VISTA DEL MAR ELEMENTARY
VERNAL POOL MITIGATION SITE

Year 5 Annual Report

Prepared for
Michael Baker International

July 22, 2016

ESA

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1.0 Introduction

1.1 Overview

The construction of the Vista Del Mar Elementary School and associated extension of Del Sol Boulevard on a 20-acre project site in Otay Mesa, California resulted in impacts to 0.02 acre of vernal pool basins and associated federally listed species. To mitigate these impacts, offsite restoration/enhancement[1] and creation[2] of vernal pool habitat (collectively referred to as "restoration" in this report) was implemented according to a Vernal Pool Restoration Plan (Helix, 2011; as amended by TAIC, 2011; Appendix A), which was approved by the U.S. Fish and Wildlife Service (USFWS) and U.S. Army Corps of Engineers (USACE) on February 2, 2011.

The vernal pool restoration site (restoration site) is located within a 1.05-acre parcel, under the ownership of the City of San Diego (City), that makes up a portion of the City's Otay Mesa West Preserve—Parcel B in Otay, California (Figure 1), on the east side of Assessor's Parcel Number 645-061-01-00. It occupies a portion of Section 31 in Township 18 South, Range 1 West of the U.S. Geological Survey 7.5-minute Imperial Beach Quadrangle (Figure 2). The restoration site occurs approximately 2,700 feet south of the Vista Del Mar Elementary School (impact) site on a mesa that is situated between Moody Canyon to the south and the San Diego Gas and Electric substation on Otay Mesa Road to the north. The restoration site historically supported low quality vernal pools that were disturbed by off-road vehicle activity. This area was previously managed by The Environmental Trust (TET), and then deeded to the City after TET declared bankruptcy. The existing Conservation Easement (CE) for the City's Otay Mesa West Preserve is currently being amended by the USACE and California Department of Fish and Wildlife (CDFW) legal offices to address the restoration site, and the CE will continue to show CDFW as third-party beneficiary.

The total impact to vernal pools from the construction of Vista Del Mar Elementary included the removal of 10 existing vernal pool basins, three of which supported the federally endangered San Diego fairy shrimp (*Branchinecta sandiegonensis*). The USFWS, which regulates impacts to federally listed species, issued a Biological Opinion (BO) in response to impacts to the San Diego fairy shrimp (USFWS, 2011; Appendix B). The BO gave specific guidance regarding the allowable impacts and required mitigation for those impacts. A USACE Section 404 permit (Appendix B) allowing the fill of these vernal pools mirrored the mitigation requirements outlined in the BO, which requires restoration of vernal pools at a 5:1 ratio with at least 16 of 18

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1 Restoration is defined in the Water Quality Certification No. 09C-017 (WDID 9-000001990) as re-establishment and rehabilitation. Re-establishment is the return of natural/historic functions to a site where vegetated or unvegetated waters of the U.S./State previously existed. Rehabilitation is the improvement of the general suite of functions of degraded vegetated or unvegetated waters of the U.S/State. "Enhancement" is defined in the Water Quality Certification as the improvement to one or two functions of existing vegetated or unvegetated waters of the U.S/State.

2 Also defined as "establishment" in the Water Quality Certification No. 09C-017 (WDID 9-000001990).

Figure 1. Regional Location

Figure 2. Site Location

restored (created) pools supporting San Diego fairy shrimp. The Regional Water Quality Control Board (RWQCB) issued a Section 401 Water Quality Certification that is consistent with the USACE's mitigation requirements.

The mitigation effort included the restoration of a vernal pool system which consisted of enhancing 14 existing, degraded pools and creating 18 pools within the single 1.05-acre restoration site. Restoration included inoculum and plant material collection, grading, invasive species control, inoculation with salvaged materials, installation of salvaged plants and seeds, and installation of four artificial burrowing owl (*Athene cunicularia*) burrows, herpetological cover-boards, and bee blocks. Vernal pool inoculum, seeds and plant materials were salvaged from the impact and restoration sites, and collected from both the San Ysidro High School (SYHS) vernal pool site (adjacent to the west side of the restoration site and within the Otay Mesa West Preserve) and a road rut adjacent to the east side of the restoration site.

1.2 Purpose

The purpose of this annual report is to document the post-restoration success of restoration activities to date and to monitor and report on progress towards mitigation goals, as identified in the Vista Del Mar Vernal Pool Restoration Plan (Restoration Plan), and specific permit requirements. Annual reports are a requirement of all permits for impacts to vernal pools and vernal pool species.

The vernal pool restoration project is being implemented in compliance with the following regulatory agency authorizations: USACE Permit No. SPL-2009-00028-LLC, the BO (FWS-SDG-09BO258-11F0076), and the RWQCB Water Quality Certification No. 09C-017 (WDID 9-000001990). In accordance with these authorizations, a 1.05-acre vernal pool restoration site has been installed within the City's West Otay Mesa Parcel B Vernal Pool Preserve. Installation was completed on March 23, 2012.

1.3 Goals

Per the Restoration Plan, the overall goal of this mitigation effort is to increase the functions and services of pre-existing degraded vernal pool habitat and create additional high quality vernal pools to an extent that would, at a minimum, replace the functions and services lost by removal of vernal pools due to construction of Vista Del Mar Elementary School. An additional goal is the restoration of San Diego fairy shrimp habitat at the restoration site. At the conclusion of this five-year restoration effort, it is expected that functions and services (e.g., water filtration, sensitive wildlife and plant habitat) that were being performed by the pre-existing degraded pools prior to restoration would be improved. The condition of the restored vernal pools would be documented by monitoring: (1) fairy shrimp, by wet season sampling, (2) hydrology, (3) surrounding upland vegetation, (4) vernal pool flora, and (5) condition of vernal pool wetlands, by conducting a California Rapid Assessment Method (CRAM) assessment. Specific permit requirements are detailed below.

1.4 Project Background

1.4.1 Permit Requirements

The permitting agencies (i.e., USACE, USFWS, and RWQCB) have included specific criteria which must be met in order for mitigation to be deemed successful. The general mitigation requirements are included in Table 1. Mitigation requirements identified in the Section 404 and 401 permits and the BO, including specific success criteria and required methods, were incorporated into the Restoration Plan. These permit documents are included in Appendix B.

Table 1. Agency Permit Requirements

Agency	Permit No.	Impact	Mitigation
USACE	SPL-2009-00028-LLC	Fill of 0.02 acre of vernal pool wetlands (10 vernal pools total).	Enhance 0.218 acre of vernal pool habitat (a total of 32 vernal pools) within a 1.05 acre parcel as described in the final approved HMMP: "*Vista Del Mar Elementary School: Vernal Pool Preserve Restoration Plan*." The mitigation site shall include a minimum of 16 restored pools, totaling a minimum of 0.10 acre, AND a minimum of 4,455 square feet of the restored pools proposed within the mitigation site shall support San Diego fairy shrimp.
USFWS	FWS-SDG-09B0258-11F0076	Removal of 0.02 acre of San Diego fairy shrimp habitat (10 vernal pools).	Restore and enhance 32 vernal pools with a basin area of 0.218 acre on the 1.05-acre West Otay Mesa B parcel; 0.10 acre of restored and enhanced vernal pool basin must support San Diego fairy shrimp.
RWQCB	Water Quality Certification No. 09C-017	Impact to 0.02 acre of vernal pools.	Mitigate at a 5:1 ratio with at least 0.02 acre of vernal pool restoration (re-establishment) and 0.08 acre of vernal pool restoration and/or enhancement at the West Otay Mesa Parcel B Preserve and as described in *Vista Del Mar Elementary School, Vernal Pool Preserve Restoration Plan*."

1.4.2 Monitoring Requirements

The restoration of the 32 vernal pools on the mitigation site extended from November 2011 through March 2012. The long-term monitoring period began in February 2012 (concurrent with final seeding in order to capture a portion of the 2011/2012 wet season for the purpose of branchiopod sampling). The Year 5 post-restoration monitoring period extends from September 1, 2015 through August 31, 2016; pursuant to USACE Permit No. SPL-2009-00028-LLC (Appendix B).

As identified in the Restoration Plan, qualitative monitoring and maintenance visits are required monthly during Year 1, every other month during Year 2, and every three months for the remainder of the monitoring period. Fairy shrimp surveys are required to occur during the wet season for the duration of the monitoring period to determine the presence or absence, as well as population estimates, of San Diego fairy shrimp populations. Additionally, hydrological monitoring is required every other week following rain events to measure depth, extent, and

duration of inundation of all restoration site and control pools. Annual monitoring of the upland enhancement, including species cover, richness, and weed cover, is required by qualitative assessment in Years 1 and 2, and by qualitative and quantitative assessment for the remainder of the monitoring period. Table 2 details the restoration and maintenance activities and qualitative and quantitative site visits conducted during the Year 5 monitoring period.

Table 2. Summary of Restoration and Monitoring Activities during Reporting Period

Date	Type[1]	Personnel	Notes
9/17/15, 9/30/15, 10/06/15, 10/20/15, 11/04/15 11/11/15, 12/24/15, 1/7/16, 1/21/16, 2/4/16, 2/18/16, 3/3/16, 3/17/16, 4/12/16, 4/26/16, 5/10/16, 5/25/16	Quantitative – hydrological monitoring	Shannon Walsh, Rocks Biological Consulting	Monitored the depth and duration of vernal pool inundation.
1/18/16	Quantitative – fairy shrimp	Melanie Rocks and Ian Hirschler, Rocks Biological Consulting	Conducted USFWS protocol-level fairy shrimp surveys of inundated restoration pools and San Ysidro High School reference site pools.
4/6/16	Quantitative – vernal pool vegetation transects	Rosanne Humphrey, and Alanna Bennett, ESA	Vernal pool vegetation transect surveys of restoration site and reference sites (J26 and SYHS).
4/28/16	Quantitative – upland vegetation transects	Rosanne Humphrey, ESA	Upland vegetation transect surveys of restoration site and reference sites (J26 and SYHS).
4/28/16	Quantitative – CRAM assessment	Rosanne Humphrey (CRAM practitioner) ESA	Conducted vernal pool California Rapid Assessment Method (CRAM) assessment at restoration site
8/3/15, 8/5/15, 8/18/15, 9/18/15, 11/9/15, 11/18/15, 12/10/15, 1/25/16, 2/12/16, 3/9/16, 3/10/16, 4/5/16, 4/1/16, 5/6/16, 5/13/16, 5/31/16,	Qualitative – maintenance visit	D&D Habitat Restoration	Inspected vernal pools, spot weeded (hand pulling and herbicide) throughout restoration area, picked up trash, hauled debris, repaired erosion, took general site photos.
11/18/15	Qualitative – site visit	Resource Agency staff, city of San Diego staff, project manager, biological consultants [1]	Site visit to inspect the restoration area and discuss upcoming sign-off and long-term management needs.

[1] Attendees at the pre-sign off site visit: Richard J. Vansant (US Army Corps of Engineers); Patrick Gower (US Fish & Wildlife Service); Lisa Honma (SD Regional Water Quality Control Board); Randy Rodriguez and Elyse Levy (California Department of Fish & Wildlife); Chris Zirkle and Betsy Miller (City of SD Park & Recreation Department, Open Space Division); Rosanne Humphrey (ESA) and Melanie Rocks (Rocks Biological Consulting); and Mike Gonzales (Michael Baker International – MBI)

2.0 Methods

2.1 Qualitative Monitoring

Qualitative monitoring efforts were conducted on the restoration site and were focused on broad spectrum restoration progress outside of the scope of quantitative monitoring efforts. During the site visits, the overall health and vigor of plants, signs of natural recruitment, survivorship of container plantings, and presence or signs of wildlife were evaluated within the vernal pool basins and surrounding upland habitat. Potential threats were also noted, including presence of trash, signs of trespass or vandalism, presence of non-native species, erosion problems, and signs of herbivory. Qualitative monitoring efforts were conducted during all monitoring and maintenance visits on the restoration site throughout the monitoring period, including quantitative monitoring surveys (Table 2). In addition, a pre-final year site visit was conducted by stakeholders on November 18, 2015 to evaluate the conditions of the restoration site and to discuss upcoming sign-off and management needs. Attendees at the site visit included: Richard J. Vansant (US Army Corps of Engineers), Patrick Gower (US Fish & Wildlife Service), Lisa Honma (SD Regional Water Quality Control Board), Randy Rodriguez and Elyse Levy (California Department of Fish & Wildlife), Chris Zirkle and Betsy Miller (City of SD Park & Recreation Department, Open Space Division), Rosanne Humphrey (ESA) and Melanie Rocks (Rocks Biological Consulting), and Mike Gonzales (Michael Baker International – MBI).

2.2 Quantitative Monitoring

Quantitative monitoring efforts conducted at the restoration site, and two reference sites (i.e., SYHS and J26) during the Year 5 monitoring period were focused on measuring specific characteristics pertaining to achievement of success criteria, as outlined in the Vernal Pool Restoration Plan. Typically, the quantitative vernal pool surveys measure the San Diego fairy shrimp populations, vernal pool plant cover and diversity, and levels of inundation. Quantitative upland monitoring evaluates the percent cover and diversity of the coastal sage scrub habitat that surrounds the vernal pools (see Figures 3, 4, and 5). The purpose of control pools is to provide a reference to which the restored pools can be compared. Fluctuations in hydrological conditions that are due to weather patterns or other abiotic conditions are visible in control pools and then used as a metric with which to measure the success of the restored habitat.

A vernal pool monitoring protocol was developed to guide the programmatic monitoring process established for the efficient and biologically sound monitoring of the Vista del Mar Elementary Project in association with other vernal pool restoration projects in progress or planned on Otay Mesa (Appendix C). Vernal pool monitoring generally requires frequent access to vernal pool complexes for the purpose of data collection. Vernal pool ecosystems are sensitive to disturbance; therefore, limited access to monitoring and control pools is desirable. In accordance with the programmatic BO developed for State Route 11, Otay Mesa East Port of Entry, Otay Crossing Commerce Park and Otay Business Park, the USFWS recommended that a common reference

Figure 3. Restoration Site Monitoring

Figure 4. Adjacent (San Ysidro High School) Reference Site Monitoring

Figure 5. J26 Complex Reference Site

pool complex be chosen for many, if not all, vernal pool restoration projects on the Otay Mesa. The J26 complex reference site was identified as one of the last remaining naturally functioning vernal pool complexes on the mesa that is reasonably accessible and would provide acceptable baseline vernal pool functions to be used as a reference for most restoration projects on the mesa. Monitoring data will be housed within the San Diego Management and Monitoring Program (SDMMP) South Coast Multi Taxa database. The development of this database is in progress and data entry will be coordinated directly with SDMMP. The methodology for quantitative monitoring for the vernal pool and upland habitat is discussed in more detail below.

2.2.1 Vernal Pool Branchiopod Monitoring

Branchiopod surveys were conducted within pools that were inundated for a sufficient amount of time and depth to support fairy shrimp, based on the results of hydrological monitoring that was being conducted within the restoration site and reference pools (see Table 2 for sampling dates). Sampling was conducted by Rocks Biological Consulting (RBC) biologist Melanie Rocks (TE-082908-1), who was assisted by RBC biologist Ian Hirschler on January 18, 2016 according to the Survey Guidelines for the Listed Large Branchiopods (USFWS, 2015). A post-survey report was submitted to the USFWS on June 29, 2016 (Appendix D).

The protocol requires that depressions be examined 24 hours after a storm event to determine if the depressions are inundated (defined as holding more than three centimeters of water). If the depressions are still inundated after two weeks, protocol fairy shrimp surveys must be conducted. All pools that were inundated to levels (i.e., extent, depth, and duration) sufficient to support fairy shrimp were sampled using a hand-held net, which was swept through the water, and the net contents were examined for invertebrates. San Diego fairy shrimp were collected and identified with the aid of a dissecting microscope after the surveys were completed. Special attention was given to differentiate hybrids from pure species. The collected voucher specimens will be accessioned to the Los Angeles Natural History Museum, Crustacea Section, Invertebrate Zoology, 900 Exposition Boulevard, Los Angeles, California 90007.

2.2.2 Hydrological Monitoring

Quantitative hydrological monitoring was conducted on the restoration site and reference sites to measure specific aspects of vernal pool hydrology, as outlined in the Vernal Pool Restoration Plan. Hydrological monitoring was conducted between September 17, 2015 and May 25, 2016 (Table 2). The monitoring initiated within 24 hours after a rain event, and continued every two weeks until the pools dried out. Depth and extent of inundation were measured during each site visit where pools were noted to be inundated, and duration of inundation was measured from the onset of inundation until all pools were dry.

2.2.3 Vernal Pool Vegetation Monitoring

Vegetation monitoring transects on the restoration site and reference sites were monitored on April 4, 2016 by ESA biologists Rosanne Humphrey and Alanna Bennett (Table 2). Sample pools were selected using stratified sampling technique to achieve a representative sample of all pools on the respective sites. A sample of six pools – four sentinel (i.e., permanent) and two rotating

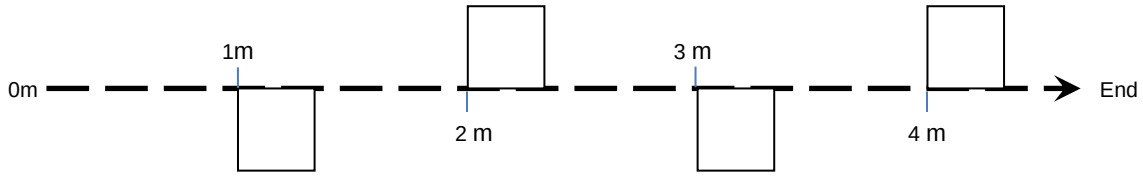
(i.e., changed every year) – was selected for the restoration site; a sample of two pools – both sentinel – was selected for the SYHS reference site; and a sample of four pools – two sentinel and two rotating – was selected for the J26 complex reference site.

Percent cover of native and non-native plant species was determined through quadrat sampling (described below). Species richness (i.e., total number of species) was determined by recording all plant species observed within the basin of each sampled pool. In addition, standard photographs were taken from the transect origin (starting point) facing toward the end point of each transect, and general photographs were taken throughout each site. Transect photographs were taken from the same vantage point as in previous years, including angle, height, direction, and focal range so that overall vegetation growth could be compared from year to year.

Transects were established within each sampled pool from one edge of the basin to the other along the greatest length of the pool, passing through the point of greatest depth; therefore, each transect was a different length, depending on the size of the pool. Spatial coordinates using a hand-held GPS unit with sub-foot accuracy were taken at the beginning and end points for all transects. During the initial monitoring period, the sentinel transects were marked in the field with rebar stakes at both ends. The origin (i.e., starting point) for each transect was marked with a PVC cap over the rebar and labeled with the pool number.

A 0.25-meter squared quadrat was used to conduct quadrat sampling along each transect to determine percent cover of each species within the pool basin. Measurements were taken every meter on alternating sides along the extent of the transect (see diagram below). Starting on the right side of the transect line (facing the end point), the quadrat was placed on the ground at the one-meter mark. One side of the quadrat was in line with the measuring tape. The final quadrat was placed at the end point and extended beyond the extent of the staked transect.

Quadrats along a transect



Two measurements were taken within each quadrat: (a) absolute percent cover (not to exceed 100 percent) of non-plant ground cover, and (b) relative cover of individual plant species. Ground cover types consisted of litter, bare ground, or rock. Plant species were recorded using a six letter code, which consisted of the first three letters of the genus and first three letters of the species name (i.e., POGNUD was used for *Pogogyne nudiuscula*, Otay Mesa mint). Unknown species were collected and labeled with the date, plot number, and a unique number. Collected specimens were later identified using the Jepson Manual (Baldwin et al., 2012). Cover data for quadrats within individual transects were pooled to calculate overall native and non-native species cover for each pool as well as cover of vernal pool indicator species.

2.2.4 Upland Vegetation Monitoring

Quantitative upland vegetation monitoring was conducted within the restoration site and adjacent SYHS reference site. The purpose of the monitoring is to assess the status of restored coastal sage scrub habitat that surrounds the created and enhanced vernal pools. Data from the restoration site was compared to data from the SYHS reference site to help evaluate the effects of climatic conditions, such as drought on the restoration site (e.g., to determine whether the observed changes in the vegetation were due to natural variability or restoration efforts).

Two belt transects within each location were established by extending a centerline 25 meters out from a randomly selected point of origin in a direction that would cover the greatest amount of upland habitat without crossing into any vernal pools (the pools are close together and the areas of upland habitat surrounding the pools are narrow). A rectangular survey area was established for each transect by extending out 2.5 meters on either side of the center line, thereby creating a 5 meter long belt along the length of the transect. Species richness was obtained for the transects by recording all species within each belt. The point intercept method was used to calculate percent cover by recording "hits" (i.e., when a plant touches a vertical wooden rod that is placed perpendicular to the measuring tape) along the centerline every 0.5 meter. The following information was collected for each hit: (a) species, (b) native or non-native, and (c) herbaceous or shrub. Non-native species were identified as "target weed species" or other non-natives. The following target weed species were identified in the Restoration Plan e: Australian saltbush (*Atriplex semibaccata*), black mustard (*Brassica nigra*), tocalote (*Centaurea melitensis*), garland daisy (*Glebionis coronaria*), fennel (*Foeniculum vulgare*), short-pod mustard (*Hirschfeldia incana*), Italian ryegrass (*Festuca perennis*), and crystalline iceplant (*Mesembryanthemum crystallinum*). In addition, photographs were taken from the origin to the end point of each transect. Percent cover was estimated by counting the total number of hits for a given species, divided by the total number of hits possible, and multiplying by 100.

2.3 Vernal Pool CRAM Monitoring

A CRAM assessment of the restoration site was conducted according to the Vernal Pool Systems Field Book, Version 6.1 (CWMW, 2013). Six pools were randomly selected for sampling (Figure 6). Within each pool, four key attributes were evaluated: Buffer and Landscape Context, Hydrology, Physical Structure, and Biotic Structure. Additional details about this methodology are given in the Year 5 CRAM report (ESA, 2014), which is included in Appendix E. CRAM assessments were conducted prior to construction by Helix Environmental at the restoration site and a reference site: the Robinhood Ridge vernal pool preserve (ESA, 2011). Although the Robinhood Ridge vernal pool preserve site was previously identified as a reference site for the Project, the J26 complex reference site (Figure 2) served as the programmatic control for the Project (as well as for unrelated projects), pursuant to consultation with the USFWS, CDFW, and the City. However, as CRAM success criteria were established for this Project prior to the establishment of the J26 complex reference site, no additional reference site CRAM assessments were conducted during the monitoring period (ESA, 2011).

Figure 6. CRAM Assessment Area

3.0 Results

3.1 Qualitative Monitoring

General health and vigor of the vernal pool basins and surrounding uplands were observed to be robust, with continued growth of seeded and planted vegetation and signs of natural recruitment during the Year 5 monitoring period. Survivorship of container stock plantings within the upland restoration was satisfactory, as no mortality was observed. Maintenance staff provided occasional supplemental watering and trimming of plantings when necessary. Herbivory of transplanted coast cholla (*Cylindropuntia prolifera*) by rabbits was not observed; however minor herbivory of flowering quillwort (*Lilaea scilloides*) was observed during the CRAM assessment in April 2016. Overall, the presence of non-native plant species in the upland restoration area was low, and all seedlings were actively removed by maintenance staff (Table 2); however it was noted that stinknet (*Oncosiphon piluliferum*) was starting to invade the surrounding area. This invasion appears to be more severe each year. Observations of wildlife within the immediate vicinity of the restoration site included red-tailed hawk (*Buteo jamaicensis*), common raven (*Corvus corax*), greater roadrunner (*Geococcyx californianus*), desert cottontail (*Sylvilagus audubonii*), and orange-throated whiptail (*Asipdoscelis hyperythra beldingi*). In addition, a southern pacific rattlesnake (*Crotalus oreganus helleri*) was observed moving from the entrance of one artificial burrowing owl burrow to another. During the CRAM assessment in late April, numerous tadpoles, presumably western spadefoot toad (*Spea hammondii*; State Species of Special Concern), were observed in pools 22 and 29. No problems with vandalism or trespass were noted; however, during the stake holder site visit conducted in November, signs of erosion from a recent storm were evident near pools 22 and 23. This area was repaired in January, and additional erosion control measures were installed. Representative photographs showing the overall condition of upland habitat are included in this report for reference (Appendix F).

3.2 Quantitative Monitoring

3.2.1 Vernal Pool Branchiopod Monitoring

Rainfall in January, 2016 was sufficient to inundate pools in the restoration area long enough to support fairy shrimp, and therefore, sampling was conducted on January 18, 2016. All of the pools held San Diego fairy shrimp when sampled, and all but two of the pools supported a population of thousands (Table 3 and Figure 7); the other two pools supported hundreds. None of the pools in either of the reference sites held water long enough to support fairy shrimp, and therefore, these areas were not sampled this year. The 90-day USFWS report, which includes the survey datasheets, is included in Appendix D.

Table 3. Fairy Shrimp Survey Results in Restoration Site

Pool Number	Description	Water Temp. (°C)	Maximum Depth (cm)	Size (m^2)	Presence of Fairy Shrimp	Population Estimate
1	Enhanced	16.1	8.0	18.0	*B. sandiegonensis*	1000s
2	Created	13.9	7.0	30.0	*B. sandiegonensis*	1000s
3	Enhanced	15.6	4.0	20.0	*B. sandiegonensis*	1000s
4	Enhanced	15.0	7.0	35.0	*B. sandiegonensis*	1000s
5	Created	15.6	7.5	35.0	*B. sandiegonensis*	1000s
6	Created	17.8	4.0	16.0	*B. sandiegonensis*	1000s
7	Created	16.7	10.0	35.0	*B. sandiegonensis*[1]	1000s
8	Created	16.7	17.0	56.0	*B. sandiegonensis*	1000s
9	Created	17.8	8.0	24.0	*B. sandiegonensis*[1]	1000s
10	Created	16.7	9.0	56.0	*B. sandiegonensis*	1000s
11	Enhanced	16.7	7.0	60.0	*B. sandiegonensis*	1000s
12	Created	17.8	6.0	20.0	*B. sandiegonensis*	1000s
13	Created	17.8	6.0	36.0	*B. sandiegonensis*	1000s
14	Created	18.9	4.0	54.0	*B. sandiegonensis*	1000s
15	Created	19.4	8.0	40.0	*B. sandiegonensis*	1000s
16	Enhanced	19.4	8.0	42.0	*B. sandiegonensis*	1000s
17	Enhanced	19.4	14.0	24.0	*B. sandiegonensis*	1000s
18	Enhanced	20.0	5.0	9.0	*B. sandiegonensis*	1000s
19	Enhanced	19.4	11.0	25.0	*B. sandiegonensis*[1]	1000s
20	Enhanced	19.4	6.0	30.0	*B. sandiegonensis*	1000s
21	Enhanced	17.8	19.0	36.0	*B. sandiegonensis*	1000s
22	Created	18.3	13.0	25.0	*B. sandiegonensis*	1000s
23	Created	18.9	2.0	6.0	*B. sandiegonensis*	100's
24	Enhanced	19.4	15.0	35.0	*B. sandiegonensis*	1000s
25	Enhanced	18.9	7.0	25.0	*B. sandiegonensis*	1000s
26	Enhanced	18.9	11.0	30.0	*B. sandiegonensis*	100s
27	Created	20.0	10.0	45.0	*B. sandiegonensis*	1000s
28	Created	20.6	5.0	12.0	*B. sandiegonensis*	1000s
29	Created	18.9	11.0	24.0	*B. sandiegonensis*	1000s
30	Enhanced	19.4	10.0	70.0	*B. sandiegonensis*	1000s
31	Created	18.9	4.5	12.0	*B. sandiegonensis*	1000s
32	Created	19.4	8.0	9.0	*B. sandiegonensis*	1000s

[1] Tadpoles (presumably western spadefoot toads; *Spea hammondii*) also present

Figure 7. Fairy Shrimp Density

3.2.2 Hydrological Monitoring

The 2015/2016 wet season was expected to be much wetter than normal due to El Niño conditions; however, between October 2015 and May 2016, a total of only 7.86 inches of rain fell in the San Diego area (based on rainfall data from Lindbergh Field; NOAA 2016), as compared to an average of 11.07 inches for that time period. According to the United States Drought Monitor, coastal San Diego County is still considered to be in extreme drought conditions (NDMC et al. 2016). Drought conditions have prevailed throughout the entire five-year restoration monitoring period. However, despite these conditions, the vernal pool basins continue to hold water well. During the 2016 monitoring year, all 32 pools inundated for a sufficient duration to support fairy shrimp. Ponding duration varied from a minimum of 14 days to a maximum of 140 days (Table 4). Maximum pool depth ranged from 7.5 to 29.7 cm. Within the adjacent SYHS reference site, only 6 of the 8 sampled pools inundated during the rainy season, but none of them held water long enough to support fairy shrimp (Table 5). Maximum pool depth ranged from 2 to 7 cm. Within the J26 reference site, 11 of the 12 pools evaluated held water (Table 5). Ten pools held water for up to 14 days, and one pool held water for up to 28 days, although the water was not deep enough to support fairy shrimp. Maximum depth of inundated pools varied from 3 to 15 cm.

Table 4. Restoration Site Hydrological Monitoring Results

Pool Number	Description	Max. Depth (cm)	Ponding Duration (days)
1	Enhanced	10.0	29-42
2	Created	27.0	29-42
3	Enhanced	10.0	29-42
4	Enhanced	27.4	29-42
5	Created	27.0	29-42
6	Created	26.9	15-28
7	Created	25.0	43-56
8	Created	26.6	43-56
9	Created	25.5	43-56
10	Created	25.9	29-42
11	Enhanced	26.7	29-42
12	Created	25.1	29-42
13	Created	26.5	57-70
14	Created	28.7	29-42
15	Created	27.5	29-42
16	Enhanced	11.0	29-42
17	Enhanced	27.4	29-42
18	Enhanced	28.8	15-28
19	Enhanced	27.0	43-56
20	Enhanced	24.8	29-42
21	Enhanced	25.8	113-126
22	Created	24.7	43-56
23	Created	7.5	29-42
24	Enhanced	28.1	43-56
25	Enhanced	29.7	29-42
26	Enhanced	28.1	43-56

Pool Number	Description	Max. Depth (cm)	Ponding Duration (days)
27	Created	27.7	43-56
28	Created	28.4	29-42
29	Created	25.1	127-140
30	Enhanced	29.7	29-42
31	Created	28.5	29-42
32	Created	28.1	43-56

Table 5. Reference Pool Hydrological Monitoring Results

Pool Number[1]	Description	Max. Depth (cm)	Ponding Duration (days)
RefA-9	Reference	3.0	1-14
RefA-10	Reference	0.0	0
RefA-11	Reference	2.0	1-14
RefA-12	Reference	4.5	1-14
RefA-13	Reference	7.0	1-14
RefA-14	Reference	2.5	1-14
RefA-15	Reference	3.5	1-14
RefA-16	Reference	0.0	0
J26-9	Reference	5.5	1-14
J26-10	Reference	2.5	1-14
J26-11	Reference	8.0	1-14
J26-12	Reference	3.5	1-14
J26-13	Reference	9.0	15-28
J26-14	Reference	15.0	1-14
J26-15	Reference	8.0	1-14
J26-16	Reference	4.5	1-14
J26-17	Reference	6.0	1-14
J26-18	Reference	11.5	1-14
J26-19	Reference	0.0	0
J26-20	Reference	6.0	1-14

[1] RefA-# pools are the San Ysidro High School Reference Pools

3.2.3 Vernal Pool Vegetation Monitoring

The average estimated cover of vernal pool indicator species within the reference sites during the monitoring period was 0.8 and 1.3 percent cover in the J26 and SYHS sites, respectively, and 3.4 percent in the restoration site (Table 6). Percent cover of invasive non-native species ranked by the California Invasive Plant Council (Cal-IPC) as moderate to high risk was 0.9 (J26 site) and 2.0 (SYHS) in the reference sites, and 0.1 in the restoration site (Table 7). The estimated cover of *other* non-native species (i.e., those not listed as moderate or high risk) was 0.7 and 14.8 percent cover in the SYHS and J26 reference sites, respectively, and 0.5 percent cover in the restoration site. Species richness of vernal pool indicator species (i.e., total number of vernal pool indicator

species) within a given pool varied from 2 to 5 within the reference sites (2-3 in J26 and 4-5 in SYHS) and from 4 to 5 within the restoration site. Overall, total species richness per site was 5 to 6 (in J26 and SYHS sites, respectively) within reference the sites and 6 in the restoration site (Table 8).

Table 6. Percent Cover of Vernal Pool Indicator Species

Control-SYHS		Control-J26		Restoration Pools	
Transect	**% Cover**	**Transect**	**% Cover**	**Transect**	**% Cover**
RefA-S-11	1.4	RefJ26-S-09	0.00	Resto-S-05	2.4
RefA-S-16	1.1	RefJ26-S-18	1.4	Resto-S-13	1.8
		RefJ26-R-13	0.5	Resto-S-18	4.9
		RefJ26-R-19	0.2	Resto-S-30	2.6
				Resto-R-06	4.4
				Resto-R-21	3.5
Site Average	**1.3**	**Site Average**	**0.8**	**Site Average**	**3.4**

Table 7. Percent Cover of Non-native Species

	Percent Cover		
Type of Non-Native Species	**Control-SYHS**	**Control-J26**	**Restoration Site**
Cal-IPC moderate/high spp.	2.0	0.9	0.1
Other non-native spp.	0.7	14.8	0.5
Total cover for all non-native spp.	2.7	15.7	0.6

Table 8. Species Richness (Vernal Pool Indicator Species)

	Control-SYHS[1]		Control-J26[2]		Restoration Pools[3]	
	Pool	**NIS[4]**	**Pool**	**NIS[4]**	**Pool**	**NIS[4]**
Per Transect (Pool)	RefA-S-11	4	RefJ26-S-09	2	Resto-S-05	5
	RefA-S-16	5	RefJ26-S-18	2	Resto-S-13	4
			RefJ26-R-13	3	Resto-S-18	5
			RefJ26-R-19	2	Resto-S-30	5
					Resto-R-06	5
					Resto-R-21	5
Average/Transect (Pool)		**4.5**		**2.3**		**4.8**
Total (per Site)		**6**		**5**		**6**

[1] Vernal pool indicator species observed within the SYHS reference site: San Diego button celery (*Eryngium aristulatum*), popcorn plant (*Plagiobothrys acanthocarpus*), Otay Mesa mint (*Pogogyne nudiuscula*), woolly marbles (*Psilocarphus brevissimus*), pygmy weed (*Crassula aquatica*), and slender plantain (*Plantago elongata*).

[2] Vernal pool species observed within J26 reference site: San Diego button celery, Otay Mesa mint, woolly marbles, pygmy weed, and toad rush (*Juncus bufonius*).

[3] Vernal pool plants observed within restoration site: pygmy weed, Otay Mesa mint, woolly marbles, slender plantain, and mousetail (*Myosurus minimus*). Note that flowering quillwort (*Lilaea scilloides*) was also observed in 4 of 6 sampled pools during the CRAM assessment.

[4] NIS = Number of Indicator Species.

Vernal pool indicator species observed within the SYHS reference site included San Diego button celery (*Eryngium aristulatum*), popcorn plant (*Plagiobothrys acanthocarpus*), Otay Mesa mint (*Pogogyne nudiuscula*), woolly marbles (*Psilocarphus brevissimus*), pygmy weed (*Crassula aquatica*), and slender plantain (*Plantago elongata*). Many of the same species were observed within J26 reference site, including San Diego button celery, Otay Mesa mint, woolly marbles, and pygmy weed, as well as toad rush (*Juncus bufonius*). The restoration site supported pygmy weed, Otay Mesa mint, woolly marbles, slender plantain, and little mousetail (*Myosurus minimus*) during the vegetation transect monitoring; flowering quillwort was also observed during the CRAM assessment.

3.2.4 Upland Vegetation Monitoring

Success of the upland vegetation areas that surround the vernal pools is based on species richness and native species cover, as compared to the SYHS reference site, overall non-native species cover, and presence of target weed species (Table 9). Target weed species, as defined in the Restoration Plan, are: Australian saltbush (*Atriplex semibaccata*), black bustard (*Brassica nigra*), tocalote (*Centaurea melitensis*), garland daisy (*Glebionis coronaria*), fennel (*Foeniculum vulgare*), short-pod mustard (*Hirschfeldia incana*), Italian ryegrass (*Lolium perenne*), and crystalline iceplant (*Mesembryanthemum crystallinum*).

Overall species richness within the SYHS reference site was 20, 13 of which (65 percent) were native. Species richness in the restoration site was 24, 18 of which (75 percent) were native. Percent cover of native species in the SYHS reference site (49%) was about equal to native cover in the restoration site (50%). Non-native species cover was slightly lower in the SYSH reference site (2.0%) than in the restoration (3.0), but still relatively low in both areas, and no target weed species were observed on either site.

Table 9. Upland Vegetation Monitoring Results

	Species Richness	Native % Cover	Non-native % Cover	Target Weed Species
SYHS Reference Site	20	49	2.0	0
Restoration site	24	50	3.0	0

3.3 Vernal Pool CRAM

As shown in Table 10 below, the overall CRAM score for the restoration site during Year 5 was fairly high at 80 (Table 10). Individual attribute scores varied between 68 and 100. The *Buffer and Landscape Connectivity* attribute score was 68; the *Hydrology* attribute score was the highest possible at 100; the *Physical Structure* score was 83; and the *Biotic Structure* attribute score 67.

Table 10. CRAM Scores for Restoration Site

Metric	Year CRAM Scores
Buffer and Landscape Connectivity	68
Hydrology	100
Physical Structure	83
Biotic Structure	92
OVERALL AA SCORE	**86**

4.0 Discussion

4.1 Vernal Pool Branchiopods

Since monitoring began (i.e., Years 1-5), none of the reference site pools have supported fairy shrimp. Within the restoration site, all 32 of the vernal pools held water long enough to support fairy shrimp, and all pools were positive for San Diego fairy shrimp during Year 5. Fairy shrimp sampling has shown a steady increase in the density of fairy shrimp over time (Figure 8). In Year 1, only 22 pools supported fairy shrimp and all of these pools had populations of tens or less. By Year 3, even though that year experienced the most extreme drought in the entire monitoring period, 13 of 14 pools that inundated long enough to support fairy shrimp were observed with thousands of fairy shrimp. By Year 5, all 32 pools supported fairy shrimp, and 94 percent of the pools held thousands of fairy shrimp (Table 11).

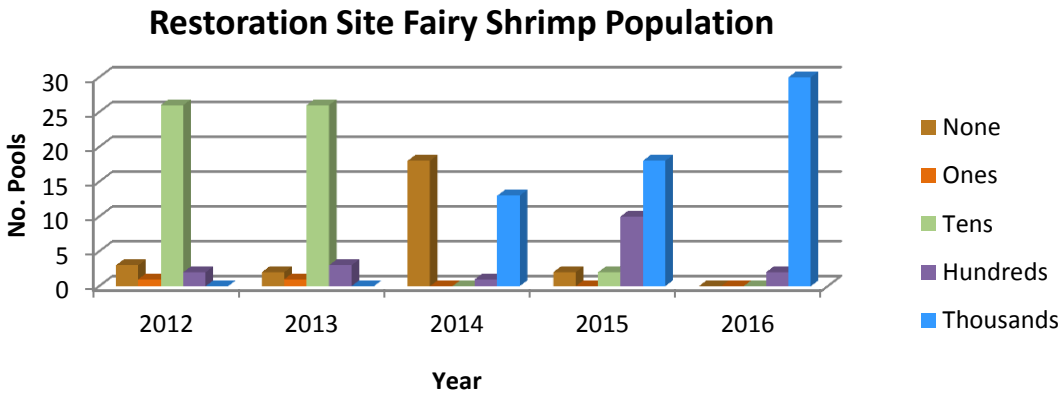


Figure 8. Fairy Shrimp population density on the restoration site. The graph above shows the number of vernal pools on the restoration site with zero, ones, tens, hundreds or thousands of fairy shrimp between 2012 and 2016.

Note that the federally endangered San Diego fairy shrimp and the more common versatile fairy shrimp (*Branchinecta lindahli*) are closely related species that are known to hybridize; such hybridization is an increasing concern due to the expanding presence of versatile fairy shrimp from human disturbance. Co-occurrence of these species happens more frequently in disturbed pools and restored/created basins, and creates the potential for hybridization (Simovich et al., 2013). Permitted biologists at Rocks Biological Consulting are aware of this problem, and have identified potential hybridized individuals at other restoration sites (i.e., Proctor Valley ORV-B vernal pool restoration site). Though genetic analysis would be required to fully assess genetic purity, no versatile fairy shrimp markers have been observed in San Diego fairy shrimp samples from the Vista Del Mar site.

Table 11. San Diego Fairy Shrimp Populations in Restoration Site - Five Year Summary

		Population Estimate				
Pool	**Description**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
1	Enhanced	0	10s	0	100s	1000s
2	Created	10s	10s	0	100s	1000s
3	Enhanced	0	10s	0	100s	1000s
4	Enhanced	10s	10s	0	1000s	1000s
5	Created	10s	100s	0	100s	1000s
6	Created	10s	10s	0	100s	1000s
7	Created	10s	100s	1000s	1000s	1000s
8	Created	1s	0	0	1000s	1000s
9	Created	1s	10s	100s	1000s	1000s
10	Created	1s	10s	1000s	1000s	1000s
11	Enhanced	1s	10s	0	100s	1000s
12	Created	1s	10s	1000s	1000s	1000s
13	Created	0	100s	1000s	1000s	1000s
14	Created	10s	10s	1000s	1000s	1000s
15	Created	10s	10s	0	1000s	1000s
16	Enhanced	0	10s	0	100s	1000s
17	Enhanced	0	10s	1000’s	1000s	1000s
18	Enhanced	1s	10s	0	0	1000s
19	Enhanced	1s	10s	1000s	1000s	1000s
20	Enhanced	0	10s	0	1000s	1000s
21	Enhanced	10s	10s	0	1000s	1000s
22	Created	0	1s	1000s	1000s	1000s
23	Created	0	0	0	0	100s
24	Enhanced	0	10s	1000s	1000s	1000s
25	Enhanced	10s	10s	0	100s	1000s
26	Enhanced	10s	10s	1000s	100s	100s
27	Created	10s	10s	1000s	1000s	1000s
28	Created	10s	10s	0	10s	1000s
29	Created	10s	10s	1000s	1000s	1000s
30	Enhanced	10s	10s	0	100s	1000s
31	Created	0	10s	0	10s	1000s
32	Created	1s	10s	1000’s	1000s	1000s

To meet the success criteria for San Diego fairy shrimp, the shrimp should recur in each year that there is enough rainfall to produce ponding, and shrimp should also be present in the control pools. If both the restored and control pool shrimp populations decline in any given year, then it would be assumed that there are other outside, seasonal effects driving the change, as opposed to specific factors at the restoration site. Otherwise, the restored pool population numbers should either be stable or show an increasing trend over the 5-year monitoring period to be considered successful. Based on these parameters, the restoration site is considered to be successful with respect to providing high quality habitat for San Diego fairy shrimp.

4.2 Hydrology

Despite continued historic drought conditions yielding significantly lower than average rainfall during the monitoring period, the restoration site vernal pools continued to perform better hydrologically than the pools at both reference sites. During Year 5, all 32 pools at the restoration site inundated during the rainy season for a sufficient amount of time to support fairy shrimp. In contrast, none of the pools in either reference site held water long enough to support fairy shrimp. Table 12 shows a comparison of the ponding duration in the restoration site from Year 1 to Year 5. To meet the success criteria, the depth, duration, and extent of ponding within the restoration site must be equivalent or better than that of the reference sites. "The pools must pond for a sufficient amount of time (estimated to be 30 days) to support San Diego fairy shrimp during 2 winters in a 5-year period or 3 winters in a 10 year monitoring period" (Helix, 2011; as amended by TAIC, 2011). This success criterion has been met – fairy shrimp have been observed every year during the monitoring period; during the last two years, 30 – 32 pools (94-100 percent) supported San Diego fairy shrimp. The success of the hydrological regime within the restoration site indicates that the site is functioning appropriately.

Table 12. Ponding Duration in Restoration Site - Five Year Summary

		Ponding Duration in Days (Rainfall October - September[1])				
Pool	**Description**	**Year 1 (7.9 in)**	**Year 2 (6.6 in)**	**Year 3 (5.1 in)**	**Year 4 (11.9 in)**	**Year 5[2] (7.86 in)**
1	Enhanced	0-7	>35	0-7	56-70	29-42
2	Created	7-14	>35	0-7	56-70	29-42
3	Enhanced	0-7	>35	0-7	28-42	29-42
4	Enhanced	21-28	>35	0-7	56-70	29-42
5	Created	7-14	>35	0-7	56-70	29-42
6	Created	0-7	>35	0-7	42-56	15-28
7	Created	21-28	>35	14-21	56-70	43-56
8	Created	21-28	>35	0-7	70-84	43-56
9	Created	21-28	>35	7-14	56-70	43-56
10	Created	21-28	>35	7-14	56-70	29-42
11	Enhanced	14-21	>35	0-7	56-70	29-42
12	Created	14-21	>35	7-14	56-70	29-42

Pool	Description	Ponding Duration in Days (Rainfall October - September[1])				
		Year 1 (7.9 in)	Year 2 (6.6 in)	Year 3 (5.1 in)	Year 4 (11.9 in)	Year 5[2] (7.86 in)
13	Created	14-21	>35	7-14	70-84	57-70
14	Created	21-28	>35	7-14	56-70	29-42
15	Created	14-21	>35	0-7	42-56	29-42
16	Enhanced	0-7	>35	0-7	42-56	29-42
17	Enhanced	21-28	>35	7-14	70-84	29-42
18	Enhanced	14-21	>35	0-7	42-56	15-28
19	Enhanced	21-28	>35	7-14	56-70	43-56
20	Enhanced	21-28	>35	0-7	56-70	29-42
21	Enhanced	21-28	>35	0-7	98-112	113-126
22	Created	21-28	>35	7-14	98-112	43-56
23	Created	0-7	0-7	0-7	28-42	29-42
24	Enhanced	21-28	>35	7-14	70-84	43-56
25	Enhanced	28-35	>35	0-7	56-70	29-42
26	Enhanced	14-21	>35	7-14	70-84	43-56
27	Created	14-21	>35	7-14	56-70	43-56
28	Created	21-28	>35	0-7	56-70	29-42
29	Created	21-28	>35	28-35	112-126	127-140
30	Enhanced	21-28	>35	0-7	56-70	29-42
31	Created	0-7	>35	0-7	56-70	29-42
32	Created	21-28	>35	7-14	56-70	43-56

[1] *Annual* rainfall based on Lindbergh Field weather station data (National Weather Service) between October 1 and September 30. A*verage* annual rainfall is 10.13 inches.

[2] Note: This report was compiled in July; therefore, Year 5 rainfall totals through September 30 could not be calculated (the rainfall total was calculated through June).

4.3 Vernal Pool Vegetation

Vernal Pool Species Richness

The success criterion for vernal pool indicator species richness is determined as a percentage of the species richness values in the control pools. During Year 5, species richness within the restoration site should be at least 100 percent of the values of the references sites (Table 13). The average per-pool species richness for the SYHS and J26 sites was 3.4; therefore the restoration site should have an average species richness value of at least 3.4. The actual average species richness per pool for the restoration site (4.8) exceeded this target value. Over the last four years, there has been a steady trend toward increasing within-pool species diversity. In addition, the overall species richness (i.e., total number of vernal pool indicator species across the entire site) within the restoration site (6) was as high or higher than the other two sites (5 at the J26 site, and 6 at the SYHS site), suggesting that the restoration site supports a high diversity of vernal pool species overall.

Table 13. Vernal Pool Vegetation Monitoring Success Criteria and Performance

	Combined Reference Sites Results					Combined Reference Sites Success Criteria					Restoration Site Results				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Vernal pool indicator species richness[1]	1.4	2.5	3.25	3	3.4	≥35%	≥50%	≥65%	≥80%	100%	0.2/**14%**	3.3/**132%**	3.5/**108%**	4.5/**150%**	4.8/141%
Percent cover vernal pool indicator spp.[2]	17.0	28.4	0.9	9.5	1.1	≥25%	≥35%	≥50%	≥70%	≥90%	1.6/**9%**	26.9/**95%**	3.4/**380%**	28.8/**305%**	3.4/309%
Percent cover Cal-IPC mod./high spp.	0.0	13.4	0.1	1.3	1.5	N/A	N/A	N/A	<5%	<1%	0.0	0.0	0.0	0.0	0.1
Percent cover for all non-native spp.	3.4	62.1	1.8	14.4	9.2	N/A	N/A	<10%	<10%	<5%	0.0	1.1	0.0	0.8	0.6

[1] Species richness is the average number of vernal pool species per pool. The success of the restoration site is evaluated relative to the reference sites. Note that a minimum of 1 vernal pool species in the restoration site is required in Years 1 and 2, at least 2 species are required for Year 3, and at least 3 species are required for years 4 and 5, regardless of the reference site values. [2] Percent cover relative to average within sampled control pools; The restoration site must have a cover of 70% of 9.45% cover (i.e. 6.62 % cover).

Table 14. Upland Vegetation Monitoring Success Criteria and Performance

	SYHS Reference Site Results[1]					SYHS Reference Site Success Criteria[1]					Restoration Site Results				
	Year 1	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**	**Year 1**	**Year 2**	**Year 3**	**Year 4**	**Year 5**
Upland species richness[2]	N/A	N/A	11	25	20	≥10%	≥20%	≥30%	≥50%	≥75%	N/A	N/A	26/**236%**	19/**76%**	24/**120%**
Percent cover of native species[2]	N/A	N/A	20	44	49	UG[4]	≥15%	≥40%	≥50%	≥70%	UG[4]	N/A	19/**95%**	28/**62%**	50/**102%**
Percent cover target weed species [3]	N/A	N/A	0.0	0.0	0	<1%	<1%	<1%	<1%	<1%	N/A	N/A	0.0	0.0	0
Percent cover all non-native species [3]	N/A	N/A	0.0	5.9	2.0	<5%	<5%	<5%	<5%	<5%	N/A	N/A	7.0	2.0	3.0

[1] No success criteria for Years 1 and 2
[2] Percent value relative to control site.
[3] Absolute value (not relative/e to control site).
[4] UG = uniform germination

Vernal Pool Species Cover

The estimated cover of vernal pool indicator species for the two reference sites combined was 1.1 percent in Year 5, which was the lowest value during the monitoring period except for Year 3 (0.9 percent) (Figure 13). Over the course of the five-year period, vernal pool species cover varied from 0.9 to 28.8 percent cover in the (combined) reference sites. Cover within the restoration site was quite a bit higher than the reference sites in Year 5 at 3.4 percent. Based on the Year 5 success criterion, the percent cover of vernal pool indicator species within the restoration site must be at least 90 percent of the estimated cover of the reference pools, which would be 1.0 percent cover. The Year 5 results in the restoration pools were 309 percent of the reference value, which far exceeds the required minimum value. This trend was observed in Years 2 – 4 as well; the percent cover of vernal pool species relative to the reference site were 108-150%.

Non-native Species Cover

The Year 5 success criteria for non-native species cover require that the cover of Cal-IPC moderate/high risk species to be less than 1 percent and the cover of non-native species overall be less than 5 percent (Table 13). The estimated Year 5 cover of Cal-IPC moderate/high risk species within the restoration site was 0.1 percent, and the overall cover of non-native species was 0.6 percent, which are both well below the target values. The restoration site continues to be well managed for invasive species, outperforming the reference sites.

Photomonitoring

Photomonitoring shows the overall growth of vegetation in both the restoration site and reference sites during Year 5 (Appendix G). Although the rainfall during Year 5 was below normal rainfall levels, the vernal pools showed healthy growth and vigor.

4.4 Upland Vegetation

Table 14 above summarizes the success criteria for restored upland vegetation that surrounds the vernal pools. For Year 5, species richness and native species cover must be at least 75 percent of the combined reference values. Upland species richness within the restoration site was 24, which is 120 percent of the average species richness in the reference sites (20). Percent cover of native species must be at least 70 percent of the cover of the combined reference sites. Upland native species cover within the restoration site was 50 percent, which is 102 percent of the average cover in the reference sites (49 percent). Overall non-native species cover must be less than 5 percent and cover of target species must be less than 1 percent. Within the restoration site, overall cover was 3 percent and cover of target species was zero percent. Therefore, the restoration site met all of the Year 5 success criteria for upland vegetation.

4.5 California Rapid Assessment Method (CRAM) Assessment

A comparison of the CRAM scores from baseline to Year 5 shows a clear trajectory towards improving wetland conditions (Table 15). All attributes improved consistently and significantly over time. The *Buffer and Landscape Connectivity* was slightly higher in Year 1 (75) than Years

3 and 5 (68); however, any change less than 10 points is not considered significant (C. Clark pers. comm). The overall increase between baseline and Years 3 – 5 were due to an increase in aquatic area abundance and buffer condition. The *Hydrology* attribute, which evaluates the extent, duration, and frequency of ponded conditions within the AA, remained unchanged between Years 1 and 5, with the highest score possible. The greatest amount of improvement occurred in the *Physical Structure* and *Biotic Structure* attributes. The *Physical Structure* attribute increased 55 points between baseline and Year 5. These improvements occurred between baseline and Year 1 (an increase of 39 points), and between Year 1 and Year 3 (an increase of 16 points). There was no change between Years 3 and 5. The increase in *Physical Structure* attribute score was due to higher structural patch richness, pool and swale density (which was not part of the CRAM module during the baseline period), and topographic complexity. The *Biotic Structure* attribute increased by 56 points between baseline and Year 5. The increase, which was fairly steady throughout the entire monitoring period, was due to an improvement in number of co-dominants, percent non-native species, endemic species richness, and horizontal interspersion.

Table 15. CRAM Scores for the Restoration Site (Mitigation Area) – Baseline through Year 5

Attributes and Metrics	Pre-Restoration Baseline[1]	Year 1[2]	Year 3[2]	Year 5[2]
Buffer and Landscape Connectivity	48	75	68	68
Hydrology	90	100	100	100
Physical Structure	28	67	83	83
Biotic Structure	36	54	67	92
Overall AA Score	**51**	**74**	**80**	**86**

[1] Conducted by Helix Environmental, Inc. (Source: Restoration Plan)
[2] Conducted by Environmental Science Associates (ESA)

The target CRAM scores for the vernal pool restoration site were defined in the Restoration Plan based on CRAM scores for the mitigation site prior to restoration, and a reference site as summarized in Table 16 below. During Year 3, the restoration area already exceeded the target Year 5 CRAM scores for individual attributes and overall AA scores recommended in the Restoration Plan, despite excessively high temperatures and drought conditions that occurred during the monitoring period. As discussed above, the Year 5 scores were even higher. These results suggest that the mitigation, including the location of the mitigation site and the restoration design and implementation, has been successful, at least in terms of the characteristics measured by CRAM.

Table 16. Year 5 Results Compared to Target CRAM Scores

	Target Values		Year 5 Results	
Attribute	**Year 3**	**Year 5**	**Year 3**	**Year 5**
Buffer and Landscape Context	50	54	68	68
Hydrology	94	100	100	100
Physical Structure	42	50	83	83
Biotic Structure	46	58	67	92
Overall Assessment Area Score	58	66	**80**	**86**

4.6 Conclusions and Recommendations

Although the rainfall during the monitoring period was below normal, the vernal pools and surrounding uplands showed robust growth and vigor, which is substantiated by the site photographs and quantitative vegetation data. All success criteria, including criteria for branchiopods, hydrology, vernal pool vegetation, and upland vegetation, were met or exceeded in Year 5. Therefore, the restoration is considered to be successful.

Due to the proximity of the restoration site to disturbed lands, aggressive non-native species control should continue in perpetuity once the site is turned over to a land manager for long-term management, and special attention should be given to stinknet and any other non-native species that threaten to take over the site. In addition, fascicled tarplant (*Deinandra fasciculata*) was observed within many of the vernal pool basins. It is recommended that the long-term land manager monitor the density of this species within the vernal pool basins and consider hand removal if it begins to overtake the vernal pools. Trash, trespass, and erosion should continue to be monitored regularly and corrected as necessary.

5.0 References

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Appendix A

Vernal Pool Restoration Plan (2011)

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Appendix B

Selected Permits and Biological Opinion

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Appendix C

J26 Vernal Pool Complex Programmatic Reference Pool Monitoring Protocol

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Appendix D

2015 Fairy Shrimp Survey Report

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Appendix E

Year 5 Vernal Pool California Rapid Assessment Method (CRAM) Report

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Appendix F

Qualitative Site Photographs

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Appendix G

Photodocumentation at Quantitative Vegetation Transects

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