SOILS OF THE CALIFORNIA ANNUAL GRASSLAND ECOSYSTEM

Annual grasslands occupy a variety of topography and edaphic situations in California's Mediterranean climate. To simplify this variety of environments, northern and southern perspectives are presented with representative transects from the coast of the Pacific Ocean through, the central valleys, to the Sierra Nevada Mountains.

Northern Perspective

Moving east from the coast, the narrow coastal terrace zone as well as the North Coast ranges and valleys are first encountered. The climate of this region produces precipitation which ranges from 25 in. to more than 100 in. per year, mostly as winter rainfall. Potential water use by vegetation or loss through evaporation is about 27 in. This produces a large water surplus amounting to more than 70 in. of runoff in some watersheds. This occurs as wintertime peaks in streamflow, with floods in very wet years. These occur at intervals of from 20 to 50 years, devastating the agricultural and urban areas in the narrow alluvial valleys.

East of the coast range the terraces of the Sacramento Valley begin. The Sacramento Valley has a deficit of water need over natural precipitation supply. The precipitation ranges from 15 in. at its southern end to nearly 40 in. at its northern end. The annual water need for vegetation, or loss to evaporation, ranges from 30 in. at the southern end of the valley to more than 36 in. at its northern end. Temperatures are mild through most of the year in the southern part of the valley but the northern third is subject to frequent frost in winter, and the summers are much warmer.

The relationships between Sacramento Valley topography and the formation of its soils are similar to the San Joaquin Valley. Almost all of the soils are formed from alluvial material deposited in the past by creeks and rivers. The location of soils in basins, along river flood plains, or on various levels of terraces representing older valley bottoms or fans, determines their general nature.

The valley terraces give way to the foothills and mountains of the Sierra Nevada and Cascade Range. The climate of the mountain regions of California presents a contrast to most of the regions discussed earlier. Precipitation totals in the Sierra through the year result in a large annual water surplus. At higher elevations it occurs mainly as one of the deepest snow packs in the United States -- frequently storing more than 40 in. of water, which usually melts quickly in the spring. Precipitation increases with elevation, from a minimum of about 15 in. in the lower foothills to between 40 in. and 80 in. at the middle elevations of 5,000 ft. to 8,000 ft., decreasing in amount above this. Precipitation may vary widely from year to year -- from twice the mean in very wet years to half the mean in dry years, while the water used by vegetation or lost by evaporation varies little. Much of the excess pours out of the Sierra Nevada as a springtime snowmelt, which if unobstructed, would flood the great valley below before running to the sea. To turn this natural sequence of destructive flooding to use, the snowmelt flood is stored in reservoirs and released during the long period of summer heat to meet irrigation needs. The large water surplus in the mountain region results in soils which are leached of salts and thus tend to be more acidic than those of the other regions. These acidic soils favor the coniferour forests typical of the area.

The Feather River roughly separates the basalt and andesitic volcanic rocks of the Cascade range to the north from the predominantly granitic and metamorphic rocks of the Sierra Nevada to the south. This difference in geology distinguishes two major soil regions.

Northern Transect

The northern transect starts north of Point Arena crossing the Coast Range near the Hopland Field Station of the University of California, and continues east across the Sacramento Valley to the Sierra Foothill Range Field Station east of Marysville, California (Figure 1).

Coastal Terraces

The first physiographic features of the transect are the marine and coastal river terraces, which occur in a narrow strip from Del Norte County in the north to San Francisco Bay in the south. Rainfall here is between 35 and 100 in. annually, with cool, wet winters and temperate, dry summers. Soils are classified as Prairie soils because of the natural grass vegetation, dark color, and other profile characteristics that are usually associated with grassland soils. A representative series is the Rohnerville, a member of the fine, mixed, isomesic family of Typic Tropohumults. The soils have grayish-brown to brown, medium-acid, silty clay-loam A horizons; light yellowish-brown, medium-acid, silty clay-loam Bt horizons; and light yellowish-brown, medium-acid, silty clay-loam C horizons.

The Rohnerville soils occur on marine and river terraces with slopes of 0 to 15% and elevations of 100 to 1,000 ft. The soils are formed on alluvium from sedimentary rocks, mostly sandstone and graywacke. They are well-drained to moderately well-drained, with moderate to moderately slow permeability and medium runoff.

The Rohnerville soils are moderately extensive, occupying more than 12,000 A from San Francisco Bay north. Among the soils closely associated

with the Rohnerville series are the Kneeland and Kinman soils on adjacent uplands.

Coast Range Mountains

The western most slopes of the mountain ranges that rise above the coastal terraces along the north coast are also often Prairie soils. Among these is the Kneeland series, a member of the fine-loamy, mixed, isomesic family of Ultic Haploxerolls. These soils have dark grayish-brown, medium-acid, clay-loam A horizons and mottled, pale brown and brownish-yellow, medium-acid, clay-loam B_2 horizons. They are moderately deep and are derived from hard sedimentary rocks.

The Kneeland soils are extensive, occupying more than 100,000 A in the Coast Range Mountains of northwestern California and southwestern Oregon.

Kneeland soils occur on moderately steep to steep, well-dissected mountains with rounded ridges and U-shaped drainages, under grass vegetation. A belt of grasslands occurs along the coastal margin, often extending inland as wind-swept ridgetop prairies. They range from near sea level to about 3,000 ft. elevation, in a humid, mesothermal climate with cool but foggy summers and cool, wet winters. These have a very high carrying capacity for grazing animals.

Proceeding inland, the next physiographic feature on the northern transect is the higher Coast Range Mountains. The mountains are characteristically strongly dissected with sharp, narrow ridges; deep V-shaped drainages; and steep slopes. The soils of these mountains generally support brush or forest plant communities and not natural grasslands.

Typical of the forest soils of the Coast Range Mountains is the Hugo series (Anon., 1976), which is in the Gray-Brown Podzolic great soil group and is now classified in the fine-loamy, mixed, mesic family of Dystric

Zerochrepts. These mountain soils also include the shallow, brush-covered Maymen series as well as the forested Josephine and Sites series.

Interior Coast Range Valleys

The foothills bordering the interior valleys of the northern Coast Range can support natural grasslands as potential vegetation. The foothills vary from rolling and rounded in outline to relatively steep. Characteristic of the grassland soils in this area is the Laughlin series. Under the 1938 Yearbook of Agriculture system, this soil was intermediate between the Prairie (Brunizem) and Noncalcic Brown great soil groups. It is now classified as a member of the fine-loamy, mixed, mesic family of Ultic Haploxerolls. Typically, Laughlin soils have brown, medium-acid, loam A horizons and brown, strongly acid, slightly finer loam B_2 horizons over sandstone.

Laughlin soils are strongly sloping to very steep and are on foothills and mountain slopes at elevations of 750 to 3,000 ft. They are formed in residuum weathered from hard sandstone, hard shale, and graywacke, usually of the Franciscan Formation. The Laughlin and associated Sutherlin soils are important soil series of the Hopland Field Station.

Deeply incised in the North Coast Range are a series of valleys with deep, well-drained or moderately well-drained soils derived from sedimentary alluvium. These valleys formerly supported a variety of natural vegetation ranging from mixed coniferous forest to open oak woodlands. Almost all of these valley soils are now used for intensive crop production. The Pinole series, a representative soil for these valleys, consists of deep, well-drained, medium-textured soils developed in alluvium from various rock sources. These Brown Lateritic soils have brown, strongly acid, gravelly loam, A horizons and brown, medium-acid clay loam B_2t horizons. Under the new Soil Taxonomy, they are classified as fine-loamy, mixed, thermic Ultic Argixerolls. The San Ysidro and the Pinole soils series are found on ter-

races in the Anderson Valley near Boonville and in the upper Russian River Valley near Ukiah.

Interior Coast Ranges

The Interior Coast Ranges closely resemble the Coast Range except that they tend to be drier. Most of the higher areas support brush or forest communities. Again, the Hugo soil series is representative.

The foothills of the Interior coast Range, facing the Sacramento Valley, are rolling to very steep uplands at elevations of 200 to 2,000 ft. The climate is characterized by hot, dry summers and cool, moist winters, with 10 to 24 in. of annual precipitation. A characteristic soil for this area is the Altamont Series in the great soils group of Grumusols. Under the descriptive classification system, the Altamont series is a member of the fine, montmorillonitic, thermic family of Typic Chromoxererts. Typically, Altamont soils have dark brown and brown, clayey A horizons that are noncalcareous in the upper portion, and a yellowish-brown, clayey, Cica horizon with disseminated and segregated lime overlying weathered sandstone. These soils shrink and swell upon drying and wetting. They are well-drained, but after the cracks swell shut with wetting, permeability is slow and runoff medium to rapid. In the north, central and southern Coast range these soils are extensive.

The Newville, Dibble, Sehorn, Nacimiento, Lodo and Millsholm series, although not on the transect, occur in the regions north of the transect just west of the Sacramento Valley terraces.

Westside Sacramento Valley

On the west side of the Sacramento Valley are extensive areas of old terraces with gravelly soils having dense clay subsoils. These soils were classified in the Noncalcic Brown Pianosol great soil group. The Corning

series is representative of the soils of this landform and is currently classified as fine, mixed, thermic, Typic Palexeralfs. It consists of deep, well-drained soils that formed in gravelly alluvium. Typically, Corning soils have a yellowish-red, strongly acid, gravelly loam, A horizons; red, strongly acid, gravelly clay B_2t horizons and yellowish-red, strongly acid, gravelly sandy clay loam C horizons. These soils are on gently sloping to hilly old terraces with hummocky microrelief. They are well-drained but have very slowly permeable subsoils and have rapid surface runoff from slopes. The Corning soils are moderately extensive in the Sacramento and San Joaquin valleys.

The older and recent alluvial fan soils of the westside Sacramento Valley formerly supported a grassland vegetation, but these soils are now almost entirely cultivated.

Eastside Sacramento Valley

The low terraces of the central valleys are old landforms 100 to 1,000 ft. in elevation. They are formed in alluvium from a variety of sources including sedimentary, metasedimentary, and metavolcanic rocks. Mean annual precipitation ranges from 12 to 24 in. The Kimball series is representative of the soils of the low terraces. Typically, Kimball soils have dark brown, slightly acid, loam A horizons; reddish-brown, neutral, clay B_2t horizons, and brown, neutral, sandy clay loam B_3 and C horizons. They are members of the fine, montmorillonitic, thermic family of Mollic Palexeralfs. These soils are in the Noncalcic Brown Planosol great soil group.

The high terraces along the east side of the Sacramento and San Joaquin valleys are often called the "red hogwallow lands" of California. The soils on these landforms are characterized by gravelly, reddish-colored surface soils with dense clay subsoils, often underlain by silica-iron cemented

hardpan that is impermeable to roots and water. The Redding series is representative of these hardpan soils. These soils fall into the Noncalcic Brown Ferrosol great soil group and are now classified as fine, koalinitic, thermic, Abruptive Durixeralfs. The Redding soils are moderately deep, moderately well-drained soils that formed a gravelly, mixed alluvium. They typically have yellowish-red, medium-acid, gravelly loam, A horizons; red, strongly acid, gravelly durapan at about 24 inches.

Redding soils are found on nearly level to rolling terraces and commonly have hummocky microrelief. Pebbles and cobbles tend to concentrate in the intermound areas. The soils formed in stratified alluvium of mixed sediments and are gravelly or cobbly. Annual precipitation in the area is 15 to 25 in.

Permeability of these soils is very slow, with local ponding in intermound areas. These soils are extensive on the eastern edge of the central valleys and may occur in association with the Corning series.

Old volcanic mudfloes cover wide areas of the terraces along the northeastern Sacramento Valley bottom, giving rise to shallow stony soils such as the Tuscan soil series.

Northern Sierra Nevada Foothills

The foothills of the northern Sierra Nevadas have undulating to steep topography. The Auburn, Argonaut, Sobrante and Las Posas series are representative of these landforms.

The Auburn series is a member of the loamy, mixed, thermic family of Ruptic-Lithic Xerochrepts. Formerly, they were classified as Noncalcic Brown soils. Typically, Auburn soils have strong brown and yellowish-red, slightly acid, silt-loam A horizons and yellowish-red, slightly acid, silt-loam B_2 horizons that rest irregularly on hard metavolcanic bedrock (meta-andesite).

The soils formed in residuum of the metabasic rocks, mainly amphiboltic schist or meta-andesite. Annual precipitation in the foothill area averages 20 to 40 in. These soils are moderately permeable and well-drained. In the lower foothills of the Sierra Nevadas this series is extensive.

The Auburn and associated Sobrante soil series are important on the Sierra Foothill Range Field Station. The associated Sobrante series is a member of the fine-loamy, mixed, thermic family of Mollic Haploxeralfs, and were formerly classified as Noncalcic Brown soils.

The Argonaut series is also a member of the fine, mixed, thermic family of Mollic Haploxeralfs. Argonaut soils have brown and yellowish-red, slightly acid, loam A_1 horizons and yellowish-red and brown, slightly acid, clay-loam and gravelly clay B_2t horizons over weathered meta-andesite. This series occurs on undulating to hilly broad ridges and slightly concave slopes at elevations of 300 to 3,000 ft. They formed in residuum from metamorphosed and intrusive basic rocks. Rock outcrops and stones are common. These soils are moderately well-drained with slow permeability. The Mariposa series to the south is similar to the Auburn series.

Above the foothills the annual grassland type is not generally found and the soils support brush or forest plant communities.

Southern Perspective

The southern transect crosses the Central Coast Ranges and Valleys. A mild climate with winter rain and occasional winter frosts, but with an overall water deficit for crop growth, is characteristic of the area extending from Santa Barbara County to the San Francisco Bay area, and inland to the great Central Valley. Precipitation ranges from slightly less than 15 in. per year in some of the inland valleys to more than 40 in. on some of

the higher coastal mountains. The potential water loss by evaporation or use by fully watered crop plants varies from 30 in. in more inland areas to about 27 in. per year adjacent to the coast. The natural vegetation adapted to this climate is annual grassland, grass-oak woodland, and chaparral in the areas of greatest soil water deficit. Douglas fir and redwood forests occur in this region. This is a rough mountainous area with peaks of moderate height and long narrow valleys. The soils of the area are mainly alluvial deposits along the river valleys, derived from the sediment from the natural erosion of shallow mountain soils on steep slopes. The nature of the alluvial soils is determined by the source of the sediment from which they were formed, and the age of the deposit. Where the upland areas are dominated by sandstones, shallow brush covered soils such as the Gaviota and Reliz series develop. Where parent material is soft calcareous sedimentary rock, soils favoring good grass growth such as the Linne and the Zaca soil series form. Southeast of Atascadero is an area of low granite hills giving rise to young, shallow granitic soils whose eroded sandy materials find their way down the Salinas River, giving its bed a characteristic broad white sandy wash appearance.

The San Joaquin Valley, the southern portion of the Great Central Valley, has a warm climate, relatively little frost, low rainfall and a large annual water deficit. A large part of the valley, particularly the southern third and the westside, receives 10 in. or less precipitation while the loss of water either through evaporation from open water surfaces or from irrigated soil is as much as 39 in. per year. Thus, if precipitation is the only water source, there is a deficit of nearly 30 in. Where groundwater occurs near the surface, the vicinity of rivers or old lake basins, the natural vegetation is tule swamps or riparian willow and shrub growth.

Occasional valley oak groves occur on eastside alluvial fans where groundwater is available at moderate depth.

The San Joaquin Valley has a great variety of soils. The topography of the valley bottom -- basins, alluvial fans, flood plains, stream ridges or terraces -- results in various soil types with agricultural practices and crops adapted to them.

The soils of the Sierra Nevada are often shallow and stony at high elevation. Glaciers eroded previous soils from the high mountains, leaving barren rock surfaces. These have weathered very slowly in the cold climate to form very shallow soils or none at all where bare granite slopes remain. The Chiquito soil series is an example. It is a shallow sandy soil at elevations of about 9,000 to 10,000 ft. in the San Joaquin Kings, and Kern river drainages.

Southern Transect

The southern transect starts on the central coast between San Francisco and Santa Barbara and extends across the Central Coast Range, Salinas Valley, Interior Coast Range, and San Joaquin Valley to the foothills of the Sierra Nevadas at the San Joaquin Experimental Range northeast of Fresno (Figure 2).

Coastal Terraces

Occupying the same physiographic position as on the northern coast, the coastal terraces are the westernmost sites with annual grassland potential along the central coast. The Watsonville series is typical of the soils on these terraces. These soils represent the Prairie Planosol great soil group and are classified as fine, montmorillonitic, thermic Xeric Argialbolls. Watsonville soils formed in sedimentary alluvium on old marine terraces and coastal benches. They are deep and somewhat poorly drained. Typically,

Watsonville soils have very dark grayish-brown, slightly acid, loam A horizons, pale brown and light gray, slightly acid, clay B_2t horizons, and verigated light gray, pale brown, and yellow, medium-acid, sandy clay loam, C horizons. Because of the restricted area of the terraces, these soils occur on limited areas.

Central Coast Range

The Central Coast Range Mountains have rounded to dissected steep topography. The Los Osos soil series is representative. Soils in this series consist of moderately deep, well-drained soils formed in material weathered from firm to hard sandstone and shale. They typically have brown, medium-acid, A horizons, yellowish-brown, medium-acid, clay B_2t horizons and pale yellow or yellowish-brown, slightly acid, sandy loam C horizons grading to yellowish-brown weathered from fairly soft shale and sandstone. Linne soils have very dark gray or gray calcareous clay loam A horizons, light gray or white, strongly calcareous fine sandy loam C horizons, and white, strongly calcareous, hard mudstone C_2 horizons. These soils occur in foothills ranging from 100 to 2,300 ft. in elevation. They are in the Rendzina great soil group and are classified as fine-loamy, mixed thermic Calcic Pachic Haploxerolls. These soils are scattered throughout the Coast Range from central California to San Diego.

Salinas Valley

The Salinas Valley is an extensive area of alluvium that has the potential for grassland but is almost entirely cultivated now.

Interior Central Coast Ranges

Extensive areas of the Interior Central Coast Ranges are vegetated with chaparral brush fields, but oak woodlands also occur. These mountains can be extremely steep and dissected. A typical soil for these areas is the Vallecitos series a member of the clayey, montmorillonitic, thermic family

of Lithic Ruptic-Xerochreptic Haploxeralfs. These soils belong to the Noncalcic Brown great soil group. Typically, Vallecitos soils have brown, medium-acid and slightly acid, gravelly loam A horizons and reddish-brown and brown, neutral heavy clay-loam B_2t horizons overlying metamorphosed bedrock at a depth of about 16 in.

Vallecitos soils are found in rolling to very steep hills at elevations of 100 to 3,000 ft. and up to 3,600 ft. on south-facing slopes. These soils are formed in residuum weathered from slightly metamorphosed sandstone and shale dominantly of the Franciscan Formation. Rock outcrops cover up to 10% of the area. In the Central Coast Range this is an extensive soil.

The interior of the Central Coast Range is relatively dry, with annual precipitation of 5 to 7 in. The Kettleman soil series is typical of this area. It consists of moderately deep, well-drained soils formed in materials weathered from soft sandstone and shale. These soils belong to the Rendzina great soil group and are classified as fine-loamy, mixed (calcareous), thermic Typic Torriorthents. Typically, Kettleman soils have brown, slightly calcareous, loam A horizons, and grayish-brown, strongly calcareous, loam C horizons which abruptly overlie grayish-brown, calcareous, soft fine-grained sandstones and shale.

Kettleman soils occur on uplands at elevations of 500 to 1,600 ft. These soils are moderately extensive along the eastern portion of the Interior Coast Range.

Westside San Joaquin Valley

Much of the alluvial area on the west side of the San Joaquin Valley is cultivated, but some areas of annual grassland persist. Typical soils for the older fans are in the Panhill series a member of a fine-silty, mixed, thermic family of Typic Haplargids. These soils belong to the Noncalcic

Brown great soil group. The soils have light brownish-gray, mildly alkaline, silty clay-loam A horizons; brown, mildly alkaline, silty clay-loam Bt horizons; and yellowish-brown, strongly calcareous upper C horizons and stratified calcareous lower C horizons.

The Panhill soils occur on level to gently sloping alluvial fans and terraces from sedimentary rock sources. These soils are moderately extensive in San Benito, Merced, and Fresno Counties.

San Joaquin Valley

The central San Joaquin Valley and recent eastside alluvial fans are largely cultivated except for saline-alkaline areas.

Eastside San Joaquin Valley

The first landform on the east side of the San Joaquin Valley that supports grasslands is the low terraces that rise 50 to 500 ft. above the valley floor. The San Joaquin series is typical of the soils of these areas. It consists of moderately deep, moderately well-drained soils formed in old alluvium, dominantly from granitic rock sources. These soils belong to the Noncalcic Brown Ferrosol great soils group and are classified as fine, mixed, thermic Abruptic Durixeralfs. Typically, San Joaquin soils have light reddish-brown, slightly acid, sandy loam A horizons; reddish-brown, slightly acid, sandy clay loam B_1 horizons; yellowish-red, slightly acid, clay B_2t horizons; with reddish brown, indurated silica cemented pans over stratified sandy loam and loam C_3 horizons. Soils of the San Joaquin series are on hummocky, gently sloping to undulating terraces. These soils are extensive on the eastside of the San Joaquin Valley.

Sierra Nevada Foothills

The foothills of the Central Sierra Nevadas rise up abruptly from the San Joaquin as their northern counterparts do along the Sacramento. Three important soil series in the foothills are Auberry, Ahwanee, and Vista.

The Auberry series is a member of the fine-loamy, mixed, thermic family of Ultic Haploxeralfs. These soils belong to the Noncalcic Brown great soil group. Typically, Auberry soils have grayish-brown, slightly acid, coarse sandy loam A_1 horizons and brown, strongly acid, sandy clay loam B_2t horizons over strongly weathered, acid, igneous bedrock. The bedrock is primarily quartx diorite or granodiorite. These soils occur on nearly level to very steep uplands at elevations of 400 to 3,300 ft. The Auberry soils are extensive in the upper parts of the granitic foothills.

The Ahwanee series is a member of the coarse-loamy, mixed, thermic family of Mollic Haploxeralfs. These soils belong to the Prairie great soil group. They have grayish-brown, slightly acid, coarse sandy loam A horizons, pale brown, slightly acid, coarse sandy loam Bt horizons that abruptly overlie multicolored, weathered quartz diorite. Ahwanee soils are on undulating to very steep hills and slopes and are extensive in the Sierra Nevada foothills. They are the most extensive soils on the San Joaquin Experimental Range.

The Vistas series consists of moderately deep, well-drained soils that formed in material weathered from decomposed granite and closely related rocks. The soils are classified as coarse-loamy, mixed, thermic Typic Xerochrepts and belong to the Noncalcic Brown great soil group. Typically, Vista soils have dark grayish-brown and brown, neutral, coarse sandy loam, A horizons, and brown or yellowish-brown, slightly acid B_2 horizons, which abruptly overlie yellowish-brown, weathered quartz diorite. The Vista soils occur on rolling foothills and mountainous upland areas and are extensive in the foothills of the Sierra Nevada and southern California.

Figure 7

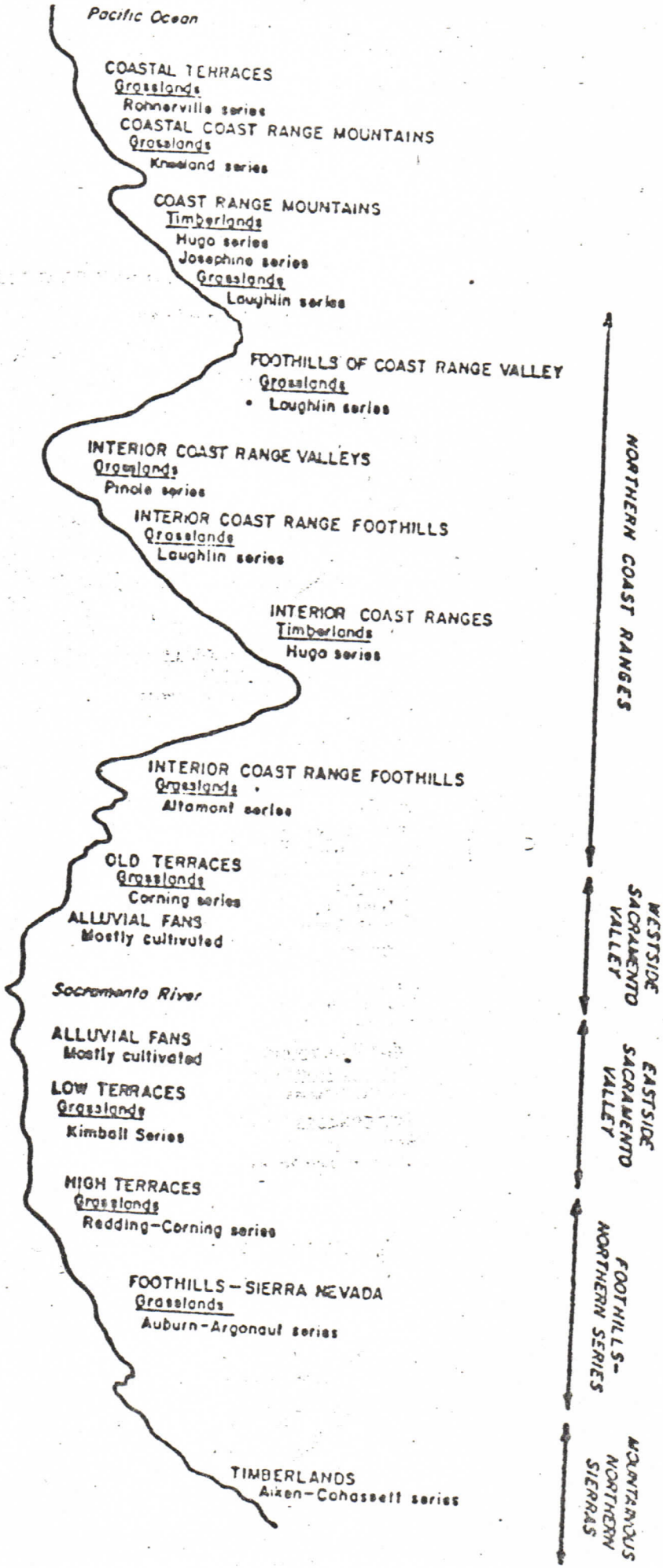
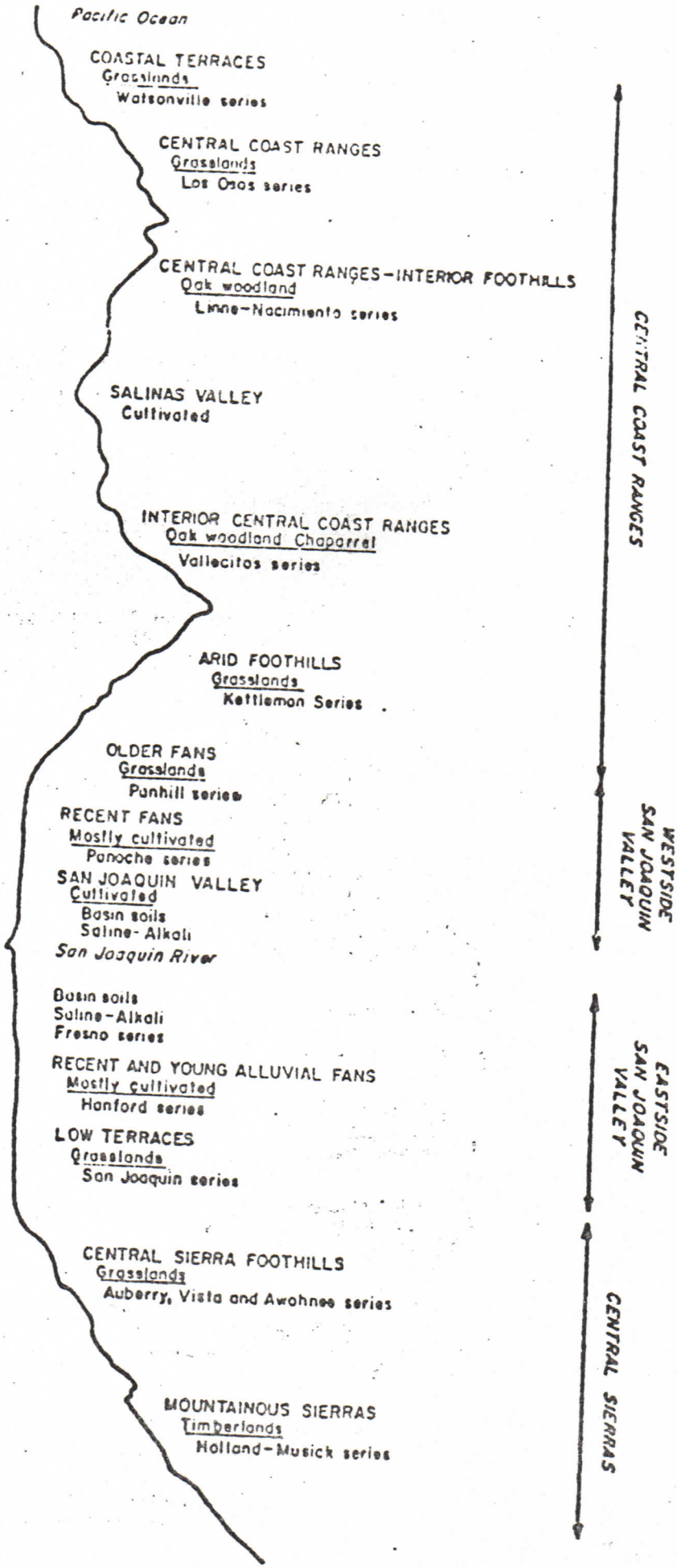
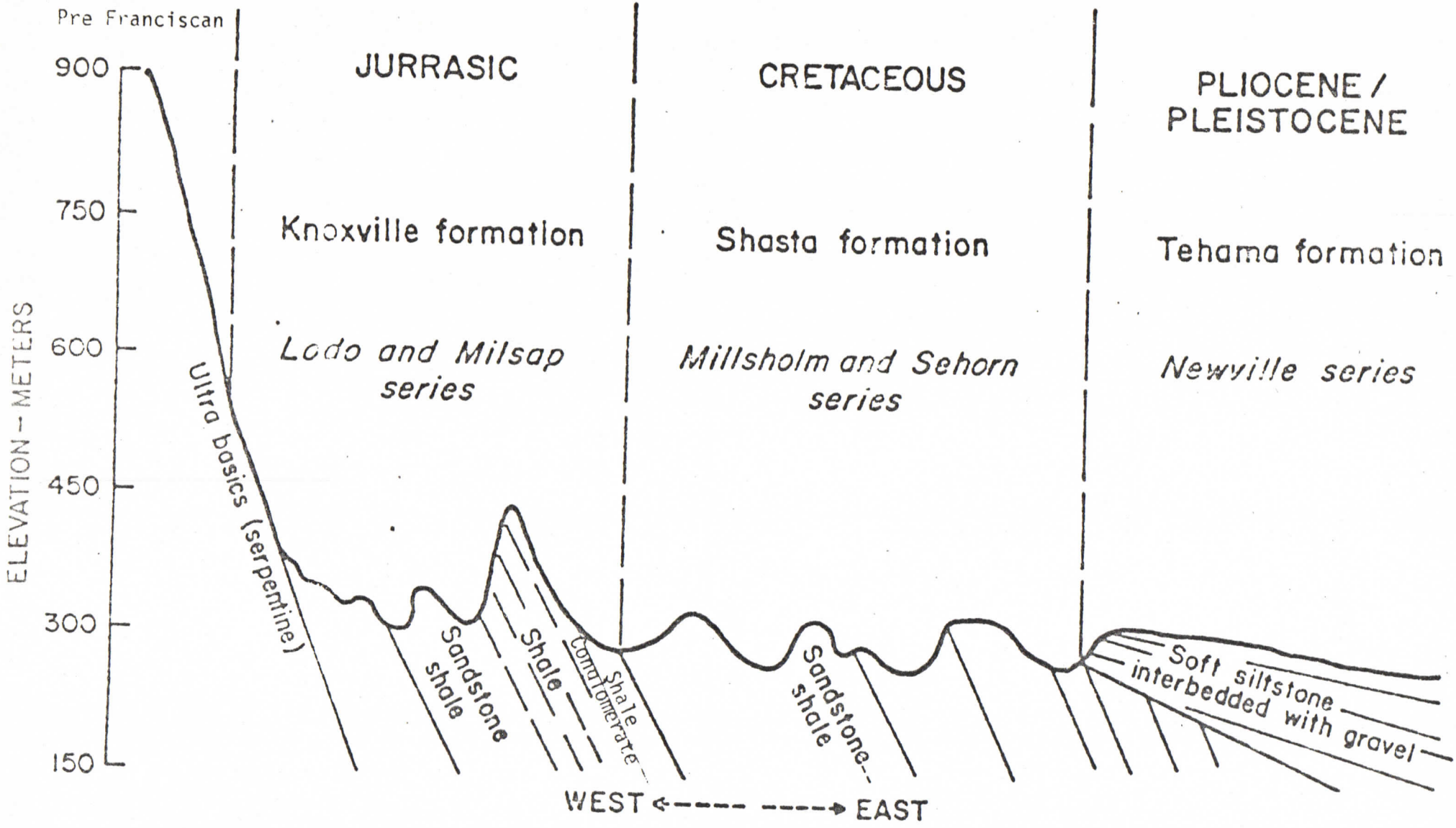

Pacific Ocean
COASTAL TERRACES
Grasslands
Rohnerville series
COASTAL COAST RANGE MOUNTAINS
Grasslands
Kneeland series
COAST RANGE MOUNTAINS
Timberlands
Hugo series
Josephine series
Grasslands
Laughlin series
FOOTHILLS OF COAST RANGE VALLEY
Grasslands
Laughlin series
INTERIOR COAST RANGE VALLEYS
Grasslands
Pinole series
INTERIOR COAST RANGE FOOTHILLS
Grasslands
Laughlin series
INTERIOR COAST RANGES
Timberlands
Hugo series
INTERIOR COAST RANGE FOOTHILLS
Grasslands
Altamont series
OLD TERRACES
Grasslands
Corning series
ALLUVIAL FANS
Mostly cultivated
Sacramento River
ALLUVIAL FANS
Mostly cultivated
LOW TERRACES
Grasslands
Kimball Series
HIGH TERRACES
Grasslands
Redding-Corning series
FOOTHILLS-SIERRA NEVADA
Grasslands
Auburn-Argonaut series
TIMBERLANDS
Aixen-Cohasset series
NORTHERN COAST RANGES
WESTSIDE SACRAMENTO VALLEY
EASTSIDE SACRAMENTO VALLEY
FOOTHILLS-NORTHERN SERIES
MOUNTAINOUS NORTHERN SIERRAS

Figure 8


Pacific Ocean
COASTAL TERRACES
Grasslands
Watsonville series
CENTRAL COAST RANGES
Grasslands
Los Osos series
CENTRAL COAST RANGES-INTERIOR FOOTHILLS
Oak woodland
Linne-Nacimiento series
SALINAS VALLEY
Cultivated
INTERIOR CENTRAL COAST RANGES
Oak woodland Chaparral
Vallecitos series
ARID FOOTHILLS
Grasslands
Kettleman Series
OLDER FANS
Grasslands
Panhill series
RECENT FANS
Mostly cultivated
Panoche series
SAN JOAQUIN VALLEY
Cultivated
Basin soils
Saline-Alkali
San Joaquin River
Basin soils
Saline-Alkali
Fresno series
RECENT AND YOUNG ALLUVIAL FANS
Mostly cultivated
Hanford series
LOW TERRACES
Grasslands
San Joaquin series
CENTRAL SIERRA FOOTHILLS
Grasslands
Auberry, Vista and Awahnee series
MOUNTAINOUS SIERRAS
Timberlands
Holland-Musick series
CENTRAL COAST RANGES
WESTSIDE SAN JOAQUIN VALLEY
EASTSIDE SAN JOAQUIN VALLEY
CENTRAL SIERRAS


Pre Franciscan
JURRASIC
CRETACEOUS
PLIOCENE / PLEISTOCENE
900
750
600
450
300
150
ELEVATION – METERS
Knoxville formation
Lodo and Milsap series
Shasta formation
Millsholm and Sehorn series
Tehama formation
Newville series
Ultra basics (serpentine)
Sandstone shale
Shale
Shale Conglomerate
Sandstone-shale
Soft siltstone interbedded with gravel
WEST
EAST

74.

Figure 9

Figure 10