Chapter 2. Vegetation of the Baldwin Hills

Travis Longcore and Nina Noujdina
University of Southern California, School of Architecture and Spatial Sciences Institute

Introduction

The Los Angeles Basin is bisected by the Santa Monica Mountains, which separate the San Fernando Valley from the large coastal plain extending from Santa Monica southward to Orange County. The only topographic features of note in this wide zone, encircled by other coastal mountain ranges (the Puente-Chino Hills), are the Palos Verdes Peninsula and a series of hills stretching from Newport in the south to the Baldwin Hills in the north (Figure 2-1). These hills are the result of an earthquake zone, the Newport-Inglewood fault, which has been the site of extensive exploration and extraction of oil over the past 100 years (Byrne et al. 2007). Because of its origin in the geological past and the dynamics of the Los Angeles River over time, the Baldwin Hills have been a site of relative ecological isolation as a plant and animal community — and island surrounded in part by wetlands (Dark et al. 2011) and in part by the sloping alluvial fan and floodplain of the Los Angeles River.

This island, rising slightly over 500 feet above sea level, has a long and interesting history. It was apparently not the site of any permanent camps by Native American people, with such locations being concentrated closer to the ocean in the Ballona Valley (Stoll et al. 2009). It was, however, grazed extensively during the Rancho period and eventually by Lucky Baldwin's ranch at the turn of the 20th Century. Baldwin purchased close to 4,500 acres of the Rancho Cienega O'Pasa de la Tijera in the 1880s (Byrne et al. 2007) and used the land almost exclusively for grazing. Oil was discovered in Los Angeles in 1892; exploration of the Baldwin Hills started in 1916 (Byrne et al. 2007). In 1924 explorations proved successful and extraction of hydrocarbons from the Baldwin Hills continues to this day.

The Baldwin Hills were used as the site of the Olympic Village in 1932 and as a location for a water reservoir that failed in 1963, killing 5 and causing $12 million in property damage (Byrne et al. 2007). This failure was attributed to tectonic activity and subsidence associated with oil field operations and two oil companies settled with the City of Los Angeles to handle claims from the disaster. It was in this context that in 1966 then-County Supervisor Kenneth Hahn saw the potential for a park in the vicinity of the former reservoir and set into motion the actions that would result in accumulation of parkland in the Baldwin Hills over decades to follow.

Surveys of the natural resources of the Baldwin Hills, especially the vegetation, were essentially nonexistent until the County efforts to plan for the new park. At that time in the late 1970s the

Longcore, T. and N. Noujdina. 2016. Vegetation of the Baldwin Hills. Pp. 6–38 in *Urban Biodiversity Assessment: Baldwin Hills Biota Update* (T. Longcore, ed.). Los Angeles: University of Southern California for Baldwin Hills Conservancy (Proposition 84) and Baldwin Hills Regional Conservation Authority (Proposition A).

County undertook a multi-year effort to describe the natural features of the hills and their history to plan the future for the land that would become "Baldwin Hills Park." The vegetation mapping was a modest effort, with more attention paid to developing a plant list and quantifying relative cover of plants at different areas within the hills (Marqua 1978), and on detailed description of the distribution of different plant associations. Subsequent mapping efforts were undertaken for studies that would launch the Baldwin Hills Conservancy (Anderson 2001), to support a Community Standards District for the oilfield operations (Marine Research Specialists 2008), and associated with environmental review for the Parks to Playa trail system (BonTerra Consulting 2013). Together, these efforts represent a baseline for vegetation in the Baldwin Hills. The current management area for the Baldwin Hills Conservancy, however, includes a greater geographic footprint than any of the previous mapping efforts and although most of the undeveloped (or industrial use) areas have been mapped at one time, no map with the same mapping standards and classifications for the entire territory has been made. This report documents the production of a map of vegetation types that covers the entire territory of the Baldwin Hills Conservancy using a standard methodology that incorporates high-resolution aerial photography over the entire territory.

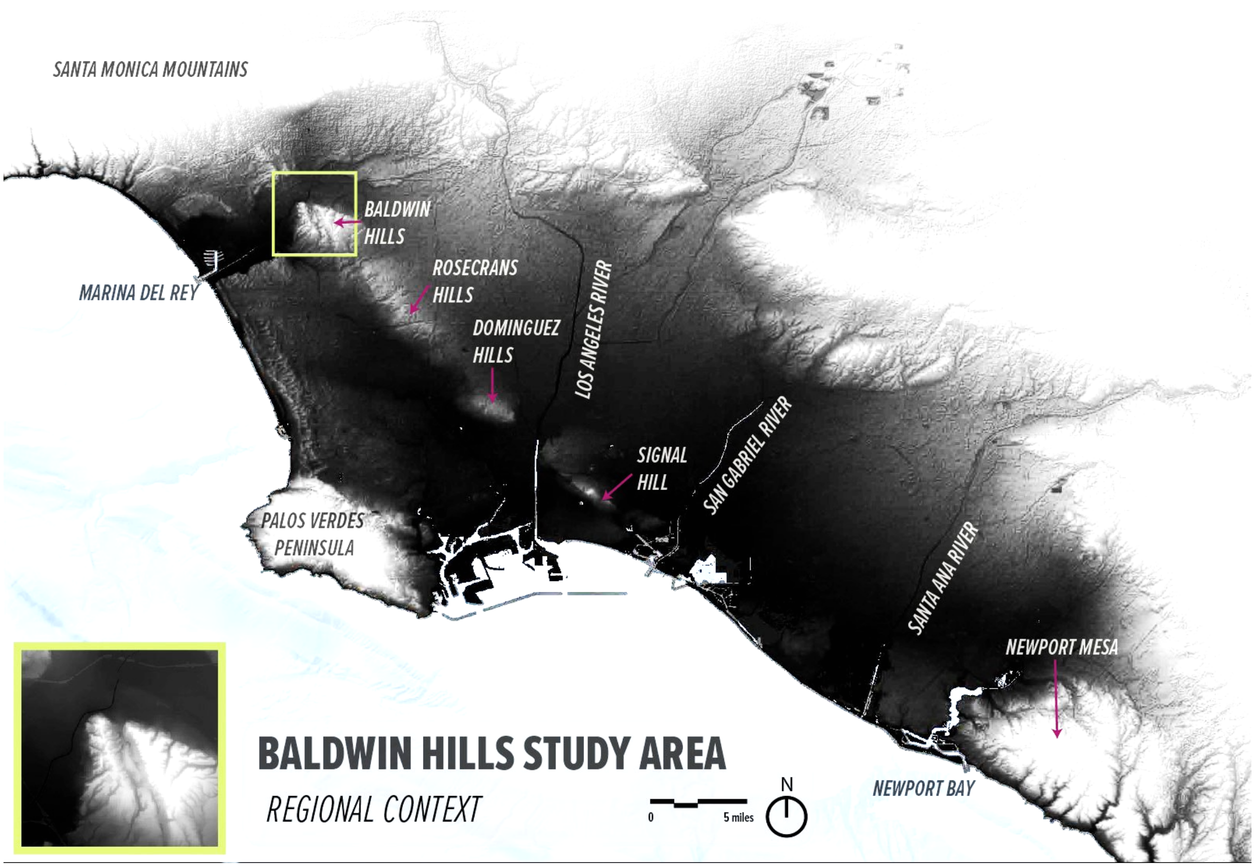

Figure 2-1. Location of Baldwin Hills within the context of the Los Angeles Coastal Plain.

Vegetation Classification

Mapping vegetation over large areas in the 21st century usually relies on high-resolution images from airborne sensors, either flown in planes or satellites and more recently on small unmanned aerial vehicles (Anderson & Gaston 2013). Many mathematical techniques are available to classify such images, including spectral clustering, expert systems, neural networks, and decision tree classifiers (Homer et al. 2004).

Table 2-1. National Vegetation Classification Standard hierarchy (Federal Geographic Data Committee 2008).

Hierarchy for Natural Vegetation	Example
Upper Levels	
1 – Formation Class	Scientific Name: Mesomorphic Shrub and Herb Vegetation Colloquial Name: Shrubland and Grassland
2 – Formation Subclass	Scientific Name: Temperate and Boreal Shrub and Herb Vegetation Colloquial Name: Temperate and Boreal Shrubland and Grassland
3 – Formation	Scientific Name: Temperate Shrub and Herb Vegetation Colloquial Name: Temperate Shrubland and Grassland
Mid Levels	
4 – Division	Scientific Name: *Andropogon – Stipa – Bouteloua* Grassland & Shrubland Division Colloquial Name: North American Great Plains Grassland & Shrubland
5 – Macrogroup	Scientific Name: *Andropogon gerardii – Schizachyrium scoparium – Sorghastrum nutans* Grassland & Shrubland Macrogroup Colloquial Name: Great Plains Tall Grassland & Shrubland
6 – Group	Scientific Name: *Andropogon gerardii – Sporobolus heterolepis* Grassland Group Colloquial Name: Great Plains Mesic Tallgrass Prairie
Lower Levels	
7 – Alliance	Scientific Name: *Andropogon gerardii* – (*Calamagrostis canadensis – Panicum virgatum*) Herbaceous Alliance Colloquial Name: Wet-mesic Tallgrass Prairie
8 – Association	Scientific Name: *Andropogon gerardii – Panicum virgatum – Helianthus grosseserratus* Herbaceous Vegetation Colloquial Name: Central Wet-mesic Tallgrass Prairie

Modern vegetation classification involves a hierarchical approach in which categories are mutually exclusive and the organization allows aggregation of mutually exclusive finer-resolution classification into broader and broader classifications (Federal Geographic Data Committee 2008). The higher-level classifications are based on the structure and growth form of the dominant vegetation (tree, grass, shrub) with floristic characteristics such as the dominant plant species introduced at lower levels of the hierarchy (Table 2-1). Floristic information is found in the Alliances and Associations, with the finest scale classification requiring detailed information about coherent stands of vegetation and their species composition to classify properly. If a researcher lacks this information, however, the vegetation can still be mapped at a higher classification in the hierarchy. For example, in this study, vegetation is classified to the Alliance level with identification of the diagnostic dominant species in the uppermost stratum.

Segmentation and Classification Approaches

Classification of aerial or satellite imagery to define units on the ground is the focus of the field of remote sensing. One approach to classifying vegetation in an image is to use the spectral characteristics of color and infrared bands that may be present in the sensor and use those characteristics to describe the features on the ground in a pixel-by-pixel approach (Xie et al. 2008). An alternative approach is to analyze the images in a way that pixels are related to their surroundings and to apply algorithms that attempt to identify "objects" made up of adjacent pixels that share similarities and are different from those around them (Blaschke 2010). This approach builds on a long history of image segmentation and classification in remote sensing (Blaschke 2010). Segmentation is the activity of dividing an image up into coherent units based on the spectral characteristics and geographic configuration of pixels, while classification involves interpreting what those units represent on the ground. The segmentation process produces candidates for definition into a vegetation class, while the classification process provides those categories and accepts or rejects the candidate objects as defined through the image segmentation algorithms (Burnett & Blaschke 2003). This approach outperforms per-pixel classification approaches and can be further improved through incorporation of height measured through LiDAR (Yan et al. 2015).

Previous Vegetation Maps

The 1978 vegetation map identifies two types of coastal sage scrub, dominated by coyote brush or sagebrush, elderberry, prickly-pear cactus, and riparian associations as native vegetation(Marqua 1978). Most of the land was mapped as "low annual growth" or "little or no plant cover." Some limited area supported eucalyptus. The map did not include most of the lands associated with the Holy Cross Cemetery or the Stocker Corridor.

Anderson (2001) undertook extensive field visits to create a map for an overall biota report on the Baldwin Hills. The oil fields were not mapped and the Stocker Corridor was not included. The vegetation classifications included coastal scrub (north-facing and south-facing), coastal sage scrub, prickly-pear populations, annuals two categories of disturbed vegetation, hardpan/seasonal standing water, urban riparian, drainage/runoff areas, grassland/prairie, highly modified/sparsely vegetated, and both habitat and populations of note.

The Community Standards District mapping was restricted to the oil field area and mapped coastal scrub/disturbed coastal scrub, coyote brush scrub/disturbed coyote brush scrub, riparian scrub/disturbed riparian scrub, willows, cottonwood, sycamore, and a range of other nonnative vegetation types (Marine Research Specialists 2008).

The environmental documentation for the Park to Playa trail system includes another map of vegetation of a subset of the Baldwin Hills Conservancy territory, extending along the northern portion of the area with a focus on the publicly owned parcels (BonTerra Consulting 2013). The vegetation classifications for this map included annual brome grasslands, California sagebrush, California buckwheat scrub, coast live oak woodland, elderberry scrub, giant wild rye grassland, ornamental, ruderal, eucalyptus grove, toyon chaparral, and willow thickets.

Methods

The purpose of producing the map is to provide a replicable approach to mapping all of the Baldwin Hills using the same classification scheme in a manner that can be applied to properties to which on-the-ground access is not available. To do so we used ortho-imagery as the primary source to segment and classify the study area. The dataset was provided by the Los Angeles Region Imagery Acquisition Consortium (LAR-IAC) and Infotech Enterprises America, Inc. We did not set a minimum mapping unit, but rather relied on automated clustering algorithm and subsequent editing through air photo interpretation to exhaustively map the study area. The aerial photography did not have an infrared band, which could have been obtained using satellite imagery, but the 4-inch spatial resolution of the data was an advantage that outweighed the lack of infrared data that otherwise might have provided information about the chlorophyll content of the ground substrate and be used to classify vegetation.

Study Area

The study area is the official boundaries of the Baldwin Hills Conservancy territory, as defined in a shapefile provided by the agency. It consists of the undeveloped portions of the Baldwin Hills, the Inglewood Oil Field, several parks, and an extent along Ballona Creek that encompasses the channel upstream and downstream from the closest point to the Baldwin Hills at the Baldwin Hills Scenic Overlook. To help understand the vegetation surrounding the Ballona Creek, we buffered this area by 100 feet and classified the vegetation within this buffer as well.

Plant Species List

We developed a list of plant species that have been observed or collected in the Baldwin Hills. This list was compiled from previous reports on the vegetation of the Baldwin Hills (Anderson 2001; Cardno ENTRIX & ENVIRON 2014; Marine Research Specialists 2008; Marqua 1978) and complemented by herbarium data. We obtained herbarium specimen records for Los Angeles County from the online records maintained by the Jepson Online Interchange (http://ucjeps.berkeley.edu/interchange.html). This database includes records from the Consortium of California Herbaria (http://ucjeps.berkeley.edu/consortium/participants.html). The online service does not allow bulk downloads so requested the data, including "habitat notes" from the herbarium labels directly from the site manager. We imported this dataset into Excel and searched for all records with place names in the Baldwin Hills.

Classification System

We used the plant alliances from *A Manual of California Vegetation* (Sawyer et al. 2009) as the classification system. This approach is consistent with the National Vegetation Classification System (Jennings et al. 2009). We tailored the classification system to the Baldwin Hills area by developing a list of additional alliances and adding them to the classification scheme. These additional alliances described areas where exotic species dominated or co-dominated plant communities. Because alliances are described based on the tallest dominant vegetation, this approach was appropriate for use with aerial photography. The understory floristic details were available from previous mapping and plant collection efforts.

Data Sources

We used the Color Orthophotography (Los Angeles County GIS Data Portal http://egis3.lacounty.gov/dataportal/) as the main source for deriving vegetated land cover. This dataset is a natural color, leaf-off, high-resolution (4-inch and 1-foot), high-accuracy orthorectified aerial imagery, acquired during winter 2010/2011. In addition, we used datasets derived from the LAR-IAC 2006 initiative: tree canopy raster data, Normalized Difference Vegetation Index (NDVI), and buildings footprints. Parcel geometry was obtained from the Los Angeles County Office of the Assessor.

NDVI is one of the most common spectral ratio indexes that are used in remote sensing field to characterize vegetation life stage and overall health. The process of photosynthesis — conversion of light to chemical energy with the release of oxygen as a side-product — is kept by the absorption of Sun energy in the visible to near-infrared (NIR) region of the spectrum. At the same time, energy of NIR region is reflected more strongly than that of the visible portion. The amount of chlorophyll contained in a plant's cell, as well as the inner structure of the plant tissue influence the proportion of absorbed and reflected solar radiation in the whole visible–near-infrared region. Analysis of the absorption/reflectance spectra reveals information about the nature, structure, and composition of vegetation substrate.

Field Data

The data were collected during fourteen site visits during fall 2014 and spring 2015 using Trimble GPS unit and ESRI Collector for GIS App. We used ProXH Trimble GPS unit to document the location of observations of vegetation that could be observed from publicly accessible roads and trails but were not open to the public. The GPS unit was equipped with TerraSync software and was configured to accept a Laser Rangerfinder with Compass to correct for the offsets between the location of the observer and the location of an observation. Each plot was recorded using detailed Data Dictionary with attached photographs.

Most data were collected using ESRI Collector for GIS. This tool is built from a template (available at www.arcgis.com), configured to meet the needs of a specific project, and downloaded to a mobile device. The data are recorded into the domain geodatabase using drop down lists, and are automatically logged with the current location and time. The application offers such capabilities as finding features and capturing photos and videos, and allows working on-line or off-line.

We used other vegetation data available from previous surveys to cross-check our results. More specifically, locations of invasive species (as mapped in 2011 in a project led by the nonprofit organization Generation Water), invasive plants polygons (Cardno ENTRIX & ENVIRON 2014), and plant associations and habitats (Marine Research Specialists 2008; Molina 2001).

Map Production

We pursued an iterative classification approach that started with two land cover classes: "Vegetated" and "Unvegetated", and followed with further separation of "Vegetated" class into first, vegetation life forms defined by height (i.e., "Trees and Tall Shrubs", "Shrubs / Scrub / Thickets" of intermediate height, and "Grass"), and then into vegetation species alliances. As classification scheme narrowed, the approach gradually shifted from automatic to manual, more heavily relying on aerial interpretation of the land cover (Figure 2-2).

We built a template in the form of a GIS shapefile that could be filled with vegetation information and excluded unvegetated areas from further analysis. A one-foot resolution color image mosaic was segmented using IDRISI Selva software. Segmentation results served as a template for vegetation classification. An iso-cluster unsupervised classification algorithm was applied to the image. Iso-cluster unsupervised classification is an iterative procedure that does not require *a priori* knowledge of the study area. It clusters pixels around class means that are distributed evenly in data space, recalculates class mean and standard deviation in each iteration, and reclassifies pixels accordingly. We calculated iso-clusters with 2 and 5 classes using color bands, 5 classes using NDVI 2006 data, and 5 classes using a composite file that had color bands from 2011 and NDVI from 2006. The resultant class values for each classification raster were summarized within the segments using majority statistics (ArcGIS Zonal Statistics tool). In addition, we included the trees dataset derived from LAR-IAC 2006 data (Figure 2-3). Segments that did not match values from either classification raster were visually examined against the 4-inch resolution aerial photography and defined. The shape and size of polygons was examined and altered to better match or generalize vegetation patterns. This resulted in the Level 1 classification: "Vegetated" and "Unvegetated".

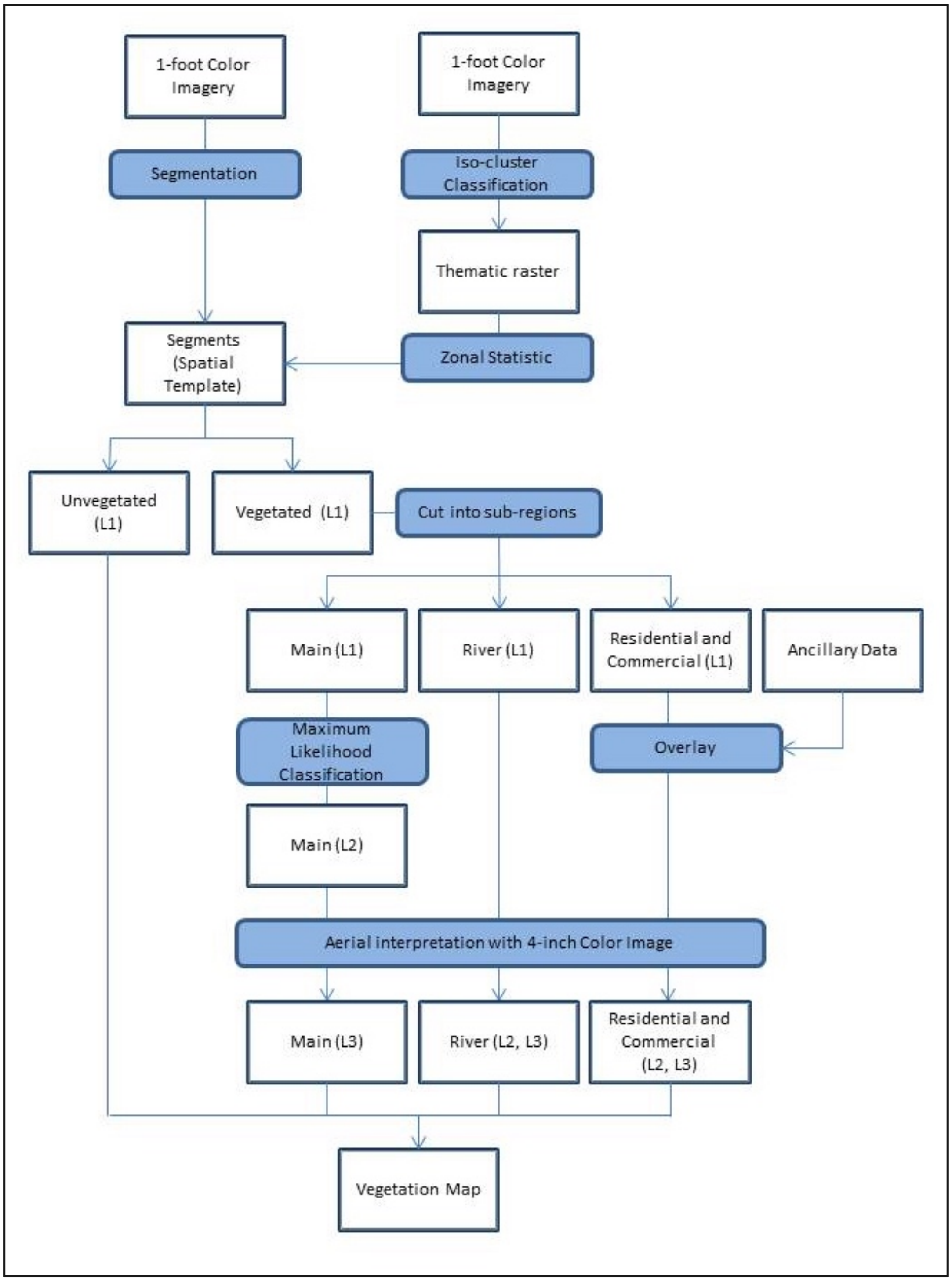

Figure 2-2. Generalized work flow to produce vegetation map.

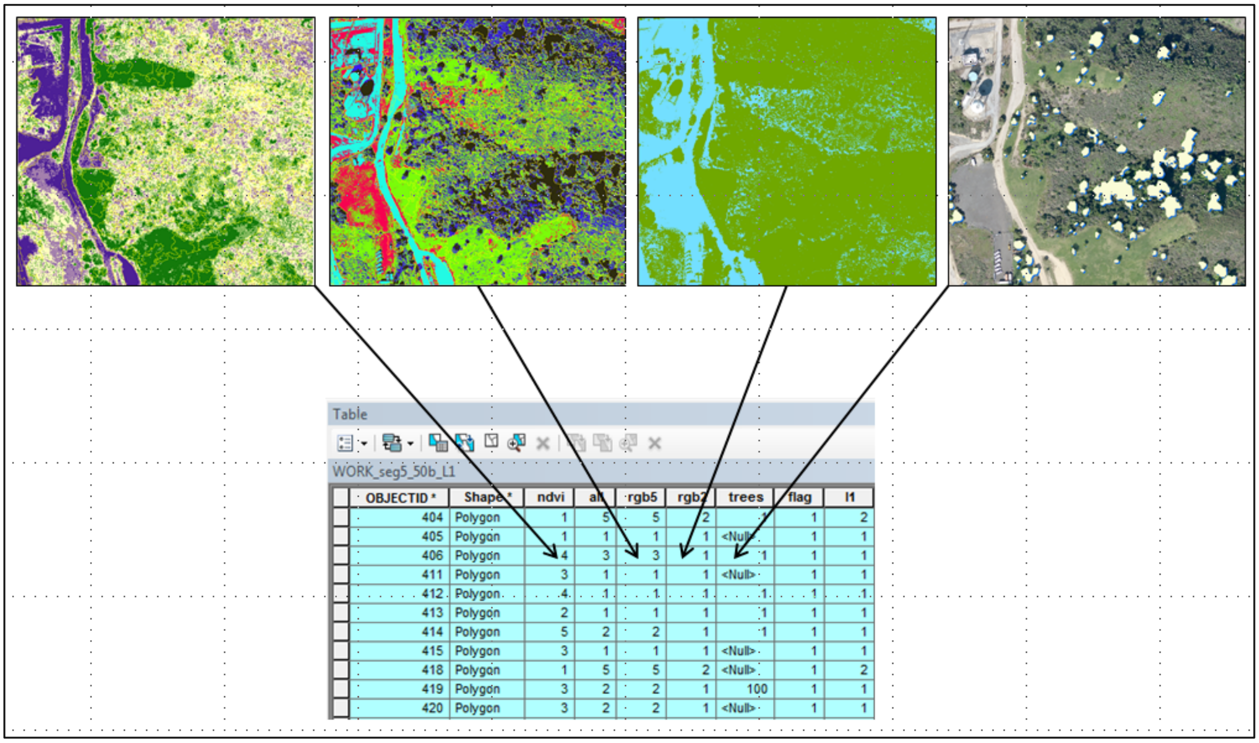

Figure 2-3. Example of data sources used for vegetation classification.

We decided not to exclude the non-vegetated class from further analysis, but rather to use it to increase confidence in the classifications. We then divided the study area into several sub-regions (Figure 2-4) and proceeded with each section separately.

The Maximum Likelihood classification method was used to discriminate vegetation life forms in the "Vegetated" part of the "Main" sub-region of the study area and to cross-check the results of the first level classification. Unlike iso-cluster algorithm, maximum likelihood classifier requires training data; it assumes that the statistics for each class in each band are normal, computes probability of class membership for each pixel, and distributes pixels among classes based on highest probability. The training set for the whole area contained following classes: Asphalt, Grass, Shrubs, Trees, Soil, and Man-made. The training set for the vegetated part of the study area had Grass, Shrubs, Trees, Dry Vegetation, and Bare Land classes. The training sites for each class were spread throughout the area to encompass spectral variation due to terrain ruggedness. The results were then examined, reclassified, and smoothed with the ArcGIS Majority filter. The spatial template was then populated with the smoothed classification results, examined, and edited where needed. The Level 2 classification of vegetation has the following classes: 1 - Trees and Tall Shrubs, 2 - Shrubs / Scrub / Thickets, 3 – Grass. In this step, Level 1 classification and polygons were edited where needed as well.

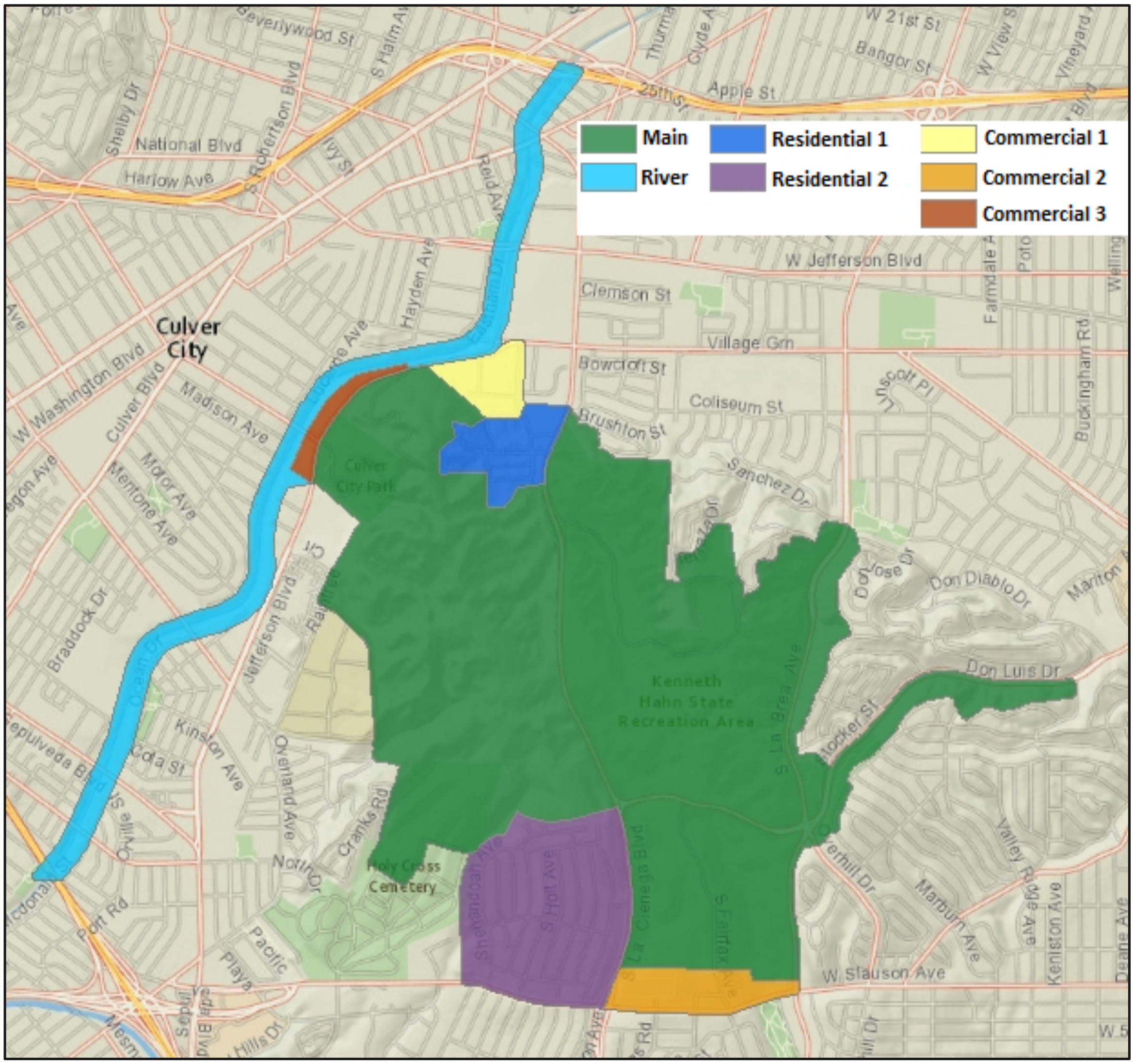

Figure 2-4. Subareas used to produce vegetation map. The "main" area includes several different land uses, including protected open space, industrial land (oil field), recreational areas, and a cemetery.

The Main and the River parts of the study area were further classified into Level 3 vegetation alliances, using newly and previously collected data and aerial photo interpretation.

The two residential and three commercial subsets were mapped by overlaying existing GIS layers: parcels, building footprints and trees. The Roads layer was built by using 12-feet inward buffer on the Parcels layer; the original Trees layer was available in a raster format with pixel values corresponding to trees and shadows. Pixels with values corresponding to "trees" were converted to vector format, buffered with 2-feet distance and simplified in ArcGIS software. The area other than roads, buildings and trees was masked out and subjected to image classification to define vegetated and unvegetated areas. Finally, the listed files were overlaid; the results were cleaned using Eliminate ArcGIS tool. Vegetation in most of residential and commercial areas consisted of ornamental trees and shrubs. Therefore, they were all assigned to a class named "Ornamental". The "River" sub-region received least of the automatic processing. Vegetation of this sub-region was mapped using extensive field data and aerial interpretation. The vegetation data were matched with the spatial template produced during the segmentation process.

Completed datasets were cross-checked with the existing maps (ecosystems, habitats, plant communities, invasive plants) and validated in the field from varying distances. We validated the segmentation and classification by observing and taking photographs of vegetation and individual plants to confirm or update identifications that had been made through air photo interpretation. Field visits were limited to the parks and public lands where permission was granted to undertake research (Culver City Park, Kenneth Hahn State Recreation Area, and Baldwin Hills Scenic Overlook) and other spaces open to the public along streets, roads, and sidewalks. We used binoculars and a combination of GPS with a laser rangefinder to locate and identify plants that were on lands to which access on foot was not feasible, such as the Inglewood Oil Field.

Map Analysis

We used ArcGIS tools to produce summary statistics for land use/land cover and vegetation cover for the different levels of our classification hierarchy. To visualize the results, we classified the vegetation alliances into the exclusive categories of native shrubland, native woodland, exotic shrubland, exotic woodland, or exotic grassland. These categories are based on the dominant plant species only and when co-dominant species were observed, the origin (native or exotic) of the more common species was used to classify the patch.

We compared our classification to previous maps of Baldwin Hills vegetation by querying our new map within the extent and land cover/land use categories presented in previous maps.

Results

Plant List

The cumulative plant list includes herbarium specimens, observations from previous survey efforts with more attention and time given to developing a comprehensive plant list, and those species encountered during our mapping (Table 2-2). Failure to report a species during any particular survey should not necessarily be interpreted as its absence because the survey efforts and survey purposes were not the same.

The plants are categorized into those that are California natives introduced to the Baldwin Hills, species not native to California at all, and species native to the Baldwin Hills prior to European colonization.

Table 2-2. Plant species documented from the Baldwin Hills from herbarium, survey, and citizen science sources. Date of most recent herbarium record is given. Reports from 2016 are not the result of a comprehensive floristic survey, but rather those species encountered in process of documenting dominant species in uppermost stratum.

Family	Scientific Name	Common Name	Herbarium	1980	2001	2016
Introduced California Natives						
	Dicots					
Anacardiaceae	*Rhus integrifolia*	lemonadeberry				X
Asclepiadaceae	*Asclepias vestita*	woolly milkweed			X	
Betulaceae	*Alnus rhombifolia*	alder			X	X
Fabaceae	*Cercis occidentalis*	western redbud			X	
Fagaceae	*Quercus agrifolia*	coast live oak		X		X
Fagaceae	*Quercus lobata*	valley oak			X	
Malvaceae	*Fremontodendron californicum*	flannelbush			X	
Oleaceae	*Fraxinus latifolia*	Oregon ash				X
Exotic Species						
	Dicots					
Aizoaceae	*Carpobrotus edulis*	iceplant		X	X	X
Altingiaceae	*Liquidambar styraciflua*	sweet gum			X	
Anacardiaceae	*Schinus molle*	Peruvian pepper			X	X
Anacardiaceae	*Schinus terebinthifolius*	Brazilian pepper				X
Apiaceae	*Conium maculatum*	poison hemlock		X	X	
Apiaceae	*Foeniculum vulgare*	sweet fennel		X	X	X
Apocynaceae	*Nerium oleander*	oleander		X		
Araliaceae	*Hedera helix*	English ivy		X		
Asteraceae	*Ageratina adenophora*	sticky snakeroot			X	
Asteraceae	*Bellis perennis*	English daisy			X	
Asteraceae	*Bidens pilosa var. pilosa*	common begggar-ticks			X	
Asteraceae	*Centaurea melitensis*	star thistle		X	X	
Asteraceae	*Chamomilla suaveolens*	pineapple weed			X	
Asteraceae	*Chrysanthemem coronarium*	garland chrysanthemum		X	X	
Asteraceae	*Cirsium arvense*	Canada thistle			X	
Asteraceae	*Cirsium vulgare*	bull thistle			X	
Asteraceae	*Conyza bonariensis*	Flax-leaved horseweed			X	
Asteraceae	*Cotula coronopifolia*	brass buttons		X		
Asteraceae	*Delairea odorata [=Senecio mikanioides]*	Cape ivy			X	
Asteraceae	*Gazania linearis*				X	
Asteraceae	*Lactuca serriola*	prickly lettuce			X	
Asteraceae	*Picris echioides*	ox-tongue		X	X	
Asteraceae	*Senecio angulatus*	Kennelworth ivy		X		
Asteraceae	*Silybum marianum*	milk thistle		X	X	
Asteraceae	*Sonchus oleraceus*	sow-thistle		X	X	
Asteraceae	*Xanthium strumarium*	cocklebur		X	X	

Bignoniaceae	*Jacaranda mimosifolia*	jacaranda			X
Brassicaceae	*Brassica nigra*	black mustard	X	X	X
Brassicaceae	*Brassica rapa ssp. Sylvestris*	field mustard	X		
Brassicaceae	*Hirschfeldia incana*	shortpod mustard		X	
Brassicaceae	*Lobularia maritima*	sweet alyssum	X	X	
Brassicaceae	*Raphanus sativus [Raphanus raphanistrum]*	wild radish	X	X	X
Caryophyllaceae	*Silene gallica*	catchfly	X	X	
Caryophyllaceae	*Spergularia villosa*	hairy sandspurry		X	
Casuarinaceae	*Casuarina sp.*	beefwood		X	
Chenopodiaceae	*Atriplex semibaccata*	Australian saltbush	X		
Chenopodiaceae	*Bassia hyssopifolia*	fivehook bassia		X	
Chenopodiaceae	*Chenopodium album*	Lamb's quarters		X	
Chenopodiaceae	*Chenopodium glaucum*	oak leaved goosefoot		X	
Chenopodiaceae	*Chenopodium sp.*	goosefoot	X		
Chenopodiaceae	*Salsola iberica [S. tragus]*	Russian thistle	X	X	X
Cistaceae	*Cistus sp.*	rockrose		X	
Crassulaceae	*Aeonium sp.*	stonecrop	X		
Crassulaceae	*Crassula argentea*	jade plant	X		
Euphorbiaceae	*Euphorbia maculata*	spotted spurge		X	
Euphorbiaceae	*Ricinus communis*	castor bean	X	X	X
Fabaceae	*Acacia sp. [Acacia longifolia]*	Acacia	X	X	X
Fabaceae	*Ceratonia siliqua*	carob tree	X		
Fabaceae	*Lotus corniculatus*	Birdfoot trefoil		X	
Fabaceae	*Medicago polymorpha*	California burclover		X	
Fabaceae	*Melilotus alba*	white sweetclover		X	
Fabaceae	*Melilotus indica*	yellow sweetclover		X	
Fabaceae	*Meliotus sp.*	sweet-clover	X	X	
Fabaceae	*Pisum sativum*	garden pea	X		
Fabaceae	*Spartium junceum*	Spanish broom	X	X	
Fabaceae	*Trifolium repens*	White clover		X	
Fabaceae	*Vicia benchalensis*	purple vetch		X	
Geraniaceae	*Erodium botrys*	long-beaked storksbill	X	X	
Geraniaceae	*Erodium cicutarium*	filareee	X	X	
Geraniaceae	*Pelargonium sp. [Geranium retrosum]*	geranium	X	X	
Lamiaceae	*Marrubium vulgare*	horehound	X	X	
Lauraceae	*Cinnamomum camphora*	camphor tree			X
Lauraceae	*Persea americana*	avacado	X		
Magnoliaceae	*Liriodendron*	Tulip Tree			X
Magnoliaceae	*Magnolia grandiflora*	magnolia			X
Malvaceae	*Hibiscus sp.*	hibiscus	X		
Malvaceae	*Malva parviflora*	cheeseweed		X	
Myoporaceae	*Myoporum laetum*			X	
Myrtaceae	*Eucalyptus sideroxylon*	red iron bark		X	
Myrtaceae	*Eucalyptus sp.*	eucalyptus	X		

Oleaceae	*Fraxinus nigra*	black ash			X
Oleaceae	*Ligustrum texanum*	privet	X		
Oxalidaceae	*Oxalis pes-caprae*	Bermuda buttercup	X		
Plantaginaceae	*Plantago lanceolata*	plantain		X	
Plumbaginaceae	*Limonium sinuatum*	sea lavander		X	
Plumbaginaceae	*Plumbago auriculata*	Cape plumbago		X	
Polygonaceae	*Polygonum arenastrum*	common knotweed		X	
Polygonaceae	*Rumex crispus*	curly dock		X	
Portlacaceae	*Portulaca oleracea*	portulaca	X	X	
Primulaceae	*Anagalis arvensis*	pimpernel	X	X	
Rosaceae	*Prunus persica*	peach tree	X		
Rosaceae	*Prunus sp.*			X	
Rosaceae	*Rosa sp*	rose	X		
Rutaceae	*Citrus sinensis*	orange tree	X		
Salicaceae	*Populus fremontii*	Fremont cottonwood	X		X
Sapindaceae	*Cupaniopsis parvifolia*				X
Scrophulariaceae	*Verbascum blattaria*	moth mullein		X	
Scrophulariaceae	*Verbascum thapsus*	common mullein	X		
Solanaceae	*Nicotiana glauca*	tree tobacco	X	X	
Solanaceae	*Solandra hartwegii*	cup-o-gold bush	X		
Solanaceae	*Solanum elaeagnifolium*	silver leaf nettle	X	X	
Tropaeolaceae	*Tropaeoleum majus*	garden nasturtium	X	X	
Verbenaceae	*Lantana montevidensis*	lantana	X	X	
Zygophyllaceae	*Tribulus terrestris*	puncture vine		X	
	Euphorbia terracina				
Gymnosperms					
Cupressaceae	*Cupressus sempervirens [C. sp.]*	Mediterranean cypress	X		X
Cupressaceae	*Juniperus sp.*	Juniper		X	
Cupressaceae	*Thuja sp.*	Cedar		X	
Pinaceae	*Cedrus deodara*	deodar cedar		X	X
Pinaceae	*Pinus canariensis*	Canary Island pline			X
Pinaceae	*Pinus halepensis*	Aleppo pine		X	
Pinaceae	*Pinus radiata*	Monterey pine		X	X
Pinaceae	*Pinus sp.*	pine	X		
	Moncots				
Agavaceae	*Agave americana [A. sp.]*	American century plant	X		X
Arecaceae	*Washingtonia robusta [W. sp.]*	fan palm		X	X
Liliaceae	*Narcissus sp.*			X	
Liliaceae	*Yucca elephantipes*			X	X
Poaceae	*Arundo donax*	giant reed		X	X
Poaceae	*Avena barbata*	slender wild oat		X	X
Poaceae	*Avena fatua*	wild oat	X	X	
Poaceae	*Bromus diandrus*	ripgut brome	X		
Poaceae	*Bromus mollis*	soft chess	X		
Poaceae	*Bromus rubens*	red brome	X	X	
Poaceae	*Bromus tectorum*	cheat grass		X	

Poaceae	*Cortaderia jubata*	Pampas grass		X	X	
Poaceae	*Cortaderia selloana*	Pampas grass			X	X
Poaceae	*Cynodon dactylon*	Bermuda grass			X	
Poaceae	*Dactylis glomerata*	orchard grass			X	
Poaceae	*Digitaria sanguinalis*	hairy crabgrass			X	
Poaceae	*Hordeum murinum ssp. leporinum*	barley		X	X	
Poaceae	*Lamarckia aurea*	goldentop		X		
Poaceae	*Lolium sp.*	annual ryegrass		X		
Poaceae	*Paspalum dilatatum*	Dallis grass			X	
Poaceae	*Pennisetum setaceum*	fountaingrass		X	X	X
Poaceae	*Piptatherum miliaceum*	smilo grass			X	X
Poaceae	*Polypogon monspeliensis*	rabbitfoot grass		X		
Poaceae	*Schismus barbatus*	schismus grass		X	X	
Native Species						
	Dicots					
Anacardiaceae	*Rhus laurina*	laurel sumac		X	X	
Anacardiaceae	*Rhus ovata*	sugar bush		X	X	
Anacardiaceae	*Toxicodendron diversilobum*	poison-oak		X	X	
Apiaceae	*Sanicula arguta*	sharp toothed snakeroot	1927			
Asclepiadaceae	*Asclepias fascicularis*	California milkweed			X	
Asteraceae	*Achillea millefolium*	yarrow			X	
Asteraceae	*Achyrachaena mollis*	blow-wives			X	
Asteraceae	*Ambrosia psilostachya var californica*	western ragweed		X	X	
Asteraceae	*Artemisia californica*	California sagebrush		X	X	X
Asteraceae	*Artemisia douglasiana*	mugwort		X		
Asteraceae	*Baccharis pilularis ssp. consanguinea*	coyote brush		X	X	X
Asteraceae	*Baccharis salicifolia [=glutinosa]*	mulefat		X	X	X
Asteraceae	*Corethrogyne filaginifolia*	common sandaster	1927		X	
Asteraceae	*Deinandra fasciculata [Hemizonia ramosissima]*	common tarweed	2009	X	X	
Asteraceae	*Encelia californica*	California sunflower	1986	X	X	X
Asteraceae	*Ericameria palmeri var. pachylepis*	broad scaled Palmer's goldenbush	1931			
Asteraceae	*Erigeron foliosus*	leafy fleabane		X		
Asteraceae	*Filago californica*	California cottonrose			X	
Asteraceae	*Grindelia camporum*	common gumplant	1931		X	
Asteraceae	*Haplopappus pinifolius*	pinebush		X		
Asteraceae	*Helianthus annuus*	common sunflower		X		
Asteraceae	*Heterotheca grandiflora*	telegraph weed		X	X	
Asteraceae	*Isocoma menziesii var. vernonioides*	coastal goldenbush	1931	X		
Asteraceae	*Lasthenia gracilis*	needle goldfields	1927			

Asteraceae	*Malacothrix saxatilis var. tenuifolia*	cliff malacothrix		X	X	
Asteraceae	*Pseudognaphalium beneolens*	cudweed			X	
Asteraceae	*Pseudognaphalium biolettii [=Gnaphalium bicolor]*	two-color rabbit-tobacco		X	X	
Asteraceae	*Pseudognaphalium californicum*	ladies' tobacco			X	
Asteraceae	*Pseudognaphalium ramosissimum*	pink cudweed			X	
Asteraceae	*Pseudognaphalium stramineum*	cottonbatting plant			X	
Asteraceae	*Stephanomeria exigua subsp. coronaria*	milk aster	1931			
Boraginaceae	*Cryptantha intermedia*	Clearwater cryptantha	1927			
Cactaceae	*Opuntia littoralis / Opuntia X occidentalis*	prickly-pear cactus		X	X	X
Cactaceae	*Opuntia oricola*	coast prickly-pear		X		
Caprifoliaceae	*Sambucus nigra ssp. caerulea*	elderberry	2008	X	X	X
Caryophyllaceae	*Silene laciniata subsp. major*	cardinal catchfly	1937			
Convolvulaceae	*Calystegia macrostegia ssp. intermedia*	south coast morning-glory	2008	X	X	
Crassulaceae	*Crassula erecta [C. ovata]*	pigmy weed		X		X
Crassulaceae	*Dudleya lanceolata*	lanceleaf liveforever	1986		X	
Cucurbitaceae	*Cucurbita foetidissima*	calabazilla		X	X	
Cucurbitaceae	*Marah macrocarpus*	bigroot		X	X	
Cuscutaceae	*Cuscuta californica*	Dodder			X	
Euphorbiaceae	*Croton californicus*	California croton	2008	X		
Euphorbiaceae	*Eremocarpus setigerus*	turkey mullein		X	X	
Euphorbiaceae	*Euphorbia albomarginata*	rattlesnake weed		X	X	
Euphorbiaceae	*Euphorbia crenulata*	Chinese caps			X	
Fabaceae	*Acmispon americanus*	Spanish lotus	2009	X	X	
Fabaceae	*Acmispon glaber*	deerweed		X	X	
Fabaceae	*Acmispon maritimus*	coastal lotus	1925		X	
Fabaceae	*Acmispon strigosus*	strigose lotus		X		
Fabaceae	*Astragalus trichopodus var. lonchus [mis-ids as Astragalus curtipes]*	locoweed	1903	X	X	
Fabaceae	*Lupinus bicolor*	miniature lupine	2009		X	
Fabaceae	*Lupinus hirsutissimus*	nettle annual lupine		X		
Fabaceae	*Lupinus longifolius*	bush lupine		X	X	
Fabaceae	*Lupinus succulentus*	succulent lupine	1934	X	X	
Fabaceae	*Trifolium albopurpureum*	Indian clover			X	
Fabaceae	*Trifolium depauperatum var. truncatum*	dwarf sack clover			X	
Fagaceae	*Quercus dumosa*	scrub oak			X	

Hydrophyllaceae	*Phacelia cicutaria var. hispida*	caterpillar phacelia			X	
Hydrophyllaceae	*Phacelia ramosissima*	branching phacelia		X		
Juglandaceae	*Juglans californica*	California black walnut		X	X	X
Lamiaceae	*Prunella vulgaris var. vulgaris*	self-heal			X	
Lamiaceae	*Salvia apiana*	white sage				
Lamiaceae	*Salvia mellifera*	black sage		X	X	
Lamiaceae	*Stachys ajugoides*	hedge-nettle		X		
Lamiaceae	*Stachys bullata*	California hedgenettle	1925			
Nyctaginaceae	*Mirabilis laevis var. crassifolia [=M. californica]*	California four o'clock	1937		X	
Onagraceae	*Camissonia bistorta*	sun cup		X		
Onagraceae	*Epilobium canum*	zauschneria			X	
Onagraceae	*Epilobium ciliatum ssp. ciliatum*	fringed willowherb			X	
Onagraceae	*Oenothera elata*	hairy evening primrose	2008			
Papaveraceae	*Eschscholzia californica*	California poppy			X	
Plantaginaceae	*Plantago erecta*	dotseed plantain	1897			
Platanaceae	*Platanus racemosa*	western sycamore			X	X
Polemoniaceae	*Gilia angelensis*	chaparral gilia	2009			
Polemoniaceae	*Linanthus dianthiflorus*	fringed linanthus	1927			
Polygonaceae	*Chorizanthe staticoides*	Turkish rugging			X	
Polygonaceae	*Eriogonoum fasciculatum*	wild buckwheat		X	X	X
Polygonaceae	*Eriogonum elongatum*	long-stemmed buckwheat		X		
Polygonaceae	*Rumex hymenosepalus*	wild rubarb		X		
Rhamnaceae	*Ceanothus spinosus*	greenbark ceanothus			X	X
Rosaceae	*Adenostoma fasciculatum*	chamise	2008			
Rosaceae	*Heteromeles arbutifolia*	toyon		X	X	X
Rosaceae	*Prunus ilicifolia ssp. Ilicifolia*	holly-leafed cherry			X	
Rosaceae	*Prunus ilicifolia ssp. lyonii*	Catalina cherry	1986	X	X	
Rosaceae	*Rosa californica*	California wild rose		X	X	
Rosaceae	*Rubus ursinus*	wild blackberry		X		
Rubiacae	*Galium angustifolium*	narrow-leaved bedstraw		X	X	
Rubiacae	*Galium aparine*	bedstraw		X		
Salicaceae	*Salix hindsiana*	sandbar willow		X		
Salicaceae	*Salix lasiolepis*	arroyo willow		X	X	X
Sapindaceae	*Aesculus californica*	horsechestnut			X	
Scrophulariaceae	*Castilleja affinis*	Indian paintbrush	1931			
Scrophulariaceae	*Mimulus aurantiacus*	monkeyflower			X	
Solanaceae	*Datura meteloides [Datura wrightii]*	jimsonweed		X	X	

Solanaceae	*Solanum douglasii*	Douglas nightshade		X	X	
Urticaceae	*Urtica holosericea*	stinging nettle		X		
Verbenaceae	*Verbena lasiostachys var. lasiostachys*	Common verbena	1986	X	X	
Violaceae	*Viola sp.*	violet		X		
Vitaceae	*Vitis girdiana*	wild grape		X		
	Ferns					
Dryopteridaceae	*Dryopteris arguta*	coastal woodfern			X	
Pteridaceae	*Pityrogramma triangularis*	goldenback fern		X		
	Monocots					
Cyperaceae	*Cyperus odoratus*	nutsedge			X	
Iridaceae	*Sisyrinchium bellum*	blue-eyed grass		X	X	
Juncaceae	*Juncus bufonius*	toad rush			X	
Liliaceae	*Chlorogalum pomeridianum*	soap plant		X		
Poaceae	*Elymus condensatus*	giant wild rye	1948	X		X
Poaceae	*Elymus glaucus*	wild bluerye			X	
Poaceae	*Melica imperfecta*	smallflower melicgrass	1925		X	
Poaceae	*Nassella pulchra*	purple needle grass			X	
Poaceae	*Vulpia microstachys var. pauciflora*	small fescue			X	
Themidaceae	*Dichelostemma capitatum (=pulchellum)*	blue dicks		X	X	
Typhaceae	*Typha latifolia*	cattail			X	

Note: Some historical entries with ambiguous classifications were updated to correspond with modern surveys. Scientific names were updated with current taxonomy.

Vegetation Alliances Mapped

Sixteen vegetation alliances that have been previously described were identified and mapped across the Baldwin Hills study area. Of these, one was dominated by exotic species (Ice plant mats) and two of the alliances dominated by California natives were described as "regionally native" in the Baldwin Hills because the dominant species were introduced through planting (Coast Live Oak, Sycamore, and Cottonwood) and no confirmation of the historical presence of these species in the area where they were planted is available.

Table 2-3. Vegetation Alliances mapped in the Baldwin Hills previously described by Sawyer et al. (2009)

Alliance	Notes
Arroyo willow thickets	With Coyote Brush, Peruvian Peppertree
California buckwheat scrub	
California sagebrush scrub	With California Buckwheat, Coyote Brush, Ice Plant
California walnut groves	
Greenbark ceanothus chaparral	
Coast live oak woodland	Planted; dominant species only, no native understory

Fremont cottonwood forest	Planted; dominant species only, no native understory
Coyote brush scrub	With California Sagebrush, Giant Rye Grass, Ice Plant, Arroyo Willow
Blue elderberry stands	With California Sagebrush, Coast Live Oak, Giant Wild Rye, Toyon
Giant wild rye grassland	
Giant reed breaks	
Ice plant mats	Exotic
Lemonade berry scrub	
Mulefat thickets	With Elderberry, Prickly Pear,
Coast prickly pear scrub	
California sycamore woodlands	Planted. Co-dominant with Blue elderberry, Coyote brush
Toyon chaparral	With Acacia, California sagebrush, Coast live oak
White sage scrub	Along Ballona Creek.
Upland mustards	With Fennel, Giant Rye Grass, Pampas Grass, Wild Radish
Pampas grass patches	With Mule Fat
Pepper tree or Myoporum groves	With Acacia, California Palm, Arroyo Willow, California Sagebrush, California Walnut, Coast Live oak, Coyote Brush, Deodar Cedar, Elderberry, Eucaplyptus, Monterey Pine, Mule Fat, Pampas Grass, Sycamore, Toyon

For those stands of vegetation that did not fit any of the defined vegetation alliances for California, we identified provisional alliances (Table 2-4). These are not true vegetation alliances because details about the floristic composition, associated species, and other elements of vegetation classification (Sawyer et al. 2009) were outside the scope of our effort.

Table 2-4. Vegetation alliances defined for this study by dominant species in uppermost stratum.

Provisional Alliance	Notes
Acacia	Co-dominants: Ash, California Sagebrush, Carrotwood, Sycamore, Eucalyptus, Monterey Pine, Pampas Grass, Peruvian Peppertree
Agave	*Agave americana*
Brazilian Peppertree	
California Palm	*Washingtonia robusta*
Camphor Tree	Co-dominants: California Palm, Peruvian Peppertree
Canary Island Pine	Co-dominants: Eucalyptus
Carrotwood Tree	Co-dominants: Acacia

Castor Bean	Co-dominants: Cheatgrass
Cypress	
Date Palm	
Deodar Cedar	
Eucalyptus	Co-dominants: Cherry Plum, Acacia, Arroyo Willow, Ash, California Palm, Camphor Tree, Monterey Pine, Peruvian Peppertree, Sycamore
Exotic Annuals	
Exotic Perennial Cane/Giant Reed	Co-dominants: California Palm, Willow
Exotic Perennial Succulents	
Exotic Shrubs	
Exotic Trees	
Fennel	
Fountain Grass	Co-dominants: Russian Thistle
Jacaranda	
Lawn	
Magnolia	
Monterey Pine	Co-dominants: Acacia, Coastal Live Oak, California Balm, Toyon, Coyote Brush, Cypress, Deodar Cedar, Pampas Grass, Peruvian Peppertree, Sycamore, Mule Fat,
Russian Thistle	
White Alder	
Wild Radish	Co-dominants: Castor Bean, Giant Rye Grass
Ash	Co-dominants: Toyon, Cherry Plum
Cheatgrass	Co-dominants: Wild Oats, Castor Bean
Redwood	
Smilograss	Co-dominants: Cheatgrass
Tree Of Heaven	Agave
Bulrush	

Vegetation Mapping

Within the entire study area, 58% of the land is vegetated, while 42% is not vegetated (Table 2-5). The most common vegetated categories were grasslands (including lawns) at 21% of the area, followed by shrublands at 19% and treed areas at 18%. In the unvegetated zones, the most common feature was bare ground in the oil field, constituting 19% of the total study area, followed by buildings (7%), roads (6%) and other commercial and residential uses (6%).

Table 2-5. Level 1 (Vegetated/Unvegetated) and Level 2 classification for entire study area.

Level 2 Class	Area (acres)
Vegetated - Grass	442.2
Vegetated - Shrubs / Scrub / Thickets	402.8
Vegetated - Trees and Tall Shrubs	380.6
Unvegetated - Disturbed inside fenced area	393.5
Unvegetated - Buildings	145.2
Unvegetated - Roads	126.3
Unvegetated - Commercial and Residential	119.8
Unvegetated - River Bank	46.5
Unvegetated - Recreational areas and trails	39.6
Unvegetated - Stream Bed	19.1
Unvegetated - Bikepath	4.3
Unvegetated - Disturbed outside fenced area	3.0
Unvegetated - Ponds, basins, water bodies	3.0
Unvegetated - Bridges	0.2

The alliance-level vegetation map is complex and reflects the long history of disturbance, recovery, and management of the vegetation in the Baldwin Hills (Figure 2-5). As documented in previous maps of the region, the northern and southwestern edges of the territory support the largest blocks of native habitats, predominantly native shrublands. The oilfields, running northwest to southeast diagonally across the study area contain large areas of bare ground interspersed with native and exotic shrublands.

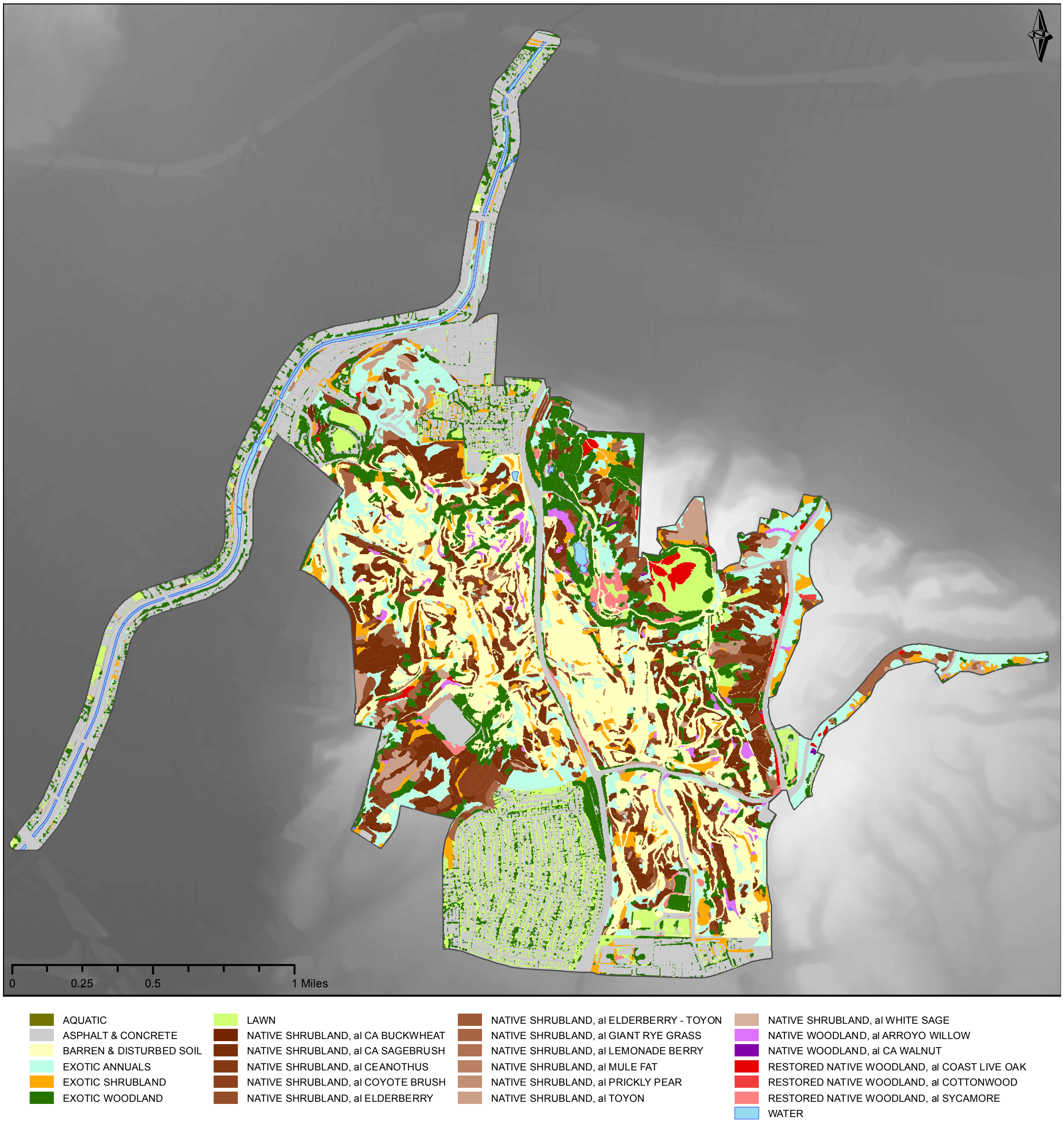

Figure 2-5. Vegetation map of the Baldwin Hills Conservancy territory emphasizing the native habitats.

For the Level 3 classification (subclasses of unvegetated zones and alliances in vegetated zones), the most common cover type was barren and disturbed soil (27% of the Main section of the study area) followed by the California Sagebrush alliance (15%; Table 2-6). The next most common vegetation types were Eucalyptus, Coyote Brush, and exotic annuals, each approximately 6% of the Main region of the study area.

Table 2-6. Cover by level 3 classification in the Main region of the study area.

Classification	Number of Polygons	Total Area	Percent
Barren and disturbed soil	312	417.61	27.20%
California sagebrush scrub	514	230.04	15.00%
Asphalt and concrete	111	96.77	6.30%
Eucalyptus	201	95.09	6.20%
Coyote brush scrub	266	93.55	6.10%
Exotic annuals	295	90.06	5.90%
Upland mustards	149	75.59	4.90%
Pepper tree or Myoporum groves	187	53.96	3.50%
Ice plant mats	214	48.49	3.20%
Lawn	96	46.21	3.00%
Russian Thistle	143	45.76	3.00%
Toyon chaparral	107	44.59	2.90%
Monterey pine forest [out of native range]	75	26.75	1.70%
Giant wild rye grassland	67	23.01	1.50%
Blue elderberry stands	42	21.45	1.40%
Arroyo willow thickets	73	17.79	1.20%
Pampas grass patches	82	16.34	1.10%
California sycamore woodlands	61	15.75	1.00%
Coast live oak woodlands	29	13.75	0.90%
Acacia	55	11.15	0.70%
Mulefat thickets	34	6.10	0.40%
Upland mustards [Wild radish]	14	5.68	0.40%
Coast prickly pear scrub	32	4.26	0.30%
Exotic Perennial Cane	21	3.69	0.20%
Exotic Trees	16	3.05	0.20%
Water	8	2.99	0.20%
Carrotwood Tree	11	2.90	0.20%
Exotic Shrubs	21	2.84	0.20%
California fan palm [planted/naturalized]	25	2.44	0.20%
Lemonade berry scrub	5	2.42	0.20%
Camphor Tree	11	2.27	0.10%
Fennel patches	6	2.05	0.10%
Peppertree or Myoporum groves	8	1.52	0.10%
California buckwheat scrub	6	1.45	0.10%
Deodar Cedar	6	0.75	0.00%
Cypress	3	0.74	0.00%
Exotic Perennial Succulents	5	0.71	0.00%
Fremont cottonwood forest [planted]	1	0.67	0.00%
White alder groves [planted]	2	0.67	0.00%
Ash	5	0.63	0.00%
Jacaranda	3	0.60	0.00%

California walnut groves	4	0.55	0.00%
Canary Island pine	4	0.43	0.00%
Fountain grass swards	6	0.40	0.00%
Castor bean	1	0.27	0.00%
Magnolia	2	0.18	0.00%
Aquatic	3	0.12	0.00%
Greenbark ceanothus chaparral	2	0.07	0.00%
Date Palm	2	0.04	0.00%

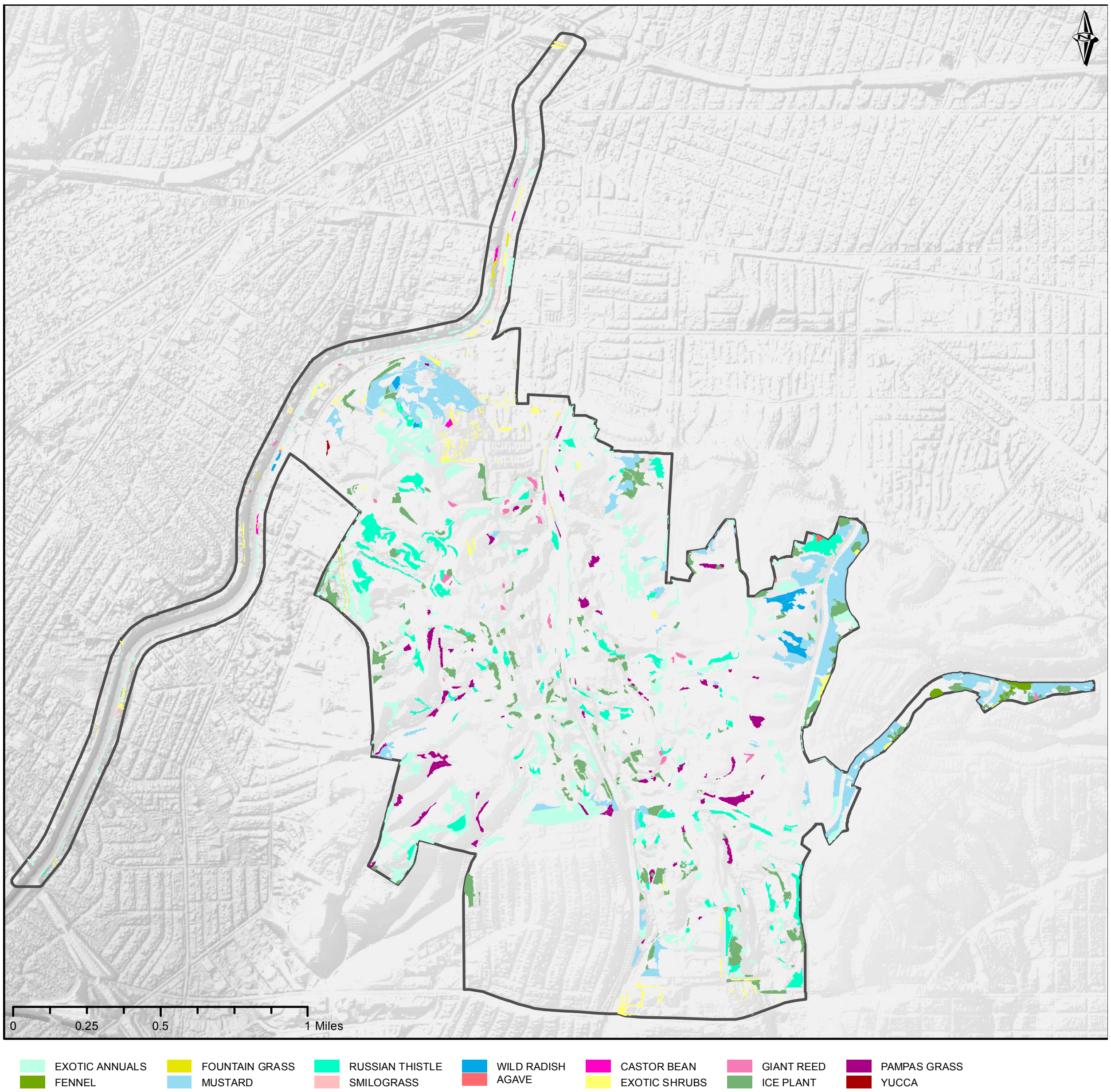

Figure 2-6. Exotic grasslands and shrublands of the Baldwin Hills Conservancy territory.

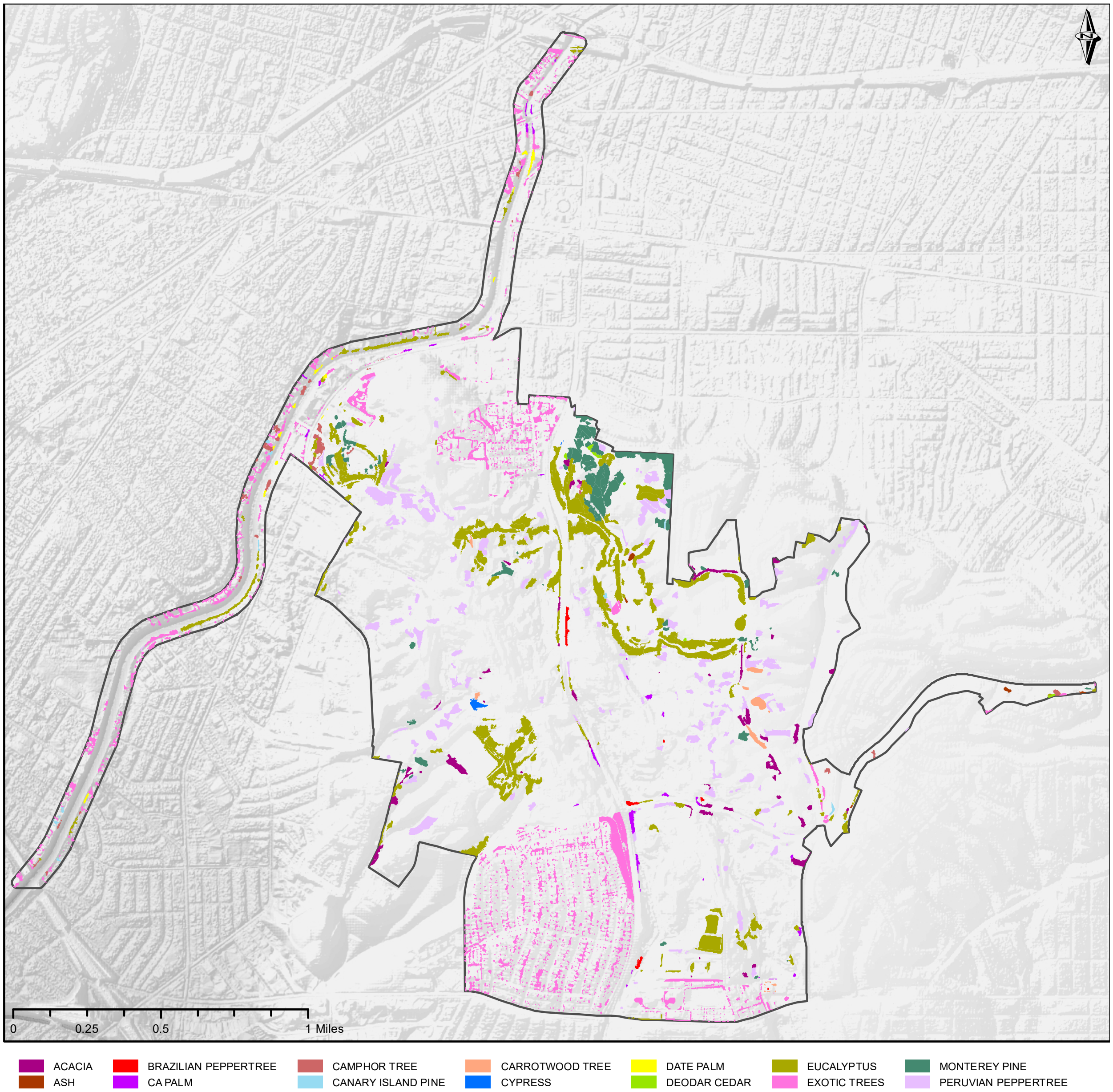

Figure 2-7. Exotic woodlands of the Baldwin Hills Conservancy territory.

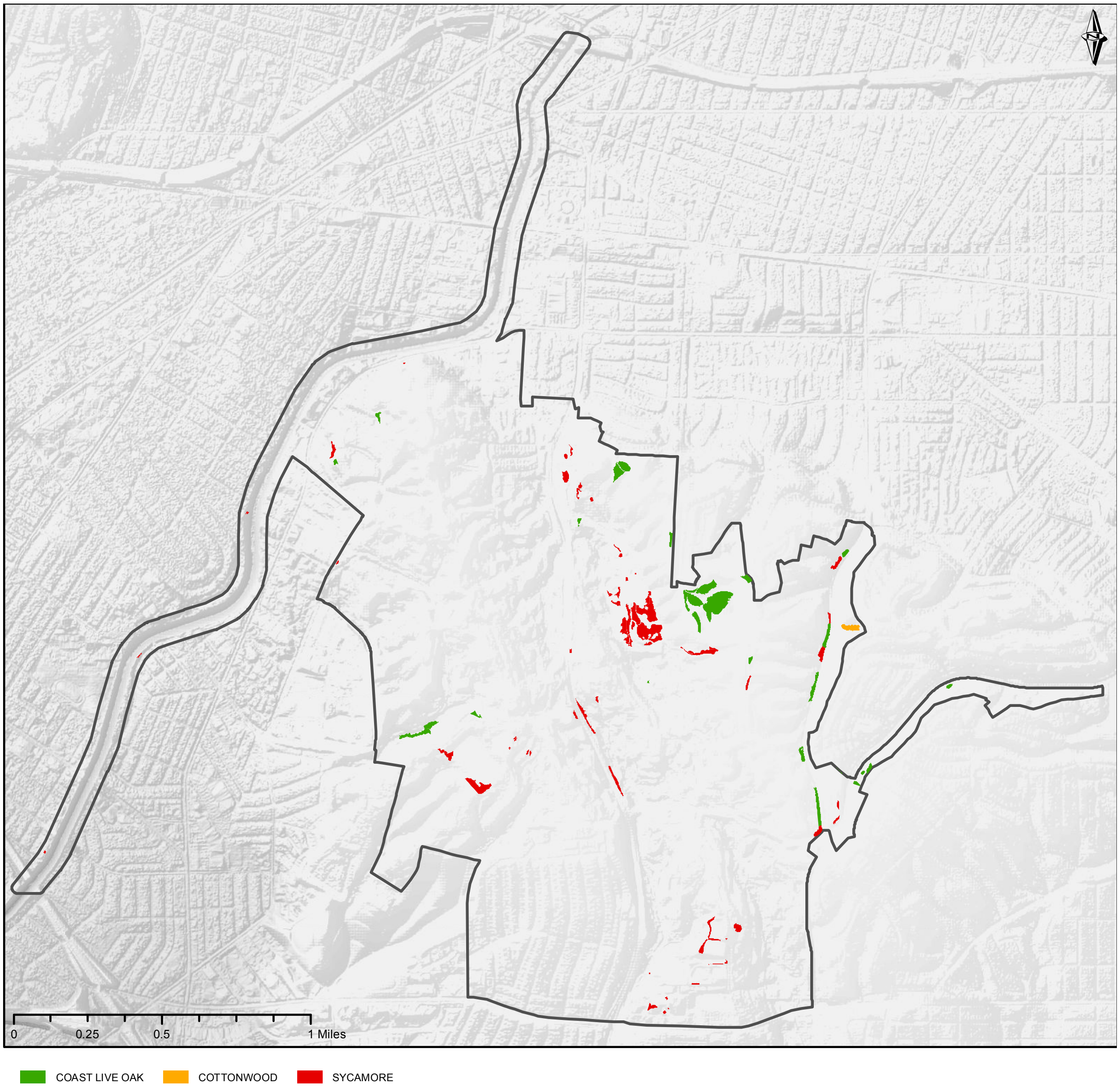

Figure 2-8. Woodlands with regionally native tree species in the Baldwin Hills.

Change Analysis

We compared the area mapped by Anderson (2001) to the 2016 update (Table 2-7), using the generalized categories of exotic/native annuals, shrubland, woodland for the comparison. The differences between the two mapping schemes are attributable both to differences in mapping methodology and to changes in the vegetation. Some interesting results included our mapping of 31.4% of the area identified as annuals in 2001 as Native Shrubland in 2016. Additionally, 52.1% of the area mapped as being disturbed with >50% nonnative vegetation in 2001 was mapped as native shrubland in 2016. We found that the large oil field area not surveyed in 2001 was dominated by bare ground (53.3%) and native shrublands (21.9%).

Table 2-7. Comparison of 2001 vegetation map with 2016 vegetation map. Extent is limited to study area covered by Anderson (2001).

2001 Description	Acres	2016 Divisions	Percentage
Annuals	60.5	Exotic Annuals	48.4
		Native Shrubland	31.4
		Unvegetated	7.6
		Exotic Woodland	6.7
		Exotic Shrubland	4.5
		Native Woodland	1.1
		Lawn	0.2
Coastal Sage Scrub	3.3	Native Shrubland	91.4
		Exotic Shrubland	5.6
		Unvegetated	3.0
Coastal Scrub, north-facing	29.3	Native Shrubland	66.0
		Exotic Woodland	18.0
		Exotic Annuals	6.8
		Unvegetated	6.4
		Exotic Shrubland	2.4
		Native Woodland	0.5
Coastal Scrub, south-facing	64.1	Native Shrubland	87.4
		Exotic Shrubland	4.5
		Exotic Annuals	4.1
		Exotic Woodland	3.1
		Unvegetated	0.4
		Lawn	0.3
		Native Woodland	0.2
Disturbed vegetation > 50% non-natives	204.4	Native Shrubland	52.1
		Exotic Annuals	16.6
		Exotic Woodland	13.0
		Unvegetated	12.7
		Exotic Shrubland	4.5
		Native Woodland	1.0
		Lawn	0.2
Disturbed vegetation > 90% non-natives	82.5	Exotic Woodland	35.6
		Native Shrubland	25.2
		Unvegetated	18.9
		Exotic Annuals	13.9
		Exotic Shrubland	4.1
		Native Woodland	2.1
		Lawn	0.2
Drainage/runoff areas	18.4	Exotic Woodland	33.9
		Native Shrubland	28.2
		Unvegetated	19.5
		Exotic Shrubland	9.0
		Native Woodland	6.1
		Exotic Annuals	2.9
		Lawn	0.4
Grassland/prairie	11.5	Native Shrubland	60.8

		Exotic Annuals	20.1
		Exotic Woodland	17.5
		Unvegetated	1.6
		Exotic Shrubland	0.1
Habitat of note	0.5	Exotic Woodland	18.3
		Native Shrubland	78.0
		Native Woodland	3.7
Hardpan/seasonal standing water	2.2	Exotic Annuals	52.7
		Exotic Shrubland	0.4
		Native Shrubland	41.5
		Native Woodland	0.9
		Unvegetated	4.4
Highly modified/sparsely vegetated	123.8	Exotic Annuals	15.3
		Exotic Shrubland	6.8
		Exotic Woodland	3.6
		Lawn	1.4
		Native Shrubland	14.4
		Native Woodland	1.5
		Unvegetated	56.9
No on-site visits (oil fields)	549.9	Exotic Annuals	9.0
		Exotic Shrubland	4.7
		Exotic Woodland	9.1
		Native Shrubland	21.9
		Native Woodland	1.9
		Unvegetated	53.3
Opuntia populations	2.3	Exotic Annuals	11.6
		Exotic Shrubland	3.2
		Exotic Woodland	5.2
		Lawn	2.0
		Native Shrubland	58.4
		Unvegetated	19.6
Population of note	0.3	Exotic Shrubland	93.6
		Native Shrubland	5.7
		Unvegetated	0.7
Urban riparian	4.9	Exotic Annuals	1.2
		Exotic Shrubland	7.9
		Exotic Woodland	20.4
		Lawn	2.2
		Native Shrubland	29.9
		Native Woodland	35.3
		Unvegetated	3.2

The oil fields were mapped in 2008 to support the development of a Community Standards District. We compared this map with the 2016 results as well (Table 2-8). Again, results will reflect both differences in methodology and changes on the ground. The results were congruent in some ways; 84.8% of disturbed areas were unvegetated, for example. Other categories diverged; only 45.3% of degraded Coastal Sage Scrub mapped for the CSD was mapped as Native Shrubland in our assessment.

Table 2-8. Comparison of area surveyed for Community Standards District area in 2008 to 2016 mapping.

Description (2008)	Acres	Division (2016)	Percentage
Coyote Brush Scrub	1.3	Native Shrubland	74.7
		Unvegetated	10.6
		Exotic Woodland	8.6
		Native Woodland	6.0
California Sagebrush Scrub	147.3	Native Shrubland	61.4
		Exotic Woodland	16.1
		Unvegetated	9.7
		Exotic Annuals	6.0
		Exotic Shrubland	5.1
		Native Woodland	1.7
Cottonwood	0	Exotic Woodland	98.7
		Unvegetated	1.3
Disturbed Areas	378.9	Unvegetated	84.8
		Native Shrubland	6.6
		Exotic Annuals	3.8
		Exotic Woodland	2.1
		Exotic Shrubland	1.6
		Native Woodland	1.0
Coyote Brush Scrub - degraded	3.3	Native Shrubland	68.9
		Exotic Woodland	16.6
		Unvegetated	9.7
		Exotic Annuals	4.7
California Sagebrush Scrub - degraded	168.9	Native Shrubland	45.3
		Unvegetated	20.5
		Exotic Annuals	17.4
		Exotic Shrubland	9.2
		Exotic Woodland	6.4
		Native Woodland	0.9
		Lawn	0.3
Southern Willow Scrub - degraded	4.4	Native Shrubland	78.8
		Unvegetated	18.2
		Exotic Annuals	1.5
		Native Woodland	1.1
		Exotic Woodland	0.4
Eucalyptus Naturalized Forest	34.2	Exotic Woodland	63.7
		Unvegetated	19.0
		Native Shrubland	8.7
		Exotic Annuals	4.6
		Exotic Shrubland	2.3
		Native Woodland	1.1
		Lawn	0.7
Non-Native Ice Plant Dominated	5.4	Exotic Shrubland	62.9
		Unvegetated	13.0
		Native Shrubland	10.9
		Exotic Annuals	9.3
		Exotic Woodland	3.9
Native Grasses	0.9	Exotic Annuals	75.5
		Unvegetated	13.4
		Native Woodland	11.1

Interior Live Oak Woodland	1.5	Exotic Woodland	61.7
		Native Shrubland	27.7
		Exotic Shrubland	6.9
		Exotic Annuals	3.2
		Unvegetated	0.6
Man-Made and Maintained Ponds	4.7	Unvegetated	91.6
		Native Shrubland	2.6
		Exotic Shrubland	2.1
		Native Woodland	1.8
		Exotic Woodland	1.1
		Exotic Annuals	0.8
Pine Trees - planted	0.3	Unvegetated	63.2
		Exotic Woodland	36.8
Southern Willow Scrub	1.3	Native Woodland	52.4
		Native Shrubland	30.0
		Unvegetated	17.6
Sycamores - remnant or planted	0.3	Exotic Woodland	79.6
		Exotic Shrubland	14.7
		Unvegetated	4.4
		Native Shrubland	1.3
Willows	0.5	Native Shrubland	44.2
		Native Woodland	31.3
		Unvegetated	16.2
		Exotic Shrubland	8.1
		Exotic Annuals	0.1
Weed Dominated	96.2	Exotic Annuals	28.2
		Unvegetated	25.8
		Native Shrubland	23.5
		Exotic Shrubland	9.2
		Exotic Woodland	8.9
		Native Woodland	4.4

Discussion

The vegetation map developed from high-resolution aerial photography describes vegetation types across the Baldwin Hills using a single classification scheme that is consistent with national standards. We confirmed alliance-level classifications in the field and integrated all available spatial data from previous studies. To further validate the results, more extensive ground survey data set would be required to those areas for which we did not have permission to survey. The map is, however, informed by site visits by previous investigators for the oil field operations area, and represents the results of a state-of-the-art approach to vegetation mapping. As acknowledged, we do not provide floristic information about stands of vegetation because the level of field work necessary and access to undertake such work were outside the scope of this project.

Our patches of vegetation tended to be smaller and of more complex shapes than previous mapping efforts (Anderson 2001; Marqua 1978). Thus, we mapped areas of native vegetation within disturbed areas that might have been classified previously as unvegetated. It is also possible that we have documented recovery in vegetation resulting from active restoration and management as well as passive recovery in the absence of disturbance, especially on the protected parklands that are being managed for natural resource values.

We produced maps that summarized the alliance-based classification into broader categories of native and exotic annuals, shrublands, and woodlands, in addition to bare ground and other unvegetated categories. These summary maps provide an intelligible level of analysis of the Baldwin Hills territory asa a whole.

Prior to disturbance by agriculture and industrial activities, the vegetation of the Baldwin Hills would have been significantly different from that seen today. The only map of this historic condition is from a state-wide map that shows the region as being entirely coastal sagebrush (Küchler 1977). Our results, and previous vegetation surveys, are largely consistent with this description, with the exception of the vegetation associated with the more mesic areas around the drainages found historically (Dark et al. 2011) and the likely presence of vernal pools (Anderson 2001). The available records do not provide evidence of widespread oak woodlands and the existing localized riparian resources are supplemented by urban runoff. Like Anderson (2001), we documented California Walnut as a dominant species in some areas but whether the species was more common historically is an open question.

Coastal scrub of the pre-agricultural Baldwin Hills was probably interspersed with grasslands (Freudenberger et al. 1987). We can offer little additional information because the grasslands in areas where we mapped were dominated by exotics and the one small area reported to support native grasses is on the oil fields, as reported previously (Marine Research Specialists 2008). In all likelihood there were vernal pools. Vernal pools have been documented to the west of the Baldwin Hills (Mattoni & Longcore 1997) and reference to pools in the "adobe" and on the "mesas" of the Baldwin Hills are found in the Abrams flora (Abrams 1904). For example, the vernal pool indicator species *Navarretia prostrata* was found, "In low adobe places on the mesas of the coast valley. Inglewood" (Abrams 1904). The western ridges of the Baldwin Hills have clay soils and this is the likely location for vernal pools meeting this description. Anderson (2001) reviewed this possibility and we can offer little additional insight.

One of the challenges of not having a vegetation map that covered the whole of the remaining undeveloped Baldwin Hills with the same classification scheme is that it has been difficult to monitor changes in the vegetation over time. Our data compilation points to some broad trends that could be monitored to track the management of this area. The extent of native scrub vegetation certainly appears to have increased in the public parklands over the past 35 years. Large areas described as "little or no plant growth" now support native scrublands and exotic woodlands. The stands of what appear to be relatively undisturbed stands of California sagebrush, coyote brush, toyon, and blue elderberry alliances found along La Brea Avenue and in the hillsides in the southwestern portion of the study area are prominent in terms of their persistence. They also constitute the largest unbroken blocks of native habitats in the Baldwin Hills.

References

Abrams, L. R. 1904. Flora of Los Angeles and vicinity. Stanford University Press, Stanford, California.

Anderson, K., and K. J. Gaston. 2013. Lightweight unmanned aerial vehicles will revolutionize spatial ecology. *Frontiers in Ecology and the Environment* 11:138–146.

Anderson, V. 2001. Vegetation of the Baldwin Hills. Pages 12–37 in *The biota of the Baldwin Hills: an ecological assessment* (K. C. Molina, ed.). Community Conservancy International and Natural History Museum of Los Angeles County Foundation, Los Angeles.

Blaschke, T. 2010. Object based image analysis for remote sensing. *ISPRS Journal of Photogrammetry and Remote Sensing* 65:2–16.

BonTerra Consulting. 2013. Initial Study/Mitigated Negative Declration for proposed Park to Playa Trail. Pages 1–206.

Burnett, C., and T. Blaschke. 2003. A multi-scale segmentation/object relationship modelling methodology for landscape analysis. *Ecological Modelling* 168:233–249.

Byrne, J., M. Kendrick, and D. Sroaf. 2007. The park made of oil: towards a historical political ecology of the Kenneth Hahn State Recreation Area. *Local Environment* 12:153–181.

Cardno ENTRIX, and ENVIRON. 2014. 2013 Invasive Plant Inventory Inglewood Oil Field: Baldwin Hills CSD Provisions E.7.b. Freeport-McMorRan Oil & Gas, Los Angeles, California.

Dark, S., E. D. Stein, D. Bram, J. Osuna, J. Monteferante, T. Longcore, R. Grossinger, and E. Beller. 2011. Historical ecology of the Ballona Creek watershed. Southern California Coastal Water Research Project. Technical Report #671.

Federal Geographic Data Committee. 2008. National Vegetation Classification Standard FGDC-STD-005-2008 (Version 2).

Freudenberger, D. O., B. E. Fish, and J. E. Keeley. 1987. Distribution and stability of grasslands in the Los Angeles [California, USA] basin. *Bulletin Southern California Academy of Sciences* 86:13–26.

Homer, C., C. Huang, L. Yang, B. Wylie, and M. Coan. 2004. Development of a 2001 national land-cover database for the United States. *Photogrammetric Engineering & Remote Sensing* 70:829–840.

Jennings, M. D., D. Faber-Langendoen, O. L. Loucks, R. K. Peet, and D. Roberts. 2009. Standards for associations and alliances of the US National Vegetation Classification. *Ecological Monographs* 79:173–199.

Küchler, A. W. 1977. The map of the natural vegetation of California. Department of Geography, University of Kansas, Lawrence, KS.

Marine Research Specialists. 2008. Final Environmental Impact Report: Baldwin Hills Community Standards District. Los Angeles County Department of Regional Planning, Los Angeles, California.

Marqua, D. 1978. Plant life. Baldwin Hills Project: Inventory of Features. County of Los Angeles Department of Parks and Recreation, Los Angeles.

Mattoni, R., and T. R. Longcore. 1997. The Los Angeles coastal prairie, a vanished community. *Crossosoma* 23:71–102.

Molina, K. C., editor. 2001. *The biota of the Baldwin Hills: an ecological assessment*. Community Conservancy International and Natural History Museum of Los Angeles County Foundation, Los Angeles.

Sawyer, J. O., T. Keeler-Wolf, and J. Evens 2009. A manual of California vegetation. California Native Plant Society, Sacramento, CA.

Stoll, A. Q., J. G. Douglass, and R. Ciolek-Torrello. 2009. Searching for Guaspet: a mission period rancheria in west Los Angeles. *SCA Proceedings* 22:1–9.

Xie, Y., Z. Sha, and M. Yu. 2008. Remote sensing imagery in vegetation mapping: a review. *Journal of Plant Ecology* 1:9–23.

Yan, W. Y., A. Shaker, and N. Al-Ashmawy. 2015. Urban land cover classification using LiDAR data: a review. *Remote Sensing of Environment* 158:295–310.