HISTORICAL CHANGE IN CALIFORNIA LANDSCAPES--A PERSPECTIVE FOR LAND MANAGERS

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Résumé

Durant les 200 ans qui se sont ecoulés depuis la fondation de la premiere mission espagnole à San Diego en 1769, des changements importants sont intervenues en Californie en ce qui concerne la population, l'occupation de l'espace, les bases economiques, la distribution et les types de vegetation et les espèces d'animaux et de plantes. L'inspection d'elements choisis du paysage revèle des changements dans la fonction et la structior des composantes des ecosystemes. Au moment de l'arrivée des espagnols en Californie, les ecosystèmes formant le paysage Mediterraneen de Californie étaient liés de manicrè structurelle et fonctionnelle et formaient un réseau different de celui d'aujourd'hui. A présent, 230 ans plus tard, ces ecosystèmes sont morcelés et gérès séparément, de façonisolée. Les changements continuent en Californie qui, avec la croissance de la population, devrait depasser 39 millious d'habitants dans une trentaine d'années. L'examen des changements au cours de l'historie donne un apperçu de l'evolution possible des zones pâturées qui inclut la poursuite de la conversion des ecosystèmes de paturages, un succès partiel dans les efforts de restauration et la perte totale de certaines communautès herbagères.

Summary

Dramatic changes in California's population, land use, economic base, extent and types of vegetation, and species of plants and animals have occurred in the last two hundred years since the Spanish founded their first mission in San Diego in 1769. Examination of selected landscape elements, within a landscape ecology framework, reveals change in both structure and function of ecosystem components. When the Spanish occupied California, ecosystems within the California Mediterranean landscape were tied together both structurally and functionally in patterns distinct from today. Now, 230 years later, these ecosystems are fragmented as they are managed as separate, often isolated systems. Change continues to occur in California as population growth is expected to exceed 39 million in the next 30 years. Examination of historical changes provides insight into possible future outcomes of California's grazed landscapes including continued conversion of the grassland ecosystem, complete loss of some communities, and partial success of restoration efforts.

Introduction

The California landscape is a complex mosaic of approximately 40,470,000 ha. The State is 1325 km long and 555 km wide at its widest point, spanning 32^{o} to 40^{o} north latitude and 114^{o} to 124^{o} west longitude (Fay et al. 1987). The most populous state in the United States, California is currently occupied by twenty-eight million people, but its population is fast-growing, projected to exceed 39 million people by the year 2020 (Ewing et al. 1988). Increases in human population, since the Spanish arrived in

California, have resulted in an array of changes in landscape elements at different spatial scales.

The state is both culturally and ethnically rich. Seven percent of the population is Asian, 8 percent is Black, almost 65 percent is Caucasian, and 20 percent Hispanic (Ewing et al. 1988). As a whole, the population is aging, and it is on average wealthier than any other state in the United States (Ewing et al. 1988).

California currently has the 6th largest economy in the world. It is an economy that has recently expanded from being based on agriculture and resource extraction to including secondary manufacturing, technology, and service industries such as insurance, finance, real estate, and communications (Ewing et al. 1988, Fay et al. 1987).

At least twenty seven major vegetation types have been described in California's diverse landscape (Barbour and Major 1977). Figure 1 (taken from Ewing et al. 1988) displays the location and extent of the five major vegetation cover types in California. Conifer forests occupy over 9 million ha, primarily in the mountainous regions of the Sierra Nevada, Klamath, and Transverse ranges. Forests also occur at higher elevations in the South Coast ranges. Hardwood woodland and savannah cover types, dominated by Quercus species, occupy about 3.8 million ha (Ewing et al. 1988). These hardwood woodland types occur in the Coast ranges and in a ring around the Central Valley in the foothills of the Sierra Nevada and Coast ranges.

The grasslands of California are now primarily dominated by introduced annual species from European Mediterranean ecosystems. Annual grasslands occupy 3.5 million ha in the Central Valley and coastal areas. Grasslands dominated by perennial grass species occur along the north and central coast, in disjunct areas, covering about 36 thousand ha (Ewing et al. 1988). Wet meadows and marshes occupy a small percentage of the acreage of California.

Shrub vegetation dominates about 19 percent of the State, and includes Mediterranean types such as coastal sagebrush and chaparral, and Great Basin shrub types such sagebrush, bitterbrush and low sagebrush. Desert vegetation types occupy approximately 8.5 million ha, primarily in the southeast portion of the State (Ewing et al. 1988). Urban settlement, irrigated agriculture, and water cover the rest of the State, approximately 6.2 million ha (Ewing et al. 1988).

In the last two hundred years since the Spanish founded their first mission in San Diego in 1769, Californians have experienced dramatic changes in population, land use, economic base, extent of vegetation, and species of plants and animals. Ecosystems continually change in structure and function over time, and these changes can be examined at different spatial and temporal scales appropriate for different management, planning, and/or research needs. Thus, we can examine how ecosystem change affects sites, populations, communities, landscapes, and/or regions (Bailey 1987).

This paper focuses on the changes in specific landscape elements since Spanish occupation of California. Changes at the State level since Spanish occupation, will first be discussed, and then the San Francisco Bay Area as a case study will be examined. Finally two specific Bay Area ecosystems will be described. Although the temporal scale is short (230 years), the paper will document exponential change. Other examinations, focussing on different temporal and spatial scales, may conclude that the dramatic changes in the California Mediterranean ecosystems since Spanish occupation are merely an interesting blip in the universal scheme of things (see Gleick 1987).

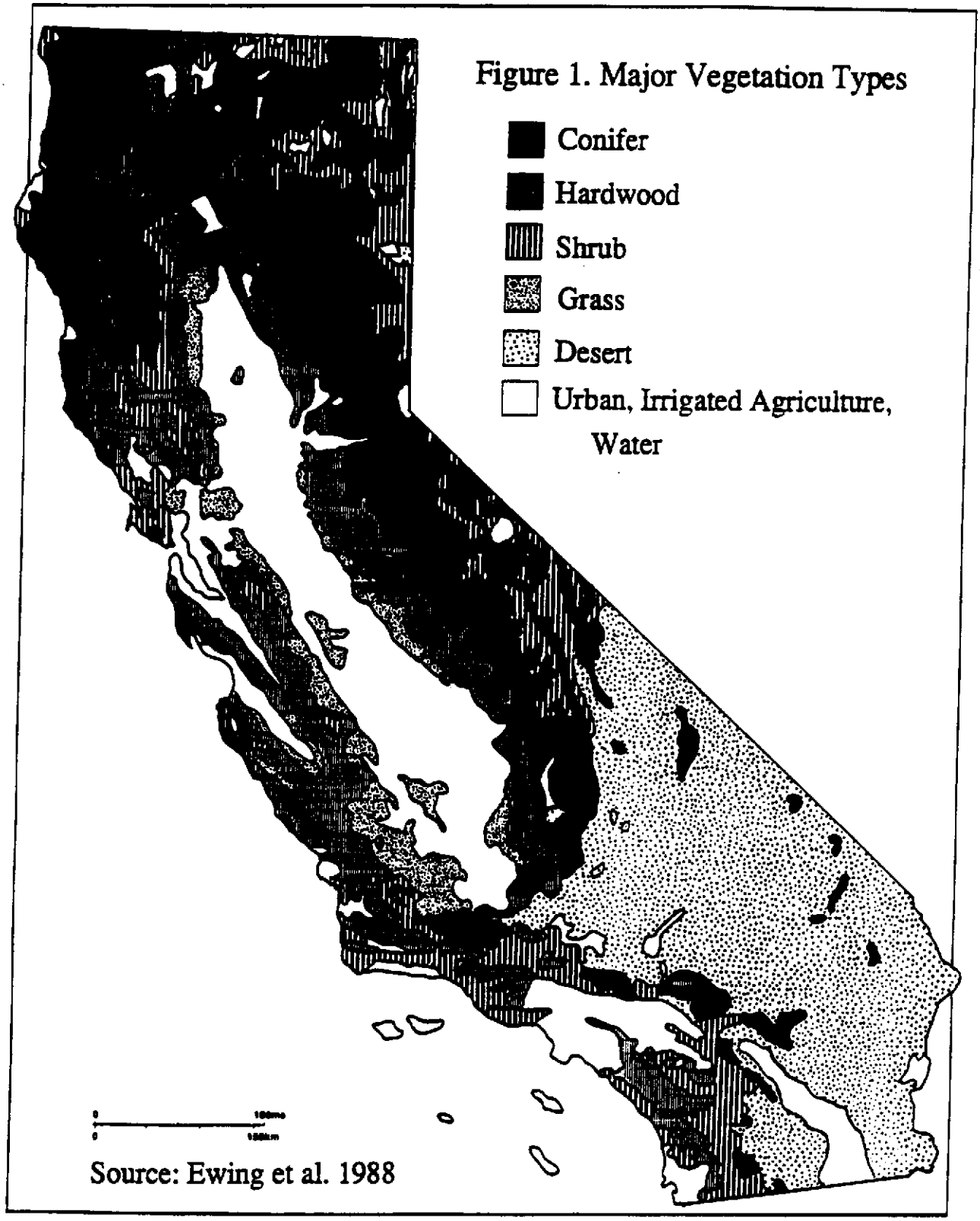


Figure 1. Major Vegetation Types
Conifer
Hardwood
Shrub
Grass
Desert
Urban, Irrigated Agriculture, Water
Source: Ewing et al. 1988

Landscape Elements of Interest

Landscape ecology can be defined as the discipline that attempts to understand the development and dynamics of pattern in ecological events at appropriate spatial and temporal scales (Urban et al. 1987). Landscape ecology addresses structure, function, and change in ecosystems (Naveh and Lieberman 1984). Landscape elements are the basic, relatively homogeneous units of land, of natural or human origin, that can be described at different scales depending on the nature of inquiry (Forman and Godron 1986).

Landscape elements may be structural or functional in nature or both (Forman and Godron 1986). Structure refers to the spatial relationships among distinctive landscape elements, such as vegetation, transportation systems, housing patterns, and livestock. Function refers to the interaction among the spatial elements, i.e. the flow of energy and materials between component ecosystems in the landscape.

In this paper, landscape elements of interest are livestock, grazing patterns, livestock products, livestock production culture, housing patterns, transportation, population, and vegetation. Significant changes in structure and function have occurred within and among landscapes in California and the San Francisco Bay Area since Spanish occupation, and can be traced using these landscape elements.

Table 1 displays a summary of changes in landscape elements statewide in 6 time periods beginning in 1769. These time periods are characterized by significant changes in grazed landscapes throughout California. Unlike European Mediterranean landscapes which have experienced several thousand years of agriculture and pastoralism (Naveh 1982), California landscapes have been influenced by human manipulation of any significance only for the last 200 years. Indigenous Indian populations survived primarily by hunting, gathering, and trade with other tribes. They did not develop agricultural techniques, although they did manipulate their environment with the use fire to promote the growth of grasses (Hornbeck 1983).

Livestock were introduced to California by the Spanish missionaries beginning in San Diego in 1769. Prior to this time, the native grasslands were grazed by large ungulates, such as tule elk, antelope, and deer (Yates 1971). By 1823, twenty-one missions stretched along the California coast from San Diego Mission to Solano Mission, north of San Francisco. Livestock grazing was a natural outgrowth of settlement by the missionaries fostered by abundant pasturage and supply of cheap native Indian labor (Durrenberger 1972). By 1833, one-sixth of California was grazed extensively yearlong by an estimated 400 thousand cattle, 300 thousand sheep, and an unknown number of horses (Burcham 1957).

During this early period non-native plant species were introduced in California from livestock feeds, animals, packing materials, and other supplies. These alien species had evolved specialized adaptations to a Mediterranean climate and centuries of grazing (Burcham 1957, Heady 1988). In addition, they tended to be prolific seeders and were able to maintain themselves under unfavorable conditions for years.

Diaries from early Spanish explorers describe abundant wildlife species including herds of tule elk, antelope, and deer (Mayfield 1978, Dana 1959). Salmon and other anadromous fish swam plentifully in California waters including San Francisco Bay and the Sacramento River. Grizzly bears were frequently reported, and flocks of geese,

Table 1. Changes in Landscape Elements in California

	Spanish Missions 1769-1833	Mexican Ranchos 1834-1850	Gold Rush 1850-1860	Agriculture 1860-1880	Development 1880-1950	Modern Change 1950-1980
Livestock	Cattle/sheep/ horses	Cattle	Improve cattle breeds	Cattle, full stocking	Fluctuating #'s of cattle	Cattle # vary Sheep # decline
Grazing pattern	Extensive yearlong	Extensive yearlong	Extensive cattle drives	Tranhumance Begin fencing	Grazing systems Improvements	Grazing systems Improvements
Livestock products	Hides/tallow	Hides/tallow	Meat/leather	Meat/leather/ wool	Meat packing Sale calves	Meat/leather/ wool
Livestock production culture	Missions: 1 kind of stock	Private ranching	Speculative Europeans/US	Land conversion to agriculture	Specialization markets,feeds	Specialization some rge fed
Housing	21 missions	500 ranches	Disjunct development	permanent towns	rise of cities	Urbanization
Transportation	Horse/water/ dirt roads	Horse/water/ wagon roads	Horse/water/ wagon roads	Railroads begin	cars/planes/ railroads	Cars: 19 mill planes/ rail
Population		5-94 thousand estimated	450 thousand estimated	865 thousand estimated	1900: 1.4 mill 1950: 11 mill	1980: 24 mill 2020: 39 mill
Vegetation change Grass/Oak woodland				13 million ha est. Burcham	8 million ha est. Ewing et al.	6.5 million ha est. Ewing et al.

Data from Burcham 1957, Ewing et al. 1988, Fay et al. 1987, Hornbeck 1983.

ducks, and other wetland birds were estimated to be in the millions (Yates 1971, Harlow 1950, Clarke 1959, Galvin 1971, Beckman 1932).

The Mexican Rancho period (1834-1850) was characterized by establishment of large land grants to Mexican citizens. The missions were secularized, a process completed by 1836, and private ranching expanded (Burcham 1957, Treadwell 1981). Ranching became the basis of economic activity and social life in California (Becker 1969). Hides and tallow were still the primary livestock products and animals were cared for using extensive animal husbandry practices.

The Gold Rush of 1849 brought an influx of European and American settlers with different cultural ideas. Native Spanish cattle breeds were upgraded with European breeds brought into California on some of the first cattle drives from Texas and the southern United States. By 1862, an estimated 3 million head of cattle grazed in the State (Burcham 1957). During this time, at least 95 alien plant species occupied California's grasslands and the conversion to a introduced annual grassland was nearly complete (Burcham 1957). San Francisco was the major port of entry into the State, the largest city, and the center of northern California development (Hornbeck 1983).

Agriculture, with new towns, conversion of native grasslands, and fence laws, began its place of prominence in California politics and economy around 1860. The period, 1860-1870, was known as the decade of wheat, with conversion of grazing lands to crop agriculture and the beginning of transhumanent grazing practices, where ranchers drove their animals to mountain ranges to find summer pasture (Burcham 1957). Flood and droughts in the 1860's and 1880's helped reduce cattle numbers to less than 1 million head (Burcham 1957). The first intercontinental railroad was completed in 1869, reducing travel time between New York and Sacramento to only seven days, facilitating immigration (Durrenberger 1972).

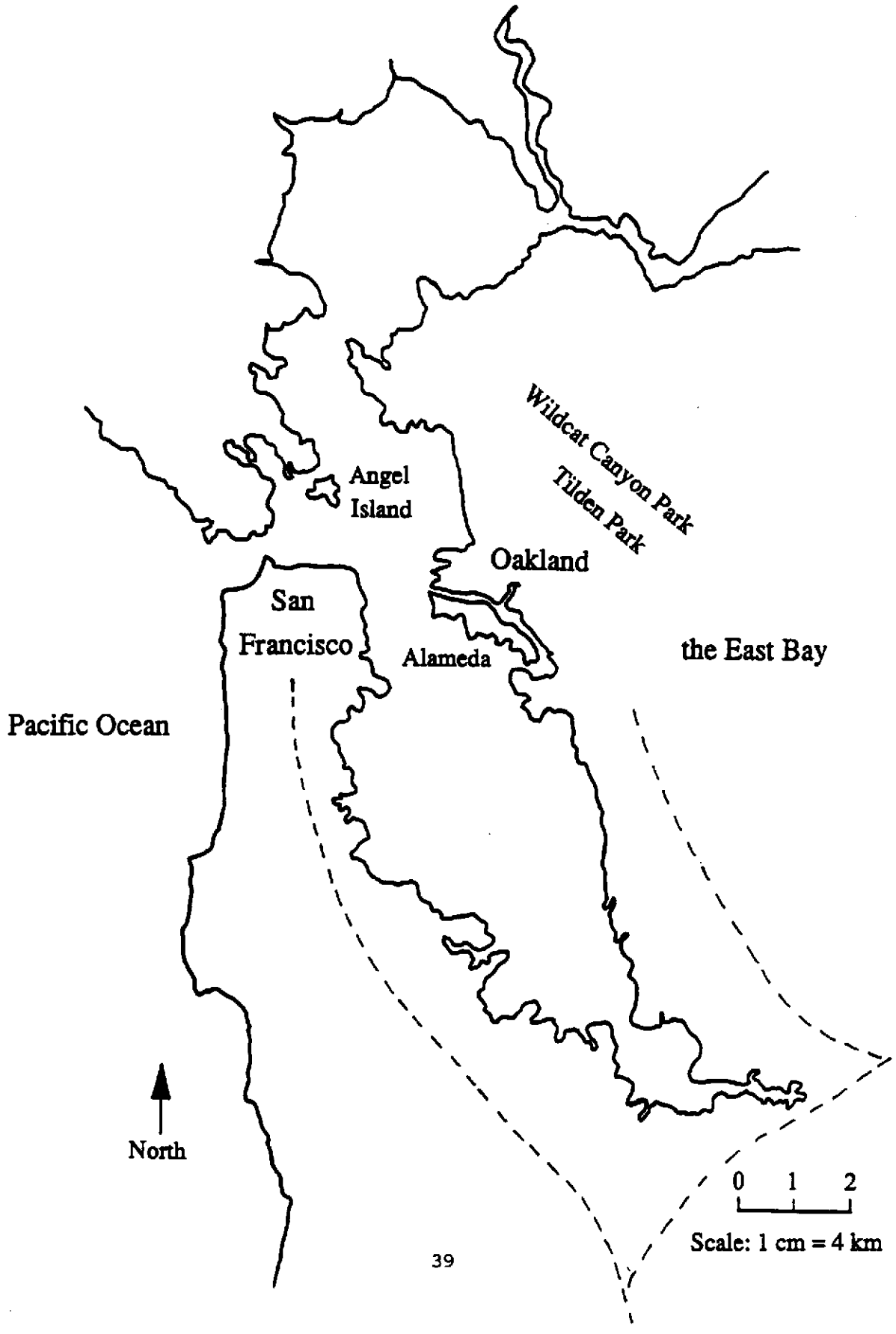
Development and change characterized California resource use from 1880 through 1950. This period saw the beginning of systematic grazing systems and range improvements. Animal numbers fluctuated, although they never reached the numbers of earlier periods. Meat packing industries, concomitant with changes in livestock production practices, supplied meat to an ever increasing population. Livestock production practices included more specialization (stocker, cow/calf etc.), marketing of younger animals, and feed-lot fattening (Ewing et al. 1988). Agriculture continued to increase, with the conversion of some 4.9 million ha of grassland and oak woodland to agricultural production. Automobiles and eventually planes brought with them human mobility and roads, freeways, and airports as population centers continued to grow.

Significant changes have occurred in the distribution of plant and animal species in California. Today, for example, California wetlands occupy only 20 percent of their previous range (Jones and Stokes 1987). Conversions of rangeland for housing, urban development, and freeway expansion continue (Ewing et al. 1988, Fay et al. 1987). Grizzly bears were last seen in 1922; other species, such as deer, antelope, and tule elk are now being reintroduced to some historical habitats. Salmon runs are estimated at less than 5 percent of their former numbers (Jones and Stokes 1987).

A Case Study: the San Francisco Bay Area

The San Francisco Bay Area landscape is a microcosm of ecosystem changes that occurred in California (Figure 2). San Francisco Bay was first sighted by Europeans in 1769 and mapped in 1771 (Harlow 1950). Jose de Canizares, sailing in the San Carlos

Figure 2. The San Francisco Bay Area



captained by Lt. Juan M. Ayala, drew the original map of the Bay. The East Bay shoreline was first explored by Lt. Pedro Fages and Father Crespi in 1775, as part of Gov. Gaspar de Portola's expedition (Beckman 1932).

In the 1770s, the Bay Area's natural landscape was dominated by a complex mosaic of plant communities (Clarke 1959). California bay (Umbellaria californica) and/or oak (Quercus spp.) woodlands extended from the hills to the shore in some places, such as Angel Island, and canyons in the hills around what is now San Leandro and Oakland (Harlow 1950, Dana 1959). Redwood (Sequoia sempervirens) groves occupied northeast sloping inland canyons along the East Bay hills (Clarke 1950, Freeman 1946). Multiple streams cascaded into the Bay on all sides with associated riparian forests of willow (Salix spp.), alder (Alnus spp.) , cottonwoods (Populus spp.), oaks and bays (Galvin 1971, Yates 1971). Tule (Scirpus spp.) marshes surrounded the Bay, open grasslands covered the East Bay plain, except for the oak forest on the peninsula which later became the city of Alameda. Coastal shrub species covered hills especially on south and west slopes (Clarke 1950, Dana 1959, Merritt 1928).

Geese, ducks, and other wild birds migrated through the Bay Area by the millions, some nesting in the tule/sedge (Scirpus spp./Carex spp.) marshes and swamps along the Bay (Beckman 1932, Galvin 1971). Tule elk, antelope, deer, grizzly bears, and coyotes inhabited the region along with numerous other mammals, reptiles, and birds (Dana 1959, Yates 1971, Merritt 1928, Harlow 1950, Mayfield 1978).

Indigenous Indian populations resided in the Bay Area at the time of Spanish discovery. Several accounts describe early explorers trading with native peoples (Galvin 1971, Dana 1959). Four tribes were indigenous to the East Bay (Beckman 1932).

Two primary roads were originally used as the main transportation system for moving goods to the Bay Area, one along Santa Clara Valley and up the San Francisco Peninsula and the other to the Mission San Jose and on to the Peralta Rancho, now Alameda County (Figure 2). Later, in the early 1800's, additional roads brought people and goods to the Bay Area. For examples, people traveled to the Mission de San Jose through Stockton Pass, to Oakland and San Leandro through Alameda Canyon where the Central Pacific Railway eventually came to the East Bay, and Fruitvale Road, where redwood lumber harvested in the East Bay hills was brought to Oakland via wagon road (Freeman 1946).

As elsewhere in California, a large ranching industry developed in the Bay Area with the secularization of the missions in 1836. Thousands of cattle grazed the East Bay plain (Freeman 1946). Large land grants were given originally to Spanish families, such as the Peralta and Estudillo families of the East Bay. Later, these large ranches were divided and developed by American interests as agriculture, shipping, and meat marketing developed to meet the needs of the large influx of people with the gold rush in the 1850's (Merritt 1928, Treadwell 1981, Havlik 1984).

By 1852, the city of Oakland in Alameda County became incorporated. It was an industrial and shipping center of the East Bay. At that time, 110 thousand cattle, 60 thousand horses, 20 thousand sheep, and 13 thousand hogs were grazed in Alameda County. Twenty-five thousand ha were under cultivation, and the Oakland, Berkeley, San Leandro plains were known as a rich agricultural production region (Beckman 1932). Across the Bay, San Francisco was a financial and cultural center, growing by leaps and bounds as gold seekers arrived at her port in search of the "good life" (Treadwell 1981). Recognition that all these new gold seekers must eat allowed for the development of a

meat industry, which flourished in San Francisco, where cattle were raised, traded, butchered, and sold (Treadwell 1981).

Preservation of open space began with water company acquisition of watersheds for supplying water to the new and growing towns of the Bay Area (Stein 1984). Later in the early 20th century, national, state, and regional park systems were established to provide recreation to the growing Bay Area population (Stein 1984).

Today, Alameda County in the East Bay is the 5th most populated county in the State, with 1.2 million people (Fay et al. 1987). It is ranked fourth in the State in population density. Twenty-five thousand cattle, 1300 sheep, and 300 hogs are now raised in the County; approximately ten thousand ha remain under some form of cultivation (Alameda County Commissioner 1989). San Francisco (city and county) ranks ninth in the State in overall population, but ranks first in population density. The nine Bay Area counties support 3 international airports, 31 thousand km of roads, 5.32 million people, and approximately 297 thousand ha of open space on its 1.8 million ha (Fay et al. 1987). It is a landscape that has radically changed in less than 200 years, yet still supports crop agriculture and livestock ranching.

A Specific Example: The City of Alameda

The City of Alameda is a smaller scale example, within the San Francisco Bay Area landscape, which has changed structurally and functionally in the last 200 years. Alameda is adjacent to the city of Oakland in Alameda County in the East Bay. Over seventy thousand people live within the city limits.

The City of Alameda was originally a peninsula, divided from the mainland by a mile-wide marshland (Merlin 1977). The peninsula was cut off from the mainland with the completion of the Tidal Canal in 1902, which linked San Antonio Creek to San Leandro Bay (Merlin 1977). The island, originally about 6.4 km long and from 1 to 2.5 km wide, was known as the Encinal de San Antonio, or Oak Grove (Freeman 1946). It was originally part of the Spanish land grant owned by Antonio Maria Peralta (Beckman 1932).

Alameda was originally a wilderness, containing a virgin stand of oak trees (Q. agrifolia), noted by the earliest explorers of San Francisco Bay (Harlow 1950, Clarke 1959, Merlin 1977). This oak forest eventually gave Oakland its name; Alameda took its name from the county of Alameda, which came from the Spanish word alameda or avenue of large, stately trees lining the creeks on an otherwise treeless East Bay plain (Beckman 1932). Only remnant oak trees remain today among the houses, roads, and shops of Alameda. Dredging and land fill operations have expanded modern Alameda from its original 890 ha to over 2225 ha (Merlin 1977).

In about 1850, the Peralta family sold the island to men named Chipman, Aughenbaugh, and Fitch, who all ended up selling housing tracts at $80 each (Merritt 1928). A levee was built in 1852 across the marsh between Alameda and Oakland. In 1871, a bridge was constructed over the estuary and a highway across the marsh establishing direct communication between Oakland and Alameda (Merlin 1977). The city of Alameda attempted to incorporate beginning in 1854, again in 1869, and was finally successful in 1872 (Merritt 1928).

San Leandro Creek bounded the City of Alameda on the south and San Antonio Creek bounded the city on the north. Today, San Leandro creek, once bordered by

willows and containing sufficient waterflows to make it impassable to travelers, is mostly dry and flows in a concrete channel through the city of San Leandro for most of its length. San Antonio Creek was channeled into the Oakland estuary (Tidal Canal), made navigable for large ships, and dammed further up to make Lake Merritt out of original marshland (Merritt 1928).

Today Alameda is a largely a bedroom community for the industrial cities of San Francisco and Oakland. The original oak forest and most of the marshland gave way to small farms and truck gardens in the late 1800s, and finally to housing developments by the 1950s. The original 890 ha of dry land in 1800 expanded to 2218 ha of dry land today, with dredging and filling of most of the original 445 ha of marshland. Small examples of tidal marsh still exist in San Leandro Bay, and along the Bay shoreline; the extensive marshland on the northeast side of Alameda has been filled and developed (Merlin 1977). Like many parts of the state, Alameda is an example of extreme changes in ecosystem structure and function contributing to the developed Bay Area landscape.

Another Specific Example: Wildcat Canyon-Tilden Parks

Wildcat Canyon and Tilden Parks are examples of Bay Area ecosystems that have remained intact as wildlands within the Bay Area landscape. However, because of the parks' location within the larger Bay Area urban landscape, flows of species and materials have changed. Site specific changes have occurred because of species introductions, species extinctions, and changed land use, altering structure and productivity of these ecosystems.

The parks are contiguous units, located along the East Bay hills, east of the current cities of Richmond, El Cerrito, Kensington, Berkeley, and Oakland. They contain 1663 ha within Alameda and Contra Costa Counties. Wildcat Canyon is largely undeveloped open space, while parts of Tilden have been highly developed for recreation.

Human occupation has had a tremendous impact on the vegetation of Wildcat Canyon and Tilden Parks. Grazing, farming, woodcutting, planting of exotic trees, brush invasion, recreational development, and full-scale logging have each left marks (Havlik et al. 1975). Yet intrinsic qualities of the landscape have been preserved.

Park grasslands were historically used for grazing, which continues today in Wildcat Canyon and was discontinued in Tilden in the 1933 because of increased development and difficulties in establishing fenced pasture units (Havlik et al. 1975). Major benefits from grazing are reduction of fire hazard and maintenance of the grassland ecosystem in Wildcat Canyon Park. Major problems are damage to riparian systems, conflicts with recreationists, and possible worsening of an exotic weed invasion by artichoke thistle (Cynara Cardunculus). Removal of grazing in Tilden has allowed the encroachment of native baccharis (Baccharis pilularis) and other shrub species into the annual grassland (McBride 1974).

Grasslands occupy less acreage than in the 1770's with encroachment of facilities, shrubs, and woodlands. The grasslands are dominated by annual species, with remnant stands of native Stipa pulchra, Hordeum brachyantherum, and Danthonia californica perennial species.

Tilden Park, but not Wildcat Canyon, was planted with blue gum (Eucalyptus globulus) and red gum (E. rostrata) eucalyptus early in this century for hardwood lumber production. Thousands of hectares were planted in the East Bay hills (Havlik et al.

1975). However, the trees turned out to be unsuitable for quality hardwood products, and the plantations were abandoned. The character of the landscape was changed however, with open grass areas converted to forest. Red and blue gum forests contained a shrub understory of poison oak (Rhus diversiloba), blackberry (Rubus vitifolius) and bay.

An unusually severe freeze occurred in December 1972, which top-killed many eucalyptus, most severely affecting red gum. A logging program was established to carefully remove dead trees and promote native vegetation, but most stands have been left untouched. The eucalyptus are vigorous sprouters that can attain 8 meters height in 2 years. Most stands which were logged have subsequently resprouted and formed closed canopy stands 25 years after cutting.

Other non-native species have also been introduced to the parks. Monterey pine (Pinus radiata) plantations and individual memorial groves of redwoods and other species have been planted. In Wildcat Canyon, exotic tree planting has been minor (Havlik et al. 1975). However, poison hemlock (Conium maculatum), scotch broom (Cytisus scoparius), Spanish broom (Spartium junceum), and acacia (Acacia decurrens) are visual intrusions on the native landscape.

The East Bay parks provide current Bay Area residents with a vision of the pre-European Bay Area landscape. Although many plant and animal species have changed and the flows of energy and materials are different, many native plants and animals remain and the visual contrast of woodland, shrubland, and grassland are a smaller scale reminder of what was once the larger Bay Area landscape.

Conclusion

Change is still occurring in the California Mediterranean landscape allowing for several possible future scenarios for California's grazed landscapes, based on projections of continued population growth. In general, California's wild landscape still persists, probably at levels much higher than might be guessed from road-bound observations (Aschmann 1959). However, at least three possible futures face California as communities interact in new patterns with human dominated systems; the California grasslands will continue to decline in extent over the next 100 years, other communities and/or species will be completely lost, and efforts to restore pristine communities will only be partially successful.

California's wildland continues to be converted to urbanization and agriculture. Overall, an additional 500 thousand ha of wildland are projected to be converted to urbanization by the year 2000 (Ewing et al. 1988). The effect of such conversion on plant and animal species diversity depends on the total acreage of a specific habitat in the state and the distribution of the habitat within the landscape. The conversion of communities of locally limited extent may be more critical to wildlife and biological diversity than conversion of thousands of hectares of extensive communities.

In the last 45 years, 26 percent of California's grasslands have been converted to housing, industry, and irrigated agriculture (Ewing et al. 1988). However, Jones and Stokes Associates (1987) report that only one-tenth of one percent of the pristine native grassland, dominated by native perennial species, remain today. The conversion of the native grassland to introduced annuals was largely completed by 1900 (Heady 1988).

Most likely, California's grasslands will continue to decrease in extent both from outright conversion to urban and agriculture uses as well as from the likely change in resource use with the removal of livestock grazing. Public demand for recreation use of remaining grasslands, particularly near urban areas like the San Francisco Bay Area, is tied to an increasing demand for the removal of livestock grazing from those lands. Removal of grazing will most likely result in the well-documented eventual conversion of the grassland to baccharis shrubland (McBride 1974). Thus, in the first scenario, California's grasslands will continue to decline in extent either from outright conversion or change in resource use.

Another future for California's grazed Mediterranean landscapes might include the complete loss of some communities. Less than 40 percent (Kahrl 1979) and maybe as little as 19 percent (Jones and Stokes 1987) of Bay Area coastal wetlands remain. Less than 11 percent of the California Central Valley riparian woodlands remain, and less than 1 percent are considered to be in nearly pristine condition (Jones and Stokes 1987). As mentioned above, only one-tenth of one percent of the native California grassland remains. These communities may go extinct, but even if they persist in a semi-natural state, they most certainly will be transformed with new species and new interactions with adjacent communities.

Finally, another future may include the partial success of efforts to restore native communities within urban/wildland landscapes. However, the changes in plant and animal species and their pattern on the land that have occurred in the last 200 years in California are irreversible. Land managers can't reconstruct ecosystems of the past with grizzlies, herds of antelope, tule elk, and salmon runs largely because the human population incompatibly occupies the space these species once occupied. The native grasslands are fundamentally changed with the naturalization of alien annual species. Some alien species, such as scotch broom, eucalyptus, and striped bass, are even considered desirable by many people, making the development of compatible land management objectives difficult. Thus, efforts to restore pristine communities can at best only be partially successful.

Furthermore, ecosystems in parks, preserves, refuges, and other similar designations are most often managed as if they are separate units, and thus the approach to the land is fragmentary, disjointed, and uncoordinated. Managers rarely recognize (or are unable to incorporate the recognition) that decisions affecting a deer population in Wildcat Canyon Park for example also affects the coyotes, the turkey vultures, and baccharis shrubs, among other species; that a decision that allows housing developments in the North Bay Area also affects the transportation system of the entire Bay Area.

Thus, agency goals to restore pre-Spanish landscapes are not feasible either biologically or ecologically. The Bay Area is a good example. Tilden, Wildcat Canyon, or other parks cannot be managed in isolation from other types of land use for preservation of species in perpetuity, or restoration of pristine ecosystems because they are affected by acid rain, smog, and other types of people-caused pollution; many of their plant communities and animals are gone, substituted with other species whose impacts are not always the same. Managers cannot restore the ecosystems of 230 years ago because the flow of energy and species are different today. Rather efforts which focus on interactions between landscape elements and the wild and human-dominated ecosystems within the landscape, will have the greatest chance of retaining biological diversity and restoring some mix of native species in new but stable patterns on the landscape.

The above scenarios are not completely independent, nor are they the only possible outcomes for California's grazed landscapes. However, the current techniques used by

land managers can lead to a partial reconstruction of nature in the past; the other part is imaginative construction, a creation of things characteristic of the future (Schultz 1967). Landscape ecology, with its focus on interacting ecosystems, at different spatial and temporal scales, provides land managers with a tool for improving resource allocation decisions. Examination of the irreversible changes in California landscapes during the last 230 years and the examination of only a few of the possible futures for California grazed landscapes should provide a clear reason for the immediacy of changing our management viewpoint.

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