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Agriculture in the Sierra

ABSTRACT

In the five intercensal years 1987 to 1992, the Sierra Nevada's proportion of California's farms increased marginally, from 6.99% to 7.08%, while the region's share of the state's farmland decreased markedly, from 16.1% to 11.2%. The income from these farms was relatively low, with Sierra Nevada farms contributing just over 2% of the state's gross farm income in 1994. The region is characterized by two major agro-ecosystems: a foothill pattern of irrigated specialized crop and animal production and a system of extensive stock grazing in the drier high-altitude rangelands with some cultivation in better-watered areas. Both these agro-ecosystems have come under pressure as the rapidly growing valley urban population looks increasingly to the Sierra Nevada for rural residential, recreational, and hobby farming opportunities. This study looks at the historical background to these agro-ecosystems and the contemporary agricultural land use and land management of the region.

INTRODUCTION

Commercial agriculture in the Sierra Nevada originated and changed in response to the demands of other resource-utilizing activities in the region: first, gold mining, followed by timber extraction and, more recently, recreation. The pattern of exploitation of these natural resources of minerals, vegetation, and landscape was largely determined by accessibility. Altitude, as it affects length of growing season, and the availability of irrigation water have been primary influences in shaping contemporary agricultural production patterns.

Two major agro-ecosystems have developed in the Sierra Nevada: a foothill pattern of irrigated specialized crop and animal production and a system of extensive stock grazing in the drier high-altitude rangelands with some cultivation in better-watered areas. Both these agro-ecosystems have come under pressure as the rapidly growing valley urban population looks increasingly to the Sierra Nevada for rural residential, recreational, and hobby farming opportunities. This influence has been concentrated along major access routes such as Interstate 80 and is spreading north and south from these infiltration points. In order to fully represent these agro-ecosystems, this chapter includes the full SNEP study area, extending northward to the Oregon border beyond the SNEP ecoregion boundary.

Mountainous areas are generally marginal for agricultural production. Under the Least Favoured Areas (LFAs) directive that the European Community adopted in 1975 as its first common instrument of regional agricultural structural policy, mountain areas are identified as the main type of LFA. The European Community defined LFAs as areas where agriculture is hampered by permanent natural handicaps (Bertrand and Hulot 1990). Recent research in European LFAs suggests that in the course of economic growth, natural conditions become increasingly important in determining the level of agricultural income because, with an improvement in regional economy, the gap in agricultural income between LFAs and normal areas widens (Terluin et al. 1995). California may well be one of the best non-European examples of these findings. As California's agriculture has become more and more efficient and productive, the farms of the Sierra Nevada have become relatively more marginal. Yet at times in the past, agriculture in the Sierra Nevada had statewide importance, and it has been a major employer in the study area since the 1860s.

In 1994 the cash farm income in Sierra Nevada counties was among the lowest in the state. Of the thirty-seven non–Sierra Nevada counties of California, only eight had gross farm incomes from crops and livestock below $100 million in 1994 (California Farmer 1995). In the Sierra Nevada, all counties had 1994 gross farm incomes of less than $100 million, even with income from sales of timber included with that from crops and livestock. The region's counties recording the larg-

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est gross farm incomes in 1994 were Lassen ($94,900,950), Modoc ($94,788,800), and El Dorado ($82,264,000) while Inyo, Plumas, and Sierra Counties all had farm incomes below $10 million (California Farmer 1995). Overall, thirteen Sierra Nevada counties (figures for Alpine and Placer were not available) produced a mere 2.24% of the state's gross farm income in 1994 (California Farmer 1995). Even among those farms with farm sales of over $10,000 in 1992, only Shasta County had an average farm net cash return above the state mean and all but Mono had average net cash farm returns of less than half that for California, according to the 1992 Census of Agriculture (Bureau of the Census 1994).

Only a small part of the total area of the Sierra Nevada is in farms, with but two foothill counties, Amador and Calaveras, with 62.6% and 37.7% respectively of their area in farmland, having more than the county mean (28.9%) for the whole state in 1992 (Bureau of the Census 1994). Furthermore, Amador has gone against the state trend and increased its proportion of farmland between 1987 and 1992 by almost 5%. Alpine, El Dorado, Inyo, Mono, Plumas, Sierra, and Tuolumne Counties all had less than 10% of their total area in farmland, although all but El Dorado and Alpine showed an increase between 1987 and 1992 (Bureau of the Census 1994). Overall, in the five intercensal years 1987 to 1992 the Sierra Nevada's proportion of California's farms increased marginally, from 6.99% to 7.08%, while the region's share of the state's farmland decreased markedly, from 16.1% to 11.2% (Bureau of the Census 1994).

Between 1987 and 1992, farm size declined in the foothill counties (Placer, El Dorado, Calaveras, Mariposa, Sierra, and Tuolumne), while it increased in the northern counties of Lassen, Modoc, Plumas, and Shasta and in the eastern counties of Mono and Inyo, reflecting the opposing pressures of suburbanization and economies of scale. At the same time, the proportion of nonresident farmers fell in the foothills (Amador, Calaveras, El Dorado, Nevada, and Placer Counties) and increased in the more isolated counties of Inyo, Modoc, Plumas, and Sierra. In California as a whole, two-thirds of farm operators have farming as their principal occupation, but in the Sierra Nevada, nine counties have less than half their farmers in this category, and only Calaveras and Modoc have more of such farmers than the state average. Clearly the nature of farming and the direction of change is not consistent across the whole Sierra Nevada.

This chapter looks at the historical development of agriculture in the region and at patterns of agrodiversity and land use. The counties of Modoc and El Dorado are considered in more detail as the most valuable agricultural producers in the Sierra Nevada and as examples of different agro-ecosystems. The changing nature of part-time farming is examined. Agro-ecosystems are defined and described, and patterns of crop-livestock mix are outlined. Emphasis is placed on spatial variations within the region.

METHODOLOGY

The focus is on agro-ecosystems seen as a subset of the general ecosystems of the region. The identification of agro-ecosystems and the allocation of counties to individual agro-ecosystems is based on principal components analysis (PCA). The dynamics of key structural and functional features of agro-ecosystems are defined using time series analysis. Considered within agro-ecosystems is agrodiversity, by which is meant the many ways farmers exploit the natural diversity of the bio-geosphere. More specifically, agrodiversity includes the maintenance of both biotic and management diversity within agro-ecosystems and responses to natural ecosystem diversity and dynamics (Brookfield and Padoch 1994). Agrodiversity of farming practices ensures that a range of "ecotypes" exist in close proximity and often succeed one another through time. Commercialization and monoculture lead to reduced agrodiversity, but the small, semisubsistence farms of the Sierra Nevada have been instrumental in maintaining agrodiversity in the region. The practices of these small and part-time farms in relation to the dynamics of agrodiversity, as developed by Zarin (1995), are examined. We also consider intensification and innovation in relation to land-management practices, the sensitivity and resilience of an ecosystem and the role of the creation of landesque capital, and population and production pressure on land management.

DATA SOURCES

We have not generated any new information through primary research in this assessment. All of the information on which this report is based is publicly available but has not been accessible in an integrated form. The main sources of written data are the agricultural censuses for California from 1860 to 1992 and the annual reports of the county agricultural commissioners. These data sources are supplemented by other publications from various county authorities and by historical studies of local areas. The mapped data comes from land-use data supplied by the United States Geological Survey (USGS) for the year 1970 and from data for 1988 and 1992 supplied by the Farmland Mapping and Monitoring Program (FMMP) of the Office of Land Conservation of the California Department of Conservation. The USGS 1970 data was obtained from the Geography Department at the University of California, Santa Barbara. 1992 land-use data downloaded in ARC-export files from the Environmental Protection Agency (EPA) Web site on the Internet. We had some mapping problems with this 1992 data and eventually discovered that it is based on 1976 USGS mapping corrected by the EPA using a statistical model to predict 1992 land use. Thus, it is not a

very solid basis for measuring actual change in land-use categories over time and so we abandoned this data set.

The statistical data is published for whole counties, whose boundaries do not coincide with those of the SNEP study area. Some counties, such as Kern, Fresno, Tulare, Madera, Merced, Stanislaus, Yuba, Butte, Tehama, and Siskiyou, have only a small, predominantly nonagricultural part of their area lying within the Sierra Nevada, so it was decided to omit these counties from the analysis. Another problem with agricultural census data is that when the number of farms in a category is so few that individual farms could be identified, the information is left out because of the need to maintain confidentiality. This was a particular problem in small counties such as Alpine and Sierra. The census allows the development of time series analysis, but the length of time between censuses varies. The first United States Census of Agriculture was taken in 1840, but the first available for California was in 1860. The next census we have for California was taken in 1880 and after that in 1910 and 1920. Censuses were then taken every five years until 1950, then next in 1954 and every five years until 1974, then at four-year intervals until 1982, returning to five-year intervals in 1987 and 1992. The content of the censuses is also not directly comparable over time.

Questions asked in the census, definitions, and county boundaries have changed. In 1860 the number of farms in each county was not recorded, and Alpine, Inyo, Lassen, Modoc, and Mono Counties did not exist. The number of acres in improved and unimproved farmland was given but in 1880 only improved land acres were recorded (U.S. Census Office 1864, 1883). The 1910, 1920, and 1930 agricultural censuses were very limited in scope (Bureau of the Census 1913, 1922, 1932) and the 1930 and 1935 censuses had a more restricted definition of cattle than in other censuses (Bureau of the Census 1936). County boundaries also changed: part of El Dorado County was annexed to Placer and part of Placer County annexed to El Dorado in 1913. More recently, in the 1974 census there was a major change in the definition of a farm, so earlier censuses are not strictly comparable with those from 1974 onward. Since 1850, when minimum criteria defining a farm for census purposes were first established, the definition of a farm has been changed nine times. In 1959 a farm was defined on the basis of the number of acres in the place, that is, the land on which agricultural operations were conducted. Farms with less than ten acres were counted if the estimated value of sales of agricultural products for the year amounted to at least $250. Farms of more than ten acres had to have an estimated minimum annual value of production of $50 (Bureau of the Census 1961, xiv–xv). In 1976 the definition was changed: the number of acres criterion was abolished and the minimum value of sales criterion raised to $1,000 per year (Bureau of the Census 1977, ix). This change had its greatest effect on small part-time farms, such as many of those in the Sierra Nevada (Bureau of the Census 1977, B1). From 1969 the census has been based on mailed questionnaires; previously it had been carried out by direct enumeration in the field. There have also been several changes in the time of year at which the census was taken. In order to minimize the impact of these internal census changes, most of the data used here are presented as percentages or related to other data from the same census.

The annual reports of the county commissioners are even more varied than the censuses. The series of reports starts in different years for the various counties, and some counties, such as Inyo and Mono, are combined. The variables for which information is presented vary from county to county and from year to year, influenced by the specific changes in each county, the availability of data, and the interests of the individual county commissioners. This variety gives a freshness and vitality that adds color and explanation to the information gleaned from the census. It also allows an appreciation of short-term changes within the intercensal period. However, these reports do not start until after the Second World War, and the publication years for each county differ.

Because data in the census and county commissioner's reports are aggregated for the whole county, it is impossible to know where within the county specific crops are grown. However, the data from the United States Geological Survey (USGS) does provide this information in great detail, giving us a snapshot of the land use of the Sierra Nevada for the year 1970. This has been supplemented by land-use data provided by the Farmland Mapping and Monitoring Program (FMMP) of the California Office of Land Conservation. The FMMP compiles two kinds of farmland maps: Important Farmland maps for those areas that have modern soil surveys and Interim Farmland maps for those areas lacking modern soil survey information and for which there is expressed local concern on the status of farmlands. Consequently, much of the agriculturally marginal land of the Sierra Nevada is not mapped by the FMMP. Only forty counties of California are mapped, excluding Alpine, Calaveras, and Tuolumne in the central Sierra; Lassen in the north; and Mono and Inyo on the east. Sierra Valley is the only part of Plumas and Sierra Counties that is mapped. These maps show land capability based mainly on the physical and chemical qualities of the soils, plus growing season and moisture availability, but they also broadly reflect current land use.

We found major problems when trying to integrate the mapped data and the county-level statistical data. Despite the considerable amount of land-use mapping undertaken by various agencies, inconsistencies in the coverage and changes in classifications make it impossible to draw meaningful conclusions about changes in land use over time for the whole SNEP region. Interrelationships between land use, production and input levels, economic returns, and farm structure and population can be obtained only from the census data. In addition, the categories used for land use differ from one source to another and sometimes vary from year to year and from county to county as the Farmland Mapping and Monitoring Program (FMMP) responds to changes in definitions made by other agencies, such as the Soil Survey (California

Department of Conservation 1992). Consequently, the mapped information has been used to illustrate and supplement the census data but, only to a limited extent, to inventory the conversion of agricultural land. The census data have been utilized for time series analysis and for the identification of agricultural ecosystems using principal components analysis (PCA).

HISTORICAL BACKGROUND TO AGRO-ECOSYSTEMS

The history of agriculture in the Sierra Nevada can be seen as consisting of four main periods, beginning nearly a century and a half ago with the gold rush. Prior to the discovery of gold in El Dorado County in 1848, agriculture and ranching had been confined to the more accessible and fertile parts of the state, and there had been very little European settlement of the Sierra Nevada. Native American occupation of the region was based on hunting and gathering, with long-term settlement occurring wherever local food resources were plentiful, as with the seeds of a water lily, Nuphar advena, at Tulelake (Pease 1965, 44). In these areas of denser settlement, conflict between American Indian and European settlers over land took place. The early boom period of the gold rush was followed by one of adjustment to loss of local markets caused by declining mining activity and technological change. In the third period large-scale lumbering, power industries, and specialized agriculture developed. The fourth period is distinguished by rural residential expansion, agricultural pluriactivity, and the suburbanization of agriculture, especially in the foothills. These stages occurred first in the central foothills and somewhat later in the higher and more isolated areas of the Sierra Nevada.

The Boom Period of the Gold Rush, 1848–60

By the end of 1848, an estimated 10,000 to 12,000 men from California, Oregon, Central and South America, and the Pacific Islands had arrived in the foothills. Within five years some one-third of a million persons had migrated to the gold camps and the boom towns of the Sierra Nevada from all over the world. El Dorado County, where Marshall's eventful discovery of gold was made, rapidly became the most populous county in the state. By 1852 it had a diverse population of 40,000, while Nevada County contained approximately 20,000 people. In addition to the mining camps, settlements such as Placerville, Gold Run, and Nevada City sprang up throughout the gold-producing regions of the foothills (Weeks et al. 1943).

This growing population generated a demand for various support activities, such as lumbering, hauling of supplies, and food production. Farming developed in the foothills during the 1850s to meet the needs of the mining camps. Many disillusioned miners moved on to new discoveries elsewhere in the western United States and Canada, but some settled as farmers in the Sierra Nevada. They cleared extensive areas of timber and brushland for the production of barley, wheat, oats, and hay to meet the heavy demands of the horse teams that transported food, lumber, mining equipment, and passengers to the gold mining areas. Peach and apple orchards were established and vegetables and potatoes grown on lands irrigated with water from ditches built by mining companies. By 1860 the value of orchard produce from El Dorado County was the highest in the state (U.S. Census Office 1864), and the Sierra Nevada counties were producing about one-third of the state's orchard fruit. The three foothill counties of Mariposa, El Dorado, and Tuolumne produced 11.7% of the state's wine, and the wine output of Mariposa County alone was greater than that of Napa County. Some 35% of the state's market-garden (i.e., truck-farm) crops by value were produced in the Sierra Nevada by 1860.

The livestock industry also expanded into both foothill and mountain regions. Dairying grew rapidly, with milk, butter, and cheese finding local markets in the foothill towns and mining camps. All the Sierra Nevada counties produced butter contributing 14% of the state's total, but only seven of the region's counties made cheese (U.S. Census Office 1864). Sierra farms had less than 3% of the state's dairy cows, concentrated in the northern part of the region and in El Dorado County, and transportation difficulties clearly encouraged a concentration on butter and some cheese rather than on fresh milk. Meat production was very important: El Dorado County had by far the highest value of animals slaughtered of any county in the state and, when combined with the figures for Amador, Sierra, and Tuolumne Counties, accounted for almost one-quarter of the total for California. Thus at this period the farms of the Sierra Nevada were among California's major producers of food for local consumption using relatively intensive methods.

The effect of summer drought on pastures at low elevations soon led to the practice of driving dairy and beef cattle from foothill ranges to meadows in the high mountains. The sight of large flocks of sheep moving between winter ranges in the Sacramento Valley and summer grazing lands in the mountains also became commonplace following the introduction of stock from eastern states. As a contemporary account noted, "Here is a succession of grassy meadows—one called the Big Meadows is several miles in extent—and some men have cut a trail in and have driven up a few hundred cattle that were starving in the plains" (Brewer quoted in Burcham 1957, 153). Plumas County was the major producer of hay in 1860, with the Sierra as a whole growing 18% of the total for the state (U.S. Census Office 1864). In 1860 the Sierra Nevada contained 14% of the state's livestock by value, with Siskiyou (then including present-day Modoc County) as the leading county in the region.

Adjustment to the Decline in Gold Mining, 1860–1910

The dramatic boom period of gold mining was relatively brief and followed by a period of bust. Exhaustion of the more accessible surface placers was rapid, and California's gold production declined sharply from a peak in 1852. The attraction of new mining discoveries in Nevada, Idaho, British Columbia, and Alberta (Momsen 1990) from the 1860s onward initiated a long decline in foothill population. However, considerable local agriculture was maintained in the foothill region to supply the remaining local markets and the booming mining operations at Virginia City and other towns in Nevada. Population movement to the state as a whole continued, and many new immigrants, finding the fertile lands of the valleys in Spanish grants or other large holdings, turned to the foothill region, where they acquired land for farms by patent or homesteading (Weeks et al. 1943). The acreage of improved farmland in the foothills increased steadily, reaching a peak about 1880, with the greatest expansion occurring away from the early gold mining areas. Sierra Valley was settled by Swiss and Italians, who produced food for the silver miners of western Nevada. From 1860 to 1880, according to the agricultural censuses, acreage of improved land in Sierra County increased by 579% and in Placer County by 414%, but in El Dorado County it declined by 20%.

At higher altitudes, settlement and the related development of agriculture came later than in the foothills. American Indians were a strong deterrent to the settlement of the northeastern uplands in the 1850s and 1860s, but many of the displaced miners and ranchers remembered the fertile meadows they had seen there along the wagon trail on their journey to California (Pease 1965). In the 1850s mining in Shasta Valley had attracted enough people to provide mutual protection. Agricultural settlement on the tableland east of the Cascade-Sierra volcanic ridge was a different matter, however, because individual ranches were far apart and therefore vulnerable to attack. Military posts were set up to protect the settlers, but they also protected the American Indian peoples from roving vigilante groups of whites. The Modoc Indians were removed northward onto a reservation in Oregon in 1863, and by 1867 farm settlements had been established in the Honey Lake, Fall River, and Shasta Valleys. In 1864 the first settlement in what is now Modoc County was established, and by 1865 there were 300 residents in Surprise Valley (Pease 1965, 75). The route to Idaho ran through the valley, and farming developed to supply the wagon traffic.

Modoc County, formerly the eastern part of Siskiyou County, was established in 1874 in the northeastern corner of the state. By 1880 the initial phase of settlement of the region had been completed and the contemporary pattern of population distribution established. Two factors made the spread of farms and ranches possible during this period: subjugation of the Native American population and the availability of free or very low cost land (Pease 1965, 79).

The last hostilities in the region, the Modoc War of 1872–73, did not deter settlement on the Lost River meadows, although several ranchers were killed (Pease 1965, 79). The Treaty of Round Valley in 1868 opened the way for white settlement of the Big, South Fork, Warm Springs, and Goose Lake Valleys (Pease 1965, 79). Although this treaty only assured good conduct and did not extinguish Indian title, lands adjacent to the Pit River were immediately assumed to be public domain and so open to European settlement. The Native Americans of Round Valley had been granted a reservation, but this did not protect their land and many died of starvation and disease. Not until 1959 were courts to decide that this land had been taken from the Native American peoples illegally (Pease 1965, 80; see Reynolds 1996).

The Homestead Act of 1862 was the most common method of land acquisition. Where land had not yet been surveyed, settlers could protect themselves under the Preemption Act of 1841, which allowed the settlement of unsurveyed land with preference for eventual purchase at $1.25 an acre. Surveys took place in time for initial settlement of the northeast to be made under the Homestead Act. This act limited the amount of land that could be acquired by free patent to 160 acres, which was not enough to support a family in the higher, more remote areas of the Sierra, but the Desert Land Act of 1877 allowed up to 640 acres of land to be patented if part was irrigated within three years. The proportion to be irrigated was ambiguous in 1880, although it was later fixed at one-eighth, so much of the land acquired under this act was never irrigated (Pease 1964, 80–81). The Swamp Act of 1850 also made possible acquisition of land at low cost. Land covered by this act had to be swampy or liable to seasonal flooding, which in much of the Sierra included the highly desirable meadowland. The land was made available at $1.00 per acre, of which 80 cents could be on credit. All that was required for land to be designated swamp was for a local official to swear that the land in question was subject to flooding. This situation led the state surveyor in 1870 to complain that many were trying to "seek shelter under State laws and gain land from the Swamp Land Act" and that many who desired large holdings hoped to see their land classified as swamp (U.S. General Land Office Report, 1 August, 1870, page 461, quoted in Pease 1965, 81). Mountain meadow wetland that could be classified as swampland was especially valuable in the late 1860s, when hay commanded a high price in the mines of western Nevada. After 1873, when the Spanish doctrine of appropriation of riparian rights was legalized under the state Civil Code, water rights became an important factor in land acquisition. By 1880, 141,000 acres, 22% of total farmland in 1992, were in private ownership in Modoc County. Only 1.1% of this land was in harvested cropland. Two-thirds of the cropland was meadow on which hay was grown, and the rest of the land was in dry-farmed wheat and barley (Bureau of the Census 1883).

The numbers of dairy and beef cattle grew considerably between 1860 and 1880, in the higher parts of the Sierra Ne-

vada, and the number of sheep almost doubled, indicating a move into livestock farming (figures 17.1 and 17.2). Movement of cattle from the valley was encouraged by the heavy rains of 1861/62 which led to the death of many cattle, and by drought in 1863 and 1864 during which many herds died of hunger and lack of water (Burcham 1957, 152). This trend was reinforced by the passing of the "no fence laws" by the state legislature in 1866, which made cattlemen liable for damage done to unfenced crops by their animals.

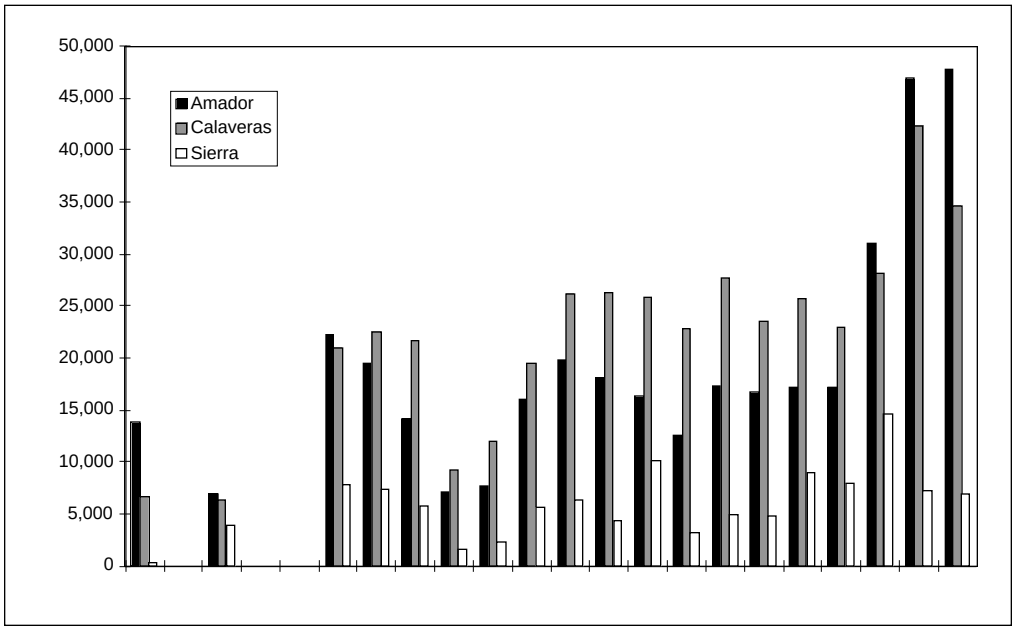
The demand for hay and feed grains declined after 1869, when the overland railroad was completed, and by 1880 a branch line of the Central Pacific Railroad had reached as far north as Redding. Local markets for food gradually fell as the mines in Nevada were depleted, and a further reduction occurred in the 1880s when hydraulic mining ceased as a result of the 1884 decision prohibiting the uncontrolled washing of debris into the rivers. Dry farming in the foothills became still more unprofitable following the replacement of teams by trucks and tractors during the early decades of the twentieth century. Competition from the more fertile valley farms became more intense as transportation costs were reduced by the construction of highways from the Sacramento Valley into the foothills. Except in areas where irrigation water was available, many farms were abandoned to brush and second-growth timber or utilized for extensive livestock production. By the close of the nineteenth century, much of the mountain and foothill rangeland was severely overgrazed in a struggle for forage among the numerous cattle and sheep outfits (Weeks et al. 1943).

With the inclusion of large parts of the higher parts of the Sierra Nevada in national forest reserves after 1891 and the establishment of the United States Forest Service in 1905, undesirable seasonal use of ranges was gradually brought under control. The Modoc Forest was established in 1903 to protect the livelihood of local ranchers (Menke et al. 1996). Grazing preference for national forest ranges was granted to small, owner-operated ranches located on foothill land adjoining the national forests in an effort to foster community prosperity and stability. Many of these small ranches, however, became uneconomic and were abandoned, and most of the private rangeland was consolidated into larger units. In 1880 the 13,000 acres of South Fork meadowland in Modoc County were controlled by only a few families, and in 1886 two of them joined to create the Modoc Land and Livestock Company, with an area of more than 11,000 acres (Duke 1939).

There was also an increase in the area of irrigated pastures used for beef and dairy cattle and for spring lambs. At higher altitudes, livestock farming was based on the use of summer range. The number of cattle in Modoc County increased from 16,000 in 1880 to 44,000 in 1909, while the number of sheep grew from 23,000 to 76,500 over the same period. The existence of large flocks of sheep in the county was an outgrowth of negotiations between local ranchers and transient flockmasters. Basque shepherds began to enter the county from 1880 as they moved their flocks from the Sacramento Valley to the mountains for summer pasture, and at about the same time Irish flockmasters moved south from Oregon into Modoc County. By the turn of the century these sheep threatened to destroy the rangeland for cattle. After 1905 permits had to be obtained for the use of rangeland and "the number of transient sheep bands was significantly reduced throughout the Sierra" (Menke et al. 1996). Shepherds could obtain these permits by settling in the area, so a number of sheep farms were established. These sheep, known as "resi-

FIGURE 17.1

Number of cattle in Amador, Calaveras, and Sierra Counties, 1860–1992.



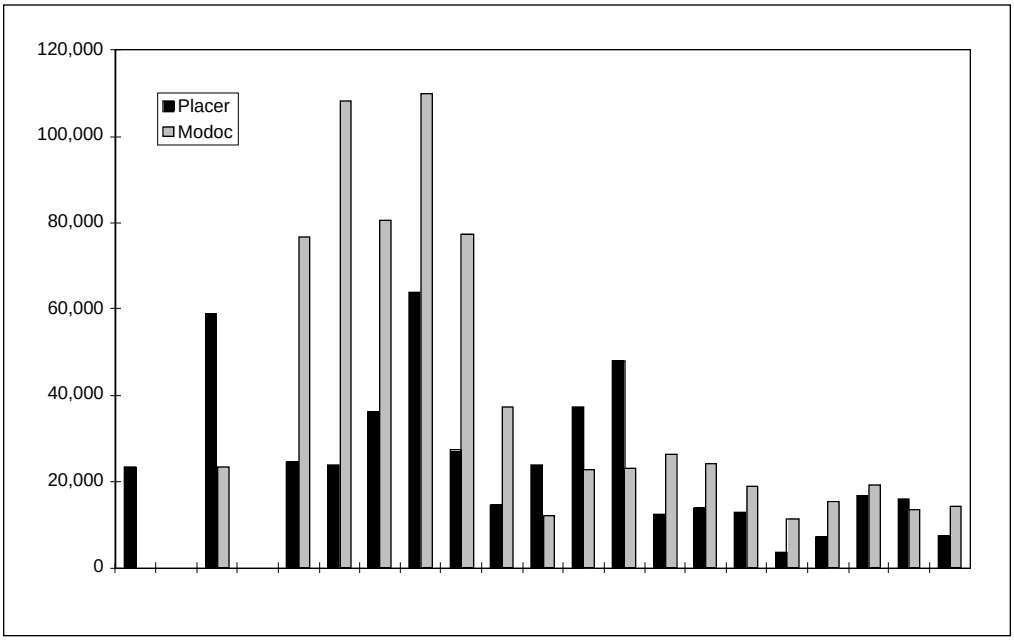


FIGURE 17.2

Number of sheep in Placer and Modoc Counties, 1860–1992.

dent sheep," were allotted rangeland too dry for cattle, so beef production was protected. In order to grow enough hay to feed the increased numbers of horses and cattle, swampy meadows were drained, and over 80,000 acres of other land in Modoc County was irrigated by 1912 (Pease 1965, 105).

New Activities, 1910–50: Lumbering, Hydroelectric Power, and Specialized Agriculture

After the turn of the century, large-scale logging became the dominant economic activity in the region (Weeks et al. 1943). The network of flumes and ditches built by the earlier hydraulic miners was gradually taken over and adapted for power, irrigation, and domestic uses. The first application for water rights for generating hydroelectric power was filed in 1891 by the Cornish manager of a gold mine in Nevada County (Larson 1996). An expansion of crop agriculture during and following the agricultural boom of the First World War brought renewed prosperity to the region. In the foothills the area in orchard crops expanded rapidly in response to the organization of irrigation districts and the rehabilitation or new construction of irrigation facilities. Pears and other fruit trees were planted on a number of ridge areas where fertile soils and water were available, as in the regions adjoining Placerville, Auburn, Grass Valley, Oroville, and Paradise. By 1924 Placer and El Dorado Counties had 15% of the state's pear trees (U.S. Bureau of the Census 1927).

The average size of farms increased from 299 acres in 1880 to 755 acres in 1925 in Modoc County, although both the number of farms and the area of farmland peaked in 1920 (U.S. Census Office 1883; U.S. Bureau of the Census 1922, 1927). In Alpine County both the number of farms and the amount of farmland fell between 1880 and 1925, as it did in Sierra and Nevada Counties, although Shasta, Mono, Inyo, El Dorado, and Tuolomne Counties increased their number and acreage of farms (U.S. Census Office 1883; U.S. Bureau of the Census 1927). In Placer County the number of farms increased rapidly, from 514 in 1880 to 1,448 in 1925, although the amount of total farmland declined: average farm size fell from 267 acres in 1880 to 233 acres in 1910 and to 157 acres in 1925. Woodland was still being cleared for agriculture, and in the counties of Placer, El Dorado, and Shasta nearly 10,000 acres (18% of the state total) on almost 900 farms (24% of the state total) was brought into agricultural production. By 1925 Modoc County was second only to San Joaquin for acres of hay grown (U.S. Bureau of the Census 1927). Clearly, several processes were going on, with a retreat from marginal land in many areas following the end of the First World War accompanied by an expansion into new areas as accessibility improved.

Increased demand during the world wars and widespread poverty during the 1930s also affected use of public grazing lands. During these periods of national crises, there was increased livestock use of national forests and other public lands throughout the West, and often inappropriate stocking levels were disregarded. During the First World War demand for wool and mutton was high and so sheep grazing increased, while during World War II cattle usage rose. The foot-and-mouth disease epidemic of 1924–25 permanently reduced grazing in the Stanislaus National Forest, where all livestock for that season were slaughtered (Menke et al. 1996). Sonora Pass was closed to transient sheep to limit the spread of the disease, and so grazing in the eastern Sierra was also affected

(Menke et al. 1996). After 1925 stocking in the Stanislaus National Forest was reduced to 66% of previous levels, and the closure of Sonora Pass to sheep ended the driveway use of the forest (Menke et al. 1996). In many areas a series of drought years between 1919 and 1935 and overstocking during the First World War led to depletion of public grazing lands. However, it was only after passage of the Taylor Grazing Act in 1934 that much attention was paid to rangeland carrying capacities (Menke et al. 1996). For economic reasons many grazing allotments changed livestock class from sheep to cattle in the interwar years (figures 17.1 and 17.2). Permitted usage of public lands rose during the Second World War but not to the pre-1920 levels. In some areas actual usage did not increase as cattlemen concentrated on feedlot management because of the shortage of manpower for range riding and the high cost of transportation during the war years (Letter to Tuolumne County Supervisor from Stanislaus Forest Supervisor, 1965, quoted in Menke et al. 1996). After this period there was a permanent decline in stocking levels on public grazing lands (Menke et al. 1996).

Tenant farming became less popular throughout California between 1910 and 1925, but in all the Sierra Nevada counties by 1925 it was below the state average of 14.7% and Mono County had the lowest proportion of tenant farmers in California. Farm values also fell. In 1880 no county in the Sierra Nevada had farms with an average value less than twice that of California farms as a whole (U.S. Census Office 1883). By 1925 the agricultural census recorded only Alpine, Lassen, Mono, and Sierra County farms as having values above the state average. However, rankings among the region's counties had changed little. Farms in Mono County were still the most valuable, with an average value exceeded by only five other counties in California, while the farms in Tuolumne County had become the poorest in the state.

The agricultural boom also resulted in a revival of population growth in the foothill region. The population of El Dorado County, which had fallen steadily from its peak of 40,000 persons in 1852 to only 6,400 in 1920, began to rise again. However, the more isolated rural areas continued to lose people while population became concentrated in the towns, suburban areas, and fruit-producing districts of the foothills. In Modoc County "farmers and ranchers immediately adjacent to the towns frequently chose town residences" (Pease 1965, 97). Small concentrations of population developed in scattered mining districts as renewed gold mining during the depression years of the 1930s once more attracted people to the foothills. Two gold-mining districts were active in Modoc by 1912, and at the peak of the boom seventy mines employing several hundred men were in operation. This new gold mining activity was short lived but stimulated production so successfully that in 1939 the output of gold from California exceeded that of any year since 1862.

For many people the Sierra Nevada became "a last refuge from unemployment" (Weeks et al. 1943, 8). Nevada County, with 38.5%, and Alpine, with 35.4%, had the highest proportions in California of their population living on farms in 1935 who were not there in 1930 (U.S. Bureau of the Census 1936). Only the counties of Lassen, Sierra, and Placer had less than the state average proportion of new farm population. Yet this farm population was becoming less dependent on agriculture. In 1935 Alpine County, with 58.8%, had the highest proportion of farm operators working for pay at jobs not connected with the farm (Bureau of the Census 1936). In Inyo and Mariposa Counties also, more than half the farm operators were working off the farm, while only in Plumas County were farmers much less likely to work off the farm than the state average (U.S. Bureau of the Census 1936). Conflict between the urban water needs of Los Angeles and the irrigation needs of farmers led to violence in the Owens Valley in the 1920s, with valley ranchers repeatedly blowing up the aquaduct. Finally much of the land was bought by the City of Los Angeles. "Since the 1930s, Los Angeles has exercised its control over more than 300,000 acres of the Inyo and Mono basins to transform the region from an agricultural area into a major recreational resource for the people of the South Coast" (Kahrl et al. 1978, 33). Only in 1995 were rural interests able to force the City of Los Angeles to reduce the amount of water it took from Mono Lake in order to preserve this lake's unique features.

Highway construction encouraged the use of the Sierra Nevada for recreation by the urban population of the state. Summer homes were built around Lake Tahoe and along streams, hunting of game became popular, and interest in historical sites grew (Weeks et al. 1943). These summer visitors stayed for relatively long periods, since the journey from the Bay Area to Lake Tahoe usually took two days, and so provided a new market for local farm produce (Trussel 1989).

In the Sierra Nevada during the first half of the twentieth century, more people were dependent on agriculture for their livelihood than on any other single economic activity. Much of this agriculture, however, involved part-time "subsistence" farming, with farmers producing some livestock and crops mainly for home consumption, while deriving supplementary income from lumbering, mining, road maintenance, activities related to recreation, or work with water or power companies. At the same time, these nonagricultural occupations did create a local market for agricultural produce.

The Suburbanization of Agriculture, 1950 to the Present

Sierra Nevada agriculture in the second half of the twentieth century is characterized by increased specialization of production, greater diversity of products, increased use of chemical inputs and integrated pest management (IPM) from the 1970s, and the development of organic farming. The role of the state in the restructuring of agriculture through subsidies for marketing and production or nonproduction of commodities and new trade, credit, and migration policies have brought many changes to the Sierra Nevada. Rural residential devel-

opment and hobby farming, often involving "equity refugees" (Starrs 1996) and more women farm operators have encouraged diversity of management strategies and changed Sierran transhumance patterns and agricultural activities. There has been much discussion of the socioeconomic impact on the Sierra Nevada of the proliferation of "ranchettes," that is, holdings of less than ten acres, but in 1992 only Placer County had a higher proportion of such farms than the state average (Bureau of the Census 1994). Indeed, the number of ranchettes declined for the SNEP area as a whole between 1987 and 1992 (U.S. Bureau of the Census 1994) although the counties of Calaveras, El Dorado, Mariposa, Mono, Nevada, and Sierra recorded small increases.

Improved communications and new counterurbanization flows (Champion 1989) have reduced the differences between rural and urban communities, and the static concept of the rural-urban continuum has become an inadequate analytical framework for the study of rural communities (Smith 1991). The influx of former urbanites, most of whom are better educated and richer than the traditional rural populace, has introduced new social divisions into many rural communities. Hobby farmers maintain the land in agriculture but have different interests from traditional farmers. Younger "in-comers" to the foothills often commute to work during the week, increasing traffic congestion and air pollution on rural roads, and have little time for community activities. Retirees moving onto small holdings may contribute by volunteering for community services but may be resented because of the new ideas and attitudes they bring. If we define nonmetropolitan counties as those not linked with large cities or with communities tied to large cities (Hoffmann and Fortmann 1996) then all the Sierra Nevada counties were nonmetropolitan until 1970, when Placer County became metropolitan. Placer was joined in this category by El Dorado and Shasta Counties in 1980. Many commuters from Sacramento and even the Bay Area have moved into El Dorado, Placer, and Calaveras Counties, while Sierra Valley has attracted Reno commuters.

Although average household incomes remain generally low in the Sierra Nevada, as in most rural areas, some counties have shown remarkable variation over time. In 1950 Mono County had the third highest average income in California and was the only county in the study area to have an average family income above the state norm. By 1992 it ranked twenty-third, with an average household income 12% below the mean for the state (Hoffmann and Fortmann 1996). On the other hand, Placer County has changed its rank from forty-seventh in 1950, when its average family income was 25% below the state norm, to twelfth in 1992, when it became the first Sierra Nevada county for more than three decades to have an average household income above the mean for California (Hoffmann and Fortmann 1996), emphasizing the increasing suburbanization of this county.

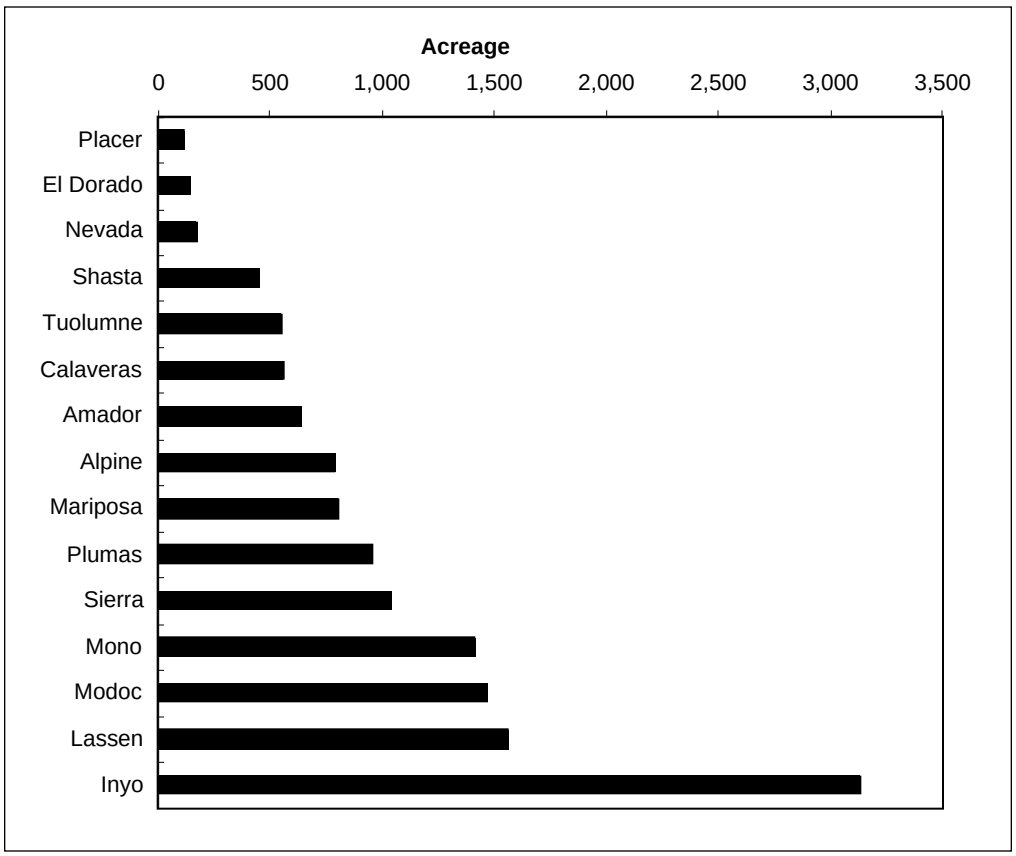
There is a worldwide trend toward an increase in farm size in order to take advantage of economies of scale as levels of mechanization and commercialization increase, and California has been a leader in the United States. However, this trend is not so clear in the Sierra Nevada. Between 1974 and 1982 farm size increased, and the number of farms declined throughout the study area, as was expected (U.S. Bureau of the Census 1977, 1984). But during the 1980s the direction of change became more confused: average farm size continued to increase in the higher-elevation counties of Shasta, Modoc, Lassen, Plumas, and Sierra and the eastern counties of Inyo and Mono, but it fell in the foothill counties of Placer, Nevada, Mariposa, and El Dorado (figure 17.3). In Amador and Calaveras, both farm numbers and farm size increased, reflecting an expansion of farmland acreage, while in Alpine County mean farm size was almost halved because farmland fell from 7,352 acres in 1982 to 4,768 acres in 1992 (U.S. Bureau of the Census 1984, 1994). The increase in the number of farms in the foothills during the 1980s indicates the widespread impact of the growth of rural residences and hobby farms in this part of the study area, while those counties farther from major urban centers were less affected by counterurbanization trends.

Taking the counties of Modoc and El Dorado as examples of these two recent trends in Sierra Nevada agriculture, it is possible to examine the differences in greater detail. In Modoc County the number of farms increased from 1974 to 1982 and then began to decline, as did the number of farm workers, tractors, and farms in individual ownership, while the proportion of full-time farmers increased from 44% in 1982 to 48% in 1992. Concentration on livestock production grew, with the proportion of livestock farms increasing from 53% in 1982 to 64% in 1992. This change suggests the substitution of family labor for hired labor and the growth of corporate extensive farming. In El Dorado the number of farms grew very rapidly during the 1980s as rural residential lots spread, and the average farm size was only one-tenth that of Modoc farms. Yet the proportion and number of commercial farms (farms with sales of over $10,000 per year) increased in El Dorado between 1987 and 1992, suggesting intensification of production. Crop production became the dominant activity on 43% of farms in 1992, as compared with only 30% in 1982. The number of tractors and hired workers peaked in 1982, but as in Modoc, the number of full-time farmers increased between 1982 and 1992. The more rapid turnover of farmers in El Dorado than in Modoc can be seen in the average years on farm statistics for 1992: 13.9 for El Dorado versus 17.4 for Modoc County (U.S. Bureau of the Census 1984, 1994)

Clearly, change has accelerated since 1980. Intensification, commercialization, and specialization have become widespread. Urbanization of foothill counties has occurred. This trend was most marked in Placer County between 1988 and 1992, when 15% of farmland was developed (California Department of Conservation 1992).

FIGURE 17.3

Average farm size in 1992 by county.



LAND MANAGEMENT

The purpose of land resource management is to ensure immediate and future production, not environmental conservation. Future production is valued over a time span that varies greatly according to the circumstances of the farmer. Conservation, in these circumstances, will arise only where future livelihood is threatened by perceived degradation or where the values of both the community and the farmer include the preservation of natural landscape and biota and a rejection of cultivation methods seen as damaging to the environment. The way individual farmers manage their land is influenced by personal perceptions that are a product of the stage in the life cycle of the farmer and the time spent on the farm, in terms both of years of experience and of labor time available daily. These perceptions will in turn influence the adoption of innovations by farmers. All farmers are faced by uncertain weather, diseases of plants and animals, and unpredictable market conditions. The strategies of risk-aversion include mixed farming, holding land across a range of resource types, and taking out insurance. Innovators will tend to be the most financially secure farmers, who are prepared to take risks in the hope of future gain.

In 1982 California farms had one hired worker per forty acres of farmland; this proportion rose to one per forty-three acres in 1992 (U.S. Bureau of the Census 1984, 1994). On Sierra Nevada farms, the ratio of workers to acres in 1982 varied from 1:86 in Placer County to 1:2131 in Inyo County. Over the next decade only five counties (Alpine, Amador, El Dorado, Nevada, and Lassen) went against the state trend with a reduction in the number of acres per worker. In El Dorado the number of acres per hired worker fell from 110 in 1982 to 63 in 1992, indicating increasing intensity of production. In both 1982 and 1992 the SNEP counties employed only 1.8% of all the hired farm workers in California (U.S. Bureau of the Census 1984, 1994).

Another way to measure intensification of production by increased inputs is to measure use of agricultural chemicals. Herbicide application was chosen as an indicator because herbicides can be used on both cropland and pastureland and because their use measures a certain level of sophistication and might be expected to decline as interest in organic production grows. In the state as a whole, herbicides were used on 15.2% of farmland in 1982, rising to 22.3% in 1992. In the SNEP study area, farms in only three counties (Mono, Modoc, and Placer) used herbicides on more than 2% of their farmland in 1982. During the 1980s herbicide use increased in all counties except Calveras, Inyo, Mariposa, and Mono so that by 1992 Placer County, with 11.2% of farmland utilizing herbicide, Modoc (4.5%), and Shasta (2.1%) were the leading counties. This ranking reflects the position of Placer and

Modoc as the counties with the highest proportions in the study area of cropland harvested in 1992.

Gender and Farm Management

There is empirical evidence for the United States that a high proportion of organic farmers are women; thus, the gender of the farm operator becomes an important element in farm management strategies.

The Sierra Nevada has long had a high male sex ratio, with men outnumbering women 12:1 in the early mining days. By 1925 the farm population in the study area was still more male than that of the state as a whole, varying from 45 women per 100 men in Alpine to 74 per 100 in Calaveras. (Inyo, where the sexes were numerically almost balanced, was the exception). Even today women rarely constitute more than 10% of farm operators in the industrialized world and even less in extensive ranching areas. Data on the number of women farmers in California have been published only since 1978 in the agricultural census, but the recorded increase in the proportion of women has been steady since then. In California as a whole, women farm operators made up only 7.9% of total farmers in 1978 but had increased to 12.4% by 1992. However, among the Sierra Nevada counties, only Modoc and Mono were below the state norm in 1992. Even more amazing is that in El Dorado, Nevada, Placer, Plumas, Shasta, and Tuolumne Counties women made up almost one-fifth of farm operators in 1992. Unfortunately, this high rate is probably more a reflection of the marginality of agriculture in the study area than of the skills of the local women, although affirmative action policies, especially in relation to farm credit, may have been a factor.

As is commonly found throughout the world, farms operated by women were much smaller than those operated by men across the region. In Mariposa, Modoc, and Plumas, the reverse was true in 1992 but appeared to be due to the effect of small numbers of large farms changing hands, possibly because of the death of a husband, as it was not true for earlier years.

Part-Time Farming

Another characteristic of farming in less-favored areas is the importance of part-time farming, which has been widespread in the study area since gold rush days. Farming was often seen as a stopgap activity until something more profitable turned up or as a source of subsistence to supplement low incomes from other activities. Today it may also be seen as a hobby for professionals who can work from their rural homes, for people taking early retirement, or for those choosing to commute from the countryside to urban employment. Part-time farming affects farm management strategies in various ways. Shortage of time may lead to the substitution of equipment and chemicals for labor to an extent that normally would not be economic. On the other hand, income from another job may support high levels of capital investment and provide the financial security that allows for innovation and risk taking. This nonfarm income may also reduce the pressures for high productivity and maximizing income; part-time farmers may be farming for pleasure rather than livelihood. Such perceptions and management strategies lie behind many of the specialized animal holdings, such as those for Arabian horses, llamas, and ostriches, found in El Dorado County and elsewhere in the foothills.

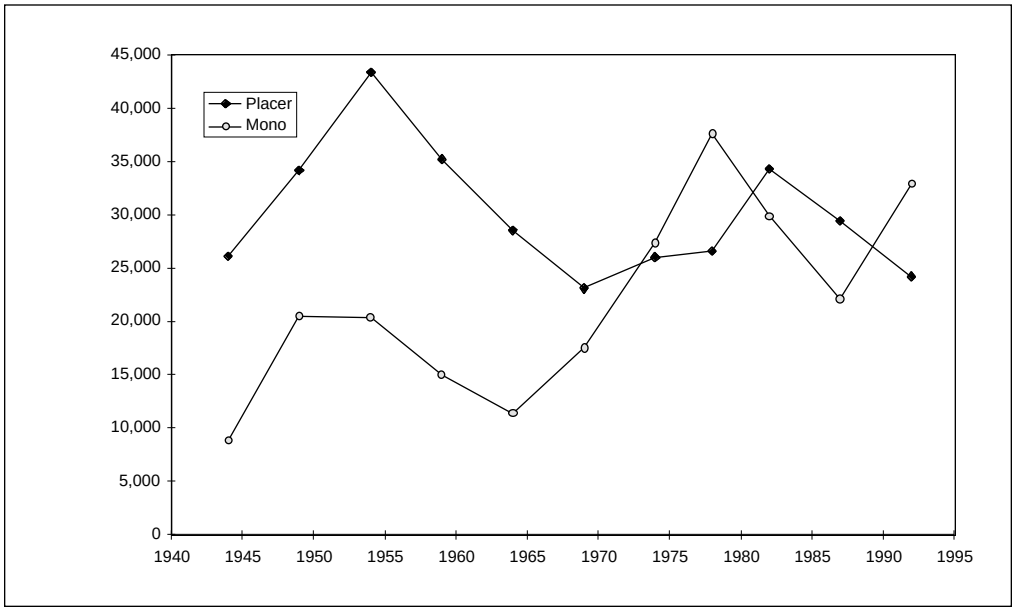
In 1982 a majority of farmers in the SNEP study area were not in full-time farming. The highest proportions of full-time farmers were found in those areas farthest from urban settlement, where non-farm jobs were not easily available as in Mono, Modoc, and Alpine Counties. The trend toward part-time farming is found in most countries, especially in environmentally marginal areas, yet unexpectedly, in the SNEP region by 1992 the proportion of farmers with no other occupation had increased in all counties except Alpine and had reached 58% in Mono County. Farmers who worked off the farm more than 200 days per year were most prevalent in those counties associated with smaller farms but with good road accessibility to urban employment opportunities. The highest proportions of such farmers (over 36% in 1992) were in the central foothill counties of Amador, Calaveras, El Dorado, and Placer (U.S. Bureau of the Census 1994). Many of these farmers could be classified as hobby farmers.

Landesque Capital and Equipment

Landesque capital is defined as physical works, created for the purpose of improving or sustaining production, that have a useful life well beyond that of a single season, crop, or crop cycle. It includes irrigation, drainage, and water-control works and tree crops such as orchards or Christmas trees. The creation of landesque capital is an important element in the management of land, biota, and water. In the foothill counties the expansion of irrigation works has been going on for the last half-century, although the number of acres under irrigation declined temporarily in the late 1950s (figure 17.4). Orchard crops have been grown on foothill farms since the gold rush days and continue to be important. In Sierra and Plumas Counties in 1964, land improvement in the form of leveling of land took place (Plumas-Sierra Counties Agricultural Commissioner 1965). At higher altitudes wetlands have been drained, as have lakes in Modoc County. The Tulelake basin is a high montane valley 4,200 feet above sea level extending from Modoc County into Oregon. Starting in the early 1900s the flat valley bottomland covered by shallow Tulelake and the surrounding marshlands were drained for irrigated agriculture and between 1917 and 1948 were opened for homesteading. Concerns for conservation of wetland habitat for wildlife led to the passage of the Kuchel Act in 1964, which enforced the coexistence of waterfowl management and agriculture in the area. Both these activities are now facing serious problems, stimulating the development of new man-

FIGURE 17.4

Irrigated acres for Placer and Mono Counties, 1944–92.



agement plans (Modoc County Agricultural Commission 1942–). Agricultural productivity has been declining because of soil infestation with nematodes and fungal pathogens. Agricultural chemicals have led to eutrophication and threaten wildlife. Researchers are now seeking nonchemical control methods for soil-borne pests and experimenting with seasonal flooding. "Sump rotation," that is, rotating areas of existing wetland into drained cropland in conjunction with flooding areas of existing cropland to create new areas of wetland, is being tried in pilot projects (Shannon 1995), an example both of the unexpected problems associated with landesque capital and of innovative management strategies.

Investment in machinery and equipment also influences management strategies. For much equipment there is a minimum size of holding below which a unit of equipment is uneconomic. Thus small farms tend to have less equipment than large farms, although part-time farms may be relatively overequipped. A farmer's investment in expensive, specialized equipment often tends to reduce flexibility in crop or livestock selection. Many of California's farms have high levels of capital investment in the most modern equipment, which is used to replace the scarce and expensive production factor of labor. Sierra Nevada farms differ from the rest of the state in this management strategy.

LAND USE

Any discussion of land use is limited by the lack of data on land use for the region as a whole. Only for 1970 is wide coverage available, so analysis of change in land use is impossible. In 1970 the Sierra Nevada presented a land-use pattern largely determined by elevation and moisture availability (figure 17.5). The SNEP western boundary delimited the upper reach of orchards and vineyards except for a few small outliers in El Dorado, Placer, Amador, and Tulare Counties (figure 17.6). Between the rich agricultural lands of the Central Valley and the forests of the mountains lay a band of herbaceous rangeland (figure 17.5). On the eastern slopes of the Sierra Nevada the forests graded into shrub rangeland, which is the dominant land use of Mono and Inyo Counties. Within the mountains and on the volcanic plateau to the north, better-watered fertile basins formed islands of cultivation and pastureland (figure 17.7).

In 1970 the USGS mapping revealed that only in Kern, Yuba, Lassen, and Inyo Counties was less than half the land in forest (table 17.1), while in Butte, Nevada, Plumas, and Shasta Counties more than four-fifths of the land within the SNEP boundaries was forested. Rangeland was most widespread in Inyo County and least in Shasta, Fresno, and Placer Counties. Only in the foothill counties of Placer, Yuba, and Fresno SNEP areas did agriculture occupy more than one-fifth of the land (figure 17.6), while in the central Sierra Nevada counties of Alpine, Inyo, Madera, Mariposa, and Tuolumne less than 1% of the land was in agriculture.

Land Capability

According to the Atlas of California (Donley et al. 1979), land in capability Classes I and II, defined as good cultivable land (USDA 1950), in the SNEP study area is confined to "a few places east of the mountains" (Donley et al. 1979, 73), which according to the map are in Modoc, Lassen, Alpine, and Mono Counties only. In 1974 virtually all this land was irrigated (Donley et al. 1979, 66). The California Office of Land Conservation in its Farmland Mapping and Monitoring Program

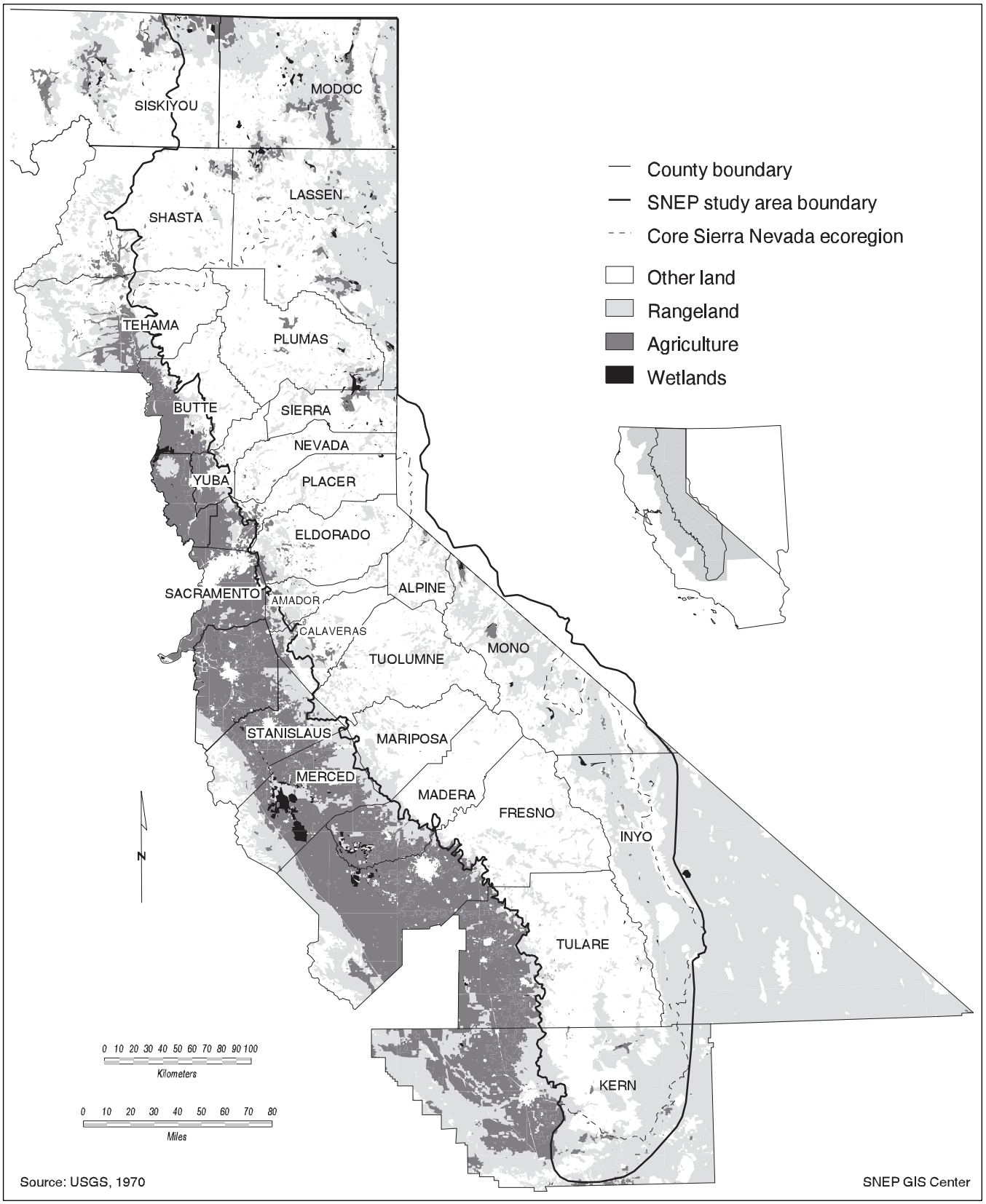


FIGURE 17.5

Land use of the Sierra Nevada, 1970.

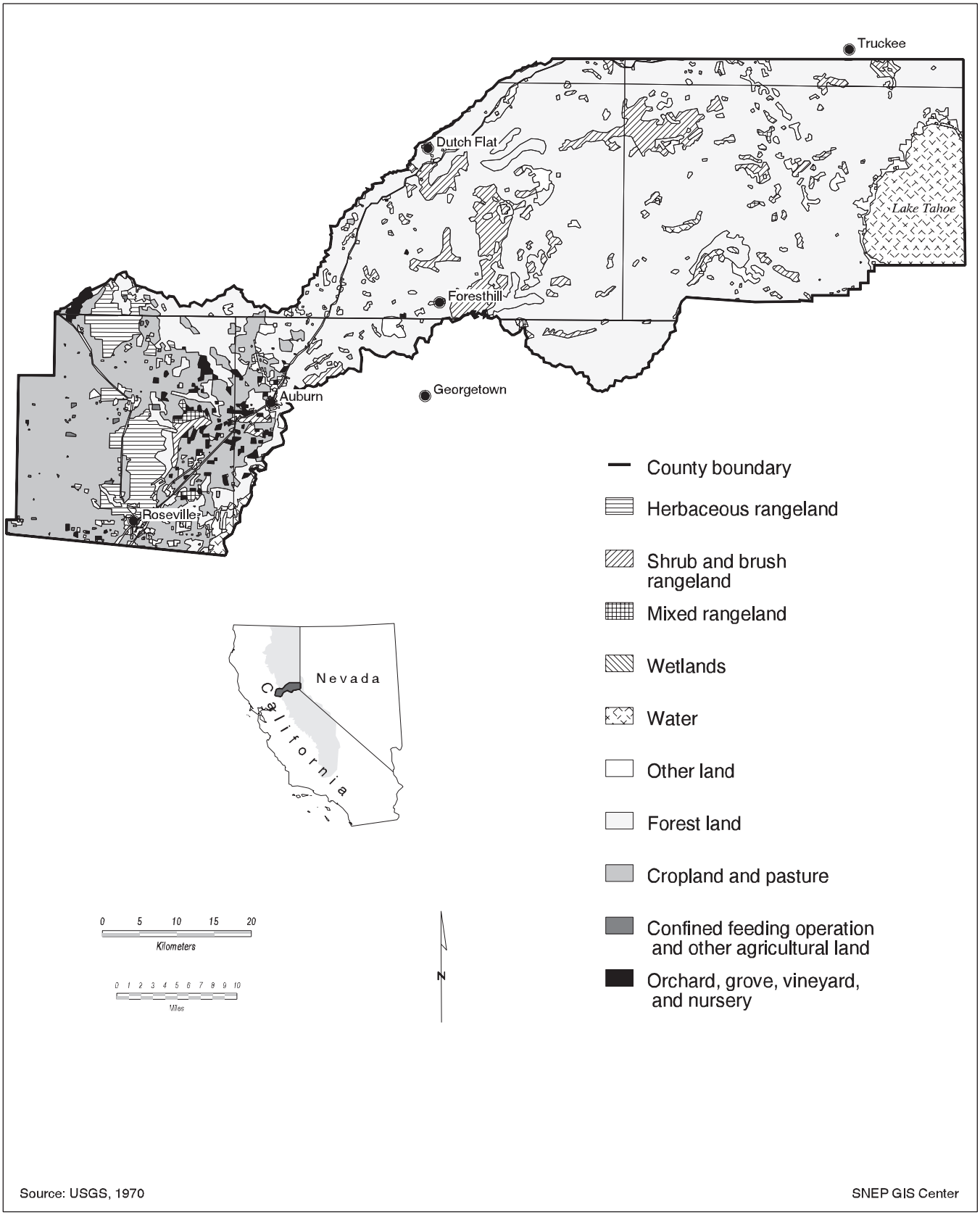


FIGURE 17.6

Placer County land use, 1970.

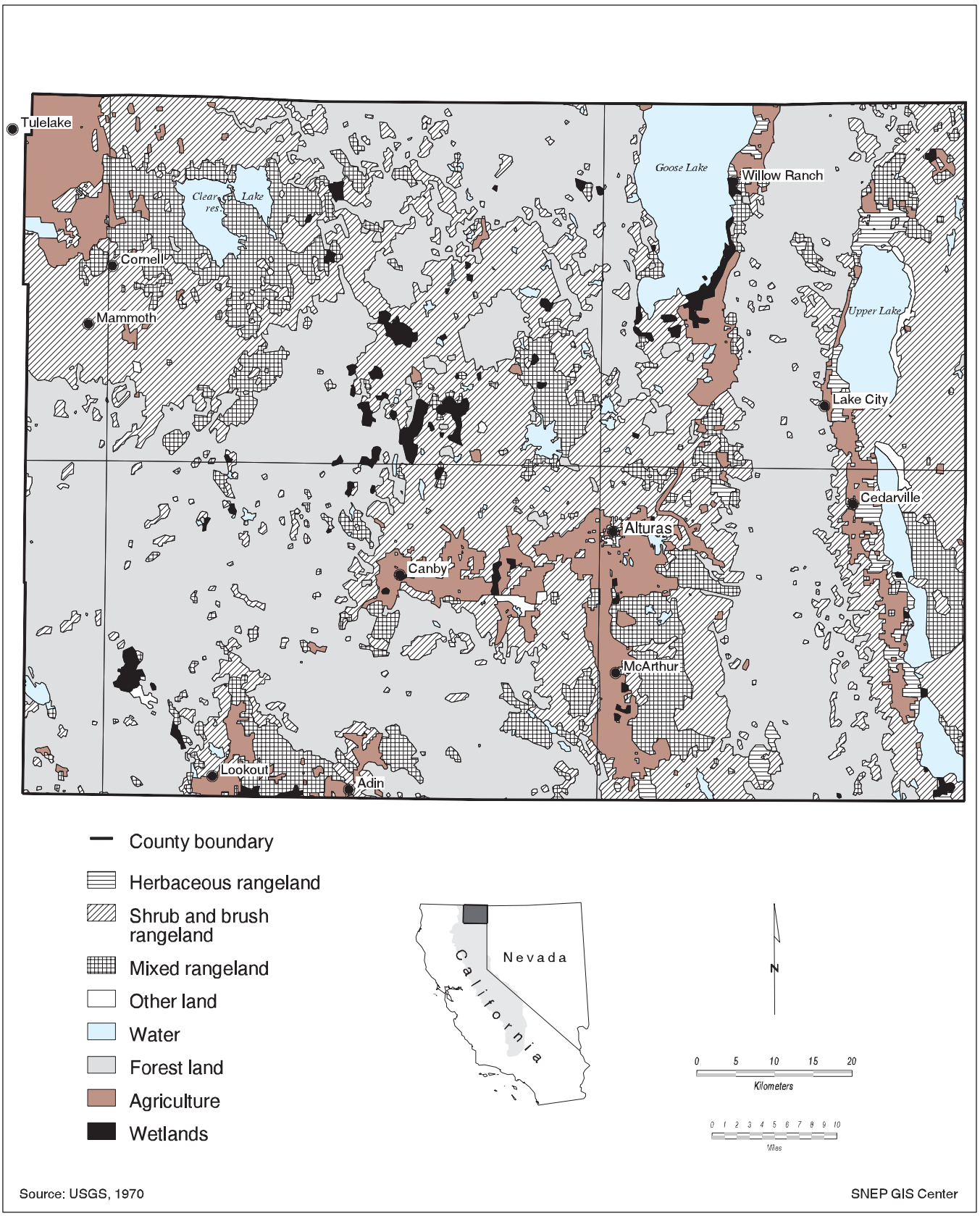


FIGURE 17.7

Modoc County land use, 1970.

TABLE 17.1

Percentage of agricultural, forested, and range land in the SNEP area by county, 1970 (USGS land-use mapping). Only those parts of counties lying within the SNEP boundary are included.

County	Forest	Range	Agriculture
Alpine	71.8	20.0	0.9
Amador	55.3	36.3	3.5
Butte	83.5	10.0	1.8
Calaveras	63.9	17.0	12.4
El Dorado	73.7	13.0	4.1
Fresno	61.4	7.2	24.7
Inyo	8.2	89.2	0.2
Kern	21.9	64.8	11.9
Lassen	47.7	43.6	3.8
Madera	73.7	23.2	0.2
Mariposa	79.1	19.7	0.1
Modoc	50.4	41.3	7.7
Nevada	82.3	9.6	1.1
Placer	62.0	7.5	20.9
Plumas	83.5	10.4	2.2
Shasta	92.8	4.1	1.3
Sierra	76.6	16.7	4.3
Siskiyou	75.4	12.8	5.5
Tulare	54.3	24.8	16.2
Tuolumne	79.7	11.8	0.4
Yuba	47.9	15.9	29.6

(FMMP) recognized two main areas classified as Prime Farmland in the SNEP area. The largest zone of such land is in Modoc County in the six basins of lava-derived alluvium of which Surprise Valley, Goose Lake Valley, and South Fork Valley are the most important (figure 17.8). Sierra Valley, a glacial lake bed, also has some Prime Farmland in the south in Sierra County. There are small, scattered patches of Prime Farmland identified and mapped by FMMP in Amador, El Dorado, Nevada, Placer, and Shasta Counties (figure 17.9). The minimum mapping unit is ten acres. Prime Farmland is land with the best combination of physical and chemical features able to sustain long-term production of agricultural crops. To be included on the map by the FMMP, this land must have been used for production of irrigated crops at some time during the two update cycles prior to the mapping date (California Department of Conservation 1992).

Farmland of Statewide Importance is similar to Prime Farmland but with minor shortcomings such as steeper slopes or soil with a lower capacity for moisture storage. There is some of this in Surprise Valley (figure 17.8) and in the northern part of Sierra Valley. The third category is Unique Farmland, which is poorer than the previous two categories and not always irrigated. There are examples of this category in Sierra Valley and western Placer County (figure 17.9). The fourth cropland category is Farmland of Local Importance, and it is determined by each county's board of supervisors and a local advisory committee (figures 17.8, 17.9). In general it includes land that is capable of agricultural production but often does not have irrigation water. It is more extensively distributed than the other cropland types. However, this land can be reclassified from year to year, which makes identifying true land-use change difficult: For example, between 1988 and 1992 a large area of Other Land in Shasta County was reclassified as Farmland of Local Importance. The last agricultural category is Grazing Land, which is defined as "land on which existing vegetation, whether grown naturally or through management, is suitable for grazing or browsing of livestock" (California Department of Conservation 1992, 14). This is mapped in eastern Modoc County and along the western edge of the SNEP study area in a buffer zone between forestlands and the cultivated farmlands (figures 17.8, 17.9).

Not all areas are yet included in this mapping system, so analysis of changes between 1988 and 1992 is limited to those areas that were mapped in both years. The SNEP counties with at least partial coverage are Amador, El Dorado, Mariposa, Modoc, Nevada, Placer, and Shasta. Most counties showed an increase in urban land, although Modoc and Mariposa actually recorded decreases. There were small increases in the acreage of Prime Farmland except in Modoc (figure 17.8) and El Dorado Counties. Both Placer and Shasta Counties had large decreases in grazing land acreage, much of which seemed to have been reclassified as Farmland of Local Importance. Overall it does not appear from this evidence that there has been any serious loss of prime farmland to urbanization in the Sierra Nevada since 1988.

Land in Farms

Settlement in frontier areas always involves a period of trial and error. The first settlers did not in every case identify immediately the best agricultural lands in the region, nor were they familiar with the vagaries of the climate. Some land was cleared that eventually proved uneconomic and was abandoned, while other land became profitable with the availability of irrigation water. In El Dorado County there was more land in farms in 1860 than in 1992 (figure 17.10) (U.S. Bureau of the Census 1864, 1994). In 1860 only 28% of California farmland was improved, but in El Dorado and Plumas Counties, and in Siskiyou (which at that time included Modoc County), about four-fifths of the land in farms was improved. This comparison reminds us of the relative importance of agriculture in the Sierra Nevada at this early period.

In the state as a whole, farmland declined from 28.9% of total land in 1900 to 27.6% in 1925, except for a brief expansion during the First World War (Bureau of the Census 1913, 1927). However, in the Sierra Nevada some counties displayed quite different patterns: the counties of El Dorado and Shasta saw steady growth in farm acreage from 1900 to 1925, the eastern counties of Inyo and Tuolumne began to increase their acreage after 1910, but Mono and Plumas experienced a decline in acreage during the war years (Bureau of the Census 1913, 1922, 1927). In Alpine County farm acres almost doubled between 1900 and 1910 and thereafter declined (U.S. Bureau of the Census 1913). Although the population of California increased by almost two-thirds between 1900 and 1910, the

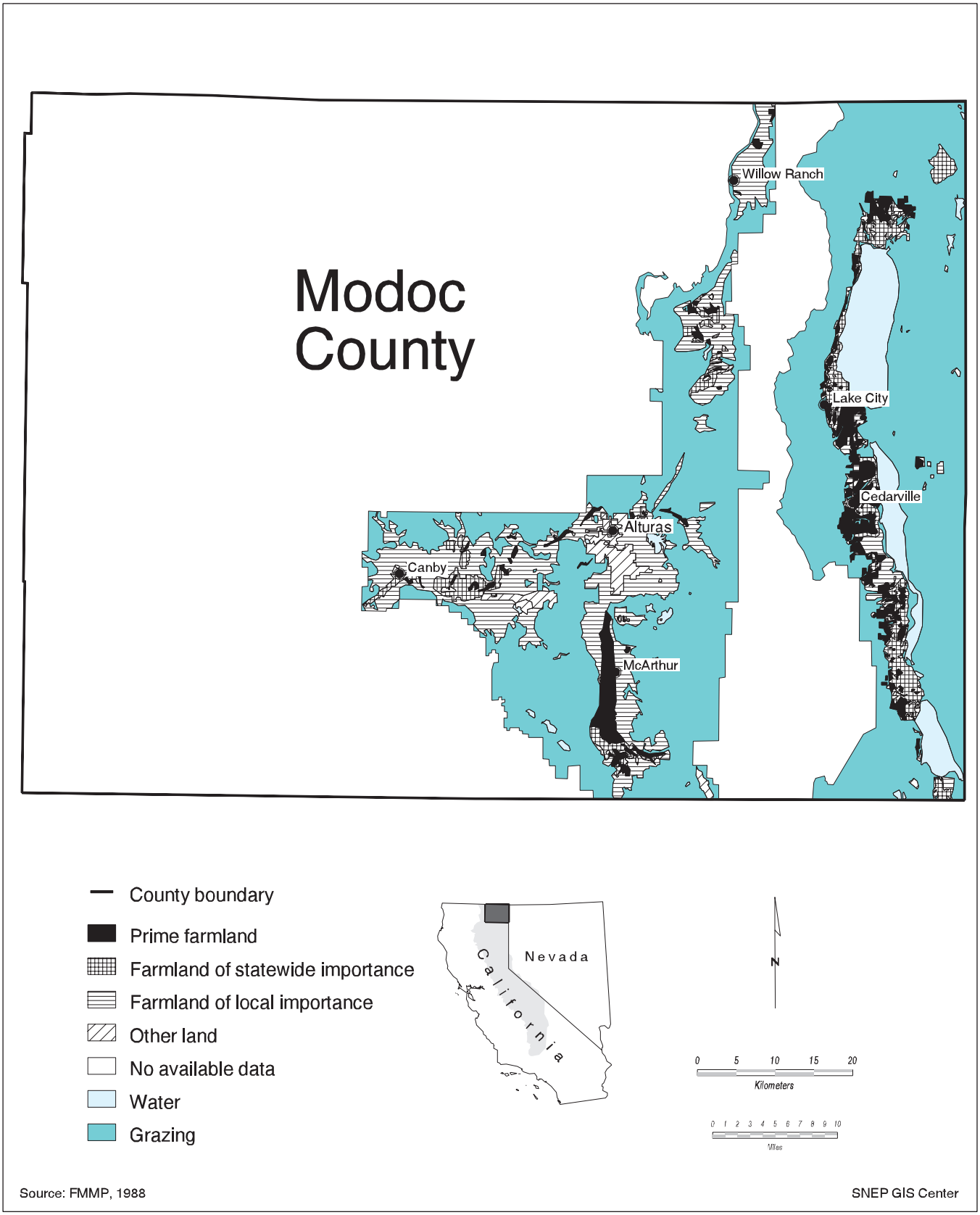


FIGURE 17.8

Modoc County land use, 1988.

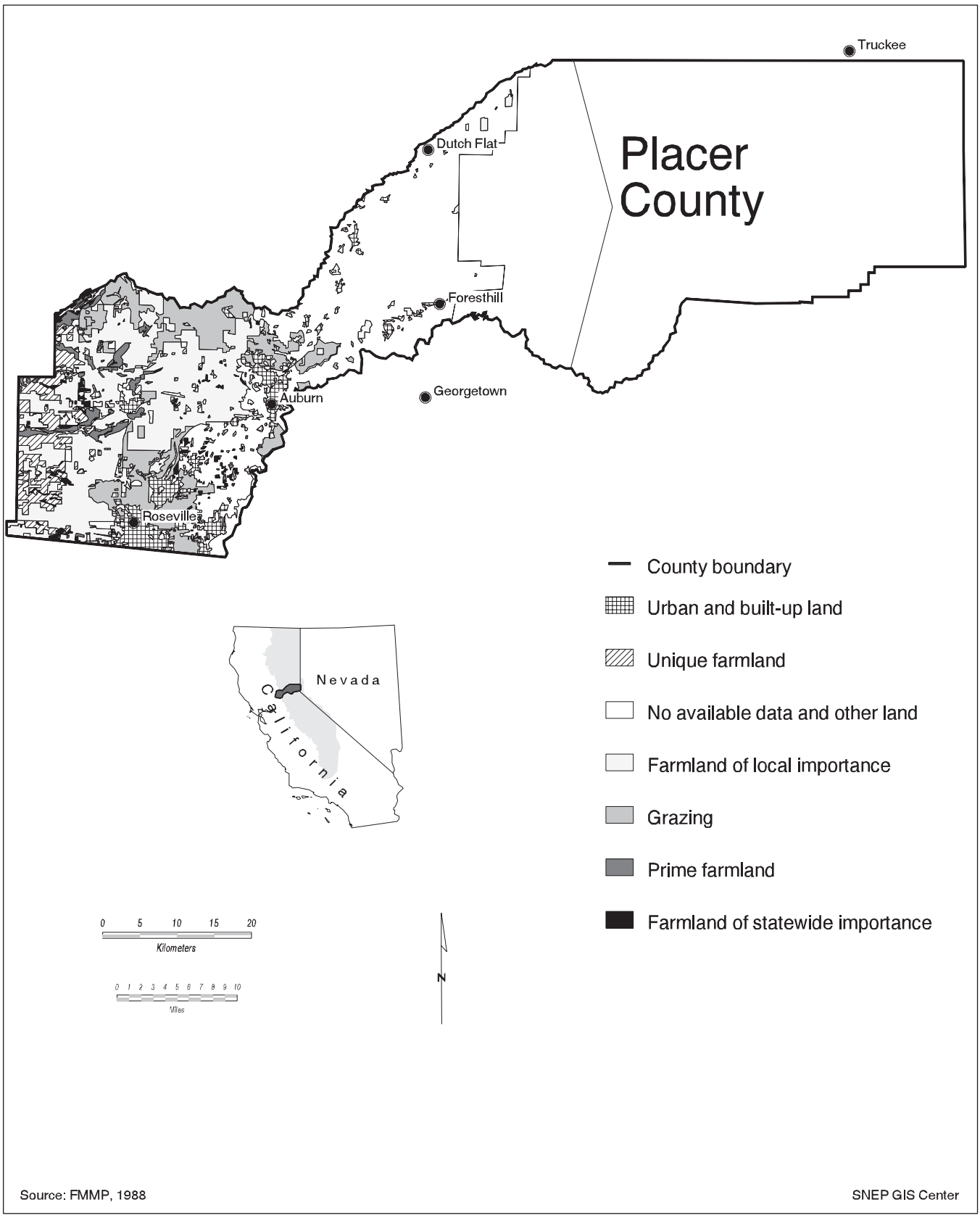


FIGURE 17.9

Placer County land use, 1988.

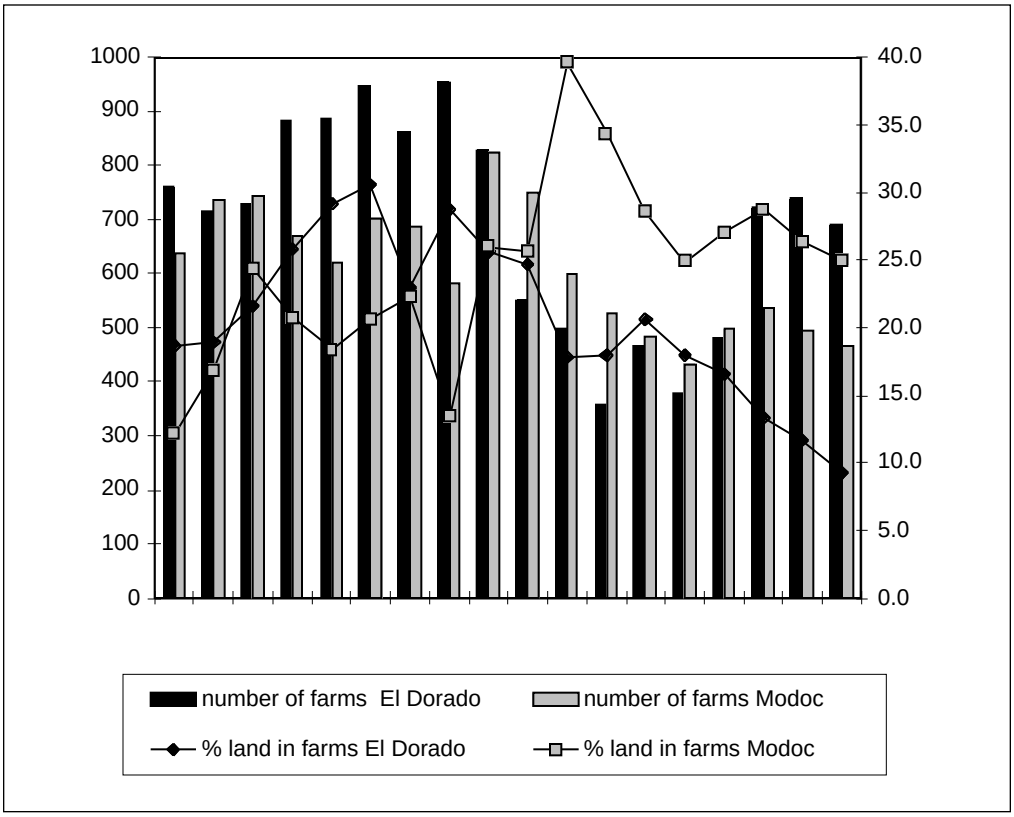


FIGURE 17.10

Number of farms and proportion of land in farms, 1900–92.

counties of Alpine, Amador, Calaveras, El Dorado, Mariposa, Mono, Nevada, and Tuolumne lost population. Only the northern counties of Modoc, Plumas, Siskiyou, Shasta, Lassen, Sierra, and Placer, plus Inyo, had a population increase during this period. Land values more than doubled for California farmland between 1900 and 1910 but declined for the Sierra Nevada as a whole, reflecting the growth of new economic opportunities outside the region (U.S. Bureau of the Census 1913), although in four counties land values increased enormously during this decade: in Modoc and Inyo land values more than quadrupled, and in Lassen and Placer they almost trebled. Only Amador, Calaveras, and Nevada Counties had a higher proportion of their land in farms than the state as a whole, and only Lassen was above the norm in proportion of improved farmland. These variations within the Sierra Nevada at the beginning of the twentieth century suggest an increasing concentration on agriculture as the dominant economic activity in many foothill counties and an expansion of rural settlement in the more isolated northern and eastern counties (figure 17.10) (U.S. Bureau of the Census 1913).

The amount of farmland in the state stabilized during the 1930s, expanded again during the Second World War, reaching a peak of 37.7% of total land in 1954, and declined in the face of competition from urban uses to 29% in 1992 (U.S. Bureau of the Census 1927, 1952, 1994). If we look at these trends at a county scale, however, a considerable amount of variation is noticeable. In the northeast of the Sierra Nevada region, in the counties of Modoc, Lassen, Plumas, Sierra, and Mono, farmland decreased during the Second World War, probably reflecting the lack of accessibility and the high transportation costs of this region. Farm acreage peaked in 1920 in Lassen County, in 1925 in Mono and Tuolumne Counties, and in 1935 in Amador, Calaveras, and El Dorado Counties. For the other Sierra Nevada counties, the greatest expansion of farmland occurred after the Second World War: in 1945 for Mariposa County; in 1954 for Placer, Plumas, Shasta, and Sierra Counties; in 1959 for Nevada County; in 1964 for Modoc; and as recently as 1969 for Inyo County (figure 17.10) (U.S. Bureau of the Census 1952, 1957, 1961, 1967, 1972).

Sierra Nevada farmland constituted 8.6% of California's total in 1860 (U.S. Bureau of the Census 1864), rose to 12.4% in 1959 (U.S. Bureau of the Census 1961), and then gradually declined to 11.1% in 1992 (U.S. Bureau of the Census 1994). Within the SNEP study area, farmland has long constituted a higher proportion of the total land area than in the state as a whole despite its relatively low productivity. In 1945 the percentage of farmland in the SNEP area was 18.2% (U.S. Bureau of the Census 1947), rising to 20.1% in 1950 (U.S. Bureau of the Census 1952) and falling from this peak to 14.3% in 1992 (U.S. Bureau of the Census 1994). By 1992 only the central foothill counties of Amador and Calaveras had a higher proportion of their land in farms than the state average, indicating an expansion of agricultural activities as urbanization pressures pushed farmers out of the Central Valley into the foothills.

Harvested Cropland

Much of Sierra Nevada farmland, that is, the total land in farm holdings, is not cropped, and even land with crops is not always harvested. The census definition of harvested cropland includes land from which crops were harvested in the census year. If two or more crops were harvested from the same land during the year, the acres are counted for each crop; therefore, the total acres of all crops harvested generally exceeds the acres of cropland harvested. The exception to this procedure is that for hay crops, whose acres are counted only once even if more than one cutting of hay was taken. If a crop was planted but not harvested, then these acres are not reported as harvested cropland. Land with crops grown purposefully for grazing is also reported as cropland harvested. Acres with bearing or nonbearing fruit and nut trees or vines are counted as harvested whether the crop was harvested or failed.

Agricultural production was becoming more intensive, and between 1924 and 1944 there was an increase of 31.7% in the amount of cropland harvested in California. However, in the mountains only Lassen County, at 61%, showed an increase in harvested acres greater than that of the state as a whole, and many of the foothill farms harvested crops from a smaller portion of their land. Mono and Inyo Counties also saw marked declines in cropland harvested because of the special situation of competition for water resources with Los Angeles. In the immediate postwar five years, as wartime demand for food disappeared, harvested cropland declined throughout the Sierra Nevada, except in Modoc, where the draining of Tulelake opened up fertile new land for homesteading. The greatest declines occurred in Shasta and Inyo Counties. At the same time, California as a whole increased its harvested cropland by 5.6%. The end of the Second World War marked the point at which the Sierra Nevada became most clearly marginalized in terms of agricultural development compared with the rest of the state. By 1992, in California 27% of farmland was in harvested cropland. The proportion of harvested cropland in the SNEP study area remained fairly constant between 1949 and 1992 at just over 7% of farmland. Placer county had 17% of its farmland in harvested cropland and Modoc 15% but all other counties harvested crops from less than 10% of their farmland.

Crop and Livestock Specialist Areas

Beef production has been important since the gold rush days, with Modoc producing the most in 1992. Calaveras and Amador Counties were the leading cattle counties in 1992 in the SNEP ecoregion, and the number of cattle increased in the 1980s (figure 17.1). In the foothills, overgrazing and repeated burnings have reduced the value of some pastures, and chaparral has engulfed many abandoned farms. Several smaller foothill properties combine feeding and grazing, producing dry-farmed grains and hay. The Sierra Nevada study area has 37% of the state's farms with grazing permits. Modoc has more of such farms than any other California county (U.S. Bureau of the Census 1992). Two-thirds of the fifteen counties studied have more irrigated pastureland than irrigated cropland. Some of this land now produces grass more intensively for commercial turf, as in Sierra and Inyo Counties, or has been turned into golf courses.

In addition to cattle, horses have long been important on SNEP area farms (figure 17.11). Percherons could still be seen working on farms into the 1960s, as noted in Modoc County (Pease 1965, 154). The number of heavy horses declined after the First World War, and by 1964 horses were no longer recorded in the census. However, riding horses are now very important in the region, and ranches for both horse breeding and recreational use of horses have proliferated since the 1970s. This modern "horsiculture" is found especially in the foothill counties, with Placer as the leading county. Altogether the SNEP study area had 14% of the state's horse farms in 1992 (U.S. Bureau of the Census 1994).

In the foothills, climate permits a variety of crops, especially in the so-called thermal belt, generally between 200 and 1,200 feet (Peters et al. 1995, 351). Orchards needing cooler weather are located on mostly nonirrigated land just above this level, with plums and cherries generally grown between 1,000 and 2,500 feet, pears between 1,500 and 3,500 feet, and apples between 2,000 and 4,000 feet (El Dorado County Agricultural Commissioner 1968). Pears were hit by disease in 1960, with Placer County losing most of its trees and El Dorado almost half (El Dorado County Agricultural Commissioner 1961, Placer County Agricultural Commissioner 1961). El Dorado County has been an important orchard area since the gold rush days, but Calaveras saw a large increase in fruit-tree planting in 1956 (Calaveras Agricultural Commissioner 1957). Harvest seasons are extended by planting many varieties of these fruit trees (El Dorado County Chamber of Commerce 1994). In 1992 the SNEP study area had 16% of California's pear farms, 15% of the plum farms, and 15% of the apple-producing farms, mainly in El Dorado County.

Proximity to Sacramento and the Bay Area and good road access mean that farmers in El Dorado County can focus on direct farmgate and U-pick sales and on on-farm value added to the product through bottling of wine, drying of fruit, and making of pies, jams, and preserves. Cut flowers, plants, and Christmas trees are also produced for direct sale. This on-farm marketing has led to the development of a combination of agriculture and recreation on many foothill farms. This concept was first developed in the Apple Hill area in 1966 and extended into the Somerset and Georgetown areas in 1983 and is now widespread (El Dorado County Agricultural Commissioner 1963). In 1992 14% of Sierra Nevada farms were involved in direct sales, more than twice the state average (U.S. Bureau of the Census 1994).

Grape growing began in El Dorado County in the early 1970s and was focused on the tourist market from the beginning. In 1981 five wineries were recorded, and by 1987 the

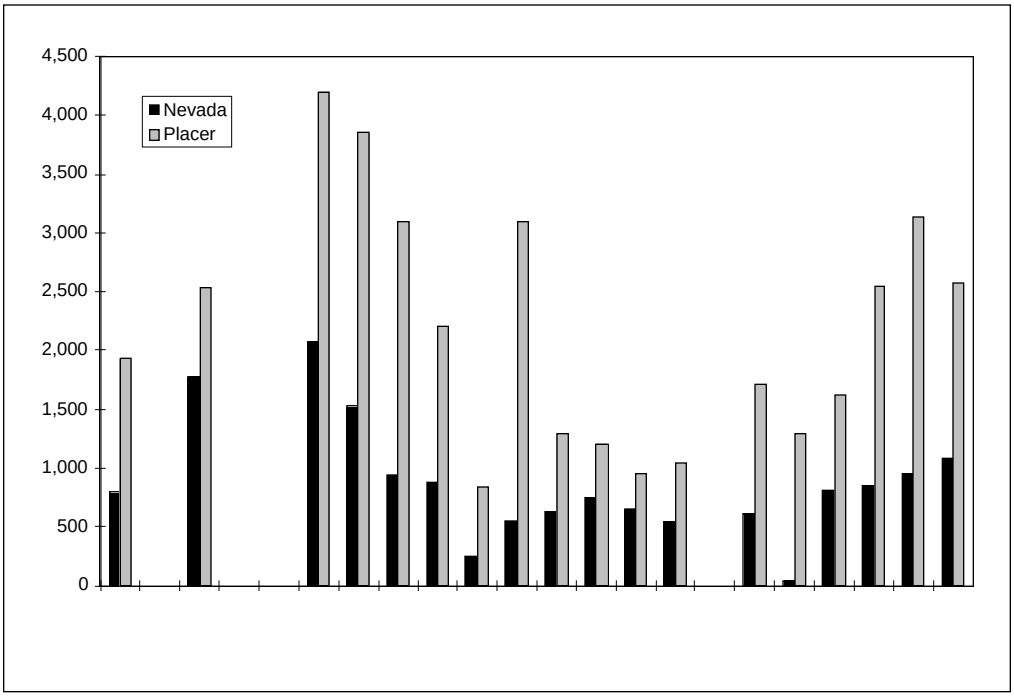


FIGURE 17.11

Number of horses in Nevada and Placer Counties, 1860–92.

county had fourteen wineries, mainly near Placerville and Somerset in the southern part of the county (El Dorado County Agricultural Commissioner 1963–).

Christmas trees are grown in the northern part of El Dorado County, with thirty-eight specialist farms listed by the Chamber of Commerce in 1994 (El Dorado County Agricultural Commissioner 1963–). Christmas tree production started in 1967 in El Dorado, followed by Sierra, Plumas, Calaveras, and Nevada Counties in 1969 (Calaveras County Agricultural Commissioner 1950–; Nevada County Agricultural Commissioner 1962–; Plumas-Sierra County Agricultural Commissioner 1960–). El Dorado and Plumas are the leading counties, with El Dorado increasingly concentrating on "choose and cut" customers (figure 17.12). Christmas trees were grown as

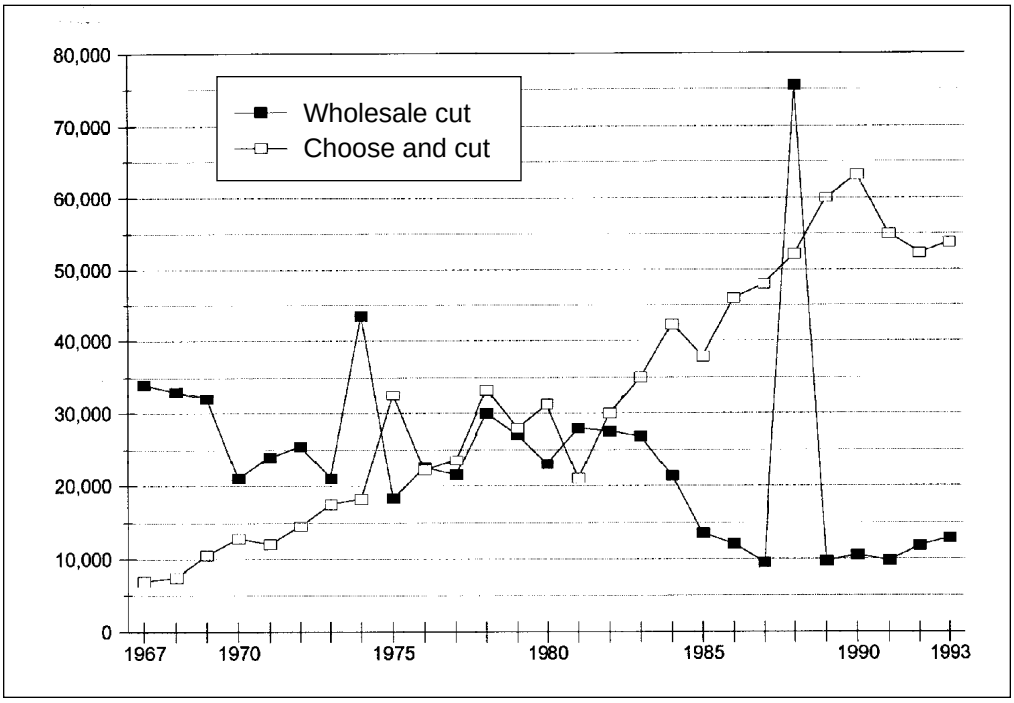


FIGURE 17.12

Number of Christmas trees grown in El Dorado County, 1967–93.

early as 1953 in Placer County but are not recorded separately after 1971 (Placer County Agricultural Commissioner 1946–). The 1992 Census of Agriculture records a big increase over 1987 in the value of Christmas trees and forest products sold and the number of farms involved in Placer County. Christmas trees were grown in Mono County for a short period in the mid-1980s (Inyo-Mono Counties Agricultural Commissioner 1974). Very few (1.3%) California farms produce forest products and Christmas trees for sale. It is perhaps not surprising that almost one-fifth (19%) of such farms are found on the forested slopes of the Sierra Nevada (U.S. Bureau of the Census 1994).

Hay is a major product on many SNEP area farms, and in 1992 the area had 10% of the farms and 11% of the hay acreage in California. Much of this is alfalfa hay, especially in Inyo and Modoc. At this elevation, agriculture is constrained by climatic limits, particularly frost frequency and length of growing season. Modoc has long been a specialist potato and onion producer, with Siskiyou County (Siskiyou County 1961–); potatoes are also grown in Shasta (Shasta County Agricultural Commissioner 1949) and Mono (Inyo-Mono Counties Agricultural Commissioner 1974–) and were introduced into Inyo County in 1979 (Inyo-Mono Counties Agricultural Commissioner 1980). Today Inyo and Mono also grow onions and garlic (Inyo-Mono Counties Agricultural Commissioner 1974–), while Modoc grows horseradish and sugar beet in the Tulelake basin (Shannon 1995).

Agrodiversity may be measured by both crop-livestock diversity and diversity of management strategies. On both measures Sierra Nevada agriculture is becoming more diverse. As California agriculture has grown more specialized, the Sierra Nevada has remained an area of semisubsistence and part-time farms producing a great range of crops and livestock, including many exotics. Off-farm employment has enabled many marginal small farms to survive. Farmers practicing organic agriculture have been increasing in number over the last decade. Isolation and inaccessibility are now being used to advantage by producers of marijuana, and some people think this illegal crop now may well be one of the most valuable in the region. However, the Sierra Nevada is probably less important for marijuana production than the northern coastal area of the state because of its less hospitable climate. Recently the production of hemp for fiber has been legally permitted in the Sierra Nevada.

FACTORIAL ECOLOGY OF AGRO-ECOSYSTEMS

The discussion so far has described how the structure and land use of Sierra Nevada agriculture has changed over time. Agriculture is marginal in much of the region, and farm income is lower than in the rest of the state. Farmers have long competed with urban populations for water resources, but they are now facing pressures from both housing and conservation issues. Counterurbanization in the 1980s changed the population and community structure in the region. In order to understand the contemporary agro-ecosystems of the Sierra Nevada, it is necessary to look at the quantitative relationship between changes in the socioeconomic situation of the farm population and land-use and structural changes in agriculture (Schulman et al. 1994). Factorial ecology methods (Davies 1984) utilizing principal components analysis (PCA) of data from four agricultural censuses, 1959, 1974, 1982, and 1992, provide this more precise description of change.

PCA is a method of multivariate analysis that seeks to identify and measure the underlying structure of the basic matrix of interrelationships in a data set. It aims to achieve scientific parsimony or economy of description while retaining all the essential information of the original set of variables. This model has been used for analysis of agricultural systems in many parts of the world (Henshall and King 1966; Brierley 1974; Swope 1995). We present here two sets of PCA output: the factor loadings, which allow identification of farming types based on the associations between the variables and the factors, and the factor scores, which measure how each county is related to the factors. In this way we are able to identify both farming types and regional farming systems.

Because this research was limited to preexisting information, the analysis is based on census data at the county level. We have included the fifteen counties that lie wholly or mostly within the SNEP study area. Because the model requires fewer variables than observations, we were able to input a maximum of fourteen variables. A further restriction was the need to choose variables that were available for all fifteen counties for all four study years. Within these parameters, variables were selected to represent six major aspects:

1. Farmer characteristics
   - Number of farmers over 65 years old (variable 12)
2. Labor input
   - Percentage of full-time farmers (variable 13)
3. Farm structure
   - Number of farms (variable 1)
   - Average size (variable 3)
   - Percentage of farms of ten to forty-nine acres (variable 8)
   - Percentage of land tenanted (variable 11)
4. Intensity of production
   - Farms using irrigation (variable 7)
   - Percentage of farms using fertilizer (variable 14)

5. Livestock
   - Number of cattle (variable 9)
   - Number of farms with sheep (variable 10)
6. Land use
   - Acres of farmland (variable 2)
   - Acres of woodland on farms (variable 6)
   - Number of farms with cropland and pastureland (variable 5)
   - Number of farms with harvested cropland (variable 4)

These data are shown in tables 17.2, 17.3, 17.4, and 17.5.

The study years were chosen to highlight key stages in the recent development of Sierra agriculture. In 1959 there was a change in the definition of a farm, and Sierra agriculture had not yet been influenced by the major road building that opened up the Sierra Nevada. In 1974 the definition of a farm was changed once again and data from this year is directly comparable with that for later years; this year also illustrates the early period of diversification, modernization and pluriactivity. The decade spanned by the censuses of 1982 and 1992 was one of rapid rural residential development.

Farm Systems

In each of the four years considered, three factors were extracted that, taken together, explained 82.3% of the total variance between counties in 1959, 87.7% in 1974, 84.25 in 1982, but only 77.4% in 1992, indicating growing complexity in the system since 1974. In all four years the first factor, which explained more than half the total variation in every year except 1992, was associated with intensive crop and livestock production on smaller farms, while the second factor was identified with large holdings raising cattle. The third factor varied from year to year but was always linked to an aspect of farm structure. The identification of these factors is based on the presence of high negative or positive "loadings" for the variables on each factor, as shown in figures 17.13–17.16. The analysis of these factor loadings allows two underlying dominant elements in the structure of Sierra Nevada farming to be recognized. These elements may be considered basic agro-ecosystems. One is associated with relatively intensive crop and livestock production and one with extensive cattle ranching.

Although there is general stability over time of the major agro-ecosystems, the weight of variables associated with these factors varies from year to year. In all years the first factor, which is associated with the dominant type of farming in the SNEP region, is identified by high loadings for the total number of farms, the number of farms of ten to forty-nine acres, the number of farms with harvested acreage and irrigated land, and the percentage of farmland fertilized and the number of sheep farms. The negative loading for average farm size declines over time, indicating a weaker relationship between small farms and intensive agriculture in 1992 than in 1959. The woodland acres variable is linked strongly and positively to Factor 1 in 1959 and 1982 and to Factor 2 in 1992 but quite weakly to all three factors in 1974, suggesting that there is no stable relationship between woodlots and other types of agricultural enterprise on farms in the SNEP area.

The number of sheep farms variable loads on both Factors 1 and 2 in 1959 but in the following three study years it is very strongly linked to Factor 1. The distribution of hogs and pigs was found, in a separate analysis, to follow a similar pattern. This association indicates an increasing division between cattle ranching and mixed farming with small stock and horses from 1974 onward.

Factor 2, which measures the second most important farming type, has high loadings for the number of acres in farmland in a county and the number of cattle in all four analyses. In the 1959, 1974, and 1982 studies, the percentage of acres fertilized is also positively linked to this factor, but in 1992 the link is negative. The addition of a high loading for woodlots and for older farmers to this factor in 1992 suggests declining intensity of production on cattle ranches.

Factor 3, associated with a minor farming type, in 1959 has high positive loadings for the proportion of farmland tenanted in the county and the proportion of farmers over 65 years of age but negative loadings for full-time farmers. Thus it seems to identify counties with older, part-time tenant farmers. In 1974, 1982, and 1992, there is a negative relationship between tenancy and older farmers, suggesting that younger farmers have been taking up tenant farms in recent years. In 1974, 1982, and 1992, Factor 3 is associated with larger farms. In 1992 this factor is identified with large full-time farms with a secondary link with cattle, and the earlier association with tenancy and older farmers has disappeared. The overall proportion of elderly farmers and of tenant farms has increased in the Sierra Nevada between 1959 and 1992 so that by 1992 it is no longer seen as being distinctive to any particular type of farming.

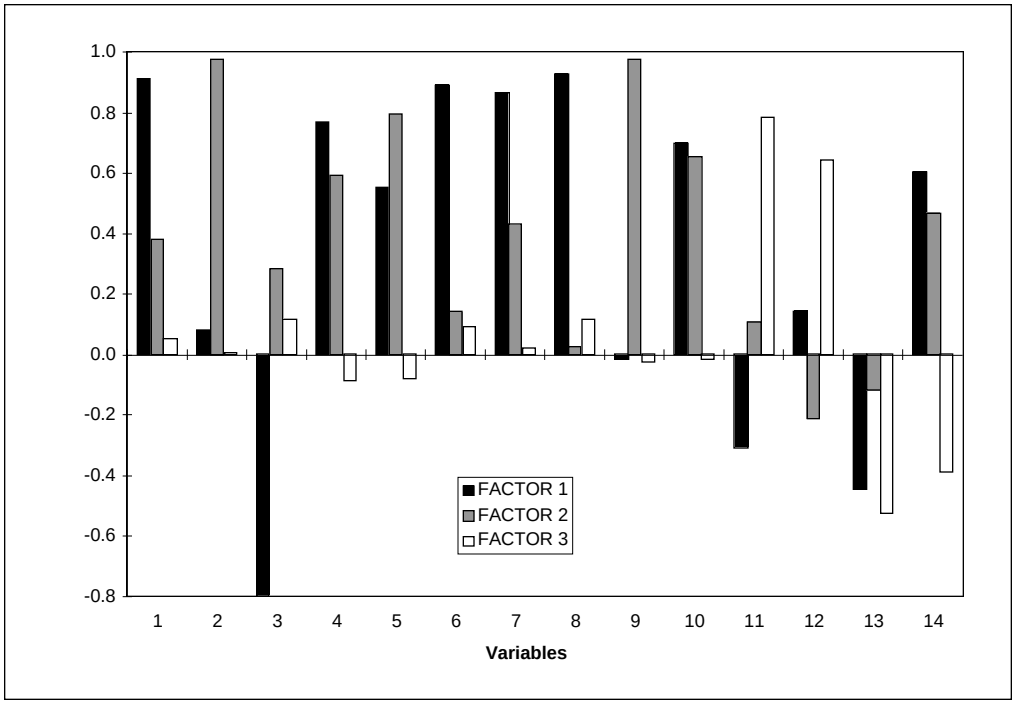
Full-time farming is strongly negatively linked to elderly and tenant farmers in 1959. In the 1974 study, full-time farming is closely and positively associated with small-farm, mixed-farming areas. By 1982 this former link has become negative, and full-time farming is associated with cattle ranching in counties with a higher proportion of farmland. In the 1992 study, full-time farming is seen as being associated only with large farms, suggesting the increasing importance of economies of scale for profitable farming.

Farming Areas

The factor scores for all four study years show the changing importance of types of farming in different parts of the SNEP study area (tables 17.2–17.5). Thus factor scores provide a spatial grouping of types of farming based on the analysis of

FIGURE 17.13

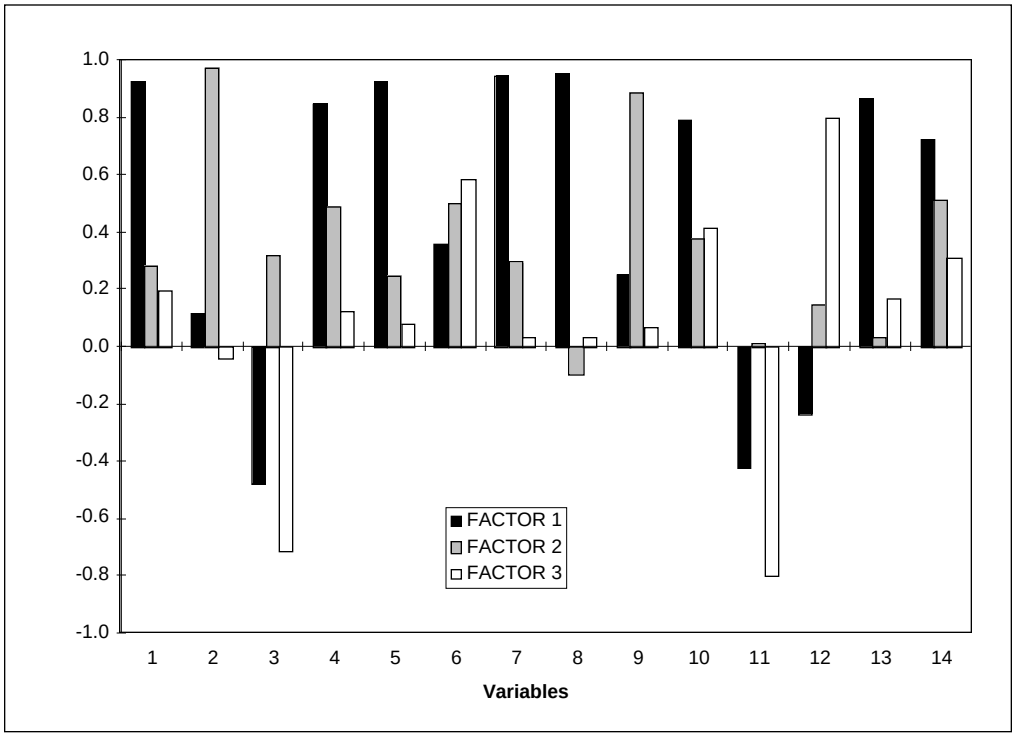
Rotated factor loadings, 1959 analysis.



the original fourteen variables for the fifteen counties. In 1959 scores on Factor 1 suggest that the major spatial division in the region's farming is between central and northern foothill counties and eastern counties, with scores on Factor 2 recognizing a secondary division between the counties of Lassen, Modoc, and Shasta in the north and the rest of the study area. This identification of a separate farming area in the north appears for each year studied but is less distinctive in 1992, when the northern counties are linked on the third factor with Inyo and Mono for the first time, perhaps indicating the grow-

FIGURE 17.14

Rotated factor loadings, 1974 analysis.



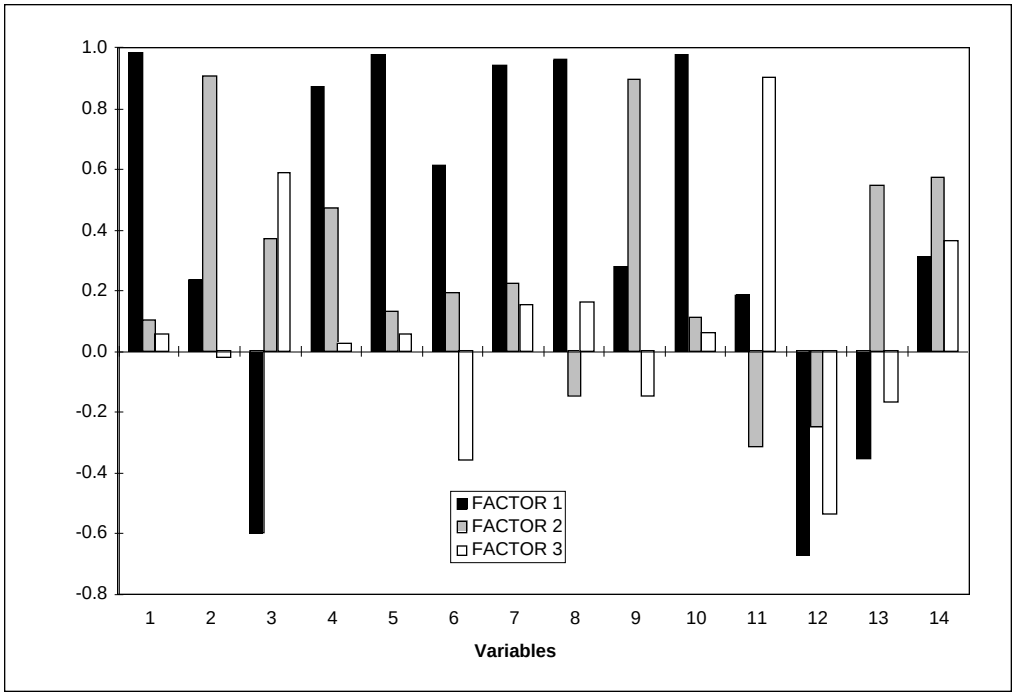


FIGURE 17.15

Rotated factor loadings, 1982 analysis.

ing importance of relative accessibility for agriculture. The third factor in 1959 identifies a minor division between the high-altitude north and the south.

By 1992 the major division is between the counties with many irrigated farms, that is, the northern county of Shasta and the central foothill counties of El Dorado and Placer, and the more rugged southern counties of Mariposa and Tuolumne and the high-elevation counties. The secondary division in 1992 is between the counties with large farms (Modoc, Lassen, Mono, and Inyo) and those with many small

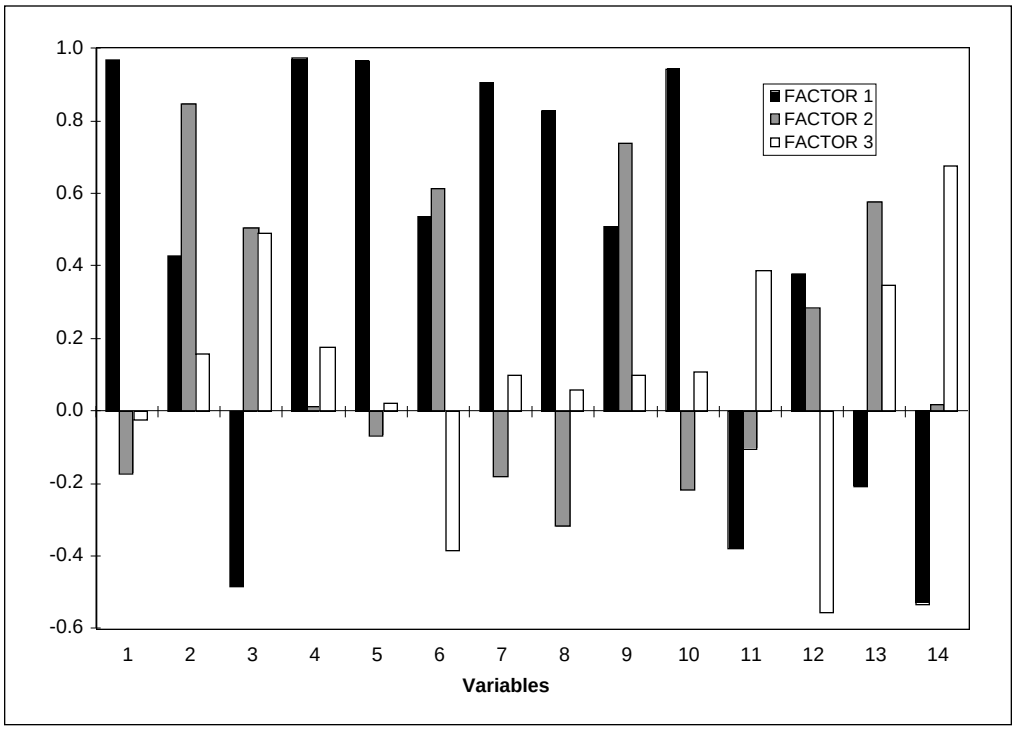


FIGURE 17.16

Rotated factor loadings, 1992 analysis.

TABLE 17.2

Analysis of farming areas, 1959.

	County														
	Alpine	**Amador**	**Calaveras**	**El Dorado**	**Inyo**	**Lassen**	**Mariposa**	**Modoc**	**Mono**	**Nevada**	**Placer**	**Plumas**	**Shasta**	**Sierra**	**Tuolumne**
Variables															
Number of farms	7	263	356	497	104	323	276	600	32	448	1213	103	880	49	308
Farmland acres	12,050	219,968	342,867	194,770	329,782	692,053	204,200	1,035,911	89,938	227,152	258,825	95,465	603,166	92,189	194,233
Average size of farm	1,721	836	963	392	3,171	2,413	1,030	1,727	2,811	507	213	927	686	1,881	631
Farms with harvested crops	5	111	159	306	60	266	59	545	20	257	685	71	402	36	98
Farms with crop and pastureland	5	65	111	105	21	199	47	295	11	115	208	38	296	18	54
Acres of woodland on farms	860	63,491	205,252	98,857	9,002	102,839	87,085	86,140	1,527	81,157	644,432	9,518	275,562	10,718	84,882
Farms with irrigation	7	82	163	309	93	198	55	485	29	336	972	70	688	32	107
Percentage of farms 10–49 acres	0	34	52	117	20	28	56	12	0	139	523	12	241	4	62
Number of cattle	1,315	10,880	20,598	10,394	26,176	57,775	15,991	80,467	4,456	11,875	16,490	13,077	38,552	5,494	10,533
Number of farms with sheep	3	64	93	107	23	98	49	161	9	102	140	16	161	9	52
Percentage of farms tenanted	0	6.2	2.7	1.6	32.7	6.7	3.6	1.5	3.2	1.8	7.3	7.1	4.9	9.4	3.5
Number of farmers over 65	0	26.2	25.3	21.7	20.4	15.3	19.3	11.0	6.7	20.1	15.1	23.5	17.3	22.9	23.8
Percentage of full-time farmers	57	46	44	48	43	53	49	52	47	40	46	50	39	66	49
Percentage of farms using fertilizer	28.6	24.7	13.8	45.1	8.7	24.8	10.5	47.3	6.3	21.7	45.4	21.4	30.3	4.1	5.8
Factor scores															
Factor 1	–.7349	.0475	.1584	.7147	–1.2563	–.6736	–.2420	–.1283	–.9582	.5929	2.6859	–.3689	1.1816	–.8932	–.0305
Factor 2	–.7967	–.5184	–.1869	–.4045	.5821	1.5476	–.5700	2.6460	–.4646	–.4149	–.1901	–.7092	.9275	–.6880	–.7599
Factor 3	–2.1415	.4515	.5657	–.5229	2.5505	–.2483	.0072	–1.1587	–.5225	.2254	.1117	.1361	.4685	–.2160	.2934

Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options. Davis: University of California, Centers for Water and Wildland Resources, 1996.

TABLE 17.3

Analysis of farming areas, 1974.

	County														
	Alpine	**Amador**	**Calaveras**	**El Dorado**	**Inyo**	**Lassen**	**Mariposa**	**Modoc**	**Mono**	**Nevada**	**Placer**	**Plumas**	**Shasta**	**Sierra**	**Tuolumne**
Variables															
Number of farms	4	194	275	379	79	296	161	433	43	169	813	89	679	28	172
Farmland acres	6,525	197,910	254,626	197,619	455,078	631,268	231,755	653,185	74,419	91,483	167,705	133,033	386,479	77,511	122,532
Average size of farm	1,631	1,020	926	521	5,760	2,133	1,439	1,509	1,731	541	206	1,495	569	2,768	712
Farms with harvested crops	3	81	102	196	39	233	23	370	26	69	435	58	379	20	26
Farms with crop and pastureland	3	85	96	155	25	177	46	156	16	67	383	54	349	14	74
Acres of woodland on farms	100	53,748	18,715	52,857	145	54,164	9,270	37,528	1,113	27,642	18,325	5,891	63,313	3,360	11,383
Farms with irrigation	4	44	88	199	68	185	37	335	36	108	608	45	450	22	62
Percentage of farms 10–49 acres	1	25	41	129	18	41	15	21	6	60	399	12	218	0	30
Number of cattle	1,990	17,190	25,769	12,732	23,355	62,399	27,144	122,715	6,405	5,189	30,819	13,781	46,385	8,982	16,050
Number of farms with sheep	1	35	46	51	6	41	27	65	7	34	80	9	64	2	32
Percentage of farms tenanted	25.00	11.30	10.20	7.40	34.20	6.40	12.40	9.90	11.60	8.90	5.80	7.90	10.20	21.40	8.10
Number of farmers over 65	1.00	32.47	23.64	21.90	10.13	22.64	24.84	17.78	9.30	25.44	15.50	19.10	15.17	28.57	19.19
Percentage of full-time farmers	2.00	95.00	119.00	139.00	21.00	127.00	71.00	127.00	227.00	74.00	297.00	48.00	237.00	15.00	65.00
Percentage of farms using fertilizer	1.00	26.29	18.18	41.16	17.72	29.59	20.63	52.19	23.26	27.81	46.86	17.05	43.22	7.14	17.44
Factor scores															
Factor 1	–.4279	–.6561	–.1990	.4513	–.7111	–.2259	–.6450	.2382	–.0414	–.2881	2.7888	–.5588	1.6551	–1.0419	–.3882
Factor 2	–1.1282	.0851	–.1434	–.1703	.9585	1.5841	–.1021	2.4500	–1.0105	–.6383	–.7453	–.5800	.5305	–.4167	–.6737
Factor 3	–1.5541	1.3949	.5394	.8826	–2.5466	.4793	.3848	.0270	–.6030	.9374	–.4196	.1808	–.0039	–.1719	.4550

Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options. Davis: University of California, Centers for Water and Wildland Resources, 1996.

TABLE 17.4

Analysis of farming areas, 1982.

	County														
	Alpine	**Amador**	**Calaveras**	**El Dorado**	**Inyo**	**Lassen**	**Mariposa**	**Modoc**	**Mono**	**Nevada**	**Placer**	**Plumas**	**Shasta**	**Sierra**	**Tuolumne**
Variables															
Number of farms	5	359	405	721	97	418	250	536	70	363	1,335	112	990	61	254
Farmland acres	7,352	198,135	214,881	146,644	300,594	555,958	231,183	747,787	77,731	79,402	182,792	103,289	405,180	53,373	110,680
Average size of farm	1,470	552	531	203	3,099	1,330	925	1.395	1,110	219	137	922	409	875	436
Farms with harvested crops	1	147	121	309	39	306	53	449	42	140	514	70	529	38	51
Farms with crop and pastureland	2	126	147	229	25	189	62	206	23	141	550	54	411	27	90
Acres of woodland on farms	0	13,988	31,335	13,439	1	22,051	19,461	12,360	1	14,538	13,977	5,958	87,105	3,886	13,639
Farms with irrigation	4	99	121	371	64	292	53	430	54	234	936	66	707	32	97
Percentage of farms 10–49 acres	0	96	128	309	21	108	45	62	21	158	581	22	327	12	67
Number of cattle	1,108	31,016	28,232	12,707	19,489	64,629	29,906	98,802	8,093	8,717	29,767	15,139	47,564	14,577	14,033
Number of farms with sheep	0	41	70	112	10	75	29	80	9	60	192	22	131	8	32
Percentage of farms tenanted	20.00	5.04	10.84	20.62	40.88	5.98	6.08	4.46	11.32	21.53	32.95	4.48	11.51	15.19	7.59
Number of farmers over 65	20.00	23.96	22.47	17.06	18.56	16.51	24.00	18.66	27.14	20.11	14.46	23.21	16.16	19.37	23.23
Percentage of full-time farmers	40.00	31.48	29.38	27.18	25.77	36.60	26.40	43.84	48.57	31.40	27.12	28.57	30.40	31.15	31.10
Percentage of farms using fertilizer	40.00	16.16	15.06	30.37	19.59	21.77	25.20	45.71	22.86	22.87	33.56	16.07	34.34	22.95	3.15
Factor scores															
Factor 1	–1.0419	–.1944	.0912	.9134	–1.0231	.0563	–.4471	–.0132	–1.0722	.1573	2.3653	–.5843	1.7696	–.6690	–.3079
Factor 2	–.0424	–.2544	–.4330	–.6907	.0156	1.3901	–.1345	2.8981	.0123	–.8386	–.6214	–.5535	.6624	–.4923	–.9176
Factor 3	1.0253	–1.0287	–.8368	.4514	2.5767	–.1804	–.6382	–.0313	–.5199	.0769	1.2452	–.6434	–.6596	.2448	–1.0820

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TABLE 17.5

Analysis of farming areas, 1992.

	County														
	Alpine	**Amador**	**Calaveras**	**El Dorado**	**Inyo**	**Lassen**	**Mariposa**	**Modoc**	**Mono**	**Nevada**	**Placer**	**Plumas**	**Shasta**	**Sierra**	**Tuolumne**
Variables															
Number of farms	6	367	438	690	79	312	256	466	73	415	1,125	125	844	53	249
Farmland acres	4,768	236,222	246,077	102,028	247,550	487,499	206,138	686,876	103,294	72,471	137,723	119,514	388,084	55,446	137,530
Average size of farm	795	644	562	148	3,134	1,562	805	1,474	1,415	175	122	956	460	1,046	552
Farms with harvested crops	2	157	118	348	28	176	40	320	44	161	423	53	396	19	49
Farms with crop and pastureland	4	122	127	157	22	134	56	201	21	148	444	72	363	26	74
Acres of woodland on farms	0	24,482	14,124	0	423	23,188	17,197	27,795	1	9,698	10,157	7,888	36,289	6,650	20,176
Farms with irrigation	4	125	106	364	56	6	37	338	58	275	783	65	594	29	94
Percentage of farms 10–49 acres	1	106	121	308	14	356	63	46	14	182	469	22	272	3	52
Number of cattle	1,213	47,812	34,658	11,355	17,837	10,381	26,410	92,986	10,402	9,630	27,990	16,627	45,050	6,909	13,685
Number of farms with sheep	0	34	45	82	9	46	21	57	6	48	147	15	74	3	11
Percentage of farms tenanted	.00	6.50	12.30	12.50	30.80	11.80	7.50	3.50	46.40	15.70	16.20	6.80	12.60	47.80	9.70
Number of farmers over 65	.00	33.50	26.90	27.40	22.80	24.70	31.30	27.30	23.30	29.20	28.00	30.40	29.10	24.50	31.70
Percentage of full-time farmers	33.30	35.40	35.80	34.50	39.20	41.40	42.60	48.10	57.50	39.50	33.10	34.40	38.20	35.80	36.90
Percentage of farms using fertilizer	33.30	26.40	12.60	40.40	21.50	39.70	3.90	36.90	20.50	21.00	30.80	18.40	35.30	17.00	5.20
Factor scores															
Factor 1	–.3655	–.3202	–.3536	1.2620	–.5930	.4624	–1.0847	.4739	–.5697	.0925	2.3504	–.8077	1.3310	–.8061	–1.0716
Factor 2	–1.7712	1.1195	.6162	–.8748	–1.0498	–.2076	1.0030	1.4146	–1.2601	–.0845	–.2572	.2269	1.0103	–.8294	.9440
Factor 3	–.2565	–.2144	–.5386	–.6965	1.2380	1.1247	–.4801	2.2946	1.1447	–.8807	–1.0191	–.6712	.2807	–.2835	–1.0419

Sierra Nevada Ecosystem Project: Final report to Congress, vol. II, Assessments and scientific basis for management options. Davis: University of California, Centers for Water and Wildland Resources, 1996.

farms, such as Placer County. Thus in 1992 there is some indication that variation in farm structure is a more important basis for the identification of farming areas than environmental differentiation.

The PCA study provides a quantitive measure of the changes in farming types and areas in the Sierra Nevada between 1959 and 1992. There is some indication that over time, accessibility and farm structure have become more important than altitude in differentiating within the region. The basic division between extensive ranching and intensive crop agriculture can be identified in all four years studied, but small stock are increasingly associated with mixed farming, while the link between small farms and intensive agriculture has weakened over time. Farmer characteristics such as age and part-time farming have become less important as differentiating features among the region's counties.

CONCLUSION

The restructuring of agriculture came later to the Sierra Nevada than to many parts of California but is now well advanced. Most areas show increased intensity of inputs, diversity of products, and farm operator pluriactivity. Farming in the Sierra Nevada is often integrated with other economic activities, such as the timber industry and tourism, but farm incomes are generally lower than elsewhere in the state.

The Sierra Nevada is environmentally marginal for agriculture. It has become economically more marginal to the state but socially more integrated. A century ago it was a substantial contributor to the state's agricultural output, but today production from the region is of minor importance. There are still many small farms in the region, and the increasing specialization of agriculture is maintaining agrodiversity. Regional differences in the structure of agriculture, such as the prevalence of part-time farming and elderly and tenant farmers, have become less marked.

Several changes have occurred in the use of land, and it appears that these changes may be accelerating. Rapid urbanization elsewhere in the state is pushing farmers into the Sierra Nevada, where they must concentrate on intensive production of high-value items in order to have a viable farm. The value of farmland and farm buildings in the foothills increased more rapidly than in most parts of California between 1987 and 1992, especially in Calaveras and Amador Counties. Such high valuations reflect amenity values rather than a value based on returns from agriculture and are indicative of the demand for rural residential sites in these areas. A smaller proportion of farmland was lost to urbanization between 1988 and 1992 in the foothills of the Sierra Nevada than in the Central Valley and the Los Angeles conurbation (California Department of Conservation 1992). Unfortunately, it is impossible to document the rate or even the direction of change over a longer period or a wider area because of the incompatibility of the existing land-use surveys. A comparison of figures 17.6 and 17.9 for Placer County shows the major urbanization that occurred around Roseville and Auburn between 1970 and 1988, much of it at the expense of cropland. The agricultural census provides the only long-term source of comparable land-use data, but it is based on an aggregation of individual farm data, some of which is omitted because of the need for confidentiality, and only deals with land use on farms. A new land-use survey of the whole area is vital for comparison with the 1970 situation. Such changes as urbanization and deforestation may be more or less extensive than popularly believed, but if environmental damage is to be minimized it is necessary to identify the location and the rate of change.

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