber Programs

The combination of reduced harvest levels and more intensive planning and in-forest management has led to significant increases in unit costs according the accounting methodology used in the Timber Sale Program Information Reporting Systems (TSPIRS) methodology. Unit costs for the Sierran forests have increased at a rate considerably less than the National Forests covered by northern spotted owl requirements but at a rate faster than the Lassen and Modoc National Forests where there are no new planning requirements.

Table 4.7: Timber Program Expenses per Thousand Board Feet for Selected National Forests in California

Year	Northern Spotted Owl National Forests	Sierra Nevada National Forests	Lassen and Modoc National Forests
1988	$78	$61	$57
1989	$93	$69	$58
1990	$104	$73	$61
1991	$112	$83	$61
1992	$154	$107	$74
1993	$201	$124	$87
1994	$225	$142	$86

Source: TSPIRS various years. Values in constant 1995 dollars.

Table 4.8: Cost Breakdown of Timber Management in Northern California Forests (Average costs per mbf between 1991-94 in 1994 dollars)

Cost Categories	Northern Spotted Owl National Forests	Sierra Nevada National Forests	Lassen and Modoc National Forests
Fixed Costs	$77	$51	$33
Variable costs	$83	$55	$38
(planning)	$33	$26	$17
(ecosystem analysis)	$17	$14	$8
(reforestation)	$29	$12	$9
(silviculture)	$5	$4	$4
Total	$161	$106	$71

Source: TSPIRS various years. Values in constant 1995 dollars.

The cost differentials between different national forests can not be ascribed to any specific activity as similar differences were reported for all fixed and variable costs (Table 4.7 and 4.8). Costs associated with additional ecosystem analysis averaged $14 per million board feet for the 1991-1994 period. Ecosystem analysis costs account for only 10 to 13% of the total costs in the National Forests in the Sierra Nevada.

Trends in Costs and Revenues from Federal Timber Harvesting

Even with increasing costs, the Sierran Forests have continued to produce a significant financial surplus after accounting for the 25% share of gross receipts given to the counties. With the exception of the Sequoia National Forest, no National Forest in the Sierra Nevada was close to becoming a below cost forest according to the TSPIRS accounting system for the period 1991 to 1994. The implication for the upcoming decade is that revenues per board foot may drop while harvest costs will increase.

Table 4.9: Estimated Net Revenue per Thousand Board Feet after TSPIRS Costs and County Revenue Sharing, 1988-94

Year	Northern Spotted Owl National Forests	Sierra Nevada National Forests	Lassen and Modoc National Forests
1988	$35	$48	$128
1989	$36	$39	$139
1990	$35	$32	$147
1991	$23	$28	$119
1992	$33	$20	$122
1993	$5	$43	$95
1994	-$8	$38	$141

Source: TSPIRS various years. Values in constant 1995 dollars.

Since 1993 timber harvests have been classified as forest stewardship (based on ecosystem management principles) or timber commodity (designed to help meet the demands of US citizens for wood products) (USDA Forest Service 1993). Although the revenue per million board feet was higher for timber commodity sales because of larger diameter and higher quality stumpage, the cost per million board feet for the forest stewardship program was 10% lower on every forest that produced a significant volume of timber in 1993 and 1994.

Conclusion

Timber harvesting on both private and public land is increasingly dominated by second growth or young growth trees. Sustainable timber harvesting policies that maintain the desired ecological viability of forests at a landscape level are under review for all types of land ownerships in the Sierra Nevada. Projections of future timber harvests vary widely because of different policy assumptions and forest growth models. It appears probable that private harvests may equal or exceed public harvests over the next few decades.

Timber industry output and employment have exhibited strongly cyclical patterns over the past fifteen years. Consolidation in logging and sawmilling sectors and expansion of remanufacturing sector have shifted activity towards the Central Valley and away from sites within the forest. The total number of mills has dropped considerably but employment has fluctuated around 10,000 workers over past fifteen years. Long term employment will depend on technological innovation; whether value-added remanufacturing is done in the Sierra Nevada or elsewhere ; and the total of public and private harvest levels.

Both public and private forestry are striving towards more realistic accounting of full costs and benefits of forest management costs so that addresses both timber and ecosystem values. Two preliminary conclusions come out of an analysis of the costs of federal forest management in the 1990s as reported in the TSPIRS accounting system. The direct costs of ecosystem management as measured by the forest stewardship programs and additional ecosystem analysis costs are minimal and appears to increase in-forest costs less than 15%.

CHAPTER 5: PRIVATE ECONOMIC SECTORS - AGRICULTURE, COMMERCIAL RECREATION, AND RESIDENTIAL DEVELOPMENT

Ranching on private lands and on public leases is the most extensive land use in terms of area in the Sierra Nevada. Irrigated agriculture is also prevalent throughout the region where water resources have been developed. Commercial recreation complements the extensive area of public land where recreation is promoted and produces the greatest amount of revenue from direct use of land and water resources. Finally, residential development is expanding rapidly and represents the largest change in total value of all natural and human assets in the Sierra Nevada. Each of these sectors is dealt with in greater depth elsewhere in the SNEP Assessment. The primary purpose of this section is to integrate the economic impacts of these sectors with the more traditional timber and water sectors.

Ranching

Private ranches cover approximately four million acres of the 20 million-acre SNEP region. In addition, grazing permits and leases cover most Forest Service, Bureau of Land Management, and most large private industrial timber lands. Grazing on both private and public lands is therefore the most extensive type of land use in the Sierra Nevada. The ecological aspects of grazing are covered in Menke (1996) and Kinney (1996). This section summarizes some of the major economic aspects of the ranching industry in the Sierra Nevada. Close links between ranching activities in the Sierra Nevada and the larger livestock industry of the Central Valley of California, as well as the western portions of Nevada, make it difficult to fully separate Sierra Nevada dependent activities from pasture- and feed lot-based activities. In a number of instances we excluded counties where most of the livestock industry is outside of the SNEP region.

Grazing by Ecological Types

Of National Forest lands available for grazing, only 75% of the actual Animal Unit Months (AUMs) are used by the lessees (USDA Forest Service 1993-b). The following tables summarize grazing in the Sierra Nevada region (including parts of Shasta and Tehama counties) by land owner and vegetation cover type. Based on a study of California's livestock industry done for the California Department of Forestry and Fire Protection (CH2M Hill 1989), most of the forage value comes from the oak woodlands on the western side of the Sierra Nevada. Conifer land is the single largest vegetation type grazed but produces only 8% of the revenues and 10% of the total forage. The market value calculations are proportional to the forage value of the lands and do not include any differences for water supplies, fencing or other services that may be included in market based AUM rates. Much of the grazed land is owned by the Forest Service or the Bureau of Land Management. Based on AUM and fee estimates, federal lands account for 34% of the acres, 15% of the forage, and only 3% of the total revenue.

Table 5.1: Grazing by Vegetation Cover Type in Sierra Nevada and Portions of Modoc Plateau

Vegetation Type	Grazed Acres	Revenue in 1995 Dollars	Full Market Value of Forage
Chaparral	772,964	1,716,494	1,958,774
Conifer	4,004,815	3,542,229	5,532,470
Desert	1,186,396	729,409	882,014
Juniper	583,251	854,007	1,469,139
Oak Woodlands	2,470,022	28,873,207	30,234,514
Sagebrush	2,168,238	6,094,819	8,243,960
Wetlands	310,530	5,257,570	5,643,368
Total Area in Study	11,496,216	$47,067,737	$53,964,239
	Percent of Acres	Percent of Revenue	Percent of Full Market Value
Chaparral	7%	4%	4%
Conifer	35%	8%	10%
Desert	10%	2%	2%
Juniper	5%	2%	3%
Oak Woodlands	21%	61%	56%
Sagebrush	19%	13%	15%
Wetlands	3%	11%	10%

Source: Adapted from CH2M Hill (1989).

Table 5.2: Grazing by Land Owner

	Grazed Acres	Revenue in 1995 dollars	Full Market Value of Forage
BLM	1,172,411	374,524	2,752,402
Forest Service	2,743,916	711,699	5,230,322
Other Public	182,938	544,755	544,755
Private	7,396,951	45,436,759	45,436,759
Total	11,496,216	$47,067,737	$53,964,239
	Percent of Acres	Percent of Revenue	Percent of Full Market Value
BLM	10%	1%	5%
Forest Service	24%	2%	10%
Other Public	2%	1%	1%
Private	64%	97%	84%

Source: Adapted from CH2M Hill (1989).

Trends in the Sierra Nevada Livestock Industry

According to County Agricultural Reports, more than two million acres of private rangeland and 150,000 acres of irrigated pasture are in the counties that are fully or mainly within the Sierra Nevada. The four southern counties of Madera, Fresno, Tulare, and Kern have more than 1.7 million acres of private non-forest land in the Sierra Nevada region. Much of this land is probably in ranches but sub-county breakdowns of acreage and revenue could not be calculated due to the dominating influence of imported feed-based livestock operations in the Valley. The following tables compare the changes in the Sierra Nevada livestock industry over the past decade.

Table 5.3: Cattle Numbers, Range Acres and Irrigated Pasture Acres, 1985 and 1994

Region 1985	Cattle Numbers	Private Range	Irrigated Pasture
North	24,700	87,150	41,500
North Central	89,763	578,000	46,050
South Central	92,415	1,233,300	5,905
East Side	48,553	256,000	70,000
Total w/o San Joaquin	255,431	2,154,450	163,455
Region 1994	**Cattle Numbers**	**Private Range**	**Irrigated Pasture**
North	43,700	88,200	41,800
North Central	69,882	539,500	36,180
South Central	76,077	1,240,200	5,950
East Side	45,418	312,000	64,000
Total w/o San Joaquin	235,077	2,179,900	147,930

Source: County Agricultural Commissioners Reports.

Over the past decade, the number of cattle and acres of irrigated pasture decreased by more than 8%. Although private rangeland acres did not show any decline, it appears that the overall livestock industry in the Sierra Nevada is declining.

Other Agriculture

In addition to scattered irrigated pasture throughout the region, other irrigated agriculture is concentrated along the western fringe of the SNEP region. In the 1990 Census 4,835 households reported some farm income. The total reported farm proprietor income was $56 million. With the exception of areas dominated by ranching, the low average household income suggests that most of these operations are only part time. Throughout the early part of this century, agriculture was the major occupation throughout the Sierra Nevada (Weeks et. al. 1943). Although irrigated acreage in 1985 was nearly identical to the 219,000 acres mapped in 1922 (U. S. Bureau of Public Roads 1922), much more of the acreage is now on the western rather than the eastern side of the Sierra Nevada. The purchase of water rights in the Owens Valley by Los Angeles and the development of pump-based irrigation on the western side have been the two major reasons for the shift. The following tables summarize the reported agricultural acreage for the twelve counties fully within the SNEP region. Counties that extend into the Sacramento and San Joaquin Valleys are excluded because of the overwhelming influence of agricultural acreage in the valleys.

Table 5.4: Sierra Nevada Crop Acreage, 1985 and 1994

Region 1985	Field Crops	Orchards and Vineyards	Row Crops	Total Crop Acreage
North	23,820	0	0	23,820
North Central	21,700	5,106	0	26,806
South Central	8,995	4,022	47	13,064
East Side	14,715	15	136	14,866
Total w/o San Joaquin	69,230	9,143	183	78,556
Region 1994	**Field Crops**	**Orchards and Vineyards**	**Row Crops**	**Total Crop Acreage**
North	16,480	0	0	16,480
North Central	24,010	5,064	0	29,074
South Central	4,738	4,722	47	9,507
East Side	11,750	25	1,715	13,490
Total w/o San Joaquin	56,978	9,811	1,762	68,551

Table 5.5: Sierra Nevada Total Agricultural Revenue, 1985 and 1994
in Million Dollars (Constant 1994 dollars)

Region 1985	Field Crops	Orchards and Vineyards	Vegetable Crops	Livestock Related	Major Crops and All Livestock Revenue
North	$5	$0	$0	$15	$20
North Central	$13	$16	$0	$31	$9
South Central	$2	$4	$0.43	$34	$41
East Side	$9	$0	$0.28	$12	$22
Total w/o San Joaquin	$29	$20	$0.70	$92	$141
Region 1994	**Field Crops**	**Orchards and Vineyards**	**Vegetable Crops**	**Livestock Related**	**Major Crops and All Livestock Revenue**
North	$3	$0	$0	$15	$18
North Central	$15	$16	$0	$23	$53
South Central	$1	$7	$0.31	$30	$39
East Side	$6	$0	$3.43	$12	$22
Total w/o San Joaquin	$25	$23	$3.74	$79	$131

Table 5.6 Sierra Nevada Gross Revenue per Acre for Major Agricultural Uses, 1985 and 1994

Region 1985	Field Crops	Orchards and Vineyards	Vegetable Crops	Irrigated Pasture	Private Rangeland
North	$208	NA	NA	$42	$3
North Central	$581	$3,041	NA	$132	$8
South Central	$228	$1,089	$9,139	$154	$10
East	$619	$1,969	$2,024	$22	$1
All Sierra	$415	$2,180	$3,851	$63	$8
Region 1994	Field Crops	Orchards and Vineyards	Vegetable Crops	Irrigated Pasture	Private Rangeland
North	$185	NA	NA	$34	$4
North Central	$606	$3,151	NA	$103	$8
South Central	$289	$1,518	$6,574	$120	$9
East	$530	$6,000	$2,000	$18	$1
All Sierra	$442	$2,372	$2,122	$47	$7

Note: Regions with small acreages in certain uses may have unusually high or low gross revenue per acre.

Table 5.7: Livestock and Major Crop Percentage of Total Agriculture Revenue by Region, 1985 and 1994

Region 1985	Livestock Related	Major Crops
North	75%	25%
North Central	52%	48%
South Central	83%	17%
East Side	56%	44%
Total	65%	35%
Region 1994	Livestock Related	Major Crops
North	83%	17%
North Central	42%	58%
South Central	77%	23%
East Side	54%	46%
Total	60%	40%

Ranching represents more than 96% of the acreage of the agricultural sector in terms of private acreage, but only 60% of total revenue in the region for which county level data can be used. Field crops such as wheat, barley and oats produce the remaining 20% of total agricultural revenue but declined by over 10% in the past decade. More intensively cultivated crops such as orchards, vineyards, and vegetables bring in revenue of over $2,000 per acre and produce more than 20% of total revenue from less than 0.5% of private agricultural land. Smaller farms that grow and sell fresh vegetables are typically not included in the County Agricultural Commissioner reports and would increase the reported farm-based acreage and revenue in many counties.

The overall trend in Sierra Nevada agriculture over the last decade has been a shrinking of the livestock based sector and an expansion of high value agricultural operations such as orchards, vineyards, and vegetable farms. In addition to the reported orchards and vegetable farms, small wineries based on the grape acreage add considerable revenue to the agricultural sector. If the acreage in the Sierra portions of the San Joaquin Valley is used in a similar fashion to the land in the South

Central region, the estimate of total agricultural revenue in the SNEP region in 1994 would be $170 million. In addition to this revenue, agriculture is valued throughout the region to maintain open space and the rural character.

Recreation and Tourism

Provision of recreational opportunities within the Sierra Nevada has been considered a major social benefit ever since the development of Yosemite Valley more than a century ago. In addition to the extensive area of federal forests, parks, and water bodies developed for recreational use, a large private sector recreation and tourism industry provides a growing range of services to visitors and local residents. In addition to lodging, restaurants, and retail stores, private firms provide a broad range of recreation oriented services. Numerous ski resorts, white water rafting operations, private campgrounds, and recreational guides provide services on lands and water bodies throughout the region.

Ninety-five percent of the population in the western United States describes participation in outdoor sports as a great idea and are more likely than others to participate in activities which take advantage of natural resources such as hiking, backpacking, camping of all kinds and rock climbing (Roper-Starch Worldwide 1995). In a recent survey of Americans' outdoor recreational habits, 68% said the main reason for such habits was for 'family togetherness', followed at 64% by 'appreciation of nature' (Roper-Starch Worldwide 1995).

Employment in recreation and tourism is focused on more developed recreational opportunities and is only part of the total value of the Sierra Nevada for recreational opportunities that do not always involve the purchase of private services. The large social value of dispersed recreation occurring in national forests, national parks, and state parks is addressed by Duane (1996-b). The private recreational and tourism sector is the single largest employer in the Sierra Nevada. Based on the 1990 Census as well as business surveys, we estimated that more than 23,000 employees work in 3,000 different enterprises associated with recreation and tourism.

Recreation and Tourism Related Businesses and Employment in the Sierra Nevada

Employment in the private businesses involved in recreation and tourism is spread among lodging, restaurants, and retail, as well as in firms supplying direct recreational services such as ski resorts, rafting companies, sports equipment suppliers, and guide services. A study of the county level travel impacts (Damon Runyan Associates 1995) was commissioned by the California Trade and Commerce Agency. Travel expenditures include many business expenses as well as expenses by local residents and will be considerably larger than recreation and tourism related revenues. After accounting for the split counties that are only partly in the SNEP study region, an estimated $2.4 billion of travel-related expenditures were spent in the Sierra Region in 1993. Our independent assessment of travel and recreation related workers from the 1990 Census data, suggests that approximately one-third of the employees and expenditures are derived from local residents, with the remaining two-thirds come from visitors to the region.

A count of all businesses listed in telephone directories involved in recreation industry (identified by four-digit Standard Industrial Codes (SIC)) provides another estimate of firms and total revenue within the California portion of the SNEP region. The large gaming industry on the Nevada side of Lake Tahoe was not included but is a major draw for visitors on the California side also. Using a 1994 CD-ROM directory of business telephone listings, firms with SIC codes clearly dominated by recreation and tourism were inventoried. This method under counts the many retail stores, groceries, bakeries, and gas stations that may get a large share of their business from visitors. In addition to the more than 2,400 motels and hotels, also more than 500 businesses provide specific outdoor activity related equipment or services. California averages for 1992 revenue for these business types were reduced by half to account for local use and assumed smaller business sizes.

Table 5.8: Major Recreational Businesses in the Sierra Nevada by Area Code

Business	Tahoe Region	Other Northern Sierra	Central Sierra	Eastern Sierra	Total
Area Code	(916)	(916)	(209)	(619)	
Motels	758	222	142	40	1,162
Restaurants	305	573	360	40	1,278
Sporting Goods	100	43	18	7	168
Campgrounds	81	156	32	0	269
Outdoor Recreation Services	51	6	3	4	64
Total	1,295	1,000	555	91	2,941
	44%	34%	19%	3%	

Source: ProPhone (1995)

Based on the businesses listings, estimates of total business, payroll, and employment estimates were developed by using the 1992 Census of Retail Trade and 1992 Census of Service Industries averages for California. Statewide averages were reduced by 50% to account for non-tourism related activity as well as smaller business size. Even with these conservative estimates, the recreation and tourism sector has an overall business revenue of nearly $1.4 billion. This estimate is very close to the $1.6 billion (two thirds of the $2.4 billion travel expenditures) estimated from the Damyon Runyan Associates study.

Table 5.9: Estimated Recreational Business Revenues in Millions

	Tahoe Region	North Sierra	Central Sierra	East Sierra	Total
Motels	$590	$173	$110	$31	$904
Restaurants	$77	$144	$91	$10	$322
Sporting Goods	$40	$17	$7	$3	$67
Campgrounds	$16	$31	$6	$0	$54
Outdoor Recreation Services	$18	$2	$1	$1	$23
Total	$741	$368	$216	$45	$1,370

Source: ProPhone (1995), Census of Service Industries (1994), Census of Retail Trade (1994).

1990 Travel and Recreation and Tourism Employment

Employment in the 3,000 firms in the travel and recreation sectors can be derived from 1990 Census data. Based on employment data from the 1990 Census supplemented with employment estimates for restaurants, the travel industry employed more than 35,000 people in the SNEP region in 1990. Based on a national estimate that a local economy will have around three percent of its workforce involved in lodging and recreation related jobs simply to serve local needs, an estimated 23,000 of these employees are serving tourists from outside the region. This estimate excludes the hundreds of employees in federal and state agencies that provide recreational opportunities. With nearly 3,000 businesses and over 23,000 employees the recreation and tourism industry is the largest employer within the region. Revenue data on local motel and hotel taxes (Transient Occupancy Taxes (TOT)) presented in

the following section suggest that the recreation and tourism sector has grown at a significant rate throughout the 1990s.

Table 5.10: Travel and Tourism Related Employment

	Travel, Recreation and Tourism			Recreation and Tourism Only		Total
Region	Lodging, Recreation	Restaurants	Total	Lodging, Recreation	Restaurants	
North	2,397	1,027	3,424	932	399	1,331
North Central	4,427	1,897	6,324	1,258	539	1,797
South Central	3,625	1,554	5,179	2,054	880	2,934
San Joaquin	1,639	702	2,341	658	282	940
Tahoe	10,955	4,695	15,650	9,772	4,188	13,960
East Side	1,885	808	2,693	1,444	619	2,063
Foothill	8,714	3,735	12,449	2,998	1,285	4,283
Conifer	3,374	1,446	4,820	1,905	816	2,721
Greater East	12,840	5,503	18,343	11,216	4,807	16,023
Total	24,928	10,683	35,611	16,118	6,908	23,026

Sources: Lodging and recreation employment - 1990 Census; Restaurants - ProPhone (1995), and Census of Retail Trade (1994).

Regional data illustrate that more than half of the recreation and tourism related employment is in the greater Lake Tahoe region. Communities on the east side and in the areas adjacent to the National Parks in the South Central region also have large travel and tourism components. Most of the travel related employment in the foothill region is associated with local residents.

Conclusion for Recreation and Tourism Industry

The recreation and tourism industry is the single largest employment sector in the Sierra Nevada with more than 23,000 employees in more than 3,000 firms. Although many of these jobs are not full time, the total number of jobs is considerably larger than employment in the timber and similar to the large construction sector. With an annual revenue of $1.4 billion spread across more than 3,000 businesses, the recreation and tourism industry is a major component of the regional economy. Like many of the commodity based sectors, the distribution of these jobs and businesses is not uniform across the region. Nearly half of the private sector employment is centered around Lake Tahoe and the nearby ski resorts. In comparison, recreation and tourism related employment is a relatively minor portion of employment in the foothill and conifer forest regions.

Residential Development

The most significant economic changes in the Sierra Nevada over the past two decades have been driven by the large inflow of new residents attracted by the environmental and social amenities available in the region. A detailed analysis of these trends is provided in Duane (1996-a). The economic impact of human settlement is addressed here for two reasons. First, the new residential and commercial construction is by far the largest change in the total financial assets of the Sierra Nevada region. New construction has substantially increased the amount of property tax collected by county governments. And second, the increase in the number of new residents has also increased the total value of environmental benefits accruing to full time residents in a manner similar to an expansion in the number of tourists.

Since 1980 over $16 billion (1995 dollars) of new residential and commercial construction have been built in the twelve counties fully within the Sierra Nevada. The total construction value is split

with around 80% residential and 20% commercial. In 1995, these properties generated an estimated 160 million dollars in property tax revenue (at the rate of one percent of assessed value). Although most of this money is used to finance infrastructure and social services for the residents, if the benefits of living in the Sierra Nevada are proportional to property values, then millions of dollars of ecosystem-based benefits accrue to the new residents of the Sierra Nevada. If ten percent of all these property value and property taxes were ascribed to environmental attributes, the annual resource value and reinvestment value from these new residents would be $110 million and $11 million respectively. The following table summarizes the value of new residential and commercial construction for the counties within the SNEP region.

Table 5.11: Value of New Residential and Commercial Construction in the Sierra Nevada, 1980-1995 in Million Dollars (Constant 1995 Dollars)

Year	North	North Central	South Central	East	All Sierra Counties
1980	$45	$583	$240	$67	$935
1981	$39	$475	$187	$117	$818
1982	$26	$378	$146	$48	$598
1983	$33	$445	$181	$17	$676
1984	$29	$540	$182	$15	$765
1985	$23	$546	$243	$21	$832
1986	$28	$734	$238	$19	$1,019
1987	$27	$949	$248	$22	$1,245
1988	$36	$1,200	$244	$34	$1,514
1989	$28	$1,377	$278	$64	$1,746
1990	$32	$1,193	$285	$105	$1,616
1991	$27	$809	$242	$33	$1,111
1992	$38	$674	$226	$40	$979
1993	$15	$588	$142	$37	$783
1994	$33	$709	$114	$36	$892
1995	$20	$667	$101	$35	$824
1980-1995 Total	$478	$11,866	$3,297	$710	$16,352

Source: California Department of Finance.

Conclusion

Private sector uses of the Sierra Nevada ecosystem are more significant than the percentage of private land would suggest. At the Sierra Nevada wide level, the economic output of every private sector except ranching grew over the past decade. The mix of ranching, irrigated agriculture, commercial recreation and tourism, and new residential development varies tremendously from region to region.

Private animals graze more acres of the Sierra Nevada than are used for timber management, recreational use, or residential development. Most forage comes from private ranches in western foothills and from irrigated pastures. The overall size of the livestock sector is highly variable but declined by nearly 10% over the past decade. For agriculture as a whole, land uses with low revenue per acre have been declining in acreage while high value orchards, vineyards and vegetable farms are increasing in size and revenues.

In contrast to the patterns within the overall agricultural sector, commercial recreation and residential development continue to grow. Commercial recreation and tourism is the largest single employment sector in the Sierra Nevada and now contributes an increasing share of county revenues. Commercial recreation occupies relatively little land and complements the recreational opportunities provided on federal and state lands. Residential development continues to expand and dominates the financial character of the Sierra Nevada. Investments in new residential and commercial development averaged more than $ 1 billion per year over the past fifteen years. Most of this residential growth is concentrated between Sacramento and Lake Tahoe.

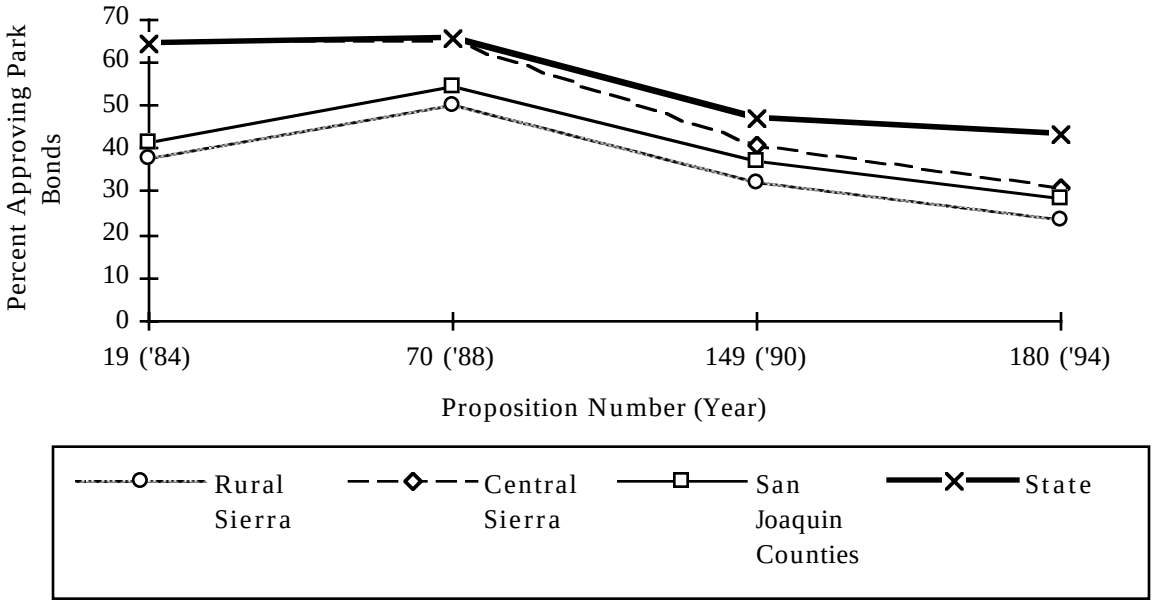
CHAPTER 6: GOVERNMENT FINANCE

Federal, state and local governments have different responsibilities for monitoring resource use and management , distributing benefits, and enforcing environmental standards. An assessment of the streams of government revenues and expenditures derived from, and directed toward, the region's natural resources highlights these patterns. This chapter's assessment of government finance provides insight into how the ecosystem generates revenue for a wide spectrum of public services. The analysis focuses on county level financing for three reasons. The first is that county level analysis illustrates the different regional patterns across the Sierra Nevada. Second, county budgets reflect the myriad responsibility and revenue sharing arrangements between federal, state, and local governments more realistically than an analysis of the small fraction of much larger federal and state budgets. And finally, county budgets integrate the traditional natural resource sectors with the other private use sectors commonly not considered in broader ecosystem analyses.

A complex pattern of land and water rights creates a situation where government jurisdictions are rarely aligned with unique ecosystems or settlement patterns. Various explicit and implicit patterns of revenue sharing and cost sharing exist among the three levels of government. In addition to the revenue sharing arrangements between national forests,school districts and the county public works, other revenue and reinvestment programs are operated by the federal, state, and county governments. Federal expenditures in the region include the operational expenditures of the land management agencies as well as numerous cost-sharing arrangements for social services, transportation, planning, and other public administration activities. Federal government expenditures on national parks, developed recreational areas, and wilderness areas provide the backdrop for a large recreation and tourism industry in the Sierra Nevada. Recreation and tourism oriented businesses then generate millions of dollars of county tax revenue through Transient Occupancy Tax (TOT) and sales tax. Expenditures by the state of California on parks, water quality programs, and land acquisition are other examples of reinvestment into the Sierra Nevada ecosystem. County governments implement programs to reduce the property tax burden on private forest and agricultural landowners to discourage dispersed residential conversion and its associated public service cost. These programs are all examples of government financing programs that address both ecosystem health and economic well-being.

In addition to financing responsibility for most education, the state provides over half the funds for all programs administered by counties. Fire protection and transportation are two of the most significant financial responsibilities of the state of California within the SNEP region. The state of California also provides financing for a wide variety of ecosystem related activities in spite of the fact that the state owns relatively little land in the Sierra Nevada. The California Resources Agency is responsible for a wide range of programs including state parks, fish and game management, land conservation, forestry and fire protection, and water quality monitoring and enforcement. Most of these programs are funded through the legislature and do not have the local revenue impacts of other financing mechanisms such as Forest Services Revenue Sharing, Williamson Act and Timber Production Zone tax programs, and the Transient Occupancy Tax. One area where state financing related to ecosystem health issues are state bond measures concerning the development and expansion of state parks and state regulations on rural land use. A measure of the public's willingness to finance recreation, wildlife protection and preservation oriented activities, is the voting pattern on these types of state bonds. The following figure summarizes regional voting trends on four sequential bonds to fund increases in the state park system.

Figure 6.1: Regional support for state park bonds



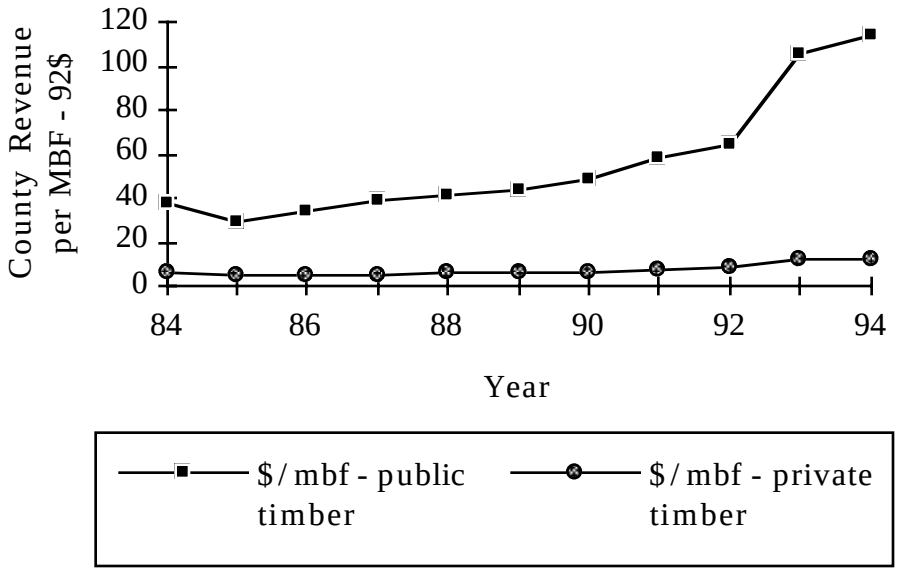
Source: Secretary of State. Statement of the Vote.

The results of these bond votes suggests that many residents in or adjacent to the Sierra Nevada see less need for more land purchase or programs to provide more parks and protected areas in the Sierra Nevada. One explanation for the results is that most of the residents experience no shortage of outdoor recreational opportunities because so much of the Forest Service lands is available for local recreation with no extra fees or taxes. Votes on state bonds involve choices on both the goals and the means by which they are to be accomplished and can not be interpreted based on only one characteristic. For example, in Contra Costa county in the San Francisco Bay Area, Proposition 180 was also voted down in 1994 . Two years earlier, residents agreed to create a special assessment district to support expanded activities of the East Bay Regional Park District (EBRPD). The EBRPD measure costs considerably more per household than the state bond, but local residents had more say in how the money would be collected and on what it would be spent (Mikkelsen 1995).

Timber-based Revenues for County Governments

Although public and private timber harvests have been similar over the past decade, the revenue implications for county governments are very different. Private timber harvests are taxed through the state yield tax set at approximately 2.9% of the stumpage value. In addition, an equal amount of revenue is collected through property taxes on the timber land. Revenues to counties from the National Forests, include a) forest revenue sharing (25% of stumpage), b) Payments In-Lieu of Taxes (PILT), and c) the State timber yield tax that is assessed on all timber harvested in the state. PILT funds from Forest Service lands follow a complex formula that consider alternative revenue sharing receipts, land zoning, and year to year fluctuations. The following figure illustrates the large differences in the county revenue per million board feet of public and private timber harvests over the past decade.

Figure 6.2: Effective County Revenue per Thousand Board Feet of Public and Private Timber



Source: California State Board of Equalization.

The proportion of total county revenues derived from National Forests has declined throughout the Sierra Nevada over the period examined. Federal timber revenue sharing makes up less than 2% of total county revenues across the SNEP study area but is substantially greater in some of the regions. From FY 1980-81 to FY 1992-93, the North region (including Lassen) showed the greatest reliance on federal timber revenues for financing county budgets. The county governments of this region received $7.6 million from federal timber revenue sharing in FY 1992-93, comprising 10.8% of total revenues. The North Central region received $3.3 million, (1% of total county revenues), and the South Central region received $2.6 million (2%) for the same period.

The net effect for Sierra Nevada counties is that increases in private harvests do not make up for reductions in public harvests in terms of taxes. However, reduced supplies can drive up prices so much that the reduction in federal receipts is far smaller than the reduction in federal harvests.

Property Tax and Transient Occupancy Tax

New residential and commercial construction produces far more revenue than any other land use (Table 6.1). As developing areas demand services and infrastructure, the costs of expansion rise along with the revenues from the expanding tax base. County land use policies regarding residential expansion result in far greater impacts on revenues than tax policies on private timber land and federal harvest levels in all regions except the far northern counties. Increasing human settlement of the North Central and South Central regions has resulted in a growing property tax base and a reduced reliance on commodity based sources of revenue. In the northern Sierra, no comparable demographic shifts have occurred and these counties and school districts have greater vulnerability to decreasing revenues from National Forests. The Transient Occupancy Tax (TOT) is collected on lodging and tracks overall expenditures in recreation. In every region except the North, TOT revenues exceed timber revenues from both public and private harvests.

Overall County Revenue from Ecosystem Related Activities

The following figures illustrate the trends in four major revenue sources for all counties in the Sierra Nevada region. Of the different revenue sources, property taxes from new residential homes are associated with the largest expenditures for new roads and other infrastructure, police protection and fire protection. Revenues from public and private forest lands and from Transient Occupancy Tax (TOT), on the other hand, far outweigh county expenditures on those enterprises. The following table summarizes the amount of revenue from local taxes and revenue sharing going to the counties in the Sierra Nevada region.

Table 6.1: Sierra Wide County Tax Revenues from Timber, Residential and Commercial Development, and Motel Taxes in Millions of Dollars, 1980-1992

Year	Federal Timber	Private Timber	Post-1980 Homes	Transient Occupancy Tax	Commercial Development
1980	$12.68	$1.97	$4.94	$7.37	$2.43
1981	$13.97	$2.13	$9.15	$7.59	$4.52
1982	$7.44	$1.03	$11.99	$7.67	$6.25
1983	$12.91	$0.81	$15.14	$8.77	$8.40
1984	$13.31	$0.87	$18.14	$8.20	$11.25
1985	$8.98	$0.91	$21.67	$8.53	$14.27
1986	$14.32	$0.95	$27.02	$9.37	$17.48
1987	$14.83	$1.17	$32.96	$10.80	$21.47
1988	$17.53	$1.82	$39.01	$11.75	$27.19
1989	$17.19	$2.35	$45.21	$12.06	$34.22
1990	$16.07	$2.28	$50.83	$12.21	$40.89
1991	$12.16	$1.78	$55.80	$14.47	$44.74
1992	$14.81	$2.82	$60.05	$15.20	$48.28

Sources: Financial Transactions of Counties, State Controller; Department of Finance; California State Board of Equalization.
Note: All figures are expressed in Nominal dollars. Federal forest revenue includes timber based revenue sharing, PILT, and the state yield tax paid on federal timber. Private forest revenue comes from similar proportions of the timber yield tax and property taxes. Residential and commercial construction values exclude Placer and the four counties in the San Joaquin region. Residential and commercial property taxes on construction since 1980 are based on 1% of assessed value increasing at the Proposition 13-allowed 2% per year. TOT revenue is based on tax rates set by each county.

The following analysis of the regions focuses on the three main sources of county revenue from forested land and its uses in the Sierra Nevada: federal timber, private timber, and TOT. Residential property taxes are much larger than these revenue sources but are left out because a substantial portion of the houses are built on the far western edge or outside of the SNEP boundary. PILT payments associated with land rather than commodity production, remain low throughout the region.

Table 6.2: Timber-related and Recreation-related County Revenue in Million Dollars
SNEP Region, 1980-1993
(Nominal Dollars)

Fiscal Year	Federal Timber Revenues	Payment in Lieu of Taxes	Private Timber Revenues	Transient Occupancy Tax
1980-81	$7.46	$1.88	$1.16	$3.99
1981-82	$9.07	$2.35	$1.38	$4.87
1982-83	$5.13	$3.62	$0.71	$5.23
1983-84	$9.16	$2.80	$0.57	$6.16
1984-85	$9.86	$4.02	$0.65	$6.02
1985-86	$6.91	$2.62	$0.70	$6.51
1986-87	$11.19	$3.21	$0.74	$7.27
1987-88	$11.96	$2.96	$0.95	$8.65
1988-89	$14.73	$2.77	$1.53	$9.81
1989-90	$15.22	$2.84	$2.08	$10.61
1990-91	$15.02	$2.61	$2.14	$11.32
1991-92	$11.81	$2.68	$1.73	$13.97
1992-93	$14.81	$2.94	$2.82	$15.08

Table 6.3: Timber-related and Recreation-related County Revenue in Million Dollars
North Region, 1980-1993
(Nominal Dollars)

Fiscal Year	Federal Timber Revenues	Payment in Lieu of Taxes	Private Timber Revenues	Transient Occupancy Tax
1980-81	$3.03	$0.11	$0.27	$0.15
1981-82	$2.63	$0.16	$0.30	$0.16
1982-83	$1.44	$0.15	$0.17	$0.18
1983-84	$2.83	$0.15	$0.16	$0.18
1984-85	$4.47	$0.15	$0.18	$0.21
1985-86	$2.53	$0.15	$0.16	$0.23
1986-87	$4.68	$0.15	$0.20	$0.26
1987-88	$4.17	$0.16	$0.28	$0.31
1988-89	$5.82	$0.16	$0.43	$0.34
1989-90	$5.20	$0.16	$0.42	$0.37
1990-91	$5.12	$0.16	$0.40	$0.41
1991-92	$4.87	$0.16	$0.49	$0.67
1992-93	$5.53	$0.16	$0.83	$0.70

Table 6.4: Timber-related and Recreation-related County Revenue in Million Dollars
North Central Region, 1980-1993
(Nominal Dollars)

Fiscal Year	Federal Timber Revenues	Payment in Lieu of Taxes	Private Timber Revenues	Transient Occupancy Tax
1980-81	$1.72	$0.05	$0.65	$0.92
1981-82	$2.42	$0.05	$0.84	$1.16
1982-83	$1.52	$0.41	$0.34	$1.19
1983-84	$2.03	$0.09	$0.22	$1.31
1984-85	$2.27	$0.04	$0.20	$1.79
1985-86	$1.53	$0.05	$0.22	$2.10
1986-87	$2.41	$0.06	$0.25	$2.06
1987-88	$2.97	$0.12	$0.44	$2.62
1988-89	$3.29	$0.15	$0.61	$3.02
1989-90	$3.53	$0.15	$0.73	$3.16
1990-91	$3.77	$0.12	$0.92	$3.19
1991-92	$3.00	$0.16	$0.77	$4.05
1992-93	$3.13	$0.16	$1.17	$4.43

Table 6.5: Timber-related and Recreation-related County Revenue in Million Dollars
South Central Region, 1980-1993
(Nominal Dollars)

Fiscal Year	Federal Timber Revenues	Payment in Lieu of Taxes	Private Timber Revenues	Transient Occupancy Tax
1980-81	$0.91	$0.06	$0.14	$0.98
1981-82	$1.73	$0.22	$0.17	$1.16
1982-83	$0.62	$0.49	$0.14	$1.38
1983-84	$1.53	$0.27	$0.14	$1.64
1984-85	$1.23	$0.88	$0.15	$1.65
1985-86	$1.15	$0.28	$0.12	$1.82
1986-87	$1.22	$0.33	$0.24	$2.33
1987-88	$2.14	$0.22	$0.20	$2.65
1988-89	$2.58	$0.43	$0.45	$2.92
1989-90	$2.46	$0.26	$0.82	$3.28
1990-91	$2.00	$0.17	$0.67	$3.74
1991-92	$1.36	$0.16	$0.43	$5.08
1992-93	$2.42	$0.16	$0.72	$5.21

Table 6.6: Timber-related and Recreation-related County Revenue in Million Dollars
San Joaquin Region, 1980-1993
(Nominal Dollars)

Fiscal Year	Federal Timber Revenues	Payment in Lieu of Taxes	Private Timber Revenues	Transient Occupancy Tax
1980-81	$1.27	$0.85	$0.09	$0.63
1981-82	$1.69	$1.16	$0.05	$0.75
1982-83	$1.10	$1.91	$0.07	$0.86
1983-84	$1.96	$1.61	$0.04	$1.08
1984-85	$1.31	$2.25	$0.08	$1.25
1985-86	$1.09	$1.42	$0.18	$1.39
1986-87	$2.22	$1.96	$0.05	$1.55
1987-88	$1.97	$1.73	$0.03	$1.86
1988-89	$2.19	$1.31	$0.03	$2.17
1989-90	$3.11	$1.55	$0.10	$2.32
1990-91	$3.42	$1.42	$0.14	$2.38
1991-92	$2.06	$1.46	$0.05	$2.35
1992-93	$2.68	$1.63	$0.10	$2.73

Table 6.7: Timber-related and Recreation-related County Revenue in Million Dollars
East Region, 1980-1993
(Nominal Dollars)

Fiscal Year	Federal Timber Revenues	Payment in Lieu of Taxes	Private Timber Revenues	Transient Occupancy Tax
1980-81	$0.52	$0.80	$0.00	$1.31
1981-82	$0.59	$0.75	$0.02	$1.64
1982-83	$0.45	$0.67	$0.00	$1.63
1983-84	$0.80	$0.68	$0.01	$1.94
1984-85	$0.59	$0.70	$0.03	$1.11
1985-86	$0.61	$0.70	$0.02	$0.98
1986-87	$0.66	$0.70	$0.00	$1.08
1987-88	$0.71	$0.72	$0.01	$1.22
1988-89	$0.86	$0.73	$0.01	$1.35
1989-90	$0.93	$0.73	$0.01	$1.47
1990-91	$0.72	$0.74	$0.00	$1.60
1991-92	$0.52	$0.74	$0.00	$1.81
1992-93	$1.07	$0.83	$0.00	$2.00

Source: Counties of California, Financial Transactions. Annual Report, State Controller, various years.

During the period from 1980 to 1993, county revenues from the Transient Occupancy Tax (TOT) surpassed the sum of all revenue from federal and private timber in every region except the North region comprised on Plumas and Sierra. For the SNEP region as a whole, TOT was roughly comparable to all timber revenue by the 1992-1993 fiscal year. Since then, drops in federal timber harvests and timber prices have reduced timber related revenue while recreation-related revenue has continued to climb.

Summary of Ecosystem-based Revenues for County Governments

County taxes on private ranchland, farmland, and forest land are kept low to discourage undesired conversion of these lands to residential and commercial development. High infrastructure costs and loss of rural quality of the landscape are major reasons why many county governments have tried to reduce the spatial extent of residential development.

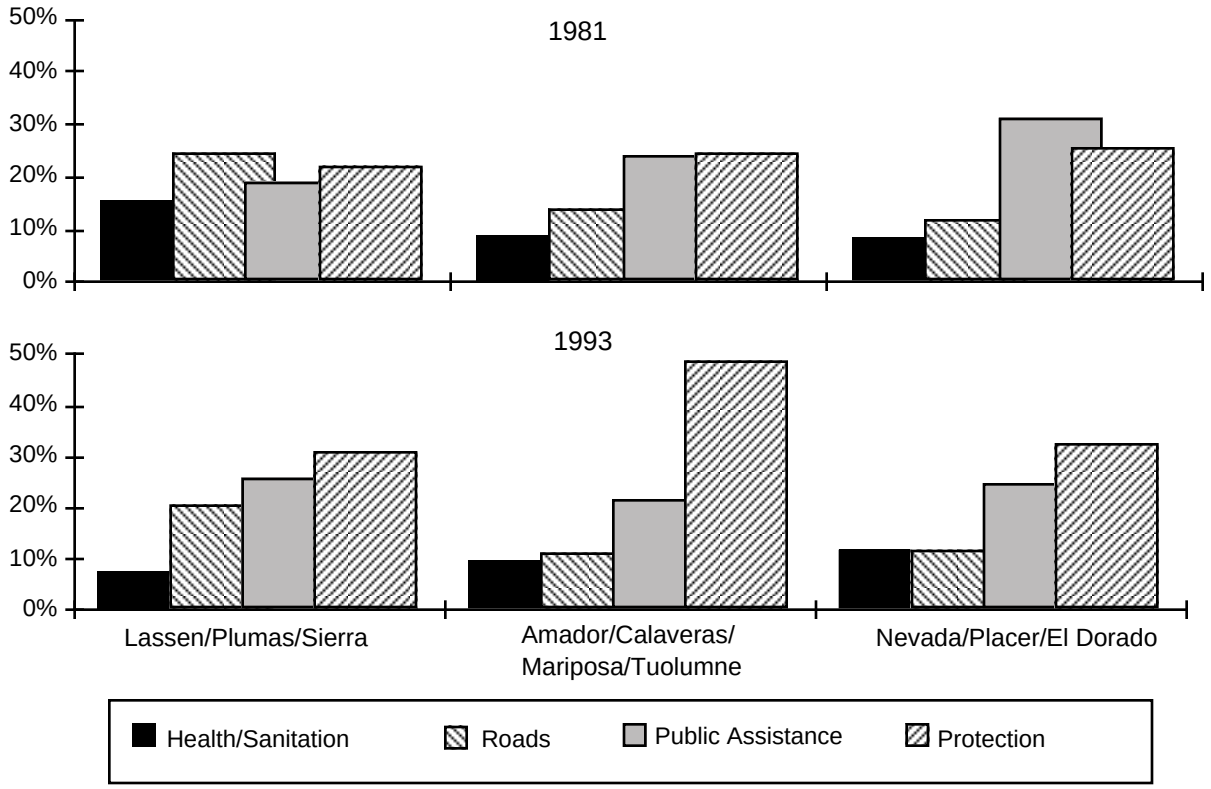
Commodity based revenues represent more than two percent of total county and school budgets in three counties in Sierra Nevada region, Plumas, Sierra, and Lassen. More important is the economic stimulus provided through the federal lands that are a backdrop to $1.4 billion dollar recreation and tourism industry. The positive impact of the federal-state compact for Lake Tahoe as well as the negative impacts of the 1995 Christmas season temporary government shutdown on Mariposa County where Yosemite National Park is located, illustrate the importance of this ecosystem-dependent economic stimulus. The unequal distribution of recreational and commodity revenues, however, can create inequitable situations at the county level for policies that are revenue positive for the region as a whole.

County Expenditures

The original revenue sharing arrangements for federal lands in rural counties were developed to account for the fact that federal land would never produce property tax revenues needed to finance local services. Over time, state-county financing arrangements, as well as the types of public services desired by counties, have changed dramatically. In California, the state ensures a basic level of school financing and takes responsibility for much of transportation infrastructure. Combined 1993 expenditures on protection services (mainly police and fire), public assistance, roads, and health and sanitation account for between 80% and 91% of total county expenditures in the three regions examined. This represents a modest increase from Fiscal Year (FY) 1980-81 for the North region (plus Lassen) and North Central region (3%), but a marked increase in the South Central region (19%), due in large part to a four-fold increase in the cost of protection services in Amador and Calaveras counties. All three regions saw the portion of their budgets dedicated to protection services increase by no less than 22%.

The North region (plus Lassen) stands out from the other regions in the proportion of the counties' budgets spent on public assistance, health and sanitation, and roads (Figure 6.3). This same region spends approximately two times what other regions spend on road maintenance, as a percentage of total expenditures. And, it is the only region where spending on public assistance increased over the period examined. Over the past decade, relative county expenditures in the northern counties are increasingly similar to those of other regions.

Figure 6.3: Major Programs as a Percent of Total County Expenditures, 1981 and 1993.



Source: Counties of California, Financial Transactions. Annual Reports 1980-81 and 1992-1993. State Controller.

Educational Revenues

Rapid escalation in stumpage prices from 1990 to 1993 mitigated the impact of dropping harvest levels for the counties receiving Forest Service revenue sharing funds. Decreasing stumpage prices and further declines in federal harvests in 1994 and 1995 reduced fiscal resources of many timber-producing counties. Table 6.8 illustrates the role of revenue sharing for the counties in the Sierra Nevada in 1991-1992.

Table 6.8: U.S. Forest Service Revenue Sharing and County Budgets, Fiscal Year 1991-92

County	Population 1992	County Budget (Million $)	School Budget (Million $)	USFS Revenue Sharing (Million $)	USFS Revenue as Percent of County Budget	USFS Revenue as Percent of School Budget
Alpine	1,195	5.58	2.27	0.71	15.54%	6.32%
Amador	32,142	25.43	18.82	0.61	1.59%	1.18%
Butte	191,207	149.37	151.54	0.90	0.29%	0.30%
Calaveras	35,712	38.87	99.58	0.19	0.09%	0.24%
El Dorado	137,241	106.14	117.33	3.81	1.62%	1.79%
Fresno	713,719	697.22	697.56	2.11	0.15%	0.15%
Kern	584,086	556.50	590.26	0.25	0.02%	0.02%
Lassen	28,718	29.12	28.35	3.33	5.85%	5.70%
Madera	97,155	72.32	97.34	0.87	0.44%	0.59%
Mariposa	15,620	21.10	13.73	0.42	1.48%	0.96%
Nevada	83,562	66.89	54.26	0.57	0.52%	0.42%
Placer	186,861	151.52	156.90	1.25	0.39%	0.41%
Plumas	20,735	25.80	21.39	7.71	17.99%	14.92%
Shasta	157,716	139.53	138.47	3.30	1.19%	1.18%
Sierra	3,362	8.43	6.68	1.44	10.74%	8.51%
Tehama	52,734	48.48	51.00	2.06	2.01%	2.12%
Tulare	329,999	315.42	208.84	0.60	0.14%	0.09%
Tuolumne	51,681	48.58	40.39	1.41	1.73%	1.44%
Yuba	61,113	62.92	58.43	0.24	0.20%	0.18%
Total	2,784,558	2569.22	2553.14	31.76	0.62%	0.62%

Source: Conserving the California Spotted Owl (Wildland Resource Center 1994).

Basic school funding provided by the State of California is equalized across the state to reduce local differences based on property taxes. The 12.5 % of Forest Service revenue (one half of the 25% revenue share split between education and roads) going to local school districts places timber-producing counties' revenue on top of the basic statewide expenditures per pupil (Table 6.9). Where the ratio of Forest Service revenue share to students is high, average expenditures per student are far above those in Los Angeles—home to California's most populous school districts and representative of the state average for urban districts. The pattern of school expenditures for 1992-93, when there was considerable Forest Service revenue sharing, suggests that without the extra Forest Service revenue, rural school districts spend far less than the state average.

Table 6.9: School Expenditures for Unified School Districts, 1992-93.

County	Average Expenditure/Pupil	Compared to Los Angeles
Alpine	$9,838	215%
Amador	$3,968	87%
Butte	$3,833	84%
Calaveras	$3,797	83%
El Dorado	$4,262	93%
Fresno	$4,371	96%
Inyo	$9,842	215%
Kern	$4,404	96%
Lassen	$5,619	123%
Madera	$4,037	88%
Mariposa	$4,731	103%
Modoc	$6,394	140%
Mono	$5,235	115%
Nevada	$4,217	92%
Placer	$4,171	91%
Plumas	$4,875	107%
Sierra	$6,168	135%
Tulare	$4,023	88%
Tuolumne	$4,912	107%
Yuba	$4,111	90%
Los Angeles	$4,572	100%

Source: Financial Transactions of School Districts, State Superintendent of Public Education, 1993.

Overall Trends in County Revenues and Expenditures

County finances provide important insights into the various streams of revenue derived from the production of goods and services from the Sierra Nevada ecosystem. They illustrate the unique patterns in different parts of the Sierra Nevada as well as the changes which have occurred over the past few decades. The historic importance of revenue based on timber harvests from the national forests has declined in most counties as other economic sectors have grown. The fiscal impact of changing public timber harvest is small relative to the large extent of federal ownership in the Sierra Nevada. Except for the three northern counties, tax and revenue sharing from timber yields represent less than 0.4% of county or school revenues. Conversion of wildlands into residential property and commercial recreational development have much greater revenue and expenditure implications. County tax revenues from overnight visitors is now equal to all federal forest revenue sharing and has grown consistently over the last decade.

Lassen, Plumas, and Sierra counties are very different from the rest of the Sierra Nevada and have a much greater dependence of federal revenue sharing for county and school revenues. The fiscal impact of overall declines in revenue from reduced federal timber harvesting will be concentrated in these counties. The sparsely populated counties of Modoc, Alpine, Mono, and Inyo also receive a considerable portion of their revenues from National Forest revenue sharing. The relative importance of commodity based revenue in these counties has dropped because of the rapid growth in tax revenue from the recreation and tourism sector.

For most of the Sierra Nevada, the most significant financial impact related to the use of Sierra Nevada ecosystems is the rapid development of new residential properties throughout the region. Residential development produces a large and growing stream of property tax revenue at the same time that it places new demands for a bigger and more extensive road network, higher levels of fire protection, and water and sewage infrastructure. These ecosystem impacts may be greater than those associated with the direct conversion of land for house sites and accompanying yards.

CHAPTER 7: OVERVIEW OF THE ECONOMIC ASPECTS OF THE SIERRA NEVADA ECOSYSTEM

The economic value of the Sierra Nevada has been and will continue to be a major force in setting overall goals for the ecosystem as a whole. The ecosystem continues to have a large and direct role in the economy through revenue-generating commodity and services, employment, government revenues, and a wide array of non-market benefits to residents and visitors. The economic assessment identified the major stakeholders and beneficiaries who benefit from existing patterns of resource use in the Sierra Nevada. From the perspective of employment and local businesses, commodities and services directly related to uses of the ecosystem account for approximately one quarter of jobs (Table 7.1). From the perspective of the natural resources, water is the basis for most of the economic value. Timber, animal forage, other agricultural crops, and a range of recreational and residential services directly dependent of the ecosystem comprise the rest of the natural resource value. At the Sierra-wide level, a majority of the economic benefits from the use of the natural resource accrue to beneficiaries outside the region. Regional accounting of employment patterns and different natural resources highlights both the differences and commonalties among regions.

The size of local economies have more than doubled over the past twenty years. Sources of personal income in the Sierra Nevada are now considerably less dominated by wages earned locally than they were twenty years ago. Personal income in the form of interest payments, dividends, social security, and government financed health services have grown considerably throughout the Sierra Nevada. In addition, a large increase in the number of workers commuting into Sacramento and other metropolitan areas have substantially broadened the sources of personal income. The net effects have been to buffer local economies from the cyclical nature of many resource dependent sectors and to tie local economies to state and national economic trends.

The distribution of Sierran jobs (between commodity-producing jobs and service-producing jobs) is the same now as it was in 1970. Diversification has occurred within each sector, the number of jobs has more than doubled, but the relative proportion of commodity and service jobs stayed constant. Recreation, timber, and agriculture are the three largest types of employment sectors directly dependent on the ecosystem. The most significant growth has been in non-timber manufacturing and high-wage service sectors. Both of these sectors are less dependent on the direct use of natural resources than the historically large agriculture, timber and mining sectors. The distribution of employment provides a clear portrait of the relative importance of different sectors across the Sierra Nevada. The patterns of employment, commodity production, and services directly dependent on the Sierra Nevada ecosystem are inconsistent across the range. Regions defined either by economic linkages or major vegetative types exhibit unique economic-ecosystem linkages. These variations complicate the application of many range-wide strategies but also are the basis for future opportunities. The major implication of this is that effective strategies for the Sierra Nevada will not be uniform across the range.

Table 7.1: Major Employment Sectors, 1990

	Number of workers in 1990	Local Services	Timber	Agr. & Mining	Travel	Public Admin.	Non-timber Manuf.	Cons-truction
Total	260,000	59%	4%	5%	8%	7%	6%	11%
North	44,000	61%	4%	6%	5%	8%	7%	9%
North Central	93,000	61%	3%	3%	5%	7%	9%	12%
South Central	46,000	57%	3%	6%	7%	8%	9%	11%
San Joaquin	29,000	58%	9%	7%	6%	9%	0%	10%
Greater Tahoe	35,000	51%	0%	2%	31%	4%	4%	9%
East Side	13,000	59%	0%	8%	13%	7%	3%	10%
Foothills	169,000	59%	3%	6%	5%	7%	8%	12%
Conifer Belt	44,000	56%	8%	8%	8%	9%	2%	9%
Tahoe & East Side	48,000	53%	0%	6%	21%	6%	3%	11%

Source: 1990 Census.

From the complementary perspective of natural resources, water is the most valuable commodity, followed by timber, livestock and other agricultural products. The Sierra Nevada ecosystem also provides the setting for a large recreation and tourism industry as well as new residences built for the large influx of people who enjoy living within the Sierra Nevada ecosystem. Based on estimates of direct resource values as one input (not the total revenue produced by resource dependent activities), the Sierra Nevada ecosystem produces approximately $2.2 billion worth of commodities and services annually. Water accounts for more than 60% of that total value. Other commodities account for 20% as do services. Most of the water value accrues to water rights holders and beneficiaries outside of the region. Although the infrastructure to hold, divert, and channel the water is very valuable, relatively little direct employment is needed to operate and maintain these facilities. The other resource-based sectors involve many more employees and firms and are hence have greater visibility in the local economies.

In addition to supporting businesses and employment, the different economic uses of the Sierra Nevada ecosystem also generate revenue for ecosystem and community reinvestment. Ecosystem reinvestment is part of overall resource management costs and involves expenditures within individual agencies and private ownerships. While reinvestment is required to sustain economic uses of the ecosystem, actual levels of reinvestment are hard to track across different resource-controlling institutions. Reinvestment that benefit local communities is more tractable when funds are transferred between different parties through revenue sharing, fees, taxes or subsidies. Under existing institutional relationships, the rate of reinvestment varies considerably among different commodities and services. Public timber and private recreation are the largest net contributors both in total dollars and as a percentage of their total value. The following table presents an overview of the major resource-based commodity and service sectors that are directly or indirectly dependent on the Sierra Nevada ecosystem.

Table 7.2: Estimated Annual Resource Values and Reinvestment for Major Ecosystem Commodities and Services

Ecosystem Commodities and Services	Resource Value (Million $)	Percent of Sierra Resources	Economic Sectors Benefiting from Sierra Nevada Resources	Direct Reinvestment (Million $)
Downstream Irrigation Water (1)	450	20%	Central Valley Agriculture	(a)
Downstream Municipal Water (1)	290	13%	Metropolitan Areas	(a)
Hydroelectric Power (1)	610	27%	All Users of Electricity	(b)
Water Total		61%		
Private Recreation & Tourism (2)	140	6%	Overall Recreation and Tourist Sector	10
Public Recreation in parks and forests (3)	225	10%	Users of Public Recreation Facilities (45 Million Visitor Days per Year)	(c)
New Residential ecosystem values (4)	110	5%	Total Residential Sectors within Sierra Nevada	10
Recreation/Resid. Total		21%		
Public Timber (5)	150	7%	Timber Industry	23
Private Timber (5)	170	8%	Timber Industry	3
Timber Total		14%		
Public Grazing (6)	8	<1%	Livestock Industry	-7 (d)
Private Grazing (6)	16	1%	Livestock Industry	<1
Private Pasture (6)	8	<1%	Livestock Industry	<1
Other Irrigated Agriculture (6)	50	2%	Local Agricultural Processing, Wineries, etc.	<1
Agriculture Total		4%		
Total	2,227	100%		39

Source: Resource value estimates:
(1) Derived value of water rights (Stewart, this volume)
(2) 10% of 1995 total revenue estimate (Stewart, this volume)
(3) $5/day for estimated 45 million annual visitor days (Duane 1996-b)
(4) 10% of annual new construction value
(5) California State Board of Equalization, 1985-1994
(6) County Agricultural Commissioners, 1985,1994
Direct re-investment estimates:
(a) Water rights are not taxed as property and hence return no value to area of origin.
(b) Hydroelectric power plants are taxed as commercial property but the assessments are very low in comparison to revenue generation.
(c) Public recreation in National Forests, National Parks, State Parks, and other facilities is funded primarily from general funds rather than user fees.
(d) Public grazing fees are far below those charged by private or other public land owners

The estimates are based on the average for the past decade and flatten out growth trends and cyclical patterns. The values are considerably less than the full value of the output of the business sectors that use the resources. For example, the total output value of the timber and livestock industries are considerable greater than the values of the stumpage or forage values. Similarly the estimates for private recreation and new construction attribute only 10% of the total revenue directly to the ecosystem. The ecosystem 'rent' of public recreation of $5 per day is far below charges at developed private recreation facilities and survey data on the consumer value ascribed to the full recreational

experiences. It was chosen to approximate the daily entrance fees charged for many state parks and charges and simple private campgrounds. Most of the private charges or consumer's willingness to pay are more accurately ascribed to other services provided by the recreational facility operators. The estimates of the water value are based only on the value of the water right (or wholesale product in the case of electric power) and not the final delivery price.

Direct reinvestment estimates are ten year averages of specific revenue sharing or taxation applied to different commodities and services. Public timber produces most of the total revenue going to counties through the 25 percent share of gross revenues allotted to counties as well as the timber yield tax that applies to both public and private stumpage. Taxes are relatively low on private timber and agricultural lands to sustain private management and prevent undesirable fragmentation and conversion to residential uses. Most of the reinvestment on these private lands is provided directly by the land owners and does not show up in this accounting framework. The transient occupancy tax (TOT) levied on the overnight visitor component of the recreation and tourism industry is the fastest growing source of ecosystem-derived funding. Property taxes on new residential development grow rapidly because they are paid every year and not just for the year the house was built. Currently, most property taxes go for infrastructure and services rather than ecosystem management. Explicit ecosystem management funding based on private residential property values are typically financed through state park bonds or parcel taxes for local park or open space districts.

In terms of funds that could potentially be reinvested into the ecosystem and communities, around 2% of all resource values are presently captured through federal, state, and county governments. Although this tally does not account for private reinvestments or other federal or state appropriations, it does suggest that additional mechanisms to promote reinvestment are necessary to maintain and enhance the Sierra Nevada ecosystem so that it can continue to provide the socially desired outputs. The status of many components of the Sierra Nevada ecosystem suggests that this level of funding is insufficient to assure long term production at current rates.

The core of the under investment problem is straightforward. The ecological and community assessments in this report suggest that sustaining and enhancing the Sierra Nevada ecosystem will require massive and directed investment of time and money. Compared to the size of the local economies and the value of the natural assets the cost is small. The investment is currently not forthcoming for four primary reasons:

1. Many attributes of the ecosystem are not valued in a manner that motivates investment.
2. Restrictions on exchange prevent value formation for aspects of the ecosystem that generate economic benefit.
3. Barriers between agencies and governments prevent efficient responses to economic values where these are known.
4. Localities lack the capacity to capture economic surpluses they generate and to then invest these surpluses for ecosystem health and social well-being.

These problems can be addressed with different kinds of institutional resolutions. Where the attributes are not valued in a manner that motivates investment, new boundaries can create the constituencies so that potential exchanges will yield their full value. Where restrictions on exchange restrict economic value formation, arrangements can be created to open opportunities for trade. Where barriers within and among governments prevent efficient responses to economic values, cooperative agreements can be formed to lessen these barriers. Where localities lack capacity to capture and invest economic surpluses, new local organizations can provide the necessary structure.

The actual configuration of possibilities vary tremendously among conditions, but certain aspects display features that benefit from common attention at higher scales of governance. In general, institutions that are oriented primarily toward the mobilization of people and synthesis of activity operate best at local levels. Those that require specialized technical, financial and legal capacities

operate better at higher levels. Programs to address reinvestment needs can be more effective if they explicitly address the full range of opportunities.

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