

Coastal Cactus Wren & California Gnatcatcher Habitat Restoration Project

Encanto and Radio Canyons

San Diego, CA



Final Report

AECOM and
GROUNDWORK SAN DIEGO-CHOLLAS CREEK
for SANDAG



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BACKGROUND

In collaboration with Groundwork San Diego and the San Diego Association of Governments (SANDAG), AECOM was selected to enhance and restore existing and potential coastal cactus wren (*Campylorhynchus brunneicapillus*) and California gnatcatcher (*Polioptila californica californica*) habitat in Encanto and Radio Canyons. Groundwork San Diego-Chollas Creek (Groundwork) is an independent, not-for-profit, environmental business that works within San Diego's Chollas Creek Watershed to improve the environment, economy, and quality of life in the area through local community projects. Over the past several years, Groundwork has been an integral part of the restoration and enhancement of the Chollas Creek area. The project was funded by SANDAG under the *Transnet* Environmental Mitigation Program (EMP).

This project was identified as an opportunity to create and enhance habitat for the coastal cactus wren (Photo 1) and California gnatcatcher and offer a more native landscape for the community surrounding the sites. The habitat enhancement and restoration objectives included removal of nonnative plant cover and planting of approximately 20,000 new cholla cactus (*Cylindropuntia prolifera*), which is preferred nesting habitat for the coastal cactus wren. The California gnatcatcher would also benefit from the improved habitat, since this species is also present in the project area and uses maritime succulent scrub habitat in conjunction with coastal sage scrub habitat. Enhancement and expansion of areas with existing occupied gnatcatcher and cactus wren habitats improves and expands habitat for both species, improving the chances for the long-term health of local and regional populations. This project also offered a unique opportunity for students and residents within the surrounding canyon communities to play an important role in project planning and implementing of the coastal cactus wren.



Photo 1: Coastal cactus wren perched on its preferred cactus habitat

AECOM and Groundwork collaborated in the execution of project tasks. AECOM led the site mapping, habitat restoration, monitoring, maintenance, and reporting tasks, and Groundwork led the educational, community involvement, and publicity aspects of the project.

The project is located in the community of Encanto in southern San Diego, California, north of Market Street between Euclid Avenue and Merlin Drive (Figures 1 and 2). The total area of both canyons combined is 73.62 acres. Encanto Canyon consists of 37.24 acres and Radio Canyon consists of 36.38 acres. The entire project area is within the City of San Diego's Multi-Habitat Planning Area (MHPA). Encanto and Radio Canyons were selected because they offered a relatively unique mix of conditions:

1. Both canyons are owned primarily by the City of San Diego, which supported the restoration project.
2. Encanto Canyon was occupied habitat for the coastal cactus wren and California gnatcatcher.
3. Portions of the habitat in Encanto Canyon were degraded and would benefit from enhancement and restoration efforts.
4. Radio Canyon was a large canyon within the MHPA containing severely degraded habitats that offered an opportunity to expand available territory for the target species.
5. The Encanto community is a socioeconomically disadvantaged neighborhood that would benefit from the educational aspects of the project.

The coastal cactus wren habitat restoration project term was 2 years, and began in April 2009. This final report summarizes all project activities completed and results achieved. It concentrates primarily on documenting the restoration design approach and implementation of the project such that the information is accessible in future years for SANDAG or other entities to correlate observed levels of success to restoration methods.

PRE-IMPLEMENTATION

Pre-implementation began in June 2009. This phase consisted of mapping the project boundary, completing vegetation mapping and a plant and animal species inventory, completing preliminary presence/absence surveys for the coastal cactus wren within the project area, establishing a cactus propagation nursery site, and harvesting cholla to supply the propagation program.

Project Boundary Definition

Project boundary mapping was accomplished by AECOM biologists in June 2009. Site mapping consisted of physically walking around the boundary of the site and digitally recording points using a Trimble Global Positioning System (GPS) unit. The recorded points were later digitally plotted on a map by AECOM Geographical Information Systems (GIS) staff (Figure 3).

Vegetation Mapping and Species Inventory

AECOM's biologists conducted detailed mapping of the vegetation in Encanto and Radio Canyons to develop better documentation of pre-project habitat patterns within the project areas. Data collected helped to determine which areas within the canyons were suitable for habitat restoration and which areas already had good-quality habitat. Vegetation field mapping was completed in December 2009. Biologists noted the location and approximate sizes of individual and groups of plant species. Mapping concentrated primarily on documenting cactus and other perennial woody species, including nonnative

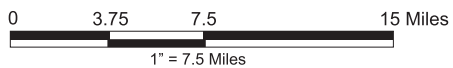
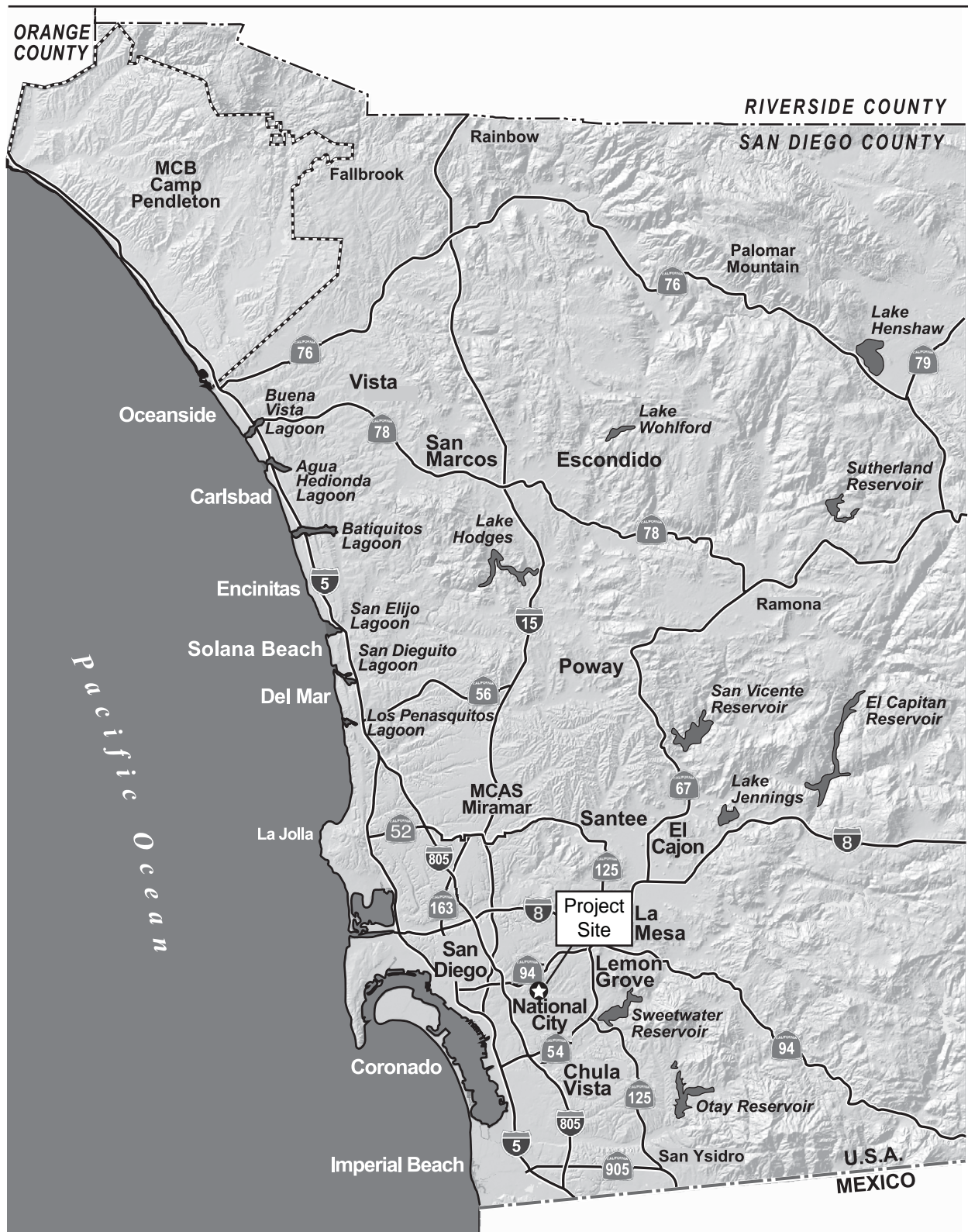


Figure 1
Regional Map

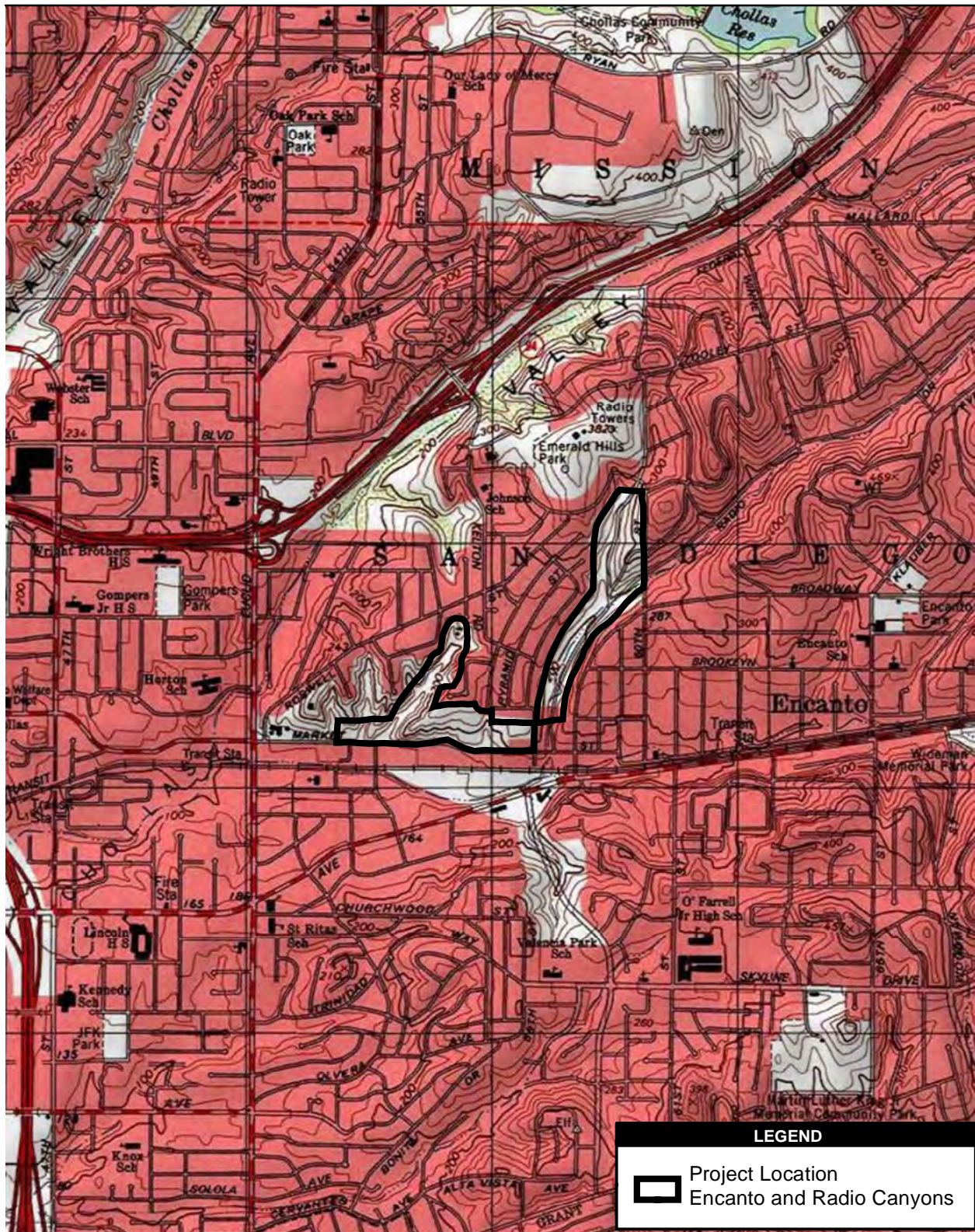
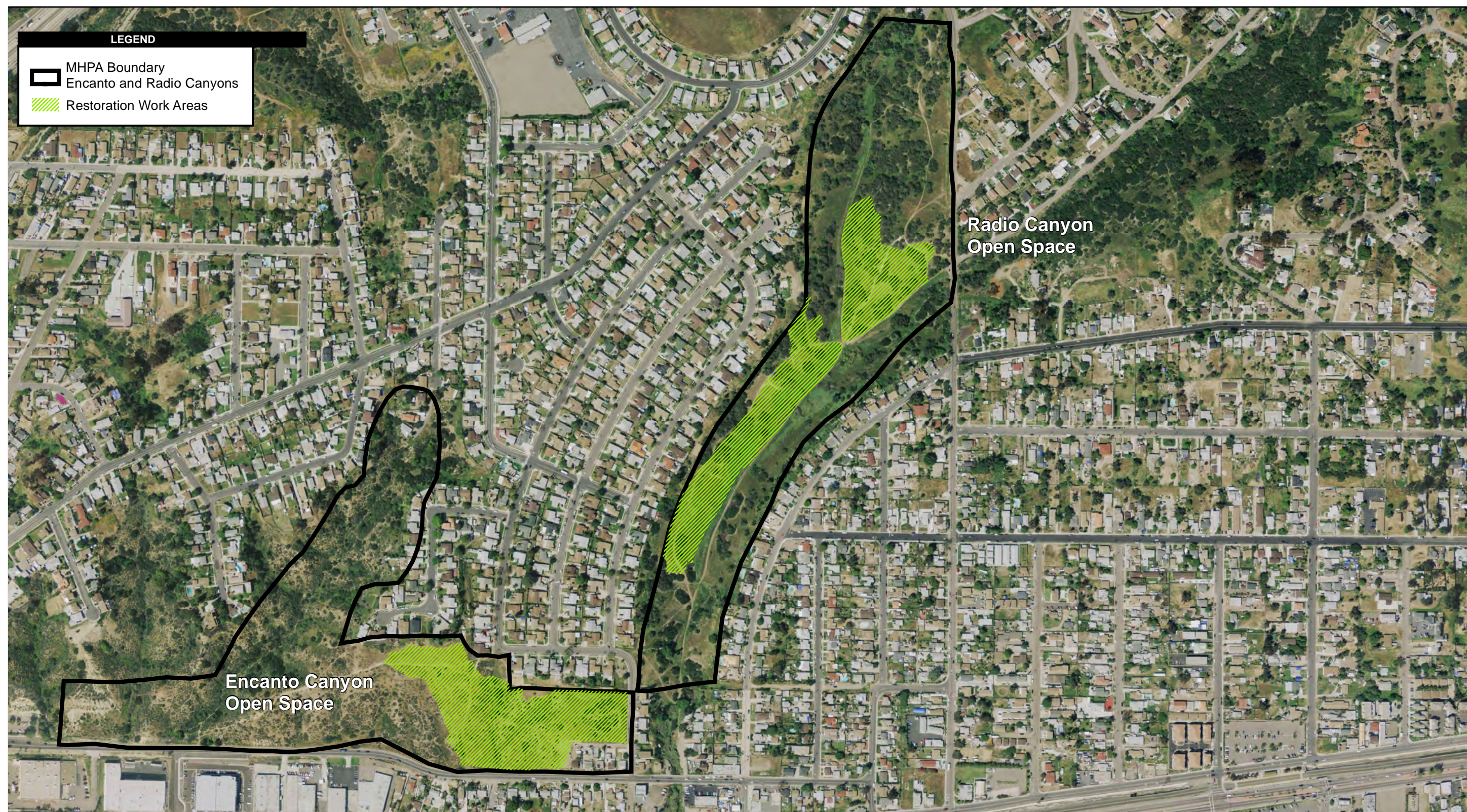


Figure 2
Project Location



Source: DigitalGlobe 2008; SanGIS 2009

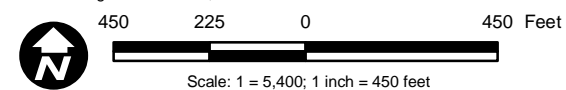


Figure 3
Restoration Site Boundary and Work Areas

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vegetation. The effort also included mapping overall vegetation communities, which was accomplished by generalizing the detailed information collected at the species level. Figure 4 depicts the results of the surveys, with species classified into habitat types. Areas within the project boundary in Figure 4 that are not shaded were dominated by nonnative species (primarily non-native grassland species) or disturbed land cover.

Habitat types within Encanto Canyon are predominantly coastal sage scrub and maritime succulent scrub (Photo 2). Common coastal sage scrub plant species within the project area are coastal sagebrush (*Artemesia californica*) and lemonadeberry (*Rhus integrifolia*). Common succulent plant species, located primarily on south-facing slopes within the project area, are coast cholla (*Cylindropuntia prolifera*), coast barrel cactus (*Ferocactus viridescens* var. *viridescens*), fish-hook cactus (*Mammillaria dioica*), and various dudleyas (*Dudleya* spp.). An abundant population of spineshrub (*Adolphia californica*) and jojoba (*Simmondsia chinensis*) exist adjacent to Market Street on exposed southern slopes. Habitat quality within Encanto Canyon varied widely. Habitat within the northern arm of the canyon was generally good quality, as was much of the habitat in the west end of the project area along Market Street. Populations of cactus wren and California gnatcatcher observed at the beginning of the project were located in these areas. The remaining areas within the canyon, particularly the eastern-most portion, consisted of large populations of exotic weeds or disturbed habitat and were identified as targets for habitat enhancement.

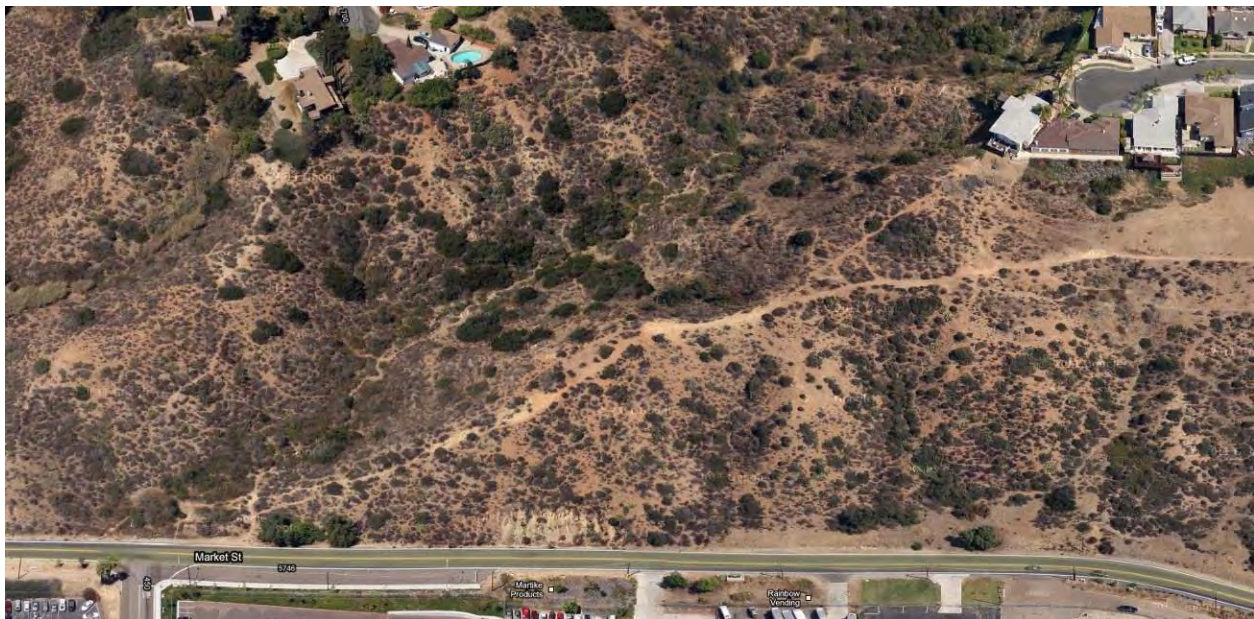


Photo 2: Representative view of Encanto Canyon habitats

Habitat types within Radio Canyon were primarily dominated by nonnative grassland and nonnative ornamental species, and were considered to be of poor habitat quality (Photo 3). Common species identified were acacia (*Acacia* sp.), palm trees (*Washingtonia* sp., *Phoenix* sp.), and nonnative grasses such as bromes (*Bromus* sp.), wild oats (*Avena* sp.), and mustards (*Brassica* sp.). Small fragments of coastal sage scrub and maritime succulent scrub plant species remained, but all habitats within Radio Canyon were degraded, making it unsuitable for use by the gnatcatcher or cactus wren. The project area



Photo 3: Representative view of Radio Canyon habitats

showed other signs of urban influence, such as litter and large trash items, which further degraded the quality of the habitat. Individual plant and animal species observed during initial surveys can be referenced in Appendix 1 and Appendix 2.

Coastal Cactus Wren and California Gnatcatcher Surveys

Establishing a baseline for the presence of the cactus wren and California gnatcatcher (Photo 4) was an important element of the project. The baseline documents how many wrens the habitat supported prior to the start of restoration, where they reside within the project area, and whether they were breeding. This data, tracked over the term of the project, can be used to make determinations about how the population responds to habitat restoration efforts.

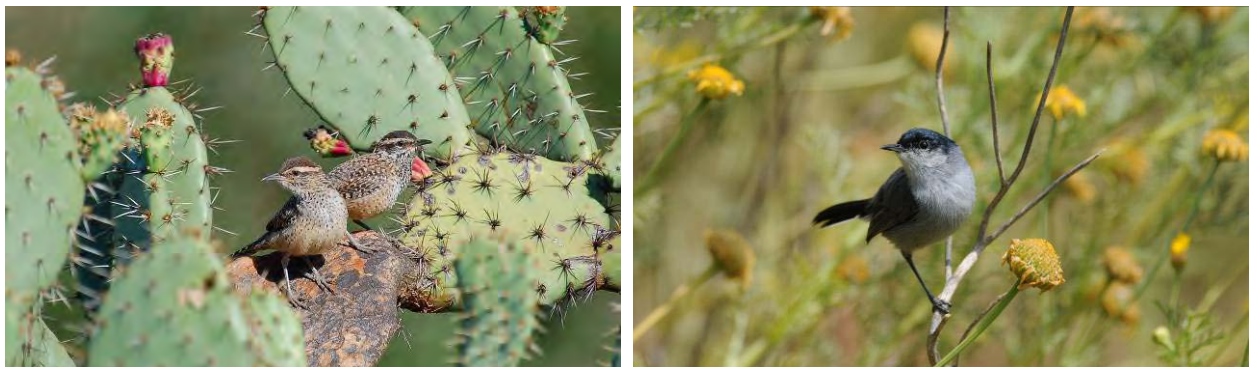


Photo 4: Coastal cactus wren juveniles (left) and California gnatcatcher (right)

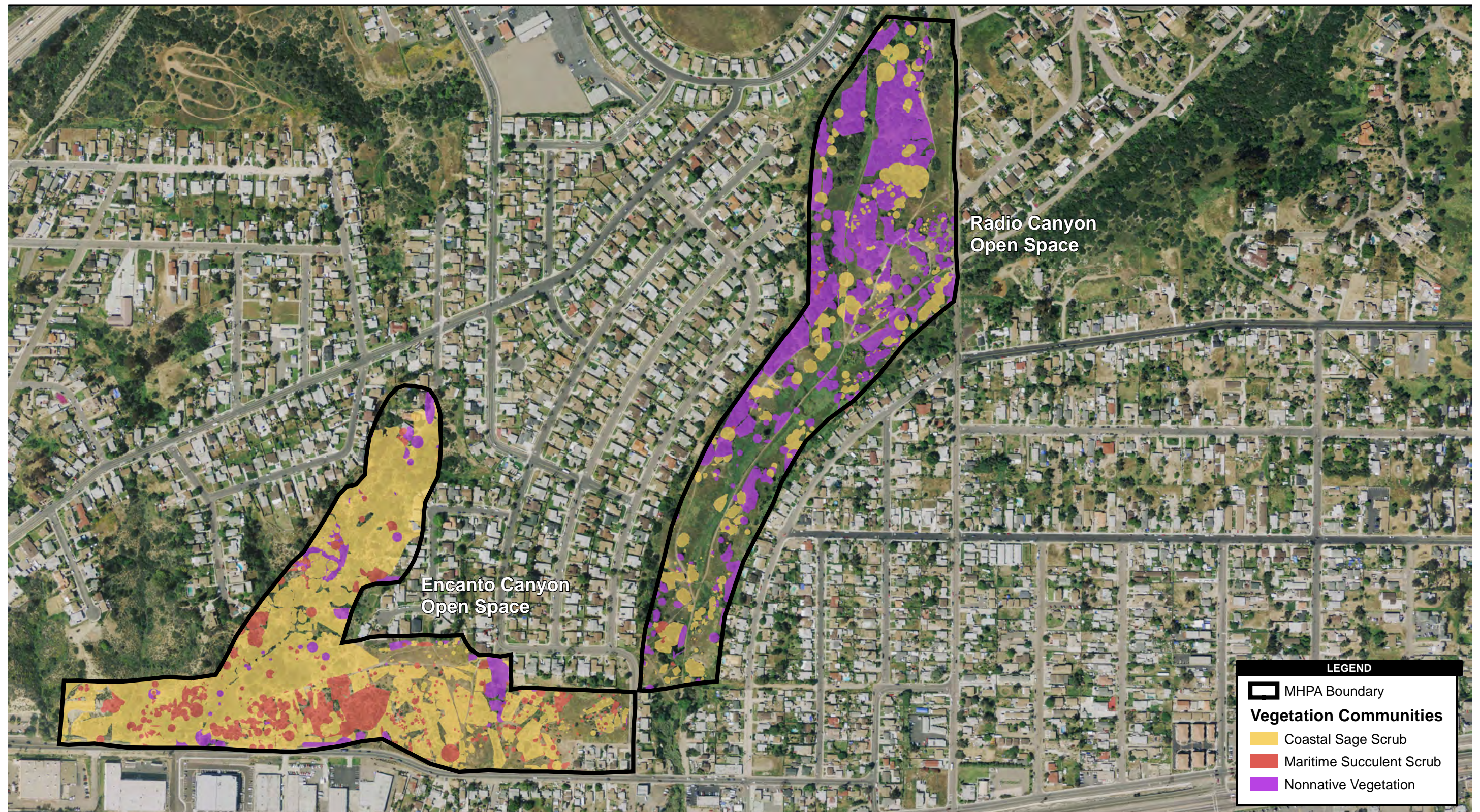


Figure 4
Vegetation Communities
in Encanto and Radio Canyons

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Informal coastal cactus wren surveys were conducted in Encanto Canyon due to the presence of suitable habitat. Surveys were not conducted in Radio Canyon due to the lack of suitable coastal cactus wren habitat. The baseline surveys occurred in spring 2009. Four surveys were conducted in 2009 (Table 1).

Table 1. 2009 Coastal Cactus Wren and California Gnatcatcher Survey Dates

Survey Date	AECOM Biologist
April 23, 2009	Andrew Fisher
May 7, 2009	Andrew Fisher
May 14, 2009	Andrew Fisher
May 20, 2009	Andrew Fisher

Coastal cactus wren and California gnatcatcher surveys were conducted during optimal times to detect these species and did not involve the use of any playback techniques. Surveys were conducted from early morning to mid-morning during periods of mild weather conditions appropriate for detecting birds. A biologist familiar with the behaviors, vocalizations, and habitats of coastal cactus wrens and California gnatcatchers conducted the surveys. The biologist meandered through suitable habitat and documented any vocalizing birds, nests, and behaviors indicative of nesting. When a coastal cactus wren or California gnatcatcher was detected, the bird was observed from a distance so as not to influence its normal behavior. The location of the bird and a rough delineation of its territory were recorded using a combination of GPS and field mapping methods.

Two coastal cactus wren pairs were observed during the 2009 surveys. Both pairs had numerous nests within their territories and nest building behavior was observed. Nesting sites were observed over time to determine if hatchlings were produced; no juvenile coastal cactus wrens were observed from either pair of coastal cactus wrens during 2009 surveys.

Encanto Canyon has a large population of California gnatcatchers that successfully breed each year. Numerous pairs with young and nests were observed. Individual observations of coastal cactus wren and California gnatcatcher are depicted in Figure 4.

Cholla Harvesting

Creation of cactus wren habitat focused primarily on establishing large new stands of cholla cactus. The goal of the project was to install approximately 20,000 individual cholla cactus on-site. Cholla cactus is a tree-like succulent shrub that grows in cylindrical segments that are easily separable, require minimal protection during transport, and readily root from the vegetative segments. These attributes lend the species well to harvesting and propagation programs. Harvesting cholla from plants within or adjacent to the project was eliminated from consideration to avoid the potential for detrimental effects to the existing coastal cactus wren population. The cholla segments used for propagation were collected from various host plants within San Diego County, with the majority originating from the Otay Mesa area. An estimated 6000 cuttings were harvested, ranging in length from approximately 6 to 24 inches. Most cuttings were 6 to 12 inches in length.

The cholla segments were collected by breaking pieces off of mature cholla plants in areas with dense cholla growth. Because cholla is spiny and not easily manipulated by hand, crews used a shovel blade to

knock segments into 5-gallon buckets. Once harvested, the cholla cuttings were transported to the AECOM restoration facility in National City, California, where they were stored until a propagation site for the project could be arranged. During this temporary storage period, the larger segments of cholla (approximately 1300 plants) were rooted in 1-gallon pots and the smaller segments were allowed to “scar off” (a natural process of cactus dormancy when segments are removed from the mature plant).

Plant Nursery Site Selection and Preparation

To maximize budget efficiency, the planting strategy relied on collecting a relatively small number of small cholla cuttings, which would then be increased in both size and number through a propagation program located near the project site. Groundwork’s relationship with Millennial Tech Middle School’s Earthlab, an outdoor education center with a large amount of usable open space, facilitated the use of the Earthlab site as the propagation nursery for this project. The Earthlab was an ideal location because it is located in the Encanto community near the project site. The proximity offered similar growing conditions to the project site and easy transport of plant materials from the nursery to the planting areas. Having the nursery site at a school also fostered local student and community involvement in the various stages of the project. A roughly 2,500-square-foot area on the east end of the Earthlab site was dedicated to the propagation program.

In August and September 2009, AECOM restoration crews prepared the nursery site for use by cleaning up trash, weeds, fallen branches, and other debris. An irrigation system was installed using an existing water source at the school. The irrigation system was built using polyvinyl chloride (PVC) pipe and rotating sprinkler heads. Soils at the propagation nursery are in the Huerhuero-Urban land complex, which is a moderately well-drained soil well-suited for cactus. Soils were not amended or tilled, and no fertilizers were used to prepare the area.

Cholla Propagation

The propagation nursery was ready for use in early September 2009. The harvested cholla segments were planted directly into the native soil. The 1300 larger cuttings kept in their 1-gallon pots at the AECOM nursery until they were planted. The remainder of the smaller cuttings were planted at the Earthlab propagation nursery. Cuttings were planted in orderly rows to facilitate maintenance and reharvesting (Photo 5). The cholla were irrigated and weeded as necessary by AECOM restoration staff until they were planted at the project site. Weeding was done primarily by chemical methods (glyphosphate-based herbicides). Irrigation was used primarily to aid establishment and rooting and was discontinued when the cuttings had successfully rooted.

ON-SITE IMPLEMENTATION

On-site implementation of the project began in July 2009. This phase of the project consisted of site preparation and planting cholla on-site.

Site Preparation

Site preparation began with the removal of nonnative plants within the planned planting area (Photos 6 and 7). Nonnative species can overwhelm many native species by competing for precipitation, sun, and space, which limits the value of the native habitat for native species such as the coastal cactus wren and California gnatcatcher. Nonnative species targeted for removal at the project site were Arundo (*Arundo donax*), black mustard (*Brassica nigra*), wild oats (*Avena barbata*), castor bean (*Ricinus communis*),



Photo 5: Earthlab propagation nursery



Photo 6: Typical pre-project winter conditions in Radio Canyon



Photo 7: Castor bean in Encanto Canyon

Russian thistle (*Salsola tragus*), brome (*Bromus diandrus*), iceplant (*Carpobrotus edulis*), fennel (*Foeniculum vulgare*), star thistle (*Centaurea melitensis*), crown daisy (*Chrysanthemum coronarium*), horehound (*Marrubium vulgare*), tree tobacco (*Nicotiana glauca*), fountain grass (*Pennisetum setaceum*), and smilo grass (*Piptatherum miliaceum*).

AECOM's implementation crews began an initial aggressive weed removal program on the restoration planting sites and a substantial additional buffer zone in June 2009. Initial weed control work, which included a combination of weed whipper removal, dethatching, hand weeding, and herbicide treatments (Round-up®; active ingredient glyphosate), was complete in October 2009 (Figure 5). A total of 7.8 acres in Encanto Canyon and 9.1 acres in Radio Canyon received initial weed control and dethatching. Care was taken to protect individual native plants during weed control efforts. All weed and thatch material was removed from the site and properly disposed of.

Planting

Three major cactus planting areas totaling approximately 12 acres were defined within the 16.9 acres that received weed control in Encanto and Radio Canyons (Figure 5). The overall size of the planting areas was determined by the number of cuttings available and the planting density required to achieve suitable cactus wren habitat. The planting locations targeted areas that lacked native vegetation and

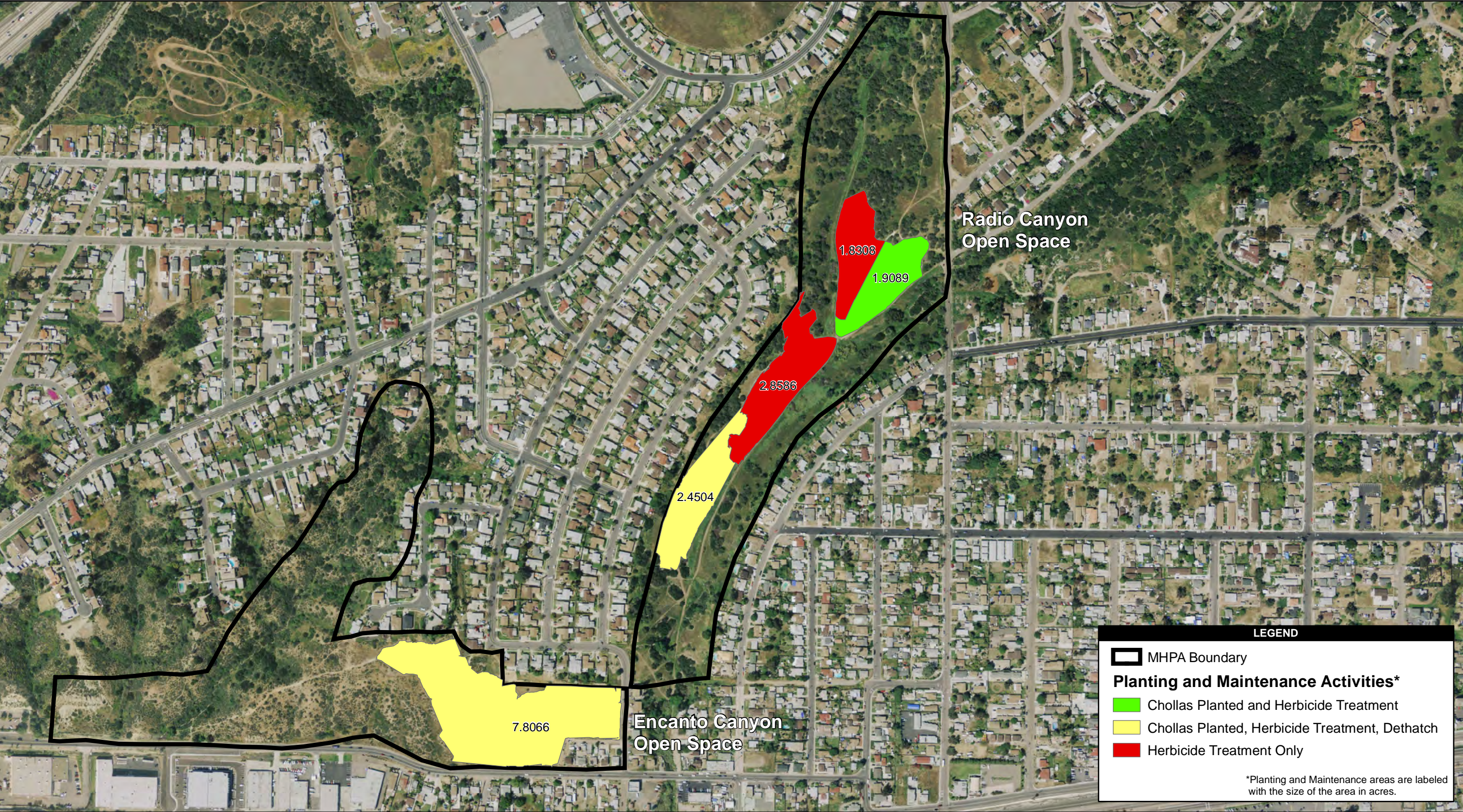


Figure 5
Planting and Maintenance Activities

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would benefit most from restoration. Planting locations were strategically placed to provide several habitat patches spaced throughout the canyon complex, allowing for a stepping stone pattern of habitats that can serve as the backbone for future restoration projects and for cactus wren use. Planting was concentrated in areas where weed control and dethatching had been most successful. This strategy will reduce potential competition from nonnative plants that may regenerate during the first few growing seasons.

The most cost-effective strategy to create cactus wren habitat is to plant large quantities of small cholla segments, which can be planted much faster than larger rooted specimens. However, that strategy does not provide near-term nesting opportunities for cactus wrens. Therefore, the chosen strategy for this project was to plant as many larger branched cacti as possible to provide potential nesting sites for the coastal cactus wren as soon as possible but to rely on the planting of many more smaller cuttings to provide the long-term bulk of habitat as they grow and mature. This strategy was implemented in two phases. The first phase consisted of planting 1,300 multi-branched, rooted cholla grown at the Earthlab propagation nursery that provided the initial structure needed within the planting islands (Photos 8 and 9). Phase 1 planting was completed during the winter of 2009/2010. The second phase (installing approximately 19,000 small cholla segments from the nursery stock at the Earthlab) was implemented in December 2010. Some of the rooted Earthlab cholla had grown large (up to two feet in height), which helped supplement the larger cactus planted the previous year. The remainder of the phase 2 plantings consisted of many thousands of short cholla segments.



Photo 8: Typical 2009/2010 planting in Radio Canyon



Photo 9: Typical 2009/2010 planting in Encanto Canyon

The cuttings were installed in a manner that mimics natural plant distribution (e.g., random and/or aggregate distributions rather than uniform rows). The cacti were planted by hand using shovels, trowels, and tongs. They were also planted using a method called “scratching in,” whereby the surface of the soil was scraped with rakes or shovels to loosen the soil surface and then the cactus segments were placed on top of the soil and expected to root during the rainy season. Planting was completed by AECOM restoration crews and students and volunteers from the community.

Irrigation

No irrigation system was installed on-site within the planting areas. Cholla cactus naturally requires little moisture to survive. It was assumed that the planted segments would be able to establish on-site with natural precipitation in the form of rain. The planting efforts were timed to occur during the winter rainy season, October through February. Planting occurred after a rain event so that the soil was saturated and moist. The cholla segments were not watered after planting and continued to establish from further rain events.

MONITORING AND MAINTENANCE

The monitoring and maintenance phase of the project began after implementation and continued through the end of the project. Monitoring consisted of follow-up bird surveys and basic restoration status observations. Maintenance consisted primarily of continued weed treatment and trash removal.

Coastal Cactus Wren and California Gnatcatcher Surveys

A second set of coastal cactus wren and California gnatcatcher surveys was performed in Encanto Canyon during 2010. Four surveys were performed during 2010 (Table 2). Two coastal cactus wren pairs were observed during surveys within the project limits of Encanto Canyon. An additional coastal cactus wren pair was observed within Encanto Canyon in a small finger canyon just outside the project boundary. Both pairs within the project boundary had built new nests since 2009 and exhibited nest-building behavior. One pair successfully raised at least two young and this family group was observed foraging together. The other pair of wrens had an active nest. The nest was observed for 2 weeks and, on the last survey, no young had emerged. It is not possible to tell if this pair was successful in 2010. The pair of coastal cactus wrens located just outside the project boundary successfully raised at least two young. Therefore, there are at least three pairs of coastal cactus wrens within and adjacent to Encanto Canyon, and two of the pairs successfully raised young in 2010.

Table 2. 2010 Coastal Cactus Wren and California Gnatcatcher Survey Dates

Survey Date	AECOM Biologist
March 15, 2010	Andrew Fisher
March 25, 2010	Andrew Fisher
May 6, 2010	Andrew Fisher
June 1, 2010	Andrew Fisher

Encanto Canyon has a large population of coastal California gnatcatchers that successfully breed each year. Numerous pairs with young and nests were observed. Individual observations of both coastal cactus wren and California gnatcatcher are depicted in Figure 6.

Site Maintenance

Weeds represent the greatest threat both to the successful establishment of native species and the long-term habitat value of the restored habitat. Given the high density of nonnative and invasive species within the restoration project area (Photo 10) and the short-duration maintenance funded by the Transnet grant, diligent weed control efforts through the life of the project were considered crucial to success. Nonnative species targeted for removal at the project site were Arundo, black mustard, wild oats, castor bean, Russian thistle, brome, iceplant, fennel, star thistle, crown daisy, horehound, tree tobacco, fountain grass, and smilo grass.

AECOM's implementation crews conducted periodic maintenance visits during the term of the project (Table 3; Figure 5). Maintenance activities included a combination of weed whipper removal, dethatching, hand weeding, and herbicide treatments (Round-up®; active ingredient glyphosate). To further protect the planting areas from weed encroachment, a weed maintenance buffer was created



Photo 10: Typical winter weed conditions before dethatching



Photo 11: Typical on-site vs. off-site winter weed conditions after weed kill and dethatching

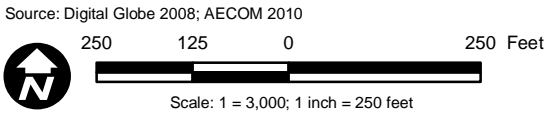
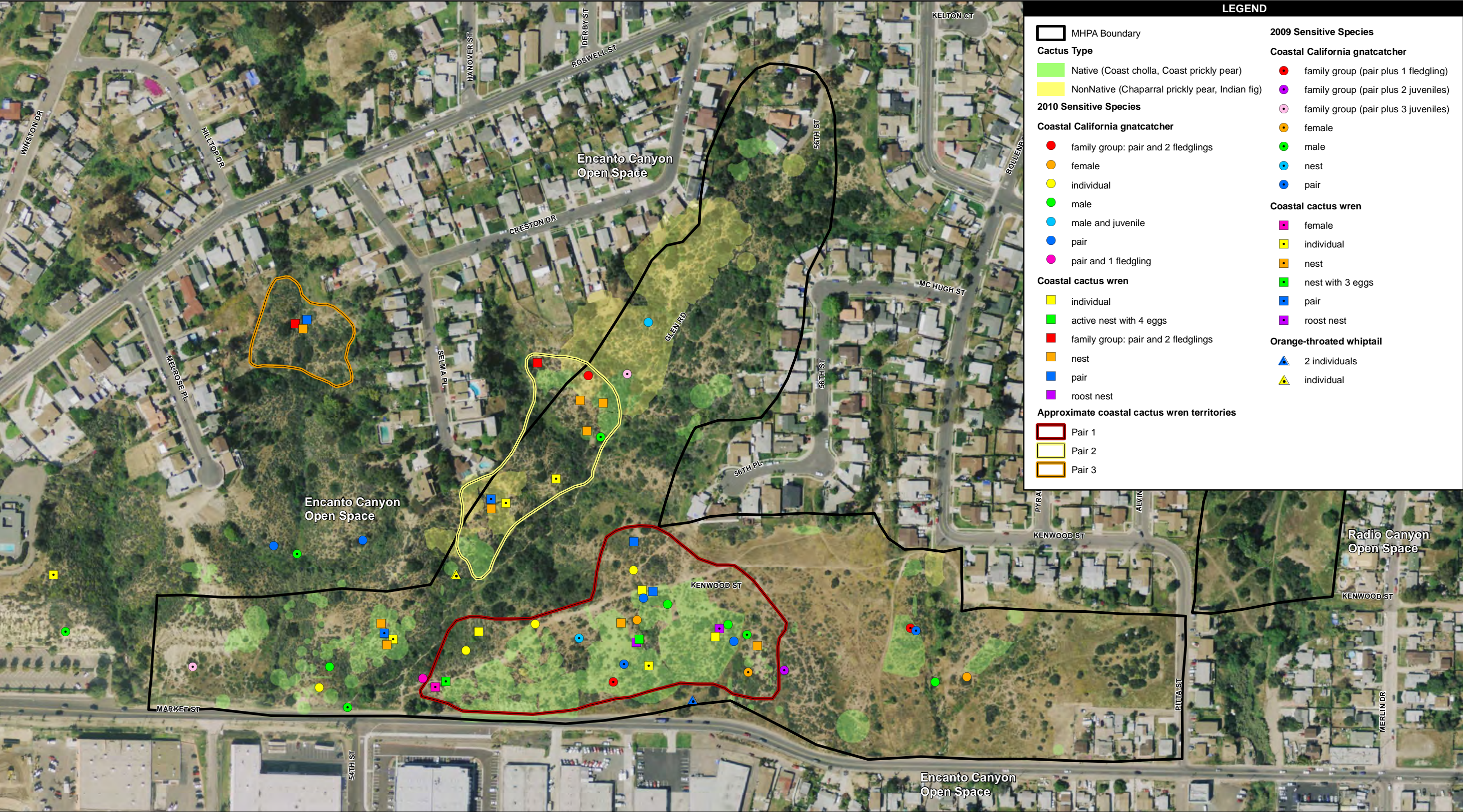


Figure 6
Coastal Cactus Wren and California Gnatcatcher
Survey Results

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Table 3. Site Preparation and Maintenance Activities for Encanto and Radio Canyons

Date	Activity Performed
June and July 2009	Dethatch Radio Canyon
August and September 2009	Dethatch Encanto Canyon
December 2009	Cholla Planting at Radio and Encanto Canyons
March and April 2010	Weed Treatments at Radio and Encanto Canyons
July 2010	Weed Treatments at Radio and Encanto Canyons
October 2010	Cholla Planting at Radio and Encanto Canyons
December 2010	Weed Treatments at Radio and Encanto Canyons
December 2010	Cholla Planting at Radio and Encanto Canyons

around the planting areas and kept free of weeds and debris for the term of the project (Photo 11). The weed buffer was also expected to add visual prominence to the planted areas to help create awareness for the enhancement activities that were being performed. All weed and thatch material was removed from the site and properly disposed of. AECOM's restoration ecologists monitored weed conditions each year so that weeding efforts could be strategically timed to treat the widest possible range of weed species with the minimum number of treatments, while never allowing them to reseed. In addition to the initial weeding efforts conducted in summer 2009, major weed eradication was completed twice in each growing season.

Education, Community Involvement, and Publicity

The project's educational efforts have resulted in a strong and sustainable partnership between Groundwork and Millennial Tech Middle School. Over the two years of the project, a broad spectrum of hands-on, habitat-based activities have been developed to align with the school's model Conservation Science course enrolling 70 students per year. Experts from the U.S. Fish and Wildlife Service, the San Diego Zoo's Beckman Center for Conservation Research, and AECOM came together to pose research questions that guided the work of the larger student group and that of the two students whose San Diego Science Fair entries featured the cactus wren. Students now work in the field, mentored by biologists and other professionals, to work on activities to include cactus propagation, soil and water quality monitoring, wren monitoring, habitat restoration, and community education and outreach. They visit the Beckman Center annually to study the genetic characteristics of the wren in the larger context of species extinction. They will also host and inform policy makers such as Senator Chris Kehoe about the value of their community's biodiversity, the wren, and student contributions toward the conservation of natural resources. The students also organize "Conservation Science Saturdays", where they work alongside family members and neighbors to install in the canyons the cacti they have helped propagate at their Earthlab.

Media coverage has been widespread, including the UT, the Voice of San Diego, the San Diego Zoo website, the Groundwork website, and the San Diego Unified School District Newsletter. Groundwork's media partner, Scribe Communication, continues to place stories.

RESULTS/CONCLUSIONS

Habitat Enhancement

Habitat restoration and enhancement efforts in Encanto and Radio Canyons achieved initial project goals. Planting efforts have improved the quality of the canyon environments and increased potential habitat for the coastal cactus wren, California gnatcatcher, and other native plant and animal species in the area. Site maintenance activities, including dethatching, herbicide spraying, and trash removal, increased the quality of habitat and improved the potential for native species to continue to occupy the project area. In addition, improving the quality of habitat in these canyons helps to address the goals of the City of San Diego's Multiple Species Conservation Program (MSCP) by contributing to the native habitat and habitat connectivity in the region.

Coastal Cactus Wren and California Gnatcatcher

It is too early to determine through measurable results if the restoration project provided real benefits for the coastal cactus wren and California gnatcatcher. The habitats are not yet mature enough to expect birds to occupy them, and no birds have yet been observed. However, it is possible to determine that the quality and distribution of cactus wren habitat is already improved and is highly likely to continue improving without further active restoration efforts. We expect a number of benefits to the coastal cactus wren and California gnatcatcher as the restoration areas mature:

- **Expanded Habitat Acreage:** New habitat has been created that can help expand the ranges of both of these species into previously unsuitable habitat. This may help in expanding the local population of these species within the canyons. The expanded habitat may also help establish populations that are more capable of withstanding annual population fluctuations, thus fortifying the population over the longer term.
- **Increased Distribution of Habitats:** The distribution of new cactus habitat in stepping stone patches will permit the expansion of occupied coastal cactus wren and gnatcatcher territories and will promote the creation of new territories by providing sufficient vegetative cover for these species during routine activities such as foraging for food. Coastal cactus wrens and California gnatcatchers are vulnerable to predators without sufficient vegetative cover that camouflages them and offers protection. The planting of cactus in stepping stone patches will allow dispersing birds to move through the habitat matrix with more protection and gain access to a much wider range that is close to protective cover.
- **Reduced Fire Hazard:** The removal of exotic weeds has reduced the potential for a wild fire to quickly burn through the canyons, which could severely damage the habitat and the existing bird populations.

Education, Community Involvement, and Publicity

The natural resources of the Chollas Creek Watershed have been significantly, but not irreversibly, compromised by development, neglect, insufficient public and private resources, and misunderstanding. The Coastal Cactus Wren and California Gnatcatcher Habitat Restoration Project in Encanto and Radio Canyons has generated amongst students, residents, community leaders, and decision-makers an awareness of the rich biodiversity and special status species of statewide significance that exist in and adjacent to their schools and neighborhoods. It has allowed them to experience firsthand the pride associated with environmental and community service, and the satisfaction of knowing their efforts

make a difference. It has cleared away much of the non native habitat that for so long has trapped trash and pollution and harbored the criminal and homeless elements that make the canyons a frightening place to be.

This burgeoning commitment is serving as the basis for new partnerships (Walk San Diego, the Jacobs Center for Neighborhood Innovation, San Diego City Schools), and new funding possibilities (Strategic Growth Council Urban Greening grant, San Diego Foundation grant, USFWS Partners Program) to return to its natural state one of the most ecologically and aesthetically significant resources in the watershed.

RECOMMENDATIONS

The work funded by this project has taken the important first step in restoring native habitats in Radio and Encanto Canyons, which will support conservation goals for the coastal cactus wren and other species. Given the highly disturbed nature of the project area and its surroundings, particularly in Radio Canyon, it would be highly advisable to follow this initial project with subsequent phases of work aimed at both measuring the efficacy of the restoration already complete and implementing additional restoration work. Additional restoration could target either improving the quality of the current restoration areas or expanding into new restoration areas. This report provides the following recommendations for the future of work in Radio and Encanto Canyons.

More work should be done to protect and improve the Phase I restoration areas and to continue avian and restoration monitoring. Recommendations targeting these goals include:

- **Monitoring:** It is critical to monitor the performance and effectiveness of habitat restoration in relation to project goals. For this project area, the key monitoring question is to determine whether and at what point coastal cactus wrens and gnatcatchers begin foraging and/or nesting in the new habitat. A robust monitoring program should be implemented that documents coastal cactus wren and California gnatcatcher use of the area for a minimum of 5 years. The monitoring program should also document growth rates, native and weed species cover, and species diversity within restoration areas, and should develop a photo log from set photo points.

Avian monitoring methods should be coordinated with regional coastal cactus wren monitoring programs to ensure consistency of data and efficiency of effort. Potential methods for monitoring could include banding, GPS/telemetry tracking, or motion activated remote cameras aimed at active nests. Banding methods are generally the easiest to implement, but are most effective when monitoring of banded birds occurs over an area broader than the immediate project area. Broader monitoring for banded birds allows the monitoring program greater probability of capturing regional dispersal patterns of birds beyond Encanto and Radio canyons. Habitat and avian monitoring programs should ideally begin immediately to keep a continuous record of data. Avian monitoring must be done by qualified professional bird biologists, but basic monitoring of restoration area growth and condition could be done by community members or Earthlab students.

- **Restoration Enhancement:** Phase I restoration work concentrated exclusively on cholla cactus establishment and initiating a weed eradication program. Given the poor pre-project condition of the planting areas and their surroundings, weed issues will certainly remain a significant threat to restoration success for several more years until the planting areas fully mature. Continuing restoration effort should be initiated that concentrates on further maintenance and

enhancement of the Phase I planting areas. Continuing restoration should ideally span 5 years and should concentrate on weed eradication and planting additional maritime succulent scrub and coastal sage scrub species between existing cactus planting. These restoration actions will ensure efforts to date are not lost to weeds or urban pressures and will provide a more complete habitat that serves all aspects of the cactus wren's ecological needs. It will also broaden the value of the restoration area to a larger suite of species. Restoration enhancement work should ideally begin in the fall of 2011 to maintain a continuous weed abatement effort and to allow for the planting of additional species before cactus patches get too dense to work within. If funding for new plantings is unavailable in the near-term, weed abatement should continue as a stand-alone effort so that weed control progress done to date is not lost.

Restoration planning should be done by professional restoration ecologists. Implementation should be completed by experienced restoration contractors; however, contracted work could be augmented by community stewardship efforts completed at the direction of an experienced restoration contractor. Stewardship efforts are likely most effective when targeted on assisting with plant propagation (i.e. seed/cutting collection and growing of seedlings) or plant material installation. Weed abatement programs for large restoration areas are typically most effective when they focus primarily on chemical methods. All chemical use must be done under the supervision of a person who holds a Qualified Applicator License (QAL) and is highly knowledgeable in native plant identification and weed eradication programs.

We recommend that Groundwork San Diego seek the services of an experienced restoration ecologist to prepare a detailed restoration plan focusing on the restoration enhancement goal. That plan would outline the intended project goals and methods, and would provide an implementation roadmap that could be followed by contractors, community stewards, and students alike.

While restoration and monitoring work continues, a long-term strategic master plan for the entire canyon complex should be prepared that guides the work of near term and long-term work in the canyons.

- **Master Plan:** San Diego's urban canyons experience a complex mix of pressures and support. They are expected to support biological values and public access/recreation values. A holistic conceptual master plan that provides a comprehensive view of the issues and opportunities and long-term goals for an entire canyon would provide multiple benefits for the coastal cactus wren restoration efforts into the future. A master plan would provide an opportunity to lay out the most ecologically beneficial pattern of habitat; identify a reasonable public access plan that is informed by ecological sensitivities; and establish an organized implementation strategy that addresses inter-stakeholder coordination, phasing strategies, cost estimates, regulatory needs, and potential funding sources. It would allow community and nonprofit groups to efficiently and effectively apply volunteer efforts to long-term goals. It would also provide a high level of confidence to funding agencies that their contributions will be effectively applied to targeted goals. Phase II work should include the preparation of a framework master plan that addresses each of these issues.

The final aspect of future restoration needs in the canyon is the expansion of the footprint of restoration work in Encanto and Radio Canyons. Expansion of restoration work should proceed as outlined in the canyon master plan recommended above. Generally, restoration in the canyons should address the following:

- Coastal cactus wren habitat, specifically maritime succulent scrub patches dominated by cholla cactus, should be further expanded by increasing the size of the current patches and/or creating new patches. Coastal cactus wren habitat should be carefully located to maximize benefit to the species and facilitate safe movement throughout the two canyons.
- Coastal sage scrub habitat should be restored to support the California gnatcatcher. This habitat should ideally become the background matrix habitat in Radio Canyon, with maritime succulent scrub habitat emerging in the hot, dry slopes most suited to that habitat.
- The ephemeral drainage defining the spine of each canyon should be restored, including the removal of arundo and other invasive exotics and establishing riparian scrub habitats where hydrology will support them. Existing storm drain and street runoff problems currently causing erosion should be addressed as well. Riparian habitat restoration should avoid establishing large tree species that could facilitate raptor predation on the coastal cactus wren or California gnatcatcher population.
- As restoration success is achieved in Radio Canyon, restoration of disturbed habitats to the north of the canyon should be considered as a tool to facilitate safe movement of coastal cactus wrens between populations elsewhere in the region.

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APPENDIX 1: FLORAL SPECIES LIST FOR ENCANTO AND RADIO CANYON

FAMILY	SCIENTIFIC NAME	COMMON NAME
ANGIOSPERMS		
EUDICOTS		
Adoxaceae		
	<i>Sambucus nigra</i> spp. <i>caerulea</i>	Mexican elderberry, blue elderberry
Amaranthaceae		
	<i>Atriplex semibaccata</i> *	Australian saltbush
	<i>Salsola tragus</i> *	tumbleweed
Agavaceae		
	<i>Agave americana</i> *	agave
	<i>Agave attenuate</i> *	fox-tailed agave
Aizoaceae		
	<i>Aptenia cordifolia</i> *	baby sun rose
	<i>Carpobrodus edulis</i> *	hottentot-fig
	<i>Malephora crocea</i> var. <i>crocea</i> *	Crocea iceplant
Anacardiaceae		
	<i>Malosma laurina</i>	laurel sumac
	<i>Rhus integrifolia</i>	lemonadeberry
	<i>Shinus molle</i> *	Peruvian pepper tree
	<i>Schinus terebinthifolius</i> *	Brazilian pepper tree
Apiaceae		
	<i>Foeniculum vulgare</i> *	fennel
Asteraceae		
	<i>Ambrosia psilostachya</i>	western ragweed
	<i>Artemisia californica</i>	California sagebrush
	<i>Artemisia douglasiana</i>	Douglas mugwort
	<i>Artemisia dracunculus</i>	tarragon
	<i>Baccharis emoryi</i>	Emory's baccharis
	<i>Baccharis salicifolia</i>	mule fat
	<i>Baccharis sarothroides</i>	broom baccharis
	<i>Dienandra fasciculata</i>	fascicled tarweed
	<i>Centaurea melitensis</i> *	totalote
	<i>Centaurea solstitialis</i> *	star-thistle
	<i>Chrysanthemum coronarium</i>	crown daisy
	<i>Conyza canadensis</i>	horseweed
	<i>Cynara cardunculus</i>	artichoke thistle
	<i>Encelia californica</i>	coast sunflower
	<i>Eriophyllum confertiflorum</i> var. <i>confertiflorum</i>	long-stem golden arrow
	<i>Hazardia squarrosa</i> var. <i>squarrosa</i>	southern sawtooth goldenbush
	<i>Heterotheca grandiflora</i>	telegraph weed
	<i>Pseudognaphalium canescens</i>	everlasting cudweed
	<i>Stephanomeria virgata</i> ssp. <i>pleurocarpa</i>	tall wreath plant

FAMILY	SCIENTIFIC NAME	COMMON NAME
Brassicaceae	<i>Brassica sp.*</i> <i>Brassica tournefortii*</i> <i>Rhaphanus sativus*</i>	mustard Saharan mustard wild radish
Cactaceae	<i>Cylindropuntia prolifera</i> <i>Ferocactus viridescens</i> var. <i>viridescens</i> <i>Mammalaria dioica</i> <i>Opuntia ficus-indica*</i> <i>Opuntia littoralis</i> <i>Opuntia oricola</i>	coast cholla coast barrel cactus fish-hook cactus mission prickly pear coast prickly pear chaparral prickley pear
Capparaceae	<i>Peritoma arborea</i>	bladderpod
Crassulaceae	<i>Crassula argentea*</i> <i>Crassula sp.</i> <i>Dudleya edulis</i> <i>Dudleya lanceolata</i> <i>Dudleya pulverulenta</i>	jade pygmyweed ladies' fingers lance-leaf dudleya chalk dudleya
Cucurbitaceae	<i>Marah macrocarpus</i>	wild cucumber
Euphorbiaceae	<i>Chamaesyce polycarpa</i> <i>Croton setigerus</i> <i>Euphorbia tirucalli</i>	small seed sandmat doveweed sticks on fire
Fabaceae	<i>Acacia melanoxylon*</i> <i>Acacia redolens*</i> <i>Astragalus sp.</i> <i>Lotus scoparius</i> var. <i>scoparius</i>	Tazmanian blackwood Desert carpet locoweed coastal deerweed
Frankeniaceae	<i>Frankenia salina</i>	alkali heath
Geranaceae	<i>Erodium cicutarium*</i>	red-stem filaree
Juglandaceae	<i>Juglans sp.*</i>	walnut
Lamiaceae	<i>Marrubium vulgare*</i> <i>Salvia apiana</i> <i>Salvia mellifera</i>	horehound white sage black sage
Magnoliaceae	<i>Magnolia grandiflora*</i>	Southern magnolia
Malvaceae	<i>Malvella leprosa</i> <i>Malacothamnus fasciculatus</i>	alkali mallow chaparral bushmallow

FAMILY	SCIENTIFIC NAME	COMMON NAME
Myrtaceae	<i>Melaleuca</i> sp.*	myrtle
Oleaceae	<i>Fraxinus</i> sp.	ash
Phrymaceae	<i>Mimulus aurantiactus</i>	monkeyflower
Polemoniaceae	<i>Navarretia hamata</i> ssp. <i>hamata</i>	hooked skunkweed
Plumbaginaceae	<i>Plumbago auriculata</i> *	cape leadwort
Polygonaceae	<i>Chorizanthe</i> sp. <i>Eriogonum fasciculatum</i> var. <i>fasciculatum</i> <i>Rumex crispus</i> *	spineflower California buckwheat curly dock
Rhamnaceae	<i>Adolphia californica</i> <i>Ceanothus tomentosus</i> <i>Rhamnus crocea</i>	spineshrub Ramona lilac Spiny redberry
Rosaceae	<i>Adenostoma fasciculatum</i> <i>Cotoneaster</i> sp.* <i>Heteromeles arbutifolia</i>	chamise cotoneaster toyon
Salicaceae	<i>Populus fremontii</i> ssp. <i>fremontii</i> <i>Salix goodingii</i> <i>Salix lasiolepis</i>	western cottonwood black willow arroyo willow
Simmondsiaceae	<i>Simmondsia chinensis</i>	jojoba
Solanaceae	<i>Nicotiana glauca</i> * <i>Solanum parishii</i> <i>Lycium andersonii</i>	tree tobacco Parish's nightshade waterjacket
Urticaceae	<i>Urtica urens</i> *	dwarf nettle
ANGIOSPERMS		
MONOCOTS		
Agavaceae	<i>Agave americana</i> * <i>Agave attenuata</i> * <i>Yucca schidigera</i>	agave fox-tailed agave Mojave yucca
Arecaceae	<i>Phoenix canariensis</i> * <i>Washingtonia robusta</i> *	Canary island date palm Mexican fan palm

FAMILY	SCIENTIFIC NAME	COMMON NAME
Alliaceae	<i>Allium</i> sp.	onion
Cyperaceae	<i>Cyperus involucratus</i> *	African umbrella plant
Hyacinthaceae	<i>Chlorogalum parviflorum</i>	small-flower soap plant
Iridaceae	<i>Sisyrinchium bellum</i>	blue-eyed grass
Poaceae	<i>Arundo donax</i> *	giant reed grass
	<i>Avena barbata</i> *	wild oat
	<i>Bromus diandrus</i> *	Rip-gut brome
	<i>Bromus</i> ssp.*	bromes
	<i>Pennisetum setaceum</i> *	African fountain grass
	<i>Piptatherum miliaceum</i> *	Smilo grass
	<i>Stipa</i> sp.	needlegrass

* Indicates a nonnative plant species (introduced).

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APPENDIX 2: WILDLIFE SPECIES OBSERVED DURING WILDLIFE SURVEYS AT ENCANTO AND RADIO CANYONS

SCIENTIFIC NAME	COMMON NAME
INVERTEBRATES	
Order Lepidoptera	Insects and Butterflies
Family Pieridae	
<i>Anthocaris sara</i>	Sara orangetip
Family Lycaenidae	
<i>blue</i> sp.	blue species
Family Nymphalidae	
<i>Nymphalis antiopa</i>	mourning cloak
<i>Vanessa cardui</i>	painted lady
REPTILES	
Order Squamata	Lizards and Snakes
Family Phrynosomatidae	
<i>Uta stansburiana</i>	side-blotched lizard
<i>Sceloporus occidentalis</i>	western fence lizard
Family Teiidae	
<i>Aspidoscelis hyperthya beldingi</i> *	orange-throated whiptail
<i>Cnemidophorus tigris stejnegeri</i> +	coastal western whiptail
Family Anguidae	
<i>Elgaria multicarinata</i>	southern alligator lizard
BIRDS	
Order Falconiformes	Diurnal Birds of Prey
Family Accipitridae	
<i>Accipiter cooperii</i> +	Cooper's hawk
<i>Accipiter striatus</i>	sharp-shinned hawk
<i>Buteo jamaicensis</i>	red-tailed hawk
<i>Buteo lineatus</i>	red-shouldered hawk
Family Falconidae	
<i>Falco sparverius</i>	American kestrel
Order Galliformes	Magapodes, Curassows, Pheasants, and Relatives
Family Odontophoridae	
<i>Callipepla californica</i>	California quail
Order Columbiformes	Pigeons and Doves
Family Columbidae	
<i>Zenaida macroura</i>	mourning dove
Order Apodiformes	Hummingbirds and Swifts
Family Apodidae	
<i>Aeronautes saxatalis</i>	white-throated swift
Family Trochilidae	
<i>Calypte anna</i>	Anna's hummingbird

SCIENTIFIC NAME	COMMON NAME
Order Piciformes	Woodpeckers
Family Picidae	
<i>Picoides nuttallii</i>	Nuttall's woodpecker
Order Passeriformes	Song birds
Family Tyrannidae	
<i>Myiarchus cinerascens</i>	ash-throated flycatcher
<i>Empidonax difficilis</i>	pacific-slope flycatcher
<i>Sayornis nigricans</i>	black phoebe
Family Corvidae	
<i>Aphelocoma californica</i>	western scrub jay
<i>Corvus corax</i>	common raven
Family Hirundinidae	
<i>Stelgidopteryx serripennis</i>	northern rough-winged swallow
Family Aegithalidae	
<i>Psaltirparus minimus</i>	bushtit
Family Troglodytidae	
<i>Thryomanes bewickii</i>	Bewick's wren
<i>Troglodytes aedon</i>	house wren
<i>Campylorhynchus brunneicapillus</i>	coastal cactus wren
<i>sandiegensis</i> *	
Family Sylviidae	
<i>Polioptila californica californica</i> ¹	coastal California gnatcatcher
Family Turdidae	
<i>Sialia mexicana</i>	western bluebird
Family Timaliidae	
<i>Chamaea fasciata</i>	wrentit
Family Mimidae	
<i>Mimus polyglottos</i>	northern mockingbird
<i>Toxostoma redivivum</i>	California thrasher
Family Sturnidae	
<i>Sturnus vulgaris</i>	European starling
Family Bombycillidae	
<i>Bombycilla cedrorum</i>	cedar waxwing
Family Parulidae	
<i>Dendroica coronata</i>	yellow-rumped warbler
<i>Vermivora ruficapilla</i>	Nashville warbler
<i>Vermivora celata</i>	orange-crowned warbler
<i>Wilsonia pusilla</i>	Wilson's warbler
Family Emberizidae	
<i>Melospiza melodia</i>	song sparrow
<i>Pipilo crissalis</i>	California towhee
<i>Pipilo maculatus</i>	spotted towhee
<i>Zonotrichia leucophrys</i>	white-crowned sparrow
Family Icteridae	
<i>Icterus cucullatus</i>	hooded oriole
Family Fringillidae	
<i>Spinus psaltria</i>	lesser goldfinch

SCIENTIFIC NAME	COMMON NAME
<i>Spinus lawrencei</i>	Lawrence's goldfinch
<i>Carpodacus mexicanus</i>	house finch
MAMMALS	
Order Lagomorpha	Rabbits, Hares, and Pikas
Family Leporidae	
<i>Sylvilagus audubonii</i>	Audobon's cottontail
Order Rodentia	Rodents
Family Scuridae	
<i>Spermophilus beecheyi</i>	California ground squirrel
Order Carnivora	Carnivores
Family Canidae	
<i>Canis latrans</i>	coyote

¹Federally threatened or endangered species

²State threatened or endangered species

³State fully protected species

*State species of special concern

+State special animal

(CDFG Special Animals List 2011)

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