VEGETATION of the BALDWIN HILLS

Valerie Anderson
Marymount College

ABSTRACT

The Baldwin Hills currently support one of the largest remaining expanses of natural open space in the Los Angeles Basin. Several significant tracts of coastal scrub, a variant of coastal sage scrub, form the dominant natural plant community in the Hills. Field surveys and the examination of high resolution aerial color imagery of the area were used to describe the vegetation associations that currently exist in these natural areas. Such documentation of the existing natural habitats is integral to the efforts of local governments and planning agencies to conserve and restore natural open space in a highly urbanized region with a considerable parkland deficit.

In descending order of extent, the natural vegetation was broadly divided into coastal scrub, grassland, and riparian zones, each with varying degrees of invasion by non-native species. Due to a long history of damaging activities associated with agriculture, industry and urban development, the extent of coastal scrub habitat in the Baldwin Hills has continually declined since the arrival of European settlers. The removal of natural vegetation for residential development and recreational development such as trail establishment and park landscaping continues to encroach on, and further fragment, the remaining coastal scrub in the Baldwin Hills.

Surrounded by urbanization, the native plant communities of the Baldwin Hills are effectively isolated from other communities. Riparian corridors that once connected this area to the nearby Ballona wetlands, the El Segundo dunes, and the upper Ballona watershed have been eliminated by urban development. A combination of the area's isolation, its particular geological makeup, and the unique disturbances that have occurred in the area, create a coastal scrub habitat unlike others.

In the least disturbed sections—canyons on the eastern side of Kenneth Hahn State Recreation Area (KHSRA) and the canyons adjacent to Holy Cross Cemetery—the coastal scrub foundation is strong enough to survive efforts to remove invasive species presently impacting the community. Protecting this small portion of the biological heritage of Los Angeles is a valuable undertaking. Serious efforts to remove the most egregious invasive species and halt additional access into those portions of habitat that have remained inaccessible must be made a priority. Efforts must be made to inform the public of the purpose in limiting additional recreational access. For success in conservation, it is mandatory to cultivate a respect for a habitat that appears to be merely brush, a landscape lacking any inherent value.

Currently, extensive "grassland"-like areas are dominated by exotic annuals such as black mustard, wild radish, and fennel; the extent to which natural grasslands dominated by native perennial grasses existed in the Baldwin Hills prior to human disturbance is uncertain. A natural riparian community is no longer present in the Baldwin Hills. Pockets of "urban runoff" riparian communities are found at a few locations. These exhibit no surface connection with Ballona Creek or the coast. Artificial aquatic and riparian habitats are also located within the KHSRA. However, periodic cleaning, as a part of parkland maintenance, includes the removal of plant and animal species. These routine activities prevent aquatic park features from returning to a more natural collection of locally native riparian species.

INTRODUCTION

The Baldwin Hills, with an area of nearly two square miles, currently host one of the largest areas of natural open space in the Los Angeles Basin. Within the Hills several significant tracts of coastal scrub, a unique southern California vegetation association, remain relatively intact within the Kenneth Hahn State Recreation Area (KHSRA) in the eastern portion of the Hills and along the western boundary in areas adjacent to West Los Angeles College and Holy Cross Cemetery. Using field surveys and high resolution color aerial imagery of the Baldwin Hills this study sought to provide a broad-scale characterization of the state of the natural vegetation presently existing in the Baldwin Hills. This report classifies the current vegetation associations existing in the Hills, presents a checklist of plant species found in areas accessible to this study, and offers recommendations for the preservation and restoration of natural habitats and potential linkages to other tracts of native habitat. Additionally, the report provides insight into the area's historical landscape from the scant published literature and from herbaria databases.

METHODS

Field surveys were undertaken in the year 2000 throughout the accessible areas of the Baldwin Hills. The focus of this field work was the non-landscaped portions of the KHSRA. Field work was also conducted in the undeveloped region behind Holy Cross Cemetery, adjacent to West Los Angeles College, at the top of St. James Drive, near the Southern California Edison power substation located near oil company property west of La Cienega Boulevard, and in the vicinity of Culver City Park. Field studies were performed over an eight-month period during daylight hours on the following days: February 29; March 11, 19, and 25; April 1, 2, 9,19, 24, and 30; May 13, 14, and 23; June 1, 4, 6, and 23; August 4 and 25; and October 2.

During these field surveys I walked along trails extending along the perimeters of, and into, the areas of natural vegetation. Identification of plant species at distant and inaccessible points was sometimes aided by binoculars. To facilitate the mapping of vegetation types in the non-accessible portions of the study area, primarily the oil fields,

high resolution color aerial imagery (1 pixel = 1 foot, AirPhotoUSA, Phoenix, AZ) was obtained of the Baldwin Hills in August 2000 (Fig. 3). The mapping of species association delineation's obtained on the aerial imagery was verified in the field for all areas that were accessible. Appendix 1 lists the plant associations used in mapping the study site.

Attempts were made to determine species presence from the historical record in or near the Baldwin Hills using older literature and herbarium specimens. Present-day dominant species and uncommon or unusual taxa which currently exist in the area, or could have existed there, were checked in the Rancho Santa Ana Botanic Garden Herbarium. Databases for herbaria at the Missouri Botanic Garden and the New York Botanical Garden, available through the Internet, were also checked.

Specimens were collected for identification purposes only; these will be deposited at the Rancho Santa Ana Botanic Garden Herbarium.

HISTORICAL INFORMATION

The native flora of coastal southern California is believed to have once consisted largely of coastal sage scrub and native grasslands (Freudenberger et al. 1987, Mooney 1988, Malanson & O'Leary 1995, Reid & Murphy 1995). These communities form mosaics with other neighboring communities, such as oak woodland and chaparral. The exact community configuration in southern California is hypothesized differently by various researchers. Agreement exists, in any case, that agricultural activities and urbanization eradicated much of the prehistoric vegetation. Estimates of the coastal sage scrub that has been eliminated in southern California as a result of human activities range from 80-90% (Davis et al. 1994, Reid & Murphy 1995).

The species makeup of native grasslands has been permanently changed by human intervention (Freudenberger et al. 1987, Keeley 1989). Annual non-native grasslands are presently one of the major vegetation types in southern California. These may occur where perennial grassland communities were once located or they may have replaced sage scrub communities in conjunction with human activities. Grassland species composition before the late 18th century is only hypothesized. The presence of native species representative of perennial grasslands may or may not be relics of the past flora (Freudenberger, et al. 1987, Keeley 1989). The areas of the Baldwin Hills that exhibit evidence of a grassland community are especially disturbed by many non-native species.

Accounts of early Native American culture may provide insight into the historic landscape in the Baldwin Hills region. The mapping of the exact locations of Native American villages is problematic in the highly disturbed Los Angeles area. Studies do indicate, however, that the Baldwin Hills did not serve as a site for any Gabrielino villages (Johnston 1962, Rios-Bustamante & Castillo 1986). Gabrielinos, the most recent Native American group to reside in most of what is now Los Angeles County prior

to the arrival of the Europeans, lived in both inland and coastal villages. The village site closest to the Baldwin Hills was located along the coast near Ballona Creek. Historians estimate that in 1770, when the Spanish arrived, the entire Gabrielino population from Orange County to Malibu was about 5000 (Johnston 1962). Although O'Leary (1989) suggested that Native Americans may have assisted "post-glacial spread" of coastal sage scrub, it may be that human activities near villages aided in the displacement of coastal sage scrub by grasslands (Freudenberger et al. 1987). Because no villages were located in the Baldwin Hills, it is unlikely that the living practices of this culture had much detrimental effect on the species diversity there.

Historical studies of the way the Native American cultures used local vegetation offer general information about a few of the species or genera that were likely present in and around the Baldwin Hills. Huts used by the Gabrielino culture consisted of a tule (*Scirpus*) or grass thatch over a willow (*Salix*) frame. The Gabrielinos created string and cordage from fibers of yucca (*Yucca*), Indian Hemp (*Apocynum*), milkweed (*Asclepias*), or nettle (*Urtica*). Their identified food items included yucca shoots (*Yucca*), acorn meal (*Quercus*), chia seeds (*Salvia columbariae*), cactus fruits (*Opuntia*), and wild plums (*Prunus* spp.; Johnston 1962). Species from most of these genera are still present in the Baldwin Hills. A few were probably widespread before urban development reduced riparian communities (*Scirpus*, *Apocynum*, *Urtica*). *Yucca* and *Salvia columbariae* were most likely present before grassland/prairie communities were greatly reduced (Mattoni et al. 1997).

It appears that the arrival of European settlers initiated the greatest changes in the vegetation due to extensive sheep grazing in the 1880s and cattle grazing beginning in 1919 (O'Leary 1989; Bartolome 1981, United States Army Corps of Engineers 1981, Ornduff 1974, French 1970). Herbarium specimens verified that few collections had been made in or near the Baldwin Hills until recent surveys (Schreiber 1981, County of Los Angeles1982, and Mattoni 1990). A few specimens from collections made by Le Roy Abrams from 1901–1904 were distributed by the New York Botanic Garden and are part of the basis for *The Flora of Los Angeles and Vicinity* (Abrams 1904). One specimen of *Epilobium canum* (syn. *Zauschneria californica*) distributed by the British Museum Herbarium and collected by George W. Barclay on his arrival to San Pedro on the *H.M.S. Sulphur* in 1839 suggested that earlier collections had been made, but no other parts of Barclay's collection have been located. Due to the scarcity of the historic record, one can determine with only partial accuracy the composition of the flora prior to the discovery of oil in the Baldwin Hills in 1924 and the intense development that followed (U.S. Army Corps of Engineers 1981, French 1970).

By the turn of the 20th century, Abrams' *Flora of Los Angeles and Vicinity* (1904) indicated that many European annual grasses and weeds, such as *Avena fatua, Bromus madritensis* ssp. *rubens*, *Cynodon dactylon*, *Hordeum murinum*, *Medicago polymorpha*, and *Sonchus oleraceus* were "common everywhere." In addition, *Arundo donax* (Giant Reed), *Cortaderia jubata, Cortaderia selloana* (Pampas Grass), and *Centaurea melitensis* (Tocalote) were already reported. These exotic plant species, imported either by accident or intention, proved to be invasive to the native vegetation.

Changes in the flora can be easily observed in the Baldwin Hills, especially where there has been intense industrial activity associated with oil production. Few, if any, native species now occur in some of these highly disturbed areas.

ANALYSIS OF CURRENT FLORA

The major plant association in the Baldwin Hills is coastal scrub, a variant of coastal sage scrub. Annual grassland/prairie and areas of riparian are represented, but to a lesser degree (Fig. 6). Coastal sage scrub of southern California is typically characterized by *Salvia* spp., *Artemisia californica* (California Sagebrush), *Eriogonum fasciculatum* (Buckwheat), *Baccharis pilularis* (Coyote Brush), and *Encelia californica* (Bush Sunflower) (O'Leary 1989, Mooney 1988, Ornduff 1974, Munz 1974). *Artemisia californica*, *Baccharis pilularis*, and *Encelia californica* dominate the coastal sage scrub found in the Baldwin Hills. *Opuntia* X*occidentalis* is locally abundant and *Malosma laurina* (Laurel Sumac) and *Sambucus mexicana* (Elderberry) are scattered within the coastal sage scrub. However in the Baldwin Hills, *Salvia* species and *Eriogonum fasciculatum* are noticeably absent from the coastal scrub areas of KHSRA and most of the undeveloped sites in the hills. Very small stands of these species are present on the west-facing slopes of the Baldwin Hills immediately adjacent to West Los Angeles College and isolated patches of *E. fasciculatum* are located on the west-facing slope north of the park entrance road along La Cienega Blvd. and in the hills near Jefferson Blvd.

Because coastal sage scrub is a highly variable plant community, it is difficult to define. Species characterizing it are often associated with other species in other habitats, such as chaparral (Davis et al. 1994, Reid & Murphy 1995). Many species complexes are distributed throughout southern California with variations in soil composition playing a major role in the variability of species groupings (DeSimone & Burk 1992, Davis et al. 1994). The Baldwin Hills flora reflects a response to the substrate as well as other environmental parameters. *Eriogonum fasciculatum* favors a granitic substrate, for example, while *Encelia californica* thrives in sandstone substrates with high available phospate levels (Westman 1981). Pipkin and Nash (1967) reported that the surface soils of the reservoir area of the Baldwin Hills are composed of a combination of sands, silts, and clays, known as Palos Verdes sand, over a deeper layer of gravels from granite, slate, and siliceous shale. The surface layer of sands probably offers a substrate preferable to *Encelia californica*, one of the dominant species of the coastal sage scrub in this area.

The local flora may also reflect the effects of air pollution with the impact of human development described by O'Leary (1989) and Westman (1990), as well as the impact of fires, such as the blaze in 1985 in the hills near La Brea Avenue north of Stocker (Rasmussen 1994). O'Leary (1989) suggested that historical and biogeographical factors most likely affect low species diversity, but included soil nutrients, topographic diversity, competition among species present, and disturbance events among the factors affecting species richness in coastal sage scrub. The

essential absence of *Salvia* and *Eriogonum* species, therefore, could reflect variations in the soil and topography or one or more significant disturbances. *Salvia* species are particularly sensitive to air pollution due to their high leaf conductance rates (O'Leary 1989). The presence of sulfur dioxide and ozone lead to increased root sprouting by the plant that uses the reserves stored in its root crown (Westman 1990). In this study, Westman demonstrated that there is also an increase in leaf production in the presence of air pollutants, which is followed by increased leaf loss that may lead to an inability of plants to re-establish during times of drought or after fire. Likewise, the loss of scrub canopy frequently leads to growth of non-native herbaceous species including many of the non-native grasses that, in turn, take the place of native perennial grasses (DeSimone & Zedler 1999). The species present in the Baldwin Hills today may be considered representative of a disclimax community (Ornduff 1974, County of Los Angeles 1975), in which native species have been replaced by introduced species, producing an unnatural plant community. However, coastal sage scrub is an extremely variable ecological community with distinct subcommunities expressing variable species associations (DeSimone & Burk 1992, Reid & Murphy 1995). Species composition differs depending on latitude, slope, aspect, soil type, and history of disturbances (Reid & Murphy 1995). The Baldwin Hills flora still exhibits the presence of coastal sage scrub, as a variation of the typical definition of dominant coastal sage scrub species. Although this may be considered an unnatural plant community, it may also demonstrate the unique response to disturbance pressures particular to this area.

Dominant shrub species in the coastal sage scrub utilize basal sprouting as the dominant means of re-vegetation after fire (Keeley & Keeley 1984, Malanson & Westman 1985) and other types of disturbance, such as frost, herbivory, air pollution or bulldozing (Malanson & Westman 1985 Westman 1985). The fire in late winter 1999-2000 on a slope in the northwest section of KHSRA offers the opportunity for a first-hand observation of the regeneration of coastal sage scrub vegetation. The re-sprouting of *Baccharis pilularis* and *Artemisia californica* occurred rapidly. By autumn, some individuals of *B. pilularis* and *A. californica* continued growth along with the aggressive growth of the non-native perennial weed, *Foeniculum vulgare* (Fennel). Rather large stands of *Opuntia* sp. are located particularly on south-facing slopes of the canyons in the Baldwin Hills (Fig. 6). Although the presence of *Opuntia* does not define the coastal sage scrub, it is a dominant member of the community and is frequently present in southern California. It is the hybrid group known as *Opuntia* X*occidentalis* that occurs in this area. Some research indicates that this widespread hybrid in southern California resulted from inbreeding between the native *O.* X*vaseyi* and the spineless species *O. ficus-indica*, which is probably native to Mexico. Historical records indicate that *Opuntia* was present in this area prior to European arrival and that the highly valued, spineless *O. ficus-indica* was traded among native people well in advance of European influence (Benson 1969). More recent studies suggest that *O.* X*occidentalis* resulted from a cross between *O. littoralis* and *O. engelmannii* X *O. phaeacantha* (Hickman 1993).

Many trees used for landscaping near margins of parkland, near oil property roads, or adjacent to structures may be naturalizing in the Baldwin Hills. These include

Aesculus californica (Horse Chestnut), *Washingtonia* sp. (Fan Palm), *Eucalyptus* spp., *Pinus* spp., and *Thuja* sp. (a member of the cypress family). Although some of these species are California natives, they are not native to the Baldwin Hills.

Southern California perennial grassland or prairie is easily characterized in its native state by bunchgrasses, such as *Stipa* spp., and a variety of annual poppies, goldfields, tarweeds, lupines, and others (Keeley 1989). According to Rios-Bustamante and Castillo (1986), the original vegetation on southern faces of the Baldwin Hills was "parklike vegetation," which could be interpreted as grassland. This contrasted to the scrub found on the northern slope faces. Species currently found in the Baldwin Hills, such as *Achyrachaena mollis*, *Lessingia filaginifolia* var. *filaginifolia*, *Lotus purshianus*, *L. salsuginosus*, *Malacothrix saxatilis*, *Nassella pulchra*, and *Sisyrinchium bellum* are among those associated with the native California grasslands or coastal prairie (Mattoni et al. 1997, Keeley 1989) and support the notion that grassland/prairie was a natural habitat in this area. Freudenberger et al. (1987) report that many of the present day grasslands in the greater Los Angeles basin were previously covered by brush. Annual grasslands, therefore, replaced shrubs when disturbances damaged or removed the scrub. Sites in the Baldwin Hills which may have once been covered with scrub or with native grasslands have undergone severe invasion by non-native species. Many of these are the pervasive annual grasses with European origins (*e.g.*, *Avena* spp., *Hordeum* sp., *Bromus* spp.). In addition, *Carpobrotus edulis* (iceplant) has overtaken some of these sites and annual mustards (*Brassica nigra* and *Raphanus sativa*), while beautiful in flower, have widely replaced native species in what may be called the grassland areas.

In the historical record, the vernal pool species, *Epilobium pygmaeum*, *Plagiobotrys trachycarpa*, and *Plantago elongata*, were found in "low places" near Inglewood and Mesmer, at the western foot of the Baldwin Hills (Abrams 1904). Species present in these areas today, such as *Juncus bufonius* (Toad Rush), *Filago californica* (Herba Impia), and *Hemizonia fasciculata* (Tarweed), are found in vernal pool basins, but are often common in other habitats (Mattoni et al. 1997). There is some evidence in the Baldwin Hills terrain today that suggests the possibility of vernal pools, however, no southern California vernal pool indicator species have been found.

Riparian communities once fed by the Ballona and Centinela Creeks naturally occurred in the vicinity of the Baldwin Hills. Discovery of smooth rounded stones during excavation for construction of the Baldwin Hills Village in 1938-1939 supports the belief water flowed through this area (French 1970). Native southern Californian riparian communities consisted of a species-rich, multiple-layered canopy, including well-developed trees such as alders and cottonwoods (Bowler 1989). However, what could currently be called riparian communities in this area may more accurately be termed urban runoff areas, as described by Bowler (1989). Reduced species diversity is expected in an area where laterally flowing water does not rise and fall at least once during the growing season, according to Bowler (1989). This is the state of riparian areas of the Baldwin Hills. The locally dominant species, *Salix lasiolepis* (Arroyo Willow) and *Baccharis salicifolia* (Mule Fat) have a shrubby growth habit. While these

sites are reduced in species diversity and, therefore, habitat diversity, the riparian zones of the Baldwin Hills may still offer habitat for certain faunal species.

It cannot be ignored that the current flora of the Baldwin Hills includes a large number of foreign species used in landscaping around homes, roads, and businesses. Most of these plants do not adapt to the more natural regions of this area. However, several species have adapted or show signs of naturalizing within coastal sage scrub as well as those areas that may have been grassland at one time. These include *Pinus halapensis* (Aleppo Pine), *Carpobrotus edulis (*Hottentot Fig), *Schinus molle* (California Pepper), *Gazania linearis*, *Senecio mikanioides* (German Ivy), *Acacia longifolia* (Golden Wattle), *Eucalyptus sideroxylon* (Red Iron Bark), *Washingtonia* sp. (Fan Palm), and *Cortaderia selloana* (Pampas Grass). Some of these continue to be planted in park picnic areas adjacent to or within areas of more natural vegetation. These, and many other foreign weedy species continue to displace species native to the Baldwin Hills. Among these weedy species are *Bidens pilosa* var. *pilosa* (Beggar Ticks), *Centaurea melitensis* (Tocalote), *Cirsium arvense* (Canadian Thistle), *Cirsium vulgare* (Bull Thistle), *Silybum marianum* (Milk Thistle), *Brassica nigra* (Black Mustard), *Raphanus sativus* (Wild Radish), *Salsola tragus* (Russian Thistle), *Euphorbia crenulata* (Chinese Caps), *Ricinus communis* (Castor Bean), *Nicotiana glauca* (Tree Tobacco), and many species of grasses.

THREATENED OR SENSITIVE SPECIES

As recently as 1995, the U.S. Supreme Court interpreted the federal Endangered Species Act to consider the harm caused to endangered or threatened species by habitat modification (Feldman & Jonas 2000). No threatened or endangered plant species are found in the Baldwin Hills area. However, one could accurately say that it is the coastal sage scrub habitat itself that is threatened. Habitat degradation, fragmentation, and conversion to non-native habitat are the major processes related to human activities affecting habitat loss and biodiversity in California (Feldman & Jonas 2000). DeSimone (1990) suggested the need to protect the full range of coastal sage scrub—once the full range of diversity is identified. DeSimone and Burk (1992) have also indicated a need for more complete description of the variability that is expressed among the species associations of coastal sage scrub.

Davis et al. (1994) examined the coastal sage scrub in southern California in terms of its distribution patterns and its conservation management. They defined coastal sage scrub vegetation as having a tree cover of less than 20%; an evergreen sclerophyll shrub (chaparral) cover of less than 20%; and a soft-leaved, drought deciduous shrub (coastal sage scrub) cover that is more than the sclerophyll cover and at least 20%. The Baldwin Hills coastal scrub fits within this definition of the community combined with features unique to this location, such as the near absence of sage species.

Davis et al. (1994) also identified several species of recognized conservation

concern, one of which is found in the Baldwin Hills—*Juglans californica* (California Walnut); individual California Walnut shrubs were found in the Baldwin Hills during this study, but it is uncertain if they represent remnants of a formerly more widespread woodland.

One population of the succulent species *Dudleya lanceolata* was found growing at the base of and on the face of a sandy bluff in the Baldwin Hills, adjacent to West Los Angeles College. Even though *D. lanceolata* is not generally considered a rare or endangered species, it appears to be very rare in the Baldwin Hills. This species had been previously collected from within the KHSRA (Rancho Santa Ana Botanic Garden, collected by Kelly & Wisura in 1986), but it is no longer present at that location. The habitats of *Dudleya* species are often destroyed by human developments and many species are considered endangered (California Department of Fish and Game 2000). The tender *Dudleya* leaves are susceptible to herbivory (Moran 1978). The local population of *D. lanceolata* may still exist due to its relative inaccessibility.

BIOLOGICAL CONNECTIVITY WITH OTHER REGIONAL NATURAL HABITATS

Dispersal and seedling establishment of most native coastal sage scrub species adjacent to grassland is limited to nearby available substrate, often within an established stand of coastal sage scrub (Freudenberger et al. 1987). Seedlings may be successful when substrate, slope, and drainage meet the preferences of that species (Westman 1981). Generally, few species have a mechanism for traveling great distances to colonize available substrate and may be part of a dispersal system controlled by disturbances (Freudenberger et al. 1987). Colonies of various populations form natural mosaics that can be very stable for decades depending on the type and frequency of disturbance. This also likely reflects species sensitivity to soil, moisture content, slope and aspect of the area (Westman 1981, Freudenberger et al. 1987, DeSimone & Burk 1992).

The soil of the Baldwin Hills has a surface layer of alluvium, composed of a combination of sands, silts, and clays, known as Palos Verdes sand, over a deeper layer of gravels from granite, slate, and siliceous shale. This contrasts to the soils of the Palos Verdes Peninsula, which are derived from marine and non-marine deposits of Palos Verdes sands and gravels over coarse San Pedro sand and calcareous siltstone (Pipkin & Nash 1967). Although the top layer of substrate in both regions is derived from the same geological formation, the local characteristics, such as terracing and the presence of marine fossils in the Palos Verdes Peninsula, create differing substrate for the vegetation growing in each region. This difference in soils leads to a difference in the dominant species composition between the two sites. The major species components of the Baldwin Hills coastal sage scrub are *Baccharis pilularis*, *Artemisia californica*, *Encelia californica*, and *Lotus scoparius*, while on the Palos Verdes Peninsula the dominant species are *Rhus integrifolia*, *Salvia leucophylla*, and *Eriogonum fasciculatum*.

Plant populations in undeveloped regions of the Baldwin Hills differ greatly from those in the Ballona wetlands, El Segundo dunes, and the nearby sea bluffs. Although annuals with generalized living requirements (mostly non-native, European annuals) succeed in each of these habitats, the physical conditions of these habitats differ, leading to the presence of native species with tolerances specific to each location. Thus, in general, estuarine wetlands plants, dune plants, and those tolerant of close proximity to the sea are not found in the Baldwin Hills.

CONSERVATION AND RESTORATION RECOMMENDATIONS

Habitat fragmentation is an important concern for restoration of coastal sage scrub (Davis et al. 1994, Reid & Murphy 1995, Griswold 2000). In their conservation guidelines, Reid and Murphy (1995) suggest that larger blocks of native habitat are preferable. Such blocks of habitat serve to support viable plant and animal populations. Research does not yet quantify necessary size requirements for a viable stand of coastal sage scrub. If particular species of plants or animals have been targeted for conservation, a determination of the minimum requirements must be determined on a species by species basis, according to Davis et al. (1994). Even without specific size minima, it is generally held that less fragmented stands of coastal sage scrub are necessary to protect the native species diversity (Westman 1981, O'Leary 1989, DeSimone & Burk 1992, Alberts et al. 1993, Reid & Murphy 1995). The remaining undeveloped habitat in the Baldwin Hills displays significant fragmentation, especially where easy access to human activities occurs. However, there are areas of coastal scrub, which show little fragmentation and offer a habitat especially worthy of conservation.

Recommendations for the conservation and restoration of native plant associations involve several levels of consideration, depending upon the particular habitat as well as the degree of invasion by non-native species. The first step in restoration could be as straightforward as the repair of park irrigation pipes. These must be leaking constantly to allow the aquatic cattail, *Typha latifolia*, and the nutsedge, *Cyperus odoratus*, which are not coastal sage scrub species, to grow at the top of some drainage sites within the KHSRA. Removal of these artificial water sources would be appropriate to eliminate these species from the scrub community.

Studies have demonstrated that coastal sage scrub species will repopulate disturbed areas with good success and will also colonize the region where grasslands meet coastal sage scrub (DeSimone & Zedler 1999). Factors such as herbivory and seasonal moisture availability affect the success of coastal sage scrub seedlings, but research offers a generally optimistic view of coastal sage scrub restoration. Foreign species have invaded many sections of the Baldwin Hills where disturbances, such as fires, trampling by human activities, or oil development have occurred repeatedly. The reduction or elimination of these types of disturbances and the eradication and control of non-natives are required for successful habitat restoration.

Where drainage from the landscaped park areas into the scrub occurs, a variety of invasive species are present. Some of these species are natural to the habitat, such as *Baccharis salicifolia* (Mule Fat), *Sambucus mexicana* (Elderberry), and *Heteromeles arbutifolia* (Toyon). However, seeds of many invasive species, such as *Cortaderia jubata* and *C. selloana* (Pampas Grass), *Ricinus communis* (Castor Bean), and *Nicotiana glauca* (Tree Tobacco) may be carried into the scrub areas of the park in these natural drainage channels.

The California Native Plant Society (1996) considers *Carpobrotus edulis* (Iceplant), *Cortaderia jubata* and *C. selloana* (Pampas Grass), *Arundo donax* (Giant Reed Grass), and *Senecio mikanioides* (German Ivy) among the most insidious examples of invasive non-native species. These species occur in abundance in the Baldwin Hills. A variety of annual grass species also hold a position on the list of most intrusive exotic species. Each of these species or species associations requires separate considerations for eradication.

Species of the coastal sage scrub are shallow-rooted and exhibit new growth during the fall and winter when rains and surface moisture from fog are available (Mooney 1988). The dense fibrous root systems of *Carpobrotus edulis*, which are concentrated in the upper 50 cm of soil, reduce soil pH, influence nutrient dynamics, and interfere with water uptake by coastal sage scrub species (D'Antonio & Mahall 1991). This study also suggested that plant roots detect and respond to the roots of adjacent plants. Scrub shrub roots were directed downward and required some time before they responded to the increase in water and nutrient availability upon removal of *C. edulis*. Nevertheless, without the removal of this species, a decline in biomass, lifespan, and reproductive output of coastal sage scrub shrubs over time was indicated.

Removal of *Cortaderia* is a particularly difficult challenge. The seriousness of Pampas Grass intrusion has been documented for many years (Cowan 1976, Lippmann 1977, California Native Plant Society 1996). In many locations in the KHSRA and the rest of the Baldwin Hills, removal of this species will offer a great challenge. Nevertheless, many of the dense, near-native coastal scrub slopes could maintain their integrity with removal of Pampas Grass at the interface with landscaped areas. Methods of removal range from digging out each individual plant and seedling to pouring diesel fuel into the crown of the plant (Cowan 1976); this action may lead to additional disturbance of the environment. Once removal is accomplished, native shrubs, such as *Baccharis pilularis* and *Encelia californica*, should be planted in their place along the margins of the landscaping. Such plantings of natives may help contain the foreign landscaping plants and blend smoothly into the existing slope vegetation. Some success has been reported in establishing planted coastal sage scrub in southern California (O'Leary 1989).

Cudney and Hodel (1986) studied herbicide effectiveness for control of *Senecio mikanioides* (German Ivy). They reported superior control following application of a

particular combination of herbicides.[1] Several patches of German Ivy are currently found on slopes on the east side of KHSRA. This plant outgrows and crowds native species in the coastal sage scrub; the ivy's shallow root system also creates serious soil erosion problems (Cudney & Hodel 1986).

The invasion of native vegetation by non-native annual grasses and other annual exotics is a universal problem. Human intrusion usually accompanies or precedes invasion of exotic species, especially in the coastal sage scrub (Freudenberger et al. 1987, D'Antonio & Mahall 1991). While the annual field mustards (*Brassica nigra* and *Raphanus sativus*) may do "no great harm" (California Native Plant Society 2000), their presence indicates that harm has already been done. These and many other exotic plants remove energy from native food chains, impairing the biological stability of the native community (California Native Plant Society 1996). Displacement of native vegetation greatly reduces the amount of suitable habitat available to many animal species. If a coastal sage scrub shrub species is a keystone species for a particular vegetative association, its loss could change the entire community structure (O'Leary, 1989).

Many annual exotic ecosystems become unusually stable in southern California, probably due to the aridity of the climate, which often reflects a proportionally higher number of annuals in a flora (Keeley 1989). Yet these climatic conditions lead to fairly stable soil temperatures that favor growth of soil fungi (Allen et al., 1995). Mycorrhizal fungi develop associations with native scrub species by increasing the availability of soil nutrients and enhancing scrub growth (Allen et al., 1995). Where annual mustards have become dominant, the inoculation of the soil with mycorrhizal fungi discourages the growth of such annuals while promoting the growth of native scrub species (Griswold, 2000).

While working with *Lotus scoparius*—a native species also abundant in the Baldwin Hills—Montalvo and Ellstrand (2000) recommended that genetically and environmentally similar specimens be used for restoration transplantation. Source plants from similar soils, elevation, and climate reduce subtle ecotypic variations and often resulted in more successful transplantations of *L. scoparius*. Such factors are likely to be important for the restoration of other coastal sage scrub species.

Methodologies for the successful removal of the Giant Reed Grass (*Arundo donax*) and of various thistle species (e.g., *Centaurea melitensis*, *Cirsium* spp., *Silybum marianum*) will require additional investigation. While restoration of certain sites of coastal scrub to a near-native state is possible, the restoration of riparian zones may be more complicated. Because such zones in the Baldwin Hills are marginal in extent and complexity, and have lost any natural connections to the remains of Ballona and Centinela creeks, the restoration of natural riparian communities in the Hills seems less likely.

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[1] Triclopyr and the combination of glyphosate and a soil residual application of simazine showed a trend toward superior control of German ivy (Cudney & Hodel 1986).

Community education can be an effective tool in the conservation and protection of native vegetation (United States Department of Interior 1996). Public outreach programs that clearly designate established walking trails and that emphasize the damaging consequences of off-trail intrusions into native vegetation should be initiated to help prevent further incursions of exotic vegetation. The showcasing of individual native species could inform the public about the unique and rapidly declining coastal sage scrub community. Enhancing the community's awareness of the area's dwindling natural habitats will be important in increasing the local appreciation for, and conservation of these natural areas.

Labeled specimens of common native scrub species (e.g., *Artemisia californica*, *Baccharis pilularis*, *Encelia californica*, *Opuntia Xoccidentalis*) with descriptive text about their biotic associations, as well as specimens of less common species, such as *Dudleya lanceolata*, could encourage appreciation and respect of the biota from all visitors to the area.

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Appendix 1. Description of plant associations and habitats found in the Baldwin Hills during ground surveys conducted in 2000. Refer to **Fig. 6** for area locations.

Map Area	Plant Associations And Habitat Explanations
1A	Coastal Scrub – often associated with south-facing slopes. Dominant species: *Artemisia californica*, *Baccharis pilularis*, *Encelia californica*. Scattered *Opuntia* X*occidentalis* may be present. *Salvia* spp. and *Eriogonum fasciculatum* are absent. 1A* - Area burned during study.
1B	Coastal Scrub – often associated with north-facing slopes. Dominant species: As in 1A with addition of scattered to locally abundant *Sambucus mexicana* and *Heteromeles arbutifolia*. *Significant presence of invasive species.
1C	Coastal Sage Scrub – in addition to species present in 1A, *Salvia mellifera* and *Eriogonum fasciculatum* present.
2	*Opuntia* populations – dominant species *Opuntia* X*occidentalis*. Populations may be accompanied by additional species – varies site to site.
3	Annuals – ≥ 90% of species found at these locations are intrusive weedy annuals: *Brassica nigra*, *Raphanus sativus*, *Conium maculatum*, annual grasses.
4	Drainage/Runoff areas – invasive species associated with erosion channels, species presumably carried from landscaped areas, and some species associated with riparian communities: *Cortaderia jubata, C. selloana*, *Baccharis salicifolia*, *Nicotiana glauca*, *Rumex crispus*, *Typha latifolia.*
5	Urban riparian – historically riparian areas which may be greatly influenced by urban runoff. Dominant species: *Salix lasiolepis*, *Baccharis glutinosa*, *Xanthium strumaritum.*
6	Hardpan—seasonal standing water – non-aquatic species which may be associated with seasonal pools. Species may include: *Lupinus bicolor*, *Lotus salsuginosus*, *Lotus pushianus*, *Hemizonia fasciculata, Juncus bufonius*, *Filago californica*, *Achyrachaena mollis.*
7	Grassland/prairie – highly disturbed by invasive annual grasses, *Brassica nigra*, and *Raphanus sativus*. Includes species associated with coastal scrub. Characteristic prairie grass species: *Nassella pulchra*.
8A	Population of note – a native succulent, *Dudleya lanceolata*

8B Habitat of note – near-vertical slope. Site of native fern (*Dryopteris arguta*) population.

9A Highly disturbed – Coastal scrub species present with 50% or more non-native species, such as *Carpobrotus edulis*, conifers, *Eucalyptus* sp., and annual grasses.

9B Highly disturbed – areas in which few or no native species are present, but in which most or all vegetation has apparently not been planted. Common species: *Eucalyptus* spp., *Carpobrotus edulis*, *Washingtonia* sp., *Pinus* spp., *Schinus molle,* weedy annuals.

9C Highly modified/sparsely vegetated – often sites of oil extraction will soils highl disturbed.

10 No on-site visits – areas appear to be highly modified by oil industry.

Appendix 2. Checklist of the vascular plants of the Baldwin Hills.

The following checklist does not include plants used in landscaping Hahn Park or other inhabited areas of the Baldwin Hills unless they are currently naturalizing in the survey region. Taxonomic nomenclature for the flowering plants follows Hickman, James C., The Jepson Manual, 1993)

Plant status/notes key:

N = Native to the Baldwin Hills
I = Introduced to the Baldwin Hills
C = Coastal sage scrub
G = Grassland
R = Riparian/urban riparian plant
Abundant = Species represents a major component of the habitat

		Status	Notes
FERNS			
DRYOPTERIDACEAE			
Dryopteris arguta		N	C; single population inaccessible on vertical wall within Hahn Park
GYMNOSPERMS			
CUPRESSACEAE			
Thuja sp.		I	
Juniperus sp.		I	
PINACEAE			
Pinus halapensis.		I	Invasive; not listed in *The Jepson Manual*
DICOTS			
AIZOACEAE			
Carpobrotus edulis	Hottentot fig, Ice plant	I	Invasive
ANACARDIACEAE			
Malosma laurina	Laurel sumac	N	C; abundant
Rhus ovata	Sugar bush	N	C
Schinus molle	California pepper	I	
Toxicodendron diversilobum	Poison oak	N	C; locally abundant
APIACEAE			
Conium maculatum	Poison hemlock	I	
Foeniculum vulgare	Fennel	I	Invasive
ASCLEPIADACEAE			
Asclepias fascicularis	California milkweed	N	C
Asclepias vestita	Woolly milkweed	N	
ASTERACEAE			
Achillea millefolium	Yarrow	N	
Achyrachaena mollis	Blow-wives	N	C, G

Ageratina adenophora		I	
Ambrosia sp.	Ragweed		
Artemisia californica	California sagebrush	N	C; abundant
Baccharis pilularis	Coyote brush	N	C; abundant
Baccharis salicifolia	Mule fat	N	C, R; abundant
Bellis perennis	English daisy	I	
Bidens pilosa var. *pilosa*	Common beggar-ticks	I	
Centaurea melitensis	Tocalote	I	Invasive
Chamomilla suaveolens	Pineapple weed	I	
Chrysanthemum coronarium	Garland, Crown daisy	I	Invasive
Cirsium arvense	Canada thistle	I	Noxious weed
Cirsium vulgare	Bull thistle	I	Noxious weed
Conyza bonariensis		I	
		N	C
Encelia californica			
Filago californica		N	
Gazania linearis		I	Invasive
Gnaphalium bicolor		N	C
Gnaphalium californicum		N	C
Gnaphalium canescens ssp. *Beneolens*		N	C
Gnaphalium ramosissimum		N	C
Gnaphalium stramineum		N	C
Grindelia camporum var. *bracteosum*	Gumplant	N	
Hemizonia fasciculata	Tarweed	N	C, G
	Telegraph weed	N	
Heterotheca grandiflora			
Lactuca serriola	Prickly lettuce	I	
Lessingia filaginifolia var. *filaginifolia*	California aster	N	C
Malacothrix saxatilis var. *tenuifolia*		N	C
Picris echioides	Bristly ox-tongue	I	
	German ivy	I	Noxious weed
Senecio mikanioides			
Silybum marianum	Milk thistle	I	Noxious weed
Sonchus oleraceus	Common sow thistle	I	Invasive
Stephanomeria virgata		N	C
Taraxacum officinale	Dandelion	I	
Xanthium strumarium	Cocklebur	N	R
BRASSICACEAE			
Brassica nigra	Black mustard	I	Invasive
Hirschfeldia incana		I	
Lobularia maritima	Sweet alyssum	I	
Raphanus sativus	Radish	I	Invasive
CACTACEAE			
Opuntia X occidentalis	Prickly pear cactus	N	C; abundant

CAPRIFOLIACEAE			
Sambucus mexicana	Elderberry	N	C; abundant
CARYOPHYLLACEAE			
Silene gallica		I	
Spergularia villosa		I	
CHENOPODIACEAE			
Chenopodium album	Lamb's quarters	I	
Chenopodium glaucum			
Bassia hyssopifolia		I	
Salsola tragus	Russian thistle	I	
CONVOLVULACEAE			
Calystegia macrostegia ssp. *Intermedia*		N	C
CRASSULACEAE			
Dudleya lanceolata		N	C; single population
CUCURBITACEAE			
Cucurbita foetidissima		N	
Marah macrocarpus	Wild cucumber	N	C
CUSCUTACEAE			
Cuscuta californica	Dodder	N	C; found in one location near La Brea Blvd.
EUPHORBIACEAE			
Chamaesyce albomarginata	Rattlesnake weed	N	
Chamaesyce maculata		I	
Eremocarpus setigerus	Doveweed	N	C, G
Euphorbia crenulata	Chinese caps	N	
Ricinis communis	Castor bean	I	Invasive
FABACEAE			
Acacia longifolia	Golden wattle	I	
Astragalus curtipes		N	C, G
Lotus corniculatus	Birdfoot trefoil	N	C
Lotus purshianus		N	C
Lotus salsuginosus		N	C
Lotus scoparius	California broom	N	C; abundant
Lupinus bicolor	Miniature lupine	N	C
Lupinus longifolius		N	C
Lupinus succulentus	Arroyo lupine	N	C
Medicago polymorpha	California burclover	I	Invasive
Mellilotus alba	White sweetclover	I	
Mellilotus indica	Yellow sweetclover	I	
Spartium junceum	Spanish broom	I	Invasive

Trifolium albopurpureum var. *albopurpureum*		N	Disturbed sites
Trifolium depauperatum var. truncatum			
Trifolium repens	White clover	I	Common in lawns
Vicia benghalensis	Purple vetch	I	
FAGACEAE			
Quercus dumosa	Scrub oak	N	C
GERANIACEAE			
Erodium botrys	Storksbill, Filaree	I	
Erodium cicutarium	Storksbill, Filaree	I	
Geranium retrorsum	Geranium	I	
HYDROPHYLLACEAE			
Phacelia cicutaria var. *hispida*		N	
JUGLANDACEAE			
Juglans californica	California walnut	N	
LAMIACEAE			
Marrubium vulgare	Horehound	I	
Prunella vulgaris var. *vulgaris*	Self-heal	I	
Salvia mellifera	Black sage	N	C; very uncommon in the Baldwin Hills
MALVACEAE			
Malva parviflora	Cheeseweed	I	
MYOPORACEAE			
Myoporum laetum		I	
MYRTACEAE			
Eucalyptus sideroxylon	Red iron bark	I	
NYCTAGINACEAE			
Mirabilis californica	Wishbone bush	N	C; sensitive to oxidant pollutants (Westman, 1981)
ONAGRACEAE			
Epilobium ciliatum ssp. *ciliatum*		N	
Epilobium canum	California fuchsia; Zauschneria	N	C
PAPAVERACEAE			
Eschscholzia californica	California poppy	N	C, G
PLANTAGINACEAE			
Plantago lanceolata	Plantain	I	
PLATANACEAE			
Platanus racemosa	Western sycamore	N	

PLUMBAGINACEAE			
Limonium sinuatum	Sea lavender	I	
Plumbago auriculata	Cape plumbago	I	Not listed in *The Jepson Manual*
POLYGONACEAE			
Chorizanthe staticoides	Turkish rugging		
Eriogonum fasciculatum	California buckwheat	N	C; few populations present
Polygonum arenastrum	Common knotweed	I	
Rumex crispus	Curly dock	I	
PORTULACACEAE			
Portulaca oleracea	Common purslane	I	
PRIMULACEAE			
Anagallis arvensis	Scarlet pimpernel	I	
ROSACEAE			
Heteromeles arbutifolia	Toyon	N	C; abundant
Prunus ilicifolia ssp. *ilicifolia*	Holly-leafed cherry	N	C
Prunus ilicifolia ssp. *lyonii*	Catalina cherry	N	C
Rosa californica	California rose	N	May be introduced
RUBIACEAE			
Galium angustifolium ssp. *angustifolium*	Narrow-leaved bedstraw	N	
SALICACEAE			
Salix lasiolepis	Arroyo willow	N	R; abundant
SCROPHULARIACEAE			
Mimulus aurantiacus	Monkeyflower	N	C
Verbascum blattaria	Moth mullein	I	
SOLANACEAE			
Datura wrightii	Jimson weed	N	G
Nicotiana glauca	Tree tobacco	I	Invasive
Solanum douglasii	Nightshade	N	C
Solanum elaeagnifolium	White horse-nettle	I	
TROPAEOLACEAE			
Tropaeolum majus	Nasturtium	I	Invasive
VERBENACEAE			
Lantana montevidensis		I	
Verbena lasiostachys		N	
ZYGOPHYLLACEAE			
Tribulus terrestris	Puncture vine	I	

MONOCOTS

ARECACEAE			
Washingtonia sp.	Fan palm	I	
CYPERACEAE			
Cyperus odoratus	Nutsedge	N	R
IRIDACEAE			
Sisyrinchium bellum	Blue-eyed grass	N	C, G
JUNCACEAE			
Juncus bufonius	Toad rush	N	G
LILIACEAE			
Dichelostemma capitatum	Blue dicks	N	C, G
Narcissus sp.		I	Not listed in *The Jepson Manual*
Yucca elephantipes		I	Introduced Mexican cultivated species, widespread in Baldwin Hills, not listed in *The Jepson Manual*
POACEAE			
Arundo donax	Giant reed	I	Noxious weed
Avena barbata	Slender wild oat	I	
Avena fatua	Wild oat	I	
Bromus madritensis ssp. *rubens*	Foxtail chess	I	Invasive
Bromus tectorum	Cheat grass	I	
Cortaderia jubata		I	Noxious weed
Cortaderia selloana	Pampas grass		Noxious weed
Cynodon dactylon	Bermuda grass	I	Invasive
Dactylis glomerata	Orchard grass	I	
Digitaria sanguinalis		I	
Elymus glaucus	Blue Wildrye	I	Invasive
Hordeum murinum	Barley	I	Invasive
Melica imperfecta		N	C
Nassella pulchra	Purple needle grass	N	G
Paspalum dilatatum	Dallis grass	I	
Pennisetum setaceum		I	Invasive
Piptatherum miliaceum	Smilo grass	I	Invasive
Schismus barbatus		I	Thrives in high oxidant pollutant levels (Westman, 1981)
Vulpia microstachys var. *pauciflora*		N	
TYPHACEAE			
Typha latifolia	Cattail	N	R

Appendix 3. Checklist Of Selected Landscape Plants

The following plants have been planted in the Kenneth Hahn State Recreation Area or near other sites of near-endemic vegetation. Some of these plants are native to California, but are not endemic to the Baldwin Hills (CN). Others are exotic species (E).

		Status
Aesculus californica	Horse chestnut	CN
Alnus sp.	Alder	CN
Casuarina sp.	Beefwood	E
Ceanothus sp.	California lilac	CN
Cedrus deodara	Deodar cedar	E
Cercis occidentalis	Western redbud	CN
Cistus sp.	Rockrose	CN
Fremontodendron californicum	Flannelbush	CN
Liquidambar sp.	Sweet gum	E
Pinus radiata	Monterey pine	CN
Platanus	Western sycamore	CN
Prunus sp.		CN, E
Pyracantha sp.	Firethorn	E
Rhus ovata	Sugar bush	CN
Quercus lobata	Valley oak	CN