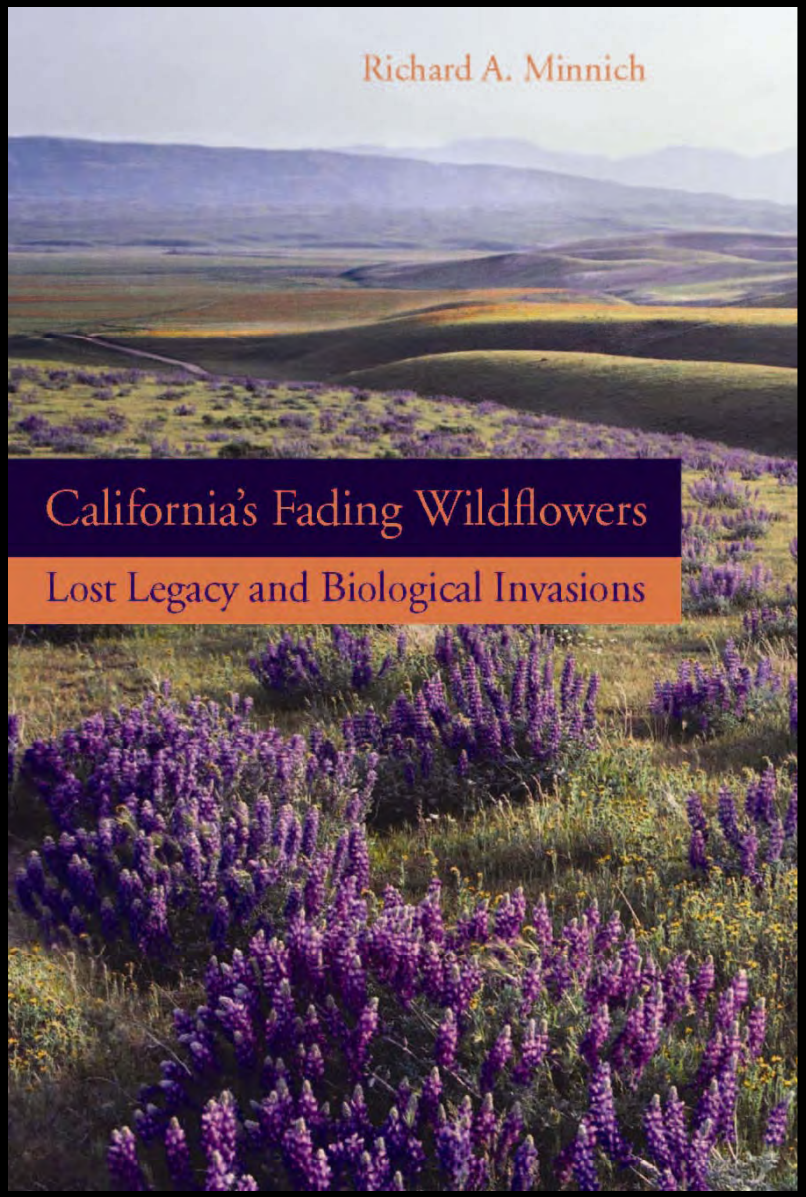
“No poet has yet sung the full beauty of our poppy, no painter has successfully portrayed the satiny sheen of it lustrous petals, no scientist has satisfactorily diagnosed the vagaries of its variations and adaptability. In its abundance, this colorful plant should not be slighted: cherish it and be ever thankful that so rare a plant is common.” John Thomas Howell



Cryptantha

Calandrinia

Penstemon

Emmenanthe

California poppy
(*Eschscholzia*)

Amsinckia

Lupinus

Nemophylla

Phacelia

Layia

Salvia (Chia)

California’s modern golden hillsides

Ground cover of European / Mediterranean bromes, oats, barleys, mustards

What was the indigenous herbaceous cover?

The furious pace of exotic annual invasions hampered scientific scrutiny because indigenous herb cover was already altered before the first botanists arrived in California, ca. 1850.

Without constraint of empirical evidence at European contact, this led to a plethora of hypotheses.

- Indigenous cover was perennial bunch grassland
- Bunch grasslands converted to wildflowers and exotic grassland due to overgrazing
- Exotic annual grasslands are invasive species that outcompete native herbs

Consensus models on California grasslands have historically resorted to deductive historical scenarios based on spatial evidence (space-for-time substitution), beginning with “climax” and “relict” theory of Clements (1916, 1934).

Modern computer similations that forecast future vegetation based on niche theory and global warming scenarios are a throwback to Clementsian thinking.

SHIFTING BASELINE SYNDROME

The choice of baseline affects the outcome of your story (Jackson et al. 2001)

- Defenders of the bunch grassland model claim that only observations of trained botanists (> 1860) have scientific merit (Clements 1934)
- But the first botanists saw biological invasions in progress.

Distribution of the California prairies

HISTORICAL ECOLOGY

Ecology is a historical science, a seamless extension of the geosciences and quaternary paleoecology (Jeremy Jackson et al. 2001 *Science)*.

To enlarge spatial and temporal scales, it is vital to sacrifice precision and analytical elegance in ecology in order to buy time and analyze long-term ecological questions.

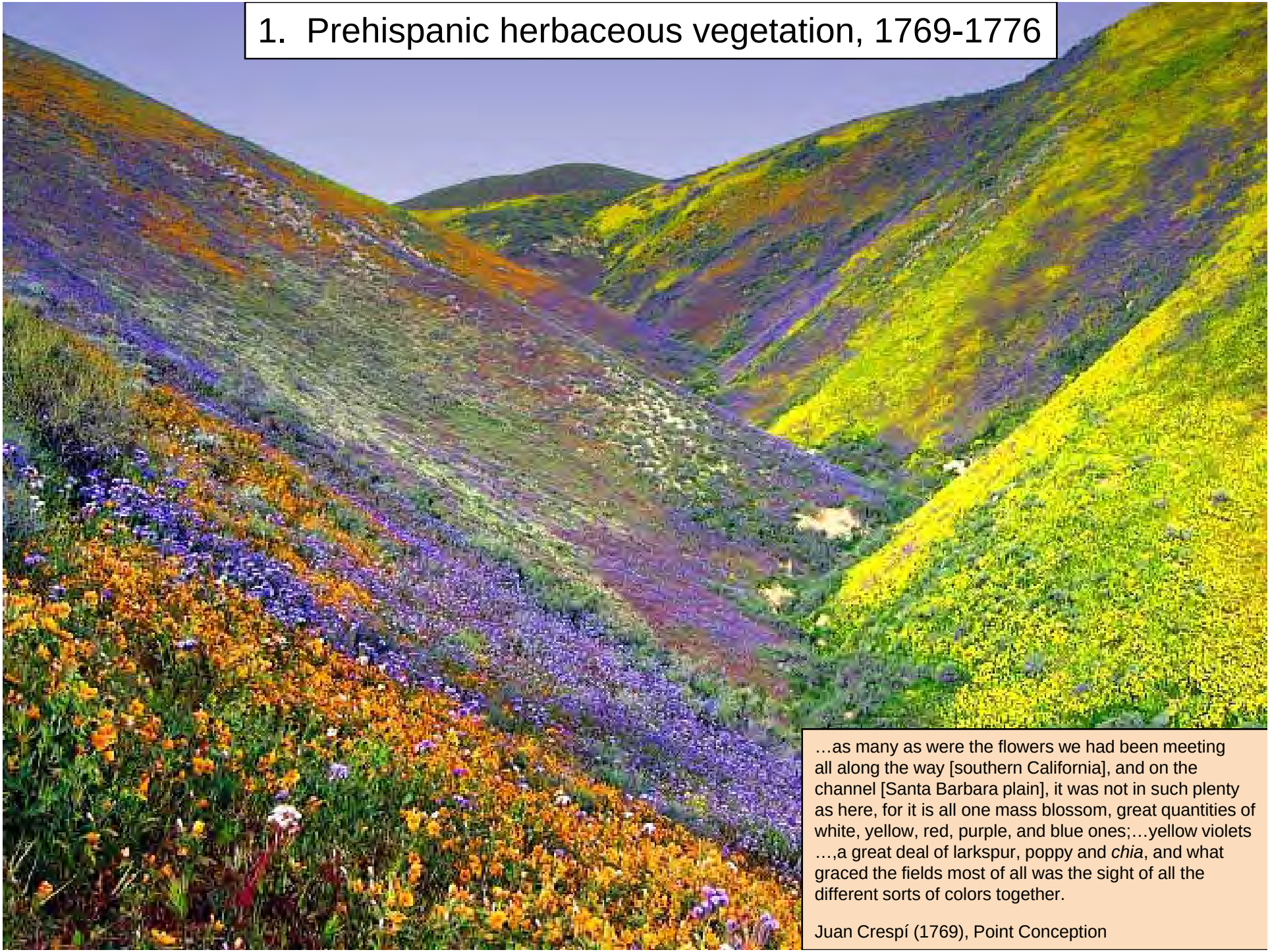
Here we begin with the Spanish record (1769-1776)
Then follow with

- Gold Rush period (1840-1880)
- Flower reports from 20th century newspapers (1880 to present)
- Paleobotany of packrat middens and mammalian paleontology

THE GLOBAL HYPOTHESIS OF MY BOOK:

INDIGENOUS WILDFLOWER FIELDS WERE DISPLACED BY INVASIVE ANNUALS

1. Prehispanic herbaceous vegetation, 1769-1776

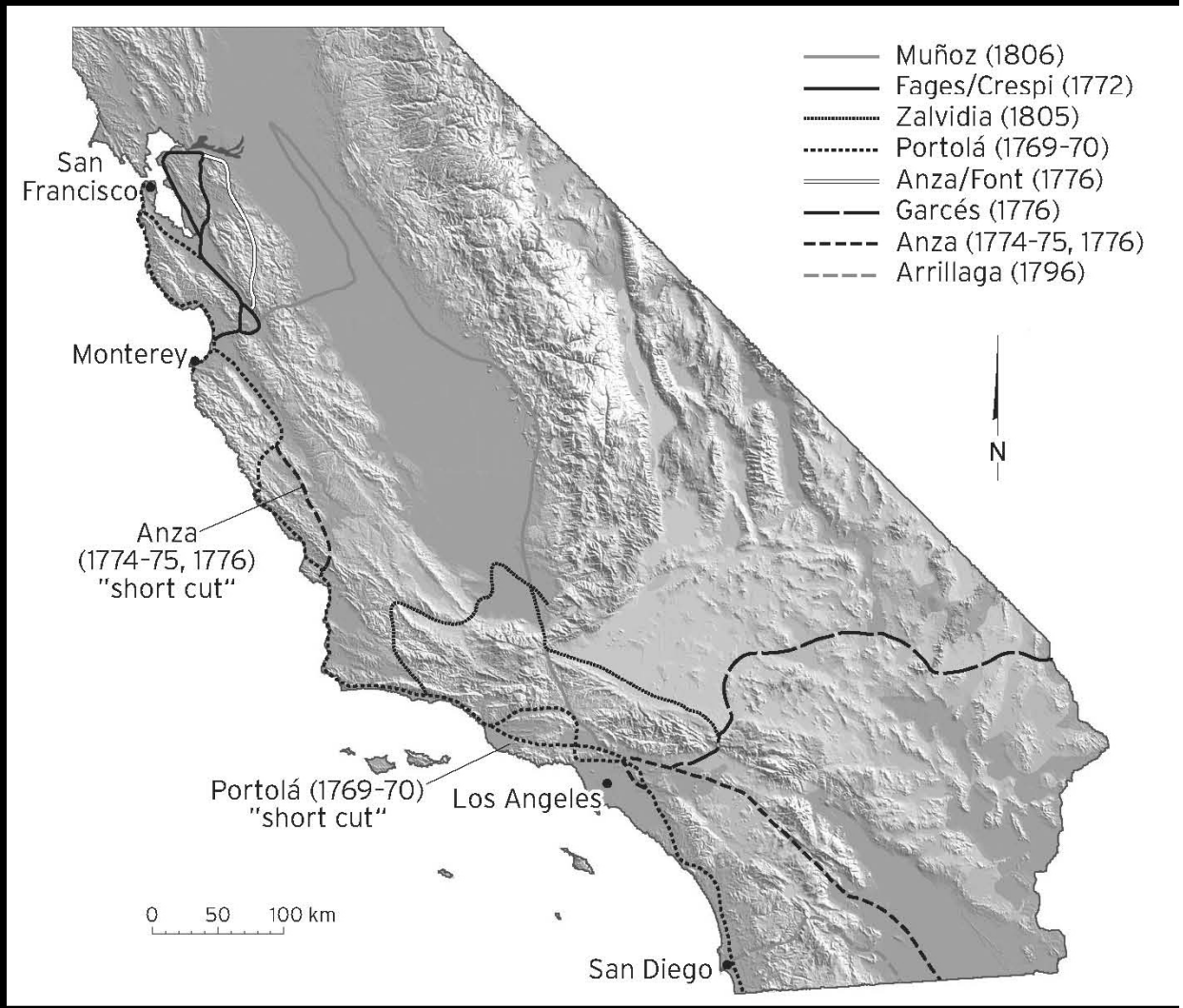


…as many as were the flowers we had been meeting all along the way [southern California], and on the channel [Santa Barbara plain], it was not in such plenty as here, for it is all one mass blossom, great quantities of white, yellow, red, purple, and blue ones;…yellow violets …,a great deal of larkspur, poppy and *chia*, and what graced the fields most of all was the sight of all the different sorts of colors together.

Juan Crespí (1769), Point Conception

The Spanish Record

- Systematic survey of the state (mandated by the Viceroy of Mexico)
- Daily assessment of vegetation and other resources necessary for the establishment of a mission system (pasture, wood, timber).
- The Spaniards were the only people to write about California's aboriginal landscape before the expansion of invasive species.
- Spanish journals must be evaluated in their historical context.



Pasture was described every day from San Diego to San Francisco

Spanish observations and vocabulary on the vegetation were made by priests, but they were the educated scholars of the period.

Baja California deserts: Identification to genus, sometimes to species.

Mediterranean vegetation: Identifications of trees species are accurate because they are congeners with Europe (riparian/conifer forest, oak woodland)

Descriptions of unfamiliar mediterranean shrublands are muddled. Chaparral was avoided, an impedance to travel.

Coastal sage scrub: “Kitchen plants” (salvia, lavender, rosemary).

APPENDIX 2

Spanish plant names for California vegetation

ABETO fir (*Abies concolor*) in southern California

ABROJOS cactus

ÁLAMO, ALAMEDA, ALAMILLO poplar, mostly Fremont cottonwood (*Populus fremontii*)

ÁLAMO NEGRO black cottonwood (*Populus trichocarpa*)

ALISO traditional meaning in Mexico is alder (*Alnus*); in California it refers to sycamore (*Platanus racemosa*); Brown (2001) and Bolton (1927, 1930a,b, 1933) erroneously translate aliso to “alder”; Roberts (1989) and Minnich and Franco-Vizcaíno (1998) translate aliso to California sycamore (*P. racemosa*)

AMARANTH *Amaranthus* spp.

ARBOL tree

ÁRBOLES CORCHO cork tree, very likely *Quercus agrifolia* (term used by Pedro Fages in Priestly 1937)

ARBOLILLO shrub

ARBUSTO shrub, bush

AVELLANAS hazelnuts, California buckeye (*Aesculus californica*)

AVENO wild oat

BOSQUE, VOSQUE thicket, woodland, wood

BOSQUE CHAPARRO a shrubby growth

BOSQUE ESPINOSO literally, “spiny brush” or “wood” in chaparral, likely dominated by *Ceanothus*

BREÑALES “brambles,” in reference to dense chaparral of the Santa Monica Mountains

CACHANILLA

Arrowweed, Mexicali Valley

CACOMITES a species of *Iris*

CALABASAS wild gourd (*Cucurbita foetidissima*)

CARDOS SANTOS prickly poppy, holythistle

CARRIZO a large cane grass, reed grass, probably tule (*Scirpus* spp.)

“Rosetta stone” for pasture in the Spanish journals

TABLE 2.1 USE OF *PASTO* AND *ZACATE* IN THE JOURNALS OF CRESPÍ, FONT, AND COSTANSÓ

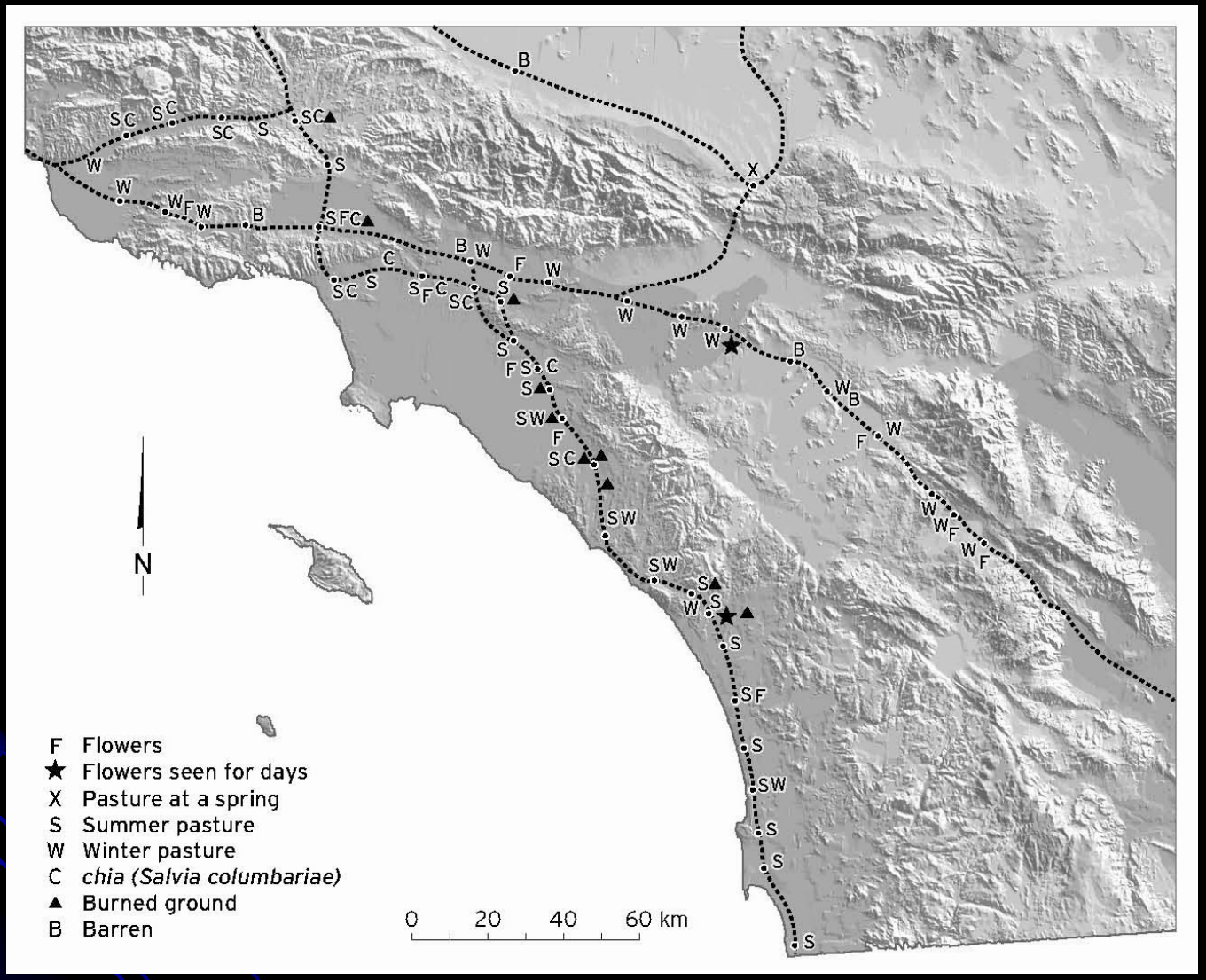
	Dry Herbage (summer)				Green Herbage (winter)		
	Salt grass	*Pasto*	*Zacate*	Both	*Pasto*	*Zacate*	Both
Crespí	2	26	24	26	9	5	4
Costansó	—	23	1	0	—	—	—
Font[a]	—	—	—	—	8	1	—

SOURCE: Brown 2001; Teggart 1911; Web de Anza Archives.
[a]. Font's explorations were entirely in the winter growing season.

esteril— barren, sterile, not useful for livestock
trigo— wheat
Centeno— rye

Words for bunch grass
Grama— bunch grass
Sabaneta— a species of bufo grass

Historians of Spanish texts translated pasto and zacate as “GRASSLAND.”
(Bolton, many books; A.K. Brown 2001)



Southern California

OBSERVATIONS IN THE GROWING SEASON

Crespí. Near Carlsbad. “It is a pleasure to see how the fields are abloom everywhere,

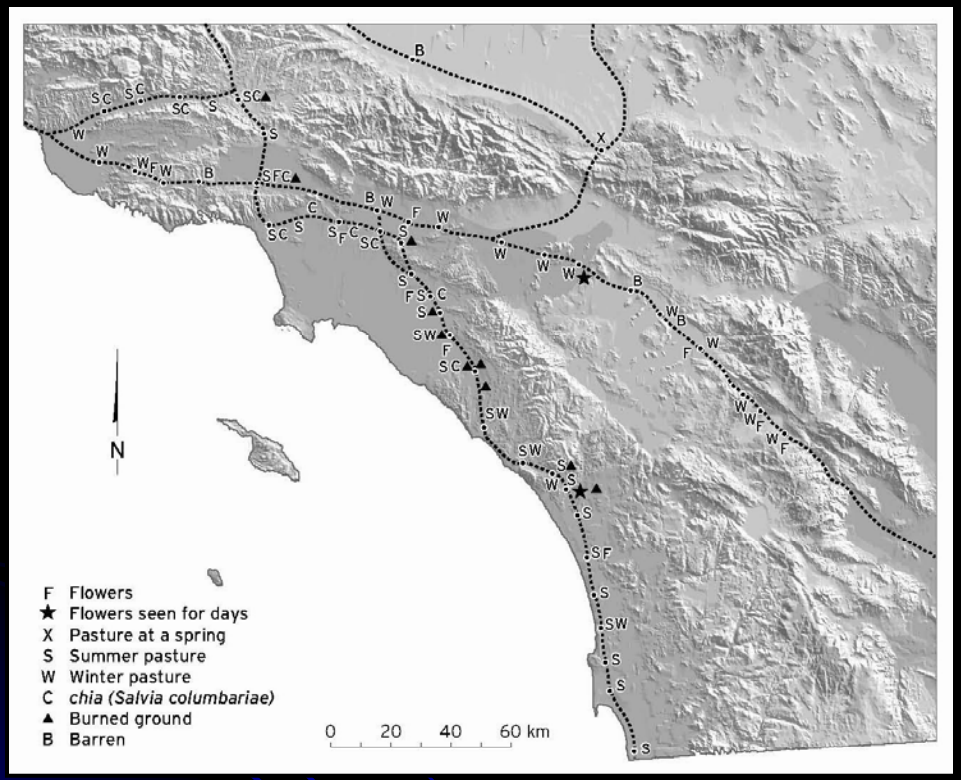
Crespí. San Luis Rey. “The entire way has been, like the preceding ones, very flowery.”

Anza. San Jacinto Valley. “All its plains are full of flowers, …”

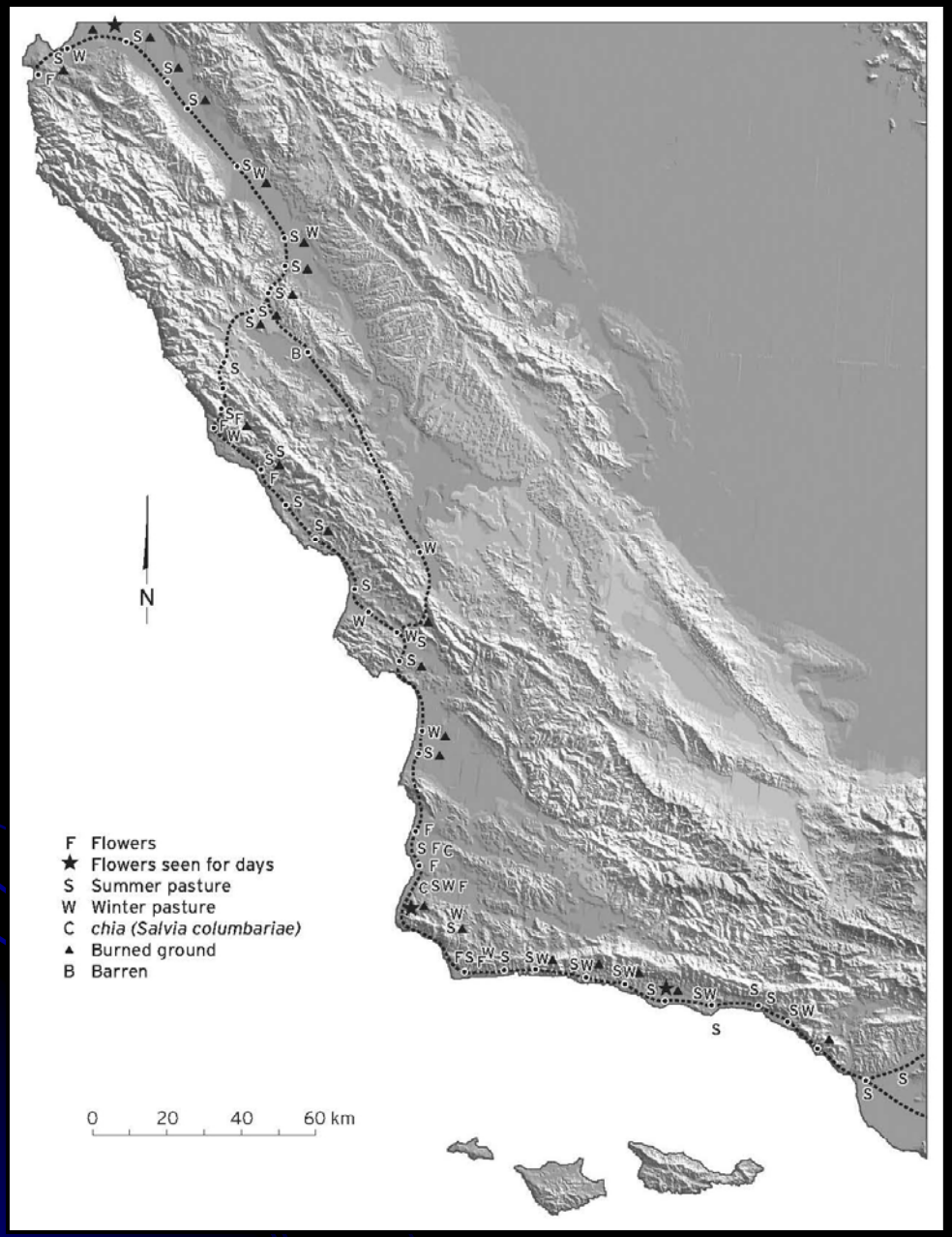
Lasthenia gracilis (gold fields)

Font, Orange County plains. “Among the infinite variety of flowers, such as tulips [California poppy] and others of very diverse colors and very pretty…”

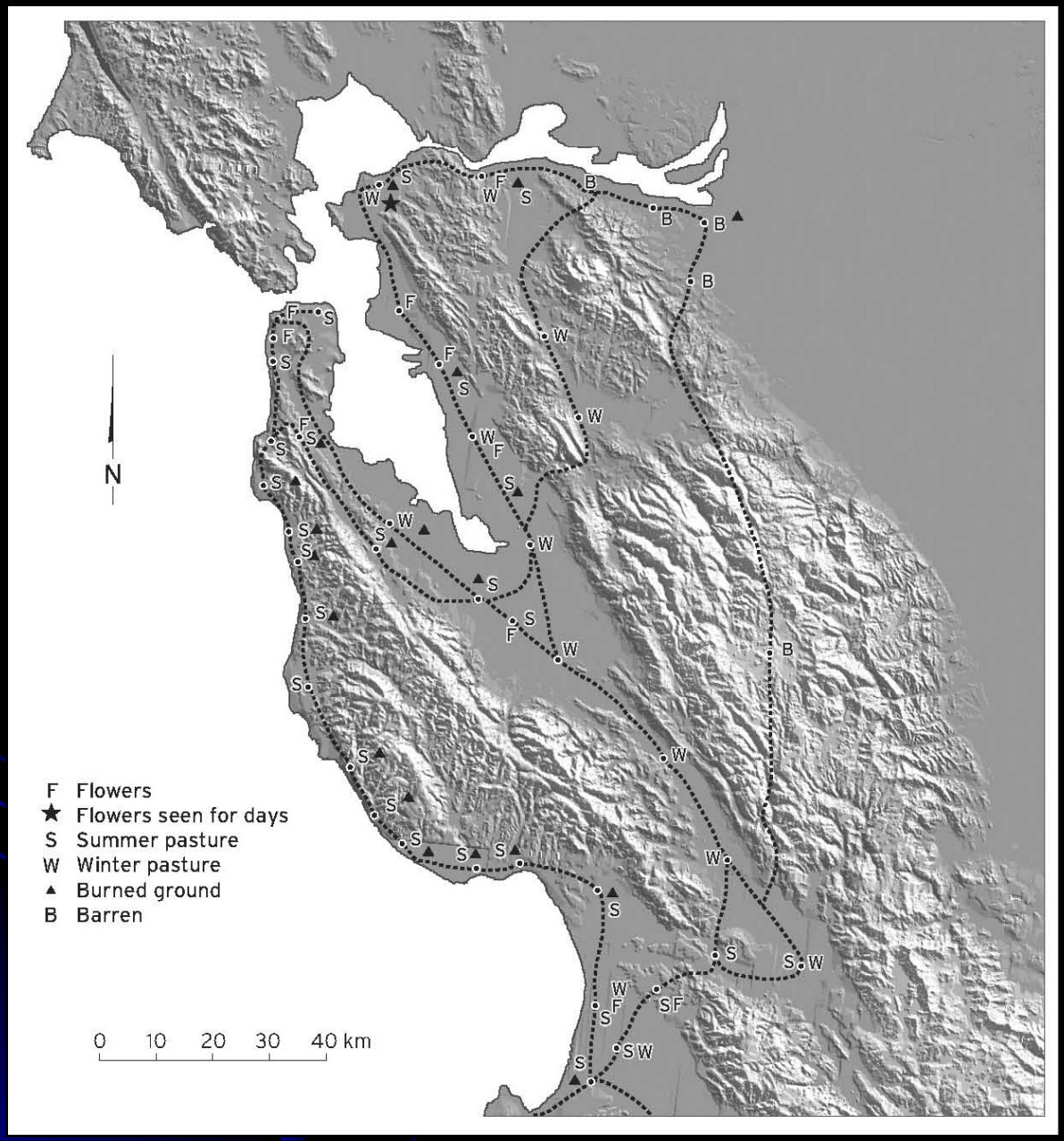
Crespí, Placentia. The entire countryside,…., is full of chia that is very good for refreshment, so much of it that I thought it impossible for the heathen folk, …..to gather even half of it. It was in bloom at present, purple-colored bloom.



Salvia columbariae (chia)



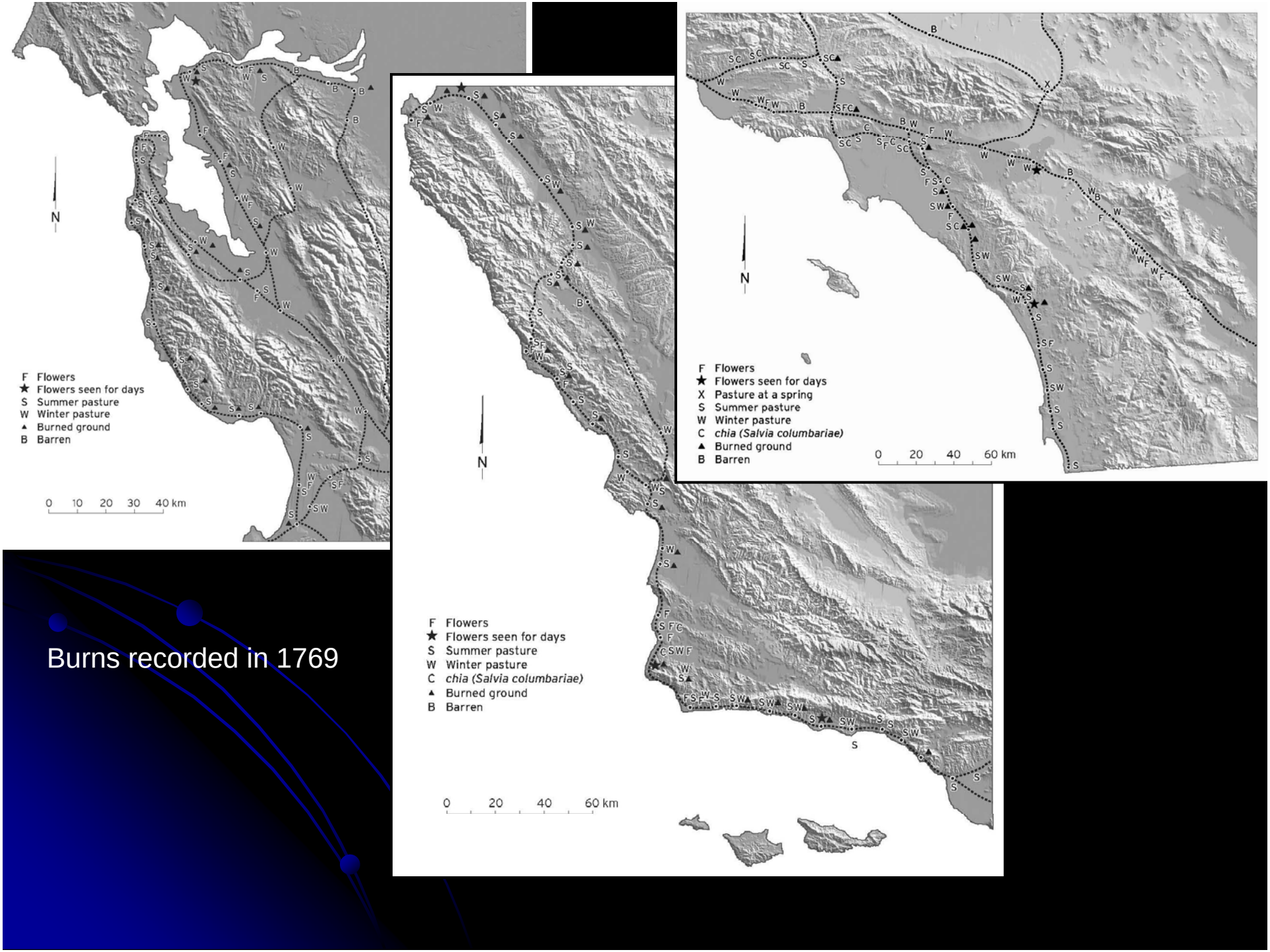
Central California



San Francisco Bay and Monterey

FONT Salinas Valley. “The road like all the rest is through pretty country,…flower-strewn,…fertile, beautiful, and splendid.”

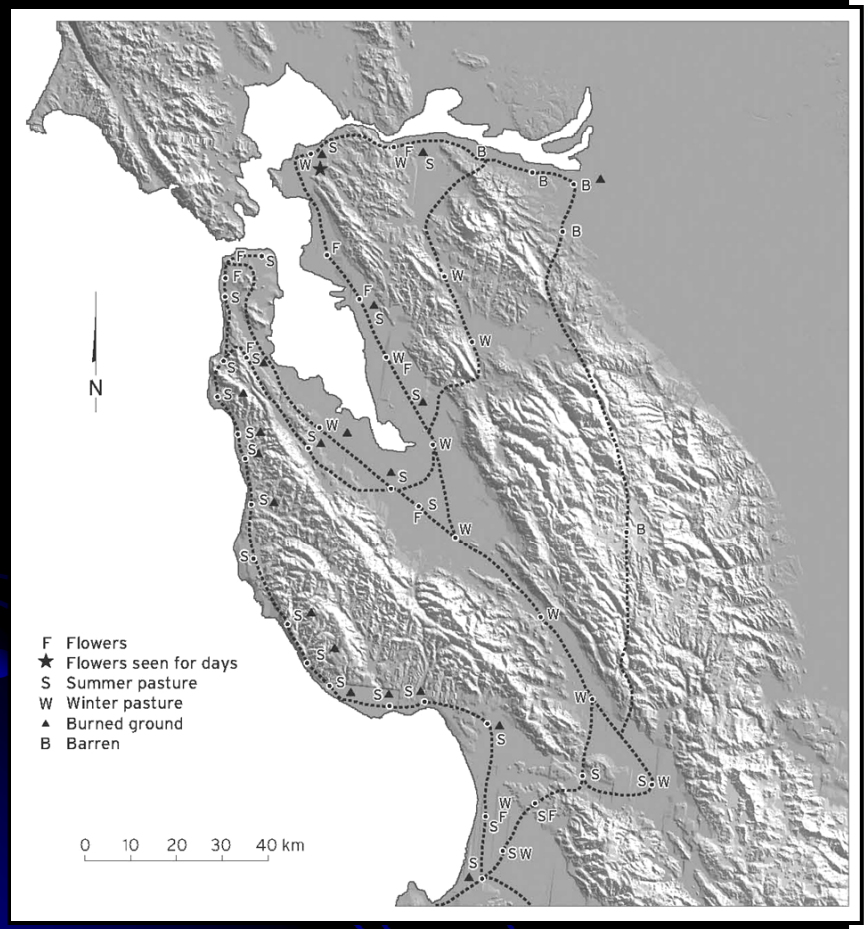
FONT April 1, 1776. Carquinez Strait, “the fields are…thickly covered with various wildflowers as those [areas] farther back.”

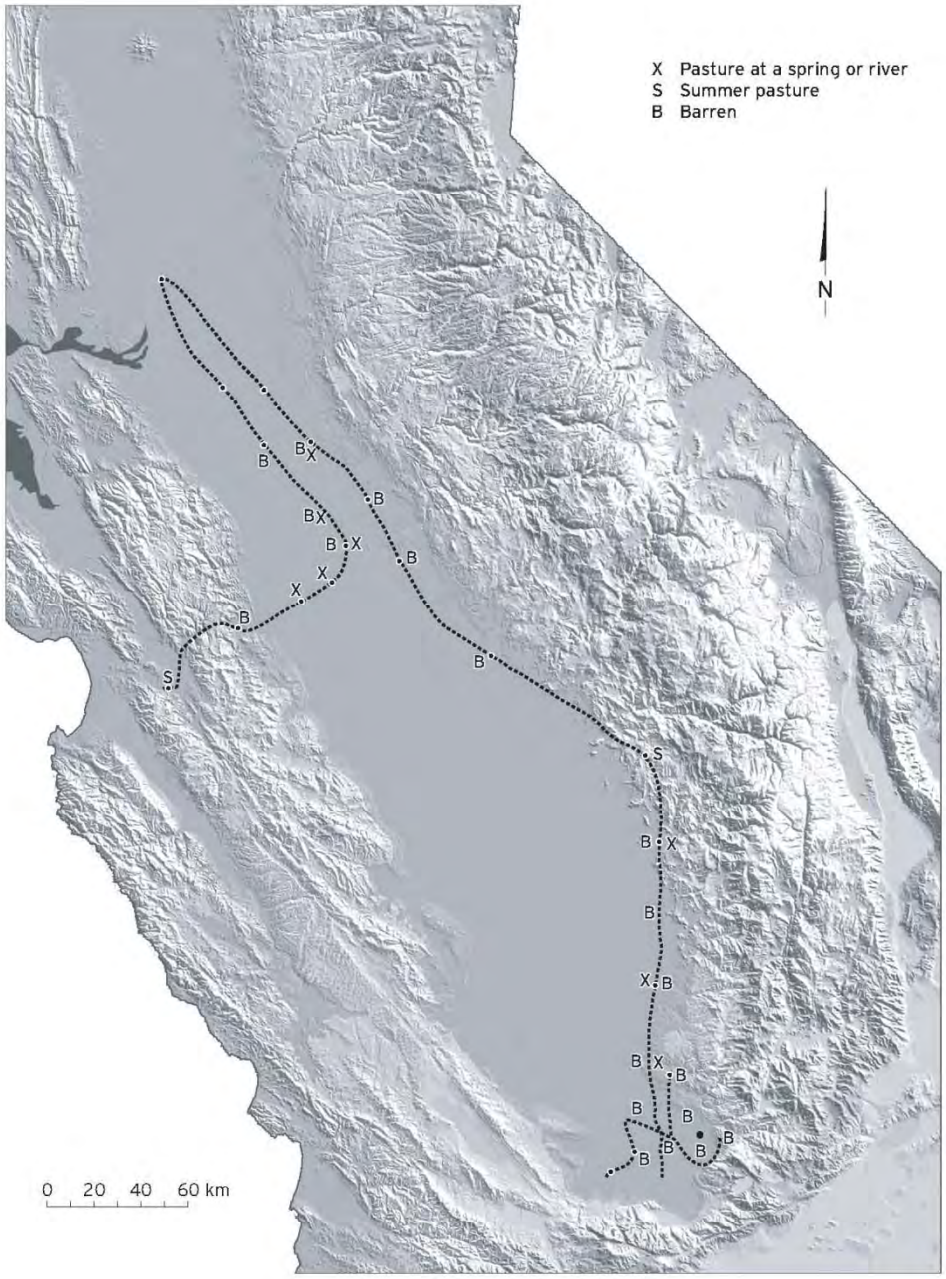


Burns recorded in 1769

Santa Barbara Channel. Rivera y Moncadas, 1776. …in the country side [there has been] extreme need of pasture for the animals,…all occasioned by the great fires of the gentiles, who,….. burn the fields as soon as they gather up the seeds,…..

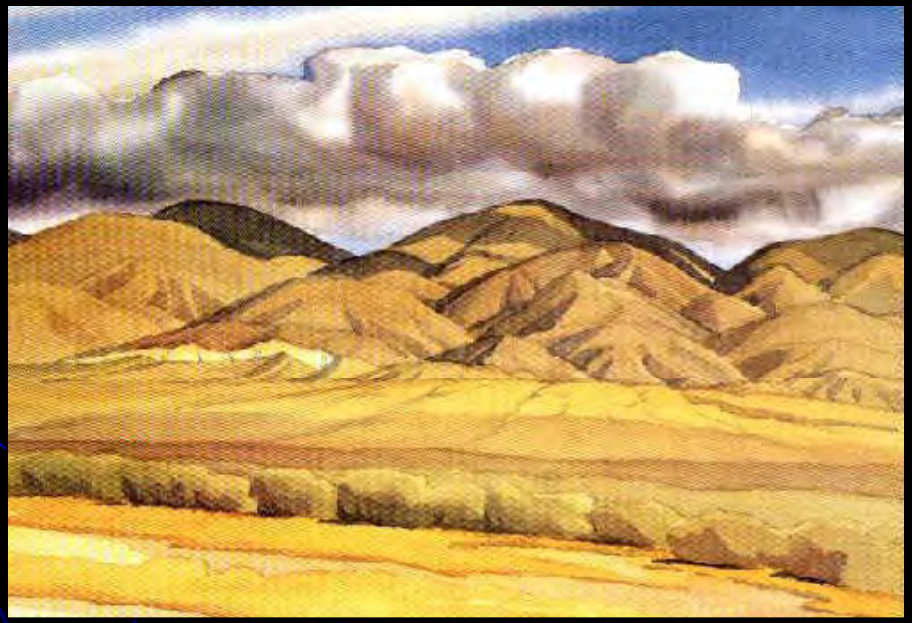
Central Valley barrens





CENTRAL VALLEY
Font, Antioch. a very sterile and dry plain

Muñoz (1806) E of Fresno. ….All the country... is worse than bad….there is little pasturage..,



Wildflowers in Chumash burials (Timbrook et al. 1982, Timbrook and Chapman 2007)

Amsinckia, Aster, Atragalus, Calandrinia, Camissonia, Chaenactis Cryptantha
Eschscholzia, Hemizonia, Heterotheca, Layia, Lepidium, Lotus, Lupinus,
Malva, Phacelia, Salvia, Senecio.

Gilia angelensis

Redmaids, *Calandrinia ciliata*

2. California pasture and biological invasions in the mid-18th century (1840-1880)

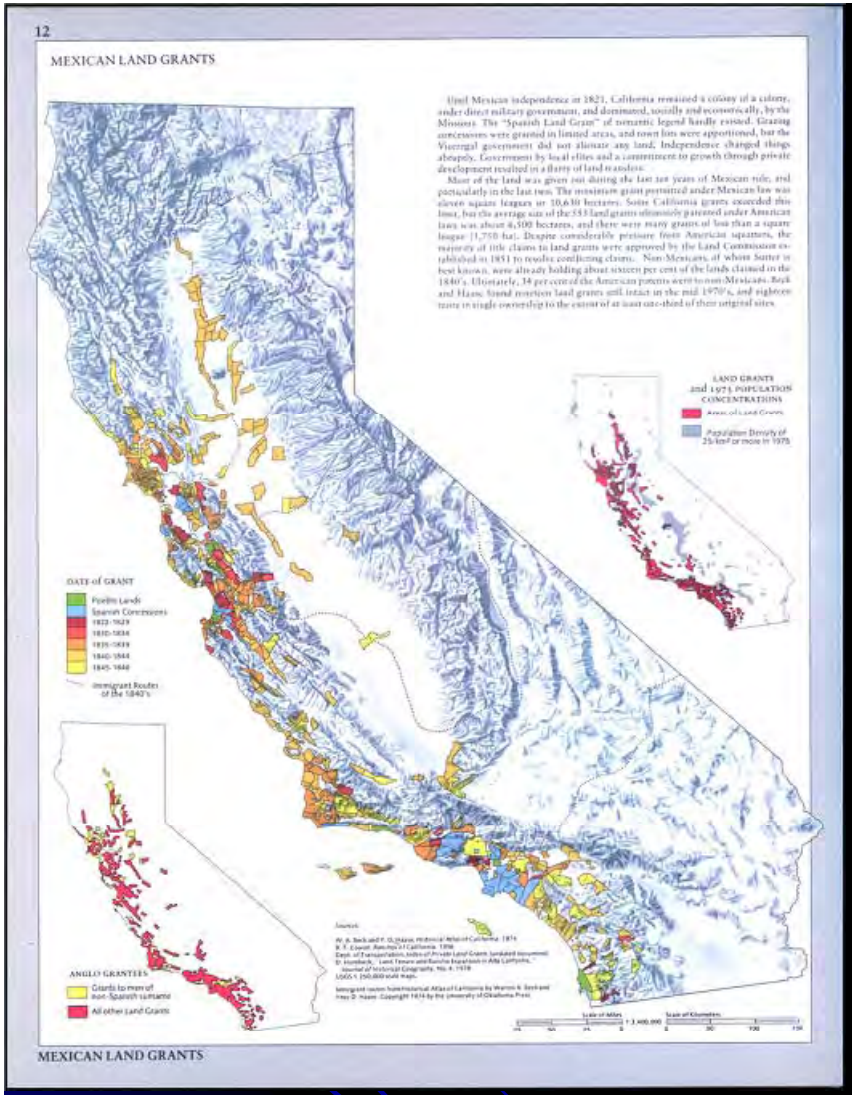
The Great Central Plain of California, during the months of March, April, and May, was one smooth, continuous bed of honey-bloom, so marvelously rich that, in walking from one end of it to the other, a distance of 400 miles, your foot would press a hundred flowers at every step.

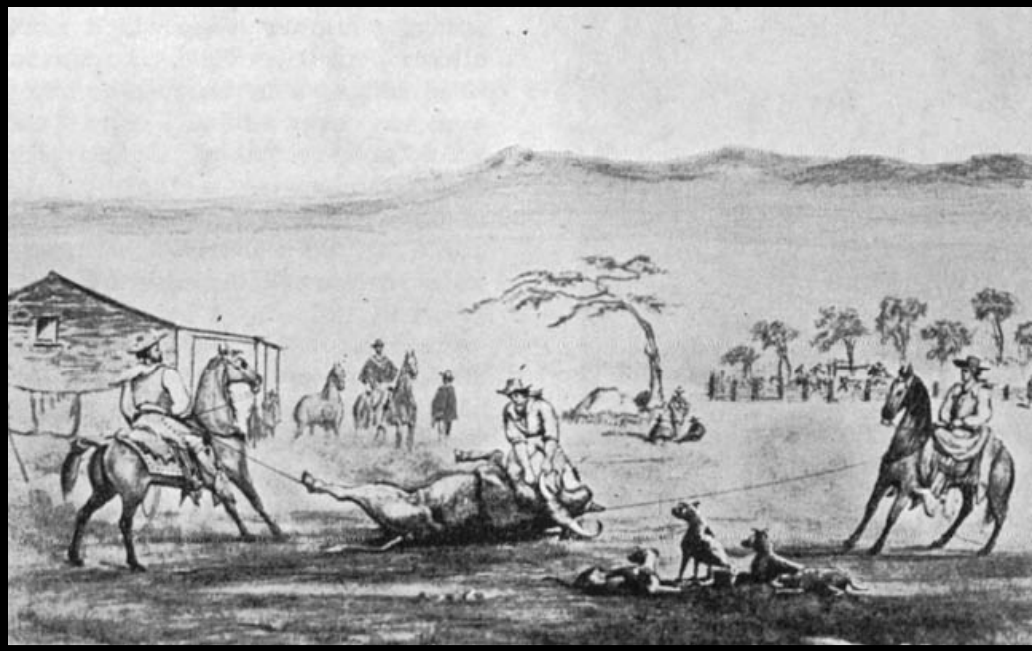
John Muir in 1868

We encountered more than one forest of mustard, … This plant has become…a terrible scourge for part of California. It invades the finest pasture lands, and threatens to spread over the entire country.

August Bernard Duhaut-Cilly in 1828

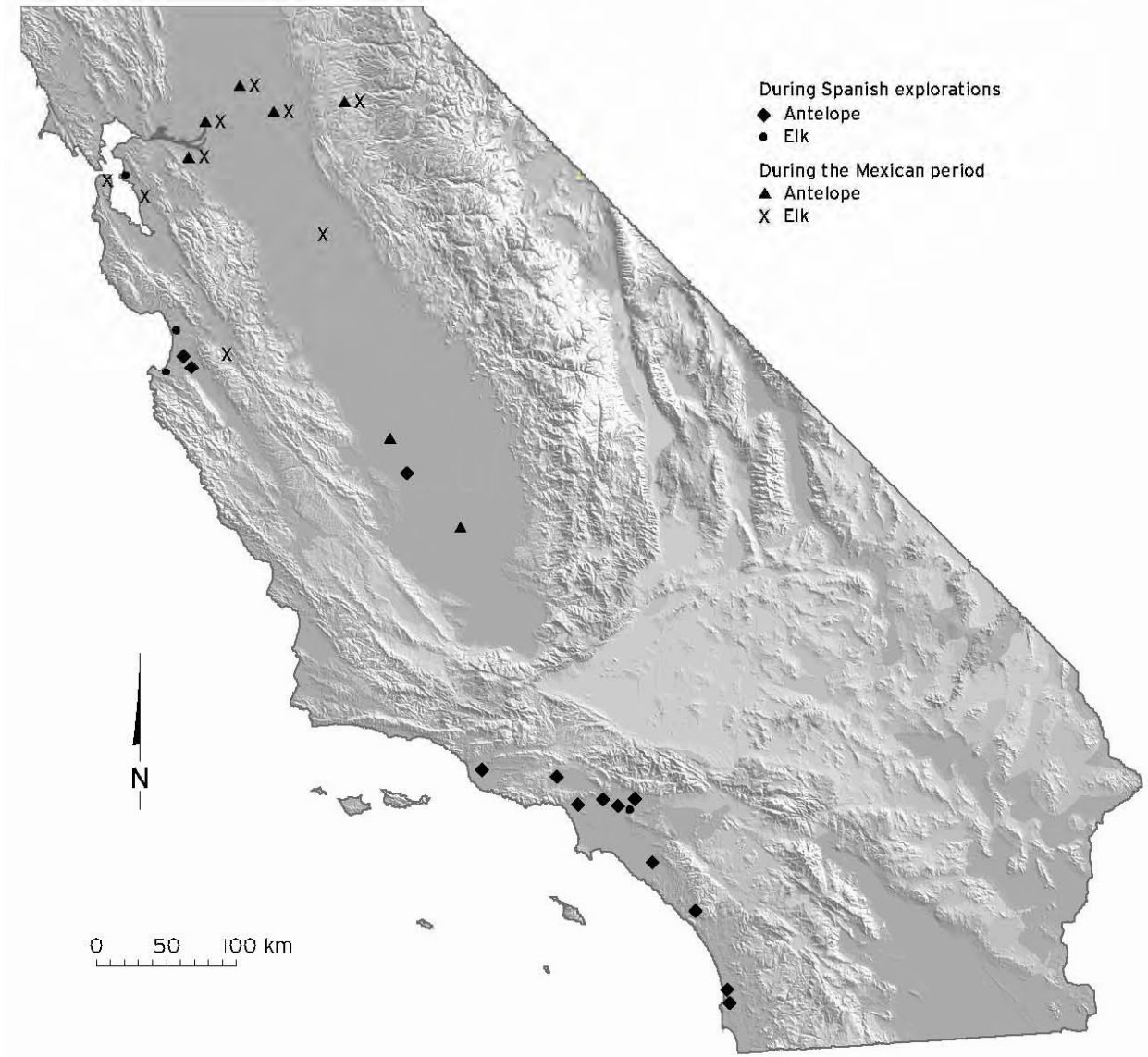
Black mustard
Brassica nigra





Cronise 1868, "In no country are cattle raised at so trifling cost. They get no shelter and no feed except the wild pasture of the mountain ranges."

Leonard 1959: 96. San Juan “The wild cattle are…much wilder than deer, elk, etc. “These cattle incline much to rough and hilly parts of the country, owing, it is supposed, to the Spaniards and Indians hunting them when found in the plains.”



Antelope

Elk

Deer

Half million cattle and other livestock

TABLE 3.1 ESTIMATES OF MISSION LIVESTOCK IN EARLY HISTORIES

A

Mission/Land Grant	Cattle	Horses	Sheep
San Juan Bautista	7,070	401	7,017
San Carlos	2,050	470	4,400
Soledad	6,599	1,070	6,358
San Antonio	5,000	1,060	10,000
San Miguel	3,762	950	8,999
San Luis Obispo	2,000	800	1,200
Presidio Santa Barbara	7,900	300	—
La Purísima	10,500	1,000	7,000
Santa Inés	7,300	320	2,200
Santa Barbara	2,600	511	3,300
San Buenaventura	4,000	300	3,100
San Fernando	6,000	300	3,000
Pueblo Los Angeles	38,624	5,280	—
Presidio San Diego	608	625	—
San Gabriel	20,500	1,700	13,554
San Juan Capistrano	10,900	290	4,800
San Luis Rey	26,000	2,100	25,500
San Diego	6,220	1,196	17,624

B

Mission/Rancho	Cattle	Horses	Sheep
San Luis Obispo	60,000	thousands	thousands
Sonoma	30,000	1,000	—
Santa Clara	65,000	4,000	30,000
San Juan Bautista	60,000	2,000	20,000
San Antonio	10,000	500	10,000
San Miguel	35,000	1,000	20,000
Soledad	25,000	1,000	10,000
La Purisima Conception	20,000	1,000	15,000
Santa Ynez	20,000	1,500	10,000
San Fernando	50,000	1,500	20,000
San Gabriel	80,000	3,000	30,000
San Luis Rey	60,000	1,000	20,000
San Juan Capistrano	20,000	1,000	10,000
San Diego	15,000	1,000	20,000
Santa Barbara	20,000	1,000	20,000
San Buena Ventura	25,000	1,500	10,000

SOURCE: Davis (1929: 389–95); based on his merchant and trading business.

C

Mission	Cattle	Horses	Sheep
San Francisco	76,000	2950	79,000
Santa Clara	74,280	6,100	82,540
San José	62,000	2,340	62,000
San Juan Bautista (1820)	43,870	6,230	69,500
San Carlos	87,600	1,800	7,500
Soledad	36,000	+	70,000
San Antonio (1822)	52,800	4,800	48,000
San Miguel (1821)	91,000	4,100	47,000
San Luis Obispo	87,000	5,500	72,000

SOURCE: Cronise (1868). Cronise states that "all the other missions [not on his list] were equally rich in livestock."
+ = greater than all the other missions

D

Mission	1834 Horned Cattle	1834 Horses	1834 Sheep, Goats, Pigs	1842 Horned cattle	1842 Horses	1842 Sheep, Goats, Pigs
San Diego	12,000	1,800	17,000	20	100	20
San Luis Rey	80,000	10,000	100,000	2,800	400	4,000
San Juan Capistrano	70,000	1,900	10,000	500	150	200
San Gabriel	105,000	20,000	40,000	700	500	3,500
San Fernando	14,000	5,000	7,000	1,500	400	2,000
San Buenaventura	4,000	1,000	6,000	200	40	400
Santa Barbara	5,000	1,200	5,000	1,800	180	400
San Ines	14,000	1,200	12,000	10,000	500	4,000
Purísima	15,000	2,000	4,000	800	300	3,500
San Luis Obispo	9,000	4,000	7,000	300	200	800
San Miguel	4,000	2,500	10,000	40	50	500
San Antonio	12,000	2,000	14,000	800	500	2,000
Soledad	6,000	1,200	7,000	—	—	—
Carmelo	3,000	700	7,000	—	—	—
San Juan Bautista	9,000	1,200	9,000	—	—	—
Santa Cruz	8,000	800	10,000	—	—	—
Santa Clara	13,000	1,200	5,000	1,500	250	3,000
San José	2,400	1,100	19,000	8,000	200	7,000
San Francisco	5,000	1,600	4,000	60	50	200
San Rafael	3,000	500	4,500	—	—	—
Solano	3,000	700	400	—	—	—

SOURCE: Bancroft (1888: 339); includes data before and after the mission slaughter of the early 1930s.

TABLE 3.2 RECORD OF SHIPS IN CALIFORNIA PORTS, AND DROUGHTS

Year	Arrivals	Drought	Year	Arrivals	Drought
1774	2		1812	0	
1775	0		1813	1	
1776	3		1814	2	
1777	0		1815	1	
1778	1		1816	8	
1779	3		1817	3	
1780	0		1818	2	
1781	0		1819	4	
1782	0		1820	0	
1783	2		1821	3	X
1784	1		1822	3	
1785	0		1823	7	
1786	4		1824	7	
1787	5		1825	33	
1788	2		1826	25	
1789	1		1827	33	
1790	0		1828	33	X
1791	5		1829	28	X
1792	0		1830	21	X
1793	0		1831	21	
1794	17		1832	24	
1795	7		1833	29	
1796	4		1834	31	
1797	5		1835	30	
1798	5		1836	16	
1799	3		1837	27	
1800	3		1838	21	
1801	1		1839	16	
1802	0		1840	19	
1803	6		1841	30	X
1804	4		1842	28	
1805	0		1843	4	X
1806	4		1844	10	X
1807	2		1845	16	
1808	0		1846	9	
1809	0	X	1847	22	
1810	0	X	1848	15	
1811	0				

SOURCE: Davis (1929: 397).

Drought in 1857, 1862-64

Drought and livestock crashes

Wild horses

The onset of biological invasions in California recorded in mission bricks

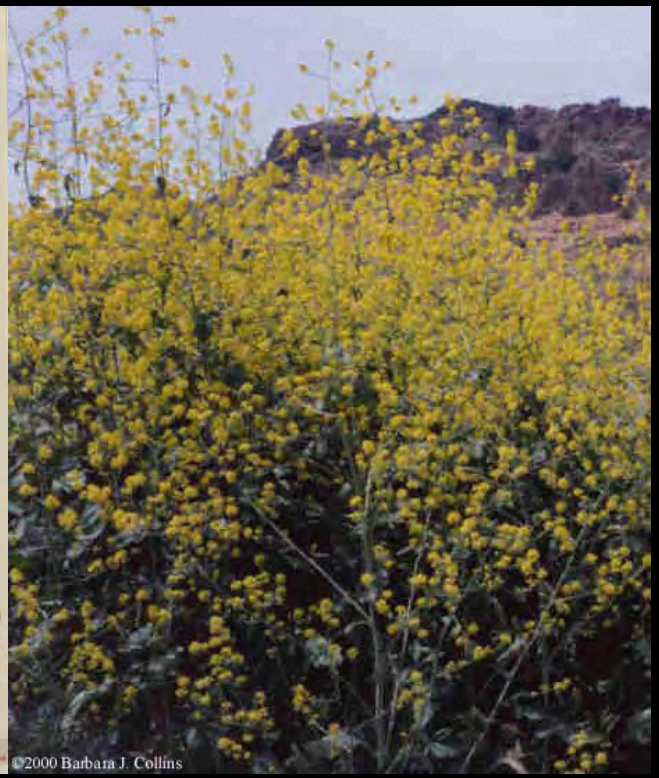
Misión San Fernando Velicatá

TABLE 3.3 SELECTED ANNUALS AND HERBACEOUS PERENNIALS FOUND IN CALIFORNIA MISSION ADOBE BRICKS

Missiona	SFV	SAN	SDM	SVC	SDD	SFR	SJS	SJB	SFS	RES	RVJ	RNV
Date of founding	1769	1771	1775	1780	1791	1797	1797	1797	1824	1834	1834–45	1837
Date of adobe brick	1769	1787	1775	1780	1793–97	1797	1811	1805–13	1824	1834	1834–45	1837
EXOTIC ANNUAL SPECIES												
Erodium cicutarium	X	X	X	X	X	X	X	X		X	X	X
Malva parviflora	X		X		X	X	X					
Brassica nigra			X		X							
Avena fatua								?				
Poa annua								X				
Hordeum murinum							X					
Medicago hispida	X											
Melilotus indica	X					X						
Trifolium involucratum												
NATIVE SPECIES												
Elymus triticoides			X	X	X							X
Eleocharis spp.							X					
Scirpus spp.	X		X	X					X			X
Carex spp.	X					X						
Stipa spp.												
Other bunch grasses												

Font, Jan 4 1775. San Gabriel Mission: “there are many turnips [*nabos*], which from a little seed which was scattered, took possession of the land.

Longinos-Martínez 1792 (Simpson, 34) Mustard, a very common field plant.



Avena fatua (wild oat). Apparently not introduced by the Spanish missionaries, as generally assumed; it was not recorded in mission bricks until 1810. It was still expanding rapidly at San Francisco in the 1830s. Widespread along coast and floodplains in the interior by the Gold Rush.

Erodium cicutarium (filarie). Expanded throughout California including the deserts before 1840.

Clovers. *Trifolium* and *Medicago*. Mission bricks document the clovers. Frémont's observations indicate they were widespread across California by the 1840s.

Filarie and clovers coexisted with wildflowers

***Hordeum murinum* (wall barley).** Recorded in mission bricks as early as 1810. It was most common in degraded, overgrazed pasture.

LANDSCAPE DESCRIPTIONS, Southern California

Revere 1847. “In the plain itself, the richest and most brilliant wildflowers flourish which far transcends all art; All colors, all shades of colors, all hues, all tints, …..

Nemophila menziesii

Amsinckia intermedia

J.F. James. *American Naturalist*, 1879. “In… Los Angeles…the plains…hills, and valleys are one mass of gorgeous, brilliant flowers…the Californian poppy,…in places where the ground was plowed…they seemed like tongues of fire running over the ground.”

Coastal central California

Wilkes (1845) Carquinez Straits that “the hills are thickly covered with wild oats;

Frémont 1846 San Francisco. “after the spring rains…the area is covered in grass….four or five varieties of wild clover [and] wild mustard ten or twelve feet high.”

Central Valley

Frémont 1845. San Joaquin Valley near Kern R. “Instead of grass, the whole face of the country is closely covered with *erodium cicutarium*, here only two or three inches high.

Frémont 1848. “The Sacramento bottoms were covered with oats.” 1844

Frémont 1848: 27. Butte County. "The range consisted of excellent grasses, wild oats in fields, red and other varieties of clover…."