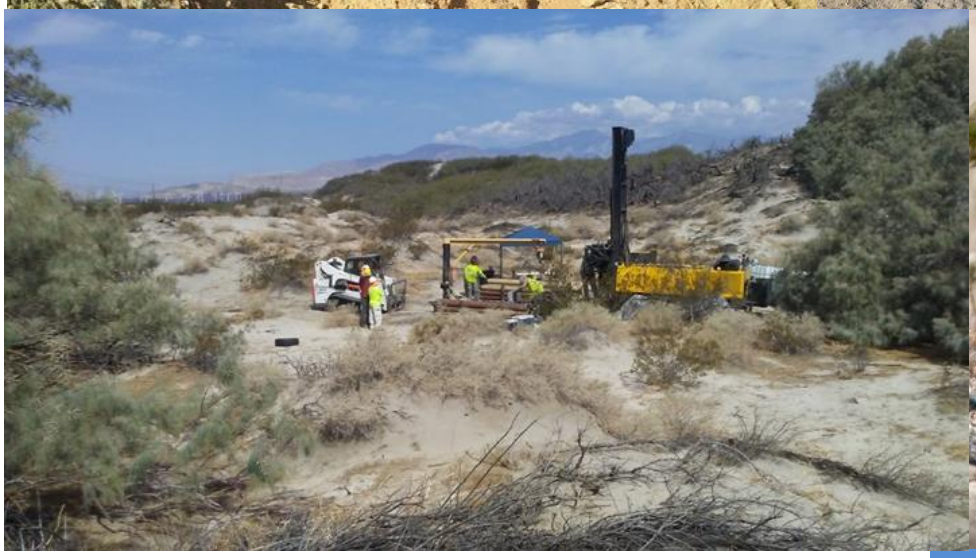
Coachella Valley
Multiple Species Habitat Conservation Plan/
Natural Community Conservation Plan

2018 Annual Report



Submitted by
Coachella Valley Conservation Commission

May 2019

Table of Contents

Appendices

I. Rules for Land Acquisition and Management Credit

II. Table of Acquisitions for Conservation in 2018

III. Status of Conservation Objectives by Conservation Area

IV. Covered Activity Impacts Outside Conservation Areas

V. Monitoring Results for Aeolian Sand Species

VI. Monitoring Results for Coachella Valley Jerusalem Cricket

VII. Monitoring Results for Triple-ribbed Milkvetch

VIII. Invasive Plants Monitoring and Modeling Results

IX. Proposed Protocol for Measuring Mesquite Health with Respect to Putative Factors Causing Declines in Stand Health in the Coachella Valley

X. 2018 Cowbird Management in the Coachella Valley

I. Introduction

The Coachella Valley Multiple Species Habitat Conservation Plan/Natural Community Conservation Plan (CVMSHCP) is a regional multi-agency conservation plan that provides for the long-term conservation of ecological diversity in the Coachella Valley region of Riverside County. Significant progress has been made in plan implementation since state and federal permits were issued in September and October 2008. The term of the permits is 75 years, which is the length of time required to fully fund implementation of the CVMSHCP. This report describes the progress made on plan implementation for the 2018 calendar year.

The CVMSHCP includes an area of approximately 1.1 million acres in the Coachella Valley region within Riverside County. The plan area boundaries were established to incorporate the watersheds of the Coachella Valley within the jurisdictional boundaries of CVAG and within Riverside County. Indian Reservation Lands are not included in the CVMSHCP although coordination and collaboration with tribal governments has been ongoing.

The Coachella Valley Conservation Commission (CVCC) is the agency responsible for CVMSHCP implementation. The CVCC is comprised of elected representatives of the Local Permittees including Riverside County, the cities of Cathedral City, Coachella, Desert Hot Springs, Indian Wells, Indio, La Quinta, Palm Desert, Palm Springs, and Rancho Mirage, the Coachella Valley Water District, Mission Springs Water District, and the Imperial Irrigation District. The Riverside County Flood Control and Water Conservation District (County Flood Control), Riverside County Regional Park and Open Space District (County Parks), and Riverside County Waste Resources Management District (County Waste) are also Local Permittees. Other Permittees include three state agencies, the California Department of Parks and Recreation (State Parks), the Coachella Valley Mountains Conservancy (CVMC), and the California Department of Transportation (CalTrans). A major amendment to include the City of Desert Hot Springs and Mission Springs Water District as Permittees was approved by the CVCC in March 2014 and all local Permittees approved the major amendment in 2014. The US Fish and Wildlife Service (USFWS) approved the Major Amendment in December 2015. The final approval of the Major Amendment by California Department of Fish and Wildlife (CDFW) was in August 2016.

The CVMSHCP involves the establishment of a Reserve System to ensure the conservation of the covered species and conserved natural communities in perpetuity. The existing conservation lands managed by local, state, or federal agencies, or non-profit conservation organizations form the backbone of the CVMSHCP Reserve System. To complete the assembly of the Reserve System, lands are acquired or otherwise conserved in three major categories:

- Lands acquired or otherwise conserved by the CVCC on behalf of the Permittees, or through Permittee contributions.
- Lands acquired by state and federal agencies to meet their obligations under the CVMSHCP.
- Complementary Conservation lands including lands acquired to consolidate public ownership in areas such as Joshua Tree National Park and the Santa Rosa and San Jacinto Mountains National Monument. These acquisitions are not a Permittee obligation but are complementary to the Plan.

In addition to acquisition, land in the Reserve System may be conserved through dedication, deed restriction, granting a conservation easement, or other means of permanent conservation. To meet the goals of the CVMSHCP, the Permittees are obligated to acquire or otherwise conserve

100,600 acres in the Reserve System. State and federal agencies are expected to acquire 39,850 acres of conservation land. Complementary conservation is anticipated to add an additional 69,290 acres to the MSHCP Reserve System. Figure 1 shows the progress as of December 31, 2018 toward the land acquisition goals identified in Table 4-1 of the CVMSHCP.

Figure 1: CVMSHCP Progress Toward Conservation Goals

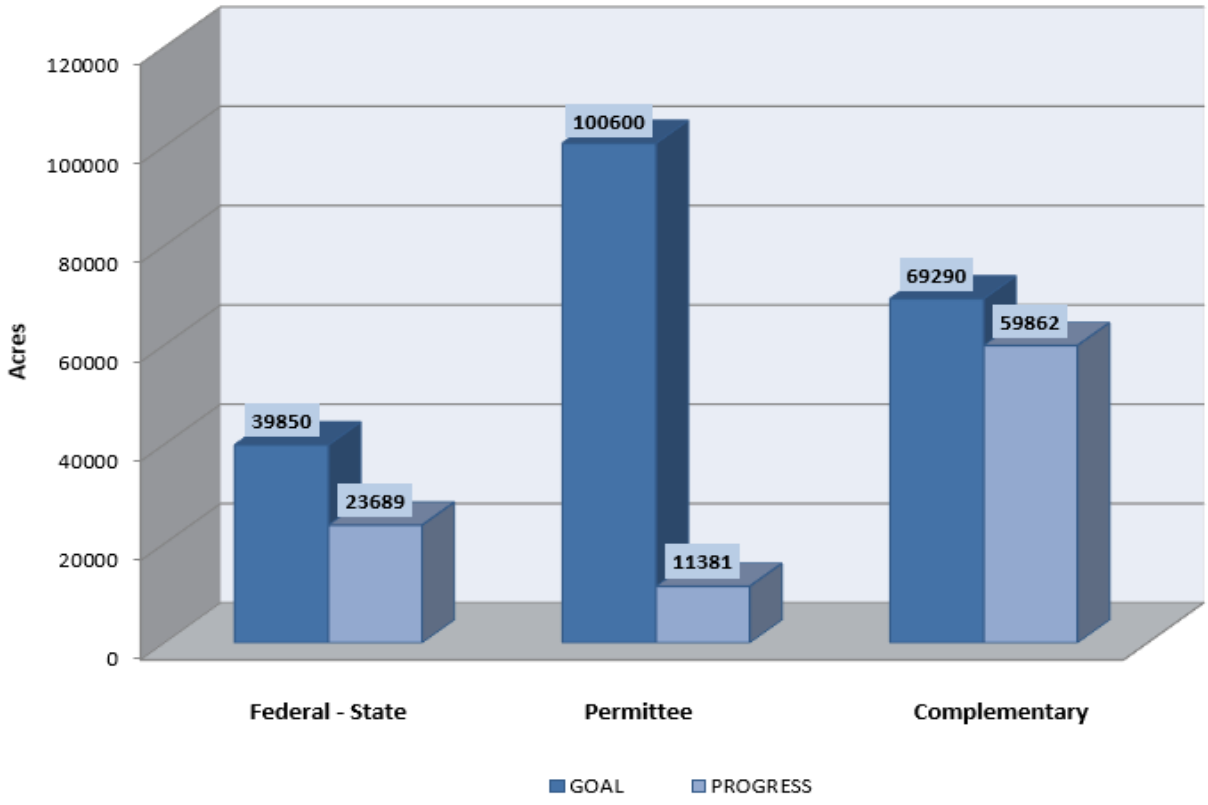


Table 1 demonstrates our progress on reserve assembly by showing the acres of conservation land protected since the issuance of the federal permit in October 2008. Significant progress has been made with over 94,932 acres of conservation lands acquired by various local, state and federal partners since 1996. In 2018, CVCC acquired 578 of land that will be credited toward our total goal of 100,600 acres. The total acres acquired by all partners in 2018 was 2,298 acres

Most of the land conserved since 1996 has been accomplished by entities other tha.n CVCC. CVCC has focused our acquisition efforts in the conservation areas on the valley floor where development is most likely to occur. Our acquisitions include smaller parcels that help to reach the important conservation goals of the CVMSHCP. This acquisition focus has had very positive results, with significant acreage in conservation areas in permanent conservation (see Figure 5).

A major update of the land acquisition database was done in 2013; additional updates were made in early 2016 which are reflected in this report. As a result, some corrections to the numbers reported in Table 1 in prior annual reports have been made. All acquisition records and the

acreage figures used thoughout the 2018 Annual Report have now been updated and made consistent with the rules shown in Appendix 1.

Table 1: Summary of Annual Progress on Reserve Assembly

Conservation Credit	Goal	Total Progress	1996 - 2010	2011	2012	2013	2014	2015	2016	2017	2018
Federal - State	39,850	23,689	16,225	908	1,819	1,102	1681	296	319	525	814
Permittee	100,600	11,381	7,254	383	315	601	242	416	799	793	578
Complementary	69,290	59,862	47,574	4,207	1,760	698	957	1,445	612	1,703	906
Total	**209,740**	**94,932**	**71,053**	**5,498**	**3,894**	**2,401**	**2,880**	**2,157**	**1,730**	**3,021**	**2,298**

Once acquired, lands within the Conservation Areas are held in public or private ownership and are managed for conservation and/or open space values. Management of these lands contributes to the conservation of the Covered Species and the conserved natural communities included in the Plan. Table 2 identifies the allocation of land management responsibility, based on the entity that ultimately holds title to the land.

Table 2: Acres of Management Credit

Management Credit	Progress (acres)
Federal - State	59,938
Permittee	13,618
Complementary	21,376
Total	**94,932**

Reporting Requirements:

This Annual Report describes the activities for the period from January 1, 2018 to the end of the calendar year on December 31, 2018. As required by Section 6.4 of the CVMSHCP, this Annual Report will be presented at the CVCC meeting of May 9, 2019, where the report will be made available to the public. The report is also posted on the CVMSHCP website, www.cvmshcp.org.

II. Status of Conservation Areas: Conservation and Authorized Disturbance

The CVMSHCP identifies both qualitiative and quantitative conservation goals and objectives that must be met to ensure the persistence of the Covered Species and natural communities. The quantitative approach is designed to be as objective as possible. The CVMSHCP includes specific acreage requirements for both the amount of authorized disturbance that can occur and the acres that must be conserved within each Conservation Area. These acreage requirements are identified in conservation objectives for each Covered Species and natural community as well as

for essential ecological processes and biological corridors and linkages. The conservation objectives provide one measure of the progress toward meeting the requirements of the CVMSHCP under the state and federal permits. This report provides a detailed accounting of the status of the conservation objectives for each of the Conservation Areas up to December 31, 2018. The planning process for the CVMSHCP was initiated on November 11, 1996, which is the baseline date for the acreages listed in the tables in Sections 4, 9, 10 and throughout the CVMSHCP document. This Annual Report provides an update of these baseline tables to account for all the Conservation and Authorized Disturbance that has occurred between January 1, 2018 and December 31, 2018 (see Appendix IV).

Table 3 provides a summary of the amount of conservation and the acres of disturbance authorized within Conservation Areas in 2018. Authorized disturbance results from development projects in the Conservation Areas. In 2018, there was zero (0) acres of Authorized Disturbance reported. The Total Authorized Disturbance in Table 3 includes Authorized Disturbance since 1996.

Table 3: Conservation and Authorized Disturbance Within Conservation Areas

Conservation Area	Conservation Goal	Conserved in 2018	Conserved Since 1996	Allowed Authorized Disturbance	Authorized Disturbance in 2018	Total Authorized Disturbance since 1996
Cabazon	2,340	0	0	260	0	0
CV Stormwater Channel and Delta	3,870	39	787	430	0	5
Desert Tortoise and Linkage	46,350	722	5,154	5,150	0	0
Dos Palmas	12,870	0	4,282	1,430	0	0
East Indio Hills	2,790	35	35	310	0	0
Edom Hill	3,060	0	2,072	340	0	2
Highway 111/I-10	350	0	54	40	0	0
Indio Hills Palms	2,290	0	1,039	250	0	0
Indio Hills/Joshua Tree National Park Linkage	10,530	15	9,000	1,170	0	6
Joshua Tree National Park	35,600	80	13,326	1,600	0	0
Long Canyon	0	0	0	0	0	0
Mecca Hills/Orocopia Mountains	23,670	59	7,140	2,630	0	0
Santa Rosa and San Jacinto Mountains	55,890	772	32,342	5,110	0	10
Snow Creek/Windy Point	2,340	0	889	260	0	0
Stubbe and Cottonwood Canyons	2,430	171	1,046	270	0	29
Thousand Palms	8,040	21	4,381	920	0	55

Conservation Area	Conservation Goal	Conserved in 2018	Conserved Since 1996	Allowed Authorized Disturbance	Authorized Disturbance in 2018	Total Authorized Disturbance since 1996
Upper Mission Creek/Big Morongo Canyon	10,810	0	7,133	990	0	21
West Deception Canyon	1,063	40	1,833	100	0	0
Whitewater Canyon	1,440	0	956	160	0	1
Whitewater Floodplain	4,140	336	908	460	0	33
Willow Hole	4,920	7	2,555	540	0	6
Total	234,793	2,298	94,932	22,420	0	168

III. Biological Monitoring Program

The CVMSHCP outlines a scientifically-based monitoring program for species, natural communities and landscapes listed under the Plan. To ensure long-term conservation goals are attained, monitoring activities are based on a three-phased approach and consist of: 1) assessing baseline conditions and identifying threats and stressors; 2) performing focused monitoring including threats and stressors, once they are determined; and 3) conducting adaptive management actions whereby the scientific method is employed to develop and implement best management practices.

The Reserve Management Unit Committee and Biological Working Group (RMUC/BWG) meet regularly to discuss updates on biological issues and adaptive management strategies. One of the tasks of these meetings is to assess current monitoring protocols to align them with research goals and management needs outlined within the CVMSHCP, as well as vetting completed monitoring activities. During the spring, the RMUC/BWG assess the monitoring priorities to be brought forth to the Reserve Management Oversight Committee as the recommended annual work plan, and each year they recommend a suite of species for monitoring that should be added in year's with or following above average rainfall. The CVCC Conservation Management Analyst facilitates these meetings of the Reserve Management Unit Committees and the Biological Working Group to better manage biological monitoring contracts, pursue funding opportunities for further research, and organize logistics for monitoring and land management efforts throughout the year.

To support these goals, CVCC staff actively pursue grant funding for monitoring programs. In May 2018, CVCC received notice of funding from the Natural Community Conservation Planning Local Assistance Grant (LAG) program, in the amount of $94,250 to support a project entitled *Determining habitat use and response to human recreation activities of Peninsular bighorn sheep (Ovis canadensis nelsoni) in a shared landscape.* This project consists of a pilot study to examine recreational use along trails within Peninsular bighorn sheep (PBS) habitat in the Santa Rosa and San Jacinto Mountains Conservation Area, including near PBS lambing areas and watering holes.In 2018, CVCC is partnering with San Diego Institute for Conservation Research on a California Energy Commission Grant to determine how active and passive trans-location affect burrowing owls displaced by development. Translocated owls were fitted with GPS backpacks

that track their movement as they establish nests throughout the breeding season. UCR and CVCC staff provided support by installing and checking wildlife cameras placed at nests in Cabazon and the Coachella Valley Stormwater Channel. Cameras documented nest productivity, prey items, and visits to the nests by other species, including predators. The final report for this study will be available in the 2019 Annual Report.

Peninsular bighorn sheep monitoring continued with tracking GPS telemetry collars that were fitted to sheep in the Santa Rosa and San Jacinto Mountains Conservation Area in October 2014 and November 2015. A California Department of Fish and Wildlife report describes the population status for bighorn sheep as well as factors affecting their survival for the period through May 2018, and is available at CDFW 2017-2018 Peninsular Bighorn Sheep Annual Report . Additional GPS collars were placed on bighorn sheep in November 2017, funded in part by CVCC and USFWS. During these bighorn captures, blood and serum samples were collected from each bighorn sheep to provide data on health and genetic status. The recently collected samples were combined with stored tissue samples collected in the past from sheep in the Santa Rosa and San Jacinto Mountains. Under a contract with CVCC, Oregon State University completed the genetic analysis of bighorn sheep in the Santa Rosa and San Jacinto Mountains. Analysis of the samples and GPS collars were funded by a Bureau of Reclamation Grant in the amount of $48,750 in July 2014 for "*Genetic and Health Profiles of Peninsular Bighorn Sheep in the Northern Peninsular Range*," as well as additional funding from CVCC ($40,000) and U.S. Fish and Wildlife Service ($11,000). A presentation on the results of the genetic analysis was made to a large crowd at UCR Palm Desert; a publication including the study results in a peer-reviewed journal is anticipated in the future.

In June 2018, a contract with UC Riverside (UCR) - Center for Conservation Biology was approved for monitoring of aeolian sand species, triple-ribbed milkvetch, jerusalem cricket, developing a mesquite monitoring protocol, as well as updating vegetation maps for the Dos Palmas and Valley Floor Conservation Areas to document change. The mesquite monitoring protocol was developed as part of the overall mesquite management for the CVMSHCP. Mission Springs Water District installed two monitoring wells in the Willow Hole Conservation Area to support these efforts. These wells will help CVCC and MSWD determine if the hydrology of the ground water basin is affecting the long-term sustainability of the mesquite habitat. During the 2017-2018 contract, UCR was also tasked with predictive species distribution modeling for fountain grass and sahara mustard. UCR also provided research and tech support as needed for the San Diego Zoo Global burrowing owl study and CDFW's desert pupfish study. The monitoring reports for the aeolian sand community, Jerusalem cricket, triple-ribbed milkvetch, predictive model for invasive species, and protocol for mesquite monitoring can be found in Appendices V - IX respectively. In coordination with the RMUC and Biological Working Group, UCR provides guidance and input on the development of the monitoring program tasks and performs the majority of monitoring efforts with their team of ecologists who have specialties in various aspects of the Coachella Valley desert ecology.

CVCC also contracted with the United States Geological Survey to monitor tortoise populations and demography within a focal plot south of Interstate 10 in the Desert Tortoise and Linkage Conservation Area, using radiotelemetry to locate the tortoises, and provide population estimates as they did previously for the population north of Interstate 10 in Cottonwood Wash (2017 Annual Report). Tortoises captured in the Desert Tortoise and Linkage Conservation Area, the Santa Rosa and San Jacinto Mountains Conservation Area and the Whitewater Canyon Conservation Area have had blood taken and genetic analysis is pending; the final report for this study will be found in the 2019 Annual Report.

2018 Biological Monitoring Activities

Photos: 1 –Nest camera captures burrowing owl behavior in Cabazon ; 2 – Giant sand-treader cricket on dune; 3 - Monitoring Triple-ribbed Milkvetch in Little Morongo Canyon (Astragalus tricarinatus); 4 –Mesquite dunes at Willow Hole Conservation Area; 5- Coachella Valley Jerusalem Cricket being measured and documented; 6- Well installed by Mission Springs Water District to monitor water levels affecting mesquite restoration in the Willow Hole Conservation Area.

IV. Land Management Program

Management of lands acquired by CVCC and other local Permittees is coordinated with management of the existing conservation lands owned by state, federal and non-profit agencies. The Reserve Management Oversight Committee (RMOC) is the inter-agency group that provides a forum for coordination of management and monitoring lands within the Reserve System and makes recommendations to the CVCC. The Reserve Management Oversight Committee is supported by the Reserve Management Unit Committees.

The Reserve Management Oversight Committee held two meetings on January 24, and May 23, 2018. Each RMOC meeting included a report regarding the Monitoring Program and the Land Management Program. The RMOC reviewed the Reserve Management and Monitoring work plans, biological monitoring and management priority activities, and tentative budget at the May 23, 2018 meeting. The recommendations from the RMOC were incorporated into the CVCC budget for FY 2018/2019 and presented to the CVCC at their June 2018 meeting. CVCC staff continues to coordinate with the RMOC and RMUCs to ensure that monitoring and research activities inform and support management of the Reserve Management Units.

Reserve Management Unit Committees

The six Reserve Management Units (RMUs) facilitate coordinated management by local, state and federal agencies to achieve the Conservation Objectives within the MSHCP Reserve System. Because many of the same staff members are involved in both the Reserve Management Unit Committee (RMUC) and Biological Working Group (BWG), meetings were combined to reduce demands on staff time and provide for better coordination between management and monitoring teams. The RMUC / BWG met on March 13, April 17, May 8, November 8, and December 11, 2018. The group discussed prioritizing invasive species and off-road vehicle control management efforts, increasing volunteer opportunities, priorities for monitoring and research, coordination on grant opportunities, and monitoring results.

Trails Management Subcommittee

The Trails Management Subcommittee (TMS) meetings were held on January 17, March 21, May 16, October 17, and November 28, 2018. During 2018, the TMS moved to a bimonthly meeting schedule with no meetings during the summer due to the creation of several working groups to focus on various issues affecting trail management. Working groups in 2018 included Dog Enforcement and Ordinances, Trail Maintenance, Schey trail reroute, and Trails Research. The TMS would then come together to report on progress of the working groups and discuss significant issues, management, and funding opportunities. CVCC partners, Friends of the Desert Mountains and their volunteer crew continued to worked closely with BLM and the cities to fix trail hazards and install clear directional and safety signage. Friends' volunteers are taking the lead on trail restoration throughout the valley. CVCC staff is also working with the Greater Palm Springs Convention & Visitors Bureau, Friends of the Desert Mountains, and other volunteers from the TMS to update trail apps and websites, and provide wayfinding signage along roadways to highlight trailheads in the Coachella Valley. This effort will provide much needed outreach of information on environmentally friendly trail use on authorized trails and appropriate recreational activities on the trails.

Land Improvement: Acquisition Cleanups

In 2018 the CVCC Acquisitions Manager performed pre-acquisition site inspections and job walks on 44 parcels/projects in multiple Conservation Areas. During these inspections the Land Acquisitions Manager identified illegal dumping, hazardous conditions, OHV & equestrian activity, and the existence of listed species, as well as determined property fencing requirements. As per CVCC's standard Purchase & Sale Agreements, willing sellers are required to clean up illegal dumping and blight prior to closing. Contractors are met in the field by the Acquisitions Manager prior to a required cleanup to review the agency's standards and specifications for the particular site in question. After cleanup, the job site is re-inspected to certify that cleanups meet the requirements, and if they are found lacking, the seller is notified if additional work will be necessary. After closing, CVCC monitors the sites at least annually for ongoing management/fencing requirements. This year, CVCC was directly responsible for removing an estimated 6.65 tons of refuse, including 308 tires, from the Coachella Valley, covering more than 632.78 acres and generating over $41,500.00 in contractor revenue from sellers' property sales.

Property Management & Monitoring

Monitoring the status of CVCC conservation lands is an essential and ongoing activity. Site visits and patrols are conducted on a monthly basis to various CVCC properties. Illegal dumping, OHV use and shooting continue to be a problem on some of the Reserve lands. In 2018, CVCC's maintenance contractor installed 24,203 linear feet of post and cable fencing to protect reserve lands, as well as signage, four gates and four horse gates in the Willow Hole, Edom Hill, Thousand Palms Conservation Areas. Working in partnership to secure adjacent state lands, the Coachella Valley Mountains Conservancy paid $2,926 to clean up property in Thousand Palms Conservation Area and reimbursed CVCC $17,138.00 for the state portion of the fencing project. CVCC also closely monitored and maintained 18,000 linear feet of post and cable fence installed previously within the Upper Mission Creek and Big Morongo Canyon Conservation Area as well as multiple signs and gates in the Upper Mission Creek, Indio Hills/Joshua Tree National Park Linkage, and Stubbe and Cottonwood Canyon Conservation Areas. The continuous monitoring of the fencing and gates continues to dissuade further dumping or OHV activity in these conservation areas. In September, CVCC's maintenance contractor partnered with CV Housing First, Path of Life Ministries, and the City of Desert Hot Springs to cleanup and fence a large, illegal homeless encampment next to Morongo Wash. Path of Life Ministries reached out to the people living at the camp and were able to place 10 families in permanent housing situations. CVCC removed 57 tons of refuse, and 6.5 tons of tires, as well as 9 RV trailers, 22 autos, and 3 boats from the parcel. Adjacent lands have been regular dumping grounds for a decade, and the camp had persisted due to scavenging.

In addition to fencing and signage, CVCC staff worked with the Urban Conservation Corps and Friends of the Desert Mountains to control invasive vegetation on properties in the Santa Rosa and San Jacinto Mountains Conservation Area. Due to the remoteness of some of the sites, a volunteer backcountry mule team helped pack water and supplies for two separate week long spike camps. The spike camps took place in November and December 2018 and targeted the removal of invasive tamarisk and fountain grass in Cat Canyon and Bear Creek. This effort was funded through a grant for $78,487 awarded to the CVCC in March 2017 from the US Fish and Wildlife Service Endangered Species Section 6 Fund for *Invasive Species Control and Restoration of Water Sources for the Peninsular Bighorn Sheep (Ovis canadensis nelsoni) in the Santa Rosa Mountains*. The Urban Conservation Corps, with an office in Indio, employs youth ages 18 to 25 to work on conservation projects. CVCC also contracted with the San Diego Natural History Museum to continue to control invasive cowbirds in the Coachella Valley Stormwater

Channel and Delta, and Dos Palmas Conservation Areas. The 2018 Cowbird Report can be found in Appendix X.The following photos illustrate the management efforts of 2018.

2018 Land Management Activities

Photos: 1 – Male cowbird caught during trapping; 2 – Crew from San Diego Natural History Museum install cowbird traps on the Coachella Valley Stormwater Channel; 3 – Before and, 4-After cleanup of homeless encampment near Little Morongo Wash; 5– Urban Conservation Corps remove invasive tamarisk from palm oasis; 6.- Fencing protecting mesquite in Willow Hole Conservation Area.

V. Land Acquisition to Achieve the Conservation Goals and Objectives of the CVMSHCP

In 2018, CVCC completed 13 transactions acquiring 25 parcels totaling 578 acres at a cost of $1,764,239 in CVCC funds. These acquisitions are listed in Table 4. Friends of the Desert Mountains acquired 26 parcels totaling 1,601 acres with $279,655 in funds from Coachella Valley Mountains Conservancy (CVMC), along with $439,000 from the California Wildlife Conservation Board (WCB).

A table of CVCC acquisitions and otherwise conserved lands recorded during the period from January 1, 2018 to December 31, 2018 can be found in Appendix III. Parcels acquired are listed by Assessor Parcel Number (APN**)** and the acreage listed is the recorded acreage from the Riverside County Assessor.

Table 4: Lands Acquired by CVCC in 2018

Project	Acres	Conservation Area	Purchase Price
Drasnin	5.12	Stubbe and Cottonwood Canyons	$ 370,000
Drasnin	154.52	Stubbe and Cottonwood Canyons	$
Drasnin	6.53	Stubbe and Cottonwood Canyons	$
Dweck	157.35	Whitewater Floodplain	$ 1,015,000
Dweck	27.50	Whitewater Floodplain	$
Dweck	39.00	Whitewater Floodplain	$
Dweck	6.00	Whitewater Floodplain	$
Dweck	26.31	Whitewater Floodplain	$
Dweck	79.76	Whitewater Floodplain	$
Hansen	35.41	East Indio Hills	$ 90,000
Hernandez Family Trust	4.85	Thousand Palms	$ 84,500
Lindsey Jensen-Archibald	0.24	Willow Hole	$ 72,000
Lindsey Jensen-Archibald	0.24	Willow Hole	$
Lindsey Jensen-Archibald	0.27	Willow Hole	$
Lindsey Jensen-Archibald	0.28	Willow Hole	$
Lindsey Jensen-Archibald	0.31	Willow Hole	$
Lindsey Jensen-Archibald	0.35	Willow Hole	$
Tax Default 2016 - Agreement 4442	2.39	Thousand Palms	$ 4,277
Tax Default 2016 - Agreement 4442	5.06	Santa Rosa and San Jacinto Mountains	$ 34,697
Tax Default 2016 - Agreement 4442	13.79	Thousand Palms	$ 64,896
Tax Default 2016 - Agreement 4442	0.32	West Deception Canyon	$ 11,940
Tax Default 2016 - Agreement 4442	5.00	Indio Hills/Joshua Tree National Park Linkage	$ 5,727
Tax Default 2016 - Agreement 4442	4.82	Willow Hole	$ 4,519
Tax Default 2016 - Agreement 4442	2.51	Desert Tortoise and Linkage	$ 1,899
Tax Default 2016 - Agreement 4442	0.28	Upper Mission Creek/Big Morongo Canyon	$ 4,784
Total Purchases	578.21		$ 1,764,239

Figure 2 shows the acquisitions completed by all local, state, and federal acquisition partners in 2018 by Conservation Area. Figure 3 shows the acquisitions by CVCC. Funding for land acquisition and CVMSHCP Reserve Assembly comes from a variety of sources including local, state, and federal agencies. CVCC acquires lands with funding from CVMSHCP development mitigation fees and CVAG contributions to mitigate for regional roads and other transportation projects. In addition, as shown in Figure 4, funding from land acquisition partners continues to be an important source of land acquisition dollars. Significant federal funding has been provided through the U.S. Fish and Wildlife Service's Cooperative Endangered Species Conservation Fund, referred to as Section 6. State funding comes from several sources. The Coachella Valley Mountains Conservancy contributes significantly to the acquisition of conservation lands through grants to various organizations, including CVCC. The state Wildlife Conservation Board/ California Department of Fish and Wildlife is another major source of funding. The non-profit Friends of the Desert Mountains has acquired lands using grants from CVMC, private donations, and other sources; many of these lands have been transferred to CVCC. Other agencies and non-profits have provided funds for land conservation. Figure 5 shows the lands acquired in 2018 by all acquisition partners. CVCC gratefully acknowledges the support from our partners.

Figure 2: Total Acquisitions in 2018 by Conservation Area

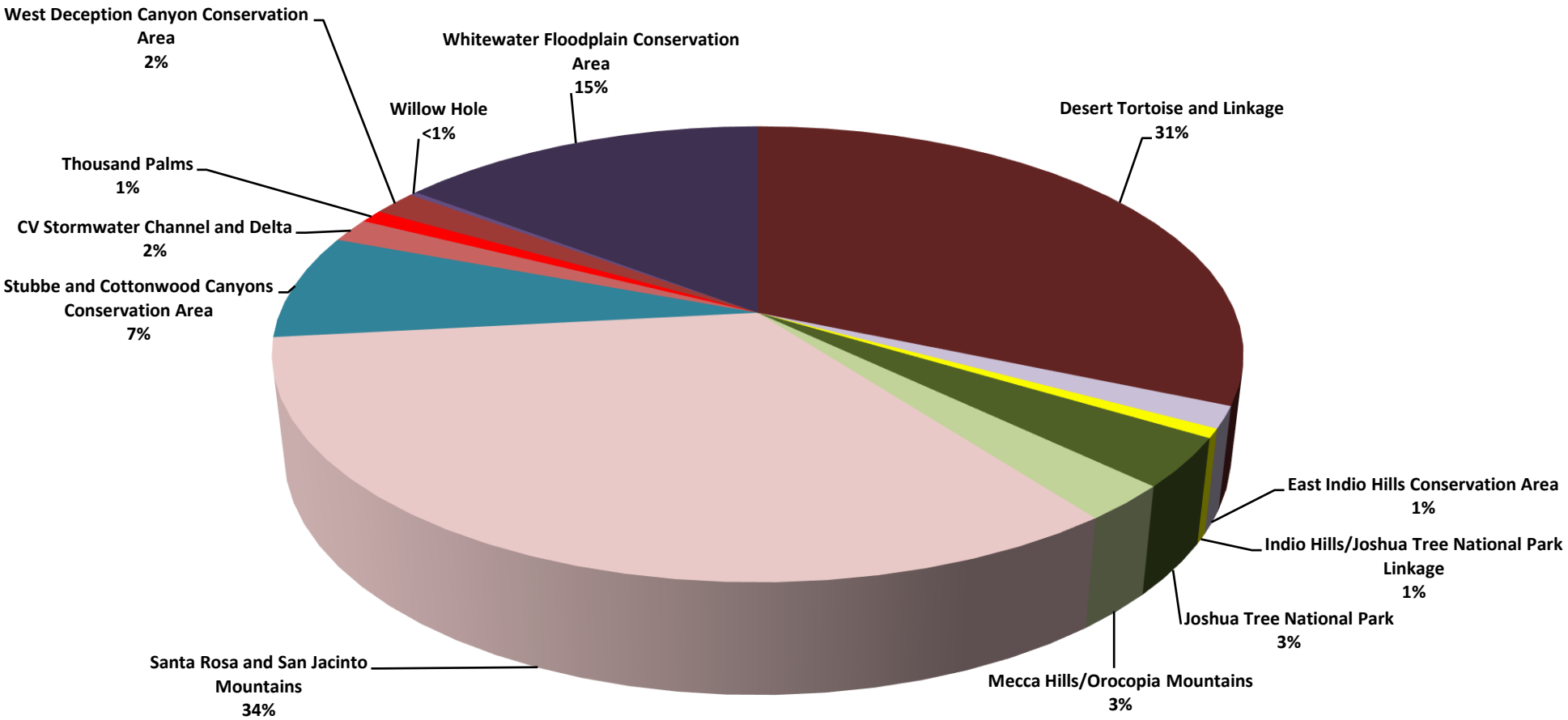


Figure 3: CVCC Acquisitions in 2018 by Conservation Area

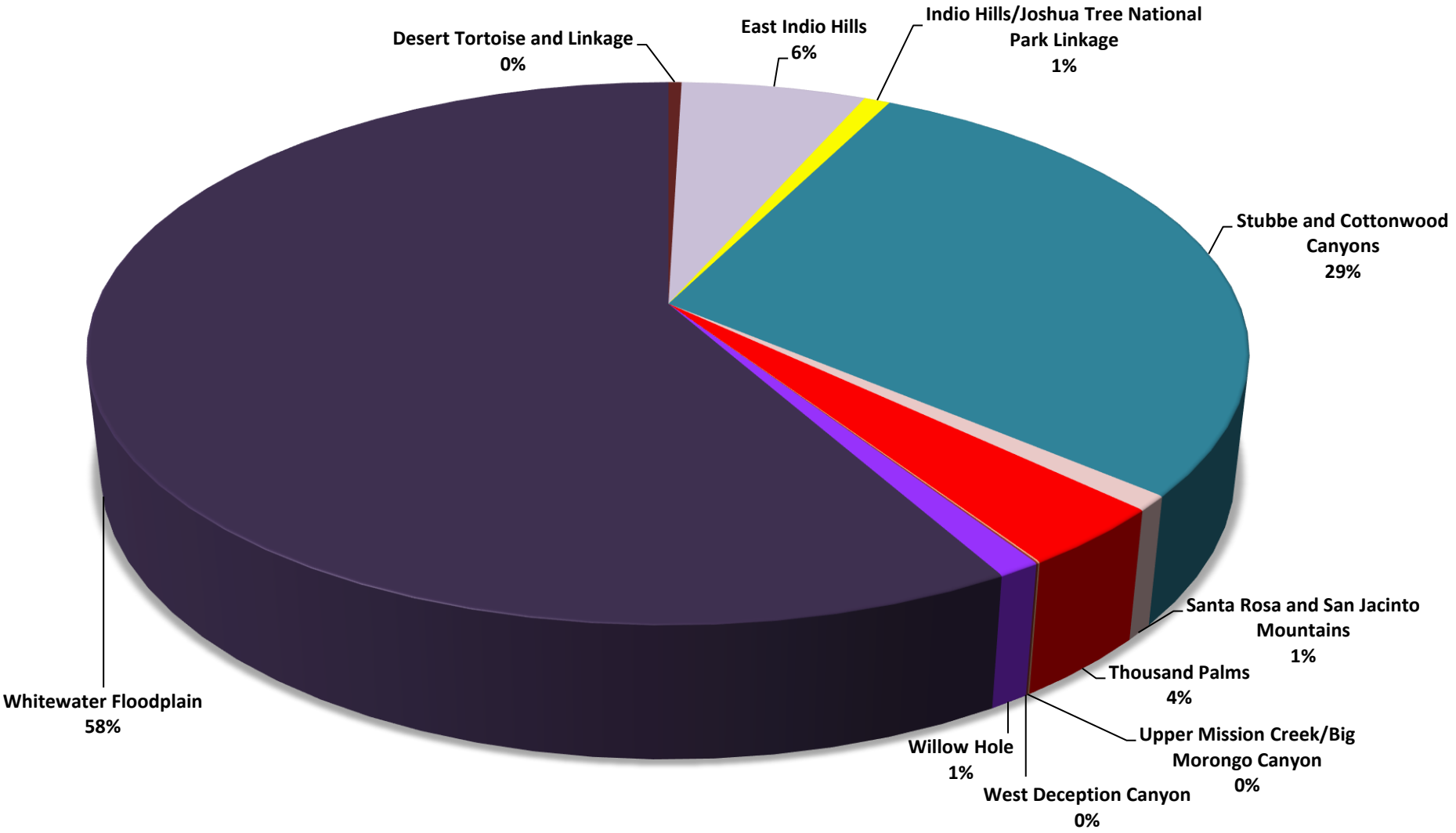
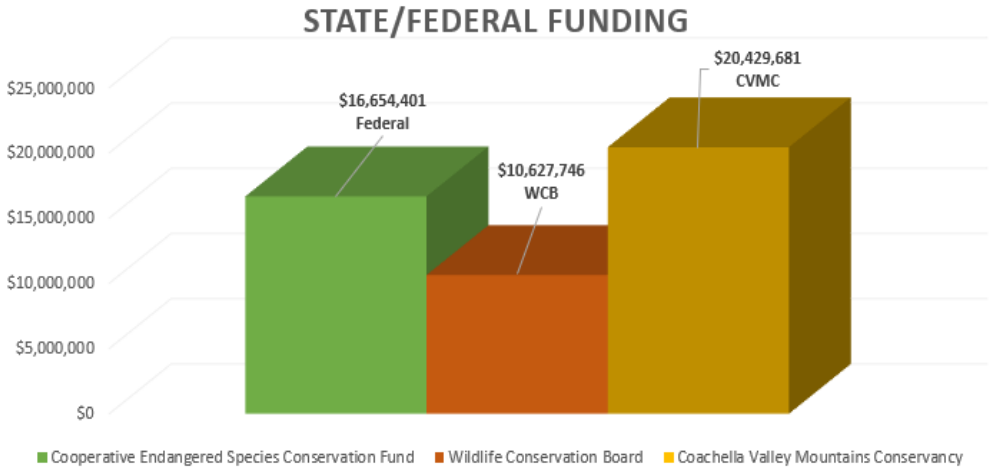
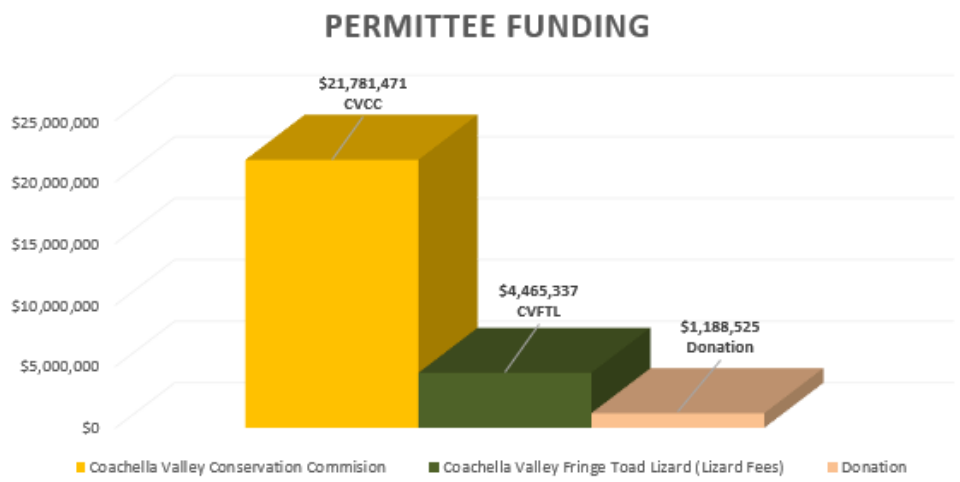


Figure 4: Funding Sources for Land Acquisition and Reserve Assembly





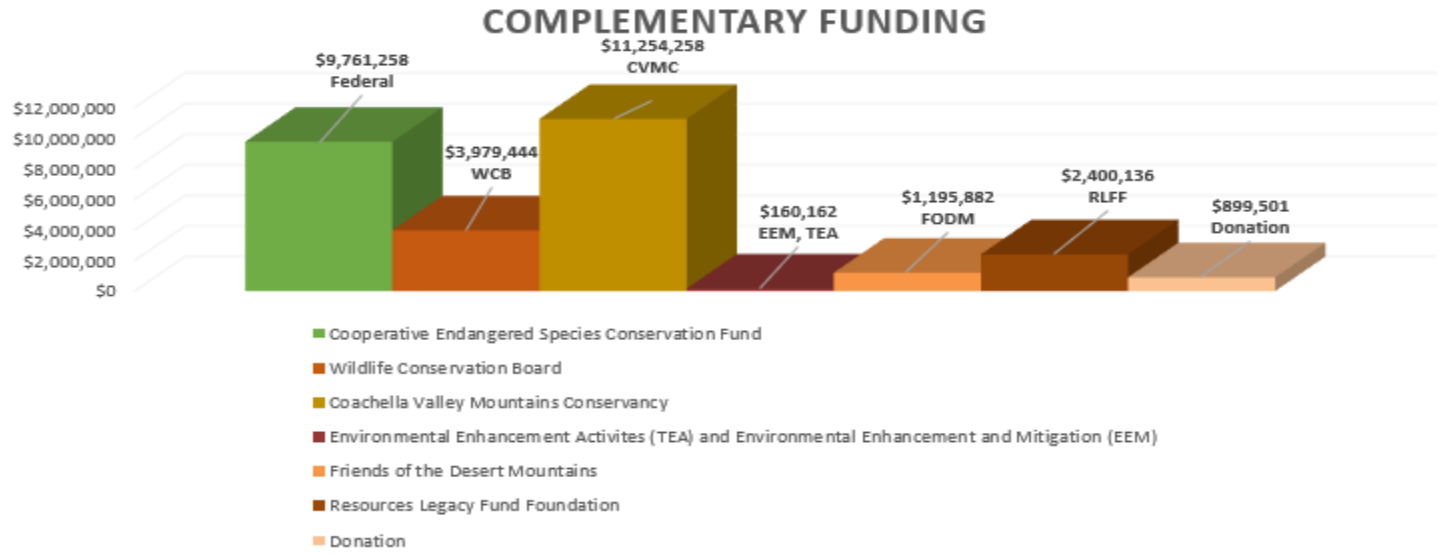
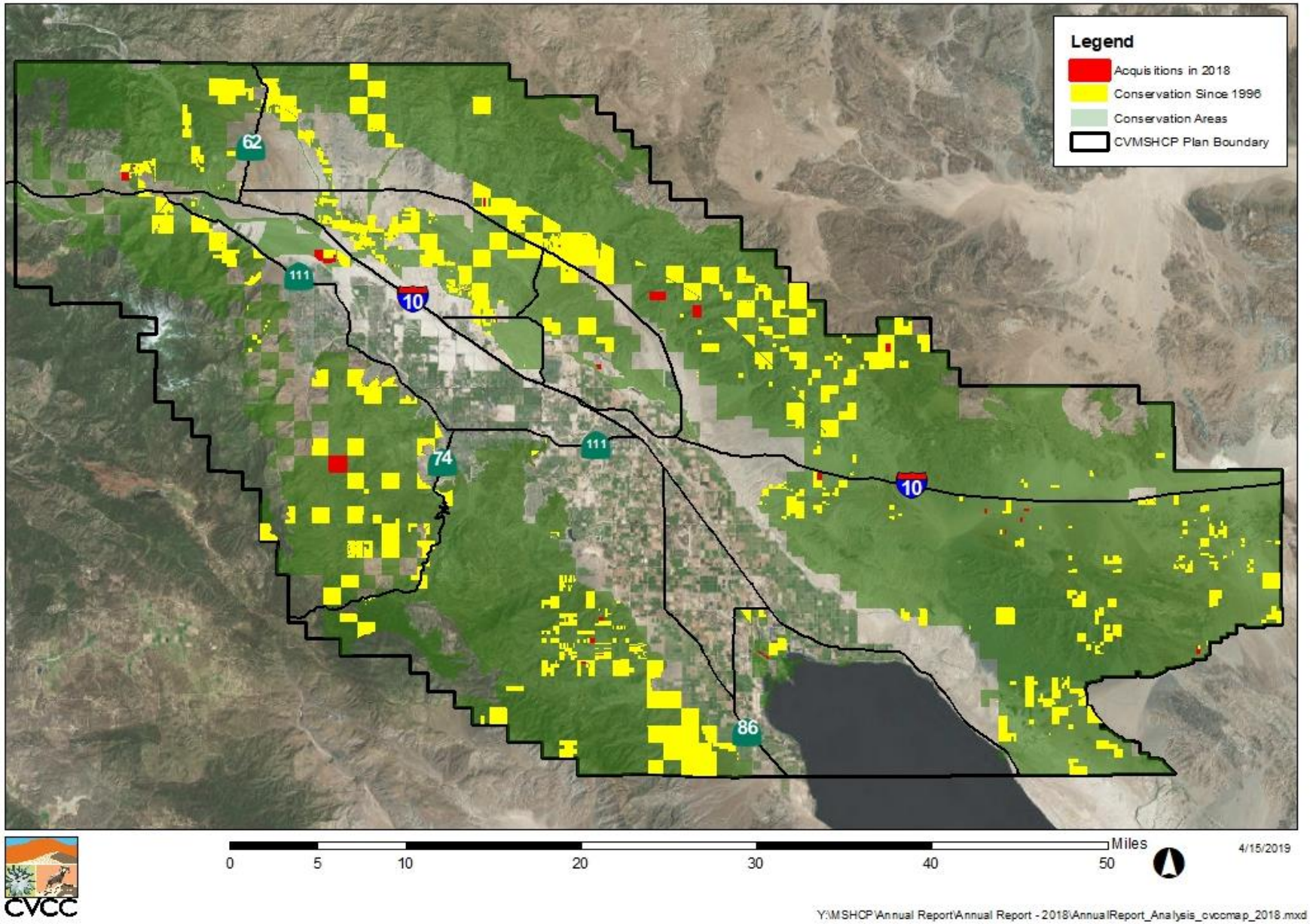


Figure 5: Land Acquisitions in 2018



VI. Conservation and Authorized Disturbance Within Conservation Areas

The progress toward achieving the Conservation Goals and Objectives for the CVMSHCP is reported here from two different perspectives, by Conservation Objective and by Covered Species or natural community. The CVMSHCP includes Conservation Objectives for conserving Core Habitat for Covered Species and conserved natural communities, Essential Ecological Processes necessary to maintain habitat viability, and Biological Corridors and Linkages within each of the 21 Conservation Areas. The amount of conservation and the amount of disturbance are reported in the same tables for comparative purposes. This Annual Report includes the conservation and authorized disturbance from January 1 to December 31, 2018.

The progress toward our goals in terms of the Conservation Objectives is presented in Appendix III.

VII. Covered Activities Outside Conservation Areas

The CVMSHCP allows for development and other Covered Activities outside the Conservation Areas which do not have to meet specific conservation objectives A table that includes an accounting of the number of acres of Core Habitat and Other Conserved Habitat for the Covered Species and conserved natural communities that have been developed or impacted by Covered Activities outside the Conservation Areas can be found in Appendix IV. This information is listed for each of the Permittees with lands impacted by covered activities outside the Conservation Areas.

Development inside Conservation Areas has been carefully tracked and subject to review under the 1996 Memorandum of Understanding that began the planning process for the CVMSHCP. For development outside Conservation Areas, the acre figures in the table are estimates derived from the Developed area of the California Department of Conservation, Division of Land Resource Protection, Farmland Mapping and Monitoring Program GIS coverages from 1996 and 2016.

See http://www.conservation.ca.gov/dlrp/FMMP/Pages/Index.aspx for more detail on the Farmland Mapping and Monitoring Program.

VIII. Status of Covered Species

An overview of the status of each of the Covered Species for each Conservation Area can be found in Appendix III.

IX. Significant Issues in Plan Implementation

A significant project is the La Quinta Peninsular Bighorn Sheep Barrier Project. This project was initiated in 2014 in response to a letter from the U.S. Fish and Wildlife Service and the California Department of Fish and Wildlife expressing their concerns about bighorn sheep using artificial sources of food and water in unfenced areas in the City of La Quinta. Terra Nova Planning and Research, Inc.of Palm Desert is working with CVCC on the state and federal environmental review for this project. The draft Environmental Impact Report (EIR) was released in early January 2017 with a 45-day public comment period. In 2018, progress was made on completing the environmental analysis, community outreach, and refining the recommended action. The project has been a challenge because CVCC does not control the land needed for a fence and private property owners have concerns about a fence on their land. CVCC staff continues to work with the local property owners, the City of La Quinta, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife, and BLM to discuss workable options for the proposed fence. A federal Environmental Assessment was prepared in coordination with the Bureau of Reclamation as fencing associated with the Coachella Canal will require their approval in the form of a license agreement. One section of the fence was installed by CVWD adjacent to SilverRock golf course as part of their work on the canal in fall 2014. The City of La Quinta installed a fence along the toe of slope adjacent to SilverRock golf course in March 2017. CVCC staff has made presentations to homeowners associations and numerous meetings with property owners to hear their concerns and discuss options. Due to concerns from residents and owners of PGA West, an alternative alignment that routes the fence over the ridge where it will not be as visible was developed. Staff is working with property owners to vet and finalize the alignment and address concerns identified in the Draft Environmental Impact Report (EIR). It is anticipated that the Final Environmental Impact Report will be presented to the CVCC for certification in 2019. It will include responses to the comments received. A public meeting will be held when the Final EIR is considered for certification by the CVCC.

X. Expenditures for CVMSHCP Use 2018/19 Budget

Full budget available at:
http://www.cvag.org/library/pdf_files/admin/CVCC%20Financials%20Reports%20FY_2018_2019/CVCC%20Budget%20(18-19).pdf

BUDGET BY PROGRAMS - FY 2018/2019

	MANAGEMENT AND MONITORING	GENERAL ADMINISTRATION	LAND ACQUISITION	ENDOWMENT	LIZARD ENDOWMENT	TRAVERTINE MANAGEMENT	MANAGEMENT CONTINGENCY	IN-LIEU FEE	TOTAL
BEGINNING FUND BALANCE	**$ 320,940**	**$ 402,213**	**$ 6,320,938**	**$ 7,222,947**	**$ 315,434**	**$ 515,149**	**$ 4,846,024**	**$ 34,275**	**$ 19,977,920**
REVENUES:									
Development Mitigation Fees	$ 306,000	$ -	$ 1,494,000	$ -	$ -	$ -	$ -	$ -	$ 1,800,000
Agencies Mitigation Fees	-	-	-	500,000	-	-	-	-	500,000
Tipping Fees	-	428,000	-	-	-	-	-	-	428,000
Contributions	-	-	-	-	-	-	-	-	-
Grants	227,937	-	2,225,000	-	-	-	-	-	2,452,937
Other Revenue	-	-	-	-	-	-	-	-	-
Investment Income	3,160	1,885	65,000	99,570	3,800	6,510	58,780	-	238,705
Total Revenues	$ 537,097	$ 429,885	$ 3,784,000	$ 599,570	$ 3,800	$ 6,510	$ 58,780	$ -	$ 5,419,642
EXPENDITURES:									
Administrative Fees	$ 3,060	$ -	$ 14,940	$ -	$ -	$ -	$ -	$ -	$ 18,000
Accounting / Bank Service Charges	-	3,850	-	-	-	-	-	425	4,275
Comprehensive Insurance	-	12,701	-	-	-	-	-	-	12,701
Per Diem Payments	-	10,200	-	-	-	-	-	-	10,200
Per Diem Taxes	-	882	-	-	-	-	-	-	882
Office Supplies	-	3,000	-	-	-	-	-	-	3,000
Printing	-	2,000	-	-	-	-	-	-	2,000
Land Improvements	2,000,000	-	500,000	-	-	-	-	-	2,500,000
Legal Services	250	30,000	1,000	-	-	-	-	-	31,250
Professional Services	3,000	9,802	135,000	-	-	-	-	-	147,802
Consultants (Regular funds)	772,471	280,404	237,088	-	-	-	-	15,723	1,305,686
Consultants (Grant funds)	228,937	-	-	-	-	-	-	-	228,937
Interest	-	-	-	-	-	-	-	-	-
Miscellaneous	-	-	-	-	-	-	-	200	200
Land Acquisitions	-	-	7,000,000	-	-	-	-	-	7,000,000
Furniture and Equipment	-	-	-	-	-	-	-	-	-
Sub-Total Expenditures	$ 3,007,718	$ 352,839	$ 7,888,028	$ -	$ -	$ -	$ -	$ 16,348	$ 11,264,933
OTHER									
Operating Transfers Out	$ -	$ -	$ -	$ 452,621	$ -	$ -	$ 2,000,000	$ -	$ 2,452,621
Operating Transfers In	(2,452,621)	-	-	-	-	-	-	-	(2,452,621)
Sub-Total Other	$ (2,452,621)	$ -	$ -	$ 452,621	$ -	$ -	$ 2,000,000	$ -	$ -
Total Expenditures and Other	$ 555,097	$ 352,839	$ 7,888,028	$ 452,621	$ -	$ -	$ 2,000,000	$ 16,348	$ 11,264,933
Net Excess (Deficit)	$ (18,000)	$ 77,046	$ (4,104,028)	$ 146,949	$ 3,800	$ 6,510	$ (1,941,220)	$ (16,348)	$ (5,845,291)
ENDING FUND BALANCE	**$ 302,940**	**$ 479,259**	**$ 2,216,910**	**$ 7,369,896**	**$ 319,234**	**$ 521,659**	**$ 2,904,804**	**$ 17,927**	**$ 14,132,629**

XI. Compliance Activities of Permittees

All Permittees are in compliance with requirements of the CVMSHCP. CVCC completed six Joint Project Reviews for Permittees in 2018.

All jurisdictions report their Local Development Mitigation Fee (LDMF) activity and remit the revenue to CVCC monthly. CVCC reviews all LDMF reports and the associated building permits and certificates of compliance. In 2018, a total of $ $2,233,124 was collected under the LDMF program, a 25% increase over the 2017 calendar year.

XII. Annual Audit

The audit of the expenditures for the period July 1, 2017 to June 30, 2018 was approved by CVCC on February 14, 2019. The financial report was designed to provide citizens, members, and resource providers with a general overview of the CVCC's finances, and to show accountability for the money it receives. Questions about this report or additional financial information can be obtained by contacting the CVCC Auditor, at 73-710 Fred Waring Drive, Suite 200, Palm Desert, CA 92260. Annual CVCC audits are available at http://www.cvag.org/cvcc_financial_reports.htm.

XIII. Unauthorized Activities and Enforcement

Off-highway vehicles and dumping continue to be issues. In 2018, areas where these problems were reported included Stubbe/Cottonwood Canyon, Willow Hole, Upper Mission Creek/Big Morongo Canyon, and Thousand Palms Conservation Areas. Further discussion of management of these issues is included in section IV. Currently CVCC forwards reports of OHVs and dumping to the appropriate law enforcement agency. CVCC is working to develop an agreement with the Bureau of Land Management (BLM) under which CVCC would contribute funds to hire additional BLM law enforcement rangers to focus on the Conservation Areas.

XIV. In-Lieu Fee Program

In 2014, CVCC completed the Enabling Instrument for an In-Lieu Fee Program (ILFP) with the U.S. Army Corps of Engineers (ACOE). The ILFP would allow organizations that need to mitigate for unavoidable Impacts to Waters of the U.S. that result from activities authorized under section 404 of the Clean Water Act and section 401 of the Clean Water Act water quality certifications to do so by paying a fee to CVCC. CVCC will perform restoration projects that are pre-approved as mitigation by ACOE and the cost of these projects, including endowment, contingency, planning and staff time would be paid from the ILFP. Much like the CVMSHCP, the ILFP will replace piecemeal mitigations that often require years to be approved with a coordinated approach that complements other conservation efforts.

The site for the proposed project has changed since 2017. The Wildlife Agencies decided that the original project might result in the take of the endangered desert pupfish. The In-Lieu Program is an Army Corps of Engineers project that does not receive coverage under the CVMSHCP. Fortunately, CVCC acquired several hundred acres in the Stormwater Channel in 2017, and we expect to use a portion of that acreage without difficulty.

The In-Lieu Fee Program Enabling Instrument allows CVCC to sell 50 acres of Advance Credits, with the actual restoration project to begin within three growing seasons of the first sale of an Advance Credit. The first Advance Credit was sold in May 2016. Table 5 lists the Advance Credit purchases completed through December 31, 2018.

Table 5: In-Lieu Fee Program Advance Credit Purchases ICF is completing this table

Applicant	Mitigation Type	Acres Purchased	Date of Purchase
City of Palm Springs	Restoration/Rehabilitation	.35	May 31, 2016
Caltrans	Enhancement	.18	December 2, 2016
Southern CA Edison	Restoration/Rehabilitation	1.26	March 28, 2018
County of Riverside	Restoration/Rehabilitation	.199	May 25, 2018
Caltrans	Enhancement	.498	September 26, 2018

Appendix I
Rules for Land Acquisition and Management Credit

Acquisition Credit

In general, the source of funds for acquisition gets the credit of acres with the following modifications:

1) Per Plan Section 4.2.1 (p. 4-10), purchases with state or federal funding will be considered Complementary in the following Conservation Areas: Joshua Tree National Park, the Santa Rosa and San Jacinto Mountains, the Mecca Hills and Orocopia Mountains, and Snow Creek/Windy Point. Purchases within these areas with CVCC funds will be considered Permittee.
    a. If land purchased with non-federal/state funding in these areas is transferred to CVCC ownership, it will be considered a donation and CVCC will receive Permittee credit if they take title. Examples include:
        i. Purchases by Friends of Desert Mountains (FODM) – only if funds are from private foundations (e.g. Resources Legacy Fund);
        ii. Donations from landowners.

2) Acquisitions in Fluvial Sand Transport Only Areas will be credited to the funding entity (Permittee, Complementary, and Federal/State).
    a. If federal/state funds will be counted as federal/state acquisition
    b. If land purchased with non-federal/state funding in these areas is transferred to CVCC, it will be considered a donation and CVCC will receive Permittee credit.

3) For 2015 Annual Report parcels adjacent to Conservation Areas will not be counted but will be included in the overall database and flagged for consideration after the issue of a legal instrument for conservation is resolved.

4) If a grant requires a matching amount, that portion of the grant will be credited to the source of the match. This includes cash contributions and in-kind contributions from bargain sales (not addressed in the plan). However, as “mitigation” cannot be used as a match for Section 6 grants, Permittees cannot receive acre credit for Section 6 matches.

5) Mitigation for projects outside Plan Area (Wildlands, Inc. is the only current example ~ 7,000 acres) or mitigation for project not Covered as part of the Plan (Southern California Edison purchase of the mitigation value of CVCC in 2014) are included in the database but are zero for all credit and noted “conserved but it does not count for the Annual Report or Plan acreage numbers.”

6) No Acres within any Tribal Land are counted for the CVMSHCP under any circumstances as Tribal Land is “Not A Part” of the CVMSHCP Plan Area.

Appendix II
Table of Acquisitions for Conservation in 2018

CVMSHCP Annual Report 2018 - Parcels Acquired for Conservation

Conservation Area	Acq_Agency	APN	Total
Desert Tortoise and Linkage Conservation Area	Coachella Valley Mountains Conservancy	709290023	2.51
	Coachella Valley Mountains Conservancy Total		2.51
	Friends of the Desert Mountains	713140012	20.01
		715260007	20.05
		715271032	22.55
		715272038	19.54
		717050005	59.44
		745180008	0.25
		745180009	78.71
		745190010	79.33
		745200004	79.43
		745210003	79.36
		745290007	86.21
		745300002	174.72
	Friends of the Desert Mountains Total		719.61
Desert Tortoise and Linkage Conservation Area Total			**722.12**
East Indio Hills Conservation Area	Coachella Valley Mountains Conservancy	750350005	35.41
	Coachella Valley Mountains Conservancy Total		35.41
East Indio Hills Conservation Area Total			**35.41**
Indio Hills/Joshua Tree National Park Linkage Conservation Area	Coachella Valley Mountains Conservancy	647410008	5.00
	Coachella Valley Mountains Conservancy Total		5.00
	Friends of the Desert Mountains	741090017	5.00
	Friends of the Desert Mountains	741130006	4.99
	Friends of the Desert Mountains Total		9.99
Indio Hills/Joshua Tree National Park Linkage Conservation Area Total			**14.99**
Joshua Tree National Park Conservation Area	Mohave Desert Land Trust	705260010	79.93
	Mohave Desert Land Trust Total		79.93
Joshua Tree National Park Conservation Area Total			**79.93**
Mecca Hills/Orocopia Mountains Conservation Area	Friends of the Desert Mountains	719090077	9.93
		719190020	19.66
		719190021	9.83
		719190022	9.83
		719190030	9.85
	Friends of the Desert Mountains Total		59.10
Mecca Hills/Orocopia Mountains Conservation Area Total			**59.10**
Stubbe and Cottonwood Canyons Conservation Area	Coachella Valley Mountains Conservancy	520030013	5.12
		520050004	154.52
		520050005	6.53
	Coachella Valley Mountains Conservancy Total		166.17
	Friends of the Desert Mountains	520030012	5.11
	Friends of the Desert Mountains Total		5.11
Stubbe and Cottonwood Canyons Conservation Area Total			**171.28**
Santa Rosa and San Jacinto Mountains Conservation Area	Coachella Valley Conservation Commission	658170014	5.06
	Coachella Valley Conservation Commission Total		5.06
	Friends of the Desert Mountains	686320013	658.16
		753160006	40.33
		753200004	38.77
		753290014	9.57
		753340010	19.92
	Friends of the Desert Mountains Total		766.75
Santa Rosa and San Jacinto Mountains Conservation Area Total			**771.81**
Coachella Valley Stormwater Channel and Delta Conservation Area	Coachella Valley Conservation Commission	729100002	4.55
		729100003	17.99
		729100008	16.62
	Coachella Valley Conservation Commission Total		39.16
Coachella Valley Stormwater Channel and Delta Conservation Area Total			**39.16**
Thousand Palms Conservation Area	Coachella Valley Conservation Commission	648170014	2.39
		648190009	4.85
		651152007	13.79
	Coachella Valley Conservation Commission Total		21.02
Thousand Palms Conservation Area Total			**21.02**

Upper Mission Creek/Big Morongo Canyon Conservation Area	Coachella Valley Conservation Commission	664100011	0.28
	Coachella Valley Conservation Commission Total		0.28
Upper Mission Creek/Big Morongo Canyon Conservation Area Total			**0.28**
West Deception Canyon Conservation Area	Coachella Valley Conservation Commission	647170011	0.32
	Coachella Valley Conservation Commission Total		0.32
	Friends of the Desert Mountains	645350011	39.95
	Friends of the Desert Mountains Total		39.95
West Deception Canyon Conservation Total			**40.27**
Willow Hole Conservation Area	Coachella Valley Conservation Commission	659230023	4.82
		660091004	0.27
		660091006	0.35
		660091007	0.31
		660091008	0.24
		660091009	0.24
		660091012	0.28
	Coachella Valley Conservation Commission Total		6.51
Willow Hole Conservation Area Total			**6.51**
Whitewater Floodplain Conservation Area	Coachella Valley Conservation Commission	660290012	27.50
		660300001	39.00
		660300005	6.00
		669460007	157.35
		669470035	26.31
		669490002	79.76
	Coachella Valley Conservation Commission Total		335.92
Whitewater Floodplain Conservation Area Total			**335.92**
Grand Total			**2,297.81**

Appendix III
Status of Conservation Objectives by Conservation Area

CVMSHCP Annual Report 2018 - Conservation Objectives by Conservation Area

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
Cabazon Conservation Area - Riverside County								
Peninsular Bighorn Sheep - Essential Habitat	264	181	83	0	0	0%	0	18
Mesquite hummocks	13	1	12	0	0	0%	0	0
Southern sycamore-alder riparian woodland	9	1	9	0	0	0%	0	0
Sand Source	7,683	181	1,629	0	0	0%	0	18
Sand Transport	4,538	0	0	0	0	0%	0	0
Fornat Wash Corridor	641	10	631	0	0	0%	0	1
Coachella Valley Stormwater Channel and Delta Conservation Area - Riverside County								
Desert Pupfish - Core Habitat	25	0	25	0	0	0%	0	0
Crissal Thrasher - Core Habitat	896	87	781	291	0	37%	5	33
California Black Rail - Other Conserved Habitat	62	6	52	0	0	0%	0	1
Yuma Clapper Rail - Other Conserved Habitat	62	6	52	0	0	0%	0	1
Le Conte's Thrasher - Other Conserved Habitat	784	78	706	291	0	41%	5	32
Mesquite hummocks	74	7	67	17	0	26%	0	2
Coastal and valley freshwater marsh	61	6	51	0	0	0%	0	1
Desert sink scrub	1,349	114	1,026	44	13	4%	0	16
Desert saltbush scrub	792	79	713	273	0	38%	5	30

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
Desert Tortoise and Linkage Conservation Area - Coachella								
Desert Tortoise - Core Habitat	300	30	270	0	0	0%	0	3
Le Conte's Thrasher - Other Conserved Habitat	300	30	270	0	0	0%	0	3
Desert dry wash woodland	121	12	109	0	0	0%	0	1
Desert Tortoise and Linkage Conservation Area - Riverside County								
Desert Tortoise - Core Habitat	88,878	4,998	44,977	4,571	722	10%	0	957
Orocopia Sage - Core Habitat	779	44	398	0	0	0%	0	4
Mecca Aster - Core Habitat	4,731	206	1,855	272	0	15%	0	48
Le Conte's Thrasher - Other Conserved Habitat	49,114	2,813	25,319	1,335	144	5%	0	415
Desert dry wash woodland	13,443	752	6,771	626	28	9%	0	138
Desert Tortoise and Linkage Corridor	26,122	1,572	14,143	1,217	122	9%	0	279

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
Dos Palmas Conservation Area - Riverside County								
Crissal Thrasher - Core Habitat	536	38	343	235	0	69%	0	27
Desert Pupfish - Refugia Locations	0	0	0	0	0	0%	0	0
California Black Rail - Other Conserved Habitat	597	37	334	281	0	84%	0	32
Le Conte's Thrasher - Other Conserved Habitat	14,882	743	6,689	2,460	0	37%	0	320
Yuma Clapper Rail - Other Conserved Habitat	682	42	374	301	0	80%	0	35
Predicted Flat-tailed Horned Lizard - Other Conserved Habitat	5,537	403	3,631	681	0	19%	0	108
Desert fan palm oasis woodland	125	6	50	29	0	59%	0	4
Arrowweed scrub	277	13	121	0	0	0%	0	1
Mesquite bosque	482	36	320	225	0	70%	0	26
Desert sink scrub	7,195	487	4,381	1,179	0	27%	0	167
Desert dry wash woodland	1,856	83	746	245	0	33%	0	33
Cismontane alkali marsh	321	23	205	200	0	98%	0	22
Mesquite hummocks	55	3	23	12	0	51%	0	2
East Indio Hills Conservation Area - Coachella								
Le Conte's Thrasher - Other Conserved Habitat	62	6	56	0	0	0%	0	1
Palm Springs Pocket Mouse - Other Conserved Habitat	8	1	7	0	0	0%	0	0
Coachella Valley Round-tailed Ground Squirrel - Other Conserved Habitat	6	1	5	0	0	0%	0	0
Predicted Flat-tailed Horned Lizard - Other Conserved Habitat	6	1	5	0	0	0%	0	0

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
East Indio Hills Conservation Area - Indio								
Le Conte's Thrasher - Other Conserved Habitat	120	12	105	0	0	0%	0	1
Palm Springs Pocket Mouse - Other Conserved Habitat	117	11	103	0	0	0%	0	1
Coachella Valley Round-tailed Ground Squirrel - Other Conserved Habitat	117	11	103	0	0	0%	0	1
Predicted Flat-tailed Horned Lizard - Other Conserved Habitat	114	11	100	0	0	0%	0	1
Mesquite hummocks	2	0	2	0	0	0%	0	0
Stabilized shielded sand fields	114	11	100	0	0	0%	0	1
East Indio Hills Conservation Area - Riverside County								
Le Conte's Thrasher - Other Conserved Habitat	1,960	139	1,253	35	35	3%	0	17
Mecca Aster - Core Habitat	1,594	116	1,045	0	0	0%	0	12
Coachella Valley Round-tailed Ground Squirrel - Other Conserved Habitat	1,353	100	896	1	1	0%	0	10
Predicted Flat-tailed Horned Lizard - Other Conserved Habitat	525	46	415	0	0	0%	0	5
Palm Springs Pocket Mouse - Other Conserved Habitat	1,526	105	944	33	33	3%	0	14
Active desert dunes	5	1	4	0	0	0%	0	0
Desert saltbush scrub	8	1	7	0	0	0%	0	0
Stabilized desert sand fields	331	33	295	0	0	0%	0	3
Mesquite hummocks	43	4	39	0	0	0%	0	0
Stabilized shielded sand fields	401	28	256	0	0	0%	0	3

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
Edom Hill Conservation Area - Cathedral City								
Coachella Valley Round-tailed Ground Squirrel - Other Conserved Habitat	134	13	121	102	0	84%	0	11
Coachella Valley Milkvetch - Other Conserved Habitat	151	15	136	102	0	75%	0	12
Palm Springs Pocket Mouse - Other Conserved Habitat	114	11	103	87	0	84%	0	9
Le Conte's Thrasher - Other Conserved Habitat	344	34	310	224	0	72%	0	26
Sand Source	345	34	310	224	0	72%	0	26
Edom Hill Conservation Area - Riverside County								
Coachella Valley Giant Sand-treader Cricket - Other Conserved Habitat	103	5	40	43	0	100%	0	5
Coachella Valley Milkvetch - Other Conserved Habitat	1,637	134	1,205	1,029	0	85%	0	116
Coachella Valley Fringe-toed Lizard - Other Conserved Habitat	103	5	40	43	0	100%	0	5
Coachella Valley Round-tailed Ground Squirrel - Other Conserved Habitat	1,701	145	1,302	1,115	0	86%	0	126
Palm Springs Pocket Mouse - Other Conserved Habitat	1,228	104	935	794	0	85%	0	90
Le Conte's Thrasher - Other Conserved Habitat	2,238	194	1,745	1,334	0	76%	2	151
Active sand fields	73	4	37	41	0	100%	0	4
Stabilized desert sand fields	29	1	3	2	0	67%	0	1
Sand Source	2,665	197	1,770	1,468	0	83%	0	167
Sand Transport	628	63	565	377	0	67%	2	42

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
Highway 111/I-10 Conservation Area - Riverside County								
Coachella Valley Round-tailed Ground Squirrel - Other Conserved Habitat	389	39	350	54	0	15%	0	9
Coachella Valley Jerusalem Cricket - Other Conserved Habitat	372	37	335	51	0	15%	0	9
Le Conte's Thrasher - Other Conserved Habitat	389	39	350	54	0	15%	0	9
Coachella Valley Milkvetch - Other Conserved Habitat	372	37	335	51	0	15%	0	9
Palm Springs Pocket Mouse - Other Conserved Habitat	389	39	350	54	0	15%	0	9
Indio Hills Palms Conservation Area - Riverside County								
Mecca Aster - Core Habitat	6,091	255	2,290	1,039	0	45%	0	130
Le Conte's Thrasher - Other Conserved Habitat	106	1	7	0	0	0%	0	0
Desert fan palm oasis woodland	93	5	42	7	0	17%	0	1
Desert dry wash woodland	79	4	33	36	0	100%	0	4
Mesquite hummocks	3	1	1	0	0	0%	0	0
Indio Hills/Joshua Tree National Park Linkage Conservation Area - Riverside County								
Desert Tortoise - Core Habitat	10,308	859	7,735	6,557	10	85%	0	741
Le Conte's Thrasher - Other Conserved Habitat	6,396	606	5,457	5,469	14	100%	0	607
Sand Transport	7,304	681	6,132	5,791	15	94%	6	641
Sand Source	5,823	460	4,135	3,205	0	77%	0	367
Indio Hills / Joshua Tree National Park Corridor	13,127	1,141	10,267	8,996	15	88%	6	1,008

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
Joshua Tree National Park Conservation Area - Riverside County								
Gray Vireo - Other Conserved Habitat	30,653	134	1,208	1,822	0	100%	0	195
Le Conte's Thrasher - Other Conserved Habitat	4,330	25	222	104	0	47%	0	13
Desert Tortoise - Core Habitat	127,161	1,708	15,367	12,690	80	83%	0	1,440
Desert dry wash woodland	2,195	13	119	192	0	100%	0	20
Mojave mixed woody scrub	57,099	800	7,195	6,349	0	88%	0	715
Desert fan palm oasis woodland	5	0	0	0	0	0%	0	0
Mojavean pinyon & juniper woodland	30,653	134	1,208	1,822	0	100%	0	195
Mecca Hills/Orocopia Mountains Conservation Area - Riverside County								
Desert Tortoise - Core Habitat	112,575	2,624	23,617	6,714	59	28%	0	934
Le Conte's Thrasher - Other Conserved Habitat	17,467	652	5,866	1,401	4	24%	0	205
Orocopia Sage - Core Habitat	66,180	1,803	16,227	4,303	59	27%	0	611
Mecca Aster - Core Habitat	31,655	465	4,181	1,222	0	29%	0	169
Desert fan palm oasis woodland	1	0	0	0	0	0%	0	0
Desert dry wash woodland	9,317	318	2,861	1,212	13	42%	0	153
Santa Rosa and San Jacinto Mountains Conservation Area - Cathedral City								
Desert Tortoise - Other Conserved Habitat	107	11	95	0	0	0%	0	1
Le Conte's Thrasher - Other Conserved Habitat	13	1	11	0	0	0%	0	0
Peninsular Bighorn Sheep - Rec Zone 2 - Essential Habitat	112	11	97	0	0	0%	0	1
Desert dry wash woodland	20	2	18	0	0	0%	0	0

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Santa Rosa and San Jacinto Mountains Conservation Area - Indian Wells								
Desert Tortoise - Other Conserved Habitat	4,375	111	999	36	0	4%	0	15
Le Conte's Thrasher - Other Conserved Habitat	419	23	206	0	0	0%	0	2
Peninsular Bighorn Sheep - Rec Zone 3 - Essential Habitat	4,617	114	1,158	36	0	3%	0	15
Desert dry wash woodland	128	7	66	0	0	0%	0	1
Santa Rosa and San Jacinto Mountains Conservation Area - La Quinta								
Desert Tortoise - Other Conserved Habitat	5,936	157	1,409	375	4	27%	0	53
Le Conte's Thrasher - Other Conserved Habitat	683	43	387	122	0	31%	0	16
Peninsular Bighorn Sheep - Rec Zone 3 - Essential Habitat	6,185	159	2,545	391	5	15%	0	38
Desert dry wash woodland	147	8	76	15	0	20%	0	2
Santa Rosa and San Jacinto Mountains Conservation Area - Palm Desert								
Le Conte's Thrasher - Other Conserved Habitat	43	4	33	0	0	0%	0	0
Desert Tortoise - Other Conserved Habitat	581	48	436	783	0	100%	0	82
Peninsular Bighorn Sheep - Rec Zone 3 - Essential Habitat	78	7	65	0	0	0%	0	1
Peninsular Bighorn Sheep - Rec Zone 2 - Essential Habitat	492	7	65	761	0	100%	0	74
Desert dry wash woodland	38	3	29	1	0	3%	0	0

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Santa Rosa and San Jacinto Mountains Conservation Area - Palm Springs								
Le Conte's Thrasher - Other Conserved Habitat	793	103	560	376	0	67%	0	72
Peninsular Bighorn Sheep - Rec Zone 1 - Essential Habitat	9,195	226	2,511	2,004	0	80%	0	185
Desert Tortoise - Other Conserved Habitat	22,571	1,317	8,856	5,037	658	57%	0	806
Peninsular Bighorn Sheep - Rec Zone 2 - Essential Habitat	18,426	866	4,700	4,142	658	88%	0	773
Gray Vireo - Other Conserved Habitat	8,416	431	3,883	1,837	0	47%	0	227
Desert dry wash woodland	40	4	36	36	0	100%	0	4
Peninsular juniper woodland & scrub	7,682	353	3,177	1,837	0	58%	0	219
Semi-desert chaparral	733	51	571	0	0	0%	0	5
Southern sycamore-alder riparian woodland	30	2	24	0	0	0%	0	0
Sonoran cottonwood-willow riparian forest	58	0	58	1	0	3%	0	0
Desert fan palm oasis woodland	218	9	76	52	0	69%	0	6
Southern arroyo willow riparian forest	16	0	0	0	0	0%	0	0
Santa Rosa and San Jacinto Mountains Conservation Area - Rancho Mirage								
Desert Tortoise - Other Conserved Habitat	5,249	147	1,326	1,205	0	91%	0	135
Le Conte's Thrasher - Other Conserved Habitat	19	2	17	0	0	0%	0	0
Peninsular Bighorn Sheep - Rec Zone 2 - Essential Habitat	5,262	42	450	1,209	0	100%	0	106
Desert dry wash woodland	19	1	9	4	0	44%	0	1

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Santa Rosa and San Jacinto Mountains Conservation Area - Riverside County								
Peninsular Bighorn Sheep - Rec Zone 2 - Essential Habitat	14,558	647	4,269	3,043	0	71%	0	480
Le Conte's Thrasher - Other Conserved Habitat	9,123	911	5,508	5,383	0	98%	0	892
Triple-ribbed Milkvetch - Known Locations	0	0	0	0	0	0%	0	0
Peninsular Bighorn Sheep - Rec Zone 1 - Essential Habitat	24,840	830	7,252	1,267	0	17%	0	213
Gray Vireo - Other Conserved Habitat	58,985	881	7,930	6,042	0	76%	0	692
Peninsular Bighorn Sheep - Rec Zone 3 - Essential Habitat	50,972	683	5,359	5,203	109	97%	0	665
Desert Tortoise - Other Conserved Habitat	86,875	2,950	23,856	16,038	109	67%	7	2,073
Peninsular Bighorn Sheep - Rec Zone 4 - Essential Habitat	34,597	258	2,325	7,522	0	100%	0	777
Southern sycamore-alder riparian woodland	518	12	117	5	0	4%	0	2
Red shank chaparral	12,514	253	2,274	1,810	0	80%	0	207
Semi-desert chaparral	16,869	233	2,093	928	0	44%	0	116
Peninsular juniper woodland & scrub	29,547	418	2,899	3,305	0	100%	0	471
Southern arroyo willow riparian forest	16	2	15	0	0	0%	0	0
Desert dry wash woodland	3,566	298	1,244	1,276	2	100%	0	305
Desert fan palm oasis woodland	716	45	404	0	0	0%	0	5

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Snow Creek/Windy Point Conservation Area - Palm Springs								
Coachella Valley Milkvetch - Core Habitat	910	91	816	256	0	31%	0	35
Peninsular Bighorn Sheep - Essential Habitat	180	16	144	22	0	15%	0	4
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	934	93	838	260	0	31%	0	35
Coachella Valley Fringe-toed Lizard - Core Habitat	749	75	672	249	0	37%	0	33
Coachella Valley Giant Sand-treader Cricket - Core Habitat	749	75	672	249	0	37%	0	33
Coachella Valley Jerusalem Cricket - Core Habitat	908	90	815	256	0	31%	0	34
Palm Springs Pocket Mouse - Core Habitat	934	93	838	260	0	31%	0	35
Le Conte's Thrasher - Other Conserved Habitat	864	86	775	218	0	28%	0	30
Ephemeral sand fields	680	68	610	207	0	34%	0	28
Active desert dunes	69	7	62	42	0	68%	0	5
Highway 111 - Whitewater River Biological Corridor	276	27	247	260	0	100%	0	28

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Snow Creek/Windy Point Conservation Area - Riverside County								
Coachella Valley Milkvetch - Core Habitat	1,700	134	1,210	633	0	52%	0	77
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	1,880	152	1,371	802	0	59%	0	95
Coachella Valley Fringe-toed Lizard - Core Habitat	625	55	502	335	0	67%	0	39
Peninsular Bighorn Sheep - Essential Habitat	525	49	443	0	0	0%	0	5
Coachella Valley Giant Sand-treader Cricket - Core Habitat	625	56	501	335	0	67%	0	39
Le Conte's Thrasher - Other Conserved Habitat	1,924	162	1,453	848	0	58%	0	101
Coachella Valley Jerusalem Cricket - Core Habitat	782	60	538	349	0	65%	0	41
Ephemeral sand fields	468	45	409	339	0	83%	0	38
Stabilized shielded sand fields	157	10	93	157	0	100%	0	16
Highway 111 - Whitewater River Biological Corridor	474	46	415	475	0	100%	0	52
Stubbe and Cottonwood Canyons Conservation Area - Riverside County								
Desert Tortoise - Core Habitat	5,735	253	2,276	990	139	43%	29	95
Le Conte's Thrasher - Other Conserved Habitat	1,265	123	1,111	814	167	73%	0	93
Desert dry wash woodland	289	26	229	112	18	49%	0	14
Sonoran cottonwood-willow riparian forest	267	3	25	0	0	0%	0	0
Sand Transport	1,375	125	1,129	818	167	72%	0	94
Stubbe Canyon Wash Corridor	1,181	117	1,058	867	171	82%	0	98

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Thousand Palms Conservation Area - Riverside County								
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	8,295	450	2,886	1,827	0	63%	38	264
Coachella Valley Milkvetch - Core Habitat	4,403	111	1,001	1,005	0	100%	4	107
Desert Pupfish - Refugia Locations	0	0	0	0	0	0%	0	0
Coachella Valley Fringe-toed Lizard - Core Habitat	3,962	93	834	683	0	82%	0	78
Le Conte's Thrasher - Other Conserved Habitat	10,539	505	3,671	1,776	0	48%	31	240
Predicted Flat-tailed Horned Lizard - Core Habitat	4,118	94	870	745	0	86%	0	82
Mecca Aster - Core Habitat	11,540	277	2,623	1,343	0	51%	5	150
Coachella Valley Giant Sand-treader Cricket - Core Habitat	3,962	93	834	683	0	82%	0	78
Palm Springs Pocket Mouse - Core Habitat	11,167	468	3,399	1,771	0	52%	36	230
Desert dry wash woodland	748	4	34	0	0	0%	0	0
Active sand fields	3,543	91	820	677	0	83%	0	77
Active desert dunes	421	2	14	6	0	43%	0	1
Desert fan palm oasis woodland	137	0	0	0	0	0%	0	0
Sonoran cottonwood-willow riparian forest	4	0	0	0	0	0%	0	0
Mesquite hummocks	58	0	0	0	0	0%	0	0
Sand Transport	12,011	519	3,615	1,694	0	47%	50	221
Sand Source	12,952	402	3,227	2,174	0	67%	5	279
Thousand Palms Linkage	24,965	919	7,238	3,845	0	53%	55	476
Thousand Palms Conservation Area - City of Indio								
Mecca Aster - Core Habitat	205	20	53	204	0	100%	0	71
Predicted Flat-tailed Horned Lizard - Core Habitat	30	3	7	0	0	0%	0	0
Le Conte's Thrasher - Other Conserved Habitat	519	47	208	323	0	100%	0	70
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	218	18	88	48	0	55%	0	11
Palm Springs Pocket Mouse - Core Habitat	540	50	189	344	0	100%	0	87
Sand Transport	539	54	485	386	0	80%	0	44
Sand Source	104	10	94	104	0	100%	0	11
Thousand Palms Linkage	642	64	578	490	0	85%	0	55

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Upper Mission Creek/Big Morongo Canyon Conservation Area - Desert Hot Springs								
Coachella Valley Jerusalem Cricket - Other Conserved Habitat	49	0	49	31	0	62%	1	-1
Le Conte's Thrasher - Other Conserved Habitat	1,832	288	1,409	807	0	57%	2	175
Palm Springs Pocket Mouse - Core Habitat	1,748	270	1,403	796	0	57%	2	163
Little San Bernardino Mountains Linanthus - Core Habitat	1,020	53	967	476	0	49%	0	29
Desert Tortoise - Core Habitat	3,554	0	1,429	796	0	56%		0
Desert dry wash woodland	135	6	58	0	0	0%	0	1
Sand Transport	1,869	286	1,399	814	0	58%	2	176
Sand Source	343	0	6	0	0	0%	0	0
Highway 62 Corridor	73	7	66	128	0	100%	0	13
Upper Mission Creek/Big Morongo Canyon Conservation Area - Palm Springs								
Le Conte's Thrasher - Other Conserved Habitat	24	2	22	0	0	0%	0	0
Palm Springs Pocket Mouse - Other Conserved Habitat	24	2	22	0	0	0%	0	0

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Upper Mission Creek/Big Morongo Canyon Conservation Area - Riverside County								
Desert Tortoise - Core Habitat	24,122	887	7,984	5,301	0	66%	23	596
Triple-ribbed Milkvetch - Core Habitat	819	47	426	421	0	99%	0	46
Coachella Valley Jerusalem Cricket - Other Conserved Habitat	666	52	460	43	0	9%	11	-1
Le Conte's Thrasher - Other Conserved Habitat	1,871	146	1,323	633	0	48%	3	74
Palm Springs Pocket Mouse - Core Habitat	1,937	151	1,363	680	0	50%	2	81
Little San Bernardino Mountains Linanthus - Core Habitat	1,390	122	1,100	677	0	62%	0	80
Southern sycamore-alder riparian woodland	104	6	52	60	0	100%	0	7
Desert dry wash woodland	125	8	76	49	0	64%	0	5
Sonoran cottonwood-willow riparian forest	100	8	76	78	0	100%	0	8
Sand Transport	2,279	168	1,509	845	0	56%	0	101
Sand Source	19,789	721	6,488	4,698	0	72%	0	542
Highway 62 Corridor	907	79	715	261	0	36%	0	34
West Deception Canyon Conservation Area - Riverside County								
Sand Source	1,302	118	1,063	904	40	85%	0	102
Whitewater Canyon Conservation Area - Desert Hot Springs								
Desert Tortoise - Core Habitat	56	0	0	0	0	0%	0	0
Sand Source	56	0	0	0	0	0%	0	0

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Whitewater Canyon Conservation Area - Riverside County								
Desert Tortoise - Core Habitat	4,438	120	1,084	742	0	68%	1	85
Arroyo Toad - Core Habitat	2,082	78	706	676	0	96%	0	75
Little San Bernardino Mountains Linanthus - Other Conserved Habitat	579	39	348	277	0	80%	0	32
Triple-ribbed Milkvetch - Core Habitat	1,295	41	368	277	0	75%	0	32
Desert fan palm oasis woodland	1	0	0	0	0	0%	0	0
Sonoran cottonwood-willow riparian forest	166	11	107	105	0	98%	0	11
Sand Transport	1,392	48	435	338	0	78%	0	38
Sand Source	12,616	94	850	618	0	73%	1	70
Whitewater Canyon Corridor	223	22	201	0	0	0%	1	1
Whitewater Floodplain Conservation Area - Cathedral City								
Coachella Valley Milkvetch - Core Habitat	107	7	61	0	0	0%	0	1
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	105	7	59	0	0	0%	0	1
Coachella Valley Fringe-toed Lizard - Core Habitat	107	7	61	0	0	0%	0	1
Le Conte's Thrasher - Other Conserved Habitat	107	7	61	0	0	0%	0	1
Palm Springs Pocket Mouse - Core Habitat	107	7	61	0	0	0%	0	1
Coachella Valley Giant Sand-treader Cricket - Core Habitat	107	7	61	0	0	0%	0	1
Active sand fields	49	5	43	0	0	0%	0	1
Whitewater River Corridor	28	2	18	0	0	0%	0	0

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Whitewater Floodplain Conservation Area - Palm Springs								
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	5,825	328	2,955	875	334	30%	20	100
Coachella Valley Milkvetch - Core Habitat	5,432	297	2,671	851	334	32%	20	95
Palm Springs Pocket Mouse - Core Habitat	6,173	347	3,122	892	334	29%	23	101
Coachella Valley Fringe-toed Lizard - Core Habitat	5,418	295	2,659	851	334	32%	20	95
Coachella Valley Giant Sand-treader Cricket - Core Habitat	5,418	295	2,659	851	334	32%	20	95
Le Conte's Thrasher - Other Conserved Habitat	6,495	381	3,433	907	334	26%	23	106
Ephemeral sand fields	2,873	132	1,185	518	305	44%	6	59
Stabilized desert sand fields	577	44	394	5	1	1%	0	5
Active sand fields	436	44	392	327	28	83%	0	37
Whitewater River Corridor	1,183	90	809	50	0	6%	13	1

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Whitewater Floodplain Conservation Area - Riverside County								
Coachella Valley Milkvetch - Core Habitat	96	6	58	0	0	0%	0	1
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	185	11	100	0	0	0%	0	1
Coachella Valley Giant Sand-treader Cricket - Core Habitat	92	6	57	0	0	0%	0	1
Coachella Valley Fringe-toed Lizard - Core Habitat	92	6	57	0	0	0%	0	1
Palm Springs Pocket Mouse - Core Habitat	701	53	477	0	0	0%	10	-5
Le Conte's Thrasher - Other Conserved Habitat	706	53	480	0	0	0%	10	-5
Ephemeral sand fields	86	6	52	0	0	0%	0	1
Stabilized desert sand fields	5	1	4	0	0	0%	0	0
Whitewater River Corridor	701	53	475	0	0	0%	10	-5

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
Willow Hole Conservation Area - Cathedral City								
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	1,485	140	1,256	684	5	54%	0	83
Coachella Valley Milkvetch - Core Habitat	938	87	782	241	5	31%	0	33
Coachella Valley Fringe-toed Lizard - Core Habitat	264	24	212	154	0	72%	0	18
Palm Springs Pocket Mouse - Core Habitat	1,147	107	959	679	2	71%	0	79
Le Conte's Thrasher - Other Conserved Habitat	1,795	167	1,505	700	5	47%	0	87
Ephemeral sand fields	227	20	178	117	0	66%	0	14
Active sand fields	37	4	33	37	0	100%	0	4
Stabilized desert sand fields	57	6	51	0	0	0%	0	1
Stabilized desert dunes	1	0	1	0	0	0%	0	0
Sand Transport	966	89	798	663	0	83%	0	75
Sand Source	833	79	710	38	5	5%	0	12

	Total Acres in Conservation Area	Acres of Disturbance Authorized (1996)	Remaining Acres To Be Conserved (1996)	Acres Conserved Since 1996	Acres Conserved in 2018	Percentage of Required Conservation Acquired	Acres of Permitted Disturbance	Acres of Rough Step
Willow Hole Conservation Area - Desert Hot Springs								
Coachella Valley Milkvetch - Core Habitat	959	96	863	379	0	44%	0	48
Coachella Valley Fringe-toed Lizard - Core Habitat	3	0	3	0	0	0%	0	0
Le Conte's Thrasher - Other Conserved Habitat	1,666	167	1,499	700	0	47%	0	87
Coachella Valley Round-tailed Ground Squirrel - Core Habitat	3	0	3	0	0	0%	0	0
Palm Springs Pocket Mouse - Core Habitat	1,713	171	1,542	723	0	47%	0	89
Ephemeral sand fields	610	61	549	217	0	40%	0	28
Stabilized desert dunes	139	14	125	51	0	41%	0	7
Stabilized desert sand fields	54	5	49	9	0	18%	0	1
Mesquite hummocks	30	3	27	16	0	58%	0	2
Sand Transport	1,713	171	1,542	723	0	47%	0	89
Mission Creek / Willow Wash Biological Corridor	308	31	277	121	0	44%	0	15
Willow Hole Conservation Area - Riverside County								
Coachella Valley Fringe-toed Lizard - Core Habitat	633	50	454	314	0	69%	6	30
Coachella Valley Milkvetch - Core Habitat	2,228	195	1,751	840	2	48%	6	98
Palm Springs Pocket Mouse - Core Habitat	3,465	298	2,684	912	2	34%	6	115
Le Conte's Thrasher - Other Conserved Habitat	3,601	298	2,677	920	2	34%	6	116
Desert saltbush scrub	169	17	152	137	0	90%	0	15
Mesquite hummocks	125	11	98	76	0	77%	0	9
Desert fan palm oasis woodland	1	0	0	0	0	0%	0	0
Stabilized desert sand fields	144	14	128	64	0	50%	2	6
Stabilized desert dunes	383	35	319	149	0	47%	4	14
Ephemeral sand fields	906	81	728	101	0	14%	0	18
Sand Transport	3,500	304	2,734	912	2	33%	6	116
Sand Source	186	2	17	8	0	48%	0	1
Mission Creek / Willow Wash Biological Corridor	509	44	397	0	0	0%	0	4

Appendix IV
Covered Activity Impact Outside Conservation Areas

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Arroyo Toad	
Riverside County	0
Arroyo Toad Total	**0**
California Black Rail	
Coachella	0
Indio	0
Riverside County	0
California Black Rail Total	**0**
Coachella Valley Fringe-toed Lizard	
Cathedral City	924
Coachella	9
Indian Wells	682
Indio	995
La Quinta	570
Palm Desert	1073
Palm Springs	1585
Rancho Mirage	1147
Riverside County	773
Coachella Valley Fringe-toed Lizard Total	**7758**
Coachella Valley Giant Sand-treader Cricket	
Cathedral City	924
Coachella	9
Indian Wells	682
Indio	995
La Quinta	570
Palm Desert	1073
Palm Springs	1585
Rancho Mirage	1147
Riverside County	773
Coachella Valley Giant Sand-treader Cricket Total	**7758**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Coachella Valley Jerusalem Cricket	
Cathedral City	934
Desert Hot Springs	46
Palm Desert	20
Palm Springs	1589
Rancho Mirage	1053
Riverside County	333
Coachella Valley Jerusalem Cricket Total	**3975**
Coachella Valley Milkvetch	
Cathedral City	806
Desert Hot Springs	55
Indian Wells	582
La Quinta	1
Palm Desert	1061
Palm Springs	1125
Rancho Mirage	936
Riverside County	1147
Coachella Valley Milkvetch Total	**5713**
Coachella Valley Round-tailed Ground Squirrel	
Cathedral City	1176
Coachella	63
Desert Hot Springs	613
Indian Wells	990
Indio	1725
La Quinta	1428
Palm Desert	1408
Palm Springs	1961
Rancho Mirage	1325
Riverside County	2702
Coachella Valley Round-tailed Ground Squirrel Total	**13390**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Crissal Thrasher	
Cathedral City	0
Coachella	60
Desert Hot Springs	8
Indian Wells	21
Indio	238
La Quinta	639
Riverside County	286
Crissal Thrasher Total	**1253**
Desert Pupfish	
Indian Wells	0
NULL	0
Desert Pupfish Total	**0**
Desert Tortoise	
Cathedral City	32
Coachella	0
Desert Hot Springs	646
Indian Wells	196
Indio	0
La Quinta	387
Palm Desert	464
Palm Springs	82
Rancho Mirage	170
Riverside County	964
Desert Tortoise Total	**2942**
Gray Vireo	
Palm Springs	0
Riverside County	29
Gray Vireo Total	**29**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Le Conte's Thrasher	
Cathedral City	1201
Coachella	72
Desert Hot Springs	1156
Indian Wells	1139
Indio	1560
La Quinta	1680
Palm Desert	1909
Palm Springs	1913
Rancho Mirage	1347
Riverside County	3843
Le Conte's Thrasher Total	**15820**
Least Bell's Vireo - Breeding Habitat	
Cathedral City	0
Coachella	7
Desert Hot Springs	9
Indian Wells	21
Indio	51
La Quinta	65
Palm Springs	0
Rancho Mirage	0
Riverside County	31
Least Bell's Vireo - Breeding Habitat Total	**184**
Least Bell's Vireo - Migratory Habitat	
Cathedral City	8
Coachella	53
Desert Hot Springs	0
Indian Wells	176
Indio	188
La Quinta	596
Palm Desert	179
Palm Springs	9
Rancho Mirage	28
Riverside County	262
Least Bell's Vireo - Migratory Habitat Total	**1500**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Little San Bernardino Mountains Linanthus	
Desert Hot Springs	1
Riverside County	0
Little San Bernardino Mountains Linanthus Total	**1**
Mecca Aster	
Indio	0
Riverside County	1
Mecca Aster Total	**1**
Orocopia Sage	
Riverside County	18
Orocopia Sage Total	**18**
Palm Springs Pocket Mouse	
Cathedral City	1189
Coachella	39
Desert Hot Springs	624
Indian Wells	998
Indio	1614
La Quinta	1274
Palm Desert	1487
Palm Springs	2061
Rancho Mirage	1362
Riverside County	2858
Palm Springs Pocket Mouse Total	13504
Peninsular Bighorn Sheep	
Cathedral City	9
Indian Wells	1
La Quinta	122
Palm Desert	209
Palm Springs	58
Rancho Mirage	18
Riverside County	9
Peninsular Bighorn Sheep Total	**427**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Potential Flat-tailed Horned Lizard	
Cathedral City	0
Desert Hot Springs	38
Palm Springs	281
Riverside County	69
Potential Flat-tailed Horned Lizard Total	**388**
Predicted Flat-tailed Horned Lizard	
Cathedral City	854
Coachella	4
Indian Wells	682
Indio	877
La Quinta	584
Palm Desert	1073
Palm Springs	1299
Rancho Mirage	1138
Riverside County	924
Predicted Flat-tailed Horned Lizard Total	**7436**
Southern Yellow Bat	
Cathedral City	0
Desert Hot Springs	1
Palm Springs	0
Rancho Mirage	0
Riverside County	0
Southern Yellow Bat Total	**1**
Southwestern Willow Flycatcher - Breeding Habitat	
Cathedral City	0
Coachella	0
Desert Hot Springs	0
Indio	0
Palm Springs	0
Rancho Mirage	0
Riverside County	0
Southwestern Willow Flycatcher - Breeding Habitat Total	**0**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Southwestern Willow Flycatcher - Migratory Habitat	
Cathedral City	5
Coachella	35
Desert Hot Springs	2
Indian Wells	209
Indio	236
La Quinta	731
Palm Desert	194
Palm Springs	7
Rancho Mirage	46
Riverside County	253
Southwestern Willow Flycatcher - Migratory Habitat Total	**1717**
Summer Tanager - Breeding Habitat	
Cathedral City	0
Coachella	0
Desert Hot Springs	0
Indio	0
Palm Springs	0
Rancho Mirage	0
Riverside County	0
Summer Tanager - Breeding Habitat Total	**0**
Summer Tanager - Migratory Habitat	
Cathedral City	8
Coachella	61
Desert Hot Springs	8
Indian Wells	197
Indio	239
La Quinta	661
Palm Desert	179
Palm Springs	9
Rancho Mirage	28
Riverside County	293
Summer Tanager - Migratory Habitat Total	**1683**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Triple-ribbed Milkvetch	
Palm Springs	0
Riverside County	0
Triple-ribbed Milkvetch Total	**0**
Yellow Warbler - Breeding Habitat	
Cathedral City	0
Coachella	0
Desert Hot Springs	0
Indio	0
Palm Springs	0
Rancho Mirage	0
Riverside County	0
Yellow Warbler - Breeding Habitat Total	**0**
Yellow Warbler - Migratory Habitat	
Cathedral City	8
Coachella	63
Desert Hot Springs	9
Indian Wells	197
Indio	266
La Quinta	661
Palm Desert	179
Palm Springs	9
Rancho Mirage	28
Riverside County	293
Yellow Warbler - Migratory Habitat Total	**1713**
Yellow-breasted Chat - Breeding Habitat	
Cathedral City	0
Coachella	0
Desert Hot Springs	0
Indio	0
Palm Springs	0
Rancho Mirage	0
Riverside County	0
Yellow-breasted Chat - Breeding Habitat Total	**0**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Yellow-breasted Chat - Migratory Habitat	
Cathedral City	8
Coachella	61
Desert Hot Springs	9
Indian Wells	197
Indio	239
La Quinta	661
Palm Desert	179
Palm Springs	9
Rancho Mirage	28
Riverside County	293
Yellow-breasted Chat - Migratory Habitat Total	**1684**
Yuma Clapper Rail	
Coachella	0
Indio	0
Riverside County	0
Yuma Clapper Rail Total	**0**
Active desert dunes	
Palm Springs	0
Riverside County	7
Active desert dunes Total	**7**
Active sand fields	
Cathedral City	0
Palm Springs	0
Riverside County	256
Active sand fields Total	**256**
Arrowweed scrub	
Riverside County	0
Arrowweed scrub Total	**0**
Chamise chaparral	
Riverside County	0
Chamise chaparral Total	**0**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Cismontane alkali marsh	
Riverside County	0
Cismontane alkali marsh Total	**0**
Coastal and valley freshwater marsh	
Coachella	0
Indio	0
Riverside County	0
Coastal and valley freshwater marsh Total	**0**
Desert dry wash woodland	
Cathedral City	8
Coachella	0
Desert Hot Springs	0
Indian Wells	176
Indio	0
La Quinta	22
Palm Desert	179
Palm Springs	9
Rancho Mirage	28
Riverside County	268
Desert dry wash woodland Total	**690**
Desert fan palm oasis woodland	
Cathedral City	0
Desert Hot Springs	0
Palm Springs	0
Rancho Mirage	0
Riverside County	0
Desert fan palm oasis woodland Total	**0**
Desert saltbush scrub	
Coachella	4
Indio	173
La Quinta	0
Riverside County	52
Desert saltbush scrub Total	**229**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Desert sink scrub	
Riverside County	60
Desert sink scrub Total	**60**
Ephemeral sand fields	
Cathedral City	0
Palm Springs	72
Riverside County	7
Ephemeral sand fields Total	**79**
Interior live oak chaparral	
Palm Springs	0
Riverside County	0
Interior live oak chaparral Total	**0**
Mesquite bosque	
Riverside County	0
Mesquite bosque Total	**0**
Mesquite hummocks	
Cathedral City	0
Coachella	7
Desert Hot Springs	8
Indian Wells	21
Indio	51
La Quinta	65
Riverside County	31
Mesquite hummocks Total	**183**
Mojave mixed woody scrub	
Desert Hot Springs	0
Riverside County	0
Mojave mixed woody scrub Total	**0**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Mojavean pinyon & juniper woodland	
Riverside County	0
Mojavean pinyon & juniper woodland Total	**0**
Peninsular juniper woodland & scrub	
Palm Springs	0
Riverside County	0
Peninsular juniper woodland & scrub Total	**0**
Red shank chaparral	
Riverside County	0
Red shank chaparral Total	**0**
Semi-desert chaparral	
Palm Springs	0
Riverside County	0
Semi-desert chaparral Total	**0**
Sonoran cottonwood-willow riparian forest	
Coachella	0
Indio	0
Palm Springs	0
Riverside County	0
Sonoran cottonwood-willow riparian forest Total	**0**
Sonoran creosote bush scrub	
Cathedral City	0
Coachella	47
Desert Hot Springs	0
Indian Wells	24
Indio	243
La Quinta	172
Palm Desert	183
Palm Springs	2
Rancho Mirage	20
Riverside County	524
Sonoran creosote bush scrub Total	**1215**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Sonoran mixed woody & succulent scrub	
Cathedral City	9
Desert Hot Springs	0
Indian Wells	0
Indio	1
La Quinta	7
Palm Desert	0
Palm Springs	242
Rancho Mirage	0
Riverside County	413
Sonoran mixed woody & succulent scrub Total	**672**
Southern arroyo willow riparian forest	
Palm Springs	0
Riverside County	0
Southern arroyo willow riparian forest Total	**0**
Southern sycamore-alder riparian woodland	
Palm Springs	0
Riverside County	0
Southern sycamore-alder riparian woodland Total	**0**
Stabilized desert dunes	
Cathedral City	0
Riverside County	0
Stabilized desert dunes Total	**0**
Stabilized desert sand fields	
Cathedral City	0
Indio	0
Palm Springs	0
Riverside County	0
Stabilized desert sand fields Total	**0**

CVMSHCP Annual Report 2018 - Covered Activity Impact Outside Conservation Areas

Conservation Objective / Jurisdiction	Estimated Acres Disturbed Outside Conservation Areas
Stabilized shielded sand fields	
Cathedral City	902
Coachella	9
Indian Wells	682
Indio	994
La Quinta	570
Palm Desert	979
Palm Springs	1322
Rancho Mirage	1147
Riverside County	346
Stabilized shielded sand fields Total	**6952**

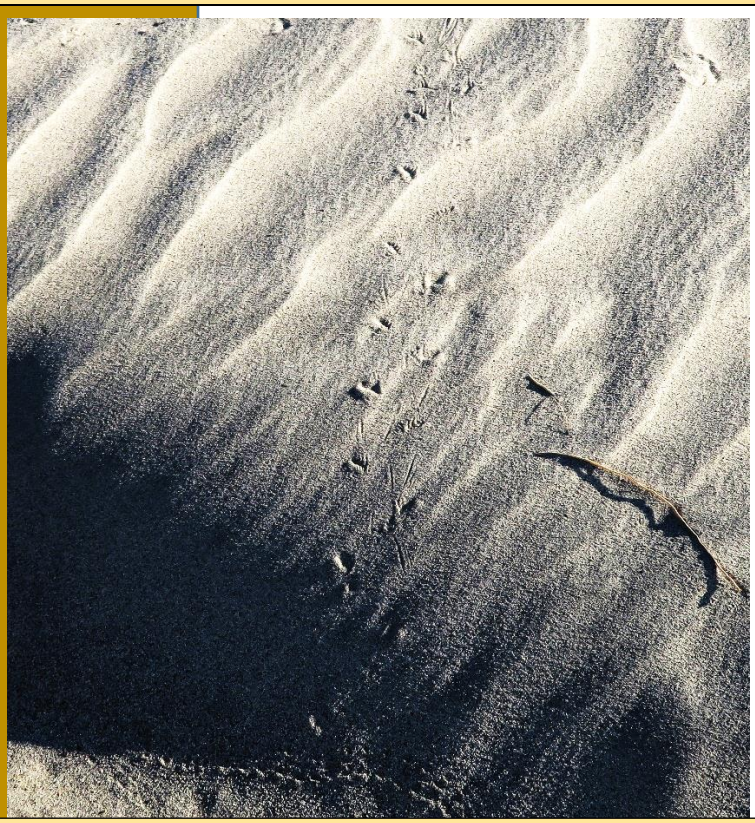
Appendix V
2018 Aeolian Sand Species Monitoring Report

Coachella Valley Conservation Commission

Coachella Valley Multiple Species Habitat Conservation Plan

Aeolian Sand Species Trends

2018



Prepared by The University of California's Center for Conservation Biology
For The Coachella Valley Conservation Commission

Contents

Introduction

Prior to the 1950s, the dominant landscape feature of the Coachella Valley floor was aeolian sand fields. Once covering over 100 mi^2, these aeolian sand communities included plant and animal associations that were often restricted to these habitats, and in several cases found no where else on earth. Sand fields (including sand dunes) are a challenging place to live; the strong winds that create these habitats are abrasive with sands that are shifting, building, and eroding at scales ranging from hours, days, weeks, and years. Nevertheless, animals and plants that have found a way to live here often thrive, occurring at densities that can far exceed that of similar species living on adjacent, more stable alluvial and upland habitats nearby. Reasons for the increased abundances include food resources (seeds and insects) that are blown in with same winds that created and maintain the aeolian sand habitats, and perhaps surprisingly, available water. Unlike alluvial soils which act more like a seive, sand dunes can act as enormous sponges, absorbing rainfall and holding it below the surface, but within reach of animals and plants, for months after a rainfall event. These resources facilitate survival on an otherwise inhospitable landscape, but also require specialized adaptations that can restrict species to that landscape. Every dune system within the temperate latitudes has species that are restricted to that system. The Coachella Valley is no exception; beetles, crickets, rodents, plants and lizards occur here and no where else on earth. With advances in genetic analyses, new species endemic to this aeolian sand landscape will undoubtedly be described.

Along with species abundance and richness, there is also diversity within the aeolian sand landscape itself (Table 1). At the western end of the valley floor, most of the sands destined to build sand dunes and hummocks enter this system through periodic flood events from the Whitewater, Mission Creek and Morongo watersheds. This is also the windiest portion of the valley, with west winds so strong that the sands are quickly transported further east. With sand-delivering flood events being episodic and the winds more continuous, the result is a "wave" of sand moving from west to east and ultimately southeast. The "wave" is initiated with a sand depostion event (a flood). While within the "wave", aeolian sands are 1-2 m or more deep and extensive, but over months and years, as that wave moves east, the landscape is left with more isolated sand hummocks, partially protected from the wind behind shrubs. We refer to this habitat as "ephemeral sand fields" due to its changing temporal character catalyzed by infrequent flood-sand delivery events. Further east, winds don't have the same energy so sands have a longer residence time, and in areas where sand delivery is high build into "active sand dunes", sometimes as crecent-shaped Barchan dunes with avalanche faces that are 5-20 m high. Peripheral to the active dunes and the main sand delivery corridors, once again sand hummocks form, which we refer to as "stabilized sand fields". Aeolian sand captured in the Indio Hills occur as "sand ramps". Finally, where there is, or once was a high water table, honey mesquite, *Prosopis glandulosa, var. torreyana,* can become established and capture aeolian sand. These habitats form yet another aeolian sand type, "mesquite hummocks (smaller) or dunes (larger)". Each of these aeolian sand landscape types includes a unique association of plant and animal species.

The Coachella Valley's aeolian sand landscape was irrevocably changed with the expnsion of residential and resort developments onto the valley floor, beginning in the 1950s and 60s. Prior

to that time developments clustered along the edges of the San Jacinto and Santa Rosa Mountains, outside of the active aeolian sand landscape. As those area filled, housing and resort construction efforts focused on stabilizing the aeolian sands to facilitate further development. By the early 1980s no more than 5% or that original aeolian sand landscape remained intact. **No other species assemblage or natural community now protected under the Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP) has been so severely fragmented, lost so much habitat area, and had its ecosystem processes (sand transport systems) so compromised.**

In 1980 one of the Coachella Valley's aeolean sand flagship species, the Coachella Valley fringe-toed lizard, *Uma inornata*, was listed as threatened under the federal Endangered species Act (ESA) and endangered under the California ESA. Those listings did not result in even a slight pause in the rate of aeolian sand habitat loss to development. In 1982 the federal ESA was ammended (Section 10a) to facilitate collaborative efforts to find mechanisms to both protect listed species and at the same time preserve the ability of local communities to maintain economic viability – named Habitat Conservation Plans (HCPs). That "promise" brought key stakeholders to the table, self-referred to as the "Lizard Club", to craft what they hoped to be a permanent solution for balancing conservation and economic prosperity. The Coachella Valley fringe-toed lizard HCP was signed in April, 1986, and was the first HCP in the nation that had been initated after the 1982 ammendment to the ESA. Three aeolian sand preserves were designated, the largest of which was entirely in private ownership, divided into dozens of small parcels with separate ownerships. A funding mechanism was put together for both land acquisition and on-going management activities that included private donations, developer fees, the State of California, and the federal government. This first HCP was ground breaking in many ways, however in their desire to keep costs managable, the Lizard Club made assumptions about the directions of future development and argued land did not need to be purchased if it was not within a likely future development footprint. Those assumptions proved to be naïve. Development did expand into those "undevelopable lands" threatening to shut down key sand transport corridors.

To resolve this problem, stakeholders decided in 1996 to expand the single species lizard HCP into the CVMSHCP that would ultimately protect 27 species, six of which reside within the aeolian sand habitats. Signed in 2008, the CVMSHCP subsumed the original lizard HCP and its generated funds, and expanded protection to five aeolian sand preserves; the CVMSHCP is explicit regarding the annual need to monitor the fringe-toed lizard populations so that it is not "lost" in an effort to address each of the other 26 species as well.

Without the initial "Lizard HCP" and then the CVMSHCP, the host of species endemic to the Coachella Valley's aeolian sand habitats would almost certainly be extinct today. Continued housing and resort development, blocking sand corridors, fragmentation, and off-road vehicle recreation would have taken their toll and extinguished these species. Still, even with these conservation plans in place, there are still substantial threats to these species. Are the sand corridors sufficiently intact? In areas where the sand corridors are clearly compromised (such as the west Indio Hills, Willow Hole, Stebbins' Dune and Snow Creek areas) are there management

techniques to keep the existing habitats suitable for the covered species? Does the existing level of fragmentation compromise population viability? Are translocations needed, and if so how do we make them effective? Will the invasive weed Sahara mustard, *Brassica tournefortii*, collapse the food web that the native species depend on? How effective are mustard control methods? Will modern climate change render the aeolian sand landscape uninhabitable? Are there locations that will provide climate refugia for aeolian species? (see Table 2 for additional details).

Monitoring Structure

Monitoring for monitoring sake, to fulfill minimum plan requirements, is a waste of finite resources. Monitoring results should be able to address an indentified potential threat, lead to a management action, or indicate no change in curent management is required at that time. The framework for this approach is the Scientific Method; ask a question (is this weed a threat impacting this population or community?), develop an hypothesis that identifies appropriate metrics (this weed may reduce habitat suitability by reducing food availability – so measure weed density vs food resources vs the target species' population response). Then design and implement a sampling approach that collects the appropriate data. Based on those results decisions can be made and management actions can be focused and prioritized.

One of the challenges for understanding the impacts of threats in hyper-arid environments such as the Coachella Valley is that rainfall, its timing and however much or little there is in a critical season is often the primary driver of population fluctuations. Partitioning the effect of potential threats from rainfall effects is necessary for informing management actions. Based on the monitoring timing and/or the breeding strategy of the covered species the effect of rainfall may be the same year as the monitoring occur, or there may be a lag of a year before those rainfall effects are apparent. Rainfall is a critical variable to be included; Figure 1 shows the patterns of rainfall on the Coachella Valley floor since 1979. The figure represents the Standard Precipitation Index (SPI) that illustrates the departure from long-term mean rainfall levels, showing the relative degree of drought or wet condition in any given year.

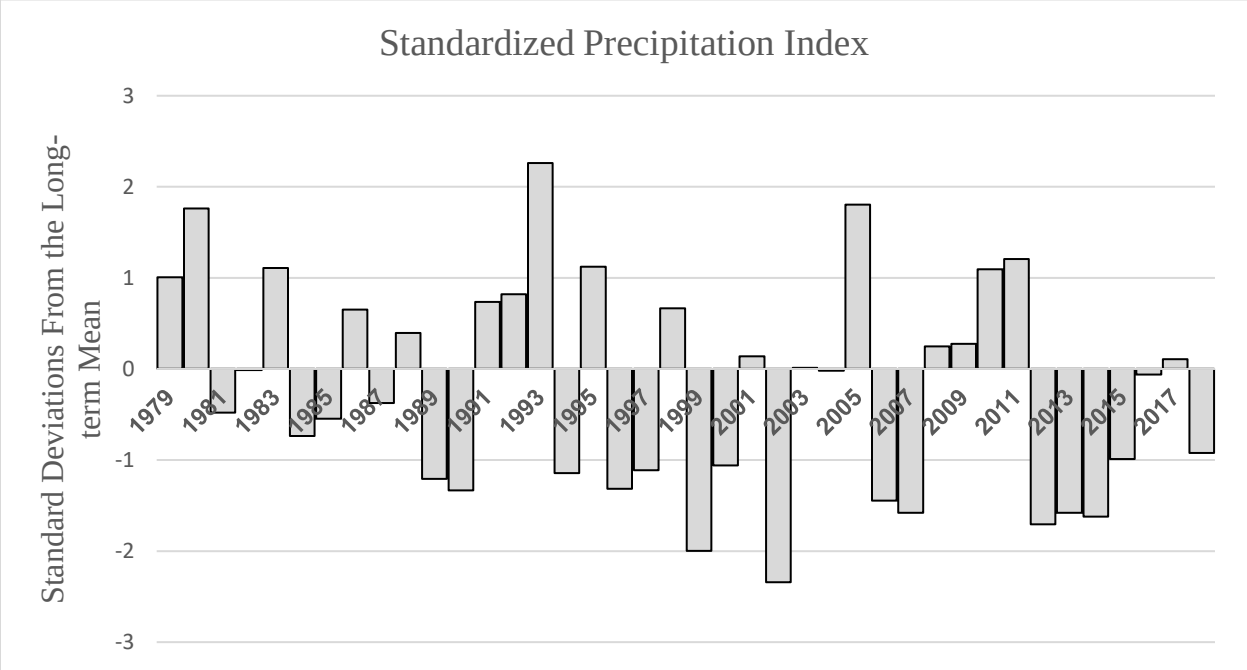


Figure 1. Standard Precipitation Index for the Coachella Valley floor for winter-spring rainfall (November-April), a period in which rainfall catalyzes annual plant growth, the foundation for the aeolian sand habitat food web. Values ≥ 1standard deviation below the mid line were considered drought years (Western Regional Climate Center, Indio Fire Station reporting station, www.wrcc.edu).

We used 0.1 ha plots (10 m X 100 m) to evaluate relative species abundances across the aeolian sand habitats of the Coachella Valley. This size is large enough to give relatively stable counts spanning repeated sampling, allows us to sample more plots (with repeated and replicated surveys) within a short weather-window (+/- six weeks), than would a larger size, and so facilitates statistical testing for the significance of between year shifts in abundance. Using a marked population of flat-tailed horned lizards in 2001 through 2003 we compared density estimates from 0.1 ha plot counts versus actual densities and found a high within year correlation (r^2 = 0.9 -0.81 for each year). For each plot, we correlate rainfall, annual and perennial vegetation, arthropods, and vertebrate use at that location. This allows us to start with the driver of primary productivity (rainfall), responses to rainfall (native and non-native invasive annual and perennial plants), responses to primary productivity (arthropods), and responses to food resources and well as interspecific interactions (the co-occurrence of predators, competitors, and target species). We distributed these plots across the aeolian sand categories as shown in Table 1.

Table 1. The number and distribution of aeolian sand survey plots across the aeolian sand categories

Plot Clusters	Number of Plots	Aeolian Sand Category	Conservation Area
AD2	6	Active Dune	CVNWR / CVP
AD4	6	Active Dune	CVNWR / CVP
J	7	Active Dune	CVNWR / CVP
MH 7-12	6	Active Dune	CVNWR / CVP
H	7	Stabilized Sand Field	CVNWR / CVP
L	7	Stabilized Sand Field	CVNWR / CVP
C	5	Stabilized Sand Field	CVNWR / CVP
MH 19-24	6	Mesquite Dunes	Willow Hole Preserve
MH 25-29	5	Mesquite Dunes	Willow Hole Preserve
ESF 7-12	6	Ephemeral Sand Field	Whitewater Floodplain Preserve
ESF 13-18	6	Ephemeral Sand Field	Whitewater Floodplain Preserve
ESF 19-24	6	Ephemeral Sand Field	Windy Point Preserve
SD 2-6	5	Ephemeral Sand Field	Stebbins' Dune
KN 1-3	3	Sand Ramp	Kim Nicol Trail / Indio Hills
Total	76		

Over the years, the location and number of plots have varied depending on questions asked or condition of the plots. At the Coachella Valley National Wildlife Refuge – Thousand Palms Preserve, due to concerns about habitat fragmentation, additional plots addressed whether there was an edge effect, and if so, what was its cause? There was an edge effect, but only for flat-tailed horned lizards, *Phrynosoma mcallii*. American kestrels, *Falco sparverius*, nesting in an adjacent golf resort community, were preying upon the lizards by hunting from power lines along the preserve edge (Barrows et al. 2006). We placed eight clusters of seven plots each along the preserve edge to answer that question; once the question was answered five of those clusters were then retired. In other cases, plot clusters were retired because of the lack of covered species occurring on them. We retired plot clusters at the north end of the Coachella Valley Preserve, at the fault line dunes, along Snow Creek Road, and at the Dos Palmas ACEC for that reason. We recently added plot clusters at Stebbins Dune (SD 2-6) and the Kim Nicol Trail (KN 1-3, west end of the Indio Hills) to address new questions. The number and location of plots is therefore fluid, although those shown in Table 1 represent a core set of plots, which with the exception of

the two new clusters, we have surveyed annually since 2005. Those plots represent the baseline for our understanding of this ecological system and the species that find habitat there.

Table 2 .Current questions regarding the covered species of the Coachella Valley aeolian sand habitats.

Question	Hypothesis	Metrics	Potential Management Actions	Concerns	Key Plot Clusters for Management
Has habitat fragmentation resulted in reduced genetic heterogeneity in the fringe-toed lizard?	Smaller, more isolated habitats should show reduced genetic heterogeneity first.	Check patterns of genetic heterogeneity on a decadal cycle. Continued erosion of heterogeneity could be an indication for management action	Translocate lizards to reconstruct historic genetic patterns	Genetic shifts may represent local adaptation. Translocation could be counterproductive.	All
		Follow population dynamics. If populations decline despite sufficient rainfall, it could indicate inbreeding depression		Translocation techniques require refinement to improve success.	
Are compromised sand transport corridors causing habitat and then population declines?	Sand stabilizes where sand delivery is insufficient.	Using a sand penetrometer, record compaction values annually	To the extent possible secure all sand transport corridors Mechanical de-stabilization of the sand		SD KN MH 19-29 ESF 7-24
		Follow population dynamics. Are declines associated with measured stabilization?	Transport sand from non-preserve areas	Introduction of new weeds	
Is Sahara mustard (or other weeds) reducing the sustainability of aeolian sand species?	The mustard crowds out native plants, stabilizes aeolian sands, and are not palatable to native invertebrates or vertebrates	Follow population dynamics with respect to mustard densities. Check for increased sand stabilization Check for arthropod declines	Hand pulling works but only in relatively small areas Chemical applications may be needed	Chemicals may have non-target impacts Continued drought may keep the mustard at low densities, obviating the need for control efforts	AD2 AD4 J MH 7-12 H L C
Will modern climate change cause the extinction of some or all of the covered species?	Climate change will impact smaller and more eastern habitat patches first	Follow population dynamics. Are declines associated with warmer/drier conditions	Build shade structures to provide cool refugia. Add water – artificial irrigation		All

Monitoring Results

Plants

Coachella Valley Milkvetch

Coachella Valley milkvetch, *Astragalus lentiginosus* var *coachellae*, (Federally endangered, CNPS Rare Plant Rank: 1B.2) occurs in its greatest abundance on the ephemeral sand fields, which are represented on the Whitewater Floodplain Preserve south of the railroad and between Indian Avenue and Gene Autry Trail, and just west of Windy Point. Populations with fewer numbers occur farther east on the Thousand Palms Preserve, possibly due to finer sand particles, reducing their seed scarification capacity (sand-stripping of the seed coat; a step believed to be necessary for germination of the seeds), and/or reduced average rainfall. At habitats with reduced sand movement, including stabilized sand fields and mesquite dunes this species is much rarer and less predictable in its occurrence.

Figure 2 illustrates the changing patterns of milkvetch abundance over the past decade. Two patterns emerge; first, the wettest years, 2009-2011, did not correlate with high milkvetch abundance. Rather they appeared to be a negative correlation. Second, plots with the highest milkvetch densities shifted after 2014 from the Windy Point region (ESF 19-24) to the Whitewater Floodplain Preserve (ESF 7-12). Sand scarification of the milkvetch seeds may explain these patterns. Wet years (without flooding) stabilize the aeolian sand habitats, and so reduce sand scarification. The Windy Point-Snow Creek region is west of the Whitewater River sand source; that region is dependent on sand input from the San Gorgonio wash further west. The San Gorgonio Wash has received considerable development and it is unclear if future floods will be able to transport new sands. This may be an early indication of the effects of a compromised sand corridor for this protected area.

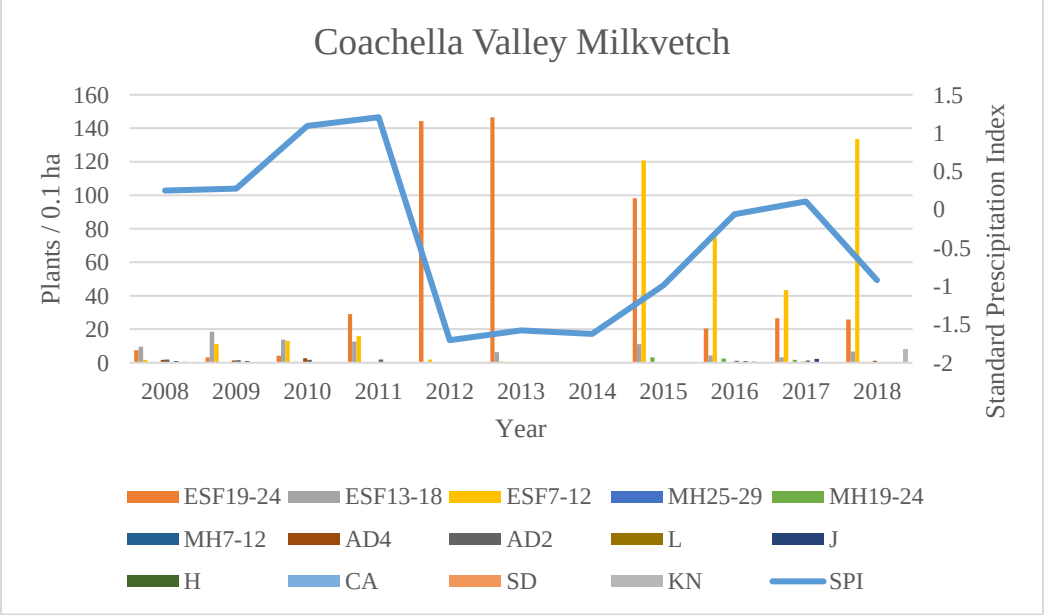


Figure 2: Coachella Valley Milkvetch population density/0.1 ha across the 14 surveyed plot clusters over time. The blue line represents winter Standard Precipitation Index. See Table 1 for plot names and their habitat types. We did not collect data in 2014 at the request of the wildlife agencies.

Annual Plant Monitoring

We surveyed native and invasive annual plant abundance and coverage within 1m x 1m quadrats arranged along our 0.1 ha plots (Figure 3). Following an extremely successful year for native annuals on the CVNWR / CVP in 2017, overall percent cover of both native and invasive annuals has predictably returned to historically low levels due to lower winter precipitation this year (Figure 1). The high coverage of invasive annuals from 2008 to 2011, particularly on the CVNWR / CVP (AD and SSF), was mostly comprised of Sahara Mustard and is a result of consecutively early winter rains which this plant favors (Figure 4). In contrast, the high coverage of annuals on the CVP in 2017 was the result of above-average amounts of late winter precipitation, which the native plants favor. A combination of drier conditions and later winter rains since 2012 has resulted in an overall reduced coverage of invasive annuals.

Figure 3. Schematic of plot design. The twelve small squares show the layout of the $1m^2$ frames where annual vegetation density and cover is measured. The three solid circles represent where arthropod pitfalls are placed. The center lined running the length of the plot is used as a line intercept to quantify perennial plant cover on the plot.

From 2008 to 2011, there was significantly higher invasive annuals coverage on the mesquite dune, active dune and stabilized sand field sites (Figure 4). Those same community types increased their species richness in 2016 through 2018, when there was less coverage of non-natives (Figure 5). Also notable is the steady increase in species richness at our westernmost

survey site, ESF19-24, since 2012. The cause of this increase in diversity was not associated with reductions in non-native species and is unknown, but may be due to changes in precipitation patterns, temperatures, and/or changes in levels of sand activity.

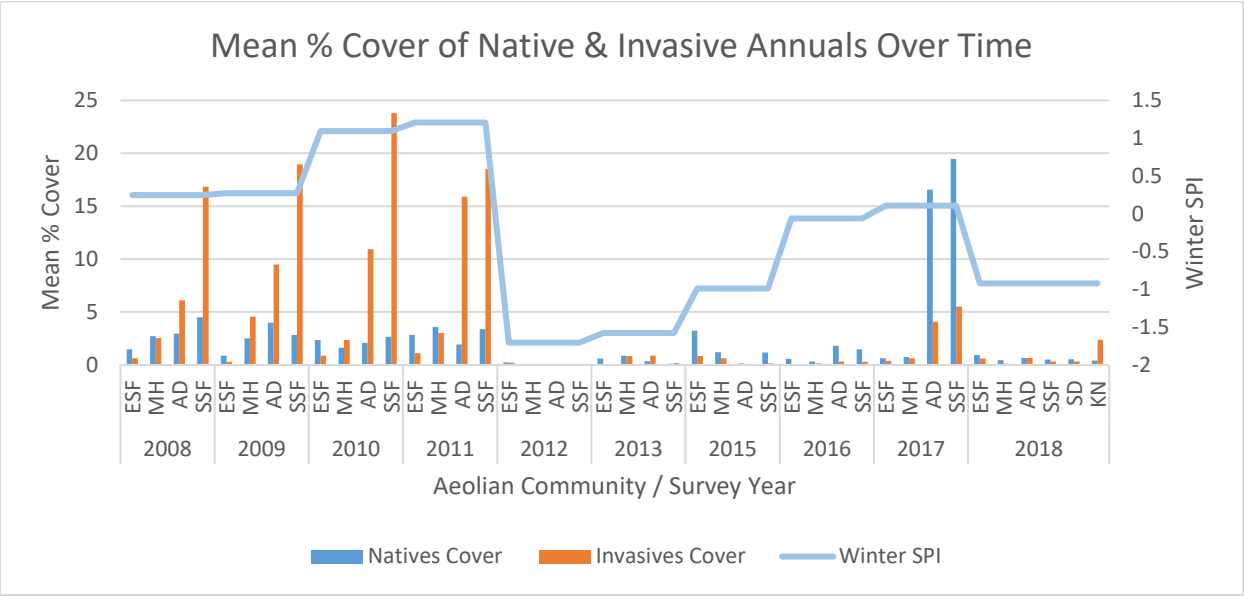


Figure 4. Mean percent coverage of native and invasive annuals across four aeolian habitats over time. ESF = ephemeral sand field, MH = mesquite hummock, AD = active dune, SSF = stabilized sand field, KN = Kim Nicol Trail / sand ramps. Winter SPI indicated by blue line. We did not collect data in 2014 at the request of the wildlife agencies.

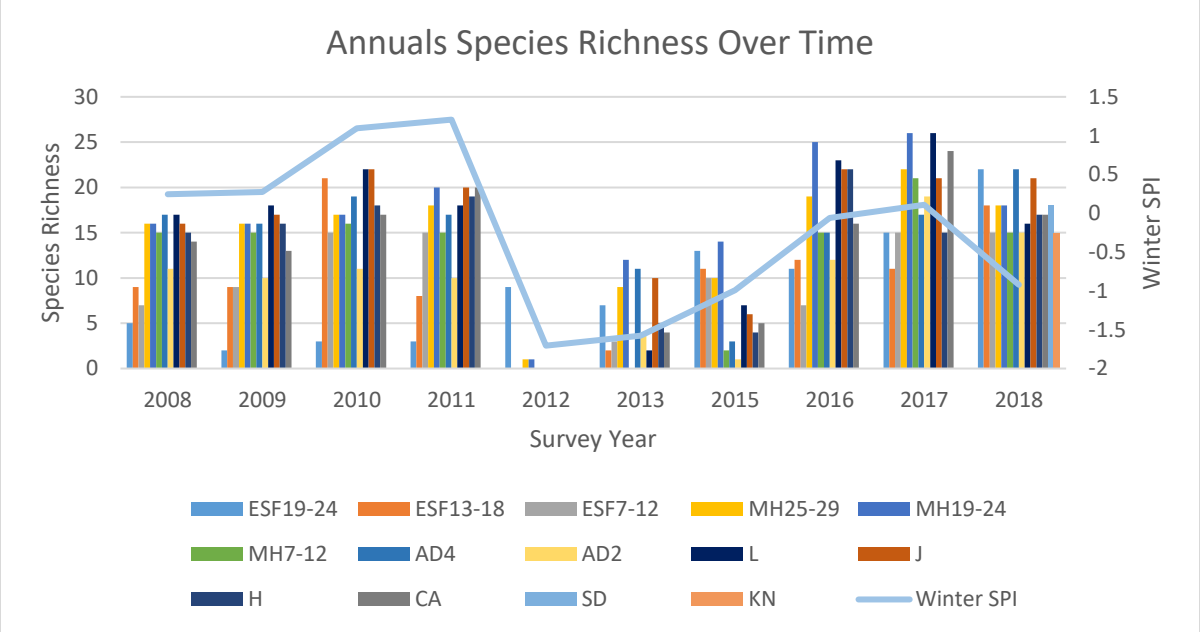


Figure 5: Species richness of annuals (both native and invasive) over time across 14 surveyed plot clusters. Winter SPI is indicated by blue line. We did not collect data in 2014 at the request of the wildlife agencies. See Table 1 for plot names and their habitat types.

Perennial Plant Monitoring

Due to high observer-based variability with previous methods, in 2018 we employed a line-intercept technique for the first time to characterize perennial plant coverage across our survey localities. We set a 100m tape measurer end-to-end down the center of a 10m x 100m plot, and used a plumb bob to record, in centimeters, the points along the tape where a perennial plant intercepted the line. We converted the intercept intervals into percent coverages (amount of line covered by a plant species, in cm, divided by 10000 cm). This method is less time consuming than our previous method that involved a full count and coverage estimation of every perennial plant within the 1000 square meter plots, and importantly greatly reduced observer-based variability.

The most common perennial is the creosote bush, *Larrea tridentata* (LARTRI). LARTRI was present in the line-intercept results in all but one of the survey clusters (CA) and was the dominant perennial cover in the western-most ephemeral sand fields and the two new survey sites at Stebbins' Dune and the Kim Nicol Trail. It was also common around the mesquite hummocks at Willow Hole. Four-winged saltbush, *Atriplex canescens* (ATRCAN) is present at all survey sites on the CV Refuge and to a lesser extent at Willow Hole. Mojave indigo, *Psorothamnus arborescens* (PSOARB) is present in high percentage most notably at the eastern ephemeral sand field sites near Gene Autry Trail. While still present in the western ephemeral sand field (south of the Tipton Road and Highway 111 intersection), it represented only a small fraction of the perennial coverage here, revealing a distinct PSOARB/LARTRI coverage ratio difference between eastern (higher) and western (lower) ephemeral sand field sties.

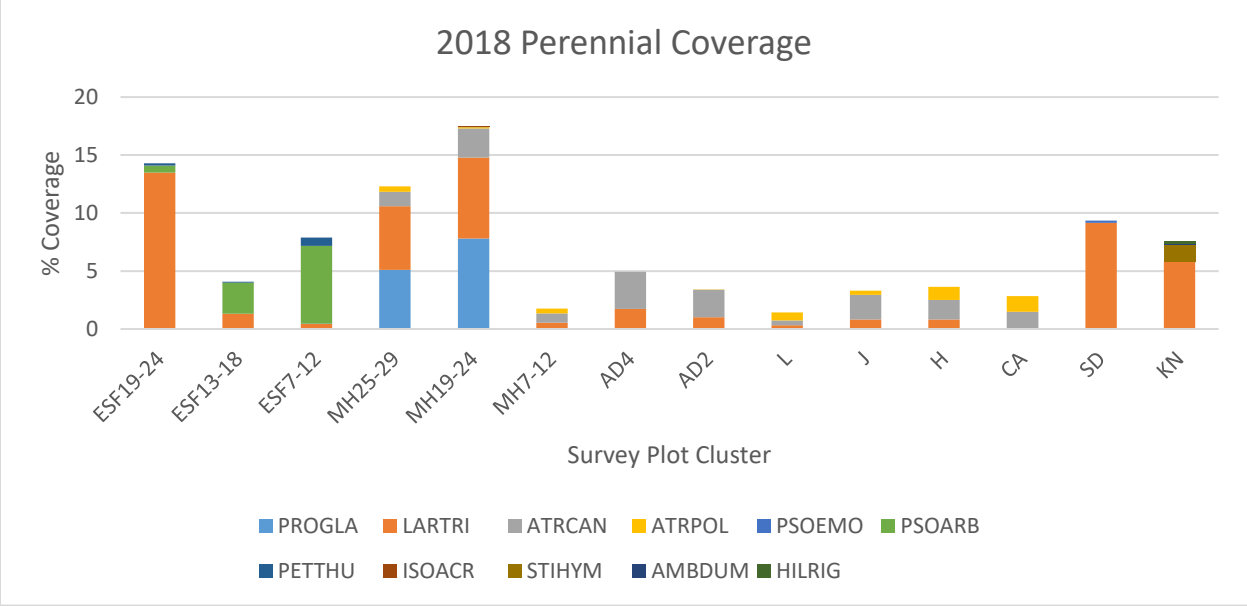


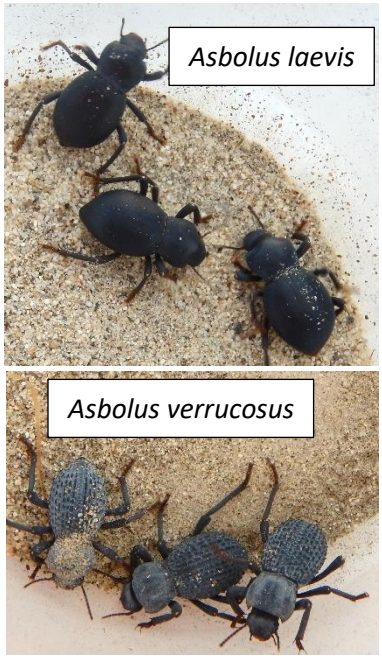
Figure 6: Line-intercept estimates of % perennial coverage across all survey sites. Shown coverages are not overlapping. PROGLA = *Prosopis glandulosa*, LARTRI = *Larrea tridentata*, ATRCAN = *Atriplex canescens*, ATRPOL = *Atriplex polycarpa*, PSOEMO = *Psorothamnus emoryi*, PSOARB = *Psorothamnus arborescens*, PETTHU = *Petalonyx thurberi*, ISOACR = *Isocoma acradenia*, STIHYM = *Stipa hymenoides*, HILRIG = *Hilaria rigida.*

Arthropod Monitoring

Ants and Beetles

We surveyed aeolian arthropods from the beginning of May to the end of June. Surveys included three pitfall traps per 100m-long plot (one at each end and one in the middle (Figure 3)) (15-21 total traps per plot cluster). The traps are 11 cm diameter, 14 cm depth plastic food containers that are set into the ground up to sand-level. We placed a funnel within the mouth of the container to prevent captured arthropods from escaping. We then placed a roughly 2 cm high raised wooden cover over the top of the trap to protect the arthropods from heat stress and predation by larger animals such as birds and rodents. Traps are set during the day and left overnight. The next morning we recorded captured arthropods and disassembled the traps. While strong winds precluded setting traps on every plot cluster, we sampled 11 of 14 plot clusters, and all aeolian communities (active dunes, ephemeral sand fields, sand ramps, mesquite hummocks, and stabilized sand fields) at least once.

We focused our analysis on two darkling beetle species (Tenebrionidae) and several ant species in order to assess their potential as indicators of aeolian community quality. Of the darkling beetles, the smooth death-feigning beetle (*Asbolus laevis*) and blue death-feigning beetle (*Asbolus verrucosus*) are by far the most commonly sampled beetles in this survey. Both of these nocturnal, long-lived species are highly tolerant of extreme heat and aridity and possess abundantly hairy tarsal segments (analogous to vertebrate feet) to aid with traction on loose sand. These hairy "feet" are more noticeable in *A. laevis*, which are associated with the most active, sparsely vegetated sand communities, such as active dunes. *A. verrucosus* are also, to a lesser degree, found in active sand communities but are more abundantly collected in comparatively stable areas with denser shrub cover (stabilized sand fields and mesquite hummocks). Still, the two species' habitat overlap widely.



Based on results of surveys since 2008 (Figure 6) *A. verrucosus* occur at the highest densities within stabilized sand fields and mesquite hummocks. There are occasional spikes in *A. verrucosus* density on active sand dunes (e.g. 2018), which may be explained by the presence of strips of silty, relatively densely vegetated habitat that flank the dunes throughout these plot clusters, where pitfall traps are occasionally placed depending on the orientation of the plot in question. We expect to find *A. verrucosus* more commonly in these areas of increased stability and higher shrub cover. We need to conduct a more fine-scale survey of these patches of habitat within a given plot to determine whether this is the case. Predictably, *A. laevis* regularly occurred at their highest abundances on areas of increased sand activity. We recorded the highest *A. laevis* abundance of 2018 on the newly installed plots near the Kim Nicol Trail, which may indicate that this community most closely resembles an active dune habitat. Conversely, and unusually, the newly surveyed Stebbin's Dune site produced only *A. verrucosus*, indicating that this area shares similarities to a stabilized sand field or stabilized dune. The ephemeral sand field plots included in this analysis lack either species, with only a single *A. verrucosus* observed since 2008. The increased amount of course sand and gravel at these sites may explain the absence of these beetles, which are clearly adapted for fine sand.

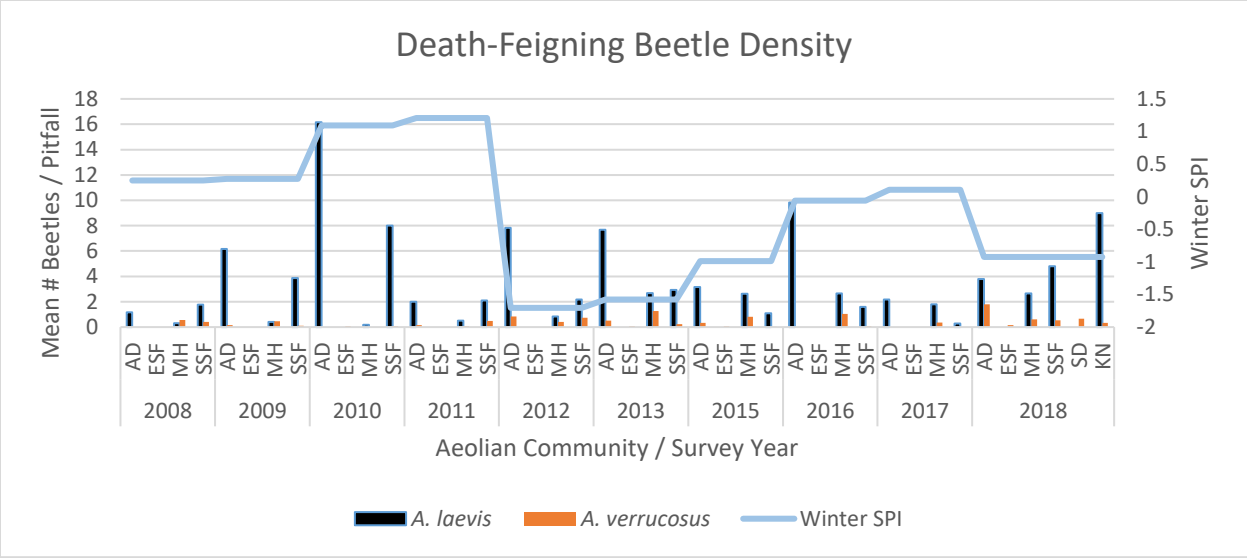
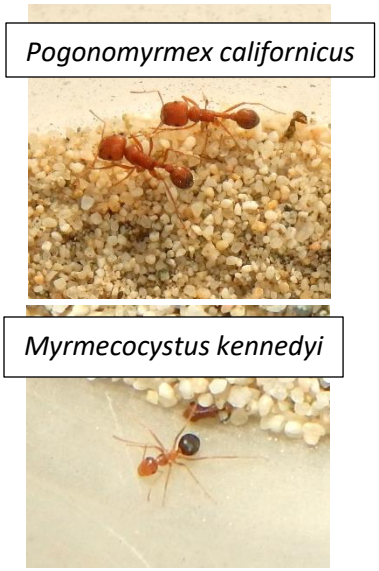


Figure 7: Average *Asbolus laevis* (smooth death-feigning beetle) and *Asbolus verrucosus* (blue death-feigning beetle) density across various aeolian communities over time. We calculated means by averaging the number of beetles sampled per trap per plot cluster, and then averaged by the number of plot clusters per community type. AD = Active Dune, ESF = Ephemeral Sand Field, MH = Mesquite Hummock, SSF = Stabilized Sand Field, SD = Stebbin's Dune, KN = Kim Nicol Trail.



The three most widely distributed ants are two Bearded Harvester Ant species (*Pogonomyrmex californicus* and *P. magnacanthus*) and a Honeypot Ant species (*Myrmecocystus kennedyi*) (Figure 2). The two Bearded Harvester Ants primarily forage for seeds while the Honeypot Ant is an opportunistic scavenger and hunter as well as a tender of honeydew-producing insects. *P. californicus* is generally the most abundant ant sampled in a plot cluster, with dozens of individuals commonly observed in a single trap. This species is most abundant on the active dunes and stabilized sand fields of the CV Refuge where it is the primary food source of the Flat-tailed Horned Lizard and, to a lesser extent, the Coachella Valley Fringe-toed Lizard, although these ants can be the fringe-toed lizards' primary food from summer to fall, when other foods are unavailable. Bearded Harvester Ants are usually conspicuously less abundant in traps set at ephemeral sand fields and tend to have another distinct group of ants in their place: *Veromessor* pergandei (formerly *Messor pergandei*, Smooth Harvester Ant), *Dorymyrmex* sp., *Myrmecocystus tenuinodis*, and *Forelius* sp., which all appear to have an affinity for ephemeral sand field-type habitat (Figure 3).

We found that *Forelius* colonies occur in many different habitats, such as mesquite hummocks, but they are rare in pitfall traps since the dense mesquite serves as their primary foraging substrate (not the open sand where we placed the traps), providing ample nectaries and honeydew-producing insects to tend. In contrast, habitats such as ephemeral sand fields which have comparatively sparse vegetation may force the *Forelius* to spend more time foraging at ground-level, thus coming into contact more frequently with pitfall traps. Future studies focused on mesquite-associated arthropods will help us explore this hypothesis. Winter precipitation levels do not appear to affect ant or beetle densities. We did not detect temporal trends in these arthropods' abundance.

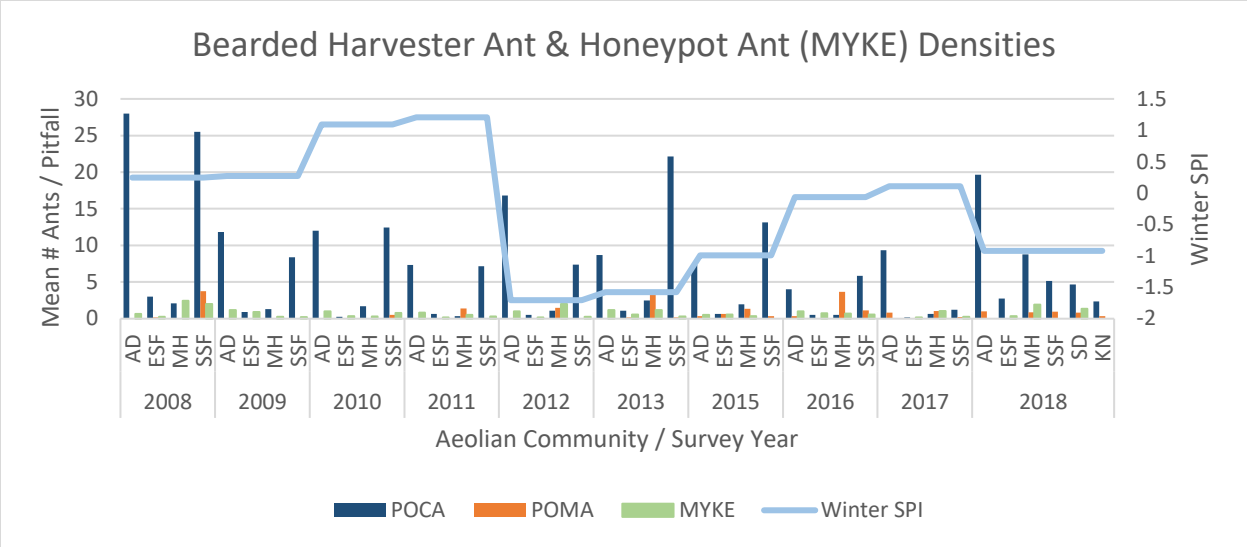


Figure 8: Average number of *Pogonomyrmex californicus* (POCA), *Pogonomyrmex magnacanthus* (POMA) and *Myrmecocystus kennedyi (*MYKE) sampled per pitfall trap. We calculated means by averaging the number of ants sampled per trap per plot cluster, and then averaged by the number of plot clusters per community type. AD = Active Dune, ESF = Ephemeral Sand Field, MH = Mesquite Hummock, SSF = Stabilized Sand Field, SD = Stebbin's Dune, KN = Kim Nicol Trail.

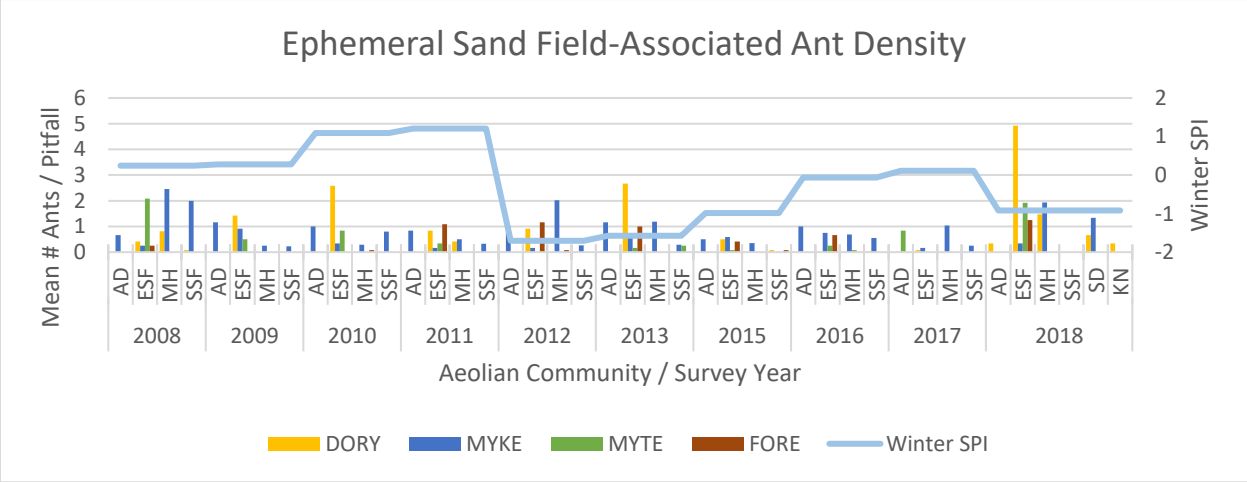


Figure 9: Average number of *Veromessor pergandei* (VEPE), *Dorymyrmex* sp. (DORY), *Myrmecocystis tenuinodis* (MYTE), and *Forelius* sp. (FORE) sampled per pitfall trap. We calculated means by averaging the number of ants sampled per trap per plot cluster, and then averaged by the number of plot clusters per community type. AD = Active Dune, ESF = Ephemeral Sand Field, MH = Mesquite Hummock, SSF = Stabilized Sand Field, SD = Stebbin's Dune, KN = Kim Nicol Trail.

Coachella Valley Giant Sand-treader Cricket

Coachella Valley Giant Sand-treader Crickets (*Macrobaenetes valgum*, or CVGST) are large, ground-dwelling, nocturnal insects that are endemic to The CVMSHCP area. CVGST excavate a new tunnel every morning for shelter during daylight hours. Their burrowing technique produces a distinctive "delta" or triangle-shaped tailing of sand at the mouth of the burrow that we used to assess population levels. We counted fresh tailings throughout each 10m x 100m plot as our measure of abundance. We assumed that there was a maximum of one cricket per burrow, and we separated previous days' vacant burrows from freshly excavated, occupied burrows.

These crickets track moisture levels (Figure 9), hatching during cooler-wetter months of the year (December to January) and disappearing completely before the hottest, driest part of summer arrives (around June). Excessive heat and aridity throughout spring results in an early decline in population levels, as indicated by the absence of any CVGST observations in this year's arthropod surveys conducted from early May through June. They are present in all the aeolian sand communities, but show a strong preference for active dunes and stabilized sand fields. Abundance appears to rely on a combination of moisture and sand activity and depth, with higher levels of all being preferable.

The 2018 data are consistent with past surveys, excluding 2007, which was a particularly dry year and resulted in minimal CVGST activity. The active dunes and sand fields of the CV Refuge continue to harbor the highest population densities of this cricket. This supports a hypothesis that sand characteristics may be an even more important factor than moisture when describing ideal CVGST habitat, as the CV Refuge (CVP) is drier and hotter than the more western ephemeral sand fields. The plot clusters on the CVP that border Avenue 38 illustrate this pattern. Plot clusters "L" and "H" were originally characterized as stabilized sand fields, whereas "J" was characterized as an active dune, with relatively deeper, more continuous sands and low shrub cover. From 2004 to 2009, CVGST densities were relatively low on L and H, but high on J; in 2018, there was a large increase in abundance on L and H. This increase (on L and H) is consistent with 2018 increases in the beetle, *Asbolus laevis*, an indicator of deep active dune sand. It is also consistent with increases in CV fringe-toed lizards on L and H in 2018 as well. These increases in sand depth, and decreases in exposed silt are the likely the result of increased sand deposition due to stabilization by Russian thistle, an exotic annual plant. County road crews regularly grade Avenue 38, which runs just south of these plots, creating a permanent berm of loose sand along the shoulder of the road that provides an attractive CVGST habitat. The CVGST using that berm habitat may also benefit from increased moisture from road runoff. We observed a similar phenomenon at Stebbins' Dune. On one plot (later retired), a dirt road and fence was recently constructed; this plot had at a 3-fold higher CVGST density than the remainder of nearby plots, possibly due to the favorable habitat created by the disturbance.

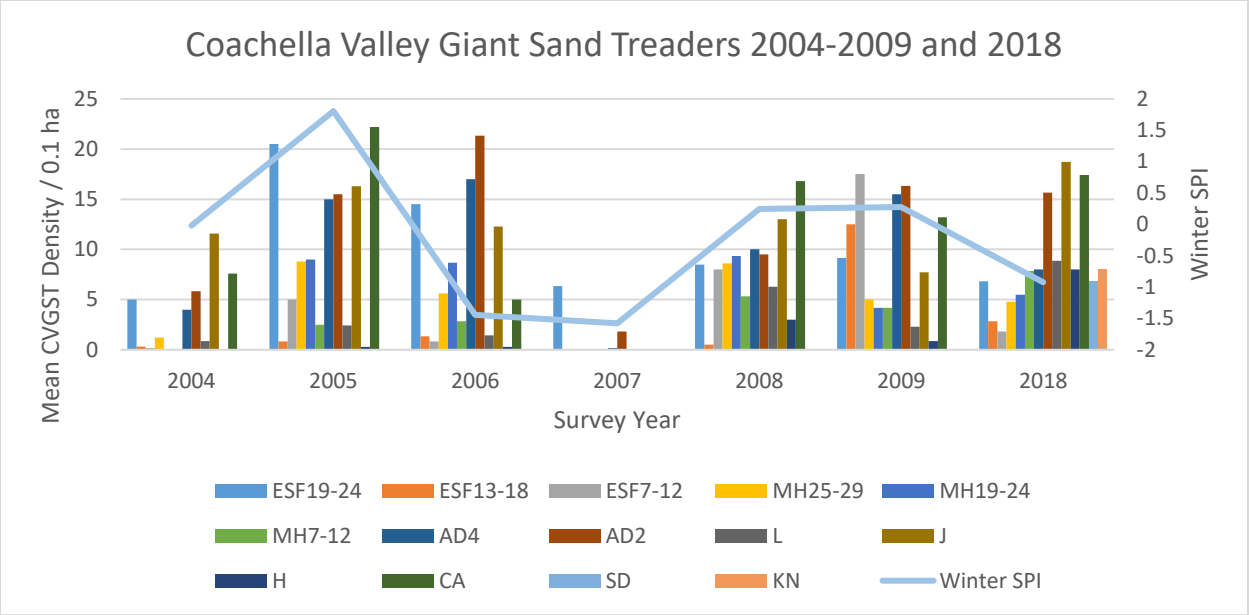


Figure 10: Average CVGST density determined by burrow counts during late winter/early spring. Winter SPI indicated by blue line.

Vertebrate Surveys

Palm Springs Pocket Mouse

Palm Springs pocket mice, *Perognathus longimembris bangsi*, (PSPM) occur in fine-textured sandy areas of the Coachella Valley. They are not restricted to aeolian sands, but occur throughout the valley's aeolian sand communities. Our survey method, similar with all the vertebrates included here, is to quantify their abundance based on the mean number of their distinctive track ways left within our 0.1 ha plots. The only other pocket mouse that commonly occurs within the aeolian communities is the desert pocket mouse, *Chaetodipus penicillatus*, whose tracks are typically nearly double the size of a PSPM track.

Figure 10 reveals a substantial increase in PSPM starting in 2015 and continuing to increase through 2018. This increase corresponds with a drought period, so do PSPM prefer conditions that are more arid? Possibly, but our data support an alternative hypothesis, that the hyper arid conditions resulted in reduced population densities of kangaroo rats and desert pocket mice; all are probable competitors to PSPM, especially desert pocket mice. With a decline in competitors, the PSPM flourished, despite (or indirectly because of) the drought. Another alternative hypothesis is that with the drought-related reduction of Sahara mustard (see Figure 4); PSPM had access to ground that is more open and a wider array of annual plant seeds. The problem with that hypothesis is that some of the large increases in PSPM occurred on the western plots, where the mustard has never been a problem.

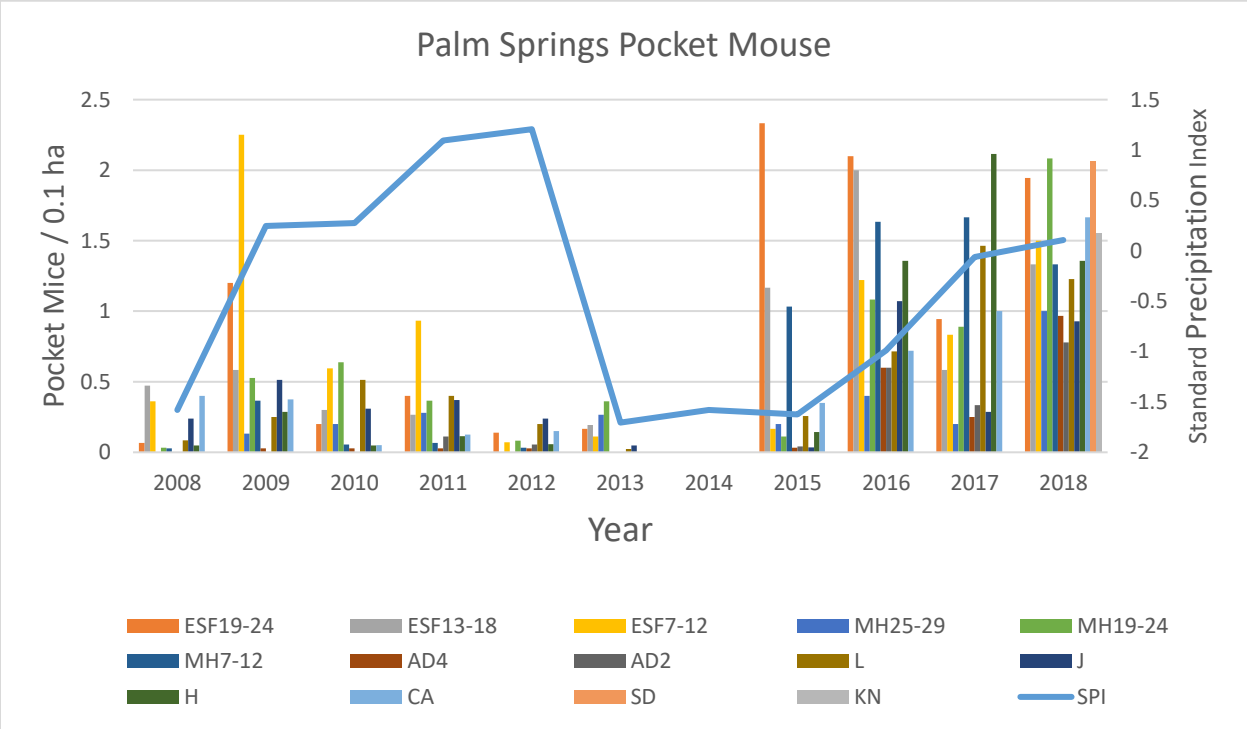


Figure 11. Temporal patterns of abundance of Palm Springs pocket mice across the aeolian sand habitats of the Coachella Valley. The SPI is off-set by one year to account for the one year lag time most vertebrate show between rain and population responses. We did not collect data in 2014 at the request of the wildlife agencies.

Round-tailed Ground Squirrel

Round-tailed ground squirrels (RTGS), *Xerospermophilus tereticaudus chlorus*, occur in fine-textured sandy areas of the Coachella Valley. Antelope ground squirrels replace RTGS in gravely and rocky soils. RTGS are mostly restricted to aeolian sands, and occur throughout the valley's aeolian sand communities, as well as in urban gardens along wildland-urban interfaces where soils are appropriate. Our survey method, similar with all the vertebrates included here, is to quantify their abundance based on the mean number to their distinctive track ways left within our 0.1 ha plots. Unlike other (non-avian) vertebrates, RTGS are quite vocal when occurring at high densities; there we use their distinctive alarm calls and tracks (whichever provides the higher number) to tabulate occurrences within our plots. However, at low densities, they rarely vocalize and we can only use their tracks for surveys.

Except for in the mesquite dune plots, RTGS are sensitive to drought (Figure 12). Within the mesquite dunes, they show little year-to-year variation in numbers, despite large swings in precipitation. The explanation for their lack of a rainfall response is that the mesquite are typically tapped into aquifer-based water sources and not reliant on annual rainfall. In areas where the mesquite have died, RTGS densities drop to match those on non-mesquite aeolian communities.

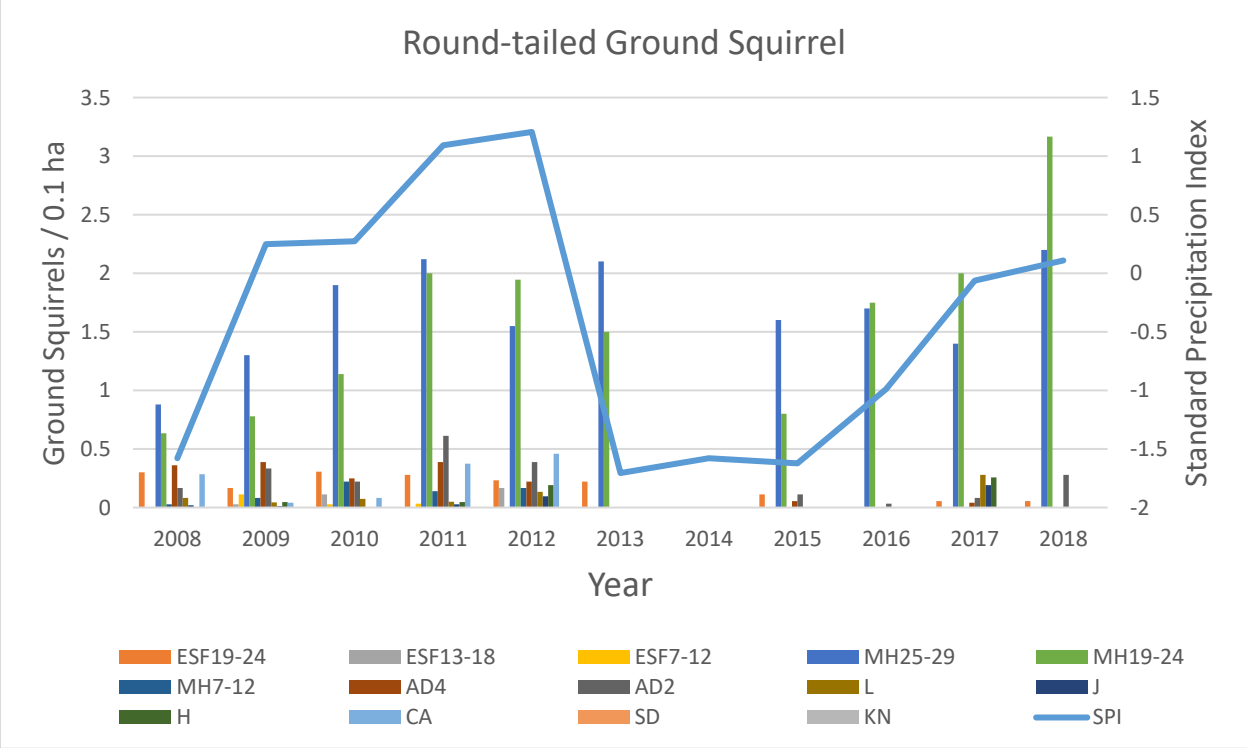


Figure 12. Temporal patterns of abundance of round-tailed ground squirrels across the aeolian sand habitats of the Coachella Valley. The SPI is off-set by one year to account for the one year lag time most vertebrate show between rain and population responses. We did not collect data in 2014 at the request of the wildlife agencies.

Flat-tailed Horned Lizard

Flat-tailed horned lizards (FTHL), *Phrynosoma mcallii*, occur at their northern-most edge of their range in the Coachella Valley. Historically there was likely continuous habitat connecting the Coachella Valley FTHL populations to populations in the Borrego Valley and perhaps East Mesa regions of San Diego and Imperial counties. Those connections were severed by agricultural development in the southern Coachella Valley and throughout Imperial County. Within the Coachella Valley, as recently as the 1980s or early 1990s FTHL were much more broadly distributed in the Coachella Valley, occurring as far west as the Whitewater Floodplain Preserve, the southern flanks of Edom Hill and east to the east end of the Indio Hills. At the Whitewater Floodplain Preserve, they co-occurred with desert horned lizards (DHL), *P. platyrhinos*. Today DHL remain on that site, as well as on the Stebbins' Dune site (southwestern flank of Edom Hill), and are common throughout the Indio Hills. DHL are apparently less sensitive to the stressors that have affected FTHL here. There are no sightings of FTHL at any of these locations since the early 1990s. Additionally, stabilized sand fields within the Dos Palmas ACEC have provided habitat for an isolated FTHL population east of the railroad right of way. Located and surveyed by BLM biologist Mark Massar in 2005, we established plots there in 2014 and surveyed those plots from 2014 through 2017 (Figure 13). In 2017, we found no FTHL on our seven Dos Palmas plots; the FTHL population at Dos Palmas appears to be below detection levels. We have temporarily retired those plots in the hope that wetter/normal weather conditions will return and bring that population back to levels where surveys can be effective. Despite land protection efforts beginning in the 1980s, along with the CV Jerusalem cricket, FTHL are one of the only species, indigenous to the Coachella Valley's floor, which are now absent from preserved lands within its original range here. It is not entirely clear why they are gone from those sites, but habitat fragmentation, climate change (drought and heat being especially severe at the below sea level lands of the Dos Palmas ACEC) and off-road vehicle recreation all appear to be contributing factors.

The CV Refuge / CVP is the only habitat within the CVMSHCP where FTHL continue to thrive. Its large size, relative to the other protected areas, may be the primary reason FTHL have persisted there. Nevertheless, there are on-going stressors affecting FTHL at this site. These include enhanced predation levels from subsidized predators including American kestrels, *Falco sparverius*, and greater roadrunners, *Geococcyx californicus*. The subsidizing component is that for both predators there are no suitable nest sites within the protected habitat; nest sites, provided through planting of non-native trees outside (and inside – by CDFW on CDFW lands) the protected lands, allow these predators to take high numbers of FTHL within a 100-150 m border of the preserve. FTHL are now rare to absent altogether from this border area. We identified this stressor in 2005-2006. Solutions include removing trees suitable for nesting, or trimming them to remove nest sites; both include working with adjacent private landowners. Edge impacts such as these fall under the broader effects of habitat fragmentation. The larger the protected area the less important (influences to population sustainability) are negative edge influences.

A second, more broadly reaching stressor is the exotic invasive Sahara mustard (SM), *Brassica tournefortii*. The effect of SM include the reduction of native plant species, the related reduction of native arthropod species (especially harvester ants, the primary food for FTHLs, Figure 8),

and the canopy closing of what were otherwise open sand fields. Control efforts have included hand pulling and chemical treatments. Both are effective but the scope of the problem is so large, that efforts to date have had impacts to a small proportion of the extent of the SM infestation. The best "treatment" for SM has been drought (Figure 8). Figure 13 illustrates the impacts of SM (when superimposed on Figure 4) on FTHL; 2008-2011 were the heaviest SM years and the lowest FTHL population levels of the past decade.

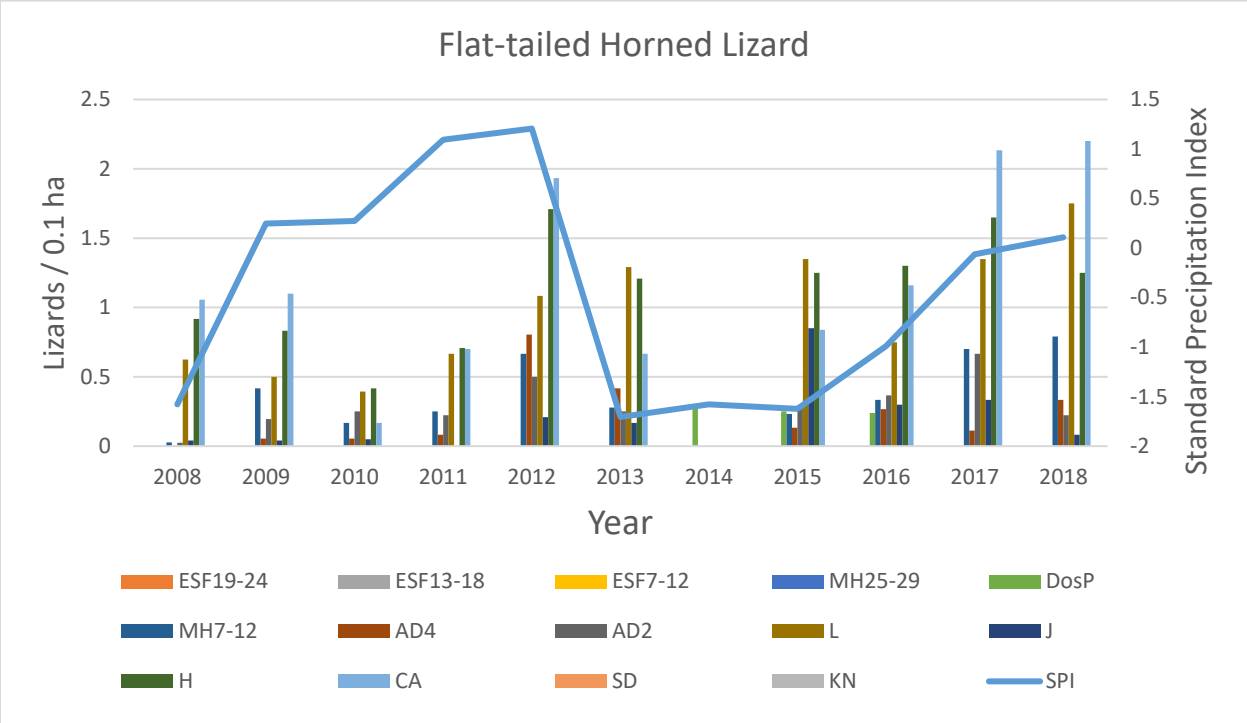


Figure 13. Temporal patterns of abundance of flat-tailed horned lizards across the aeolian sand habitats of the Coachella Valley. The SPI is off-set by one year to account for the one year lag time most vertebrates show between rain and population responses. We did not collect data in 2014 (except at Dos Palmas) at the request of the wildlife agencies.

Coachella Valley Fringe-toed Lizard

Coachella Valley fringe-toed lizards (CVFTL), *Uma inornata*, (Federally endangered) are the flagship species for the conservation of aeolian sand habitats of the Coachella Valley (see Introduction). CVFTL have what appear to be persistent, if not thriving, populations on each of the five areas that have been set aside to protect this species (CV Refuge / CVP, Willow Hole, West Indio Hills / Kim Nicol Trail, Whitewater Floodplain Preserve, and the Windy Point Preserve) (Figure 14). Nevertheless, there are long-term stressors that need to be monitored, and if warranted, managed. Those stressors include:

- Habitat and population fragmentation. There is little or no genetic communication between the five protected areas. Empirically, other than direct habitat loss, fragmentation is implicated in the loss of unprotected CVFTL populations across the Coachella Valley more than any single stressor. Even when new sand delivery has been blocked to large unprotected lands, CVFTL have been able to sustain populations. On the other hand, if the site is small, unless sand delivery is on-going, extirpation has occurred 100% of the time. Is inbreeding depression occurring (no evidence so far)? Is translocation warranted? If translocation is warranted, what are the most effective means of implementing this tool?
- Compromised sand transport corridors. All of the protected areas' sand transport corridors are compromised to some degree. No new sand has entered Willow Hole, Stebbins' Dune, or the West Indio Hills sites since before the initial CVFTL HCP. Willow Hole, the CV Refuge and Windy Point all have housing developments within their sand delivery corridors. The Whitewater Floodplain Preserve's sand corridor is blocked by the CVWD's percolation ponds. Sand delivery is episodic, stochastic, and flood dependent. Determining the efficacy of these corridors is dependent on observing post flood sand movements. If determined to be insufficient, can we deliver sand be to the up-wind portions of protected areas? Are there tools for mechanically destabilizing Aeolian sands without "take" of protected species? Stebbins' Dune is in dire need of new sand or mechanical destabilization.
- Sahara mustard continues to be a threat. So far, the best control has been drought and late winter rains. This infestation is episodic, and has been here for many decades. A threshold for management question is whether these episodic threats, over the long-term, threaten population viability. Figure 14 illustrates the "dampening" effect of the mustard on CVFTL populations on the CV Refuge. 2009-2011 were wet years with dense mustard; since then the mustard has stayed at lower levels and the CVFTL population has rebounded.
- Climate Change. The big question is how bad will it get, and what are the threshold climate levels for CVFTLs. We don't know, and modeled projections are inadequate. On-going monitoring is critical to address this question. Vegetation provides critical shading, cooling and insect food; could perennial vegetation plantings help?

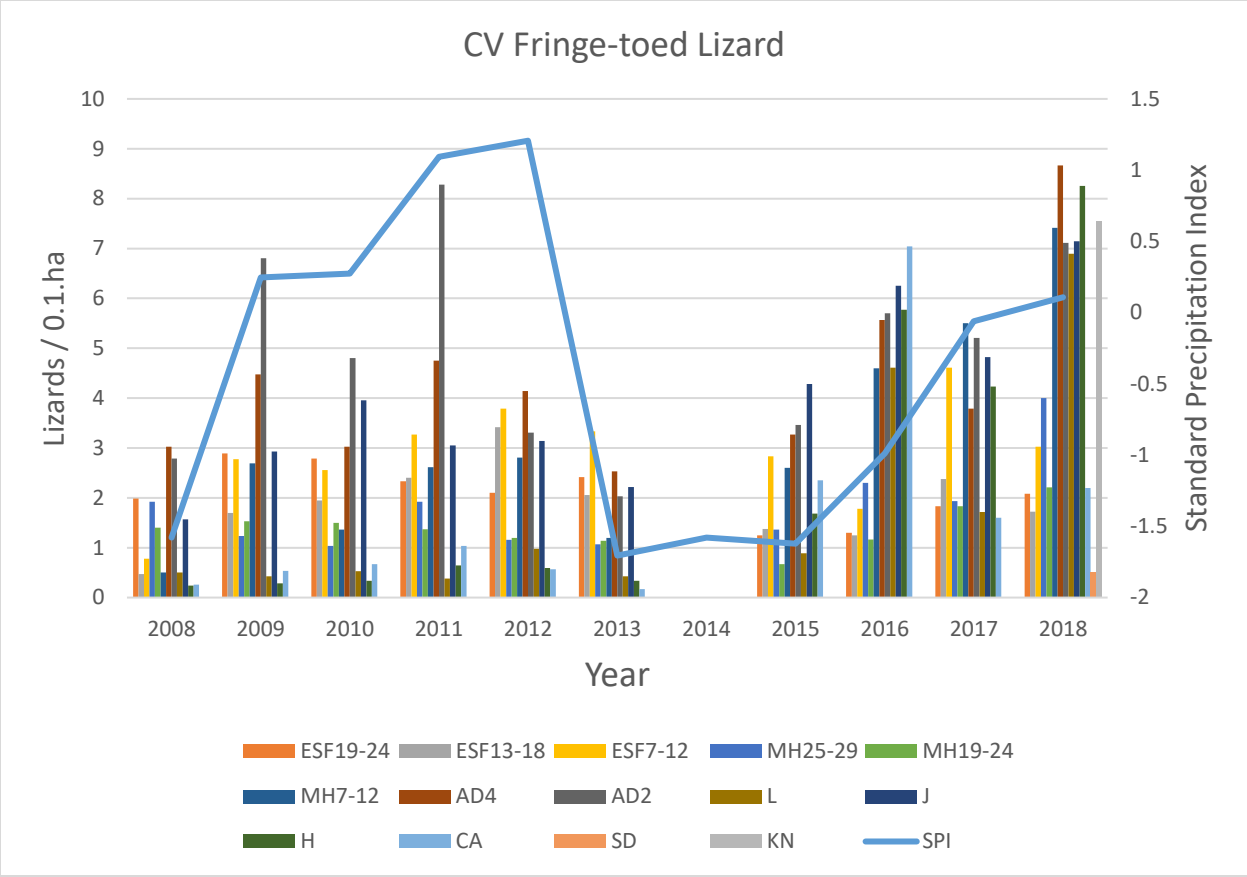


Figure 14. Temporal patterns of abundance of Coachella Valley fringe-toed lizards across the aeolian sand habitats of the Coachella Valley. The SPI is off-set by one year to account for the one year lag time most vertebrate show between rain and population responses. We did not collect data in 2014 at the request of the wildlife agencies.

Stebbins' Dune illustrates the outcome of a blocked sand transport corridor. In the 1940s-1960s (and before) this site was considered prime habitat for CVFTL. It was so-named because it was the site of Robert C. Stebbins' research on this species in the 1940s. Until purchased for conservation and fenced, this site was heavily impacted by illegal off road vehicle recreation.

The result was the finer sands were largely lost or compacted, the larger grain sizes were compacted, and we found no CVFTLs remaining on site. In 2017, we used this site for an experimental translocation of CVFTLs from a non-protected site scheduled for development. We translocated 46 CVFTL of various ages. In 2018, repeated surveys located 2-3 lizards from the original translocated cohort, plus four or more that had hatched on the site, presumably from translocated gravid lizards of the 2017 cohort. Genetic verification that these lizards all originated from that translocated cohort is in process. All CVFTL located in 2018 were either on or adjacent to plot SD6. Whereas SD6 had a mean sand compaction index of 1.82, the other four plots averaged 2.6. Our previous analyses have shown that CVFTL occupancy can drop off dramatically at sand compaction indices >2.5 (Figure 15).

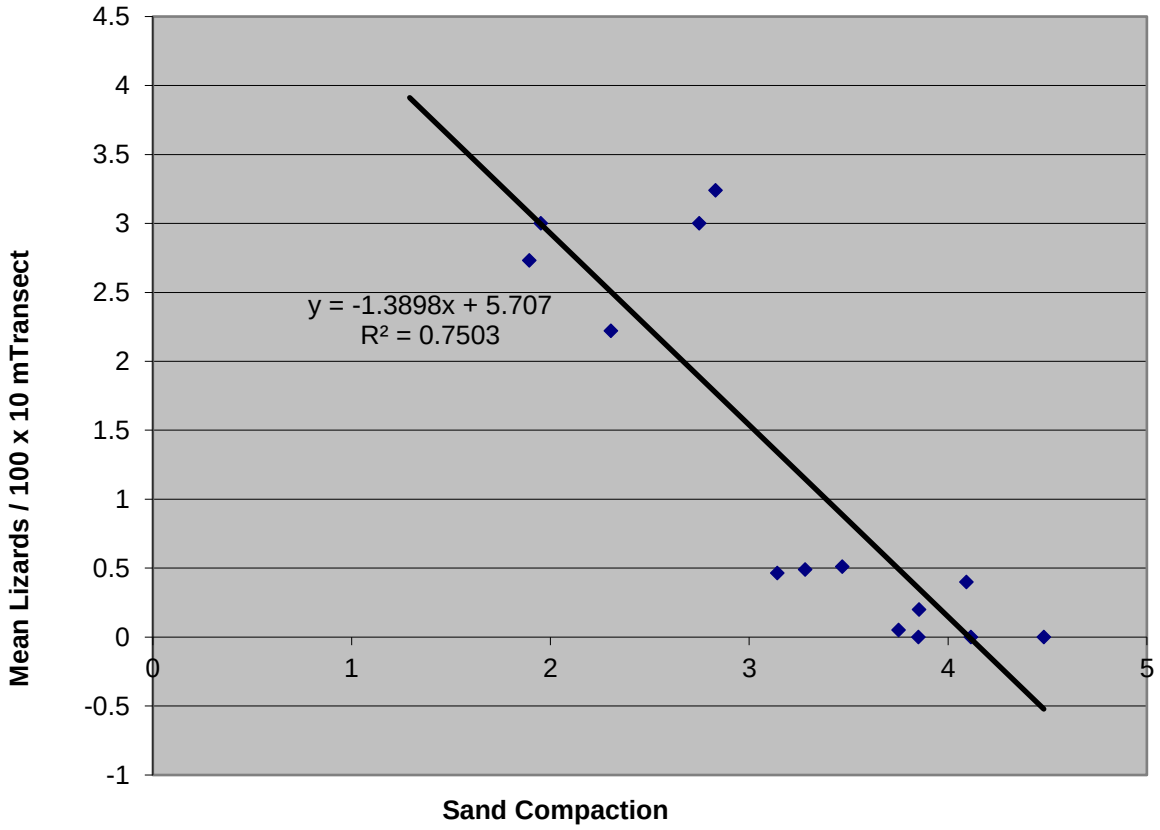


Figure 15.The relationship of sand compaction to Coachella Valley fringe-toed lizard densities.

Sand control structures placed along Interstate 10 and the railroad have blocked Stebbins Dune sand delivery. It now offers an opportunity for experimental restoration, either through bringing in new sand or mechanically un-compacting the non-occupied portions of the site. This experimental restoration will be needed if additional translocations to this site occur, and if there is hope to allow this population to grow to a viable size.

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Appendix VI –
Coachella Valley Jerusalem Cricket

Coachella Valley Conservation Commission

CVCC

2018

Coachella Valley Multiple Species Habitat Conservation Plan

& Natural Community Conservation Plan

2017-2018 Monitoring Results for the Coachella Valley Jerusalem Cricket (*Stenopelmatus cahuilaensis*) within the Coachella Valley MSHCP Area

UC RIVERSIDE UNIVERSITY OF CALIFORNIA

Prepared by the University of California Riverside's Center for Conservation Biology for the Coachella Valley Conservation Commission

Contents

COACHELLA VALLEY JERUSALEM CRICKET MONITORING

Stenopelmatus cahuilaensis Tinkham 1968 (Coachella Valley Jerusalem Cricket, or CVJC) is a large, fossorial (spending the majority of its life below ground) insect endemic to the cooler-wetter western areas of the Coachella Valley Multiple Species Habitat Conservation Plan area. It is generally associated with loose sand provided either by dune activity or river drainages, is nocturnal, and is only found above ground during the coolest months of the year, presumably only after the ground has been sufficiently moistened by winter rains (Weissman 2001a, Prentice et al. 2011).

As such, this species is rarely encountered by chance and a novel detection method was required to accurately assess population size and distribution. Prentice and others (Prentice et al. 2011) developed a "detection tile" survey technique which employs 2' x 2' plywood sheets placed on the desert floor throughout the CVJC's known distribution. These detection tiles, also referred to as cover boards, provide a moist, cool shelter for nocturnally wandering crickets to take refuge under during the day. With minimal effort, the cover boards can be regularly monitored during daylight hours for the presence of CVJC and relative population sizes and distribution can be estimated.

The results of the first two surveys by Prentice and others in 2003 and 2009 revealed a drastic westward movement of the population, most significantly involving its eastern boundary. Presumably due to a combination of climate change (habitat becoming hotter and, more importantly, drier) and habitat modification (development and lack of sand movement), CVJC can no longer be found as far east as the Palm Springs Airport, where it was recorded in 1999. Significantly, the western boundary was reported to be expanding westward at a much slower rate than the eastern boundary, which may indicate an inability for this species to shift much farther to the west in the future. It is possible that this species' current population boundaries may represent the only remaining suitable habitat (Prentice et al. 2011). A survey of CVJC using the detection tile method was carried out in 2015, but only yielded one cricket, possibly due to prolonged drought conditions.

Objectives

This survey represents the fourth large-scale effort to monitor the CVJC populations of the Coachella Valley and San Gorgonio Pass. Due to the apparent rapidly shrinking population boundaries of the CVJC, more information is needed regarding their preferred habitat and centers of highest population density so that targeted conservation efforts can be considered. We attempted to elucidate both population boundaries and areas of highest relative abundance using previously developed and effective monitoring strategies. Varying levels of soil moisture are investigated as a predictor of suitable CVJC habitat. Also, we employed photographic "fingerprinting" techniques which will allow us to determine, with reasonable confidence, the amount of resampling present during a monitoring effort. This technique will help to refine our population density estimates as well as provide valuable insights into the natural history of this elusive insect.

Methods

Eighty-six cover board sites and five mattresses/box springs covering nine broad localities were selected to form the focus of this survey (Figure 1). Of the 91 sites, 33 were newly placed in 2017 and the remaining 58 boards were reused, in their original locations, from previous surveys. The western-most survey sites were located in Cabazon along the San Gorgonio River. The eastern-most survey sites were located south of the I-10 in the ephemeral sand fields near Gene Autry Trail, but this group of cover boards was only checked once to confirm that there were no CVJC still remaining in this area. The western-most, regularly monitored sites included Mission Creek, near the Highway 62 crossing and Whitewater Hill. Regular surveying of most sites began January 9 following a substantial soaking rain and continued on a weekly basis until February 16 (6 weeks). An additional two weeks of monitoring was conducted at the Snow Creek and Whitewater Hill sites. In addition to cover board monitoring, nearby debris, cow patties, and cover boards used in previous studies that were not selected for this survey were opportunistically overturned. Debris and cow patty searching has proven to be an effective detection method, although it lacks the increased variable control that cover boards provide (Prentice et al. 2011). When a piece of debris yielded a CVJC, it was subsequently checked weekly alongside the usual complement of cover boards. Five cover boards were remoistened with approximately 2 liters of water each at Whitewater Hill during week 7 of the survey in an attempt to attract Jerusalem Crickets, which had not been observed there since week 1, however no additional crickets were observed in this area.

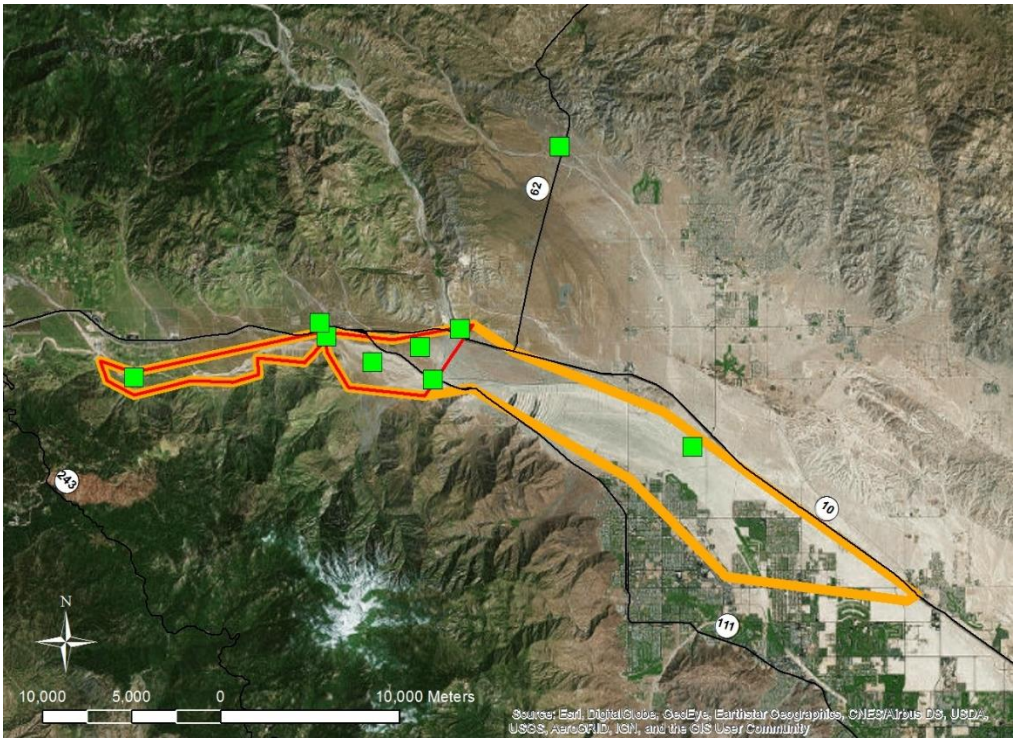

Figure 1: Map of broad localities included in this survey. Survey sites are indicated by green squares. Each survey site consisted of multiple cover board and debris sites. The orange outline represents the CVJC historical population boundaries. The inset red outline represents the estimated current boundaries of CVJC.

When a CVJC was located, it was immediately captured alive in a transparent plastic or glass vial (Figure 2c). Identification to species was performed in-field using foretibial morphology and, more reliably, distinctive dorsal abdominal banding patterns. CVJC are known to have characteristically narrow and muted abdominal bands. Various photographs were taken to document the morphological characters, coloration, size, and where possible, sex of the specimens. Soil moisture data was obtained using a General MMH800 moisture meter. Moisture readings were taken from one or multiple points from the soil surface directly beneath a cover board/debris item that yielded a CVJC. Once all data was collected, the cover board was replaced and a small gap was inserted into the sand underneath the margin of the board so that the insect could easily retreat back to shelter.

Figure 2: (a) Soil beneath a 2'x2' plywood cover board which retains moisture much longer than uncovered soil. (b) Debris in the San Gorgonio River at Fingal's Finger which yielded a CVJC. (c) CVJC undergoing measurements and photographs.

The collected images were later used for a newly-developed "fingerprinting" tracking strategy that allowed us to confirm the resampling of individual CVJC without the need to perform stressful and potentially harmful modifications to the animal, such as marking, clipping, or injections. Specimen images from all collection events within a broad survey locality were compared, noting consistencies in injuries, deformities, size, sex, and the minute patterning of the dark abdominal bands. The latter proved to be extremely effective in confirming a resampled CVJC since the small, dark blotches that constitute the banding are analogous to a human's fingerprint in their uniqueness (Figure 3). However, due to the fact that insects undergo periodic molting which results in a shedding and reforming of the exoskeleton (and thus new abdominal banding patterns, healing of injuries, etc.), this strategy can only confirm that two sampled CVJC are the same individual, but it cannot confirm that they are different individuals.

Figure 3: Comparisons of two CVJC identified as resamples through the use of our photographic "fingerprinting" method. Each photo represents a different sampling event. Both individuals were sampled at Snow Creek and were all resampled under the same detection tile they were originally observed at.

Results

Our survey yielded a total of 25 Jerusalem cricket detections. Fifteen of these detections were from plywood cover boards, 7 were from mattresses, 2 were from debris, and 1 was from beneath dried cow dung. Of these 25 detections, 5 represented confirmed resampling of 3 individuals. Two detections were of potentially undescribed species, one from the western-most survey site in Cabazon (from beneath dried cow dung), and another from Whitewater Hill (Weissman pers. comm.). Therefore, it was determined that a maximum of 18 unique CVJC and 2 *Stenopelmatus* of undescribed species were observed. All CVJC that were resampled were observed under the same shelter as their original detection. Previous surveys from 2003 and 2009 (Prentice et al. 2011) produced similar amounts of CVJC found under plywood cover boards only, but our results from 2018 represent a significant increase from the single CVJC observed in 2015 (Figure 4).

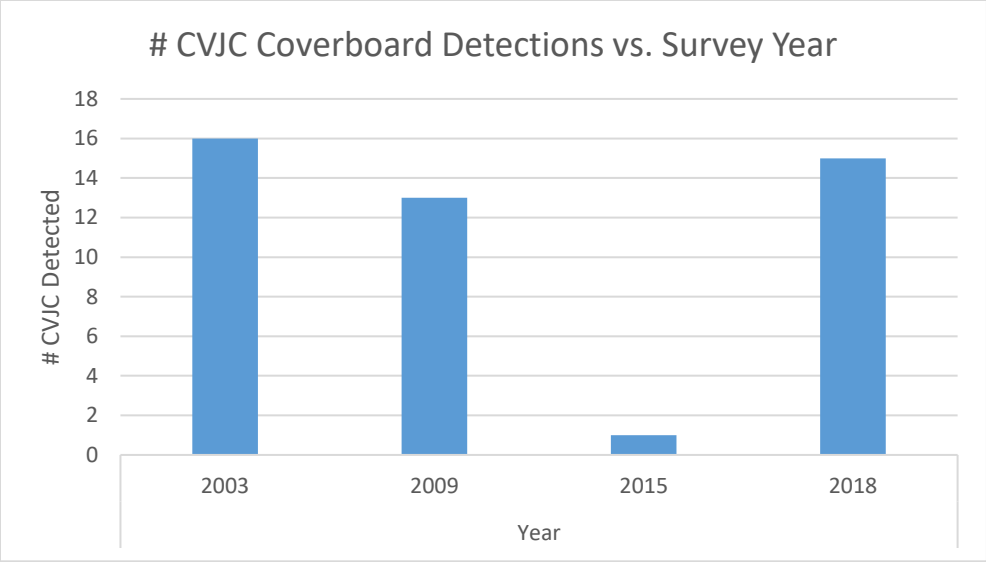

Figure 4: Total CVJC detections from beneath plywood coverboards only.

The majority of the CVJC were found at our Snow Creek survey sites (20 detections, 15 maximum individuals) with the remaining CVJC found at Fingal's Finger (3 detections, 3 maximum individuals). The peak time for detections appears to be during the second week of our study (January 14-20) (Figure 5). However peak activity times may vary considerably from year to year due to differences in precipitation and temperature. Our results clearly indicate that the Snow Creek alluvial fan is home to the highest CVJC population densities, with an 8% detection success versus the 3.4% detection success at Fingal's Finger (Table 1).

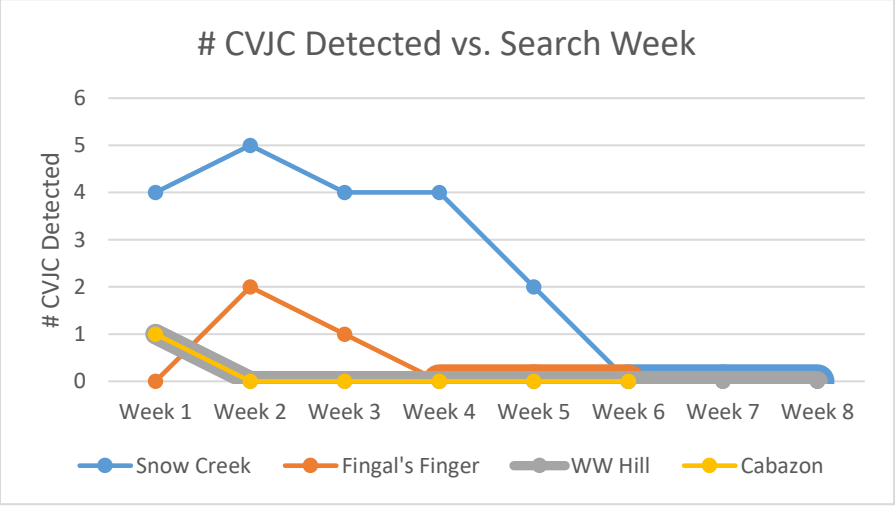

Figure 5: Number and location of Jerusalem Crickets observed during each week of the survey. Surveying at Fingal's Finger and Cabazon concluded at Week 6.

Location	# Focus Sites	# Searches	# Jerusalem Crickets	Detection Rate
Snow Creek	26	187	15 (CVJC)	8.0%
Fingal's Finger	15	88	3 (CVJC)	3.4%
Whitewater Hill	12	54	1 (n.sp.)	1.9%
Cabazon	12	67	1 (n.sp.)	1.5%

Table 1: Summary of detection success for all areas where a Jerusalem Cricket was observed. # Focus Sites is determined as the minimum number of regularly checked detection tiles/debris at a locality. Resampled individuals were not included in this calculation.

Moisture readings taken from the soil beneath a shelter at the time of a CVJC observation appears to show that, as expected, CVJC tend to prefer shelters with a fairly high moisture content, roughly in the 20% moisture range (Figure 6). Although the soil beneath 5 cover boards at Whitewater Hill were remoistened during Week 7, no additional CVJC were detected in Week 8.

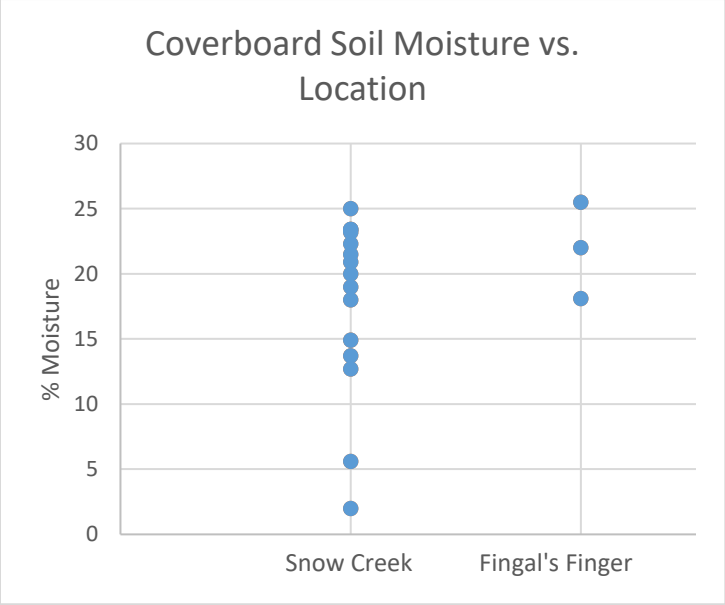

Figure 6: Percent soil moisture of soil beneath detection tile recorded for CVJC observations at Snow Creek and Fingal's Finger.

Discussion

The relatively high number of CVJC observed during this survey allowed us to draw significant conclusions regarding population densities and areas of preferred habitat. The Snow Creek alluvial fan clearly represents the highest population density of CVJC out of the areas surveyed. The factors leading

to this high population density are likely a combination of several environmental variables, including temperature, moisture, and soil characteristics (Prentice et al. 2011). The failure to observe CVJC in the most eastern survey sites (such as Windy Point, just south of Highway 111) may indicate that its western range contraction has continued to progress, however more extensive surveys of these areas will be required to confirm this.

The success of our "fingerprinting" technique to determine the presence of a resampled individual has been demonstrated and will provide continued utility for future studies. As noted, the downside of this technique is that once an individual molts, it will no longer be identifiable in relation to its previous instar, but we believe that this technique is still preferable to other potentially harmful techniques such as radioactive labeling and clipping. The fact that all 3 resampled individuals were detected at the same site as their original observations reveals that CVJC occasionally either periodically return to the same shelter site, or they can remain temporarily inactive for weeks at a time. These resampled individuals represent the minority, however, and it has been noted that disturbing a shelter site usually results in the vacating of any Jerusalem crickets, even if they are replaced back in their original position (Weissman pers. comm.)

Recommendations

Future studies focused in the Snow Creek area will provide us with an opportunity to refine our environmental data collection techniques. Obtaining data related to sand characteristics, such as moisture retention over time, composition, and compaction, will allow us to answer questions pertaining to preferred habitat conditions and could create a framework for predicting more precise population boundaries in the present and future.

The potential undescribed species of *Stenopelmatus* found at Whitewater Hill may represent yet another Jerusalem Cricket species within the CVMSHCP area with a restricted and/or shrinking range. Little is known about this species, so future efforts should first focus on confirming its identity through collection and collaboration with Dr. David Weissman (California Academy of Science, Department of Entomology).

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Appendix VII-
Triple Ribbed Milkvetch

Coachella Valley Conservation Commission

2018

Coachella Valley Multiple Species Habitat Conservation Plan

& Natural Community Conservation Plan

2018 Monitoring Results for the triple ribbed milk vetch (*Astragalus tricarinatus*) within the Coachella Valley MSHCP Area

Prepared by the University of California Riverside's Center for Conservation Biology for the Coachella Valley Conservation Commission

Contents

TRIPLE RIBBED MILK VETCH MONITORING

The triple ribbed milk vetch (*Astragalus tricarinatus*, cover photo) is a short lived perennial herb that is endemic to southern California primarily along the ecotone of the Mojave and Colorado Deserts (Fraga & Palapil, 2012, USFWS 2009). It occurs primarily in the San Bernardino and Little San Bernardino Mountains between 450 and 1300 m, with populations also being found in the Santa Rosa Mountains (a report from further east in the Orocopia Mountains by Barneby that has no specimen for authentication) (USFWS 2009). In 1998 *A. tricarinatus* was listed as endangered by the United States Fish and Wildlife Service based on field observations that it occurred primarily in desert washes, canyon bottoms and alluvial fans which are now known to be waif or deme populations (USFWS 2009). As a result of information generated by Joshua Tree National Park (JTNP) and the Rancho Santa Ana Botanic Gardens (RSA) it is now known that individuals found in washes originated from permanent upland populations on exposures of an undescribed gray-blue-green colored soil that creates steep, highly eroded slopes with little vegetation cover, often high above the canyon bottom (Sanders 2006).

For waif/wash populations, threats to the species under the ESA are not well-documented, but may be related to land-use changes, invasive species, or disturbance; however, for upland populations, even less is known regarding real threats to populations. Threats to these populations may differ from wash populations in that these are located in remote, steep, and unstable soils, thus it is less clear what factors threaten these populations, and threats may be limited to the presence of invasive species and changes in climate. To further build on knowledge from the recent discovery of preferred habitat, more research is needed to better understand plant community composition, population dynamics and to identify threats to the stable upland populations in order to properly regulate land and to update listing of the species.

Objectives

Surveys for *A. tricarinatus* were carried out again in 2018 in order to meet monitoring and management goals within the Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP) by the University of California, Riverside Center for Conservation Biology (CCB). We focused on following up from our 2017 study (see CVMSHCP Report, 2017) revisiting extant populations in the region, with the goal of documenting the longevity of plants and population dynamics within these populations.

We were interested in re-surveying the populations documented and measured in 2017, including the large source population in the Whitewater River basin near Wathier Landing (Amsberry & Meinke 2007), as well as documented populations between Wathier Landing and Mission Creek Preserve, and the Dry Morongo Canyon area.

Methods

Survey Area

We concentrated our efforts monitoring for *A. tricarinatus* in the southeast portion of the San Bernardino Mountains; the eastern portion of the transverse range, which exhibits the typical “distressed granite” soil

that *A. tricarinatus* appears to thrive in (White 2004). We conducted our surveys in the same area as last year, relocating individual plants within our study area in the Whitewater River, Mission Creek and Dry Morongo Canyon drainages (Figure 1).

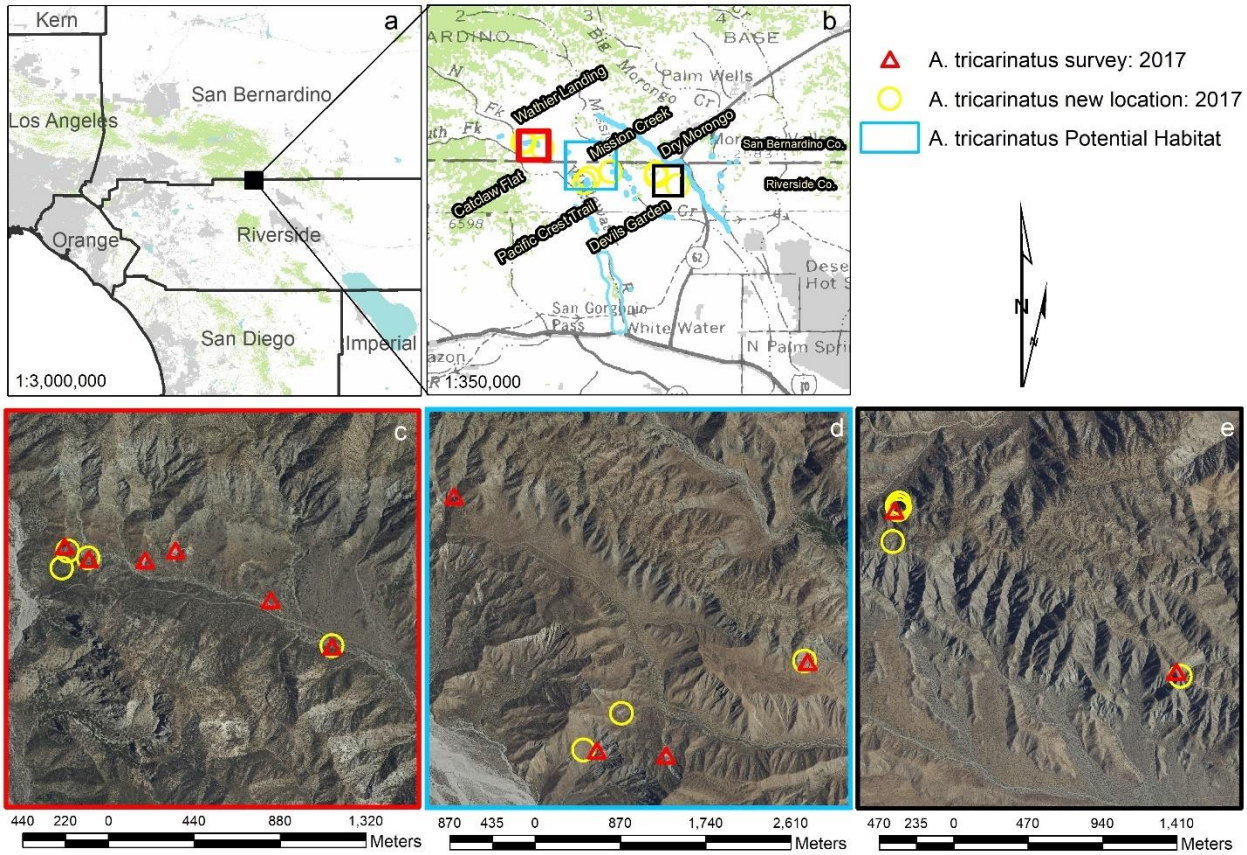

Fig. 1. This multi-frame figure shows: (a) the *Astragalus tricarinatus* study area in southern California; (b) the general geographic location where the surveys were conducted and; (c)-(e) specific study sites in larger scale, matching the extent indicator rectangles in frame (b). California Natural Diversity Database areas where *A. tricarinatus* might be found are shown in (b) at small scale, and it should be noted that this is not the full extent of its range. The three lower maps (c)-(e) show the areas in true-color aerial imagery (USDA, National Agricultural Imagery Program, 2016), displaying the gray-green substrate on which the plant is found. Triangles indicate where we conducted surveys; circles show *A. tricarinatus* locations that were not previously documented prior to 2017.

Data Collection

Between March and May of 2018, we relocated 68 plants that were previously surveyed in 2017 and assessed whether the plant was dead or alive, and whether it was fruiting. Nine plants could not be relocated using the GPS coordinates or the plot photos from 2017 (Figure 2). We recorded data for an additional 10 new plants. We photographed the plants again and tagged some individuals for further study. When surveying a population every attempt was made not to disturb the area more than was necessary. We cleaned all equipment before entering a new area with potential for A. tricarinatus to prevent ourselves from being a vector for invasive species.

Figure 2: An *Astragalus tricarinatus* individual within Dry Morongo Canyon that was identified in 2017 (left) that was relocated in 2018 (right). Photos taken on May 1, 2017 (left) and April 12, 2018 (right).

Results

Of 68 plants relocated, 45 were alive and 23 were dead. Of the 2+ year individuals, 22 of 32 (69%) plants were dead, and of the first-year individuals, 1 of the 3 (33%) were dead. Only five of the individuals relocated had (estimated) first-year seedlings within 1m of the plant. Of the variables measured in 2017 (including invasive cover, native cover, fruit number, height, number of other conspecifics within the plot, slope and aspect), only location (e.g. identity/location of the population) and estimated age (either first year or more than 1 year old) were significant in logistic regression analysis in predicting whether plants would live or die by 2018 (Prob > Chisq = 0.0045 and 0.0349, respectively).

We did notice an unusually-heavy load of aphids on one individual within Dry Morongo Canyon (Figure 3a,b), but this appeared to be isolated to this plant, and not affecting nearby plants. Similarly, several scattered nymphal *Largus californicus* were observed feeding on *A. tricarinatus* within a roughly 5 square meter area near Wathier Landing (Figure 3c) and were not observed elsewhere on this plant.

Figure 3: (a), (b) Clusters of aphids on an *Astragalus tricarinatus* individual within Dry Morongo Canyon. (c) *Largus californicus* nymph feeding on stem of *Astragalus tricarinatus* near Wathier Landing.

Discussion

Federally-endangered *Astragalus tricarinatus* population dynamics, reproductive biology, and ecological relationships are not well understood for several reasons: populations are typically isolated, the plants are cryptic and difficult to detect even under the best circumstances and they typically grow in places that are topographically rugged and difficult to reach (USFWS 2009). The goal of this study was to further document status of extant populations in the Plan area, and document the presence of threats to the species, of which we did not identify any additional actors, and the factors influencing longevity of individuals remain to be determined. As we surveyed source populations, we expected that these populations are fairly stable, with some variation in wet and dry cycles. We observed that the large boom of young individuals near Wathier Landing seemed to be a temporary increase in the population, as half of those individuals we located for study were dead in 2018 and the majority of the mature plants that were still alive showed reduced levels of new growth, few fruits or flowers, and were largely composed of dead material from the previous year. Although higher invasive plant cover was correlated with lower overall reproductive output in 2017, there was no evidence this year that the invasive cover affected mortality in the year following. In terms of additional information gleaned from this study, we positively established here that individuals may live 3 years or more, but longevity may be more accurately measured in our tagged individuals over the next few years.

Recommendations

A major question remaining for this species is how the waif populations, those found in the canyon bottoms, contribute, if at all, to maintaining population size. Are the waifs key connections between canyon populations? This issue is highly relevant to the species' conservation, as "waifs" occur in the canyon bottoms, and upland populations high on canyon walls, and the threats to each respective type differ regarding Endangered Species listing status. To this end, we recommend a genetic study of individuals to understand the fine and coarse-scale genetic structure of these populations. Known populations of the species should be sampled from a broader area, following on the 20xx Joshua Tree study, including those in the Santa Rosa Mountains. Such a study would provide information on relatedness between upland and waif populations, and some insight into regional dynamics, in addition to the genetic relationship between the Transverse Range and the Peninsular Range populations.

In addition, we recommend that the revisit surveys continue on a semi-regular basis to better understand the longevity of plants within the populations, as well as the search for additional populations Plan-wide. As has been noted, this species seems to occur on particular soil types, and although soil samples have been collected by various entities, results have not been disseminated (Fraga & Palapil 2012). Thus it would be prudent to resample areas that have self-sustaining, stable populations as well as ephemeral waif and deme populations to identify the properties of the soils that *A. tricarinatus* appears to thrive on.

As with our previous year's recommendations, to better understand the lifecycle we recommend a pollination study coupled with a seed dispersal study. The seed dispersal study could possibly be done with wildlife cameras based on the observation of the scat and the seeds in 2017. We are working in consultation with rare plant biologists in adjacent jurisdictions (e.g. Joshua Tree National Park) in order to share data about *A. tricarinatus* occurrence and biology as well as to standardize rare plant monitoring protocols with the aim of providing useful information for effective management. This information will enable surveys to be timed effectively, cited appropriately and allow for continued evaluation of OHV recreational activity, development and invasive species impacts to this species.

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Appendix VIII – 2018 Invasive Plants Monitoring and Modeling Results

Coachella Valley Conservation Commission

CVCC

2018

Coachella Valley Multiple Species Habitat Conservation Plan

& Natural Community Conservation Plan

2018 Invasive Plants Monitoring and Modeling Results

UC RIVERSIDE UNIVERSITY OF CALIFORNIA

Prepared by the University of California Riverside's Center for Conservation Biology for the Coachella Valley Conservation Commission

Contents

Invasive species monitoring and research

Background

After habitat loss and fragmentation, invasive plants represent the largest threat to maintaining native biodiversity and ecosystem functions. Within the southwestern arid lands, including the CVMSHCP, Sahara mustard, *Brassica tournefortii*, is among the weeds with the greatest potential to erode biodiversity and so is a threat to the CVMSHCP meeting its management and protection objectives. For Sahara mustard this threat has been well documented (Barrows et al. 2009; Barrows and Allen 2010; Hulton et al. 2013). However, it is important to recognize that not all invasive species diminish population persistence in native species, and species need to be evaluated in the context of the local communities within the Plan. Russian thistle, *Salsola tragus*, can be extremely invasive and its control represents an economic cost to agriculture; however in wildland habitats its impact can be positive. Barrows (1997) found significantly higher hatchling Coachella Valley fringe-toed lizards associated with Russian thistle clumps, with no impact on adult lizards or native vegetation; the *Salsola* provided important escape habitat for the hatchlings at a time when they were otherwise prey to everything else on the dunes. Similarly, the highly invasive stork's bill, *Erodium cicutarium*, provides important food to many native rodents.

Invasive plants at varied levels of localized and regional spread may demand different strategies for monitoring and management efforts. A focused, standardized monitoring protocol is appropriate for species that are already widespread, known threats, in order to document variation in abundance and impact to native (especially listed and sensitive) species. Meanwhile, for less-widespread species, potential habitat modeling to predict where species may spread, together with early detection of new invasion foci is recommended. In both cases, coordination with the Valley community of land managers for a dispersed regional network of early detection and monitoring is necessary to document the spread of invasives from neighboring areas or their arrival via anthropogenic means (e.g. transportation of fill, landscaping escapes) and manage known regional populations towards the goals of the CVMSHCP.

Research Objectives

- Assess whether the covered aeolian sand species can sustain populations in areas where Sahara mustard has invaded

- Analyze year-to-year variation in climate and assess the abundance of Sahara mustard with a goal of predicting management feasibility and impacts on native flora and fauna

- Continue to investigate control methods such as herbicide application, hand-pulling and other means as they are effective year to year, towards a prescriptive recommendation for land managers

- For this and other species, such as Tamarisk, that are distributed in specific habitat types, we plan to continue to work with partner agencies to identify specific, current control questions for investigation.

Projects

Regional Coordination

We have continued to participate in regional coordination efforts, supporting invasive species coordination and management. In 2017-2018, staff has actively participated on the steering committee for the Low Desert Weed Management Area and helped bolster support of state funding for Weed Management Areas. UCR-CCB has continued to be a resource to local and statewide weed management coordination efforts. These efforts include membership on the board of Directors of the Cal-IPC, assistance to FDM in their volunteer efforts, participation in the regional team for a Cal-IPC grant to eradicate the new invasive *Volutaria tubularifolia* (from just south of the Plan Boundary), participation in early action on early detection targets (such as Stinknet), and support of WMA mapping objectives using the new Weed Manager tool.

Distribution Monitoring

UCR-CCB has also documented invasive species in conjunction with vegetation mapping and other monitoring of covered species Plan-wide, noting presence of invasive species in Rapid Assessment plots among other opportunities. We have contributed data on invasive species and abundance to the CVMSHCP database through the Vegetation Assessment Plot database and the Aeolian Sand Community data. Additionally, CCB has documented invasive species occurrences using the early detection tool (iNaturalist Project) and a mapping tool (CalFlora Weed Manager). These data may be used in early detection efforts, to give advice on coordination of management efforts, and create habitat suitability models for current and future distributions of these problematic species.

Research

Sahara Mustard Field Experiment

Since 2005, UCR-CCB has an established research program focused on understanding the impacts of invasive weeds, especially Sahara mustard. Our activities include focused annual monitoring of Sahara mustard and other invasive weeds in the aeolian sand communities, studies that document mustard abundance in relation to the endangered Coachella Valley Milkvetch and the Coachella Valley Fringe-Toed Lizard, Flat-tailed horned lizard, as well as other native species. This ongoing research (e.g. Hulton et al. 2013)includes determining how the 2012-2016 drought has affected Sahara mustard populations, and whether dynamic population shifts by the mustard can result in coexistence with covered species, or whether control efforts are warranted, and if so which methods will likely have the greatest success without damaging native plants or animals. Results of the aeolian sand community monitoring will be reported separately.

Controlling Sahara mustard at the spatial scale necessary to have population-level impacts is logistically and economically challenging. As well, we are working towards better insight into when the timing of control is most effective, and how that varies by the pattern of precipitation. We aim to discover what control methods work best under each precipitation regime. To that end, we have performed research in coordination with UC Cooperative Extension into control techniques for this species. In past years, we have investigated whether the early application of herbicide application, with early-season rainfall, can minimize negative impacts on native desert shrubs. These experiments are only possible under certain rainfall patterns that have not occurred during the recent drought period.

Sahara mustard's impacts are most severe during wet years, and it is much less abundant during dry years and years with later/summer rain. However, regardless of the aboveground biomass of mustard, there is still a seed bank waiting to germinate when conditions are appropriate; multi-year and likely perpetual control efforts will be required to lessen the impact of this species. Some of the largest-scale efforts to control mustard in the CVMSHCP areas have been hand pulling, by paid and volunteer staff. Challenges to this approach include the labor involved with pulling and bagging plants (per common protocol) and disposal of biomass. In 2016, we set up an experiment to test the efficacy of hand-pulling without bagging the biomass as a control technique, since Sahara mustard was in low-medium density and amenable to hand-pulling, in partnership with Friends of the Desert Mountains (FODM). The goal of this experiment was to ascertain whether it is necessary to bag Sahara mustard after pulling it to achieve sufficient control.

In April 2016, we delineated plots on a parcel of CVCC land (previously owned by FODM) in the Edom Hill Conservation Area, where Sahara Mustard was previously established in low-moderate density. Three comparison plots each were established, in 3 repetitions, located within a 1 ha area. Overall cover of Sahara mustard in the area was low and variable across the repeated plots, ranging from average of 1% to 28% cover, however, within each repetition, initial cover varied under 10% between the treatment plots. Treatments within each repeated plots were randomized, and included: A) pull and leave (mustard plants were pulled and left in place); B) pull and bag (mustard plants were pulled and all were bagged); C) the comparison control (no treatment). Unfortunately, the mustard had begun to fill seed heads as treatments were being implemented. Therefore, differences between the "leave" and bagged plots should be interpreted in this context, specifically, heads containing seed were left on the ground. Pre and post-treatment data including species richness and cover was recorded. As well, the effort in person-hours were tallied for each of the treatment types- bagged, non-bagged and control plots.

During treatments, each of 6 volunteers contributed a total of 4.5 hours of labor to work on the 25 x 5m plots, covering a total of 750 m^2. Non-bagged plots took an average of 0.013 person hours/m^2, and bagged plots took more than twice the time, at 0.028 person hours/m^2 (Table 1). The following year, in 2017, there was sparse annual growth on the site, and we found a significant decline in Sahara mustard percent cover on all plots ($p<0.01$), including the control using matched pairs analysis. The highest decline was in the bagged plots, at 12%, compared with 6% in the non-bagged plots, and 4% in the no-treatment control plots. Differences in the declines between treatments were non-significant, however. There were no significant differences in native species cover between treatments; however, there was a significant decline in native species richness in the bagged treatment as compared to the control (2 vs. 3.4 species per m^2, $p <0.01$).

	Average person-hours per square meter	Average SM % cover	Average change in SM % cover	Average native annual species % cover	Average native annual species richness
Control	0.000	5.8	-4.1	0.3	**3.4**
Pull/Leave	0.013	7.7	-5.8	0.4	3.0
Pull/Bag	0.028	1.8	-11.6	0.2	**2.0**

Table 1: Effort, and change in percent cover of Sahara mustard and native annual species within hand-pulling test plots within the Coachella Valley, CA. Statistically-significant differences in bold.

These results show that hand-pulling Sahara mustard is a viable way to reduce cover to some extent. From these single-year results, it is suspected that bagging plants could cause declines in native species richness, because seeds of native species could be impacted by the ground disturbance involved, or because they are removed along with the bagged biomass. This finding is preliminary and warrants further investigation. Whether the bagging the biomass is necessary to reduce or eliminate Sahara mustard cover remains to be determined, because these treatments were initiated after seed set. If this can be established, this would reduce labor and other costs. Certainly, multiple treatments over years is necessary, as the species' seed bank is known to persist more than one year. We were unable to repeat this experiment in 2018, but it may be worthwhile to do so in the future. We will continue to explore research questions concerning the control of this species, as funding and ecological opportunity (climate, abundance of plants) allows.

Predictive Species Distribution Modeling

Fountain grass (*Pennisetum setaceum*) is an example of a plant that is widespread, but that is located in specific areas of the Plan area, a target for early-detection type monitoring of new invasions. This species is a warm-season exotic invasive grass that is adapted to extensive areas of southern California where it is able to respond to moisture with opportunistic growth year-round (Sweet, 2011). Prior studies conducted in 2008-2009 have indicated that this species is widespread in some ephemeral streams and canyons within the plan area, and that it has the potential to invade many low-lying canyon areas across the Plan area (Sweet and Holt 2010). These areas support listed species such as Bighorn sheep, as well as other endemics like Triple-ribbed milkvetch (*Astragalus tricarinatus*).

In order to better target detection and control efforts, species distribution modeling may be performed, that is based on the similarity between the values at the points where the species occurs, and uses that to project suitable areas across the landscape. We employed this technique to create more up-to-date predictive distribution models for both fountain grass and Sahara mustard. During 2018-2019, we acquired all currently available location observation data for the Coachella Valley and vicinity, including data captured during surveys and other monitoring activities, as well as Calflora and iNaturalist. A suite of predictive variables were used that were developed by UCR CCB for species distribution modeling, including minimum and maximum temperature, average precipitation of the winter season, soil types, and disturbance variables such as roadedness. Variables used in the preliminary models were predicted to influence the distribution of the species by affecting growth, reproduction or mortality, and the number of variables were reduced in the final predictive model based on the relative contributions of each to the

model. The final set of variables used in the distribution model are shown in Table 2. To create the models, we used Maxent (Phillips, et al. 2018). For Sahara mustard, 402 observations were used for model training, and for fountain grass, 255 observations were used.

ATTRIBUTE	TYPE	DESCRIPTION	*Brassica tournefortii* mean value	*Pennisetum setaceum* mean value
awc_r	edaphic	water content available to plants as fraction of volume, representative value	0.07	0.07
aws025wt	edaphic	available water storage as cm of water	1.79	**1.47**
curve	terrain	median value from a 18 x 18 neighborhood of 10m cells, each containing the results of overall terrain curvature analysis of a 3x3 neighborhood of 10m cells containing elevation		0.07
east	terrain	median eastness value from a 18 x 18 neighborhood of 10m cells where eastness = sin of aspect (in radians North Azimuth)		0.10
lndscp01	landcover	count of 30m cells within a 17x17 (510x510m) neighborhood that are classified as **Developed, Open Space**	13.88	
lndscp02	landcover	count of 30m cells within a 17x17 (510x510m) neighborhood that are classified as **Developed, Low to High Intensity**	11.84	
local01	landcover	count of 30m cells within a 6x6 (180x180m) neighborhood that are classified as **Developed, Open Space**	**2.82**	
local02	landcover	count of 30m cells within a 6x6 (180x180m) neighborhood that are classified as **Developed, Low, Medium, or High Intensity**	1.32	
north	terrain	median northness value from a 18 x 18 neighborhood of 10m cells where northness = cos of aspect (in radians North Azimuth)		0.04
pc_clay	edaphic	percent clay	8.03	5.91
pc_sand	edaphic	percent sand	78.52	77.02
pc_silt	edaphic	percent silt	10.96	
pdecmar	climate	average total precipitation from December through March for period 1971 - 2000 (in mm)	**120.43**	138.02
pjunoct	climate	average total precipitation from June through October for period 1971 - 2000 (in mm)	37.51	46.77
pnovmay	climate	average total precipitation from November through May for period 1971 - 2000 (in mm)	137.92	**158.47**
ppt_av_c	climate	average annual calendar water year precipitation for period 1971 - 2000 (in mm)	175.53	202.14
rdns0100	disturbance	density of all mapped motor vehicle travelways (irrespective of type) w/in 1000m radius neighborhood given. in units of km road / km2	**1.43**	0.62
rugd18xn	terrain	mean value from a 18 x 18 neighborhood of Sappington analysis results based on a 3x3 neighborhood of 10m cells		**0.01**
slope	terrain	median slope value from a 18 x 18 neighborhood of 10m cells where slope is given in degrees above horizontal	5.01	19.27
sula_ba	edaphic	count of 30m cells within a 17x17 (510x510m) neighborhood that are classified as badlands	32.45	
sula_ro	edaphic	count of 30m cells within a 17x17 (510x510m) neighborhood that are classified as rock outcrops		**173.28**
sulo_aeol	edaphic	count of 30x30m cells in 6x6 (180x180m) neighborhood classified as aeolian	**5.63**	
suloMaD	edaphic	count of 30m cells within a 6x6 (180x180m) neighborhood that are classified as Myoma fine sand,m5-15%	3.78	
tmax	climate	average maximum temperature occuring during period July through August during years 1971 - 2000. unit = degrees Celsius	**40.03**	**38.04**
tmin	climate	average minimum temperature occurring during period January through February during years 1971 - 2000. unit = degress Celsius	3.60	2.61

Table 2: Variables used in species distribution modeling for Sahara mustard and fountain grass. Values within the right two columns indicate the mean value of the variable over the observations used in the model, respectively. Blanks indicate that the variable was not used in building that respective model. Values in bold indicate the top 5 predictor variables in each model, and underlined numbers indicate variables that are best correlated with the distribution of observations on their own.

The resulting models of habitat suitability both had AUC scores > 0.9 (scale of 0 (lowest) to 1.0 highest) (Figures 1 & 2). Models were evaluated using jackknife to assess relative importance of predictor variables. Mean values of predictors across observations for each species are shown in Table 1. Areas predicted to be suitable reflected well the observations of each species; Sahara mustard's predicted suitable habitat is in the flat, open areas of the valley, whereas the area predicted to be suitable for fountain grass is within canyons and the foothills on the edges of the Coachella Valley. While there is no dispersal function inherent in these models, they do "assume" that the species has spread and/or been detected across its full range of habitat conditions. Thus, as more detections occur, these results from distribution modeling may be further refined in the future. These results should provide an ongoing search area for these problematic invasive species, and future research may focus on the overlap between CVMSHCP covered species and invasive species potential habitat.

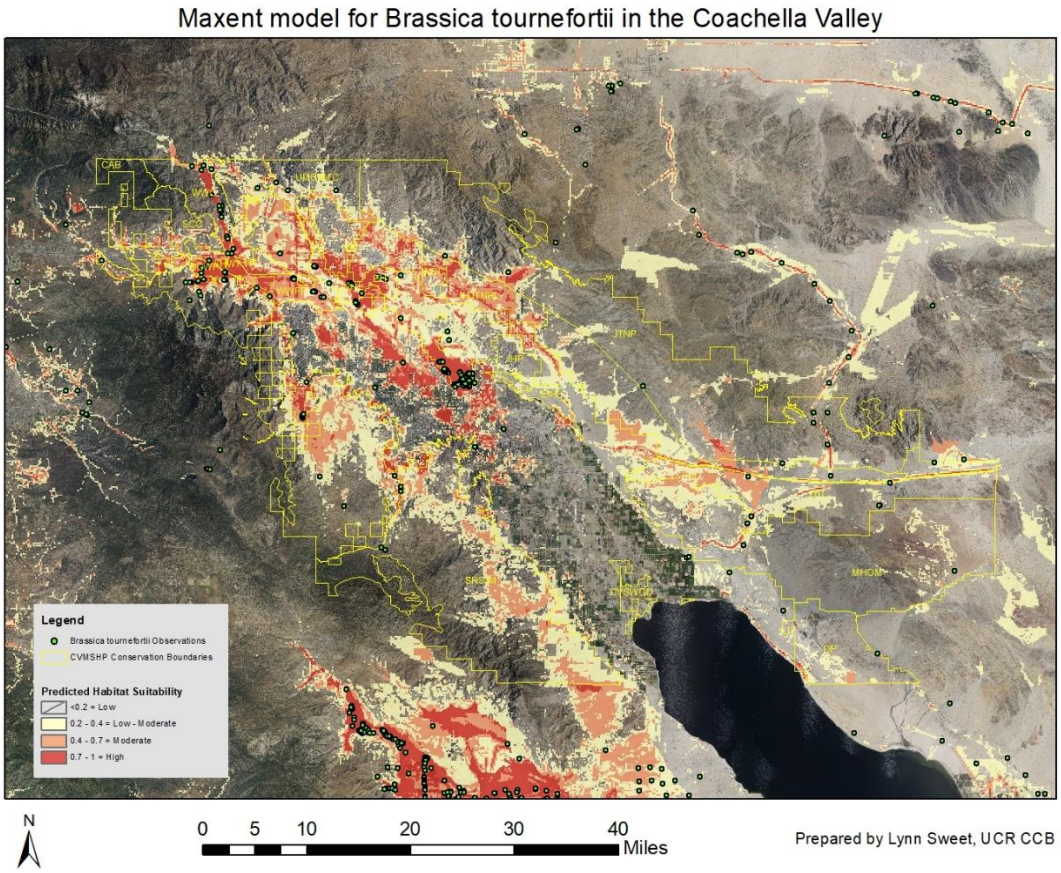

Figure 1: Habitat suitability for Sahara mustard across the Coachella Valley, California, as predicted using Maxent software. Values of salmon and red indicate higher suitability.

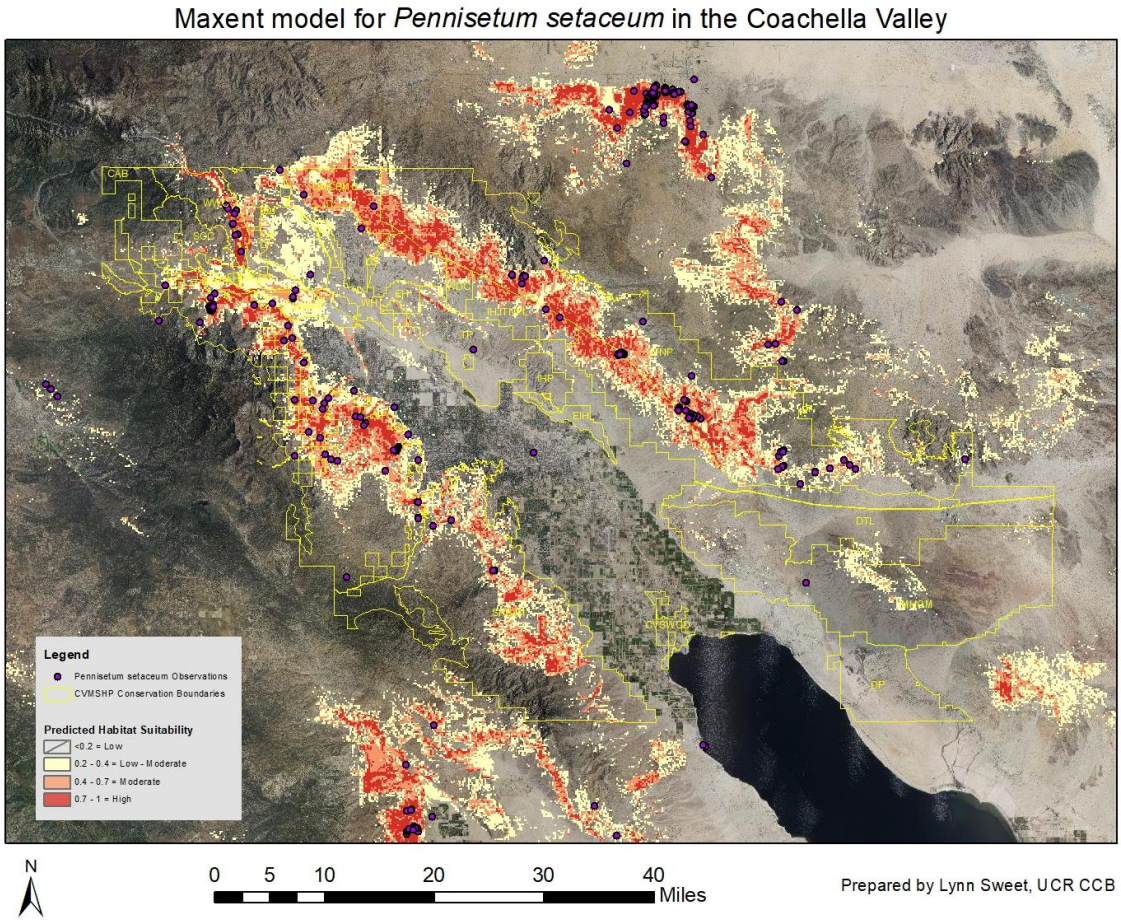

Figure 2: Habitat suitability for fountain grass across the Coachella Valley, California, as predicted using Maxent software. Values of salmon and red indicate higher suitability.

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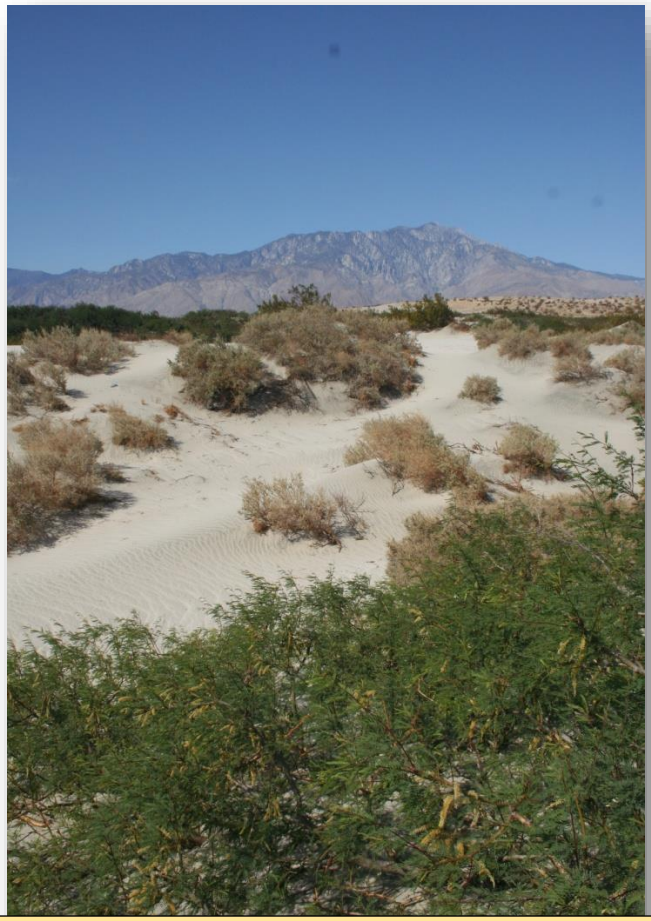
Appendix IX-
Honey Mesquite Monitoring Protocol

Coachella Valley Conservation Commission

2018

Proposed protocol for measuring mesquite health with respect to putative factors causing declines in stand health in the Coachella Valley



June 2018

Prepared by The University of California's Center for Conservation Biology
For The Coachella Valley Conservation Commission

Proposed protocol for measuring mesquite health with respect to putative factors causing declines in stand health in the Coachella Valley

June 2018

Prepared by the
University of California Riverside, Center for Conservation Biology
for
The Coachella Valley Conservation Commission

Introduction

Southern California's desert populations of honey mesquite, *Prosopis glandulosa torreyana*, occur within seemingly divergent biotic associations including desert riparian communities as peripheral to species such as willows, cottonwoods and palms, within and surrounding dry lakebeds, and as isolated sand dune hummocks imbedded (Barbour and Major 1977). Phreatophytes are plants that require year-round access to water; they live in oases, riparian habitats, and, though seemingly dry, areas where the water table is at or near the surface due to earthquake faults (David et al. 2007, Catchings et al. 2009). Honey mesquite has been categorized as a facultative phreatophyte (Heitschmidt et al. 1988), indicating that it can shift its primary water uptake between a relatively deep tap root to more shallow near-surface roots that take in water from rainfall events. This designation may be misleading, suggesting that honey mesquite can thrive either with a high water table, or with the infrequent desert rain typical of the Coachella Valley. The common denominator of the different biotic associations where honey mesquite can thrive is that they are restricted to areas of very high water tables, or temporarily high water tables following uncommon summer monsoon floods where seedling honey mesquite germinate and extend their taproots to maintain contact with groundwater levels. While mesquite can absorb surface rain water through near surface roots, all long-lived honey mesquite stands in the Coachella Valley occur where there is a relatively high water table, often associated with earthquake fault zones.

In areas with active wind-blown sand movement, mesquite hummocks provide structure that can be a nucleus for accumulating and stabilizing large quantities of aeolian sand. With access to sufficient water mesquite can maintain high enough growth rates to continue to stay above the dune sand accretion. This can result in large dunes several tens of meters tall with

living mesquite emergent throughout. It also can give a misleading impression that the mesquite germinated and grew on the dune; rather the dune grew around the mesquite.

While honey mesquite are protected both in dune and riparian habitats as components of natural communities under the NCCP portion of the Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP), honey mesquite here also provide critical habitat for several CVMSHCP covered species. Species occurring on mesquite sand dunes include Coachella Valley fringe-toed lizards, *Uma inornata*, Palm Springs pocket mice, *Perognathus longimembris bangsii*, round-tailed ground squirrels (*Spermophilus tereticaudus)*, Coachella Valley giant sand treader crickets (*Macrobaenetes valgum*) and Le Conte's thrashers, (*Toxostoma lecontei*). In riparian habitats Bell's vireos (*Vireo bellii pusillus*) and Crissal thrashers (*T. crissale)* also utilize honey mesquite. Managing and sustaining honey mesquite is an important objective of the CVMSHCP.

Honey mesquite stands are declining in some portions of the Coachella Valley, while they appear much healthier elsewhere. There are notable declines in the southern Desert Hot Springs region, while healthier stands occur from Thousand Palms Canyon south to Dos Palmas (UCR CCB Report 2014). There are stands of mesquite skeletons (dead) on the dunes of the Coachella Valley National Wildlife Refuge that predate anyone's current memory, but include evidence of extensive aboriginal use. The question, of course is why? How extensive are these patterns, are they trends, and if so what be done to reduce that trend?

In 2014, UCR-CCB undertook a targeted study to identify trajectories of the spatial and temporal dynamics of mesquite hummock natural communities in the Coachella Valley, identify drivers of these changes, and recommend site characteristics that may support sustainable restoration of mesquite hummocks based on those findings. To that end, we identified and analyzed multiple hypotheses that could contribute to an understanding of causes for the recent declines in this community. Among the leading hypotheses considered were the effects of a lowered aquifer and whether human disturbance, including off-road vehicle activity, could best explain the observed patterns of mesquite trajectories. We documented community dynamics by digitizing the extent of live mesquite visible in a series of historic images, dating as far back as 1938 through 2012. We then employed five separate tools to identify drivers of those changes: 1) a historic perspective of climate and lacustrine filling and drying in the east valley, 2) ground penetrating radar to identify near-surface ground water, 3) well records to document changes in ground water levels, 4) stable isotope analyses of the water being used by the mesquite, and 5) patterns of off-road vehicle trails with respect to dead or stressed mesquite versus more healthy stands. As stated, lack of access to finer-scale well data precluded specific attribution of the decline of some stands vs. others due to declines in the ground water table.

The stable isotope analysis identified the mesquite's access to groundwater resources, and the use of that water during summer drought periods. Both the well records and ground penetrating radar were used to indicate the availability of near-surface ground water at the more vigorous mesquite stands; more destructive, expensive and precise methods, such as excavating or drilling new wells, were not used. Sites without access to near surface ground water showed

the greatest declines in live mesquite. Off-road vehicle trails were not more abundant adjacent to dead or stressed mesquite compared with more vigorous mesquite patches. Potential restoration sites were therefore recommended to include near-surface groundwater and a stable aquifer in order to provide a sustainable mesquite hummock community. Moving forward, in line with Plan actions to monitor hydrologic regimes, correlate these with mesquite hummock health, we propose the following plan for restoration monitoring. With the planned tamarisk treatment and well installation in the Willow Hole Conservation Area (advisably the latter prior to the former), there is a unique opportunity to analyze more definitively the relationship between tamarisk presence and groundwater depth, as well as mesquite health and restoration potential.

Monitoring Objectives

This monitoring protocol will:

1. Document the baseline health condition and age status of the hummocks and demographic status (if possible) through fieldwork surveys (metrics such as leaf area, fruit set), and use aerial images to document any overall woody cover changes since the last study (which was in 2012, prior to the historic drought in the region) and,
2. Partition possible explanatory variables to identify which are the likely contributors the differences in the honey mesquite's health condition. Additionally we will monitor groundwater depth and hummock health, as well as any changes following the removal of the invasive tamarisk. Specifically, we will examine hummock health in the trees nearest the well locations at the initial time of installation, as well as the initial groundwater levels in these locations.

Monitoring under the CVMSHCP has the objective of identifying the occurrence and extent of area occupied by covered species. Of equal importance, an additional objective is to determine stressors that may compromise the sustainability of those species. For honey mesquite, we will quantify metrics of occurrence and extent through the vegetation mapping component of both the valley floor and Dos Palmas management units of the CVMSHCP. For assessing stressors and their impacts, first we must identify potential stressors, and then identify response variables that would indicate when those stressors are having an impact on the mesquite.

Potential Hypotheses (Explanatory Variables)

Reduced aquifers. People everywhere need and use water. Due to the heat and aridity of the Coachella Valley, in order to maintain lush landscaping and golf courses, people here use a tremendous amount of water. With the exception of agriculture, which acquires much of its water from Colorado River via the Coachella canal, the majority of the rest of our water comes from an extensive aquifer system, partitioned by underground faulting into at least five sub basins. Over the past decades, the Coachella Valley has experienced reductions in that aquifer as well as

ground subsidence. The same aquifer also supports honey mesquite habitats. To reduce over drafting, Colorado River water now fills three percolation pond arrays that have successfully slowed or stopped further reductions in much of the aquifer. The question is whether in those areas where the mesquite are found and are declining, has the aquifer already dropped too low, or are those sub basins not being serviced by the percolation ponds?

Aging mesquite without recruitment. A restoration management action must include study of the conditions necessary for establishment. Adult mesquite in this region are characterized as being primarily phreatophytic, with little use of surface water, a scarcity in these environments. Our "model" of mesquite establishment on the valley floor suggests rare punctuated events, which require areas of very high water tables or temporarily high water tables following uncommon monsoon flood events, seedling honey mesquite germinate and extend their taproots to maintain contact with groundwater levels. This makes the possibility of renewing the population via establishment by seedlings even more precarious when surface water is so rarely available in quantity. It suggests that all or the majority of a mesquite stand germinated at the same time, and thus form even aged communities. No data exist that indicate how old mesquite can be before senescence. When they reach "old age", we might expect the whole community to decline in unison. Thus, the preservation of the health of existing adults as well as an understanding of their age and frequency of recruitment becomes necessary to understanding the demographics mesquite trees in these systems.

Insect invasions. Healthy honey mesquite stands can host many species of native insects without damage. However, in our global commerce there is always a possibility of the introduction of an insect that could overwhelm the resources that need to survive. The insect community associated with honey mesquite in the Coachella Valley (native or invasive) has yet to be described.

Fire. Fire is not a natural component of a desert mesquite stand's ecology. Intense fires could kill mesquite, whereas light fires on healthy stands should result in some root sprouting. Fire scars should be obvious in fire-killed mesquite stands.

Response Variables (What to Measure)

An important tool for partitioning these potential stressors will be access to local well records and water samples. If the well depths are shallow, not declining and if water isotopes match those that the mesquite are utilizing, then the aquifer may not be a candidate for explaining declining mesquite. This will be key in separating aquifer from age related declines. Following treatments of tamarisk within the Willow Hole study area, we will utilize plant measurements and monitoring, as well as the new groundwater/well data from the area to gain

knowledge about the effects of tamarisk removal, the water requirements of these mesquite trees, the sources of water that the hummocks use, and the relationship between plant health and groundwater levels. This may provide evidence of a causal relationship between the two, provided adequate sampling of both variables. An investigation of water level over time at the location proximal to the study plants, over several years, together with health conditions on an individual-basis (using cross correlation functions for the time-series) may also provide more direct evidence of this relationship. Both studies are reliant on adequate proximity of groundwater wells to relevant vegetation, and adequate and accurate data provided from MSWD to allow discernment of significant differences (assuming they exist) between the wells.

Response variables, garnered from direct or indirect mesquite measurements will include:

1) Area of living mesquite using aerial imagery – measuring the extent of actively photosynthesizing surface area in a given stand of mesquite, within the focal study area nearest the wells. Reduced leaf area over time indicates stress. Using historic imagery will allow trend detection. The USDA NAIP program gathers fine-scale aerial imagery for extensive areas of the US, producing GIS data products that include Vegetation Indices. These indices, specifically Normalized Difference Vegetation Index (NDVI) provide an indirect measure of plant health, based on absorptance and reflectance of infrared and near infrared by plant tissue. We will use NAIP imagery taken during the late spring over the years that NDVI is available, currently 2005, 2009, 2010, 2012, 2014 and 2016 to quantify the surface area within the mesquite dune areas that contain photosynthetic tissue. By comparing the size of this area over a series of years, we should be able to detect any recent trends in mesquite health, before and after the recent historic drought.
2) Percentage live, flowering/fruiting, age – measuring the vegetative and reproductive health of plants. Plants unable to produce flowers and fruits (seed pods) indicate a deepening level of stress. As the areas of study are sensitive both ecologically and culturally, we are limited to non-destructive and low-disturbance assessments of plant health. Field surveys will be staged such that minimal disturbance to living mesquite and the abiotic environment occur. Mesquite are winter-deciduous, and flower in the springtime, thus field campaigns will be timed appropriately to measure plants at the peak of leaf-out and flowering, respectively. As well, as sampling of the entire stand is impractical, we will conduct sampling across mesquite areas using instrument, visual estimates and sub-sampling.

   To estimate % of live biomass, we will use instrument, visual estimates and subsampling. We will first visually estimate the % of identified individuals' live stems within the plant, if 10m in radius or less. If >10m in radius, we will treat consecutive 10m areas as subsamples of the individual, or individuals (if identity cannot be determined). For more direct measurements, pin sampling will be used: we

will arrange a sampling line across the individual mesquite stands. Within each line, a pin will be lowered at an appropriate interval (e.g. 5 or 10cm), hitting either live or dead tissue. The number of hits with living parts of each species expressed as percentage of total hits was used as an estimate of its cover degree (Troumbis and Memtsas 2000). As well, at regular intervals along the line, we will acquire measurements from a leaf area meter in order to determine leaf area.

Since reproductive output is a measure of plant vigor, we will also visually estimate the % of identified individuals' live stems that contain flowers/fruit. Together these measures will allow us to ground-truth the aerial-based assessments of plant health, and get a finer-scale look at health of individual plants. Although there is no practical way to assess the age status of the stands, obvious seedlings <2m in branch length will be mapped and recorded within the survey areas.

3) Mesquite water use and health with respect to groundwater depth:
    a. Leaf-water isotope analyses – measuring the source of water being utilized by plants. Mesquite roots can access water from deep roots (aquifer water) or shallow roots (recent rainwater). Increased reliance on recent rainwater indicates an aquifer that is too deep to sustain the mesquite. To more definitively link the groundwater with plant health, hydrogen and oxygen isotopes can be used to determine the source of water in plant tissue and therefore the sources of water relevant to recent plant growth. Mesquite trees utilize roots at various depths, some of which may be utilizing upper-horizon rainwater resources and others that may be accessing more steady groundwater sources. We may be able to determine the degree to which these trees are reliant on one of these two sources, and more specifically, link the isotope ratio within the well water to the water detected in plant tissue. In our fieldwork, we will sample plant tissue, as well as water from the wells, if possible, which will be submitted to the Facility for Isotope Ratio Mass Spectrometry (FIRMS facility at UCR-CCB, http://ccb.ucr.edu/firms.html) to analyze isotope composition. This analysis is critical to understanding to what degree these trees are reliant on the same sources measured by well depth.
    b. Analysis of well depth with respect to tamarisk removal (if possible) and mesquite health. Statistical methodology such as Pearson correlation may be used to analyze the relationship between water level and hummock health.
4) Insect Communities – by sampling the associated insect communities and stressed versus healthy mesquite plants, we may gain insights into their relative health – and provide early detection of non-native invaders. In some systems, insects may have significant impact on new growth from meristems (Nilsen et al. 1987). During the field campaign, a survey of insect taxa present on the mesquite plants will be undertaken. For suspected pest species, as well as tissue indicating other pathogens,

we will consult experts with the UC Extension for information and identification, to the degree practical.

Future Directions:

There are several other factors that deserve attention for a full investigation of the historical and current decline of the mesquite stands in the Coachella Valley, that are beyond the scope of the current proposal and capacity. First of all, we lack knowledge of the water status of the plants across stands. As is well-known, plant water potential reflects the degree to which a plant is experiencing drought at a physiological level. To determine any differences in drought status across mesquite stands, which is highly suspected, a full study would involve time-consuming and expensive measurements using a pressure chamber, which is beyond the capacity of this office at this time. As well, cultural management of mesquite health by Native Americans may have impacted the health and age structure of stands of mesquite in other systems, such as in Death Valley (Fowler et al. 2003). In particular, members of the Timbisha Shoshone Tribe cleared away branches and sand that gathered within the mesquite stands in that system. It would be important to determine to what degree mesquite in the Coachella Valley were managed historically and whether the current resource management approach is contributing to the decline of the mesquite.

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BUDGET ESTIMATE:

Communication, Acquisition, Analysis and Summary of Well Data:
- 80 Hours Associate Spec
- 80 Hours PI @

Acquisition and Analysis of imagery:
- 80 hours: Associate Spec

Measurement of Plant Health, Sampling: Instruments and materials
- Leaf area meter
- Supplies:

Measurement of Plant Health, Insects, Sampling: Fieldwork
- 40 Hours Associate Spec
- 80 Hours Jr Spec
- 20 Hours PI

Analysis and Summary, Report preparation:
- Sample prep and Transportation
- Isotope Lab Cost grinding, H2, O18 approx. 50 samples
- 80 Hours Associate Spec
- 40 Hours PI

DELIVERABLES:

1) Maps and calculations of healthy mesquite area for the areas nearest the wells from the NAIP imagery
2) Summaries of the field-measured health data
3) Analysis of relationships between groundwater depth and mesquite health, and summaries of findings of the isotopic composition of mesquite-tissue and well water
4) Summary of insect community findings

Appendix X-
Coachella Valley Cowbird Report

Cowbird Management in the Coachella Valley

December 21, 2018

Prepared For:
Coachella Valley Conservation Commission

Prepared By:
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Table of Contents

List of Tables

List of Figures

INTRODUCTION

The Coachella Valley Multiple Species Habitat Conservation Plan (CVMSHCP 2007) identified five species of riparian birds as targets for conservation, the Willow Flycatcher, Least Bell's Vireo, Yellow-breasted Chat, Yellow Warbler, and Summer Tanager, and one species as a potential threat with management concern, the Brown-headed Cowbird (Table 1).

Table 1. Riparian bird species identified by the CVMSHCP for conservation monitoring.

Common name	Code	Scientific name	Status
Willow Flycatcher, incl. ssp. Southwestern Willow Flycatcher	WIFL	*Empidonax traillii (Empidonax traillii extimus)*	State Endangered (Federally Endangered)
Least Bell's Vireo	LBVI	*Vireo bellii pusillus*	State Endangered/ Federally Endangered
Yellow Warbler	YEWA	*Setophaga petechia*	State Species of Special Concern
Yellow-breasted Chat	YBCH	*Icteria virens*	State Species of Special Concern
Summer Tanager	SUTA	*Piranga rubra*	State Species of Special Concern
Brown-headed Cowbird	BHCO	*Molothrus ater*	None (potential threat)

From 2002 to 2004, the Center for Conservation Biology conducted baseline surveys for these six riparian bird species and established standardized monitoring survey protocols (Allen et al. 2005). The baseline surveys covered 18 riparian sites in the Coachella Valley with a total of 116 count points.

In 2014, the San Diego Natural History Museum (SDNHM) performed resurveys at seven of these sites that were identified as higher priority on the basis of presence of target species from 2002-2004 and lack of recent surveys. The 2014 resurvey found low numbers of target riparian bird species compared to historic levels and neighboring regions, and high numbers of Brown-headed Cowbirds, with 100% nest parasitism of the Least Bell's Vireo at Chino Canyon (Hargrove et al. 2014). However, successful nesting of the Least Bell's Vireo was documented at upper Whitewater Canyon, where no Brown-headed Cowbirds were observed. Three sites, Chino Canyon, Dos Palmas Preserve, and Whitewater Delta, were identified as having the most potential for riparian bird habitat where cowbirds were likely depressing riparian bird populations below a sustainable level, thereby creating a population "sink." Therefore, initiation of cowbird control was planned for 2017 at these three sites in conjunction with continued nest monitoring. At least three years of cowbird control was recommended in conjunction with nest monitoring. Broader-scale monitoring of population trends that includes additional riparian sites was recommended at a five-year interval.

In 2017, Cowbird control was implemented at two sites, Whitewater Delta, and Dos Palmas Preserve (San Diego Natural History Museum 2018). A total of 84 Brown-headed Cowbirds

were trapped during 2017, 75 at Whitewater Delta Storm Channel and nine at Dos Palmas Preserve using modified Australian Crow traps (Griffith and Griffith 2004). Of the 84 total trapped, 23 males were banded and released, to determine recapture rate, and 60 were collected. Only nine cowbirds were captured at Dos Palmas Preserve, and alternative methods of cowbird capture were recommended, namely targeted mistnetting. In this method, mist-nets are deployed along with taxidermied decoy cowbirds and broadcast of recorded vocalizations. This method is highly mobile and can be targeted for areas where cowbirds were recently observed. This method also allows for the immediate release of any non-target birds captured, and eliminates the daily visits required to maintain the food and water in the traps.

METHODS

Two cowbird traps were installed and opened on 2 April 2018, both at the Whitewater Channel (Table 2, Figure 1). Live decoy birds were placed into each of the four traps on 5 April, and traps were checked and maintained on a daily basis. The two traps were shut down and removed on 9 July.

Four mistnet stations were established at Dos Palmas Preserve, and operated approximately every two weeks from 16 April to 25 June (Table 2, Figure 2). At each station a 12-meter net was deployed under which a remote speaker was placed broadcasting male and female cowbird calls. Three stuffed decoy cowbirds were also placed on short posts adjacent to the mist-net (Figure 3). As cowbirds are highly social, the broadcast calls and decoys provide auditory and visual cues to attract cowbirds in the area to the net where they can be captured. Any non-target birds captured can also be immediately released with this method.

Table 2. Locations of cowbird traps and mistnet stations Coachella Valley, 2018.

Trap	Latitude	Longitude
Whitewater Delta Trap #1 (WW1)	33.512734	-116.063309
Whitewater Delta Trap #2 (WW2)	33.568267	-116.106378
Dos Palmas Net A (used once)	33.495020	-115.829902
Dos Palmas Net 1 (DP1)	33.49857	-115.83145
Dos Palmas Net 2 (DP2)	33.50929	-115.82772
Dos Palmas Net 3 (DP3)	33.50408	-115.83843
Dos Palmas Net 4 (DP4)	33.50344	-115.83763

Figure 1. Locations of two cowbird traps at Whitewater Delta.

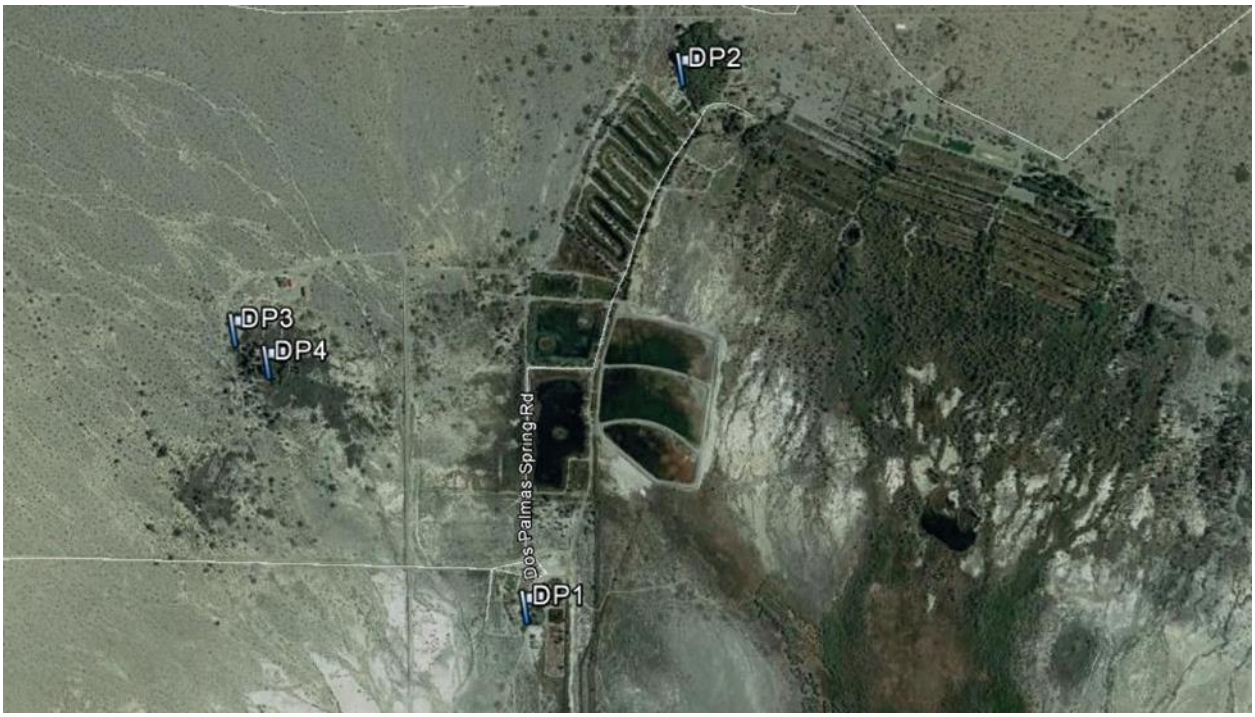

Figure 2. Locations of mistnet stations at Dos Palmas Preserve.

Figure 3. Mistnet station DP1 at Dos Palmas Preserve. Note the short stakes with decoy stuffed cowbirds. A speaker playing cowbird vocalizations is located at the base of the central decoy stake.

RESULTS

Cowbird Trapping:

A total of 55 cowbirds were trapped at the two Whitewater Delta traps (Table 3). This includes 22 males, 15 females, and 18 juveniles. Two males banded in 2017 were regularly trapped and released throughout the duration of the season (see further discussion below). This compares to 17 males, 5 females, and 53 juveniles trapped at the same locations in 2017. The traps in 2017 were left open through 21 July, and therefore had twelve more days of trapping time during July which is the peak of the juvenile fledging period to capture juvenile cowbirds. The 2018 trapping was more effective in catching adult cowbirds, especially breeding females (15 in 2018 vs. 5 in 2017).

Table 3. Summary of cowbird trapping data, Whitewater Delta, 2018. Numbers do not include recaptures.

Totals	Males	Females	Juveniles	Totals	Bycatch	Dates
WW 1						
collected	12	11	12	35		
released	2	0	0	2		
Trap Total	14	11	12	37	12 GAQU; 1 ABTO	5 April - 9 July
WW 2						
collected	8	4	6	18		
Trap Total	8	4	6	18	None	5 April - 9 July
Both Traps	**22**	**15**	**18**	**55**		

Non-target birds captured and released, included a single Abert's Towhee (*Melozone aberti*), and twelve Gambel's Quail (*Callipepla gambelii*). On one occasion a covey of eight juvenile Gambel's Quail were found and released from trap WW1, and on another occasion four juveniles were found and released as well. One western diamondback rattlesnake (*Crotalus atrox*) was found and removed from WW2 on 30 May (Figure 4).

Figure 4. Western diamondback rattlesnake found and removed from WW2 on 30 May by Field Technician Marco Combs.

Dos Palmas Mistnetting:

Only two cowbirds, one male and one female, were captured and collected at Dos Palmas in 2018 (Table 4, Figures 5-6).

Table 4. Dates, Times, and Captures at Dos Palmas Mist-Net Stations in 2018.

Date	Site	Net Open	Captures
4/16	Net A	0715-0845	No captures; 3 BHCO flew over heading north
4/30	NA	NA	No mistnetting-too windy
5/14	Net 1	0620-0830	1♀ BHCO collected; HETH, WIWA, 2 SWTH
5/14	Net 2	0640-0850	SWTH; No BHCO detected
5/14	Net 3	0920-1035	1 ♂ collected; SWTH
5/14	Net 4	0930-1025	No captures; 6 ♂ BHCO observed near house
5/29	Net 1	0620-0815	No captures; No BHCO detected
5/29	Net 2	0635-0805	No captures; No BHCO detected
5/29	Net 3	0835-0958	No captures; 2 ♂ 1 ♀ BHCO at net for 20 minutes
5/29	Net 4	0840-0958	No captures; No BHCO detected
6/11	Net 1	0830-1010	No captures; No BHCO detected
6/11	Net 2	0845-0955	No captures; No BHCO detected
6/11	Net 3	0640-0805	No captures; 4 ♂ 1 ♀ BHCO in area
6/11	Net 4	0635-0800	No captures; 4 ♂ 1 ♀ BHCO in area
6/25	Net 1	0755-0850	No captures; No BHCO detected
6/25	Net 2	0815-0910	No captures; No BHCO detected
6/25	Net 3	0620-0720	No captures; No BHCO detected
6/25	Net 4	0630-0730	No captures; No BHCO detected

BHCO: Brown-headed Cowbird; HETH: Hermit Thrush; WIWA: Wilson's Warbler; SWTH: Swainson's Thrush. All non-cowbirds captured in mistnets were immediately released.

Figure 5. Breeding female cowbird at Dos Palmas Preserve.

The two captures in five field days at Dos Palmas in 2018 compares with nine captures, including only one adult female, in 86 days of trapping in 2017. In 2018, Brown-headed Cowbird numbers were noted to be low at Dos Palmas with up to six cowbirds observed flying around the area, but many netting sessions ended with no cowbirds observed. Only one to two breeding female cowbirds were noted in any given day.

Figure 6. Adult male cowbird at Dos Palmas Preserve

Parasitism observations:
Two instances of Brown-headed Cowbird parasitism were observed. On 6 June a juvenile cowbird in the trap at WW2 was observed to be fed through the trap mesh by an adult Bewick's Wren (*Thryomanes bewickii*). On 25 June a fledgling cowbird was observed being fed by a Black-tailed Gnatcatcher (*Polioptila melanura*) along the channel near Lincoln Street.

Specimens:
Four collected cowbirds have been prepared as specimens and accessioned into the research collections of the SDNHM (Table 5, Figure 7).

Table 5. Four specimens were accessioned in the research collection of the SDNHM.

Catalog #	Sex	County	Locality	Date
55693	M	Riverside	Whitewater R. 4.0 mi. SSE Mecca	16 Apr 2018
55694	M	Riverside	Whitewater R. 4.0 mi. SSE Mecca	16 Apr 2018
55698	F	Riverside	Whitewater R. 4.0 mi. SSE Mecca	16 Apr 2018
56008	F	Riverside	Whitewater R. 4.0 mi. SSE Mecca	29 May 2018

Figure 7. Specimens prepared for accession into the research collection. Note the bottom specimen which was extremely large and may represent the Great Basin subspecies *Molothrus ater artemisiae*.

Recaptured Banded Cowbirds:

Two male Brown-headed cowbirds that had been banded in 2017 were routinely trapped and released throughout the 2018 season. The first (#1751-48124; Figure 8) was recaptured on 14 April at WW1 and continuously re-captured and released daily until the traps were closed on 9 July. This bird had been originally banded at Dos Palmas Preserve on 13 July, 2017, and thus had moved the 14 miles between the two sites. The second (#1891-29110) was first recaptured 29 May and continuously re-trapped and released daily until the traps were closed on 9 July. This bird had been banded from trap WW1 on 21 July 2017.

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Figure 8. Banded male cowbird (1751-48124) captured and released at Whitewater trap WW1. The male, first banded in 2017 at Dos Palmas Preserve, was captured and released nearly daily throughout the duration of the 2018 trapping season.

DISCUSSION AND RECOMMENDATIONS

The cowbird trapping at Whitewater Delta removed 53 cowbirds from the population, including fifteen breeding females. Given the high number of both adult and juvenile cowbirds captured in the second season of trapping, we recommend continuing these traps at the same two locations in 2019. The cowbird population in this area is large and will require a sustained trapping effort to reduce the numbers. This area support numerous Yellow-breasted Chat territories, and is suitable breeding habitat for other focal riparian bird species including Yellow Warbler and Least Bell's Vireo.

In contrast to the Whitewater Delta, the Dos Palmas Preserve is host to very few cowbirds, with never more than two females observed in the Preserve in a given field day in 2018. Because of the low numbers of cowbirds observed and captured at Dos Palmas Preserve in 2018, it is recommended that cowbird control be suspended at this site in 2019.

Remaining funding would be better spent in establishing a third trap location in the Whitewater Channel, ideally a few miles farther north of WW2. With over 17 miles of riparian habitat in the Whitewater Channel from the water source at the Valley Sanitary District Treatment Plant in Indio down to the Salton Sea, there is significant potentially suitable habitat for target riparian species in this portion of the Coachella Valley.

It would also be advisable to try to further document cowbird parasitism events in the Whitewater Channel. This could be accomplished in conjunction with further survey efforts in the Channel to better document the population of Yellow-breasted Chat in the region. Survey work in 2014 documented Yellow-breasted Chat breeding in only two sites in the Coachella Valley: Chino Canyon with one territory, and the Whitewater Delta with 7-10 territories from Lincoln St. to the Salton Sea (Hargrove et al. 2014). No survey work was conducted north of Lincoln St. in 2014, though one singing Yellow-breasted Chat was heard consistently near the WW2 cowbird trap in 2018. The total size of the Chat population in the Whitewater Channel is therefore unknown. The potential occurrence of other target riparian bird species such as Least Bell's Vireo or Yellow Warbler within this portion of the Whitewater Channel is also unknown. Should these species be found, specific areas of the Channel can be identified for focused management.

ACKNOWLEDGMENTS

Cowbird management in 2018 was conducted by Tracy Thomas, Marco Combs, and Kevin Clark. Joel Miner and Bill Pope facilitated access to Dos Palmas Preserve. Brett Daniels of the Coachella Valley Water District and Alberto Ramirez from the Torres-Martinez tribe facilitated access to the Whitewater Delta. Funding was provided through contract with the Coachella Valley Conservation Commission, and supported in part through the Natural Community Conservation Planning Local Assistance Grant Agreement P1582109. Kathleen Brundige facilitated site access and overall contract management.

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