ALLUVIAL SCRUB VEGETATION IN COASTAL SOUTHERN CALIFORNIA[1]

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Abstract: Certain floodplain systems in southern California sustain a unique scrub vegetation rather than riparian woodlands due to a lack of perennial water. Alluvial scrub occurs on outwash fans and riverine deposits along the coastal side of major mountains of southern California. This vegetation type is adapted to severe floods and erosion, nutrient-poor substrates, and the presence of subsurface moisture. Ten major stands were sampled by line intercepts to determine their species composition, community structure, and successional status. Plant ecology and successional dynamics of these stands are compared. Loss of this unique floodplain vegetation type in the past, and current urban pressures from mining and flood control practices are discussed.

Scrub vegetation in California is extensive and diverse, occupying coastal and desert dunes, coastal valleys and foothills, interior mountains and desert flats. Holland (1986), in the State's Preliminary Descriptions of the Terrestrial Natural Communities of California, recognizes 73 different scrub types endemic to California. However, one scrub type not included in these descriptions is the unique and threatened vegetation called alluvial scrub. This vegetation is considered a unique habitat with a high priority for preservation by the California Natural Diversity Data Base (1987).

Alluvial scrub is an open vegetation adapted to the harsh conditions of the outwash environment. It grows on sandy, rocky alluvia deposited by streams that experience infrequent episodes of severe flooding. This vegetation dominates major outwash fans at the mouths of canyons along the coastal side of the San Gabriel, San Bernardino, and San Jacinto Mountains and lesser floodplain and riverine locations of southern California. Some alluvial scrub species occur also in sandy washes of coastal southern California apart from alluvial fans and large rivers.

Alluvial scrub is composed of an assortment of drought-deciduous subshrubs and large evergreen woody shrubs that are adapted to the porous, low fertility substrate as well as to survival of intense, periodic flooding and erosion. Step-like shrub covered terraces above the wash channels exhibit different phases of alluvial scrub vegetation. These phases are related to the amount of time that has elapsed since the most recent flood at each level. Three types of alluvial scrub have been recognized and are related to such factors as the scouring action of flood channels, distance from the flood channel, time since the last catastrophic flood, and substrate features such as texture and moisture content (Smith 1980). The three types can be referred to as: *pioneer* - vegetation is sparse and of low species diversity and stature, and is found within active stream channels or recently scoured streambeds; *intermediate* - vegetation is rather dense and is composed mainly of subshrubs; and *mature* - vegetation is composed of fully developed subshrubs and woody shrubs.

Mature alluvial scrub is distinguished by its vegetative composition, which contrasts in several respects with that of coastal sage scrub as described by Axelrod (1978), Cooper (1922), Epling and Lewis (1942), Kirkpatrick and Hutchinson (1977), Mooney (1988), Smith (1980), and Westman (1981a,b). Specifically, (1) alluvial scrub has more mesic species than most coastal sage scrub stands; (2) alluvial scrub consists of numerous evergreen shrubs, a diverse assemblage of subshrubs, and a springtime ground cover of annual wildflowers, whereas coastal sage scrub vegetation is composed primarily of drought-deciduous subshrubs with sparse, if any, annual wildflowers; (3) scalebroom *(Lepidospartum , quamatum),* a shrub with high fidelity to alluvial substrates, is found throughout alluvial scrub communities, but seldom in coastal sage scrub vegetation; (4) species commonly found in chaparral or desert plant assemblages, such as California redberry *(Rhamnus crocea),* lemonadeberry *(Rhus integrifolia),* sugarbush *(Rhus ovata),* mountain mahogany *(Cercocarpus betuloides),* holly-leaved cherry *(Prunus ilicifolia),* California juniper *(Juniperus californica),* and yucca *(Yucca whipplei)* are also common in the alluvial scrub community, but not in coastal sage scrub vegetation; and (5) small-statured riparian woodland species, such as California sycamore *(Platanus racemosa)* and mulefat *(Baccharis glutinosa)* are laced through alluvial scrub stands along major drainages, but are not present in stands of coastal sage scrub.

[1] Presented at the California Riparian Systems Conference; September 22-24, 1988; Davis, California.

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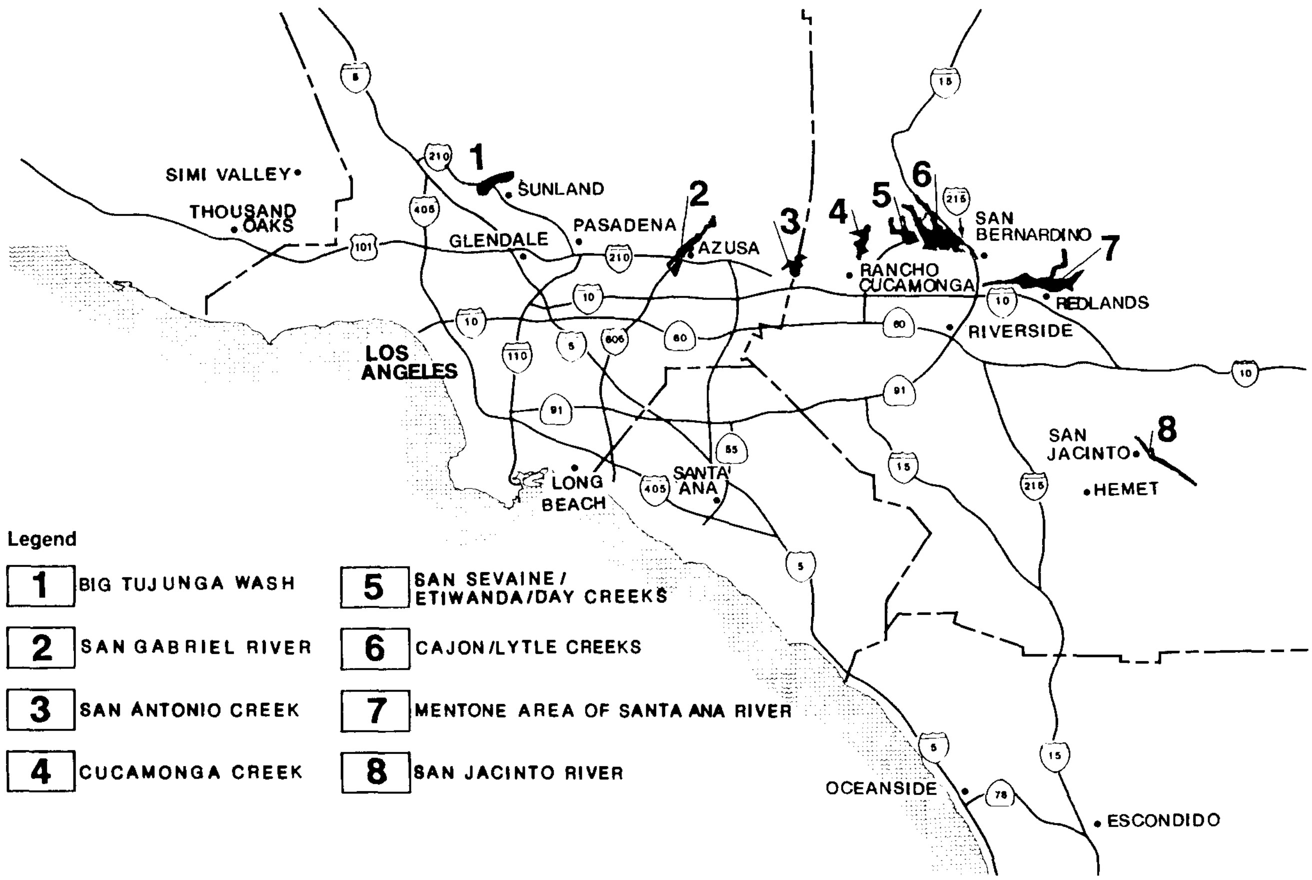

Figure 1– Distribution of major stands of alluvial scrub vegetation in southern California, U.S.A.

Methods

Ten stands of alluvial scrub vegetation were studied, comprising the largest, intact stands in southern California. These stands are associated with the Big Tujunga Wash and San Gabriel River (Los Angeles County); Cucamonga, Day, Etiwanda, San Sevaine, Lytle, and Cajon Creeks and the San Antonio and Santa Ana Rivers (San Bernardino County); and the San Jacinto River (Riverside County), (fig. 1).

Each stand was sampled by a series of 20 m line intercepts. Several "lines of march" along a compass line perpendicular to the associated stream channel were established within each of the alluvial scrub study sites, beginning at the edge of the stream channel in most cases and progressively moving up onto the higher stream terraces until reaching the site boundary. At 30 m intervals (50 m intervals in degraded alluvial scrub), a 20 m line intercept, perpendicular to the line of march, was established. The intercepts alternated at each interval from right to left of the line of march. Only subshrubs and evergreen woody shrubs were measured. Plants that were bisected by the intercept line (as projected vertically) were identified by species. Their intercept lengths (to the nearest 5 cm) were recorded, and the number of dead and live individuals of each species was counted along each 20 m intercept. Any intercept length not containing shrub cover was recorded as "bare ground." Intercept data were grouped by development stage of alluvial scrub vegetation (pioneer, intermediate, or mature) for each site. The values derived were used to describe and quantify the structural and successional composition and status of each alluvial scrub site.

Physical Setting

Soils

The floodplain soils upon which alluvial scrub occurs is of two types. Riverwash Association soils are found along the main river channels and consist of river-deposited sands, gravels, cobbles and stones. Inundation occurs each year and is accompanied by scouring, deposition, and removal depending upon the intensity and number of rainstorms each winter. All vegetation is scoured from the main channel during peak flow episodes.

Soboba Association soils are located along the terraced banks of the river and are formed of alluvium on the outwash of the rivers. Soboba soils have a cobbly, coarse loamy sand surface underlain by pale brown, single-grain, loosely stratified very gravelly and cobbly sand or loamy sand subsoils. These soils are excessively drained and exhibit very high permeability, very slow runoff, low water-holding capacity and low fertility.

Climate

The climate of the study area is Mediterranean, with an annual rainfall of approximately 460 mm, most of which falls during a few heavy winter storms. Once every 10 to 20 years, rainfall far exceeds the norm, resulting in catastrophic floods, such as 1938 and 1969. During such past floods, the rivers have carried debris eroded from upstream slopes and riverbeds, forming broad rocky alluvial outwash fans nearly 600 m thick. The river channels within the fans are subject to frequent scouring and flooding resulting in a barren state. The most significant recent floods in the study area occurred in 1938 and 1969. These and previous major floods produced floodplain terraces bordering the main channels and upon which the three recognizable phases of alluvial scrub vegetation have developed.

Site Conditions

The sample sites exhibit many similar conditions as well as a few distinctive features. Table 1 summarizes the various site conditions and features.

Results

A total of 237 plant species was encountered on the 10 study sites. To facilitate comparison of species composition between the sites, importance values were calculated for each species. Table 2 lists those species with importance values greater than 5.0 for each site.

Eriogonum fasciculatum was an important component of all 10 sites. *Lepidospartum squamatum* occurred on 9 of the 10 sites. *Salvia apiana* and *Lotus scoparius* were next in importance, occurring in 6 of the 10 sites. *Artemisia californica* occurred on 4 of the 10 sites. Longer-lived, woody species that characterized mature stands (see fig. 2) often had importance values less than 5.0 and are not shown in Table 2.

Most (6) of the sites were composed of all three successional stages, but a few sites had two or only one stage. Lytle Creek lacked mature alluvial scrub, whereas San Sevaine lacked intermediate scrub, and Etiwanda lacked both pioneer and mature stages. Presence and absence of developmental stages reflected various factors such as upstream damming or channelization, time since the last major flood, human disturbances, or soil moisture.

Table 1 - Summary of the Alluvial Scrub Sample Site Conditions and Features (material adapted from Michael Brandman Associates. 1988)

Site	Acreage	Location	Conditions and Features
San Jacinto	2,677	Upper San Jacinto River	Relatively undisturbed except for small sand and gravel operation, golf course downstream; limited water conservation dikes, diversion channels, and percolation basins.
Mentone	11,440	Upper Santa River	Variously disturbed by rock and sand quarries, aqueducts and railways; industrial, commercial, and residential developments; extensive flood control and water conservation facilities
Cajon/ Lytle Creeks (Combined)	17,347	Cajon and Lytle Creeks	Crossed by 2 railroad tracks, old Route 66, and (combined) Interstates 15 and 215. Residential and commercial developments along Route 66 and portions of Cajon and Cable Canyons. Quarrying operations in lower Lytle Creek
San Sevaine/ Etiwanda/Day Canyons	12,531	San Sevaine/ Day Canyon outwash	Large lateral flood control dikes, diversion canals, and percolation basin. Major electric transmission corridor and water treatment plant. New extensive residential developments south and west.
Cucamonga	3,091	Cucamonga Canyon outwash	Flood control structures and percolation basin; small rock quarry. Surrounded by residential developments.
San Antonio	2,318	San Antonio Canyon outwash	Streamflow controlled outwash by dam and large lateral dikes. Two highways cross the site. Quarry operation, small airport and commercial buildings present
San Gabriel	300	San Gabriel Canyon outwash	Streamflow controlled outwash by dams, major lateral dikes, drop structures, and percolation basins. Crossed by Route 66 and Interstate 210. Paved bikeway on east dike. Major quarrying operations. Dam, recreation area, and county natural area downstream.
Big Tujunga	1,587	Big Tujunga Canyon outwash	Natural braided floodplain flanked by hills. Bisected by Interstate 210. Dam, recreation area, and quarrying operation downstream.

Table 2 - Comparison of Species Composition of Ten Alluvial Scrub Stands Using Importance Values Greater Than 5.0*

		Importance Values by Development Stage		
Site	Dominant	Pioneer	Intermediate	Mature
San Jacinto	*Artemisia dracunculus*	7.74	16.77	4.13
	Baccharis glutinosa	16.10	0.82	
	Croton californica	7.13	8.02	
	Ericameria palmeri	4.96		4.25
	Eriodictyon crassifolium		1.75	11.61
	Eriogonum fasciculatum	10.59	31.54	41.17
	Lepidospartum squamatum	35.86	28.84	12.11
	Lycium andersonii	0.94	7.76	7.48
	Opuntia parryi		0.82	7.38
	Rhamnus crocea			9.51
	Salvia apiana		5.38	
Mentone	*Adenostoma fasciculatum*			28.96
	Baccharis glutinosa	8.24		
	Ericameria palmeri		19.50	3.91
	Eriodictyon trichocalyx		17.43	3.63
	Eriogonum fasciculatum	84.35	33.93	16.88
	Lepidospartum squamatum	7.40		
	Yucca whipplei		6.63	1.23
Cajon	*Eriodictyon trichocalyx*	18.20	18.79	12.00
	Eriogonum fasciculatum	51.18	18.87	8.76
	Lepidospartum squamatum		5.98	8.88
	Lotus scoparius	13.10	12.38	7.51
	Opuntia littoralis	4.34	4.69	7.84
	Salvia apiana		5.05	12.18
	Toxicodendron divers / ohm		3.95	8.42
	Yucca whipplei	4.30	12.46	16.74
Lytle Creek	*Artemisia dracunculus*	2.25	16.25	
	Eriodictyon trichocalyx		8.00	
	Eriogonum fasciculatum	63.20	30.98	
	Lepidospartum squamatum	30.19	5.43	
	Lotus scoparius	1.10	5.19	
	Opuntia littoralis	1.08	5.48	
	Opuntia parryi	1.08	7.88	
	Salvia apiana	1.08	6.10	
San Sevaine	*Adenostoma fasciculatum*			9.12
	Artemisia californica	6.28		17.04
	Cercocarpus betuloides	15.05		15.70
	Eriogonum fasciculatum	37.35		25.96
	Lepidospartum squamatum	15.04		7.32
	Lotus scoparius	10.64		1.38
	Salvia apiana	19.40		14.08
Etiwanda	*Croton californica*		7.54	
	Eriogonum fasciculatum		33.48	
	Lotus scoparius		9.06	
	Salvia apiana		43.70	
Cucamonga	*Adenostoma fasciculatum*			6.34
	Artemisia californica	22.69	12.30	23.70
	Eriodictyon trichocalyx		30.70	11.91
	Eriogonum fasciculatum	37.54	21.09	23.19
	Lepidospartum squamatum	30.46	16.65	11.73
	Lotus scoparius		7.47	1.88
	Rhamnus crocea			6.54
San Antonio	*Achillea millefolium*		9.50	8.13
	Artemisia californica		29.67	41.25
	Ericameria pinifolia		10.67	
	Eriogonum fasciculatum		10.09	14.51
	Lepidospartum squamatum		4.91	15.94
	Lotus scoparius		6.69	
	Malosma (=Rhus) laurina			8.13
	Salvia mellifera		12.99	2.22
San Gabriel	*Artemisia californica*		2.12	11.79
	Brickellia californica	8.10		
	Eriogonum fasciculatum		22.76	12.19
	Lepidospartum squamatum	31.43	22.53	13.02
	Opuntia littoralis		17.03	22.07
	Rhus integrifolia.			7.76
Big Tujunga	*Baccharis glutinosa*	29.29		
	Ericameria linearifolia		8.37	5.18
	Ericameria pinifolia	2.41	5.08	
	Eriogonum fasciculatum	33.56	36.39	33.37
	Lepidospartum squamatum	13.89	15.25	9.72
	Opuntia parryi		5.31	2.21
	Ribes aureum	1.36	1.35	5.97
	Salix sp.	4.53		9.85
	Yucca whipplei	3.35	10.48	12.71

*Standard importance values were utilized and divided by 3 to convert them to a base of 100 for convenience.

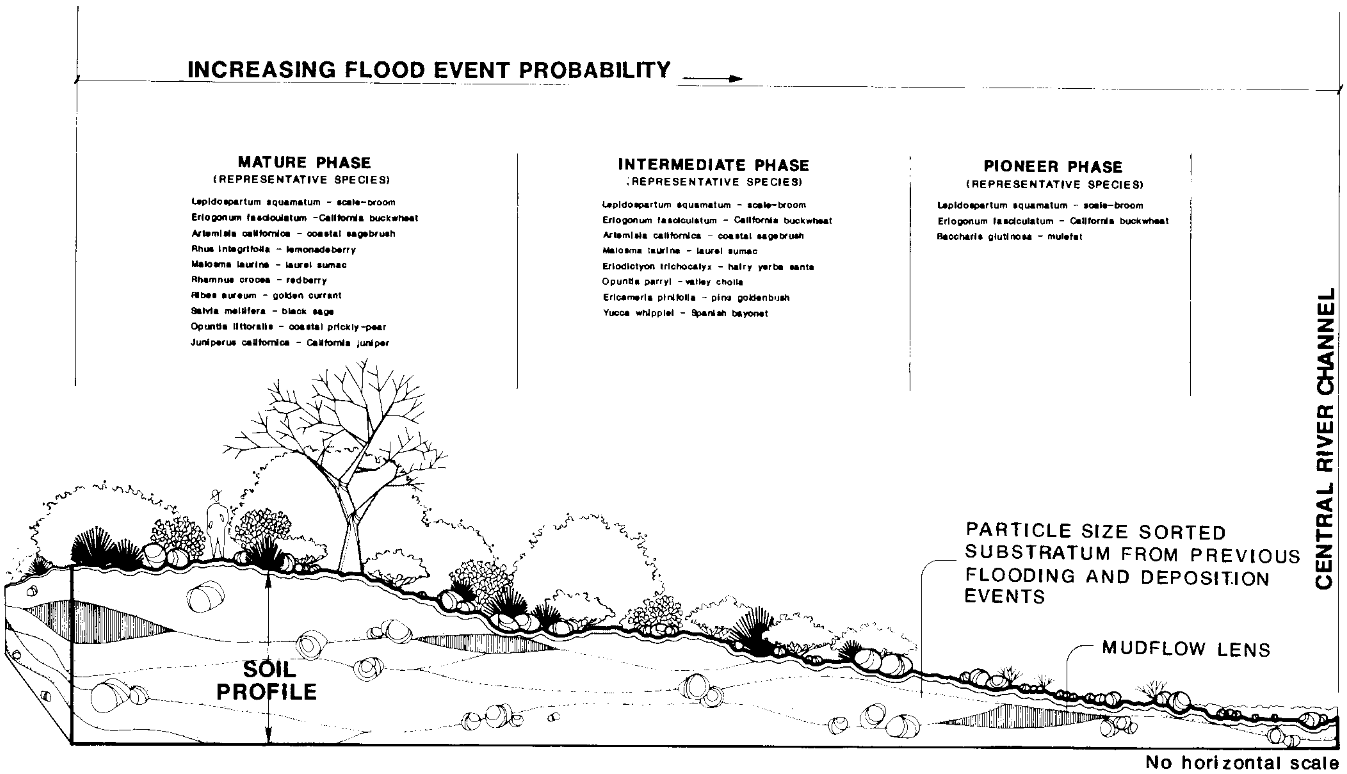

Figure 2– Profile diagram of alluvial scrub vegetation, showing representation of the three phases of development and their representative species.

In order to quantify compositional and structural features of the 3 phases of alluvial scrub at each sample site and to compare the 10 stands, various indices were used: native plant species diversity, percent dominance of the shrub component, and structural diversity of the shrub component (Table 3). These indices were standardized to values between 0.0 and 1.0 against an ideal condition in a manner similar to the Habitat Evaluation Procedure (HEP) developed by the U.S. Fish and Wildlife Service (USFWS 1980). The procedure for establishing and standardizing these indices are currently being documented in a manuscript in preparation by Friesen, Jones, and Keane, and are being referred to as a Habitat Quality Assessment (HQA).

San Jacinto, Cajon, and Big Tujunga sites exhibited the greatest species diversity of 8 sites. Etiwanda showed the smallest species diversity, having neither pioneer nor mature stages.

Cajon and Cucamonga sites had the highest shrub component of 8 sites with San Jacinto and Big Tujung a sites nearly as high. As with species diversity, the Etiwanda site showed the lowest shrub component.

The Cajon and San Gabriel sites exhibited the greatest structural diversity of 8 sites with Etiwanda showing the lowest structural diversity.

Current Status

The distinctive character of alluvial scrub vegetation as it relates to flood-deposited alluvia, makes it one of California's unique riparian systems (fig. 2). The intensity and magnitude of episodic floods creates recognizable vegetation phases that are related to both the age of the stand and to the site conditions of substrate and soil moisture. As a stand develops along a time gradient from pioneer to mature, there is a general trend in species composition replacement from short-lived subshrubs to long-lived woody shrubs. Severe flooding as well as fire and man-caused disturbances can eliminate existing stands of alluvial scrub, and thus initiate new pioneer stands. In contrast, a lack of sufficient soil moisture can prevent an intermediate stage stand from progressing to the mature stage. This condition is best illustrated in the Etiwanda stand. Such intermediate stands may be old in years, but not fully mature in species composition and stature.

Table 3 - Standardized Vegetation Parameters of Ten Alluvial Scrub Sites Based Upon Three Stages of Development

Site	Stage of Development	Species Diversity[1]	Shrub Dominance[2]	Structural Diversity[3]
San Jacinto	Pioneer	1.0	1.0	1.0
	Intermediate	0.8	0.8	0.2
	Mature	0.9	0.8	0.4
Mentone	Pioneer	0.2	1.0	0.0
	Intermediate	1.0	0.8	0.3
	Mature	1.0	0.5	1.0
Cajon	Pioneer	1.0	1.0	1.0
	Intermediate	0.9	1.0	0.8
	Mature	0.9	1.0	0.4
Lytle Creek	Pioneer	0.5	1.0	0.1
	Intermediate			
	Mature			
San Sevaine	Pioneer			
	Intermediate			
	Mature	0.9	1.0	0.4
Etiwanda	Pioneer	NP	NP	NP
	Intermediate			
	Mature			
Cucamonga	Pioneer	0.9	1.0	0.3
	Intermediate	0.7	1.0	0.2
	Mature	1.0	1.0	0.3
San Antonio	Pioneer	NP	NP	NP
	Intermediate	0.9	1.0	0.6
	Mature	0.8	0.6	0.3
San Gabriel	Pioneer	NP	NP	NP
	Intermediate	1.0	0.7	1.0
	Mature	1.0	0.8	1.0
Big Tujunga	Pioneer	1.0	1.0	0.4
	Intermediate	0.8	1.0	0.3
	Mature	1.0	0.7	0.2

[1] Species Diversity = $D = p_i \log_2 p_2$ where: p_i = decimal fraction of total individuals belonging to the ith species

[2] Shrub Dominance = $\frac{\text{total line intercepts of a shrub species}}{\text{total length of all intercepts per stage}} \times 100$

[3] Structural Diversity = ratio of shrubs (greater the 1.0 m tall) to subshrubs (less than 1.0 m tall)

* NP = not present

Alluvial scrub vegetation once was more widely distributed along the coastal washes and rivers emanating from the Transverse and Peninsular Ranges of southern California, where coalescing bajadas formed extensive, and in places nearly continuous, skirts along these ranges. Agricultural and urban developments in the past century have resulted in its elimination from most of its former range. As a consequence, alluvial scrub is isolated to stands along unaltered streams and outwashes on major alluvial fans. Industrial and residential developments and flood control projects continue to invade these remaining stands. A number of large projects, including a professional football stadium and an international-class golf course, are proposed for development within some of the premier examples of this vegetation.

Historically, rock and sand mining operations have quarried large pits within the floodplain alluvium upon which alluvial scrub vegetation depends. As these building materials become scarce in the southland, alluvial scrub resources become more threatened. Proposed flood control projects further threaten the integrity and long-term vitality of this unique floodplain scrub type.

Endangered Species

Two alluvial scrub species are listed as endangered by both the U. S. Fish and Wildlife Service and California Department of Fish and Game (State of California 1988): Santa Ana River woolly-star *(Eriastrum densi-*

folium ssp. sanctorum) is a much-branched subshrub now restricted to sandy soils on river floodplains or terraced alluvial deposits of the upper Santa Ana River drainage, San Bernardino County. These sites mostly are on privately owned and Bureau of Land Management lands. The Corps of Engineers currently is supporting research on the ecology of the woolly-star.

Slender-horned spineflower *(Centrostegia leptoceras)* is a delicate prostrate annual found on fine-textured, flood deposited river terraces and washes in Los Angeles, Riverside and San Bernardino counties. Extant populations are small and seriously threatened. Most occurrences are on private land and are unprotected.

Future Prospects

At present there is no program of conservation that will ensure the future existence of alluvial scrub vegetation. However, the designation of this vegetation by the California Natural Diversity Data Base (1987) as a unique habitat with a high priority for preservation is a worthy first step. Yet, this designation lacks legal power. The presence of the two rare and endangered plant species in some of the alluvial scrub stands brings both state and federal agencies into action in the protection and management of these alluvial scrub endemics. To a limited extent some alluvial scrub stands are the beneficiary of these agencies' actions.

Urban development pressures and flood control structures and practices increasingly will threaten alluvial scrub by direct removal or indirectly by altering the dynamics of its hydrology. Only through the acquisition and management of major stands of alluvial scrub can its future be secured.

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