2024 CVCC ANNUAL REPORT

Coachella Valley Multiple Species Habitat Conservation Plan
Natural Community Conservation Plan
Published March 2025

Table of Contents

List of Figures

List of Tables

Introduction

This Annual Report describes the progress made on implementation of the Coachella Valley Multiple Species Habitat Conservation Plan for the 2024 calendar year. Acquisition of key properties continued, with 265 acres added to the reserve system to protect habitat for native plants and animals. The CVCC acquired all those acres. Participating agencies have made significant progress since the Plan's inception, with over 100,000 acres conserved in just 12 years. Authorized disturbance in conservation areas remains infrequent: three acres of disturbance took place in 2024, and only 473 acres have been developed since baseline planning began in 1996. Development outside the conservation areas, including important road projects, water infrastructure, and housing development, continued through the streamlined process facilitated by the Plan.

Following Tropical Storm Hilary in August 2023, CVCC coordinated with Permittees on a number of emergency repair activities for damaged infrastructure within the Plan area. Many of the repair activities incorporated improvements to enhance flood resiliency, and CVCC provided guidance on ensuring these improvements also facilitated wildlife connectivity and fluvial sand transport, among other goals and objectives of the CVMSHCP. Unfortunately, both the storm itself and the associated emergency repair activities had a major impact on burrowing owl habitat within the Plan area. Burrowing owl was nominated for listing under the California Endangered Species Act in the fall of 2024; CVCC staff will continue to provide guidance to Permittees on the ramifications of its potential listing.

CVCC coordinated two like exchanges over the course of 2024. The first, proposed by the Coachella Valley Water District, will facilitate flood control activities in the Whitewater Floodplain Conservation Area, while the second, proposed by the City of Coachella, will allow for the buildout of a master-planned community on the outskirts of the East Indio Hills Conservation Area. Additionally, CVCC negotiated a transfer of conservation objectives between the City of La Quinta and the County of Riverside as part of finalizing the Peninsular Bighorn Sheep Barrier Fence project. Finally, CVCC successfully negotiated the reimplementation of the tipping fee, which will enhance revenue streams for management and monitoring activities.

Biological monitoring activities continue to gather important data on covered species, including tracking Peninsular bighorn sheep use patterns around the recently completed La Quinta fence, initiating studies for the genetic analysis of small mammals and remote tracking of wildlife migration patterns through the Coachella Valley, and assessing connectivity under Interstate 10. The information gathered through the biological monitoring program helps to better manage reserve lands and ensure the survival of the 27 plant and animal species the Plan is charged with protecting.

On the land management side, the Desert Recreation District maintained fencing and signage throughout the conservation areas. Crews from the Uban Conservation Corps removed invasive tamarisk from our properties in the Willow Hole Conservation Area and cleared encampments from the Palm Hills properties in the Santa Rosa and San Jacinto Mountains Conservation Area. The Living Desert assisted CVCC in seed collection and propagation, while CVCC staff took on management duties for the Low Desert Weed Management Area collaborative effort.

We appreciate the support of the members of the CVCC, partners agencies, and non-profit collaborators for the ongoing success of this visionary Plan.

PLAN BACKGROUND

The Coachella Valley Multiple Species Habitat Conservation Plan/Natural Community Conservation Plan (CVMSHCP) is a multi-agency conservation plan that provides for the long-term conservation of ecological diversity in the Coachella Valley region of southern California. The CVMSHCP includes an area of approximately 1.1 million acres and incorporates the watersheds within the jurisdictional boundaries of the Coachella Valley Association of Governments (CVAG). Tribal lands are not included in the CVMSHCP although coordination and collaboration with tribal governments has been ongoing. State and federal permits were issued in October 2008 and run for a 75-year term, during which the CVMSHCP is expected to be fully implemented and funded.

The CVCC was established in 2008 to oversee CVMSHCP implementation, and is comprised of elected officials from Riverside County, the cities of Cathedral City, Coachella, Desert Hot Springs, Indian Wells, Indio, La Quinta, Palm Desert, Palm Springs, and Rancho Mirage, as well as the Coachella Valley Water District, Mission Springs Water District, and the Imperial Irrigation District. The Riverside County Flood Control and Water Conservation District, Riverside County Regional Park and Open Space District, and Riverside County Waste Resources Management District are also members, as are the California Department of Parks and Recreation, the Coachella Valley Mountains Conservancy (CVMC), and the California Department of Transportation (Caltrans). Collectively, with the addition of the Coachella Valley Association of Governments (CVAG), these entities constitute the CVMSHCP Permittees.

The CVMSHCP established a Reserve System to ensure the conservation of 27 Covered Species, 23 natural communities, and 3 Essential Ecological Processes in perpetuity. This Reserve System consists of 21 priority Conservation Areas built around existing protected lands managed by local, state, or federal agencies and non-profit conservation organizations.

To complete the assembly of the Reserve System, lands are acquired or otherwise conserved (1) by the CVCC directly on behalf of the Permittees, (2) through state and federal agencies to meet their obligations under the CVMSHCP, or (3) through complementary conservation, whereby lands are acquired to consolidate public ownership in areas such as Joshua Tree National Park and the Santa Rosa and San Jacinto Mountains National Monument. Complementary conservation is not a Permittee obligation but does benefit the Plan.

In addition to acquisition, land in the Reserve System may be conserved through dedication, deed restriction, granting of 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 100,800 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 CVMSHCP Reserve System.

This Annual Report describes the activities for the calendar year from January 1, 2024, to December 31, 2024. As required by Section 6.4 of the CVMSHCP, this Annual Report will be presented at the CVCC meeting on April 10, 2025, which will serve as a public workshop. The report is also posted and available to the public on the CVMSHCP website, www.cvmshcp.org.

Reserve Assembly Progress

As of December 31, 2024, Permittees have conserved 18,577 acres, just over 18% of their conservation goal (Figure 1). State and federal conservation has reached 28,950 acres, or about 73% of their required contribution, and complementary conservation has accounted for 57,213 acres, about 83% of the anticipated acreage. Since 1996, 104,740 acres have been conserved under the CVMSHCP, with the assembly of the Reserve System just under 50% complete (Table 1, Figure 2). A description of how CVCC allocates acreage credit is included in Appendix I.

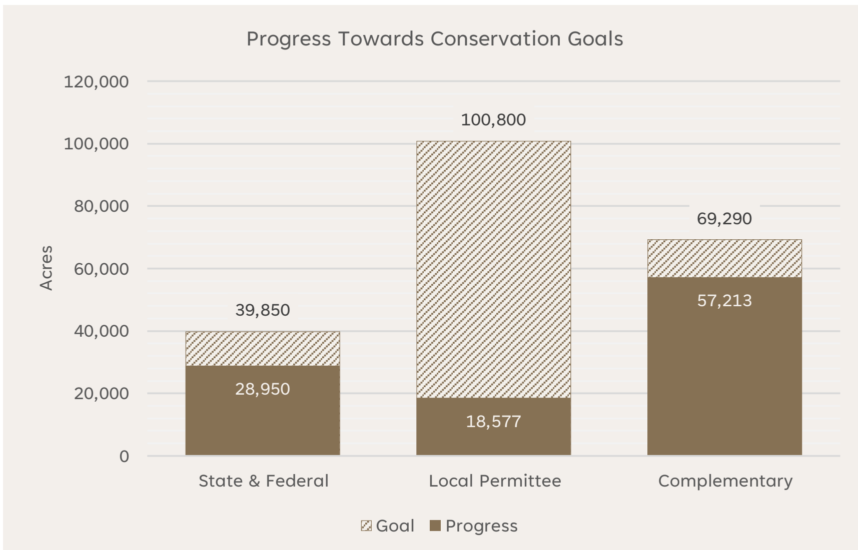


Figure 1: CVMSHCP conservation progress towards conservation goals

Table 1: Summary of annual progress on Reserve System assembly

Report Year	State & Federal	Local Permittee	Complementary	Total Acres
2013	24,947	7,605	49,638	82,190
2014	1,291	241	1,417	2,949
2015	300	350	1,127	1,778
2016	319	827	669	1,816
2017	446	793	1,699	2,938
2018	711	584	1,115	2,411
2019	747	346	110	1,203
2020	0	2,104	202	2,306
2021	128	849	1,156	2,133
2022	60	3,480	30	3,570
2023	0	1,132	50	1,182
2024	0	265	0	265
Acquisition Credit	28,950	18,577	57,213	104,740
Management Credit	54,969	25,488	24,282	104,740

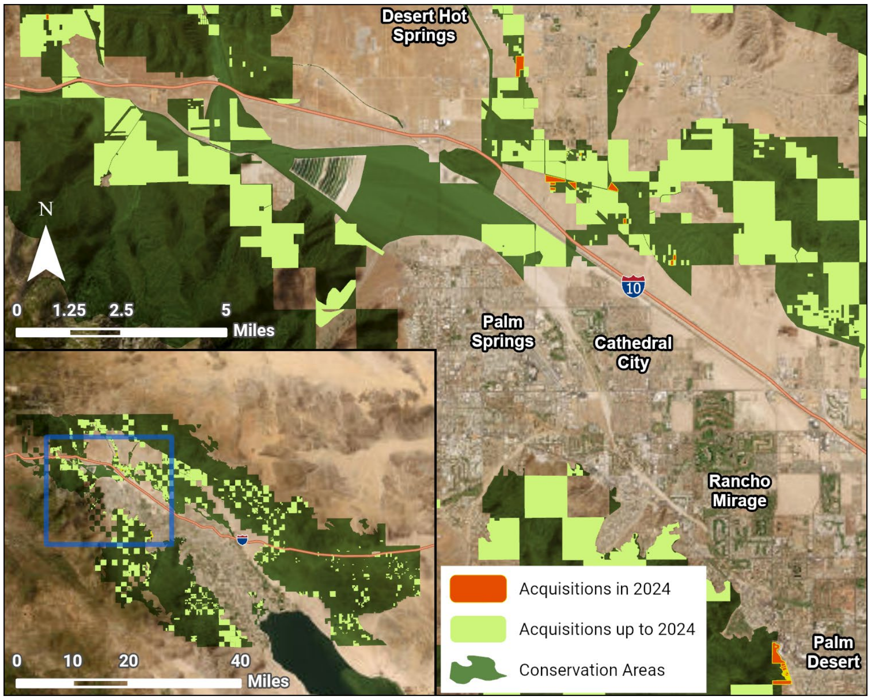


Figure 2: CVMSHCP reserve assembly status, including 2024 acquisitions

Once acquired, lands within the Reserve System are held in public or private ownership and are managed for habitat conservation and open space values. Land acquired under complementary conservation is often transferred in fee to either a state or federal agency or to CVCC for long term management. Management of these lands contributes to the conservation of the Covered Species and the conserved natural communities included in the Plan.

LAND ACQUISITION

In 2024, CVCC completed 10 transactions acquiring 13 parcels totaling 148 acres at a cost of $3,182,439 in CVCC funds and including two donated properties worth $22,800 (Table 2). In addition to these fee title acquisitions, CVCC also received a conservation easement from the City of Palm Desert covering 116 acres in the Santa Rosa and San Jacinto Mountains Conservation Area, including parcels containing the Bump and Grind trailhead. CVCC conservation on behalf of local Permittees occurred predominantly in the Santa Rosa and San Jacinto Mountains Conservation Area, as well as four other Conservation Areas (Figure 3). Local, state, and federal partners did not acquire any additional acres. All lands conserved pursuant to the CVMSHCP during the period from January 1, 2024 to December 31, 2024 are depicted in Figure 2 and listed in Appendix II.

CVCC acquires lands with funding from CVMSHCP's Local Development Mitigation Fee on private development as well as public agency contributions to mitigate for regional roads and other transportation projects (Figure 5). Significant federal funding has been provided by the U.S. Fish and Wildlife Service (USFWS) through the Cooperative Endangered Species Conservation Fund. State funding includes grants made to the CVCC and conservation partners by the CVMC, Wildlife Conservation Board (WCB) and Caltrans' Environmental Enhancement and Mitigation (EEM) program. The non-profits

Friends of the Desert Mountains and Oswit Land Trust have acquired lands using grants from CVMC, private donations, and other sources; many of these lands have been transferred to CVCC or to the Bureau of Land Management (BLM).

Table 2: Lands acquired by CVCC in 2024

Project	**Conservation Area**	**Parcels**	**Acreage**	**Cost**
Hill	Long Canyon	1	1	$0
Palm Desert Bump and Grind Trailhead	Santa Rosa / San Jacinto Mountains	34	116	$0
Larkin	Stubbe and Cottonwood Canyons	1	5	$65,000
Halperin	Upper Mission Creek/Big Morongo Canyon	1	49	$580,000
Jarvis	Willow Hole	1	0	$30,000
Johnston	Willow Hole	1	5	$0
Kading	Willow Hole	4	56	$1,909,180
Pador	Willow Hole	1	5	$15,000
Rockland	Willow Hole	1	5	$15,000
Sirelson	Willow Hole	1	21	$538,259
Stills	Willow Hole	1	1	$30,000
Total		**47**	**265**	**$3,182,439**

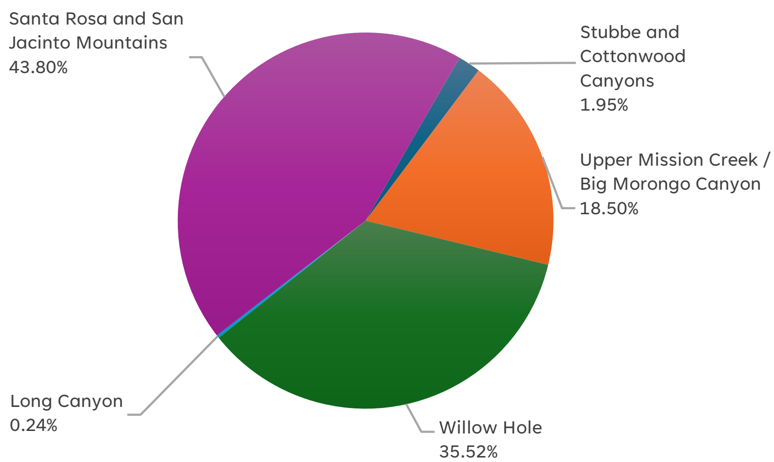


Figure 3: Proportional acquisitions in 2024 by Conservation Area

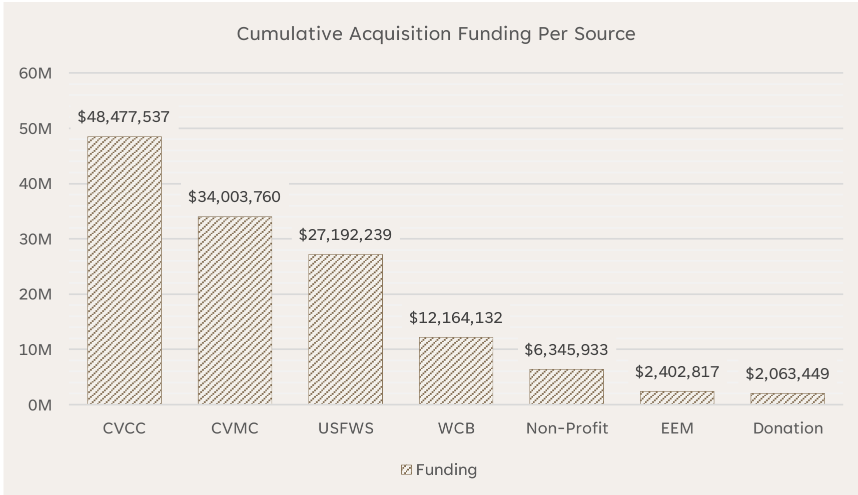


Figure 4: Cumulative acquisition funding per source

CVCC continues to improve and revise its land ownership database, which includes all property interests that count towards Permittee conservation obligations under the CVMSHCP. Through this iterative auditing process, CVCC is able to capture errors in acreage allocation, update lot-line adjustments, and update ownership information, which can cause some amount of fluctuation in the total acreages reported from year to year. In 2024, auditing efforts identified that the above conservation easement, begun in 2013, had never been finalized, despite being included in previous acreage totals. Conversely, CVCC also identified the previous inclusion of parcels that were subsequently subject to subdivision and had over-reported the amount of conservation achieved. In addition to maintaining its own records, CVCC is constantly coordinating with conservation partners to ensure that external records are as accurate as possible.

LAND IMPROVEMENT

In 2024, the CVCC acquisitions manager performed pre-acquisition site inspections and job walks on 13 parcels in multiple Conservation Areas. During these inspections, the land acquisitions manager identified illegal dumping, hazardous conditions, OHV and equestrian activity, and the existence of listed species, as well as determined property fencing requirements. As per CVCC's standard purchase and 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 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 that additional work will be necessary. After closing, CVCC monitors the sites at least annually for ongoing management and fencing requirements.

This year, CVCC was directly responsible for removing an estimated 8.09 tons of refuse, including 7 tires, from conservation lands, generating over $9,337 in contractor revenue from sellers' property sales.

Status of Conservation Areas

To ensure the persistence of Covered Species and natural communities, the CVMSHCP includes specific acreage requirements for both the amount of authorized disturbance that can occur and the acres of habitat that must be conserved within each Conservation Area. These acreage requirements provide one measure of progress toward meeting the conservation objectives for each Covered Species, natural community, and Essential Ecological Processes in the Plan. The planning process for the CVMSHCP began on November 11, 1996, which serves as the baseline date for the authorized disturbance and conservation acreages listed throughout the CVMSHCP document.

This report updates the authorized disturbance and conservation acreages for each of the Conservation Areas through December 31, 2024 (Table 3). In certain cases, disturbance may be permitted by the CVMSHCP but not accrue against the authorized disturbance for a given Conservation Area. These cases include disturbance where the only conservation objective is to maintain fluvial sand transport processes, disturbance incurred as part of a Covered Activity, and disturbance allocated to Participating Special Entities or to Permittees for non-Covered Activities lacking take authorization. For the latter two instances, disturbance is allocated directly from the CVMSHCP permits. In 2024, three acres of authorized disturbance took place within the Conservation Areas. To date, approximately 473 acres of disturbance have taken place within the Reserve System boundaries. As previously discussed, 265 acres of conservation were recorded.

This space intentionally left blank.

Table 3: Conservation and authorized disturbance within Conservation Areas

Conservation Area	Conservation Goal	Conserved in 2024	Conserved to Date	Disturbed 2024	Disturbed to Date
Cabazon	2,340	0	0	0	0
Coachella Valley Stormwater Channel and Delta	3,870	0	882	0	5
Desert Tortoise Linkage	46,350	0	7,006	0	1
Dos Palmas	12,870	0	4,690	0	0
East Indio Hills	2,790	0	35	0	0
Edom Hill	3,060	0	2,120	0	2
Highway 111/I-10	350	0	156	0	0
Indio Hills Palms	2,290	0	1,040	0	0
Indio Hills/JTNP Linkage	10,530	0	9,013	0	6
Joshua Tree National Park	35,600	0	13,171	0	0
Long Canyon	0	1	15	0	0
Mecca Hills/Orocopia Mountains	23,670	0	8,410	0	0
Santa Rosa & San Jacinto Mountains	55,890	116	36,011	0	9
Snow Creek/Windy Point	2,340	0	907	0	0
Stubbe and Cottonwood Canyons	2,340	5	698	0	20
Thousand Palms	8,040	0	6,171	0	46
Upper Mission Creek/Big Morongo Canyon	10,810	49	7,603	0	76
West Deception Canyon	1,063	0	1,965	0	0
Whitewater Canyon	1,440	0	957	0	5
Whitewater Floodplain	4,140	0	1,166	0	98
Willow Hole	4,920	94	2,721	0	0
Fluvial Sand Transport	NA	NA	NA	0	18
Direct Permit Take	NA	NA	NA	3	187
Total	234,703	265	104,740	3	473

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. The Rough Step value for Other Conserved Habitat for Coachella Valley Jerusalem cricket within the Riverside County portion of the Upper Mission Creek/Big Morongo Canyon Conservation Area is negative, indicating that development is outpacing conservation for that Conservation Objective. CVCC will prioritize acquisitions to rectify this imbalance over calendar year 2025, but until adequate conservation acres have been acquired, further development by Riverside County in Jerusalem cricket habitat within the Upper Mission Creek/Big Morongo Canyon Conservation Area would be deemed inconsistent with CVMSHCP objectives; appropriate mitigation measures – up to and including land conservation – for any such proposed development would need to be identified through the Joint Project Review process.

COVERED ACTIVITIES OUTSIDE CONSERVATION AREAS

The CVMSHCP allows for development and other Covered Activities outside the Conservation Areas which do not have to meet the stringent measures required for development within the Conservation Areas. An accounting of the acres of Core Habitat and Other Conserved Habitat for the Covered Species and natural communities that have been developed or otherwise 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 is subject to review under the 1996 Memorandum of Understanding that began the planning process for the CVMSHCP. For development outside Conservation Areas, estimated development acreages between 1996 and 2016 were 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. The coverages provided by the Farmland Mapping and Monitoring Program have not been updated since 2016, and so CVCC has instead utilized imagery provided by the Sentinel-2 10-meter Land Use/Land Cover Time Series for the period between 2017 and 2023, the most recent date for which data is available. The acre figures in Appendix IV are the sum of the two datasets, which gives an estimate of all development impacts between 1996 to 2023. CVCC continues to assess remote sensing technologies and applications to better track development outside of the CVMSHCP-designated Conservation Areas.

Biological Monitoring Program

In 2024, CVCC undertook several critical projects aimed at enhancing wildlife conservation and habitat management within the Coachella Valley. CVCC completed the La Quinta Peninsular Bighorn Sheep Barrier Fence project, engaged in data management activities related to the Peninsular bighorn sheep, received grants for genetic analysis of small mammals and the Motus Wildlife Tracking System project, and initiated the Wildlife Connectivity Assessment for Interstate 10 project. These projects collectively aimed to improve habitat connectivity, protect endangered species, and inform wildlife managers in the region.

WILDLIFE CONNECTIVITY ASSESSMENT

In 2024, CVCC made significant strides in the Wildlife Connectivity Assessment for Interstate 10 and Closely Associated Transportation Infrastructure in the Banning Pass project. This initiative aims to study wildlife movement and behavior, focusing on the effectiveness of habitat corridors. Cameras were placed at various locations starting in April 2024; 40 species have since been identified from the camera images. CVCC staff deployed 18 tracking plates in these underpasses and collected tracking prints 5 times per quarter starting in July 2024. This data will be used to guide future infrastructure designs to benefit wildlife linkages.

PENINSULAR BIGHORN SHEEP DATA MANAGEMENT AND BARRIER FENCE

CVCC also focused on data management activities related to Peninsular bighorn sheep. A data sharing agreement with the California Department of Fish and Wildlife (CDFW) was signed in October 2024, allowing the acquisition of normalized difference vegetation index (NDVI) data sets from Sentinel-2 satellite measurements. This data will be used to reconstruct habitat models and produce final models with recommendations for a trail management plan. The project timeline was extended to December 31, 2024, to accommodate these tasks.

The La Quinta Peninsular Bighorn Sheep Barrier Fence project, initiated in October 2022, was completed in January 2024. This fence aims to prevent injuries and deaths from urban-related dangers such as drowning, toxic plant ingestion, and vehicle strikes. CVCC worked with USFWS and CDFW to develop an inspection and maintenance plan for the fence, ensuring its effectiveness in protecting the endangered Peninsular bighorn sheep.

GENETIC ANALYSIS OF SMALL MAMMALS

In July 2024, CVCC received a $75,000 grant from CDFW for the Genetic Analysis to Test Effectiveness of Linkages for Corridor Dwelling Small Mammals project. This project aims to study habitat corridors and threats to species like the Palm Springs pocket mouse and Coachella Valley round-tailed ground squirrel. The project involves trapping at 12 sites, collecting blood and environmental DNA (eDNA) samples, and comparing data with wildlife camera footage. The final report is expected by March 2027.

MOTUS WILDLIFE TRACKING SYSTEM PROJECT

CVCC also received a $94,482 grant from CDFW for the Motus Wildlife Tracking System project, proposed to track the movement and behavior of up to 12 species covered by the CVMSHCP. This project, starting in March 2025, will help gather movement data and assess the feasibility of using Motus tags for various species. The project is expected to conclude by March 2027.

DESERT TORTOISE GENETICS RESEARCH AND FIELD DATA COLLECTION

In 2024, CVCC continued to work with the University of California, Riverside researcher, Dr. Brian Jennings, to complete the research project schedule for the Genetic Structure and Evolutionary History of Desert Tortoises in the Western Sonoran Desert Using a Conservation Genomics Approach study. This study builds on previous work by examining the genetic structure and gene flow between tortoise populations in the Santa Rosa Mountains and the San Gorgonio Pass region near Whitewater. Using restriction-site associated DNA sequencing data, the study will determine the extent of gene flow among tortoise populations, infer the colonization timeline of the Santa Rosa Mountains, and estimate the genetic diversity of the Santa Rosa population. The initial findings have been presented to the Reserve Management Unit Committee and Reserve Management Oversight Committee.

From July 10 to September 11, 2024, US Geologic Survey (USGS) desert tortoise research activities included field data collection and manuscript preparation. Collaborative efforts at the Mesa and Deep Canyon study sites involved working with biomonitors during construction to track tortoise movements and prevent harm. Visits to the Mesa site were conducted to track tortoises, including replacing a lost radio transmitter. Legacy data from 1991-1992 was reviewed, revealing a decline in the tortoise population. At the Deep Canyon site, collaboration with site staff and students facilitated data collection from trail cameras and tracking of tortoises, with a notable increase in hatchlings and juveniles, likely due to favorable weather conditions in recent years.

Additionally, manuscripts, including a resubmission to Ecosphere and a paper on Peninsular bighorn sheep behavior, were submitted to scientific journals. The agreement between USGS and CVCC concluded at the end of August. The team remains hopeful for the acceptance and publication of their research papers in the near future. These efforts highlight the importance of ongoing research and collaboration in understanding and conserving desert tortoise populations and other Covered Species.

RESEARCH COORDINATION AND ADVISORY ROLES

From January to March 2024, Dr. Lynn Sweet and her team at the University of California Riverside's Center for Conservation Biology coordinated various research activities and provided scientific advisory on the CVMSHCP. They attended multiple committee meetings, presented their biological monitoring program, and submitted a final report for FY2024 (Appendix V). The team completed perennial shrub monitoring, conducted surveys for Coachella Valley milkvetch, giant sand-treader cricket, and aeolian annual plant communities, and continued refining datasets for climate resilience. They also held a meeting for the Low Desert Weed Management Area and planned a field trip to Dos Palmas Preserve.

From April to June 2024, the team continued their coordination and advisory roles, attending additional workshops and meetings while preparing final reports for the fiscal year ending in 2024. They executed a no-cost extension for their research project schedule and completed all remaining aeolian species monitoring surveys. The team also developed an ArcGIS data collaboration with CVCC, submitted conference abstracts, and created a volunteer newsletter. Their efforts included assisting with corrections to previously amended projects and preparing for the upcoming monitoring season, including planning for perennial plant surveys and other fall activities.

Throughout these months, the team focused on enhancing their research and monitoring capabilities. They worked diligently to refine their datasets for climate resilience, ensuring that their findings would contribute to the long-term conservation goals of the CVMSHCP. The collaboration on the ArcGIS platform further strengthened their ability to analyze and visualize ecological data, which is crucial for effective habitat management and conservation planning.

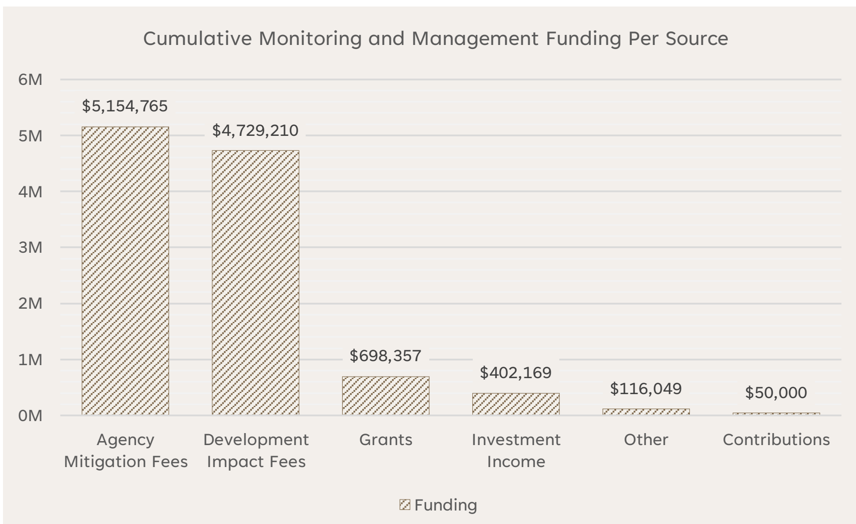


Figure 5: Cumulative monitoring and management funding per source

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 inter-agency Reserve Management Oversight Committee (RMOC) provides a forum for coordination of management and monitoring lands within the Reserve System and makes recommendations to the CVCC. The RMOC is supported by individual Reserve Management Unit Committees (RMUC) and Biological Working Groups (BWG).

SUMMARY OF COMMITTEE ACTIVITIES IN 2024

In 2024, the RMOC held several hybrid meetings (Table 4), focusing on updates regarding Reserve assembly and acquisitions, the biomonitoring program, and the land management program. Key topics included invasive species projects, the Peninsular bighorn sheep fence and drinker, ranger and enforcement initiatives, and various fencing, cleanup, and signage efforts. The committee also discussed the annual workplan, climate resiliency studies, and the 30x30 I-10 Undercrossing Study. Recommendations from these meetings were incorporated into the CVCC budget for the fiscal year.

The RMUC and BWGs held joint meetings throughout the year to facilitate coordinated management and monitoring efforts. Discussions included the status of the aeolian sand community, climate resiliency, desert tortoise monitoring and genetics, and the 30x30 I-10 Wildlife Connectivity project. The committee also addressed invasive species management, fencing, signage, and cleanup projects, as well as the peninsular bighorn sheep fence and guzzler. These meetings seek to align monitoring protocols with research goals and management needs.

The Trails Management Subcommittee (TMS) held multiple hybrid meetings in 2024, focusing on trails management, enforcement of dog ordinances, outreach to the cycling community, and e-bike issues. The subcommittee worked on Palm Hills trails management in the Santa Rosa and San Jacinto Mountains Conservation Area, the Peninsular Bighorn Sheep and Recreational Use research project, and the North Valley Trails Plan. They also discussed maintenance, safety signage, and the Conservation Ranger Initiative. The TMS collaborated with various organizations to address trail hazards and install clear directional and safety signage, ensuring the trails' safety and accessibility.

Table 4: Meeting dates for CVMSHCP oversight committees, 2024

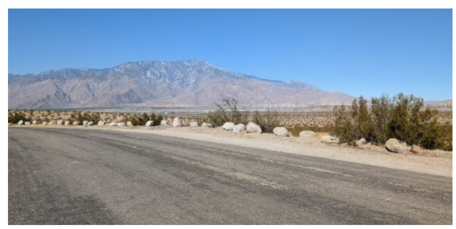
Reserve Management Oversight Committee	Jan 24, Apr 24, Oct 23
Reserve Management Unit Committee / Biological Working Group	Mar 12, Jun 11, Sep 10
Trails Management Subcommittee	Jan 17, Mar 20, May 15, Sep 18, Nov 20, Dec 10

PROPERTY MANAGEMENT AND MONITORING

In 2024, CVCC undertook extensive efforts to address various land management challenges and enhance habitat conservation within the Coachella Valley. Faced with significant issues such as illegal dumping, vandalism, off-highway vehicle (OHV) trespass, and encampments, CVCC implemented a range of strategies to mitigate these problems. This included applying for grant funding, collaborating with local organizations, and executing targeted cleanup and maintenance projects. The combined efforts of CVCC, the Desert Recreation District (DRD), the Urban Conservation Corps (UCC), and the Living Desert Zoo and Gardens were instrumental in maintaining and restoring the integrity and safety of the Conservation Areas.

LAND MANAGEMENT AND IMPROVEMENTS

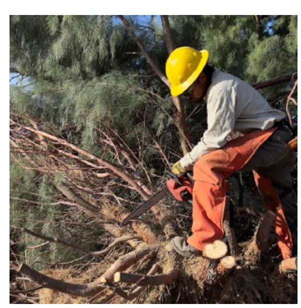
Throughout the year, DRD completed various work orders for CVCC, including fence repairs, trash removal, and general maintenance across multiple locations. Key tasks involved repairing damaged fences, removing dumped items and encampments, and installing boulders and barriers to prevent vehicle access. The team frequently traveled to sites in and around Palm Hills, Thousand Palms, and Desert Hot Springs to assess and complete these tasks. Detailed records of each work order, including dates, locations, and actions taken, were documented to ensure accountability and effective project management.

The UCC played a significant role in land management activities. In the beginning of January 2024, UCC spent four days repairing severely eroded conditions along the McManus Trail. On March 26, 2024, UCC conducted a clean-up operation in Palm Hills, successfully removing trash left by unhoused individuals and revisiting problematic areas. Additionally, graffiti present at the main gate was removed during the operation.

By the end of the year, UCC successfully completed two additional projects in collaboration with CVCC: a comprehensive clean-up initiative at Palm Hills and tamarisk re-treatments at Willow Hole. The clean-up operation addressed issues related to encampments, and the team collected approximately 67 cubic feet of trash. The tamarisk re-treatments involved systematic cutting and herbicide application to areas with new regrowth, treating a total of 1.61 acres.





HABITAT ENHANCEMENT

In 2024, CVCC collaborated with the Living Desert Zoo and Gardens' Conservation Department to advance several key projects aimed at enhancing habitat restoration and invasive plant management. Additionally, CVCC staff took on new roles and responsibilities to further support these initiatives, including coordinating the Low Desert Weed Management Area and developing a native tree nursery at North Shore Ranch. These comprehensive activities were designed to address the ecological challenges within the CVMSHCP area and ensure the long-term sustainability of the region's diverse habitats.

Throughout the year, the Living Desert Zoo and Gardens' Conservation Department advanced several projects for CVCC. These projects included invasive plant monitoring, assessing plant propagation facilities, seed collection, and sign design. Additionally, they focused on seed collection for a CVAG habitat restoration project for Casey’s June beetle, collecting 8.37 pounds of scalebroom seeds from various locations in the Coachella Valley. Despite challenges due to unusually hot weather, the team successfully propagated 250 desert willow and 125 smoketree plants. They also identified areas for invasive plant removal, assisted with installing wildlife camera traps, and grew 100 honey mesquites for future restoration in North Palm Springs, South Desert Hot Springs, and Mecca.

In July, CVCC took on the role of coordinator for the Low Desert Weed Management Area. This collaborative effort focuses on invasive plant detection and removal throughout the CVMSHCP boundaries. The group met in the fall to discuss an upcoming funding opportunity for invasive plant mapping and implementation, set to begin in early 2025.

CVCC staff continued their planning efforts to develop a native tree nursery at North Shore Ranch in the Coachella Valley Stormwater Channel and Delta Conservation Area. They visited similar nurseries at Joshua Tree National Park, Mojave Desert Land Trust, and the Living Desert Zoo and Gardens. Both short and long-term strategic plans were created to include a nursery, a public-private partnership with duck clubs, and a conservation training and education center on the 160-acre property. Native plants will be hardened on the property before being transplanted to their restoration sites throughout the CVMSHCP area.

These comprehensive efforts by the Living Desert Zoo and Gardens' Conservation Department and CVCC staff have significantly contributed to the advancement of habitat restoration and invasive plant management within the Coachella Valley. By focusing on seed collection, plant propagation, and the development of a native tree nursery, they have laid a strong foundation for future restoration projects. The collaborative initiatives, such as the Low Desert Weed Management Area, further demonstrate commitment to addressing ecological challenges and ensuring the long-term sustainability of the region's diverse habitats. Overall, these activities highlight the importance of coordinated conservation efforts and the positive impact they can have on preserving the unique ecosystems of the Coachella Valley.

Unauthorized Activities and Enforcement

The ongoing misuse of public lands continues to be documented, with abandoned vehicles reported to the appropriate agencies and instances of dumping, vandalism, and off-road damage recorded for future restoration efforts.

In March 2024, CVCC was awarded a Climate Resilience Community Action Grant by CVMC to support the establishment of a conservation ranger program. These funds enabled CVCC to hire a conservation ranger coordinator in August 2024 to lead the development of the enforcement entity.

To effectively deploy rangers, a regional ordinance must be adopted granting rangers the authority to issue and collect citations throughout the CVMSHCP boundary. The Coachella Valley Desert and Mountains Recreation and Conservation Authority (CVDMRCA), a joint powers authority between CVMC and DRD, is working with CVCC to draft the ordinance and determine adoption requirements. Input on the ordinance is being integrated from local partner agencies, conservation landowners and land managers, existing ranger programs, and wildlife and social service agencies. CVMC and DRD legal counsels have been engaged in identifying the ordinance adoption process and establishing the program's operational framework.

The conservation ranger program is being developed with a comprehensive framework to ensure effective enforcement, public engagement, and land stewardship. Key components of program design include establishing policies and procedures, procuring necessary equipment, defining certification and training standards, and creating a structured hiring process. Additionally, the program will develop interpretive materials to support public education and outreach efforts.

A core focus of the program will be addressing regional challenges such as unauthorized OHV use, illegal dumping, trail use conflicts, and the management of encampments on conservation lands. These strategies will be integrated into both enforcement and public education initiatives to promote responsible land use.

The initial ranger deployment is scheduled to launch in January 2026. By April 2026, CVCC anticipates having four rangers in place—two dedicated to enforcement and two specializing in interpretation and education. This phased implementation ensures a balanced approach, combining regulatory enforcement with proactive community engagement to support long-term conservation efforts.

Significant Issues in Implementation

In March 2024, a coalition of conservation advocates submitted a petition to list the western burrowing owl as threatened or endangered under the California Endangered Species Act, which petition was accepted by the California Fish and Game Commission in October 2024. While burrowing owl is a Covered Species under the CVMSHCP, its take authorization extends only to burrows and the land around them; individual burrowing owls are protected against take by California Fish and Game Code. While the CVMSHCP had upwards of 88 individuals and over 40 breeding pairs, much of the occupied habitat was along the banks of Mission Creek in the Upper Mission Creek/Big Morongo Canyon Conservation Area, which was destroyed during the floods and subsequent repair activities caused by Tropical Storm Hilary in 2023. Despite the habitat loss, CVCC continues to develop a long-term conservation strategy to ensure the protection of burrowing owl in the Plan area, and has contributed to CDFW's data collection efforts as the agency analyzes the species' health across the state ahead of a listing recommendation to the Fish and Game Commission in fall 2025.

In response to rising land costs, especially on the Valley floor where acquisition efforts have traditionally been focused, CVCC has revised its acquisition policy to allow for greater flexibility in identifying acquisition targets. The revised policy enables CVCC to identify parcels for acquisition on a rolling basis, taking into account local Rough Step, progress towards meeting Conservation Objectives, habitat sensitivity and vulnerability, and land management needs. Furthermore, CVCC will be exploring the possibility of a revised nexus study for its Local Development Mitigation Fee to accommodate not just increased acquisition costs, but rising management and monitoring costs as well.

The reinstatement of tipping fees at the Coachella/Indio Waste Transfer Station (C/I WTS) has been a significant step toward addressing previous years' funding gaps for the CVMSHCP. These fees are a critical revenue source for implementing conservation efforts, especially given the commitment outlined in the CVMSHCP to acquire and protect mitigation lands for permissible activities like solid waste facilities. The tipping fees had originally halted in June 2021 due to an administrative oversight and are now set to resume at $1 per ton starting July 1, 2025. Efforts are underway to address tipping fees in arrears (June 2021 to June 2025), with $557,661 already invoiced for June 2021–October 2024, to be paid from C/I WTS reserves once their Fiscal Year 2025-26 budget is approved.

Overlapping regulatory jurisdiction between the CVMSHCP and certain sections of the State of California Fish and Game Code continue to cause confusion among Permittees regarding resource coverage. The need for mitigation actions under these disparate programs and statutes is beginning to cause conflicts that ultimately affect the ability of CVCC to conserve habitat. CVCC is discussing this complexity with CDFW.

Permittee Compliance Status

Permittees requested a number of minor changes to the CVMSHCP that were processed over the course of 2024. The completion of the Peninsular Bighorn Sheep Barrier Fence project necessitated a transfer of conservation objectives between the City of La Quinta and the County of Riverside to ensure the City had sufficient take authorization to compensate for the loss of bighorn sheep habitat left inaccessible by the fence. CVCC negotiated a memorandum of understanding, executed by all parties by summer 2024. Upon receipt of all signatures, the transfer, which constitutes a minor amendment under the CVMSHCP, was provided to USFWS and CDFW for concurrence, and is anticipated to be implemented in 2025.

CVCC also entered into a memorandum of understanding (MOU) with the Coachella Valley Water District (CVWD) to progress a like exchange originally reviewed and approved by CVCC, USFWS, and CDFW in 2016. The like exchange would allow for the construction of a flood control facility underneath the Union Pacific Railroad bridge in the Whitewater Floodplain Conservation Area, and enhance sand transport from Mission Creek north of Interstate 10 into the Whitewater River channel south of the railroad bridge. The like exchange requires the transfer of certain properties within the project footprint to CVCC, which would complicate project buildout were the transfer to take place at the outset of the project. Instead, the MOU allows the project to move forward ahead of any land transfer, and obligates CVWD to provide the properties to CVCC upon project completion free of any disturbance caused by the facility. The transfer is expected to take place in 2026.

Finally, CVCC received a request from the City of Coachella to initiate a like exchange to address inherent CVMSHCP inconsistencies with a proposed master-planned community partially within the East Indio Hills Conservation Area. The City identified equivalent habitat around the Dos Palmas Conservation Area within the County of Riverside, and received concurrence on the proposed like exchange from USFWS and CDFW. The City and the County are expected to approve the like exchange in 2025, after which CVCC will implement the boundary adjustment to both Conservation Areas.

In addition to the above changes to the CVMSHCP, CVCC completed four Joint Project Reviews for proposed projects in the Upper Mission Creek/Big Morongo Canyon, Whitewater Floodplain, Thousand Palms, and West Deception Canyons Conservation Areas. These projects will be counted towards the CVMSHCP's authorized disturbance totals upon issuance of a grading permit.

Permittees are also complying with the funding requirements of the CVMSHCP by reporting their Local Development Mitigation Fee (LDMF) activity and remitting the revenue to CVCC monthly. CVCC reviews all LDMF reports and receipts. The LDMF generated $3,347,102 in Fiscal Year 2023/2024, representing a 5.07-percent decrease over the $3,526,026 generated in the previous fiscal year.

Expenditures

CVCC approved their Fiscal Year 2024/2025 budget (Table 5) at their June 13, 2024 meeting. Note that it differs from the budget for the CVCC as a whole, which includes non-CVMSHCP program funding from the ILF program, endowments for conservation easements required by state lake and streambed alteration agreements, and funding for monitoring of Casey's June beetle.

ANNUAL AUDIT

The audit of the expenditures for the period July 1, 2023 to June 30, 2024 was approved by CVCC on January 9, 2025. The financial report is 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 74-199 El Paseo Dr., Suite 100, Palm Desert, CA 92260. Annual CVCC audits are available at https://cvag.org/cvcc-financial-reports/.

This space intentionally left blank.

Table 5: CVMSHCP Budget for Fiscal Year 2024-2025

	Endowment	General Administration	Land Acquisition	Lizard Endowment	Management & Monitoring	Management Contingency	Travertine Point Monitoring	Total
Beginning Balance	$15,348,038	$-	$18,785,835	$346,699	$454,371	$2,357,808	$566,207	$40,193,380
Revenues / Funding Source								
County Tipping Fees	$-	$300,000	$-	$-	$-	$-	$-	$300,000
Development Mitigation Fees	$-	$-	$2,605,421	$-	$533,641	$-	$-	$3,139,062
Agencies Mitigation Fees	$911,032	$-	$1,168,268	$-	$-	$-	$-	$2,079,300
CA Fish & Game	$-	$-	$-	$-	$641,238	$-	$-	$641,238
Friends of the Desert Mountains	$-	$-	$-	$-	$80,000	$-	$-	$80,000
Other Revenue	$-	$-	$-	$-	$18,000	$-	$-	$18,000
Advertising Revenue	$-	$-	$103,357	$-	$7,500	$-	$-	$110,857
Investment Income	$-	$-	$-	$-	$3,500	$-	$-	$3,500
Total Revenues / Funding Source	$428,185	$3,572	$539,979	$9,645	$14,391	$91,113	$15,751	$1,124,339
Expenditures / Expenditure								
Professional Services	$-	$102,020	$84,000	$-	$1,068,000	$-	$-	$1,278,020
Meeting Attendance Stipends	$-	$12,967	$-	$-	$-	$-	$-	$12,967
Office Operations	$-	$28,000	$-	$-	$31,752	$-	$-	$59,752
LDMF Admin Fee	$-	$-	$26,054	$-	$5,336	$-	$-	$31,391
Land Management Costs	$-	$-	$196,000	$-	$92,500	$-	$-	$288,500
Land Acquisitions	$-	$-	$3,967,000	$-	$-	$-	$-	$3,967,000
CVAG Admin Reimbursement	$-	$790,740	$133,473	$-	$746,810	$-	$-	$1,683,141
Operating Transfers In	$-	$(630,154)	$-	$-	$(730,062)	$-	$-	$(1,360,216)
Operating Transfers Out	$1,360,216	$-	$-	$-	$-	$-	$-	$1,360,216
Capital Outlay	$-	$-	$-	$-	$10,000	$-	$-	$10,000
Total Expenditures / Expenditure	$1,360,216	$303,572	$4,406,527	$-	$1,224,336	$-	$-	$7,330,770
Net Excess (Deficit)	$(21,000)	$(0)	$10,498	$9,645	$73,934	$91,113	$15,751	$165,526
Ending Balance	**$15,327,038**	**$(0)**	**$18,796,333**	**$356,344**	**$528,305**	**$2,448,921**	**$581,958**	**$40,358,906**

Appendix I: Acquisition and Management Credit Allocation

ACQUISITION CREDIT

In general, allocation to Federal and State, Permittee, or Complementary conservation is determined by the source of the acquisition funding, with the following modifications:

1. Purchases with state or federal funding that overlap with Joshua Tree National Park, Santa Rosa and San Jacinto National Monument, or the Mecca Hills and Orocopia Mountains Wilderness Area will be considered complementary conservation. Purchases within these areas with Permittee funds will be considered Permittee conservation.
2. Acquisitions in Fluvial Sand Transport Only areas will be credited to the funding entity. Any overlap between Fluvial Sand Transport Only areas and Joshua Tree National Park or Santa Rosa and San Jacinto Mountains National Monument would be allocated pursuant to the above.
3. If a Section 6 grant or Environmental Enhancement and Mitigation (EEM) 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. However, as "mitigation" cannot be used as a match for Section 6 grants, Permittees cannot utilize Local Development Mitigation Fees or agency mitigation fees as matching funds.
4. If joint funds are used to purchase the property, the credit shall be allocated proportionally based on the relative amount contributed by each entity, excluding any closing costs.
5. Mitigation for impacts other than incidental take of Covered Species, natural communities, or Essential Ecological Processes (such as Waters of the United States or Waters of the State) or mitigation for projects not covered under the Plan (including utility projects that do not receive Participating Special Entity status) do not count toward Plan conservation.

MANAGEMENT CREDIT

In certain instances, a non-profit may acquire land that is in neither Joshua Tree National Park, Santa Rosa and San Jacinto National Monument, nor Mecca Hills and Orocopia Wilderness Area, but is in a CVMSHCP Conservation Area, and will transfer the property to CVCC. These transfers result in a situation wherein an entity that did not get conservation credit for purchasing the land nonetheless absorbs the long-term management responsibility for it. To acknowledge this management responsibility, CVCC tracks management credits in addition to acquisition credits.

Appendix II: Conservation Acquisitions during 2024

Conservation Area and APN	Acres
STUBBE AND COTTONWOOD CANYONS	**5**
520030003	5
UPPER MISSION CREEK/BIG MORONGO CANYON	**49**
665110002	49
WILLOW HOLE	**94**
659250002	5
659250003	5
660060033	35
660091011	0
660110032	1
660170002	5
660170006	5
660200040	11
660220006	21
660260012	5
LONG CANYON	**1**
656310002	1
SANTA ROSA AND SAN JACINTO MOUNTAINS	**116**
640080009	55
640180016	27
640350001	0.5
640350002	0.3
640350003	0.3
640350004	0.3
640350005	0.2
640350006	0.3
640350007	0.2
SANTA ROSA AND SAN JACINTO MOUNTAINS (CONT.)	
640350008	0.3
640350009	0.3
640350010	0.3
640350011	0.4
640350012	0.3
640350013	0.4
640350014	0.3
640350015	0.3
640350016	0.3
640350017	0.3
640350018	0.4
640350019	2
640350020	1
640350021	1
640350022	1
640350023	2
640350024	3
640360001	4
640360002	4
640360003	5
640360004	1
640360005	1
640360006	1
640360007	0.1
640360008	2
Total	**265**

Appendix III: Conservation Objectives by Conservation Area

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
CABAZON								
RIVERSIDE COUNTY								
Biological Corridor/Linkage	10	0	0	631	0	0	0.00%	1
Mesquite Hummocks	1	0	0	12	0	0	0.00%	0.1
Peninsular Bighorn Sheep	0	0	0	83	0	0	0.00%	0
Sand Source Area	181	0	0	1629	0	0	0.00%	18.1
Sand Transport Area	NA	0	0	NA	0	0	NA	NA
Southern Sycamore-Alder Riparian Forest	1	0	0	9	0	0	0.00%	0.1
COACHELLA VALLEY STORMWATER CHANNEL AND DELTA								
RIVERSIDE COUNTY								
California Black Rail	6	0	0	52	0	0	0.00%	0.60
Coastal and Valley Freshwater Marsh	6	0	0	51	0	0	0.00%	0.60
Crissal Thrasher	87	0	5	781	0	360	46.10%	39.67
Desert Saltbush Scrub	79	0	5	713	0	340	47.68%	36.78
Desert Sink Scrub	114	0	0	1026	0	84	8.20%	19.81
Le Conte's Thrasher	78	0	5	706	0	360	50.99%	38.48
Mesquite Hummocks	7	0	0	67	0	20	29.92%	2.48
Yuma Clapper Rail	6	0	0	52	0	0	0.00%	0.60
DESERT TORTOISE LINKAGE								
COACHELLA								
Desert Dry Wash Woodland	12	0	0	109	0	0	0.00%	1.20
Desert Tortoise	30	0	0	270	0	0	0.00%	3.00
Le Conte's Thrasher	30	0	0	270	0	0	0.00%	3.00
INDIO								
Biological Corridor/Linkage	1572	0	0	14143	0	0	0.00%	156.98
RIVERSIDE COUNTY								
Desert Dry Wash Woodland	752	0	1	6771	0	914	13.50%	165.67
Desert Tortoise	4998	0	1	44977	0	6876	15.29%	1186.06
Le Conte's Thrasher	2813	0	1	25319	0	2497	9.86%	529.64
Mecca Aster	206	0	0	1855	0	454	24.50%	66.02
Orocopia Sage	44	0	0	398	0	0	0.00%	4.40
DOS PALMAS								
RIVERSIDE COUNTY								
Arrowweed Scrub	13	0	0	121	0	0	0.30%	1.33
California Black Rail	37	0	0	334	0	302	90.51%	33.84
Cismontane Alkali Marsh	23	0	0	205	0	215	105.07%	24.05
Crissal Thrasher	38	0	0	343	0	244	71.23%	28.16
Desert Dry Wash Woodland	83	0	0	746	0	268	35.89%	35.11

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
Desert Fan Palm Oasis Woodland	6	0	0	50	0	29	58.80%	3.78
Desert Sink Scrub	487	0	0	4381	0	1265	28.88%	175.26
Flat-Tailed Horned Lizard (Predicted)	403	0	0	3631	0	657	18.10%	105.96
Le Conte's Thrasher	743	0	0	6689	0	2525	37.74%	326.70
Mesquite Bosque	36	0	0	320	0	234	73.15%	27.30
Mesquite Hummocks	3	0	0	23	0	10	44.56%	1.50
Yuma Clapper Rail	42	0	0	374	0	322	86.20%	36.78
EAST INDIO HILLS								
COACHELLA								
Coachella Valley Round-Tailed Ground Squirrel	1	0	0	5	0	0	0.00%	0.10
Flat-Tailed Horned Lizard (Predicted)	1	0	0	5	0	0	0.00%	0.10
Le Conte's Thrasher	6	0	0	56	0	0	0.00%	0.60
Palm Springs Pocket Mouse	1	0	0	7	0	0	0.00%	0.10
INDIO								
Coachella Valley Round-Tailed Ground Squirrel	11	0	0	103	0	0	0.00%	1.10
Flat-Tailed Horned Lizard (Predicted)	11	0	0	100	0	0	0.00%	1.10
Le Conte's Thrasher	12	0	0	105	0	0	0.00%	1.20
Mesquite Hummocks	0	0	0	2	0	0	0.00%	0.00
Palm Springs Pocket Mouse	11	0	0	103	0	0	0.00%	1.10
Stabilized Shielded Desert Sand Fields	11	0	0	100	0	0	0.00%	1.10
RIVERSIDE COUNTY								
Active Desert Dunes	1	0	0	4	0	0	0.00%	0.10
Coachella Valley Round-Tailed Ground Squirrel	100	0	0	896	0	1	0.09%	10.08
Desert Saltbush Scrub	1	0	0	7	0	0	0.00%	0.10
Flat-Tailed Horned Lizard (Predicted)	46	0	0	415	0	0	0.00%	4.60
Le Conte's Thrasher	139	0	0	1253	0	35	2.83%	17.44
Mecca Aster	116	0	0	1045	0	0	0.00%	11.60
Mesquite Hummocks	4	0	0	39	0	0	0.00%	0.40
Palm Springs Pocket Mouse	105	0	0	944	0	33	3.48%	13.79
Stabilized and Partially Stabilized Desert Sand Fields	33	0	0	295	0	0	0.00%	3.30
Stabilized Shielded Desert Sand Fields	28	0	0	256	0	0	0.00%	2.80
EDOM HILL							0.00%	
CATHEDRAL CITY		0			0			
Coachella Valley Milkvetch	15	0	0	136	0	42	30.63%	5.64
Coachella Valley Round-Tailed Ground Squirrel	13	0	0	121	0	42	34.43%	5.33
Le Conte's Thrasher	34	0	0	310	0	75	24.25%	10.82
Palm Springs Pocket Mouse	11	0	0	103	0	41	40.05%	5.07
Sand Source Area	35	0	0	310	0	75	24.25%	11.14
RIVERSIDE COUNTY								
Active Desert Sand Fields	4	0	0	37	0	41	110.08%	4.36
Coachella Valley Fringe-Toed Lizard	5	0	0	40	0	43	107.90%	5.36
Coachella Valley Giant Sand-Treader Cricket	5	0	0	40	0	43	107.90%	5.36

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
Coachella Valley Milkvetch	134	0	0	1205	0	1127	93.50%	126.17
Coachella Valley Round-Tailed Ground Squirrel	145	0	0	1302	0	1215	93.35%	136.33
Le Conte's Thrasher	194	0	2	1745	0	1527	87.52%	170.61
Palm Springs Pocket Mouse	104	0	0	935	0	880	94.10%	98.48
Sand Source Area	197	0	0	1770	0	1622	91.64%	181.86
Sand Transport Area	63	0	1	565	0	421	74.50%	47.25
Stabilized and Partially Stabilized Desert Sand Fields	1	0	0	3	0	2	80.98%	0.83
HIGHWAY 111/I-10								
PALM SPRINGS								
Coachella Valley Jerusalem Cricket	37	0	0	335	0	126	37.48%	16.18
Coachella Valley Milkvetch	37	0	0	335	0	126	37.48%	16.18
Coachella Valley Round-Tailed Ground Squirrel	39	0	0	350	0	137	39.08%	17.62
Le Conte's Thrasher	39	0	0	350	0	137	39.08%	17.62
Palm Springs Pocket Mouse	39	0	0	350	0	137	39.08%	17.62
INDIO HILLS PALMS								
RIVERSIDE COUNTY								
Desert Dry Wash Woodland	4	0	0	33	0	36	109.83%	4.35
Desert Fan Palm Oasis Woodland	5	0	0	42	0	7	16.61%	1.25
Le Conte's Thrasher	1	0	0	7	0	0		0.10
Mecca Aster	255	0	0	2290	0	1039	45.38%	129.65
Mesquite Hummocks	1	0	0	1	0	0		0.10
INDIO HILLS/JOSHUA TREE NATIONAL PARK LINKAGE								
RIVERSIDE COUNTY								
Biological Corridor/Linkage	1141	0	6	10267	0	8987	87.53%	1007.21
Desert Tortoise	859	0	0	7735	0	6540	84.55%	739.54
Le Conte's Thrasher	606	0	0	5457	0	5462	100.09%	606.52
Sand Source Area	460	0	0	4135	0	3202	77.43%	366.57
Sand Transport Area	681	0	6	6132	0	5785	94.34%	640.57
JOSHUA TREE NATIONAL PARK								
RIVERSIDE COUNTY								
Desert Dry Wash Woodland	13	0	0	119	0	192	161.33%	20.18
Desert Fan Palm Oasis Woodland	0	0	0	0	0	0	0.00%	
Desert Tortoise	1708	0	0	15367	0	12529	81.53%	1424.14
Gray Vireo	134	0	0	1208	0	1822	150.85%	195.33
Le Conte's Thrasher	25	0	0	222	0	103	46.58%	12.98
Mojave Mixed Woody Scrub	800	0	0	7195	0	6353	88.29%	715.71
Mojavean Pinyon-Juniper Woodland	134	0	0	1208	0	1822	150.85%	195.33
MECCA HILLS/OROCOPIA MOUNTAINS								
RIVERSIDE COUNTY								
Desert Dry Wash Woodland	318	0	0	2861	0	1376	48.10%	169.45
Desert Fan Palm Oasis Woodland	0	0	0	0	0	0	0.00%	
Desert Tortoise	2624	0	0	23617	0	7960	33.70%	1058.38

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
Le Conte's Thrasher	652	0	0	5866	0	1568	26.74%	222.08
Mecca Aster	465	0	0	4181	0	2014	48.17%	248.11
Orocopia Sage	1803	0	0	16227	0	5369	33.08%	717.15
SANTA ROSA & SAN JACINTO MOUNTAINS								
CATHEDRAL CITY								
Desert Dry Wash Woodland	2	0	0	18	0	0	0.00%	0.20
Desert Tortoise	11	0	0	95	0	0	0.00%	1.10
Le Conte's Thrasher	1	0	0	11	0	0	0.00%	0.10
Peninsular Bighorn Sheep	11	0	0	97	0	0	0.00%	1.10
INDIAN WELLS								
Desert Dry Wash Woodland	7	0	0	66	0	0	0.00%	0.70
Desert Tortoise	111	0	0	999	0	36	3.63%	14.70
Le Conte's Thrasher	23	0	0	206	0	0	0.06%	2.29
Peninsular Bighorn Sheep	114	0	0	1158	0	36	3.12%	14.60
LA QUINTA							0.00%	
Desert Dry Wash Woodland	8	0	0	76	0	15	19.97%	2.24
Desert Tortoise	157	0	1	1409	0	424	30.07%	57.52
Le Conte's Thrasher	43	0	0	387	0	125	32.24%	16.78
Peninsular Bighorn Sheep	159	0	1	2545	0	430	16.88%	39.37
PALM DESERT								
Desert Dry Wash Woodland	3	0	0	29	0	0	0.00%	0.30
Desert Tortoise	48	0	0	436	94	206	47.32%	25.24
Le Conte's Thrasher	4	0	0	33	0	0	0.65%	0.42
Peninsular Bighorn Sheep	14	0	0	130	84	392	301.54%	39.39
PALM SPRINGS								
Desert Dry Wash Woodland	4	0	0	36	0	10	28.15%	1.41
Desert Fan Palm Oasis Woodland	9	0	0	76	0	0	0.00%	0.90
Desert Tortoise	1317	0	0	8856	0	4764	53.80%	769.13
Gray Vireo	431	0	0	3883	0	780	20.08%	120.98
Le Conte's Thrasher	103	0	0	560	0	318	56.85%	63.00
Peninsular Juniper Woodland and Scrub	353	0	0	3177	0	780	24.54%	113.26
Peninsular Bighorn Sheep	1089	0	1	7211	0	10351	143.55%	1380.29
Semi-Desert Chaparral	51	0	0	571	0	0	0.00%	5.10
Sonoran Cottonwood-Willow Riparian Forest	0	0	0	58	0	1	2.54%	0.00
Southern Arroyo Willow Riparian Forest	0	0	0	0	0	0	0.00%	
Southern Sycamore-Alder Riparian Forest	2	0	0	24	0	0	0.00%	0.20
RANCHO MIRAGE								
Desert Dry Wash Woodland	1	0	0	9	0	1	6.44%	0.16
Desert Tortoise	147	0	0	1326	0	572	43.11%	71.73
Le Conte's Thrasher	2	0	0	17	0	0	0.00%	0.20
Peninsular Bighorn Sheep	42	0	0	450	0	575	127.73%	52.48
RIVERSIDE COUNTY							0.00%	

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
Desert Dry Wash Woodland	298	0	0	1244	0	1306	105.00%	311.41
Desert Fan Palm Oasis Woodland	45	0	0	404	0	52	12.95%	9.74
Desert Tortoise	2950	0	7	23856	0	20110	84.30%	2526.62
Gray Vireo	881	0	0	7930	0	7804	98.41%	868.33
Le Conte's Thrasher	911	0	0	5508	0	5575	101.22%	920.97
Peninsular Juniper Woodland and Scrub	418	0	0	2899	0	5050	174.19%	697.05
Peninsular Bighorn Sheep	2418	0	0	19205	0	88165	459.07%	10247.92
Redshank Chaparral	253	0	0	2274	0	1828	80.37%	208.27
Semi-Desert Chaparral	233	0	0	2093	0	927	44.28%	116.15
Southern Arroyo Willow Riparian Forest	2	0	0	15	0	0	0.00%	0.20
Southern Sycamore-Alder Riparian Forest	12	0	0	117	0	5	4.51%	1.69
SNOW CREEK /WINDY POINT								
PALM SPRINGS								
Active Desert Dunes	7	0	0	62	0	43	69.67%	5.09
Biological Corridor/Linkage	27	0	0	247	0	249	100.91%	27.22
Coachella Valley Fringe-Toed Lizard	75	0	0	672	0	248	36.96%	32.45
Coachella Valley Giant Sand-Treader Cricket	75	0	0	672	0	248	36.96%	32.45
Coachella Valley Jerusalem Cricket	90	0	0	815	0	252	30.88%	34.02
Coachella Valley Milkvetch	91	0	0	816	0	252	30.86%	34.38
Coachella Valley Round-Tailed Ground Squirrel	93	0	0	838	0	253	30.21%	34.58
Ephemeral Desert Sand Fields	68	0	0	610	0	205	33.64%	27.39
Le Conte's Thrasher	86	0	0	775	0	210	27.09%	29.57
Palm Springs Pocket Mouse	93	0	0	838	0	253	30.21%	34.58
Peninsular Bighorn Sheep	15	0	0	144	0	23	16.23%	3.69
Sand Transport Area	93	0	0	838	0	253	30.21%	34.58
RIVERSIDE COUNTY								
Biological Corridor/Linkage	46	0	0	415	0	145	34.86%	19.03
Coachella Valley Fringe-Toed Lizard	55	0	0	502	0	401	79.91%	45.05
Coachella Valley Giant Sand-Treader Cricket	56	0	0	501	0	401	80.07%	45.95
Coachella Valley Jerusalem Cricket	60	0	0	538	0	524	97.47%	58.64
Coachella Valley Milkvetch	134	0	0	1210	0	855	70.68%	98.64
Coachella Valley Round-Tailed Ground Squirrel	152	0	0	1371	0	1039	75.79%	118.88
Ephemeral Desert Sand Fields	45	0	0	409	0	393	96.15%	43.44
Le Conte's Thrasher	162	0	0	1453	0	1077	74.11%	124.26
Palm Springs Pocket Mouse	148	0	0	1331	0	1085	81.49%	123.35
Peninsular Bighorn Sheep	49	0	0	443	0	264	59.59%	31.18
Sand Transport Area	165	0	0	1482	0	1087	73.32%	125.38
STUBBE & COTTONWOOD CANYONS								
RIVERSIDE COUNTY								
Biological Corridor/Linkage	117	0	0	1058	5	882	83.33%	99.44
Desert Dry Wash Woodland	26	0	0	229	0	137	59.97%	16.63
Desert Tortoise	253	0	20	2276	5	1005	44.14%	105.97

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
Le Conte's Thrasher	123	0	0	1111	1	825	74.26%	94.27
Sand Source Area	138	0	20	1241	0	229	18.44%	17.10
Sand Transport Area	125	0	0	1129	5	832	73.68%	95.16
THOUSAND PALMS								
RIVERSIDE COUNTY								
Active Desert Dunes	2	0	0	14	0	6	42.65%	0.97
Active Desert Sand Fields	91	0	0	820	0	679	82.81%	76.92
Biological Corridor/Linkage	9831	0	51	7816	0	6031	77.16%	7759.49
Coachella Valley Fringe-Toed Lizard	93	0	0	834	0	684	81.97%	77.91
Coachella Valley Giant Sand-Treader Cricket	93	0	0	834	0	684	81.97%	77.91
Coachella Valley Milkvetch	111	0	4	1001	0	834	83.27%	90.71
Coachella Valley Round-Tailed Ground Squirrel	468	0	30	2974	0	2045	68.75%	306.42
Desert Dry Wash Woodland	4	0	0	34	0	16	47.38%	2.11
Desert Fan Palm Oasis Woodland	0	0	0	0	0	0	0.00%	
Flat-Tailed Horned Lizard (Predicted)	97	0	0	877	0	721	82.19%	81.45
Le Conte's Thrasher	552	0	24	3879	0	2618	67.49%	366.32
Mecca Aster	297	0	5	2676	0	2652	99.09%	289.31
Mesquite Hummocks	0	0	0	0	0	0	0.00%	
Palm Springs Pocket Mouse	518	0	30	3588	0	2443	68.09%	339.34
Sand Source Area	412	0	6	3712	0	3368	90.73%	371.70
Sand Transport Area	5731	0	45	4100	0	2683	65.44%	3903.66
Sonoran Cottonwood-Willow Riparian Forest	0	0	0	0	0	0	0.00%	
UPPER MISSION CREEK/BIG MORONGO CANYON								
DESERT HOT SPRINGS								
Biological Corridor/Linkage	10	0	0	88	0	2	2.38%	1.21
Coachella Valley Jerusalem Cricket	10	0	1	90	0	30	33.80%	2.90
Desert Dry Wash Woodland	8	0	0	76	0	0	0.00%	0.80
Desert Tortoise	252	0	10	2271	44	1231	54.21%	138.12
Le Conte's Thrasher	382	0	5	3430	49	3430	100.00%	377.42
Little San Bernardino Mountains Linanthus	107	0	0	966	9	495	51.22%	60.03
Palm Springs Pocket Mouse	207	0	2	1865	49	1008	54.06%	119.12
Sand Source Area	16	0	7	141	0	66	46.81%	1.11
Sand Transport Area	217	0	2	1949	49	1030	52.85%	122.62
PALM SPRINGS								
Le Conte's Thrasher	2	0	0	22	0	0	0.00%	0.20
Palm Springs Pocket Mouse	2	0	0	22	0	0	0.00%	0.20
Sand Transport Area	2	0	0	22	0	0	0.00%	0.20
RIVERSIDE COUNTY		0			0			
Biological Corridor/Linkage		0	0	688	0	356	51.75%	
Coachella Valley Jerusalem Cricket	47	0	16	419	0	61	14.52%	-4.95
Desert Dry Wash Woodland	8	0	0	76	0	76	100.00%	8.00
Desert Tortoise	882	0	66	7936	0	5718	72.05%	594.42

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
Le Conte's Thrasher	119	0	0	1072	0	959	89.43%	107.68
Little San Bernardino Mountains Linanthus	117	0	0	1052	0	945	89.87%	106.34
Palm Springs Pocket Mouse	124	0	0	1112	0	998	89.78%	112.59
Sand Source Area	721	0	66	6488	0	4753	73.25%	481.88
Sand Transport Area		0	0	1259	0	1209	96.03%	
Sonoran Cottonwood-Willow Riparian Forest	8	0	0	84	0	78	92.49%	7.46
Southern Sycamore-Alder Riparian Forest	0	0	0	13	0	60	459.04%	0.00
Triple-Ribbed Milkvetch	47	0	0	426	0	420	98.69%	46.44
WEST DECEPTION CANYON								
RIVERSIDE COUNTY								
Sand Source Area	118	0	0	118	0	944	799.77%	861.16
WHITEWATER CANYON								
DESERT HOT SPRINGS								
Desert Tortoise	0	0	0	0	0	0	0.00%	
Sand Source Area	0	0	0	0	0	0	0.00%	
RIVERSIDE COUNTY		0			0			
Arroyo Toad	78	0	0	706	0	717	101.55%	79.09
Biological Corridor/Linkage	22	0	1	201	0	0	0.00%	0.79
Desert Fan Palm Oasis Woodland	0	0	0	0	0	0	0.00%	
Desert Tortoise	120	0	5	1084	0	742	68.46%	81.29
Little San Bernardino Mountains Linanthus	39	0	0	348	0	277	79.72%	31.88
Sand Source Area	94	0	3	850	0	618	72.73%	67.69
Sand Transport Area	48	0	1	435	0	338	77.77%	36.99
Sonoran Cottonwood-Willow Riparian Forest	11	0	0	107	0	105	98.52%	10.85
Triple-Ribbed Milkvetch	41	0	0	368	0	277	75.38%	31.83
WHITEWATER FLOODPLAIN								
CATHEDRAL CITY								
Active Desert Sand Fields	5	0	0	43	0	0	0.00%	0.50
Biological Corridor/Linkage	2	0	0	18	0	0	0.00%	0.20
Coachella Valley Fringe-Toed Lizard	7	0	0	61	0	0	0.00%	0.70
Coachella Valley Giant Sand-Treader Cricket	7	0	0	61	0	0	0.00%	0.70
Coachella Valley Milkvetch	7	0	0	61	0	0	0.00%	0.70
Coachella Valley Round-Tailed Ground Squirrel	7	0	0	59	0	0	0.00%	0.70
Le Conte's Thrasher	7	0	0	61	0	0	0.00%	0.70
Palm Springs Pocket Mouse	7	0	0	61	0	0	0.00%	0.70
Sand Transport Area	7	0	0	61	0	0	0.00%	0.70
PALM SPRINGS							0.00%	
Active Desert Sand Fields	44	0	0	392	0	349	89.06%	39.67
Biological Corridor/Linkage	90	0	8	809	0	33	4.07%	3.93
Coachella Valley Fringe-Toed Lizard	295	0	66	2659	0	873	32.84%	50.33
Coachella Valley Giant Sand-Treader Cricket	295	0	66	2659	0	873	32.84%	50.33
Coachella Valley Milkvetch	297	0	66	2671	0	873	32.69%	50.73

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
Coachella Valley Round-Tailed Ground Squirrel	328	0	74	2955	0	875	29.59%	46.05
Ephemeral Desert Sand Fields	132	0	34	1185	0	523	44.15%	31.23
Le Conte's Thrasher	381	0	74	3433	0	906	26.40%	54.91
Palm Springs Pocket Mouse	347	0	77	3122	0	892	28.57%	46.96
Sand Transport Area	387	0	77	3484	0	906	26.01%	52.04
Stabilized and Partially Stabilized Desert Sand Fields	44	0	0	394	0	0	0.00%	4.40
RIVERSIDE COUNTY								
Biological Corridor/Linkage	53	0	30	475	0	278	58.61%	3.39
Coachella Valley Fringe-Toed Lizard	6	0	0	57	0	6	10.98%	1.19
Coachella Valley Giant Sand-Treader Cricket	6	0	0	57	0	6	10.98%	1.19
Coachella Valley Milkvetch	6	0	0	58	0	6	10.79%	1.18
Coachella Valley Round-Tailed Ground Squirrel	11	0	0	100	0	43	42.80%	5.34
Ephemeral Desert Sand Fields	6	0	0	52	0	0	0.00%	0.60
Le Conte's Thrasher	53	0	30	480	0	290	60.47%	4.27
Palm Springs Pocket Mouse	53	0	30	477	0	288	60.38%	4.28
Sand Transport Area	53	0	30	481	0	290	60.35%	4.21
Stabilized and Partially Stabilized Desert Sand Fields	1	0	0	4	0	6	156.41%	1.51
WILLOW HOLE								
CATHEDRAL CITY								
Active Desert Sand Fields	4	0	0	33	0	37	110.82%	4.39
Coachella Valley Fringe-Toed Lizard	24	0	0	211	14	194	92.01%	22.27
Coachella Valley Milkvetch	87	0	0	782	24	296	37.86%	38.34
Coachella Valley Round-Tailed Ground Squirrel	140	0	0	1256	32	741	58.96%	88.29
Ephemeral Desert Sand Fields	20	0	0	178	14	158	88.52%	17.93
Le Conte's Thrasher	168	0	0	1508	33	807	53.52%	97.72
Palm Springs Pocket Mouse	107	0	0	959	27	753	78.57%	86.36
Sand Source Area	79	0	0	710	10	76	10.68%	15.49
Sand Transport Area	89	0	0	798	23	731	91.64%	82.30
Stabilized and Partially Stabilized Desert Dunes	0	0	0	0	0	37	0.00%	0.00
Stabilized and Partially Stabilized Desert Sand Fields	6	0	0	51	0	0	0.00%	0.60
DESERT HOT SPRINGS								
Biological Corridor/Linkage	31	0	0	277	0	140	50.49%	17.19
Coachella Valley Fringe-Toed Lizard	0	0	0	3	0	0	1.28%	0.00
Coachella Valley Milkvetch	96	0	0	863	0	422	48.91%	51.86
Coachella Valley Round-Tailed Ground Squirrel	0	0	0	3	0	0	1.28%	0.00
Ephemeral Desert Sand Fields	61	0	0	549	0	269	48.98%	32.99
Le Conte's Thrasher	167	0	0	1499	0	789	52.61%	95.77
Mesquite Hummocks	32	0	0	27	0	16	57.89%	19.87
Palm Springs Pocket Mouse	171	0	0	1542	0	720	46.69%	88.96
Sand Transport Area	171	0	0	1542	0	720	46.69%	88.96
Stabilized and Partially Stabilized Desert Dunes	14	0	0	125	0	51	41.10%	6.58
Stabilized and Partially Stabilized Desert Sand Fields	5	0	0	49	0	16	32.03%	1.94

Conservation Area, Permittee, Conservation Element	Authorized Disturbance	Disturbed 2024	Disturbed to Date	Required Conservation	Conserved 2024	Conservation to Date	Percent Conserved	Rough Step
RIVERSIDE COUNTY								
Biological Corridor/Linkage	13	0	0	120	0	0	0.00%	1.30
Coachella Valley Fringe-Toed Lizard	50	0	0	452	0	317	70.20%	36.20
Coachella Valley Milkvetch	99	0	0	888	24	852	95.98%	95.02
Coachella Valley Round-Tailed Ground Squirrel	120	0	0	1078	24	927	86.01%	104.50
Desert Fan Palm Oasis Woodland	0	0	0	0	27	0	0.00%	0.00
Desert Saltbush Scrub	17	0	0	152	0	141	92.90%	15.91
Ephemeral Desert Sand Fields	20	0	0	179	0	102	57.04%	12.27
Le Conte's Thrasher	131	0	0	1178	23	957	81.26%	108.51
Mesquite Hummocks	82	0	0	71	59	75	106.12%	86.51
Palm Springs Pocket Mouse	127	0	0	1142	0	945	82.75%	106.89
Sand Source Area	2	0	0	17	59	8	48.31%	1.07
Sand Transport Area	133	0	0	1193	0	949	79.55%	108.12
Stabilized and Partially Stabilized Desert Dunes	21	0	0	244	0	150	61.48%	16.51
Stabilized and Partially Stabilized Desert Sand Fields	9	0	0	79	59	65	82.16%	7.40

Appendix IV: Development outside Conservation Areas

Conservation Element and Jurisdiction	Acres Disturbed
ACTIVE DESERT DUNES	**7**
Palm Springs	0
Riverside County	7
ACTIVE DESERT SAND FIELDS	**269**
Cathedral City	1
Indio	0
Palm Springs	0
Riverside County	269
ARROWWEED SCRUB	**0**
Riverside County	0
ARROYO TOAD	**0**
Riverside County	0
CALIFORNIA BLACK RAIL	**2**
Coachella	1
Indio	**0**
Riverside County	1
CHAMISE CHAPARRAL	**0**
Riverside County	0
CISMONTANE ALKALI MARSH	**0**
Riverside County	0
COACHELLA VALLEY FRINGE-TOED LIZARD	**8,913**
Cathedral City	1,021
Coachella	9
Indian Wells	735
Indio	1,186
La Quinta	575
Palm Desert	1,300
Palm Springs	1,722
Rancho Mirage	1,222
Riverside County	1,142
COACHELLA VALLEY GIANT SAND-TREADER CRICKET	**8,913**
Cathedral City	1,021
Coachella	9
Indian Wells	735
Indio	1,186
La Quinta	575
Palm Desert	1,300
Palm Springs	1,721
Rancho Mirage	1,222
Riverside County	1,141
COACHELLA VALLEY JERUSALEM CRICKET	**4,698**
Cathedral City	1,032
Desert Hot Springs	71
Palm Desert	21
Palm Springs	1,751
Rancho Mirage	1,116
Riverside County	707
COACHELLA VALLEY MILKVETCH	**6,709**
Cathedral City	902
Desert Hot Springs	81

Conservation Element and Jurisdiction	Acres Disturbed
Indian Wells	631
La Quinta	1
Palm Desert	1,288
Palm Springs	1,242
Rancho Mirage	1,011
Riverside County	1,552
COACHELLA VALLEY ROUND-TAILED GROUND SQUIRREL	**15,974**
Cathedral City	1,312
Coachella	91
Desert Hot Springs	825
Indian Wells	1,056
Indio	2,037
La Quinta	1,527
Palm Desert	1,655
Palm Springs	2,183
Rancho Mirage	1,419
Riverside County	3,869
COASTAL AND VALLEY FRESHWATER MARSH	**9**
Coachella	0
Indio	0
None Specified	9
Riverside County	0
CRISSAL THRASHER	**1,554**
Cathedral City	0
Coachella	77
Desert Hot Springs	10
Indian Wells	22
Indio	288
La Quinta	727
Riverside County	431
DESERT DRY WASH WOODLAND	**734**
Cathedral City	9
Coachella	0
Desert Hot Springs	0
Indian Wells	181
Indio	0
La Quinta	27
Palm Desert	183
Palm Springs	9
Rancho Mirage	31
Riverside County	293
DESERT FAN PALM OASIS WOODLAND	**0**
Cathedral City	0
Desert Hot Springs	0
Palm Springs	0
Rancho Mirage	0
Riverside County	0
DESERT SALTBUSH SCRUB	**466**
Coachella	18
Indio	187

Conservation Element and Jurisdiction	Acres Disturbed
La Quinta	77
Riverside County	184
DESERT SINK SCRUB	**257**
Riverside County	257
DESERT TORTOISE	**4,110**
Cathedral City	35
Coachella	2
Desert Hot Springs	827
Indian Wells	203
Indio	0
La Quinta	422
Palm Desert	540
Palm Springs	174
Rancho Mirage	197
Riverside County	1,710
EPHEMERAL DESERT SAND FIELDS	**5**
Cathedral City	1
Palm Springs	4
EPHEMERAL SAND FIELDS	**79**
Cathedral City	0
Palm Springs	72
Riverside County	7
FLAT-TAILED HORNED LIZARD	**9,082**
Cathedral City	948
Coachella	7
Desert Hot Springs	59
Indian Wells	735
Indio	1,101
La Quinta	589
Palm Desert	1,300
Palm Springs	1,716
Rancho Mirage	1,213
Riverside County	1,413
GRAY VIREO	**443**
Palm Springs	0
Riverside County	443
INTERIOR LIVE OAK CHAPARRAL	**2**
Palm Springs	0
Riverside County	2
LE CONTE'S THRASHER	**18,883**
Cathedral City	1,304
Coachella	101
Desert Hot Springs	1,393
Indian Wells	1,216
Indio	1,871
La Quinta	1,790
Palm Desert	2,150
Palm Springs	2,155
Rancho Mirage	1,437
Riverside County	5,468
LEAST BELL'S VIREO	**2,235**
Cathedral City	9
Coachella	78
Desert Hot Springs	11
Indian Wells	203
Indio	288
La Quinta	753
Palm Desert	183
Palm Springs	9
Rancho Mirage	31
Riverside County	669

Conservation Element and Jurisdiction	Acres Disturbed
LITTLE SAN BERNARDINO MOUNTAINS LINANTHUS	**1**
Desert Hot Springs	1
Riverside County	0
MECCA ASTER	**1**
Indio	0
Riverside County	1
MESQUITE BOSQUE	**0**
Riverside County	0
MESQUITE HUMMOCKS	**245**
Cathedral City	0
Coachella	7
Desert Hot Springs	8
Indian Wells	21
Indio	51
La Quinta	65
None Specified	62
Riverside County	31
MOJAVE MIXED WOODY SCRUB	**46**
Desert Hot Springs	6
Riverside County	40
MOJAVEAN PINYON & JUNIPER WOODLAND	**0**
Riverside County	0
OROCOPIA SAGE	**18**
Riverside County	18
PALM SPRINGS POCKET MOUSE	**16,360**
Cathedral City	1,326
Coachella	57
Desert Hot Springs	855
Indian Wells	1,064
Indio	1,917
La Quinta	1,343
Palm Desert	1,735
Palm Springs	2,342
Rancho Mirage	1,461
Riverside County	4,258
PENINSULAR BIGHORN SHEEP	**427**
Cathedral City	9
Indian Wells	1
La Quinta	122
Palm Desert	209
Palm Springs	58
Rancho Mirage	18
Riverside County	9
PENINSULAR JUNIPER WOODLAND & SCRUB	**0**
Palm Springs	0
Riverside County	0
PENINSULAR JUNIPER WOODLAND AND SCRUB	**3**
Palm Springs	0
Riverside County	3
PENINSULAR BIGHORN SHEEP	**151**
Cathedral City	1
Indian Wells	0
La Quinta	6
Palm Desert	62
Palm Springs	52
Rancho Mirage	4
Riverside County	25
RED SHANK CHAPARRAL	**0**
Riverside County	0
REDSHANK CHAPARRAL	**0**

Conservation Element and Jurisdiction	Acres Disturbed
Riverside County	0
SEMI-DESERT CHAPARRAL	**0**
Palm Springs	0
Riverside County	0
SONORAN COTTONWOOD-WILLOW RIPARIAN FOREST	**2**
Coachella	0
Indio	0
Palm Springs	0
Riverside County	2
SONORAN CREOSOTE BUSH SCRUB	**2,046**
Cathedral City	1
Coachella	56
Desert Hot Springs	14
Indian Wells	26
Indio	296
La Quinta	198
Palm Desert	190
Palm Springs	42
Rancho Mirage	37
Riverside County	1,186
SONORAN MIXED WOODY & SUCCULENT SCRUB	**672**
Cathedral City	9
Desert Hot Springs	0
Indian Wells	0
Indio	1
La Quinta	7
Palm Desert	242
Palm Springs	0
Rancho Mirage	0
Riverside County	413
SONORAN MIXED WOODY AND SUCCULENT SCRUB	**502**
Cathedral City	1
Desert Hot Springs	212
Indio	12
La Quinta	3
Palm Desert	5
Palm Springs	83
Riverside County	187
SOUTHERN ARROYO WILLOW RIPARIAN FOREST	**0**
Palm Springs	0
Riverside County	0
SOUTHERN SYCAMORE-ALDER RIPARIAN WOODLAND	**0**
Palm Springs	0
Riverside County	0
SOUTHERN YELLOW BAT	**1**
Cathedral City	0
Desert Hot Springs	1
Palm Springs	0
Rancho Mirage	0
Riverside County	0
SOUTHWESTERN WILLOW FLYCATCHER	**1,717**
Cathedral City	5
Coachella	35
Desert Hot Springs	2
Indian Wells	209
Indio	236
La Quinta	731
Palm Desert	194

Conservation Element and Jurisdiction	Acres Disturbed
Palm Springs	7
Rancho Mirage	46
Riverside County	253
STABILIZED & PARTIALLY STABILIED DESERT SAND FIELDS	**0**
Cathedral City	0
Indio	0
Palm Springs	0
Riverside County	0
STABILIZED & PARTIALLY STABILIZED DESERT SAND DUNES	**0**
Cathedral City	0
Riverside County	0
STABILIZED AND PARTIALLY STABILIZED DESERT DUNES	**0**
Riverside County	0
STABILIZED AND PARTIALLY STABILIZED DESERT SAND FIELDS	**2**
Indio	0
Palm Springs	0
Riverside County	1
STABILIZED SHIELDED DESERT SAND FIELDS	**1,133**
Cathedral City	96
Indian Wells	53
Indio	191
La Quinta	5
Palm Desert	225
Palm Springs	132
Rancho Mirage	75
Riverside County	355
STABILIZED SHIELDED SAND FIELDS	**6,952**
Cathedral City	902
Coachella	9
Indian Wells	682
Indio	994
La Quinta	570
Palm Desert	979
Palm Springs	1,322
Rancho Mirage	1,147
Riverside County	346
SUMMER TANAGER	**2,235**
Cathedral City	9
Coachella	78
Desert Hot Springs	10
Indian Wells	203
Indio	288
La Quinta	753
Palm Desert	183
Palm Springs	9
Rancho Mirage	31
Riverside County	669
TRIPLE-RIBBED MILKVETCH	**0**
Palm Springs	0
Riverside County	0
YELLOW WARBLER	**2,265**
Cathedral City	9
Coachella	80
Desert Hot Springs	11
Indian Wells	203
Indio	316
La Quinta	753
Palm Desert	183

Conservation Element and Jurisdiction	Acres Disturbed
Palm Springs	9
Rancho Mirage	31
Riverside County	669
YELLOW-BREASTED CHAT	**2,235**
Cathedral City	9
Coachella	78
Desert Hot Springs	11
Indian Wells	203
Indio	288
La Quinta	753

Conservation Element and Jurisdiction	Acres Disturbed
Palm Desert	183
Palm Springs	9
Rancho Mirage	31
Riverside County	669
YUMA CLAPPER RAIL	**2**
Coachella	1
Indio	0
Riverside County	1

Appendix V: Biological Monitoring Results for the Coachella Valley Aeolian Sand Species

Report begins on following page.

Coachella Valley Multiple Species Habitat Conservation Plan

2023–2024 BIOLOGICAL MONITORING RESULTS FOR THE COACHELLA VALLEY AEOLIAN SAND SPECIES

2023-2024 FINAL REPORT

DRAFT REPORT

COACHELLA VALLEY MULTIPLE SPECIES HABITAT CONSERVATION PLAN 2023–2024 BIOLOGICAL MONITORING RESULTS FOR THE COACHELLA VALLEY AEOLIAN SAND SPECIES

Prepared by:

Lynn C. Sweet, Remy M. Vincent, Scott A. Heacox, Melanie J. Davis, and Danelle Baronia

Center for Conservation Biology
University of California, Riverside
75-080 Frank Sinatra Dr.
Palm Desert, CA 92211

Prepared for:

Coachella Valley Conservation Commission
73-710 Fred Waring Dr.
Palm Desert, CA 92260

Suggest citation: *Sweet, L.C., Vincent R.M., Heacox, S.A., Davis, M.J, & Baronia, D. (2024) Coachella Valley Multiple Species Habitat Conservation Plan 2023–2024 biological monitoring results for the Coachella Valley aeolian sand species. Final Report. Prepared for: Coachella Valley Conservation Commission*

TABLE OF CONTENTS

LIST OF FIGURES (CAPTIONS ABBREVIATED)

List of Tables (captions abbreviated)

1 INTRODUCTION

The Coachella Valley Multiple Species Habitat Conservation Plan, or CVMSHCP (hereafter "Plan"), signed into law in 2008, is designed to ensure long-term protection for 27 of the Coachella Valley's most vulnerable plant and animal species within the Palm Springs region, in Southern California. The Plan expands upon the original 1986 habitat conservation plan (HCP) created following a 1982 amendment to the Endangered Species Act and focused on protecting the federally-threatened and state-endangered Coachella Valley fringe-toed lizard (*Uma inornata*) and the habitat it relies upon. This charismatic lizard is found solely within the now-rare sand dune habitats of the Coachella Valley, which are also home to five additional Plan-covered species. These sand dunes are fed by sediments deposited from floodwaters arising from San Gorgonio Mountain (Whitewater River and Mission Creek), Palm Canyon in the Santa Rosa Mountains, and Thousand Palms Canyon in the Indio Hills, plus many smaller ephemeral washes. Many of these drainages have experienced alteration by human activity, thus limiting the efficiency by which sediments are deposited in a way that is useful for recharge of downwind sand habitats (Beheiry 1967, Barrows 1996, Katra et al. 2009). Importantly, these habitat conservation plans not only put forth realistic species-focused conservation goals, but also serve to protect important landscape-scale processes, such as these major sand sources and the corridors over which the sand must then travel to reach dune habitats, that are necessary for the long-term survival of these species.

The Coachella Valley fringe-toed lizard, Coachella Valley giant sand-treader cricket (*Macrobaenetes valgum*), and Coachella Valley milkvetch (*Astragalus lentiginosus* var. *coachellae*) are entirely dependent on aeolian (wind-driven) sand systems and are found only in the Coachella Valley. The flat-tailed horned lizard (*Phrynosoma mcallii*) is now restricted, within its northern range extent, to a tiny portion of the surviving aeolian habitat in the Coachella Valley; its full range extends south along both sides of the Salton Sea and into northern Mexico (Barrows 2009). The Palm Springs pocket mouse (*Perognathus longimembris bangsi*) and Coachella Valley round-tailed ground squirrel (*Spermophilus tereticaudus chlorus*) rely heavily on aeolian systems but can also be found in adjacent landscape types within the Coachella Valley (Swei et al. 2003, Hoefler and Harris n.d.). The Coachella Valley's aeolian habitat in its pre-colonial form covered an interconnected area exceeding 100 square miles (Barrows and Heacox 2021). Now, after decades of urban development, only 5-10% of that original sand habitat remains (Barrows 2006, Barrows and Heacox 2021). As demonstrated in our previous reports, the present dune habitat is facing a series of complex pressures from invasive plants, interruptions in fresh sand input, rising temperatures, drought, flooding, severe fragmentation, and more. We have installed a series of permanent plots across conserved portions of the remaining dune habitat which we survey annually, in some cases since 2003.

Here we present the results of our 2023-2024 annual monitoring efforts investigating how these plan-covered species respond to these pressures. We also track the populations of several ecologically important arthropod species that are either critical food sources for the Coachella

Valley fringe-toed lizard and flat-tailed horned lizard, or may be useful as indicator species of habitat quality. Finally, we present detailed information on annual and perennial plant communities (including invasive/nonnatives) which represent key variables in determining the overall stability, productivity, and structure of these habitats. For this season, we also highlight the impacts of Tropical Storm Hilary, a novel and impactful event in the late summer of 2023. These data collected during this monitoring season will add to a much larger dataset spanning more than two decades, allowing us to understand and anticipate how the populations of these important species change over time. Furthering our fine-scale knowledge of the dynamics of the abundances of these species as well as potential drivers of change will result in more informed and effective management actions.

2 METHODS: AEOLIAN COMMUNITY PLOT NETWORK

We conducted the entirety of our aeolian community monitoring across 84 0.1ha (10 m x 100 m) rectangular plots situated throughout the Coachella Valley (Figure 1). Aeolian habitat species monitoring began in the 1980's with the Coachella Valley fringe-toed lizard HCP and evolved into the current long-term plot-based method by approximately 2003. We marked each plot with five thin fiberglass poles placed every 25 m down the centerline of the plot to aid researchers in relocating and navigating the plots. We used this type of pole as markers specifically because they are too thin for predatory birds to use as a perch for hunting lizards. We grouped the plots into 15 "plot clusters" each containing 3 to 7 plots situated within contiguous habitat. Researchers selected the locations for each cluster within different aeolian habitats or placed them in a nonrandom pattern to investigate a certain question (i.e. the three plot clusters J, L, and H on the Coachella Valley National Wildlife Refuge are placed at set distances from a roadside to investigate the effects of power lines on lizard predation by perching predatory birds). Within a cluster we placed plots at least 25 m apart, but usually greater than 50 m apart, to avoid resampling individuals between plots. The Coachella Valley fringe-toed lizard has an approximate home range of 25-29 m (Fisher et al. 2020) which is sufficiently smaller than the distance between plots within a cluster.

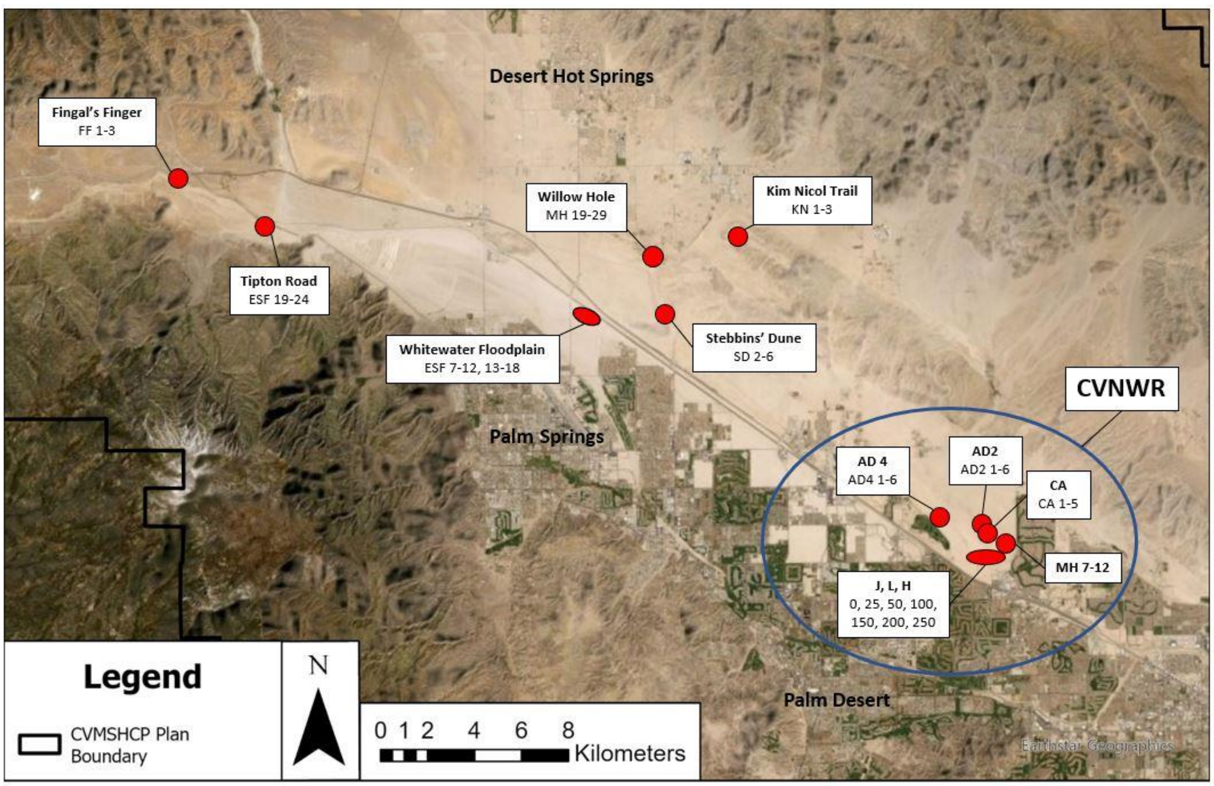


Figure 1. Map of plot network (15 clusters, 84 plots) used in this study. CVNWR = Coachella Valley National Wildlife Refuge indicated in the solid circle.

Plot clusters are located within remaining major fragments of sand dune habitat. Hereafter the names of the plot clusters are as follows, with locations starting at the western most plot moving east: “Fingal’s Finger” cluster FF 1-3, near the Haugen-Lehmann exit on I-10 (north of the geographic feature “Fingal’s Finger”), “Tipton Road” cluster ESF 19-24 (near the intersection of Tipton Road and Highway 111), “Whitewater Floodplain” clusters ESF 13-18 and ESF 7-12 (in the Whitewater Floodplain Conservation Area) , “Willow Hole” clusters MH 19-24 and MH 25-29 (located in the mesquite dunes near the Willow Hole oasis), “Stebbins’ Dune” cluster SD 2-6 (an informal place name, after accomplished herpetologist Robert Stebbins, located just south of Willow Hole), “Kim Nicol” cluster KN 1-3 (named after the Kim Nicol Trail along which the plots are situated), and the Coachella Valley National Wildlife Refuge “CVNWR” clusters AD4 1-6, AD2 1-6, CA 1-5, J 0-250, L 0-250, H 0-250, and MH 7-12 (Figure 1). We installed plots at Fingal’s Finger, in the Kim Nicol Trail area, and Stebbins’ Dune between 2018 and 2019. The remaining plots have been in service since before the inception of the Plan, some as early as 2003. Missing data for 2014 were the result of no funding being allocated for surveys that year, although Thousand Palms Preserve surveys were conducted at no charge on behalf of the CVMSHCP in order to maintain some portion of this critical data set. Our previous reports often categorized and analyzed our plots based on aeolian habitat type groupings (see Introduction), but due to recent fluctuations in sand deposition, we have decided to keep clusters ungrouped in order to reevaluate the most optimal assignment of plots to habitat type. Therefore, we discuss the changes at each plot in terms of their respective locally-measured biophysical factors.

3 INDEPENDENT VARIABLES

3.1 PRECIPITATION

Precipitation in arid ecosystems is the main driver of biological processes and is often irregular year-to-year (Noy-Meir 1979). As such, we must understand local precipitation patterns and how it contributes to the persistence of habitat quality and species populations across the Coachella Valley. Precipitation in the Coachella Valley generally follows a west-east gradient, with higher precipitation in the west and less in the east, driven predominantly by winter storms accompanied by inconsistent summer monsoonal rain. With local precipitation patterns in mind, we obtain our precipitation data from two publicly online-accessible weather stations located at the Palm Springs International Airport as a representative of the west valley (Station 046635) and at the Indio Fire Station as a representative of the east valley (Station 044259), both administered by the National Weather Service Cooperative Observer Program (WRCC 2024). These weather stations have decades of data, but their records have occasional gaps (presumably due to equipment malfunction or other difficulties). Hence, the precipitation data used here extends from 2010 to spring 2024 for Indio, and 2008 to spring 2024 for Palm Springs (Figures 2a and 2b). In addition to looking at precipitation by location, we break down precipitation by season to account for how shifts in the timing of precipitation affect productivity and populations across the region.

In August 2023, Tropical Storm Hilary brought an unusually high amount of summer rain and flooding, a wet period which was drawn out by another monsoonal storm shortly after. These storms caused flooding in three of our CVNWR plot clusters (H, J, and CA), transporting sand out of the habitat and resulting in high silt coverage throughout these plots. The overall summer 2023 monsoonal precipitation amount, which encompassed these storms, was high, and this caused a flourish of annual wildflowers starting in fall 2023 which persisted through spring 2024, supported by winter precipitation. The precipitation totals for solely the month of August 2023 were 3.33 inches for Palm Spring and 1.46 inches for Indio, out of the annual precipitation totals of 8.49 inches and 2.63 inches respectively.

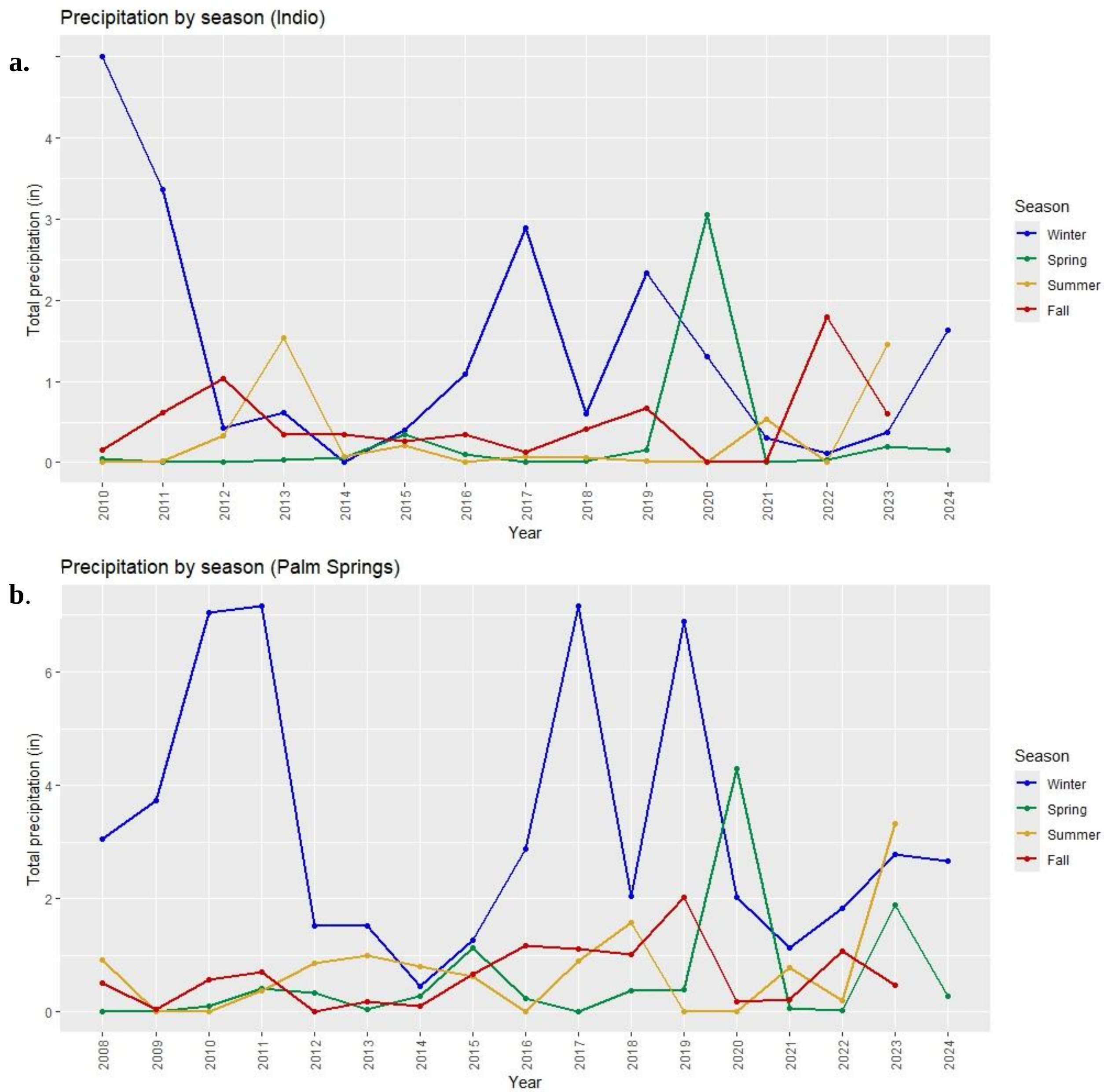


Figure 2a & b. Seasonal and yearly precipitation for Indio (a) and Palm Springs (b), serving as a proxy for precipitation in the eastern and western parts of the Coachella Valley, respectively. Seasons were divided as follows: Spring (March, April, May); Summer (June, July, August); Fall (September, October, November); Winter (December, January, February). Data are summarized through the complete spring season ending in May, 2024.

3.2 WIND PATTERNS

Long-term wind and climate trends show that for this region, east-west winds experienced a positive anomaly (windier than the mean for 1991-2020) in March, May, and June, and the anomaly was negative (less windy) in April (NOAA 2024). Data for the years 2021-2024 over the same period show that this anomaly did not deviate very far from the 1991-2020 mean, except for March 2023 and 2024, where the anomaly exceeded past fluctuations. We note these wind trends because some of the aeolian monitoring protocols require specific conditions to collect the most accurate data and thus changing wind patterns poses challenges to the opportunities to implement these protocols, which is relevant to the overall implementation of monitoring. Additionally, since aeolian habitats rely on wind patterns to maintain sand within the system, we pay special attention to deviation from predominant wind patterns. For example, in years such as this, when extreme fluvial movement occurs (flooding), sand is removed from some areas of the landscape as it moves to other areas, and wind contributes heavily to the reestablishment of sand in these habitats. Thus, we continue to consider wind anomalies to help us understand the abundance and patterns of sand, which impact the habitat for sand-dwelling species.

3.3 SAND COMPACTION

Measuring sand compaction within aeolian habitats can provide us with vital information about whether the habitat has enough loose sand to be suitable for species that rely require it for survival, like for the Coachella Valley fringe toed lizard (*Uma inornata*) (Barrows, 1997, 2006). This also gives us an indication of the patterns of sand abundance across our plots. While performing the winter perennial plant surveys using the line-point intercept (LPI) survey method (see section 6.2.2), we simultaneously measure sand compaction along each plot midline (transect) using a Pocket Penetrometer (AMS Inc.) fitted with a “foot” attachment to allow accurate measurements in loose substrates such as aeolian sand. We take compaction measurements every 4 m along the 100 m mid-line, resulting in twenty-five compaction measurements collected at each plot. The Pocket Penetrometer reads sand compaction on a scale of 1-5 (increasing compaction with increasing value). We record measurements to the nearest 1/4 value measurement on the device, which is converted to kg/cm^2 (converted score = measurement * 0.625). We have recorded sand compaction data intermittently on all plots since 2003, with several gaps throughout (Figure 3), but nearly consistent collection of data from 2022 onward.

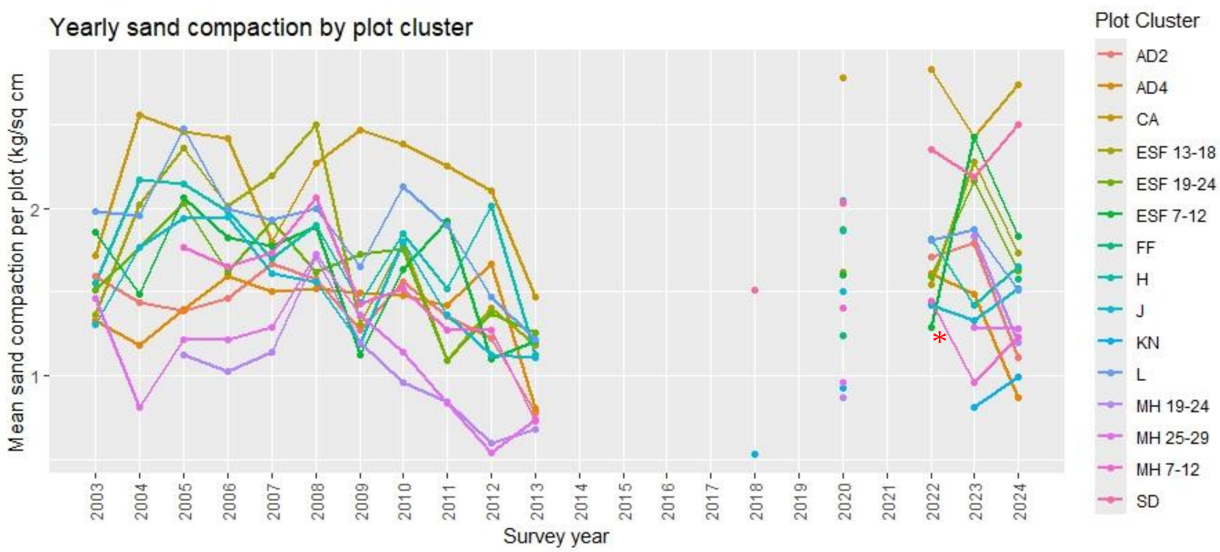


Figure 3. Mean sand compaction (kg/sq cm) by plot cluster over time. Years missing: 2014-2017, 2019, and 2021. Data not collected from MH 19-24 and MH 25-29 in 2022.

In fall 2023 we saw an overall decrease in compaction on our plots, aside from H, J, MH7-12, and CA at the CVNWR, as well as at SD and KN. These plots on the Refuge and Stebbins' Dune received flooding from tropical storm Hilary, resulting in blow sand being transported out of these systems and replaced with a layer of fine, packed silt. We know that increased plant cover stabilizes sand systems so the increase in perennial shrub cover and fall annual plants at KN (see following sections for detailed results) could contribute to the increase in sand compaction at this cluster (Figure 3). The overall decrease in sand compaction elsewhere could be influenced by the fresh influx of sand carried in by the summer floods and the higher average wind speeds in September which helped begin the distribution of blow sand to the aeolian habitats in the Coachella Valley.

3.4 SAND TRANSPORT

Sediment that supports the aeolian (wind-driven) systems in the Coachella Valley is primarily sourced from the San Bernardino and Little San Bernardino Mountain headwaters. During flash flooding events, xeric washes (ephemeral streams) deliver sediment from granitic hillslopes and headwaters to the floodplains. While the floodplains of the Coachella Valley receive sediment deposition from a complex network of sources throughout the surrounding mountain ranges, alluvial fans, and bajadas, the primary sources include the Whitewater River, San Gorgonio River, Mission Creek, and Morongo Wash (Figure 4; Griffiths et al. 2002, Katra et al. 2009, USGS 2023).

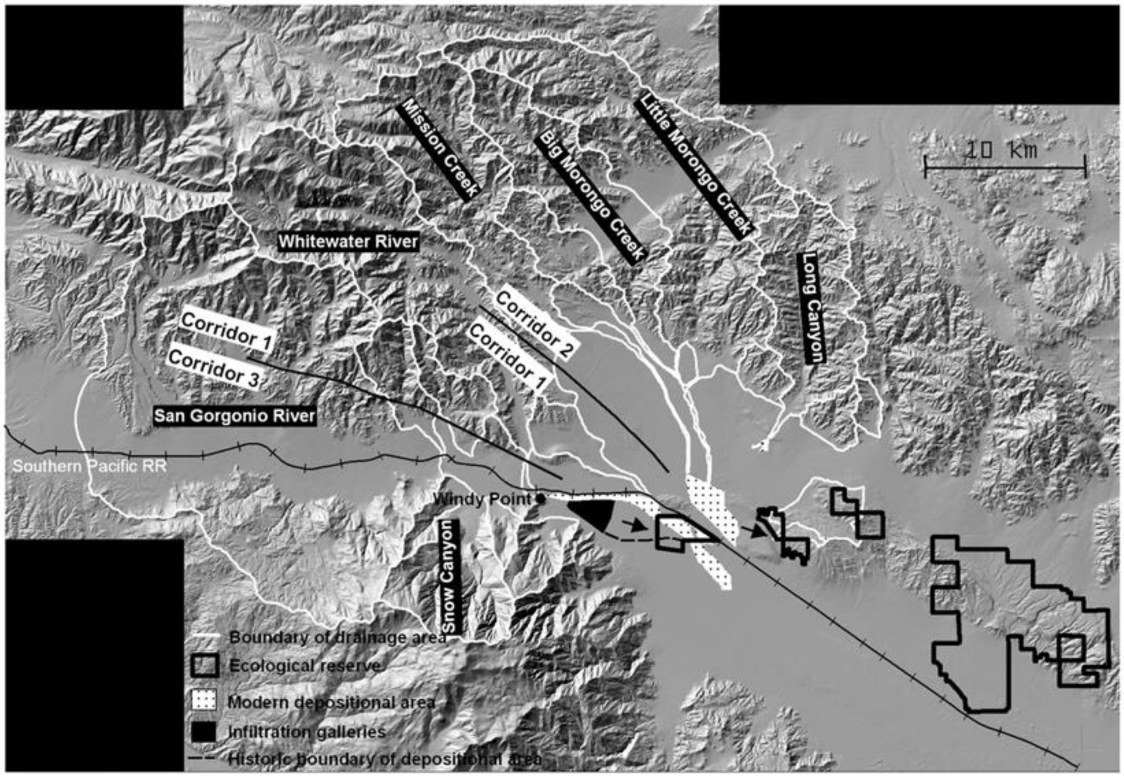


Figure 4. Map compiled by Katra et al. (2009). Fluvial and aeolian features in northwest end of the Coachella Valley. The arrows indicate general paths of aeolian transport from areas of fluvial deposition to the Whitewater Floodplain and Willow Hole Reserves. White lines delineate major drainage areas (Griffiths et al. 2002, USGS 2023). Aeolian corridors modified after Wasklewicz and Meek (1995).

The San Gorgonio River and the Whitewater River serve as the primary sources that feed the Whitewater Floodplain, making up the valley bottom of the northwestern Coachella Valley, with Snow Creek and Mission Creek also contributing to sand and water input. In the central part of the Coachella Valley, sand sources also include fluvial deposits from the Little San Bernardino Mountains and Joshua Tree National Park, primarily Long Canyon, Thousand Palms Canyon, Pushwalla Canyon, Fan Canyon, and Berdoo Canyon (Katra et al. 2009, USGS 2023). Once sand is deposited into the valley via flooding, it then may be carried by wind to create and sustain aeolian habitat. Our long-term plot cluster network receives sand flow from all of the afore-mentioned sources (Table 1).

Tropical Storm Hilary delivered massive fluvial (water-driven) movement of sediment through these channels. Throughout this report, we will consider how the differences in sand transport to our plot network contributes to variability in vegetation community composition, sand compaction, and differential impacts on the abundance of sensitive aeolian psammophilic species (species that prefer/thrive in sandy soils).

Table 1. Primary sand transport systems that provide sand flow deposits to plot network. Plot clusters are ordered here in a west to east order.

Plot Clusters (West to East)	**Primary Transport System**
Fingal's Finger	San Gorgonio River
ESF 19-24 (Tipton Road)	San Gorgonio River; Snow Creek
ESF 13-18	Whitewater River
ESF 7-12	Whitewater River
Willow Hole (MH 19-24; MH 25-29)	Morongo Wash; Mission Creek
Kim Nicol Trail	Morongo Wash; Long Canyon
CVNWR (AD2, AD4, CA, J, L, H, MH 01-12)	Thousand Palms Canyon

4 VERTEBRATES

Our vertebrate surveys monitor the populations of four Plan protected species: Coachella Valley fringe-toed lizard (*Uma inornata*), flat-tailed horned lizard (*Phrynosoma mcallii*), Palm Springs pocket mouse (*Perognathus longimembris bangsi*), and Coachella Valley round-tailed ground squirrel (*Spermophilus tereticaudus chlorus*). Our long-term studies of these animals reveal population dynamics that can advise management strategies of these species. In addition to these four Plan-covered species, we also monitor all identifiable vertebrate species that we encounter during our surveys to assess important interspecific interactions such as competition and predation. We relate results from our plant surveys to fluctuations in vertebrate populations due to their importance as primary producers and direct influence of important species such as seed-harvesting ants which serve as a food source for flat-tailed horned lizards and, to a lesser extent, fringe-toed lizards. We consider the degree of cover of plants across the ground (termed "plant cover") in our analysis as well as an indication the degree of shelter available from predatory birds and as well as changes in habitat quality. Due to the significant rain brought by Tropical Storm Hilary in August of 2023, we also explore how localized habitat changes (loss of fine sand) from flooding affect lizard populations at the CVNWR.

4.1 METHODS

For the aeolian suite of species, we used a unified protocol for most of our survey data. We use tracking as a standard method for identifying and collecting vertebrate species data because individuals leave conveniently diagnostic tracks on soft, fine sand characteristic of aeolian habitats. Surveys are performed during early and later breeding season for lizard species, approximately April through June in the springtime; and during the fall, timed to maximize juvenile lizard cohort encounters, approximately September-November, depending on the weather patterns. We used these tracks to identify which species visited the plots from the night before to the morning of the survey. One to three people surveyed each plot: a professional biologist plus 1-2 volunteer community scientists or additional CCB staff. Surveyors walked equidistant from the plot midline, in parallel to each other along the length of the plot, noting all vertebrate tracks which were identified and recorded by the biologist. The addition of the community scientists significantly increased detection rates for lizards and their tracks (Barrows et al. 2016). Our vertebrate surveys rely on specific wind conditions for us to accurately count species presence. Wind during the preceding night should be strong enough to clear the dunes of previous days' tracks, but the wind must also decrease by the early, pre-sunrise morning to ensure we also can observe tracks of nocturnal species. When these conditions are met, we survey in the mornings as soon as temperatures are warm enough for lizard activity. Field notes indicate any surveys undertaken under less-ideal conditions, as long as the surveyors are confident that tracks can be detected and counted in a usual manner, given extra time and care.

We aim to resurvey each plot at least three times during the monitoring season to account for the effects of day-to-day variability in animal activity.

We performed vertebrate surveys in the fall of 2023 with the purpose of quantifying the density of hatchling lizards, and therefore reproductive output from the previous spring. Excessive heat at the end of summer and the approach of cooler fall weather limits the timeframe within which we can accurately survey hatchlings because the cooling weather diminishes lizard activity to a point where lack of detectability impedes the utility of surveys. This limits our ability to perform a full suite of surveys, as with our spring efforts. We performed at least one survey on all plot clusters at the CVNWR, except CA, which was not surveyed because flooding left insufficient sand to accurately detect tracks. We surveyed plot clusters AD4, H and MH 7-12 on the CVNRW twice. At the western end of the valley, we surveyed plot clusters ESF 13-18, ESF 19-24, and KN once.

Tracking allows us to monitor the abundance of the Plan-listed species as well as a variety of vertebrate species that co-occur and may influence abundance of species through ecological interactions (e.g. competition, predation). The Plan-listed species for which we track in order to quantify changes in populations are the Coachella Valley fringe-toed lizard (*Uma inornata*), flat-tailed horned lizard (*Phrynosoma mcallii*), Palm Springs pocket mouse (*Perognathus longimembris bangsi*), and Coachella Valley round-tailed ground squirrel (*Spermophilus tereticaudus chlorus*). We also record as many other vertebrate species as possible to produce a clear picture of the overall vertebrate community. Identifiable tracks of other species include desert iguanas (*Dipsosaurus dorsalis*), zebra-tail lizards (*Callisaurus draconoides*), western whiptail lizards (*Aspidoscelis tigris*), side-blotched lizards (*Uta stansburiana*), long-tailed brush lizards (*Urosaurus graciosus*), sidewinder rattlesnakes (*Crotalus cerastes*), shovelnose snakes (*Chionactis occipitalis*), kangaroo rats (*Dipodomys* spp.), desert pocket mice (*Chaetodipus penicillatus*), black-tailed jackrabbits (*Lepus californicus*), coyotes (*Canis latrans*), and a variety of birds including predators such as ravens (*Corvus corax*), kestrels (*Falco tinnunculus*), loggerhead shrikes (*Lanius ludovicianus*) and greater roadrunners (*Geococcyx californianus*). We also recorded visual sightings and vocalizations of species which can be used to corroborate tracks or better inform the presence of predatory birds. The following subsections below detail the background information for each Plan-covered species and the results of the surveys for each respective species, and we note in the discussions any relationship or important findings related to other species.

4.2 COACHELLA VALLEY FRINGE-TOED LIZARD (*UMA INORNATA*)

4.2.1 Results

The Coachella Valley fringe-toed lizard (*Uma inornata*, here CVFTL) is a species of dune-obligate lizard endemic to the Coachella Valley. It is listed as threatened under the USFWS Endangered Species Act (USFWS 1980) and endangered under the California Endangered Species Act. It has a suite of morphological features adapted specifically for life in aeolian sand habitat, such as a countersunk lower jaw to aid in burrowing and a row of enlarged scales on the hind toes (the namesake “fringes”) that increase mobility on loose sand. These adaptations give the CVFTL an advantage over other lizard species when it comes to living in aeolian habitats, where they can dominate. However, the extreme loss of aeolian sand habitat in the Coachella Valley (approximately 90%) has left this species vulnerable to extinction. Regular monitoring of the CVFTL allows us to understand how this species population naturally fluctuates and when we notice indications that require management intervention.

Monitoring of this species takes place twice a year, as above – in late spring and early summer when the population consists of primarily adults, and again in the fall when hatchling activity peaks. Springtime monitoring captures how seasonal precipitation and sand transport causes trophic impacts on the lizard’s primary food source, arthropods. Precipitation correlates with annual plant productivity which effects arthropod populations and thus food availability for the CVFTL. Considering how the presence of adequate food and the availability of fine sand habitat contributes to the reproductive success of the lizard, we further investigate hatchling survival through our fall monitoring.

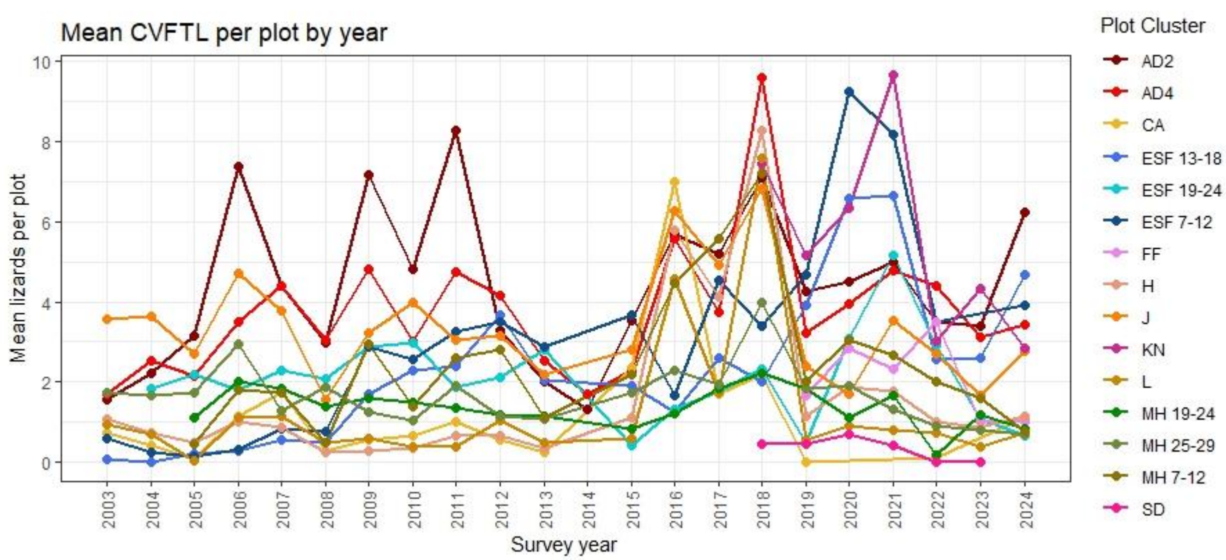


Figure 5. Mean density of CVFTL during spring surveys across plot clusters from 2003 to 2024.

Fall surveys took place from September 29 to October 25, 2023. We saw lower recruitment numbers in the fall of 2023 for most of the plots resurveyed except H on the CVNWR. KN had the highest density of CVFTL hatchlings, however we recorded a slight decrease in adult populations from spring 2023, perhaps due to increased sand compaction and high invasive cover at this site. We performed spring surveys from April 18 to June 22 and despite lower recruitment numbers, we observed higher or similar CVFTL densities at most of our plots during spring surveys. Clusters MH 19-24, MH 25-29, KN and ESF 19-24 saw slight decreases in their populations.

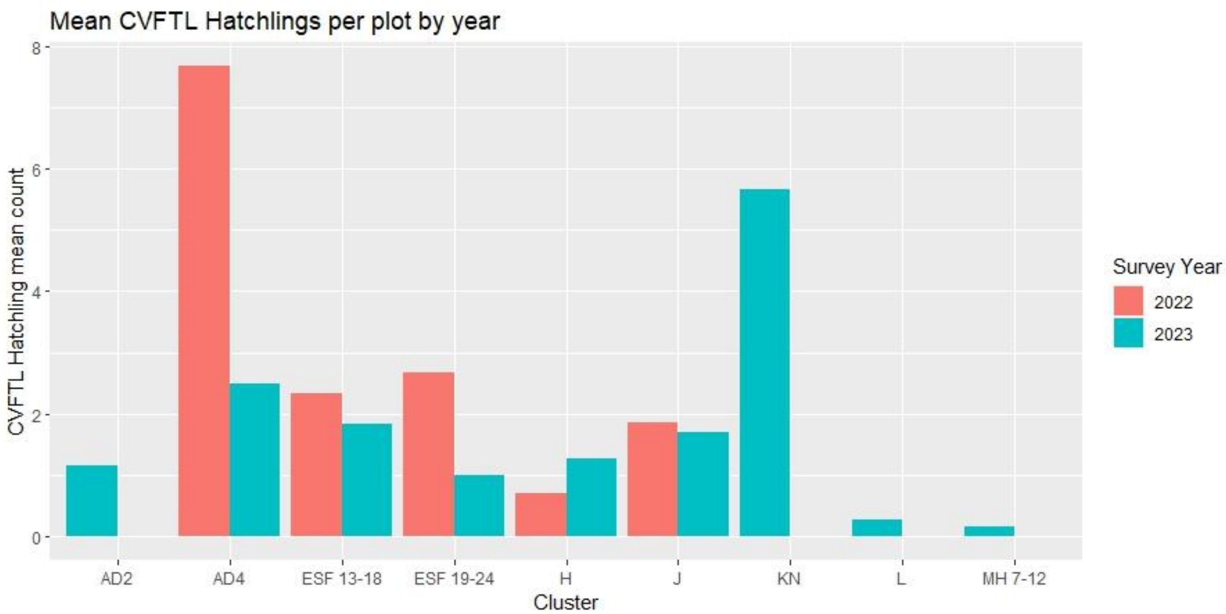


Figure 6. Mean count of hatchlings across plots in fall of 2022 and 2023. We did not survey AD2, KN, L, MH7-12 in the fall of 2022.

4.2.2 Discussion

Declines in recruitment of CVFTL reflect the conditions of the year before, since 2023 experienced low annual plant cover in the spring because of a dry winter. Last year’s spring surveys showed lower populations of CVFTL a finding which corresponds with these environmental stressors and explains the lower recruitment we saw in fall 2023. In the spring of 2024, we observed an increase in the abundance of CVFTL at most plots. These increases can be linked to a few different factors: flooding from tropical storm Hilary coupled with higher winds brought new sand into the dune system which is reflected in lower sand compaction in most of our plots (see section, Sand Compaction) and high annual plant cover (see section, Perennial Plants) which supports the populations of prey arthropods for the CVFTL. Observers noted the increased presence of raven tracks in CVNWR during springtime surveys (Figure 7). This increase may be a result of a change in behavior/detectability, with the same abundance of ravens, which are more apparent if they are leaving tracks on the dunes. A change in behavior of ravens to focus on predating lizards by hunting on the ground would be relevant if it proves to be a verified threat, thus, we will continue to note this consistently in the future. As well, disturbances such as loose dogs, some potentially associated with unhoused individuals west of Gene Autry continue to be a concern, with dog tracks on downwind sand mounds where we frequently observe lizards, and one lizard was found with damage consistent with a canine attack.

4.2.3 Recommendations

We recommend a continuation of this monitoring program for this species, as required under the Plan. Importantly we believe closely documenting landscape changes in these areas, such as considerable flooding causing silt flats to develop within aeolian habitat, and they affect vertebrate populations and how long it takes (or if) the landscape returns to pre-flood conditions. The CVFTL faces threats from these landscape changes because these species depend on the presence of sand for survival. Additionally, we will continue to monitor and consider changes in threats to these species, such as an increasing presence of ravens and the impacts of extreme weather events on populations. Importantly, we will continue to note and report any immediate threats to management during the survey period.

4.3 FLAT-TAILED HORNED LIZARD (*PHRYNOSOMA MCALLII*)

4.3.1 Results

Flat-tailed horned lizards (*Phrynosoma mcallii*, here FTHL), occupy areas of sparse, low vegetation on fine-textured soils, sandy flats, and stabilized sand dunes throughout the Colorado Desert (Belnap et al., 2016), with a distribution as far west as the Whitewater Floodplain that extends east past the Indio Hills and south toward the US/Mexico border. The FTHL's range has since been heavily developed by urban and agricultural projects, resulting in a loss of approximately 92% habitat within the Coachella Valley (Rorabaugh and Young, 2009; Barrows et al., 2008). Current records indicate that the FTHL exists only at the CVNWR and has been extirpated from most of the remaining fragmented suitable habitat within the Coachella Valley, becoming replaced often by the desert horned lizard (*Phrynosoma platyrhinos)* (Barrows et al. 2022).

As with other horned lizards, FTHL subsist almost exclusively on harvester ants, (Pianka and Parker, 1975; Turner and Medica, 1982) especially bearded harvester ants of the genus *Pogonomyrmex* and black harvester ants (*Veromessor pergandei*). Two species of *Pogonomyrmex* live on the CVNWR – the "big-eyed" harvester ant (*P. magnacanthus*) and the more abundant California harvester ant (*P. californicus*); while black harvester ants rarely occur within the sandy areas of the CVNWR (however, see the arthropod monitoring section of this report for details on new sightings here). As with the Coachella Valley fringe-toed lizard, our goal is to ultimately identify natural patterns of density fluctuation in FTHL populations, so that we can recognize if abnormal patterns arise that may warrant management actions.

As shown in Figure 8, FTHL show a fairly regular approximately 5-year cycle of density increases and decreases. Both this year and the 2023 monitoring efforts generally agree with this cycle, and place FTHL population density at a low point in this apparent cycle. The decrease in FTHL continued this year with individuals counted at CA and H plot clusters only and absent at all other plot clusters within the CVNWR.

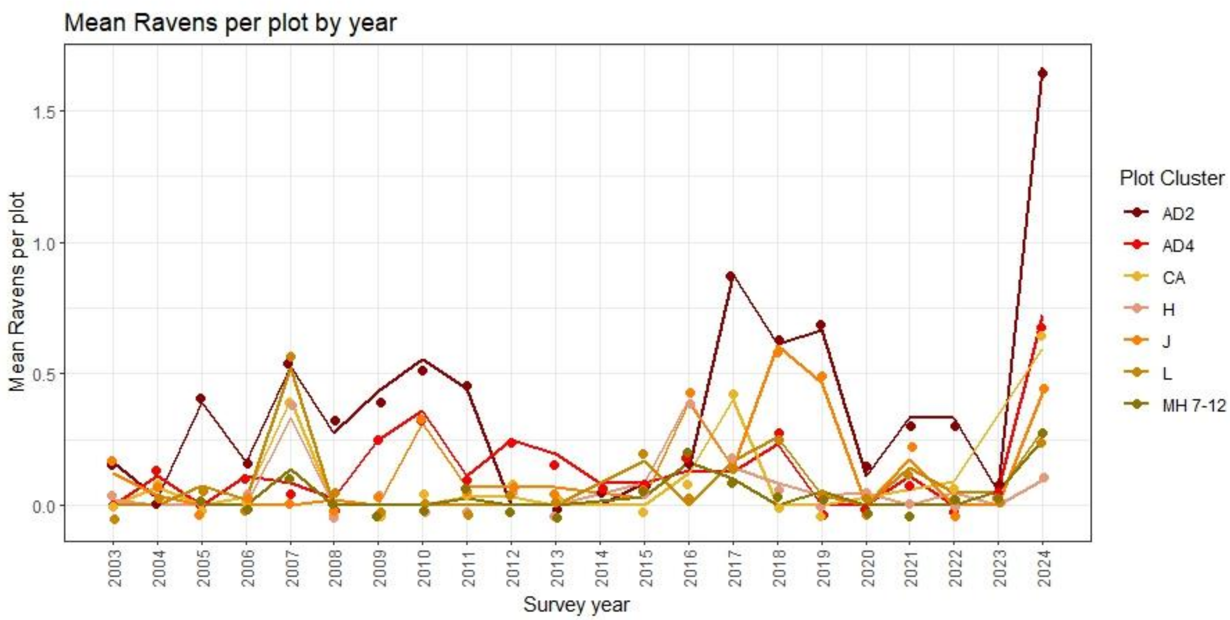


Figure 7. Mean density of ravens during spring surveys on our plots within the CVNWR from 2003 through 2024.

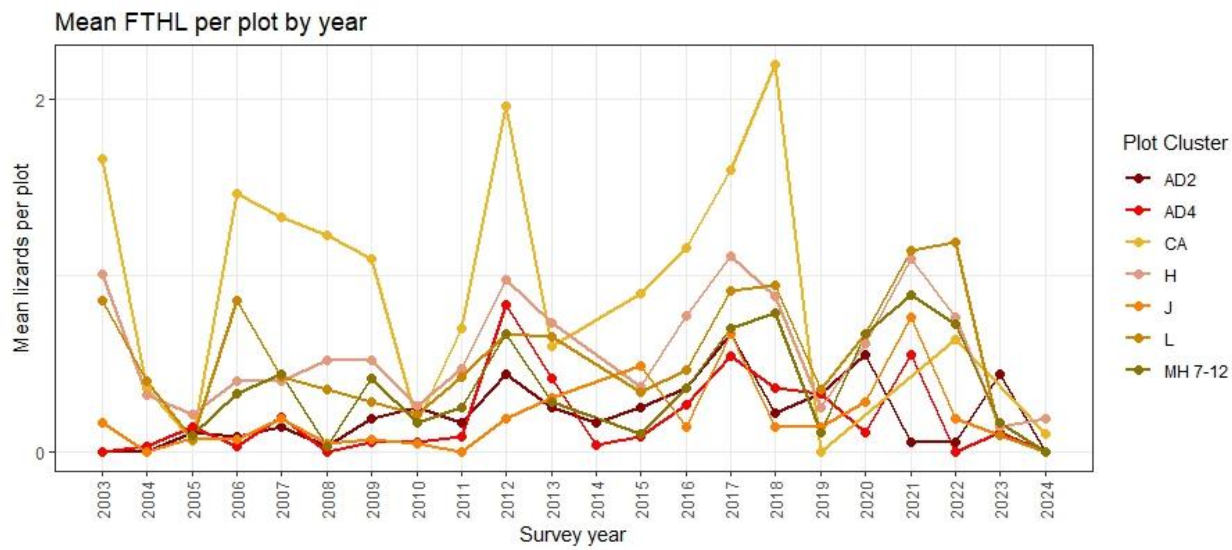


Figure 8. Mean density of FTHL during spring surveys on our plots within the CVNWR from 2003 through 2024.

4.3.2 **Discussion**

On some of our plots, specifically those at CVNWR, we experienced some difficulties surveying this year because of the monsoonal floods that washed out large swaths sand and left behind hard silt. By spring, sand had not been appropriately distributed back into these areas, making surveying difficult among silt patches within our plots. While this made surveys difficult, this may have only influenced our detection, rather than the true abundance of lizards--research has not found a strong correlation between precipitation (and therefore primary productivity/annual plant growth) and sand compaction with FTHL densities (Barrows et al. 2022). However, extreme precipitation such as seen this year may result in different impacts than normal fluctuations in precipitation, and so we should continue to monitor the impact of habitat degradation moving forward. Informal reports from Imperial County indicated that FTHL did not decline in the annual surveys to the south (CDFW, pers. comm), so we are hoping that we have a lack of detection, vs. a real decline this year. Additionally, we have been unable to establish a link between ant density and FTHL density presumably because harvester ant populations remain plentiful enough, even in otherwise resource-starved years, to avoid becoming a limiting factor of the FTHL populations here (Barrows et al. 2022). If these declined below a yet-to-be determined threshold, this may negatively impact the abundance of lizards.

Observations of higher raven presence at the CVNWR led us to examine raven predation as a possible factor contributing to lower FTHL numbers. While this year we recorded high raven presence and therefore cannot rule out raven predation as a contributing factor to lower FTHL numbers, based on our past data, there does not seem to be a strong trend between higher raven numbers and low FTHL numbers (Figure 8). It’s possible that the influx of available resources at the CVNWR following Tropical Storm Hilary attracted a higher number of ravens compared to years with lower productivity.

4.3.3 Recommendations

We recommend a continuation of this monitoring program for each of these species. Importantly, as with the CVFTL, as described above, it is important to continue to follow landscape changes and recovery in these areas, such as the persistence or disappearance of the new silt deposits within aeolian habitat. Additionally, we will continue to monitor and consider changes in threats to these species, such as an increasing presence of ravens and the impacts of extreme weather events on populations.

4.4 PALM SPRINGS ROUND-TAILED GROUND SQUIRREL (*XEROSPERMOPHILUS TERETICAUDUS CHLORUS*)

The Palm Springs Round-Tailed Ground Squirrel (*Xerospermophilus tereticaudus chlorus*, or PSRTGS, also known in Plan materials as the Coachella Valley round-tailed ground squirrel), is a small ground squirrel endemic to the Coachella Valley. Within our plot network we find this species regularly at Willow Hole, FF, and Tipton where the landscape provides both sandy soils and sufficient vegetation to maintain populations. As discussed in our previous annual reports, this species appears susceptible to drought, with populations dwindling during dry years (Ball et al. 2010). The mesquite at Willow Hole, which possess deep roots capable of tapping into ground water, likely provide refuge for PSRTGS in dry years. Similarly, the wetter and cooler climate at Fingal's Finger provides similar stability for PSRTGS to maintain populations.

PSRTGS are extremely elusive, so we rely primarily on track counts to estimate this species' abundance. However, PSRTGS also produce loud alarm calls we use for confirming the presence of the species, and these are distinguished by biologists based on vocal pattern and tone from other ground squirrels that occur in the Valley. We record the number of alarm calls heard during surveys which can be useful in noting occupancy where tracks are otherwise not evident, but we typically refer to tracking data for population density estimates.

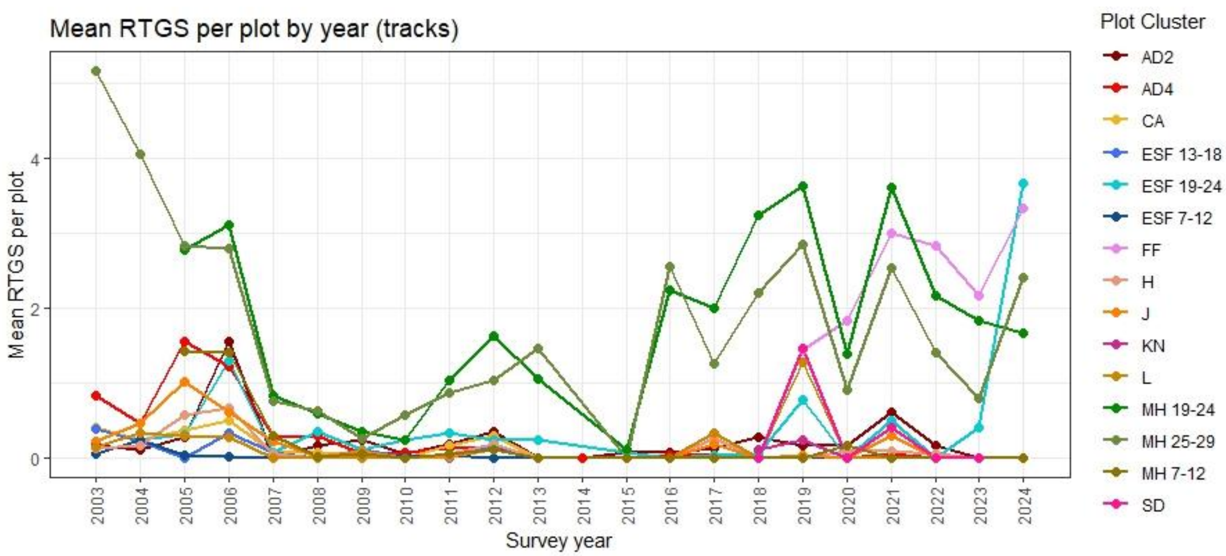


Figure 9. Mean Palm Springs round-tailed ground squirrel densities per plot since 2003. Data shown is for tracking only.

4.4.1 **Results**

We recorded the presence of PSRTGS (tracks and/or alarm calls) at four plot clusters this year: Fingal's Finger (FF), Tipton Road (ESF 19-24), and Willow Hole (MH 19-24, MH 25-29). Fingal's Finger (FF) continues to show relatively high PSRTGS density, with this year being the highest for this location (about 3.3 per plot on average) since monitoring here began in 2018. We also recorded a sharp increase in density at our Tipton Road plots from less than one PSRTGS on average per plot in 2023 to nearly four in 2024. At Willow Hole, we recorded both a decrease (MH 19-24) and an increase (MH 25-29) in density. Both plot clusters at Willow Hole remain at relatively high abundance compared to most plots, but still lower density than FF and ESF 19-24.

4.4.2 **Discussion**

The high density of PSRTGS recorded at our western-most plots (FF and ESF 19-24) reflects a likely preference for cooler, wetter conditions (Ball et al. 2010). However, in spite of abundant precipitation over the last two years (Figure 9) we failed to observe any squirrels at the CVNWR or Whitewater Floodplain. We cannot yet conclude that these squirrels have been extirpated from these areas, especially considering the historically low densities at these plots. Rather, we consider these populations as being too sparse to detect. Also, this squirrel has an apparent preference for habitat providing cover from large, dense shrubs. Fingal's Finger and Tipton Road have abundant, dense creosote, and Willow Hole consists primarily of dense mesquite thickets, which almost certainly helps to promote the dense squirrel populations here based on similar studies in the literature (Ball et al. 2010).

4.5 PALM SPRINGS POCKET MOUSE (*PEROGNATHUS LONGIMEMBRIS BANGSI*)

The Palm Springs pocket mouse (*Perognathus longimembris bangsi*, or PSPM) is a minute heteromyid mouse restricted to the Coachella and Imperial Valleys. It is primarily nocturnal, granivorous, and inhabits areas of sandy creosote scrub (Swei et al. 2003), and regularly occurs throughout our network of aeolian community plots. Its tiny tracks are distinct enough to differentiate it from the similar, larger, desert pocket mouse (*Chaetodipus penicillatus*) which occupies much of the same habitat in the Coachella Valley.

4.5.1 Results

We observed an increase in Palm Springs pocket mouse density at all plot clusters except for Tipton Road (ESF 19-24) and CA (at the CVNWR; Figure 10). Many of the plot clusters saw extremely sharp increases, such as MH 7-12 (CVNWR) increasing from a mean of approximately 0.2 pocket mice per plot in 2023 to about 4.2 in 2024. ESF 7-12 (Whitewater Floodplain) and L, J, and H (CVNWR) also saw sharp increases in pocket mouse density, from a near-zero mean per plot in 2023 to between approximately 2.1 to 3.1 in 2024. Tipton Road (ESF 19-24) continues to display a general decreasing trend since peaking in 2020 at a mean of approximately 3.6 mice per plot to approximately 0.7 per plot in 2024.

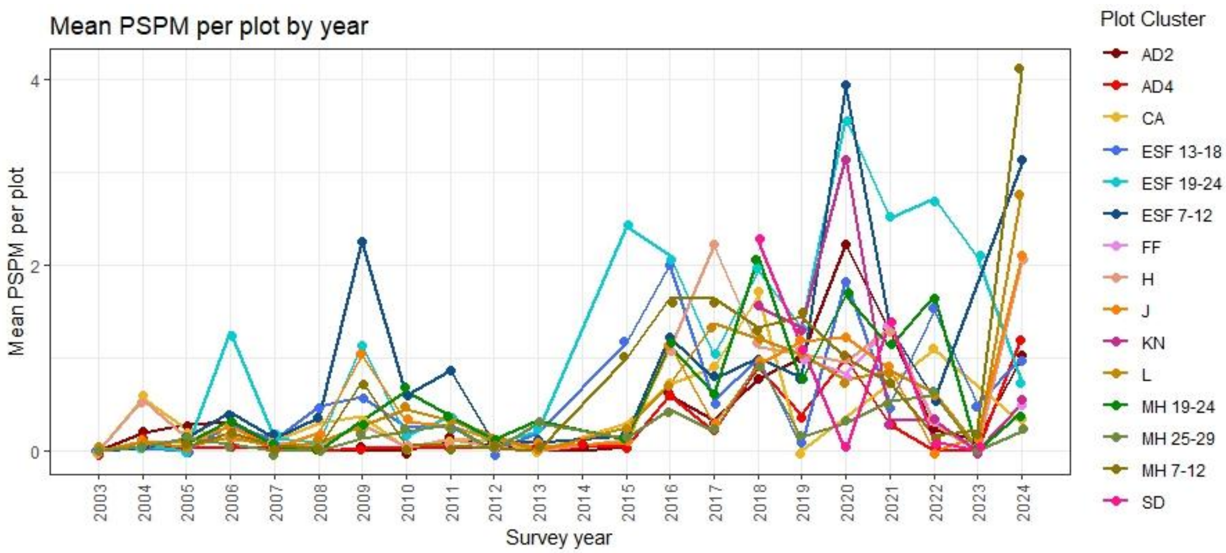


Figure 10. Mean Palm Springs pocket mouse densities per plot since 2003.

4.5.2 Discussion

As discussed in our previous reports, PSPM often exhibit a "lag time" in response to drought, where population recovery after the end of a drought period may not be evident until the following year. The Coachella Valley received low annual precipitation in 2021 (approximately one inch in Indio), but increased precipitation in the fall of 2022 (nearly 2 inches), the summer of 2023 (about 1.5 inches), and the winter of 2024 (about 1.7 inches) (Figure 10). Hence, we can speculate a correlation between several relatively wet seasons, high annual plant growth (increased food availability), and a rebound in PSPM density. The cause of decrease at plot cluster CA on the CVNWR may be related to severe flooding experienced during tropical storm Hilary in the summer 2023, but the likely cause(s) of the decrease at Tipton Road (ESF 19-24) is unclear. A variety of factors may contribute to this decrease here, including increased competition, predation, etc., or other impacts from a possible change in sand texture (coarser sand grains) as impacts their movement and other factors. Additionally, although this was not specifically noted by surveyors, a decrease in detectability of the PSPM tracks in coarser-grained substrate is possible, as the tracks are extremely delicate and shallow.

Overall, simultaneous studies such as the CVCC and partner-coordinated I-10 connectivity and corridor project and studies using small mammal trapping may help discern if there is a change in the population numbers of Palm Springs pocket mice within the western corridor due to unknown causes. Overall, population trajectories are positive, showing recovery after a longer-term drought period.

5 VEGETATION

5.1 ANNUAL PLANT MONITORING

5.1.1 Introduction

Annual plant communities in arid ecosystems can vary widely in species composition, abundance, and density year-to-year, usually in large part in response to the naturally variable of interannual precipitation patterns (Inouye 1991, Guo and Brown 1996). The Coachella Valley on average receives most of its yearly precipitation in the winter, resulting in the bulk of primary productivity occurring in the spring (McHargue 1973, Barrows and Heacox 2021). A second, but typically less substantial, growing period can occur following summer storm events and includes some species that typically only germinate this time of year, including some summer-active C4 grasses and herbs such as fringed amaranth (*Amaranthus fimbriatus*). While summer precipitation is less reliable than winter precipitation, there is great variability the storm totals for summer rainfall events both in amount and the pattern of rainfall across the landscape. The powerful Tropical Storm Hilary in 2023 was unusual, but similar storms have produce an average year's-worth of precipitation (McHargue 1973), such as the storm of September 1976 that causeed widespread flooding as well. Our yearly annual plant-focused surveys take place in the spring, and so most effectively describe the plant communities that rely on winter precipitation.

Figure 11. Examples of quadrats at the start of two different plots (left, stable sand fields at CA; right, mesquite hummock at MH7-12) at the CVNWR (Photos: R.Vincent 2024).

In addition to tracking the population dynamics of native annual plant species, including the federally-endangered and Plan-protected Coachella Valley milkvetch (*Astragalus lentiginosus* var. *coachellae*), our annual plant surveys also provide critical information on how invasive plants utilize aeolian systems and interact with native species. For example, our long-term survey data has revealed important population patterns of Sahara mustard (*Brassica tournefortii*) and how this species affects native plant and wildlife populations (Barrows et al. 2009, Hulton VanTassel et al. 2014, Rodriguez et al. *In Prep*). Continuation of this long-term dataset can help further clarify remaining questions regarding the effects of invasive plants at these aeolian areas, as well as provide critical information on relatively new arrivals to this area, such as stinknet (*Oncosiphon pilulifer*), which will aid in early detection and control efforts.

5.1.2 **Methods**

Our sampling protocol uses 1m² quadrat frames to sample plant cover and density. We place the frame four times each per plot at the 0m, 50m, and 100m poles, for a total of 12 quadrat frame samples per plot (Figure 12). Within the quadrat frame we identified, counted, and visually estimated percent cover of all live annual plants, plus identifiable dead annual plants (noted separately from live) and perennial seedlings that germinated in the summer, winter or spring growing season, July 2023- June 2024. We also recorded total plant cover which includes both annual and perennial plant growth. We visually estimated the percent cover of different substrate types by the same definitions we used for LPI protocol (see section, Perennial Plant Communities: Methods). When estimating percent cover, we record to the nearest whole percentage, meaning that species and ground cover types that are less than 1% are simply recorded as “<1%”. For the purpose of calculating means, this year we used a value of 0.5% to account for all percent cover values below 1%.

In 2024, we conducted annual plant monitoring from late February to May in the spring season of 2024 on 84 of our long-term plots, many of which have been regularly surveyed since 2003 (Figure 1). Data was not collected in 2014 (no funding allocated) and 2021 (due the drought, there was essentially zero annual plant cover which was inadequate to justify the survey effort across sites). Overall, these metrics provide us with species richness, abundance, and habitat composition.

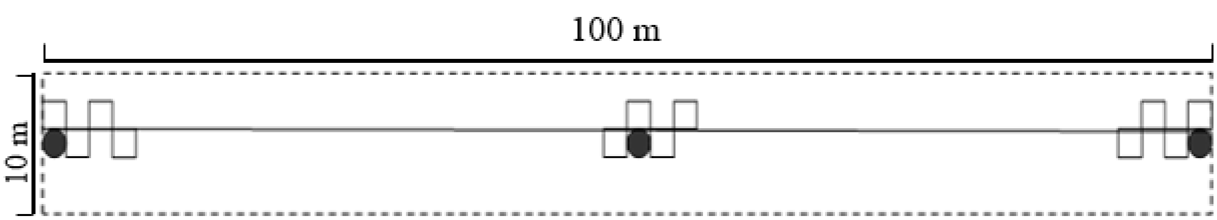


Figure 12. Diagram of quadrat layout along a plot midline.

5.1.3 Results

We observed an overall increase in richness across most plots with the exception of ESF 13-18 on the Whitewater Floodplain which decreased slightly from 2023. Across all plots we documented a total of 88 plant species, 13 of which were non-native. We recorded the highest species richness on CA (42 species) and AD2 (38 species) plot clusters within the CVNWR. These plot clusters are both located near the middle of the Refuge and both received substantial flooding from Thousand Palms Canyon during the summer monsoonal storms in August 2023. We found annual species not typical of aeolian habitat in these clusters and other clusters that saw flooding on the Refuge, such as *Eschscholzia minutiflora* and *Washingtonia filfera*. The mean native percent covers for all plots measured over 1% and saw an increase from 2023 (Figure 13). Notably, clusters CA (19.4%), L (17.5%), and MH 7-12 (14.8%) on the CVNWR had the highest native species mean percent cover (Table 2) which coincides with areas that flooded during the 2023 summer rains. A note on taxonomy: different from previous years, we have not assigned all observations of grasses in the genus *Schismus* to the species *S. barbatus*, recognizing that we are not distinguishing them in the field from the ecologically-similar invasive grass, *S. arabicus* which may also be present. This change should have no impact on comparability to previous reports, as all were previously lumped into *S. barbatus*, and they are now lumped under the genus, *Schismus* sp.

Table 2. Summarizing the annual plant species richness as well as mean total percent cover of native annuals and total cover of non-native annuals, *Brassica tournefortii*, and *Schismus* sp. by plot cluster for the 2024 spring quadrat surveys.

Plot Cluster	Species Richness	Native % Cover (Mean)	Invasive % Cover (Mean)	*Brassica tournefortii* % Cover (Mean)	*Schismus* sp. % Cover (Mean)
AD2	38	5.1	3.4	0.5	2.9
AD4	21	1.7	0.7	0.6	0.1
CA	42	19.4	2.8	2.1	0.7
ESF 07-12	10	2.4	0.0	0.0	0.0
ESF 13-18	8	1.3	0.0	0.0	0.0
ESF 19-24	23	2.9	0.3	0.0	0.2
FF	24	1.9	1.6	0.7	0.7
H	25	7.5	0.5	0.4	0.2
J	24	5.5	0.8	0.4	0.4
KN	23	5.1	5.7	4.7	1.0
L	24	17.5	1.1	0.7	0.2
MH 19-24	30	2.4	1.0	0.5	0.3
MH 25-29	22	1.7	1.6	0.8	0.8
MH 7-12	22	14.8	1.3	0.6	0.1

Most plot clusters saw an increase in non-native plant mean percent cover from 2023, though remaining at a low level (<5%) in most cases; only plot cluster FF decreased slightly from 2023 (Figure 15). Despite these increases from last year, mean non-native percent cover remained low at less than 5% for every plot cluster except KN which had 5.7% non-native cover and was the only plot cluster where non-native cover exceeded native percent cover (5.1%) (Table 2). We saw less than 1% difference in percent cover values between native and non-native plants for clusters MH 25-29 and FF (Table 2). We documented the highest percent cover of *Brassica tournefortii* at KN and CA plots where they made up a majority of non-native plant cover for those clusters. We saw the highest percent cover of *Schismus* sp. at AD2 where it made up most of the non-native plant cover for this cluster.

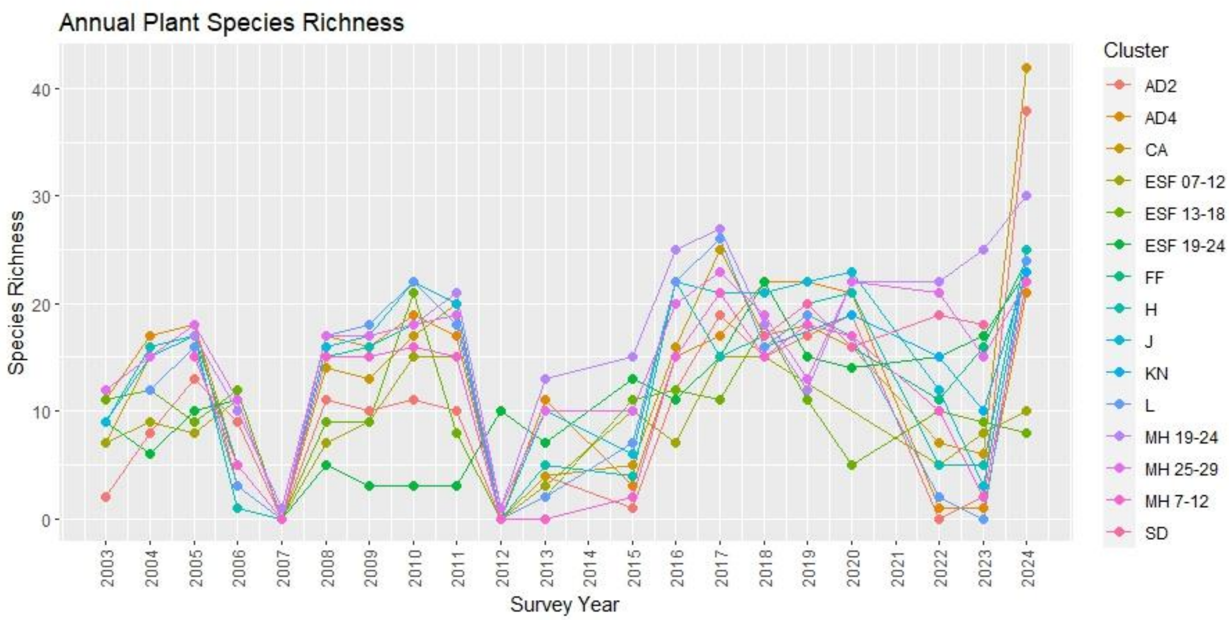


Figure 13. Annual plant species richness per plot cluster from 2003 to 2024. Data was not collected in 2014 (no funding allocated) and 2021 (due to the drought). Points represent the total number of species recorded at each plot cluster per survey year.

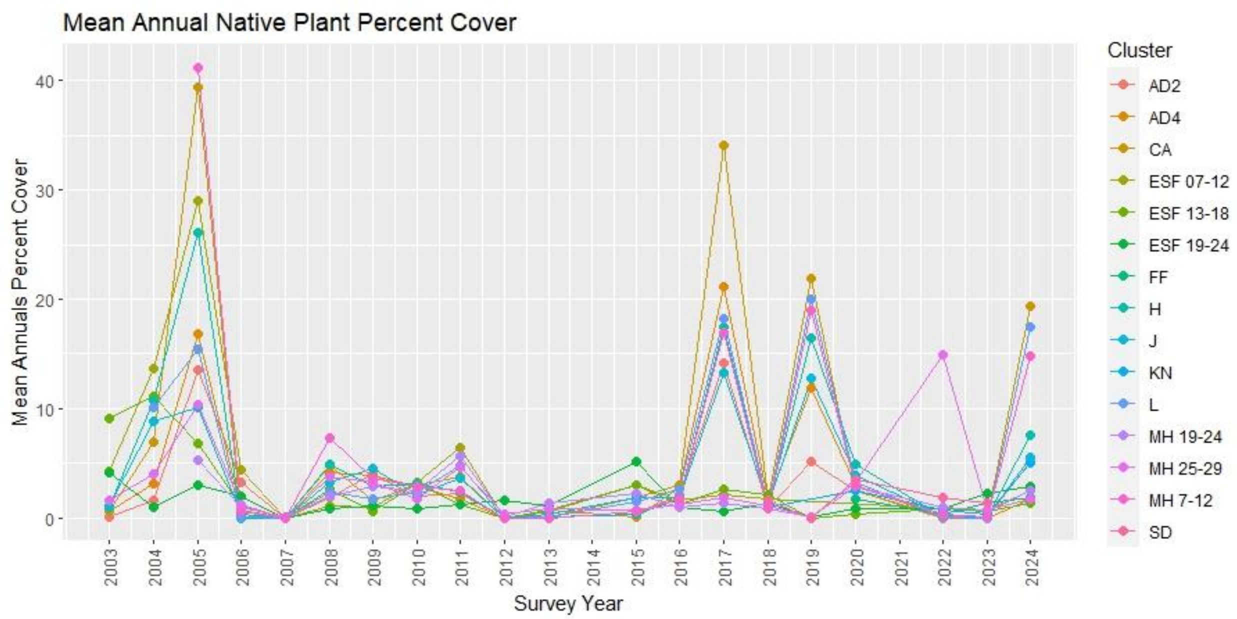


Figure 14. Mean annual native plant percent cover per plot cluster from 2003 to 2024. Data was not collected in 2014 and 2021.

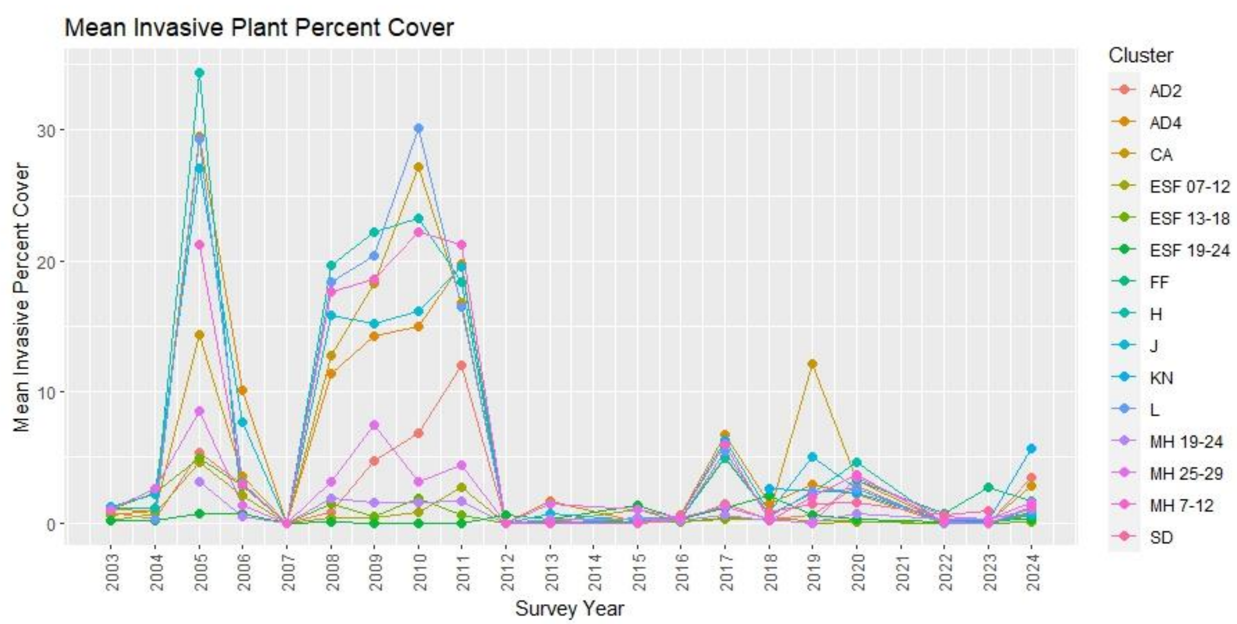


Figure 15. Mean non-native annual plant percent cover per plot cluster from 2003 to 2024. Data was not collected in 2014 and 2021.

Table 3. All plant and fungus species documented as rooted within 1m² quadrat frames in 2024. We only counted shrubs as seedlings. We counted perennial grasses and herbs if they appeared to have germinated within the survey season. Percentage represents the number of quadrats the species occurred in over the total number of quadrats across all sites (n=948). F = fungi; AH – annual herb; PH = perennial herb; AG = annual grass; PG = perennial grass; SH = shrub; T = tree. Red text represents non-native species. Green cells represent species that were documented within these surveys for the first time (2003-2023). Asterisk indicates species that were excluded from species richness analyses due to lack of species level identification and the potential for duplicate documentation.

Family	**Scientific Name**	**Common Name**	**Lifeform**	**% Occurrence**
Agaricaceae	Montagnea arenaria*	Desert inkcap	F	0.1%
Amaranthaceae	Amaranthus sp.	Amaranthus species	AH	0.7%
Arecaceae	Washingtonia filifera	California fan palm	T	0.3%
Asteraceae	Ambrosia dumosa	Burrowbush	SH	0.1%
	Ambrosia salsola	Cheese bush	SH	0.1%
	Asteraceae sp.	Aster species	AH	0.3%
	Baileya pauciradiata	Lax flower	AH	4.7%
	Chaenactis fremontii	Desert pincushion	AH	1.6%
	Dicoria canescens	Desert twinbugs	AH	31.6%
	Encelia farinosa	Brittlebush	SH	0.1%
	Geraea canescens	Desert hairy sunflower	AH	10.1%
	Isocoma acradenia	Alkaline goldenbush	SH	0.5%
	Logfia depressa	Dwarf cottonrose	AH	0.8%
	Malacothrix glabrata	Desert dandelion	AH	1.1%
	Palafoxia arida	Spanish needle	AH	23.7%
	Perityle emoryi	Rock daisy	AH	0.3%
	Rafinesquia neomexicana	Desert chicory	AH	0.1%
	Sonchus oleraceus	Sow thistle	AH	0.1%
	Stephanomeria exigua	Small wire lettuce	AH	4.4%
Boraginaceae	Cryptantha micrantha	Redroot cryptantha	AH	10.9%
	Johnstonella angustifolia	Narrow-leaved cryptantha	AH	40.5%
	Pectocarya recurvata	Arch nut combseed	AH	0.3%
	Pectocarya sp.	Combseed species	AH	0.4%
Brassicaceae	Brassica tournefortii	Saharan mustard	AH	27.3%
	Descurainia pinnata	Western tansy mustard	AH	1.7%
	Dithyrea californica	Spectacle pod	AH	0.7%
	Lepidium lasiocarpum	Shaggyfruit pepperweed	AH	0.5%
	Sisymbrium irio	London rocket	AH	0.9%
Caryophyllaceae	Achyronychia cooperi	Frost mat	AH	3.9%
	Loeflingia squarrosa	Speading pygmyleaf	AH	0.1%
Chenopodaceae	Atriplex canescens	Fourwing saltbush	SH	21.5%

	Atriplex polycarpa	Cattle spinach	SH	9.8%
	Atriplex sp.*	Saltbush species	SH	0.2%
	Chenopodium album	White goosefoot	AH	0.3%
	Chenopodium sp.	Goosfoot species	AH	0.2%
	Salsola tragus	Russian thistle	AH	4.7%
	Suaeda nigra	Bush seepweed	SH	0.3%
Crassulaceae	Crassula connata	Sand pygmyweed	AH	0.1%
Ehretiaceae	Tiquilia plicata	Fanleaf crinklemat	PH	14.5%
Euphorbiaceae	Croton californicus	California croton	PH	3.2%
	Euphorbia ocellata	Dune spurge	AH	1.9%
	Euphorbia sp.	Spurge species	AH	0.1%
	Stillingia linearifolia	Linear leaved stillingia	PH	0.6%
	Stillingia spinulosa	Broad leaved stillingia	AH	0.8%
Fabaceae	Acmispon strigosus	Strigose lotus	AH	0.5%
	Astragalus aridus	Desert milkvetch	AH	2.1%
	Astragalus didymocarpus	Dwarf white milk vetch	AH	0.3%
	Astragalus lentiginosus var. coachelleae	Coachella Valley milkvetch	AH	2.6%
	Dalea sp.	Dalea species	AH	0.1%
	Lupinus arizonicus	Arizona lupine	AH	0.6%
	Lupinus shockleyi	Shockley's lupine	AH	0.4%
	Psorothamnus aborescens	Mojave indigo bush	SH	4.9%
	Psorothamnus emoryi	Dyebush	SH	0.4%
	Psorothamnus schottii	Schott's indigo bush	SH	0.1%
Geraniaceae	Erodium cicutarium	Redstem stork's bill	AH	0.1%
Hydrophyllaceae	Phacelia crenulata	Notch-leaved phacelia	AH	0.3%
	Phacelia distans	Lace leaf phacelia	AH	0.1%
	Phacelia sp.*	Phacelia species	AH	0.1%
Lamiaceae	Salvia columbariae	Chia	AH	0.1%
Loasaceae	Mentzelia albicaulis	White stemmed blazing star	AH	1.9%
	Petalonyx thurberi	Sandpaper plant	SH	1.3%
Malvaceae	Eremalche exilis	Dune mallow	AH	13.0%
Montiaceae	Calyptridium monandrum	Common pussypaws	AH	0.1%
Nyctaginaceae	Abronia villosa	Desert sand verbena	AH	30.0%
Onagraceae	Camissoniopsis pallida	Pale yellow sun cup	AH	2.0%
	Chylismia claviformis	Brown-Eyed primrose	AH	37.2%
	Eremothera boothii	Booth's sun cup	AH	0.2%
	Eulobus californicus	California primrose	AH	0.7%
	Oenothera deltoides	Birdcage evening primrose	AH	22.5%
Papaveraceae	Eschscholzia minutiflora	Pygmy poppy	AH	0.6%
Plantaginaceae	Antirrhinum filipes	Twining snap dragon	AH	0.1%

	Plantago ovata	Desert plantain	AH	1.4%
Poaceae	Aristida sp.	Three-awn species	UNK	0.1%
	Bromus rubens	Red brome	AG	0.9%
	Bromus tectorum	Cheatgrass	AG	0.5%
	Hilaria rigida	Big galleta grass	PG	0.5%
	Hordeum marinum	Seaside barley	AG	0.1%
	Panicum urvilleanum	Desert panic grass	PG	0.5%
	Poaceae sp.*	Unknown grass seedling	UNK	0.5%
	Polypogon monspeliensis	Rabbitsfoot grass	AG	0.3%
	Schismus barbatus	Mediterranean grass	AG	33.1%
	Stipa hymenoides	Desert rice grass	PG	5.2%
Polemanaceae	Eriastrum eremicum	Desert woollystar	AH	2.1%
	Gilia stellata	Star gilia	AH	0.1%
	Linanthus sp	Phlox species	AH	0.1%
	Loeseliastrum schottii	Schott's calico	AH	2.2%
	Chorizanthe brevicornu	Brittle spineflower	AH	0.3%
	Eriognum inflatum	Desert trumpet	AH	0.1%
	Eriogonum thurberi	Thurber's buckwheat	AH	0.1%
Resedaceae	Oligomeris linifolia	Lineleaf whitepuff	AH	0.1%
Solanaceae	Nicotiana obtusifolia	Desert tobacco	AH	1.1%
	Physalis crassifolia	Thick-leaved ground cherry	AH	0.1%
Zygophyllaceae	Larrea tridentata	Creosote bush	SH	1.3%
Unknown	Unknown species 1*	Unknown species 1	UNK	0.1%
	Unknown species 2*	Unknown species 2	UNK	0.1%

5.1.4 **Discussion**

We saw a flourish of annual plant activity and increased plant biodiversity as a result of the summer rains in 2023 followed by strong winter rains in 2023-2024 across the Coachella Valley (NOAA 2024). In our plots we saw a cover and number of annual species not matched in recent years, especially at the CVNWR, where we recorded some of the highest cover of plants and richness out of all our plots. We also recorded additional species most likely transported in during flooding, from upstream riparian and alluvial habitats in Thousand Palms Canyon and environs, as seeds that germinated in our study sites after sufficient winter rains (see Table 3). The changes in substrate contributes to the persistence of these species as we found many of these species along the silt beds where floods removed the soft sand. While these changes allowed certain unusual species to survive on the CVNWR this year, it will be interesting to see if they can persist in their new, unusual localities. If weather patterns become more dry and sand moves back into the local habitat, it may become unsuitable for these unusual species to continue to persist at the CVNWR.

We predict that increase in annual plant cover, with associated increases in the number of flowers, and seeds being produced, will likely result in a larger soil seed bank within our study areas. In turn, another benefit to the increase in native plant cover is that this increase in seed production sustains important mammal and ant populations, the latter being a necessary food source for some lizards. Additionally, increased plant cover provides shelter for lizards against predators. Fortunately, much of this increase was composed of native plants by the spring of 2024; while we documented a small increase in non-native species occurrences throughout our plots, the native species largely established much earlier in the season, and dominated the landscape. It should be noted that the early season native cover as asssessed by the perennial plant surveys in the fall, was dominated by a select suite of species, with the three most dominant, *Oenothera deltoides*, *Abronia villosa* and *Gerea canescens* (data not shown), and by the time of spring surveys, the full suite of native annual species was apparent. While overall cover of non-native plants was relatively low, we documented high cover of *B. tournefortii* at the KN plot cluster in the middle of the Valley, which sees abundant OHV activity. Later in the season, we noticed that there was a high cover of *Salsola tragus* on the Refuge that did not get adequately represented recorded during our annual surveys. Although this is a non-native plant, as shown by prior studies, this late season persistence of high plant cover benefits lizards by providing shelter from predators (Barrows et al., 2009).

During annual surveys at Willow Hole (MH 19-24, MH 25-29), we noticed the persistence from last year of non-native invasive stinknet (*Oncosiphon pilulifer)* in a patch between two of our plots. We also found a new occurrence for the speces this year patch between plots ESF-23 and ESF-24 in the floodplains by Tipton Rd. (ESF 19-24). We notified CVCC and control was implemented by management within days. The Willow Hole stinknet patch was visited again in June during vertebrate surveys and one of our staff members along with a CVCC staff member pulled a patch of plants that had gone to seed, placed them in a plastic trash bag on-site, and removed them for proper disposal. In June 2024, our staff members pulled the patch at ESF 19-24 that had gone to seed and disposed of them in a similar manner. The patch at the ESF 19-24 plot cluster intersects with the San Gorgonio River near the Pacific Crest Trail. We believe that hikers and flood waters here could contribute to the spread of stinknet seed throughout the Coachella Valley and education and eradication upstream should be considered. While we did not document this invasive plant on our plots, we find it important to monitor its progress to anticipate areas of concern and continue coordinating eradication efforts.

5.1.5 Recommendations

Continued monitoring of species composition of annual plants across our long term monitoring sites will provide us with an understanding of factors that affect habitat health. We will continue to monitor *O. pilulifer* near our plots and pull on-site following appropriate containment procedures and recommend eradication efforts and education to reduce the spread of this invasive species.

5.2 PERENNIAL PLANT COMMUNITIES

5.2.1 Introduction

The long-term sustainability of aeolian habitats is partially determined by fluctuations in their plant communities, which impact sand retention, patterns of accumulation, and stabilization. Stabilization of sand fields can reduce prey and forage availability for animal species living within aeolian habitats, such as those monitored under the CVMSHCP Plan. The perennial plant community structures the habitat long-term, and the annual plant community heavily influences inter-annual variability in habitat for aspects such as ground cover and seed sources for granivorous animals. We perform surveys in the fall to capture the condition of ground cover, as it is highly relevant to the amount of cover available to hatchling lizards and likely many other species (Barrows and Allen 2010). In this section, we aim to understand and measure long-term diversity and stability of perennial plants in aeolian habitats as a measure of conservation success and how environmental and anthropogenic pressures may change these vegetation stands over time.

5.2.2 Methods

We conducted all surveys on our long-term plot network of 84 0.1 ha plots (Figure 1; and as described in Methods: Aeolian Community Plot Network). In 2022 we implemented the widely-used, standardized methodology of the line-point intercept method of plant community monitoring (hereafter LPI) as a replacement for the previous use of the belt-transect and line-intercept methods. Our goal in switching to LPI is to decrease the error when used in sparsely vegetated communities such as aeolian systems (Mueller-Dombois et al. 1974, University of Idaho 2009, Drezner et al. 2021, UCR 2022, USDA n.d.). This methodology is designed to capture changes in species richness, canopy density, and substrate type over time and is usable and repeatable across a wide range of habitats.

At each plot, we ran a 100 meter measuring tape down the midline of the 0.1 ha plot to mark where measurements are taken (Figure 17). Each plot midline (transect) has permanent fiberglass poles every 25m, (0m, 25m, 50m, 75m, and 100m) to aid in laying a consistently positioned midline year-to-year. We laid the transect line as close to the ground as possible and pulled it taut before taking measurements. Surveyors began at the 0m pole and working towards the 100m pole, walked on one side of the line, and dropped a 30” 15.5-gauge (1.75mm) wire pin flag (hereafter referred to as “the pin”) on the other side directly next to the line. We took measurements every meter on the half-meter (0.5, 1.5, 2.5…99.5) to help avoid influence from the fiberglass poles (Figure 17). We held the pin vertically and perpendicular to the tape, lined it up at each half meter point, and released it approximately 6” from the ground. To avoid bias, we did not guide the pin from the tape to the ground, allowing the pin to fall freely rather than precisely on the mark. We recorded everything that was touching the pin according to the four positional categories: Top Canopy, Lower Canopy, Litter, and Soil Surface (Figure 18). We took soil compaction measurements using a Pocket Penetrometer (AMS Inc.) every 4 meters, totaling 25 measurements every transect, along the midline.

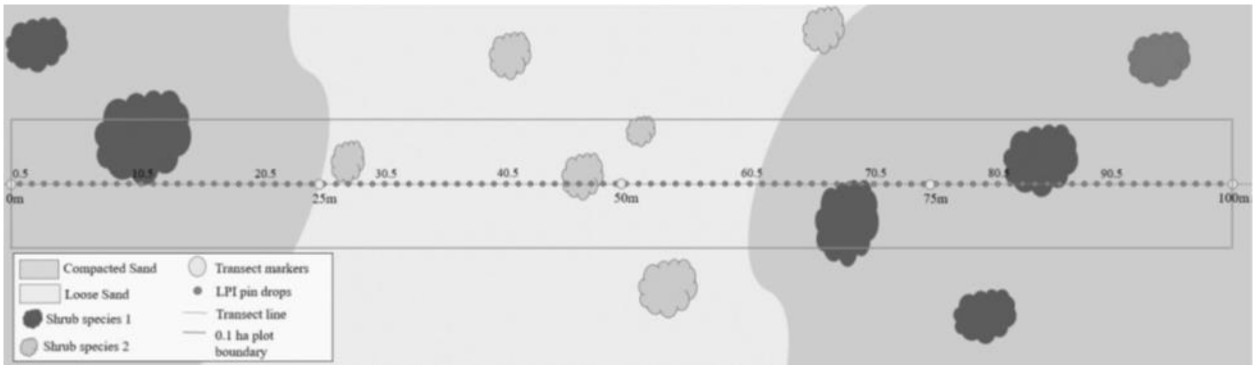


Figure 16. Illustrated example of the line-point intercept protocol, showing pin drops every meter on the half-meter mark down the centerline of the 0.1 ha plot. This example shows 9 intercepts for shrub species 1 (9% cover), 5 intercepts for shrub species 2 (5% cover), 35 intercepts for loose sand (35% cover), and 65 intercepts for compacted sand (65% cover).

We recorded the top canopy as the first rooted plant the pin touched, alive or dead. We considered a plant dead only if the entirety of the individual was dead; if the pin hit a dead or portion of a live plant, as counted, this was still part of a live plant. If we could not identify the species of a dead perennial shrub, we recorded it as an unknown dead shrub. We identified all live plants to species, or variety if known.

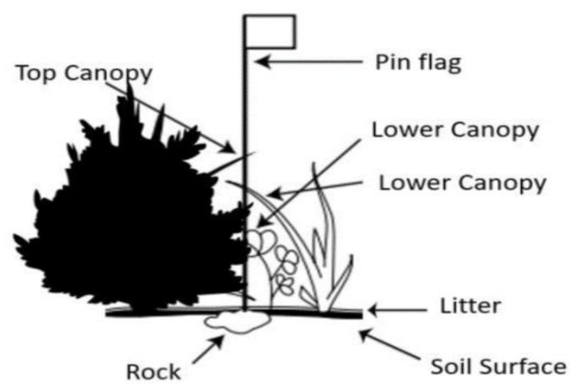


Figure 17. Illustrated example of a pin intersecting cover categories. Adapted image from USDA, n.d..

The bulk of the annual plant biomass is dead or dormant by the fall; however, fall surveys serve to tally the surface cover and habitat, composed of perennial shrubs, dead annual herbs, long-lived perennial herbs, and live and dead summer annual herbs. We identified live and dead annual species, if rooted, to the degree possible using field identification (we did not collect samples). If not identifiable, we documented plants as "annual forb" and grasses as "unknown grass." We recorded non-native species, dead or alive, to species level as well. We classified unrooted plant matter as follows: windblown debris as "litter", understory leaf litter as "duff", or coarse woody debris as "wood". Lastly, we recorded the soil surface types: blow sand, compacted sand, large rocks, small rocks, and silt, defined by the size of granules and compaction. We classified blow sand as loose sand on the ground surface that could be moved with 20 mph winds and with granules larger than silt (0.5-2mm). We defined compacted sand as sand that was stabilized, or not easily moved by wind and with granules less than 2 mm in diameter (Moorberg and Crouse 2021). While sand compaction may be measured as a continuous variable from very loose to well-compacted; defining a threshold between blow and compacted sand remains challenging. We consider the defining line between blow and compacted sand to be attributed by how Plan protected species use sand within habitats for cover and camouflage. We identified silt as a very fine substrate lacking easily visible granules like sand. We defined small rocks as having a diameter from 2 – 10 mm and large rocks as having greater than 10 mm diameter (USDA n.d.).

All cover types are calculated as a percent for each plot by averaging the number of intercepts per category across the number of pin drops total at the site, using the following equation:

$$Cover\ of\ spp\ A = \left(\frac{\#\ spp\ A\ intercepts}{total\ \#\ drops}\right) \text{ x } 100$$

5.2.3 Results

We conducted this set of surveys from October 2023 through January 2024. Plot clusters varied between 5-7 plots per cluster except for Fingal’s Finger and Kim Nicol which both have 3 plots per cluster (Figure 1). We documented 18 species of perennial plants (10 shrubs/trees, 4 perennial herbs and 4 perennial grasses) (Table 4) and calculated the mean number of perennial plant intercepts per plot by cluster, which is approximately equivalent to mean percent cover. *Larrea tridentata* was the only perennial species present across all plot clusters and among other dominant species, *Atriplex canescens* was present at all plot clusters at the CVNWR as well as MH 19-24 and MH 25-29 (Willow Hole). While the change in cover was not tested statistically, the following general trends were observed, which may also be attributable to slight variations in sampling. We saw an increase in mean live perennial plant cover from 2023 to 2024 at all plot clusters except for AD2, AD4, J, and CA, which slightly decreased, and at MH 7-12 which had no change in perennial plant cover (Figure 17). Fingal’s Finger (FF) had the highest perennial plant cover, approximately 24%, which is an increase of 8% from 2023. ESF 19-24 (Tipton Road), MH 19-24 and MH 25-29 (Willow Hole) also exhibited high cover, at 20%, 21%, and 17%, respectively. The lowest cover for all three years was MH 7-12 (1%) at the CVNWR.

We included annual plants in our analysis to determine whether the increase in summer rain impacted the number of annuals we saw in the fall, either as spring annuals past late phenology (dead) or as summer/fall-active growing phenology. We counted 13 annual species during the LPI survey (Table 4) with dramatic increases of native species in most of our plots compared to 2022 and 2023. We observed decreases in AD2, AD4 and J, where we recorded no annual plants this year (Figure 20). *Dicoria canescens,* a spring annual with an exceptionally long growing season that reaches peak size in the fall, was present at all the plot clusters in the western part of the valley (WWFP, West Valley, West Indio Hills). Plot clusters CA, ESF 19-24 and FF had the highest cover of native annuals with approximately 11%, 7% and 6% respectively. Fingal’s Finger (FF) also consistently showed the highest non-native cover across all three years: 2022 (13%), 2023 (5%), and 2024 (12%).

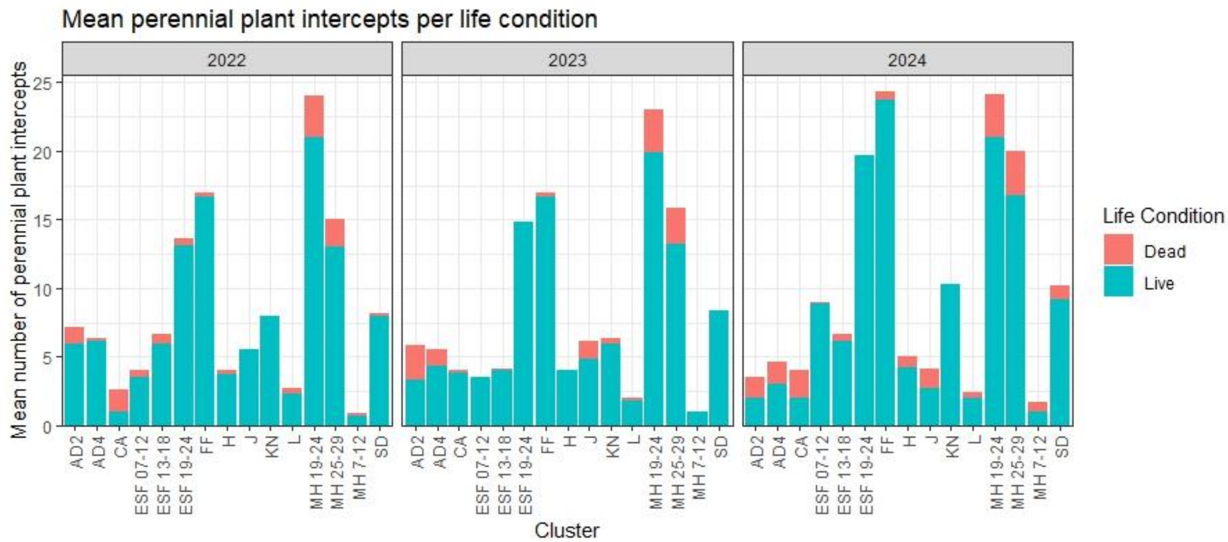


Figure 18. Mean number of live and dead perennial plant intercepts per plot for each cluster for 2022, 2023, and 2024. Mean number of intercepts is approximately equal to mean percent cover.

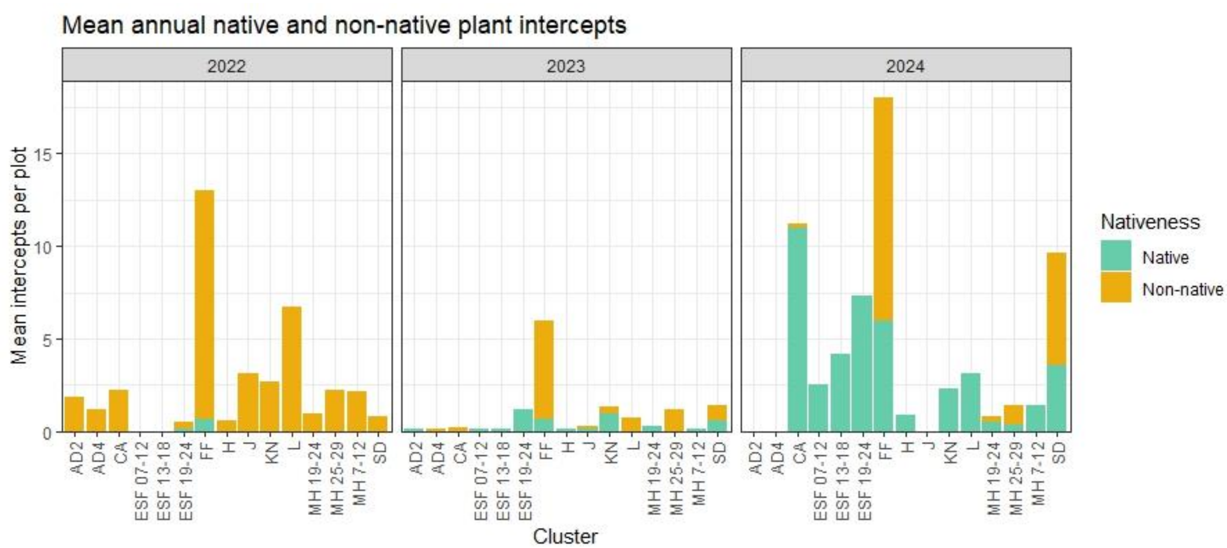


Figure 19. Mean number of live and dead annual plant intercepts per plot for each cluster for 2022, 2023, and 2024. Mean number of intercepts is approximately equal to mean percent cover.

Table 4. Species, growth form, and mean percent cover of plants recorded at each plot cluster surveyed this year. White cells indicate the presence of a species at a plot cluster and black cells indicate a species was not recorded at a particular plot cluster.

		CVNWR							WWFP		West Valley		West Indio Hills			
Lifeform	**Species**	**AD2**	**AD4**	**CA**	**H**	**J**	**L**	**MH 07-12**	**ESF 07-12**	**ESF 13-18**	**ESF 19-24**	**FF**	**KN**	**MH 19-24**	**MH 25-29**	**SD**
Perennial Shrubs*	*Ambrosia dumosa*											■	■	■		
	Atriplex canescens	■	■	■	■	■	■	■						■	■	
	Atriplex polycarpa			■	■		■	■						■		
	Isocoma acradenia													■		
	Krameria bicolor											■				
	Larrea tridentata	■	■	■	■	■	■	■	■	■	■	■	■	■	■	■
	Petalonyx thurberi										■					
	Prosopis glandulosa var. torreyana													■	■	
	Psorothamnus arborescens								■	■	■					
	Psorothamnus emoryi														■	■
Perennial Shrubs - Dead*	*Atriplex canescens*	■	■			■	■							■	■	
	Atriplex polycarpa			■	■	■										
	Atriplex species	■		■	■		■							■		
	Larrea tridentata			■	■										■	
	Prosopis glandulosa var. torreyana							■						■	■	
	Psorothamnus arborescens								■	■						
	Psorothamnus emoryi													■	■	■
Perennial Herbs**	*Croton californicus*									■	■	■	■	■	■	■
	Datura wrightii			■												
	Tiquilia palmeri															■
	Tiquilia plicata		■						■	■	■				■	
Perennial Grasses	*Hilaria rigida*												■			
	Panicum urvilleanum										■					
	Stipa hymenoides										■	■	■			
	Perennial grass species											■				
Exotic Annuals**	*Amaranthus albus*						■									
	Brassica tournifortii			■								■			■	■
	Salsola tragus											■				
	Schismus barbatus											■		■	■	■
Native Annuals**	*Abronia villosa*			■	■		■	■				■				
	Ambrosia acanthicarpa										■					
	Astragalus lentiginosus var. coachellae										■					
	Chaenactis fremontii															■
	Cryptantha micrantha															■
	Descurania pinnata													■		
	Dicoria canescens								■	■	■	■	■	■	■	■
	Gerrea canescens			■												
	Johnstonella angustifolia															■
	Native annual forb species											■			■	
	Oeoethra deltiodes			■									■			
	Palafoxia arida			■	■		■	■			■		■		■	■
	Stephanomeria exigua												■	■		
Total % Cover by Lifeform	Perennial Shrubs*	0.02	0.03	0.02	0.04	0.03	0.02	0.01	0.07	0.04	0.17	0.2	0.08	0.21	0.15	0.08
	Perennial Shrubs - Dead*	0.02	0.02	0.02	0.01	0.01	0	0.01	0	0	0	0	0	0.03	0.03	0
	Perennial Herbs**	0	0	0	0	0	0	0	0.02	0.03	0.01	0.03	0.01	0.01	0.02	0.02
	Perennial Grasses	0	0	0	0	0	0	0	0	0	0.03	0.02	0.02	0	0	0
	Exotic Annuals**	0	0	0	0	0	0	0	0	0	0	0.12	0	0	0.01	0.06
	Native Annuals**	0	0	0.11	0.01	0	0.03	0.02	0.03	0.04	0.07	0.06	0.03	0.01	0.01	0.04

5.2.4 **Discussion**

This marks the third year that we used LPI to effectively monitor perennial plant community structure and the condition of the sand substrate throughout our aeolian plot network. This year we saw an increase in overall plant cover across most of our plots which is an indication of how perennial and annual plants respond to intense monsoonal precipitation, such as with Tropical Storm Hilary.

This protocol serves as a valuable supplement when performing this protocol in the fall and winter as it has proven effective at providing insight into often-overlooked late summer and fall growth. Continuing to perform this post-monsoon monitoring will help us understand how annual plants in aeolian habitats, including important invasive species such as Sahara mustard, respond to monsoon precipitation. This will be critical in the future if the Coachella Valley can indeed expect to experience more frequent extreme monsoonal weather conditions, in which case summer and fall plant growth will become more important in the shaping of aeolian communities.

5.2.5 **Recommendations**

We will continue monitoring during the fall-winter field season, as this also provides an opportunity to track the effects of this more atypical fall in the Coachella Valley on both perennial and annual plant communities across our aeolian habitat plot network. We recommend continuing to build on this LPI dataset with further fall/winter surveys to capture the results of summer growth. Adding additional years of data will greatly improve the ability to leverage this data into management actions.

6 COACHELLA VALLEY MILKVETCH (*ASTRAGALUS LENTIGINOSUS* VAR. *COACHELLAE*

6.1 INTRODUCTION

Figure 20. Coachella Valley milkvetch in flower, May 2024 (Photo: L. Sweet 2024).

Coachella Valley Milkvetch, *Astragalus lentiginosus* (Douglas) Barneyby var. *coachellae* [Fabaceae] (hereafter CVMV;Figure 20, Figure 21) is a plant endemic to the Coachella Valley that occurs throughout a wide portion of the CVMSHCP area. CVMV is categorized as California Rare Plant Rank (CRPR) 1B.2 (fairly endangered in California and elsewhere, with 20-80% occurrences threatened / moderate degree and immediacy of threat; CNPS 2023) and is listed as endangered at the federal level (USFWS 1998). This taxon is listed due to its endemism and limited range, within which development and OHV activity are the highest ranked threats to the species (USFWS 1998, CNPS RPR 2023). It is found only in areas with abundant loose, wind-blown sand, as seed scarification aids germination (Meinke et al. 2007). It occurs at its highest density on the ephemeral sand fields of the Whitewater Floodplain Conservation Area but can also be found as far east as the Coachella Valley National Wildlife Refuge (CVNWR) and as far west as the San Gorgonio River in Cabazon, CA. While there are vouchers for this taxon collected near Desert Center, CA (CCH2 2024), we believe those are misidentified and most likely are *Astragalus lentiginosus* var. *borreganus*; we have been unable to locate plants at these localities, so we have been unable to confirm this identity and will require further investigation (UCR CCB 2023).

Figure 21. CVMV fruits, leaflets, and flowers (Photo: M. Davis 2023).

Yearly counts of CVMV provide us with a snapshot of the condition of the overall population throughout aeolian habitats in the Coachella Valley through presence and abundance data. This year, we were interested in collecting an additional dataset that would show the proportion of seedlings that survive to adulthood (reproductively active) in a given year. In the field, we observed what appeared to be mass germination events, where, in some cases, we documented over 200 seedlings within a single plot (0.1 ha). When we returned later in the season for other wildlife monitoring surveys, we noticed that many of these seedlings had died. From these observations, consistent with the population ecology of many annual plants, we understand that high counts of seedlings do not accurately reflect the expected abundance of plants reaching adulthood, because a high proportion of seedlings will not reach maturity. Thus, counts that are performed too early may not accurately represent the status of the species because it may be lacking important context; in this case, how many plants reach maturity and reproduce. We investigated the degree of attrition of early stage classes that reduces the number of plants achieving reproduction by implementing a secondary survey later in the season to calculate seedling survival rates. This investigation allows us to better inform management by scaling monitoring to better reflect the proportion of reproductive individuals within populations and expand the understanding of what stable populations of the species look like demographically for conservation success.

Addititionally, this year, we investigated the impact of a high amount of late summer rainfall. In August 2023, the Coachella Valley experienced much higher than average rainfall as Tropical Storm Hilary hit southern California. Palm Springs recorded a total of 3.33 inches of rain just in August, and Indio received 1.46 inches (Figure 24, WRCC 2024). These rains also produced massive fluvial movement of sediment and water into the Whitewater Floodplain via the Whitewater River, Mission Creek, San Gorgonio River, and other smaller sources. In some places, the local landscapes were completely altered by this input of sand and debris. While

CVMV does require winter rains for emergence and growth, when precipitation is higher than normal within the winter growing season, we start to see a decline in CVMV counts (UCR CCB 2019-2023). We previously hypothesized that this was due to higher soil moisture reducing the mobility of the sand and thereby affecting its ability to efficiently scarify seeds (scraping the seed coat to allow the seed to imbibe water and germinate). This year, to understand the additional factor of the effects of Tropical Storm Hilary, we incorporated into our study the amount of the summer rainfall in the prior year.

6.2 METHODS

We have conducted CVMV count surveys since 2005 (excluding 2014 and 2021) across all active 0.1 ha aeolian plots, surveying each plot once per year (see Methods: Aeolian Community Plot Network, and note that Stebbins' Dune was not included in this year's survey effort). Surveys typically take place in the spring, approximately from late March to late April. At least two surveyors search the 0.1 ha plots (10 x 100 meter belt). We tally all CVMV individuals found within the belt area and make a distinction in the data recorded based on phenology as such: 'seedling', 'flowering', or 'fruiting'. A seedling is defined for our purposes as a plant that had germinated this year and showed no sign of having reproduced (Figure 22). If a plant flowered but had not yet fruited, we classified it as flowering. If the plant had started to develop fruit, was fully fruiting, or it showed sign of having had fruited this season, we classified it as fruiting (Figure 23). CVMV is considered an annual to perennial herb, and while most individuals complete their lifecycle in the span of a single year, some individuals will persist for several years given adequate resources (Wojciechowski and Spellenberg 2023). We identified these perennial individuals by the presence on a woody caudex (perennialization of the stem)

Figure 22. Seedling CVMV (Photo M.Davis 2024).

Figure 23. Dried fruit of CVMV and remaining calyx and filament. (Photo: M. Davis 2024)

and an abundance of dead stem segments from the previous growing season. These individuals were only documented separately if they did not show any sign of fruiting or flowering this year, but were considered successful adults as they had likely flowered in previous years.

An additional repeat census was conducted later in the season at select plot clusters to test our hypothesis regarding the proportion of plants that reach reproductive maturity. We recognize that attrition and early mortality may differentially occur among sites with different substrate, moisture condition, topographic position, competitive community and other factors. Some more marginal sites may display patterns that differ from where CVMV are more abundant. However, in order to obtain an adequate sample for study, we returned to plot clusters where the initial CVMV census had consistently high counts to provide what we roughly deemed an adequate sample size of >10 individuals per plot. We determined individuals to be reproductive if they had evidence of successful fruiting, (i.e., the presence of fruit or an inflorescence stalk with the inflated calyx and/or filament still attached; Figure 23).

For both the initial and repeat census, we analyzed and summarized our data by plot cluster (each plot being a sub-sample) in accordance with the other sections of this report. To test if the initial and repeat census counts were statistically different, we used the ‘coin’ package for R (Hothorn et al. 2006) to conduct two-sided Wilcoxon matched pairs test for non-parametric data.

6.3 RESULTS

6.3.1 Initial Census

This year, our surveys recorded the highest overall CVMV density since 2015 and the fifth highest densities in our 18-year dataset (Figure 24). In the initial census, we surveyed CVMV at all 13 long term plot clusters (79 0.1 ha plots) from late February to early May. We counted a total of 970 individual CVMV across all plot clusters. On the CVNWR, we did not find densities of CVMV to be consistent across all plot clusters, which is in accordance with findings from previous years.

Within the CVNWR, we found that CVMV density was highest at the active sand dune plot clusters AD2 and AD4, with mean values of 14.8 and 4.8 CVMV per 0.1 ha plot respectively (n = 6 per cluster; Table 5). Although historically we have documented consistent populations of CVMV at these two plot clusters, this year was the highest density in our record (Figure 25 a, b). This year and in previous years we also found consistent occurrence of CVMV at plot cluster J, although at much lower densities than the aforementioned clusters (Figure 25 e, Table 5). Our past data shows that CVMV has been present at very low densities at the other CVNWR plot clusters (CA, H, L, and MH 07-12). This year we did not find CVMV at H and L, however we documented one individual each at CA and MH 07-12.

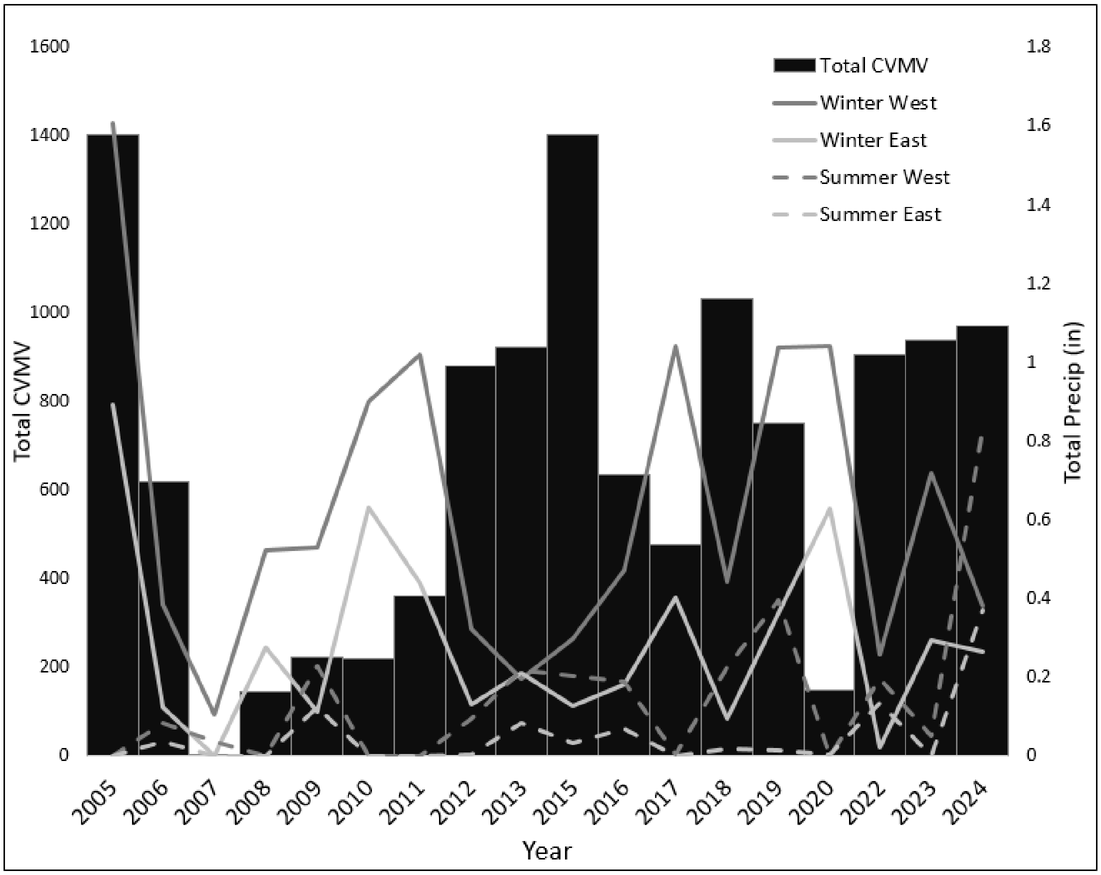


Figure 24. Mean CVMV density across all 0.1 ha plot clusters with summer precipitation (Summer = May-Aug, year prior to surveys) and growing season precipitation (Winter = Sept-April) totals for both Palm Springs (West) and Indio (East; WRCC 2024).

Our two plot clusters within the Whitewater Floodplain, ESF 07-12 and ESF 13-18, have shown some of the highest CVMV counts and both have been consistent in CVMV presence (Figure 25 j, k; Table 5). At ESF 07-12, we counted a total of 466 individual CVMV, our highest count of the year, and a total of 16 individuals at ESF 13-18. Additionally, we see consistent populations at our single cluster within the San Gorgonio River, with a slight decrease in counts: ESF 19-24 (also referred to as "Tipton Road"), with 129 individuals this year, mean 21.5 (Figure 25 i, Table 5). Since 2005 CVMV density had decreased at this location, and this year's mean fell below the overall average from 2005-2023 (51.6; min 0, max 195.7, Figure 25 i).

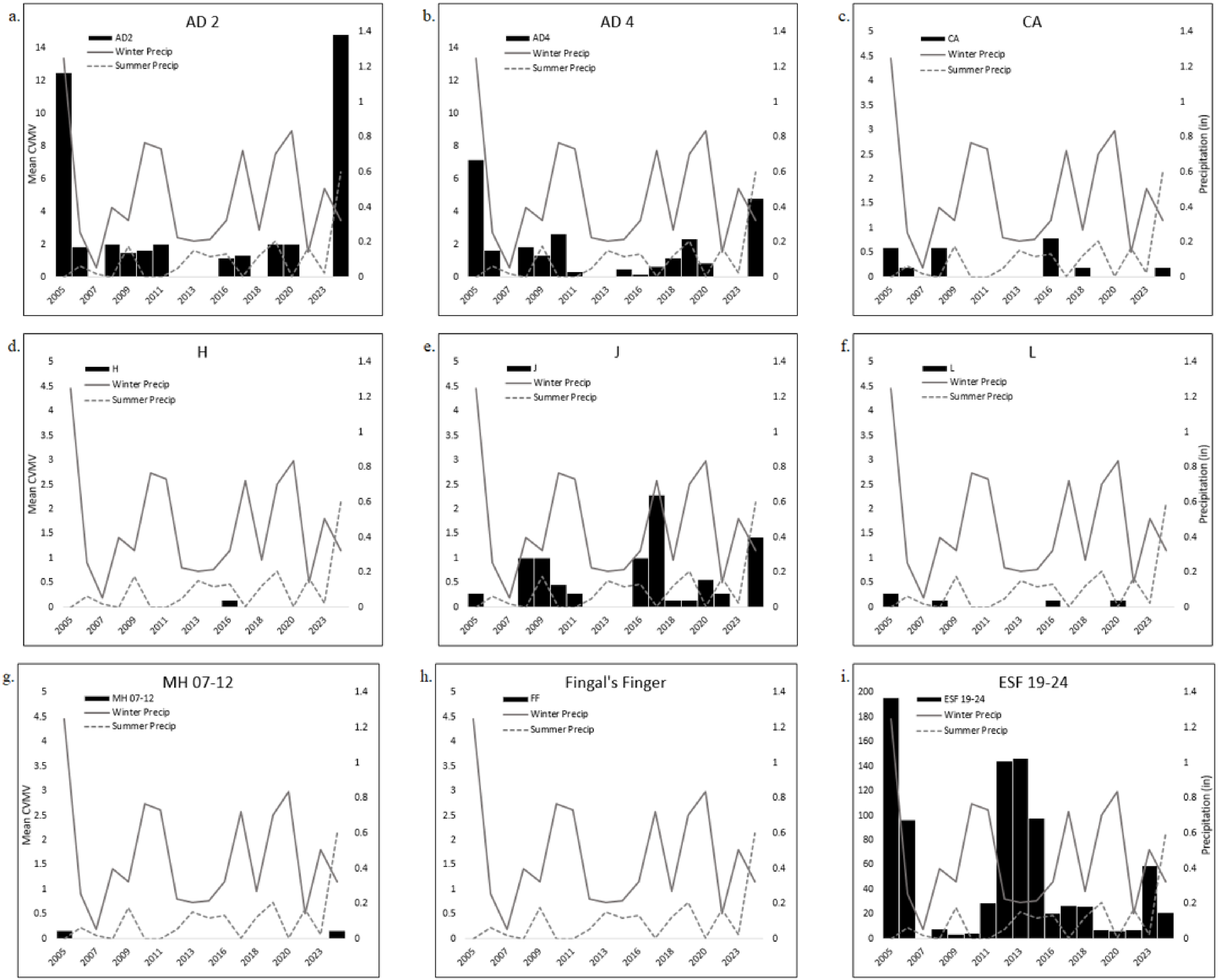
In 2018 we started monitoring three plots on Kim Nicol trail; this year we observed the highest count of CVMV here. For the first time, mean counts exceeded 70 CVMV per plot (72.66; Figure 25 l), however, we have only ever recorded CVMV on a single plot, KN3, within this cluster (n=3) since we began monitoring this site. This year we counted a total of 218 individuals at KN3, which is nearly triple the second-highest count in 2020 with 74.

We did not find any CVMV at the plot cluster we call Fingal's Finger, our most westerly cluster (Figure 25 h, Table 5). We have monitored this location since 2018 and since then have not documented CVMV across the three plots within the cluster. Although, we have incidental confirmation of CVMV at the site (S. Heacox, personal observation) it is not at a detectable density at the scale of sampling using the current monitoring methods. Whether presence at the site at this density is sustained year-to-year demographically or rather whether presence onsite is due to stochastic processes, such inter-site immigration from dispersal, has yet to be determined.

We have reported CVMV presence at Willow Hole (MH 19-24; MH 25-29; Figure 25 m, n; Table 5) throughout 14 years out of the 18 years we have conducted surveys since 2005. Plot cluster MH 19-24 is situated within the mesquite hummocks of Willow Hole, and individual plots span areas of sandy depressions protected by mesquite stands. By contrast, plot cluster MH 25-29 is situated on the south-east side of Willow Hole and does not have the same terrain and protected sand bowls as MH 19-24, but instead plots are all on south facing sandy slopes that span from the edge of mesquite hummocks into creosote scrub. We have found CVMV occurring most reliably within the sandy bowls and depressions that separate clumps of mesquite trees on MH 19-24.

Table 5. Counts of CVMV and the mean number of plants per 0.1 ha plot across plot clusters from 2022 to 2024. Plot clusters are generally categorized by location within the Coachella Valley; CVNWR = Coachella Valley National Wildlife Refuge; WWFP = Whitewater Flood Plain.

Locale	Plot Cluster	Plots (*n*)	***2022*** Total	***2022*** Mean *per 0.1ha*	***2023*** Total	***2023*** Mean *per 0.1ha*	***2024*** Total	***2024*** Mean *per 0.1ha*	***2024*** Min/Max	
CVNWR	*AD2*	6	0	0.00	0	0.00	89	14.83	1	30
	AD4	6	0	0.00	0	0.00	29	4.83	0	10
	CA	5	0	0.00	0	0.00	1	0.20	0	1
	H	7	0	0.00	0	0.00	0	0.00	0	0
	J	7	2	0.29	0	0.00	10	1.43	0	6
	L	7	0	0.00	0	0.00	0	0.00	0	0
	MH 7-12	6	0	0.00	0	0.00	1	0.17	0	1
WWFP	*ESF 7-12*	6	730	121.67	505	84.17	466	77.67	13	199
	ESF 13-18	6	68	11.33	29	4.83	16	2.67	0	12
West Valley	*ESF 19-24*	6	44	7.33	18	3.00	129	21.50	7	42
	Fingal's Finger	3	0	0.00	0	0.00	0	0.00	0	0
West Indio Hills	*Kim Nicol*	3	44	14.67	27	9.00	218	72.67	0	218
	MH 19-24	6	6	1.00	16	2.67	10	1.67	0	4
	MH 25-29	5	9	1.80	2	0.40	1	0.20	0	1
	Stebbins' Dune	5	3	0.60	6	1.20	NA	NA	-	-
	TOTAL	**84**	**906**	**10.79**	**603**	**7.18**	**970**	**12.28**	0	218



a.
AD 2
AD2
Winter Precip
Summer Precip
Mean CVMV
b.
AD 4
AD4
Winter Precip
Summer Precip
c.
CA
CA
Winter Precip
Summer Precip
Precipitation (in)
d.
H
H
Winter Precip
Summer Precip
Mean CVMV
e.
J
J
Winter Precip
Summer Precip
f.
L
L
Winter Precip
Summer Precip
Precipitation (in)
g.
MH 07-12
MH 07-12
Winter Precip
Summer Precip
Mean CVMV
h.
Fingal's Finger
FF
Winter Precip
Summer Precip
i.
ESF 19-24
ESF 19-24
Winter Precip
Summer Precip
Precipitation (in)
2005
2007
2009
2011
2013
2016
2018
2020
2023

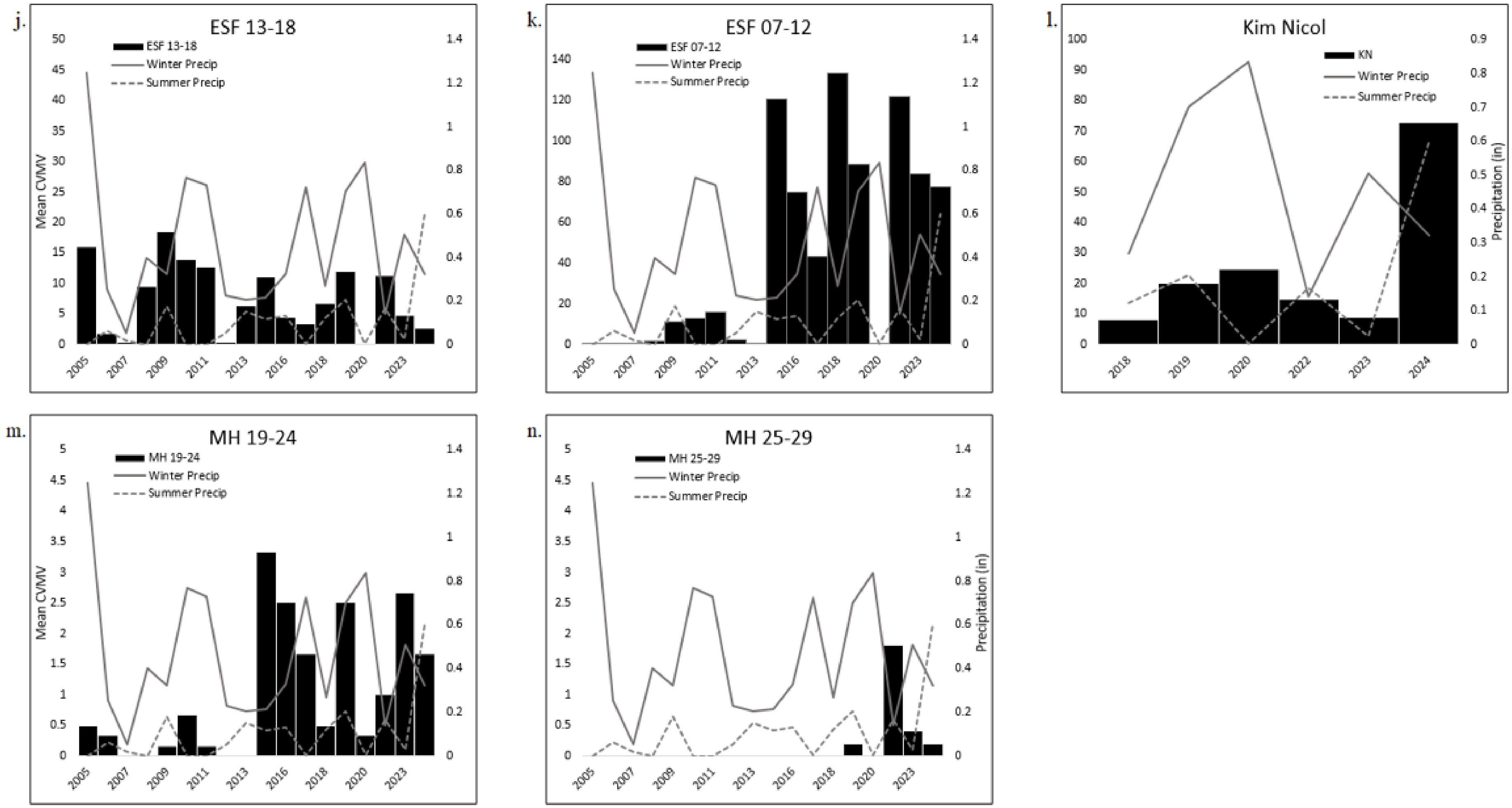


Figure 25 a-n. Mean CVMV over time with precipitation data. Precipitation data taken from Palm Springs (west) and Indio (east) weather stations (WRCC 2024). Data is separated by the total inches per growing season (Winter = Sept-Apr; Summer = May-Aug) and averaged across east and west weather stations. Summer totals are from the year prior to winter, i.e. the growing season. Note that the scale of mean CVMV differs by plot. Years surveyed 2005-2024, excluding 2014 and 2021.

6.3.2 Repeat Census

In May 2024, we resurveyed a total of 6 plot clusters (33 0.1 ha plots) to capture intra-seasonal CVMV survival rates (survival from detectable seedling stage to reproductive maturity). We repeated surveys for the qualifying clusters: the active sand dune sites on the CVNWR (AD2 and AD4), the two sites on the Whitewater Floodplain (ESF 07-12 and ESF 13-18), Kim Nicol, and Tipton Road (ESF 19-24; Table 6). We did not set a standard interval for days lapsed between surveys; thus, the survey intervals differ by plot cluster (Table 6). We resurveyed plots after an average of 58.17 days (minimum 19 at Kim Nicol and maximum 83 at AD4).

We counted a total of 947 per 0.1 ha (mean 32.36, min 16, max 466, standard deviation 167.85) CVMV in the initial surveys throughout the above listed plots and counted 332 reproductive individuals per 0.1 ha in the repeat census (mean 10.06, min 2, max 199, standard deviation 42.15), for an overall 35% survival rate (Table 6). The Whitewater Floodplain ephemeral sand fields (ESF 07-12 and ESF 13-18) had the lowest ratio of survival to reproductive maturity, at 17% and 13%, respectively. Tipton Road ephemeral sand fields (ESF 19-24) had the highest rate of survival, at 92%.

Table 6. Total counts of reproductive individuals, plot means, and survival rates from initial surveys and resurveys by plot cluster. We categorized perennialized plants as reproductive individuals.

Plot Cluster	Plots (*n*)	Interval (*days*)	Initial Total		Initial: Phenology			Resurvey		Survival Ratio	*p*-value
			Total	**Mean**	**Flwr**	**Frt**	**Total Repro-ductive***	**Total**	**Mean**		
AD2	6	78	89	14.83	8	0	8	66	11.00	74.16%	*0.1694*
AD4	6	83	29	4.83	2	0	2	22	3.67	75.86%	***0.0495***
ESF 07-12	6	44	466	77.67	13	143	156	80	13.33	17.17%	***0.0277***
ESF 13-18	6	71	16	2.67	5	2	9	2	0.33	12.50%	*0.0874*
ESF 19-24	6	54	129	21.50	20	37	68	119	19.83	92.25%	*0.2905*
Kim Nicol	3	19	218	72.67	0	65	65	43	14.33	19.72%	NA*
TOTAL	**33**	**58.17**	**947**	**32.36**	**48**	**247**	**308**	**332**	**10.06**	35.06%	NA

We found that the change from the initial count to the number of reproductive plants in the repeat census were only significant at AD4 (p = .0495) and ESF 07-12 (p = .0277; Table 6). Statistical testing of our data shows that the counts of reproductive CVMV during the resurvey were not found by the statistical tests used here to be lower on the remaining plots. However, the directionality of the trend towards a lower count was ubiquitous across plots. We did not run a test for differences for the Kim Nicol site due to insufficient and outlier data, where one plot contained all of the individuals, and the other two did not contain any; making it impossible to calculate a mean. To study the populations at the Kim Nicol site in the West Indio Hills in this type of resurvey, additional plot samples could be spread outside of our long-term plots to better cover CVMV habitat with plants present.

6.4 Discussion

Although we recorded the highest overall density of CVMV since 2015 this year, our results imply nuanced trends when we break down the counts by habitat type and locale within the Valley. Our results also show that the increased seasonal precipitation had an overall positive effect on CVMV abundance. Looking at the effect of the late season rainfall, we considered the relationship between past season summer rainfall, finding that in years where we had high counts of CVMV but below average winter rains, those were years with higher-than-average summer rains, for example 2013, 2018, and 2022 (Figure 24). Like winter rains, heavy summer rains can induce soil compaction and sheet flow, however summer conditions would provide ample opportunity for the soil to dry out before the growing season, thus not affecting sand mobility. While there have been years when there were no summer rains and high winter rains, and CVMV counts were high (e.g. 2005), this does not appear to be a consistent relationship. The dramatic difference we see in CVMV counts on the CVNWR from 2023 (lower) to 2024 (higher) highlights the pattern that populations are driven by seasonal weather events, especially ones that alter sand flow and input resources. The CVNWR saw very little precipitation in 2023, and significantly more in 2024 (Figure 24, Winter and Summer East). Here we see a clear response in CVMV to increased warm seasonal weather events and overall precipitation (Figure 25 a-g).

CVMV responses across the CVNWR are also varied and nuanced; the CVNWR is not a single homogenous habitat type. The CVNWR, like the rest of the Coachella Valley, hosts a variety of aeolian habitat types, from active sand dunes, to silt flats, saltbush and creosote shrublands to mesquite hummocks. Our plots are stratified across the varying habitat types and in previous studies we summarized and analyzed monitoring data from the CVNWR by habitat type (UCR CCB 2019-2023). Here we have removed the constraints of habitat type to allow our data to reflect individual plots, however we can still better understand the nuanced relationship between CVMV and habitat type through continued analysis of changes on a habitat scale.

The results from plot clusters ESF 07-12 and ESF 13-19 on the Whitewater Floodplain show us some interesting differences in abundance, density, and east-west gradients. These two plot clusters are closely proximal to each other (Figure 1), and counts per individual 0.1 ha plot show an increase in CVMV along an east-west gradient, where at the western most plots (ESF 13-19) population densities are lowest, and increase eastward (ESF 07-12) within this specific area. While it could be hypothesized that independent variables, such as wind, slope, and sand input drive CVMV populations eastward, and lower counts in the west are due to a compromised sand source, we do not see higher counts in previous years at the western plots (Figure 25 j, k). Instead, a more likely hypothesis is that there is a relationship between the terrain and wind driven habitat and CVMV. The landscape here reflects the west to east driven wind patterns and anthropogenic effects. The western plot cluster (ESF 13-19) is composed primarily of windblown, flat ephemeral sand fields and shrubs (creosote (*Larrea tridentata*) and small Mojave indigo bush (*Psorothamnus arborescens*) hummocks. The eastern plot cluster (ESF 07-12) is similar to the western cluster, ESF 13-19, for several of the westernmost plots, however the eastern half of the plot cluster shifts in type to sandy hills and dunes that protect CVMV from the high winds. These hills and dunes are not entirely natural, and are primarily here due to the construction of the railroad, I-10 freeway offramp, and Gene Autry Trail. Here we see again fine scale habitat preferences that influence CVMV presence and cause variability even within our plot clusters, and this underscores the need to increase the sampling through a plot network-wide analysis.

As in previous reports, we see a downward trend of population density at ESF 19-24 near Tipton Road on the west side of the Valley. This trend may be attributed to a lack of seed sources, seed dispersal, decreased connectivity, compromised sand flow, and changes in resource availability. At this time, we are unable to point to a specific cause for this trend, however due to the historical density and importance of this population, we recommend further investigating the variables that could be causing this overall decrease in population density here.

Our plot cluster along Kim Nicol trail provides some interesting insights into CVMV distribution. Unlike all other plot clusters, Kim Nicol is within the west Indio Hills, instead of on the valley floor. The three 0.1 ha plots here cut through gullies within the Indio Hills where sand has collected in bowls and sand ramps, with moderate threats to plants and animals at this site: we have observational evidence that there is repeated off roading use here, as well as high cover of *Brassica tournefortii* impacting this site. We have surveyed this site annually since 2018, and we have never found CVMV on any plot other than KN3, despite the other plots appearing to contain suitable habitat (presence of co-occurring aeolian species and sufficient blow sand). This could be due to differences in exposure, shrub cover, land use history, and/or issues associated with seed dispersal. Further comparisons of these plots would be warranted. Due to the limited potential for inference of trends based on the data from this plot cluster, we should also better search the West Indio Hills for additional occurrences and establish additional plots where CVMV is present to better understand the pressures it faces within this unique habitat. As this cluster stands now, CVMV occurrence is too locally-concentrated to allow for strong conclusions regarding the relationship between CVMV abundance and any abiotic factors.

At Willow Hole (MH 19-23; MH 24-29), it appears that this population has maintained consistent numbers since 2015, with an average of about 1 individual per 0.1 ha plot (n = 11). However, like Kim Nicol, CVMV does not occur across all plots within the survey site area, and appears in sandy bowls, depressions, and small dunes nestled within the mesquite hummocks. The first of the two plot clusters (MH 19-24) best represents this habitat type and coincides with where we have regularly recorded higher mean densities of CVMV since 2015. Despite sand transport from Mission Creek potentially being compromised by two major roads (Palm Dr. and Mountain View Rd.) to the west of Willow Hole, these micro-habitats maintain enough sand flow either from the primary sand source (Mission Creek) or enough sand remains in the system (contained by the dense mesquite) to support CVMV and other aeolian species populations. This year we saw lower means here compared to last year (Table 5, Figure 25 m-n). We found dense *Brassica tournefortii* within the depressions and bowls that we normally find CVMV, which has been found to negatively affect CVMV through competition (Barrows & Allen 2007).

Figure 26. Fruiting CVMV on ephemeral sand field with exposed taproot excavated by strong winds (Photo: L. Sweet 2024).

This is the first year that we conducted resurveys of CVMV to collect demographic data concerning the rate of survival to maturity. Our results are variable, with significant differences in initial and repeat counts on some sites (AD4 and ESF 07-12), and by contrast, in some cases, most of the seedlings and young plants counted in the initial census survived to reproductive maturity and they were detectable in the repeat census. At ESF 19-24 at Tipton Road, we saw that although we had a lower count of CVMV in the repeat survey (net loss of 10, p=.29505), our reproductive adult counts increased by 75% (Table 6). ESF 19-24 is a more sheltered plot cluster, with large creosote acting as wind breaks and creating bowls where CVMV is generally denser. This indicates that there is variability in the amount of the population reaching reproductive maturity at any given site, which we were unable to attribute to a particular cause, and which warrants further study.

Overall, due to differences in phenology, timing of soil drying, accumulation of heat load, and other abiotic factors, plants persist at different rates given their surrounding habitat and conditions, complicating a reliance on a single static time count. To better assess survival rates, ideally, individual plants should be tracked throughout the growing season. Future study designs should also address other specific challenges to this approach, including how to account for reduced detectability in the late sample, for example, if reproductive individuals succumbed to mortality due to environmental or trophic community impacts (e.g. covered by sand or blown away by high winds or eaten by herbivores) by the time of the repeat census (Figure 26). Overall, a more thorough survey with additional subsamples (plots) within habitat, a bigger dataset and analysis using paired metrics may be more robust to variability and useful in understanding the trends that our results suggest.

6.5 RECOMMENDATIONS

It is our recommendation that future monitoring efforts continue to include demographic data at a broad scale, which is still very useful for determining site presence and coarse trends in abundance and distribution, in combination with finer-scale population monitoring via tracking the life history of individual plants. While CVMV can be found as far east as the CVNWR, on sand ramps and mesquite hummocks in the western Indio hills, and throughout semi-developed areas of Desert Hot Springs (UCR 2022), our data show that the populations throughout the floodplains on the valley floor have the highest density of CVMV and detectable occurrences of plants persist even during very dry years. However, these populations are also the most exposed and potentially display lower survival rates. Tracking individual plants will help us continue to investigate this trend, as it is possible that individuals within the floodplain have an accelerated lifecycle due to environmental conditions, and may be missed during later season surveys.

Additional effort may be needed to analyze environmental data collected at all plot clusters to better understand nuanced trends and differences in abiotic variables that lead to variation in CVMV survival and growth. Better understanding these habitat preferences will allow managers to continue prioritizing protection of specific habitat and environmental processes that benefit this species. We added plot clusters Kim Nicol and Fingal's Finger in 2018 because of their unique aeolian habitat characteristics as well as the geographic extent of surveys. However, both sites have limited opportunity to physically place our plots and therefore these have only three plots at each site that are highly variable in CVMV density, so picking out meaningful trends is difficult. While these sites are useful in confirming presence or absence across geography, they continue to be of limited value in investigating finer habitat relationships for this species.

In addition to continued and more intensive survey efforts, we also recommend active management for populations threatened by the invasion of *Brassica tournefortii* and *Oncosiphon pilulifer*. This may be most effective in the form of manual weed pulling treatments specifically targeting the depressions and bowls where sand collects, and where CVMV generally grows at higher densities. Additionally, continued care when accessing, managing and monitoring the sites and guiding the public and others to minimize impact using the best available knowledge is necessary in order to conserve this species.

7 AEOLIAN COMMUNITY ARTHROPODS

7.1 INTRODUCTION

Every spring, we measure ground-dwelling arthropod species richness and abundance across our aeolian community plots using non-lethal pitfall traps. This year, we focused on describing changes in abundance for three species of harvester ants, *Pogonomyrmex californicus* (California bearded harvester ant), *Pogonomyrmex magnacanthus*, and *Veromessor pergandei*, which are important food sources for flat-tailed horned lizards and CV fringe-toed lizards, as well as two important darkling beetle (Tenebrionidae) species, *Asbolus laevis* (smooth death-feigning beetle) and *Asbolus verrucosus* (blue death-feigning beetle) which, due to their often distinct habitat preferences, may have potential as indicator species (Barrows and Heacox 2021). Specifically, *Asbolus laevis* has a strong affinity for active dune habitat, and its presence may be an indicator of a healthy aeolian system (Barrows 2000). Conversely, *Asbolus verrucosus* is more generalist, and tends to replace *Asbolus laevis* in more stabilized areas. Big-eyed harvester ants also strongly prefer aeolian habitats (Johnson et al. 2013). Black harvester ants appear to mostly avoid dunes in preference for areas with at least some hard-packed sand and gravel, while California harvester ants are relatively unparticular regarding substrate type.

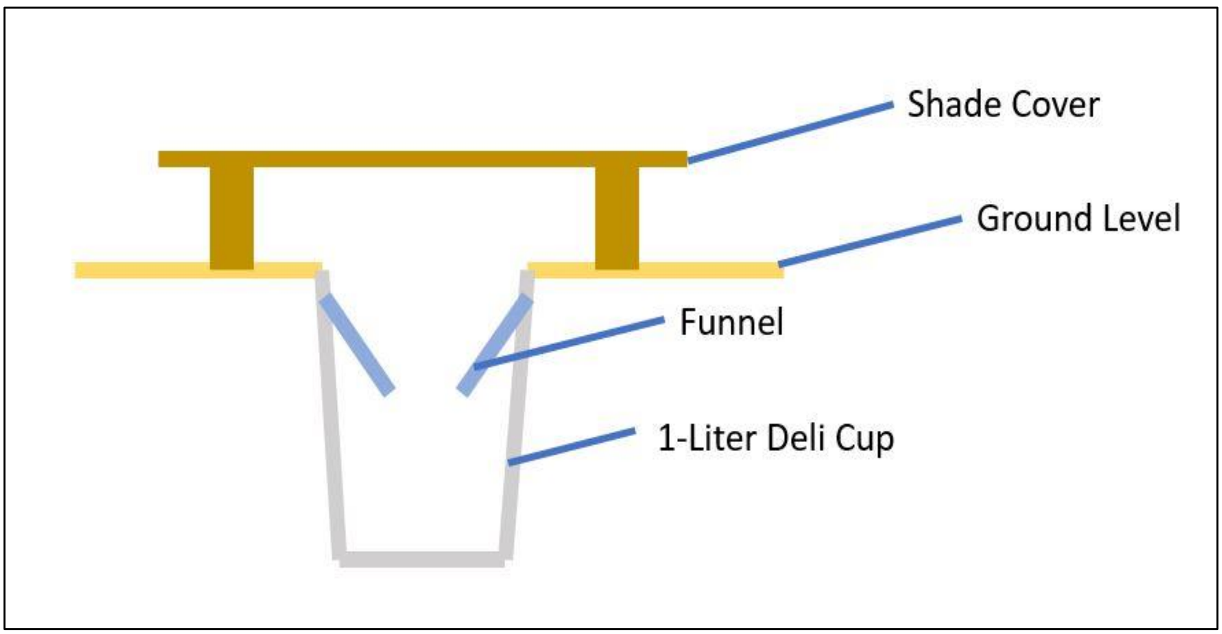


Figure 27. Diagram of the pitfalls used in this study.

7.2 METHODS

Pitfall Trapping

Each trap consists of a single plastic 1-liter plastic cup, funnel, and shade cover (Figure 27). We sink the cup into the ground so that the top of the cup is flush with ground level, and then place a funnel into the top of the cup, preventing escape of captured arthropods. We use a small wood board elevated above the trap by wooden pegs to provide shade for captured insects and camouflage from animals that might tamper with the traps, such as ravens. Wandering arthropods encounter the trap and fall into the cup where they remain until we arrive the next day to collect the pitfalls. To record the contents of the traps, we remove the cups from the ground and dump the contents onto a light-colored surface such as a pillowcase or white fiberboard. We record the sampled species and abundance with the assistance of magnifying loupes and aspirators. We release captured nocturnal arthropods into a shady area, so we do not cause harm by exposing them to the sun and daytime temperatures.

Each plot hosts 3 pitfall traps – one trap per 0 m, 50 m, and 100 m mark. We set traps for an approximately 24-hour period and intentionally select sampling periods which have low wind to minimize the risk of traps filling with blowing sand. To further minimize the risk of blowing sand, we often place traps on the downwind side of shrubs which provide some protection. We conducted trapping from April 3 to June 12. Unlike the previous three years, we were able to complete many more surveys due to more favorable wind conditions. The only plot clusters that we were unable to survey this year were SD, KN, and FF.

7.3 RESULTS

Harvester Ants (Figure 29a-c) – It is difficult to assess trends in ant density over the last few years due to incomplete data, however, it is apparent that this year California harvester ant density has dramatically increased on the active dune clusters (AD2 and AD4) and two stable sand field clusters (J and MH 7-12) at the CVNWR. We recorded mean CA harvester ant density at MH 7-12 at over 10 ants per pitfall, which is near the highest ant density recorded since 2008 (almost 12 ants per pitfall at cluster H). However, clusters L and H showed a notable decrease in CA harvester ant density since their last surveys (2023 for H and 2022 for L). California harvester ants continue to exhibit the highest densities at the CVNWR when compared to our other plots throughout the Coachella Valley.

Big-eyed harvester ants rarely exceed the abundance of CA harvester ants, and this remains true for this year's surveys except for at cluster L (mean 0.9 CA harvesters per pitfall vs. mean 2.3 big-eyed harvesters). Regardless, big-eyed harvesters showed an increase in abundance since 2022 at all sites at the CVNWR except plot cluster H where abundance declined to near-zero.

Black harvester ants have historically been essentially nonexistent at our CVNWR plots – only 5 traps have detected small numbers of this species on the CVNWR since 2008 (excluding

2024), favoring instead the Whitewater Floodplain (Figure 30c) However, incidental colony sightings have increased over the last 3-4 years, and this year, a single trap at the active dune plot cluster AD4 trapped 146 individuals (Figure 29c).

Darkling Beetles (Figure 31a-b) – Since 2008, smooth death-feigning beetles at the CVNWR vary in abundance year-to-year, and data appear to generally indicate a downward trend, especially at areas with higher sand activity, such as plot clusters AD2, AD4, and J (Figure 31a). Even though they are a more generalist species, blue death-feigning beetles historically achieve much lower abundance than smooth death-feigning beetles at the CVNWR. However, smooth death-feigning beetles have decreased in abundance here in recent years (since approximately 2021) to abundances that are nearly the same as those for the blue death-feigning beetles (Figure 31b).

***Centrocoris volxemi* (Figure 28)** – This year, we recorded what we believe to be the newly introduced nonnative insect *Centrocoris volxemi*, an herbivorous species of squash/leather bug of the family Coreidae. This bug is native to the Middle East and central Asia and was recently recorded introduced to the western US around 2020 (Stokes 2022, Zahniser et al. 2022). It has spread rapidly due to the prevalence of its host plant, the aggressively invasive Russian thistle (*Salsola tragus*), which was present in abundance on the CVNWR this year.

Figure 28. *Centrocoris volxemi* found at the CVNWR this year. (Photo: S. Heacox 2024).

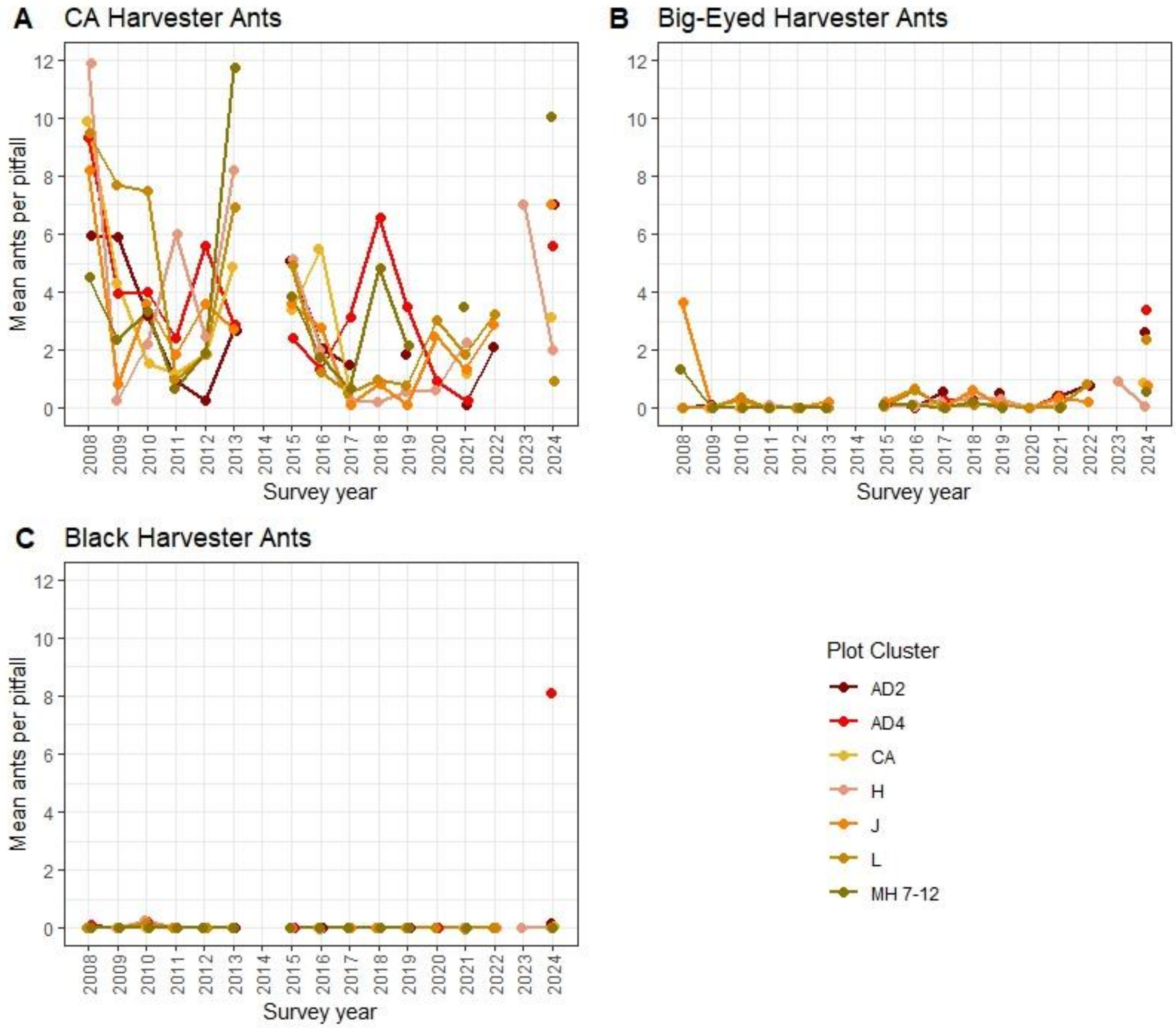


Figure 29 a-c. Results of our pitfall trapping at the CVNWR of three important native ant species, California harvester ants (*Pogonomyrmex californicus*), big-eyed harvester ants (*Pogonomyrmex magnacanthus*), and black harvester ants (*Veromessor pergandei*), since 2008 to 2024.

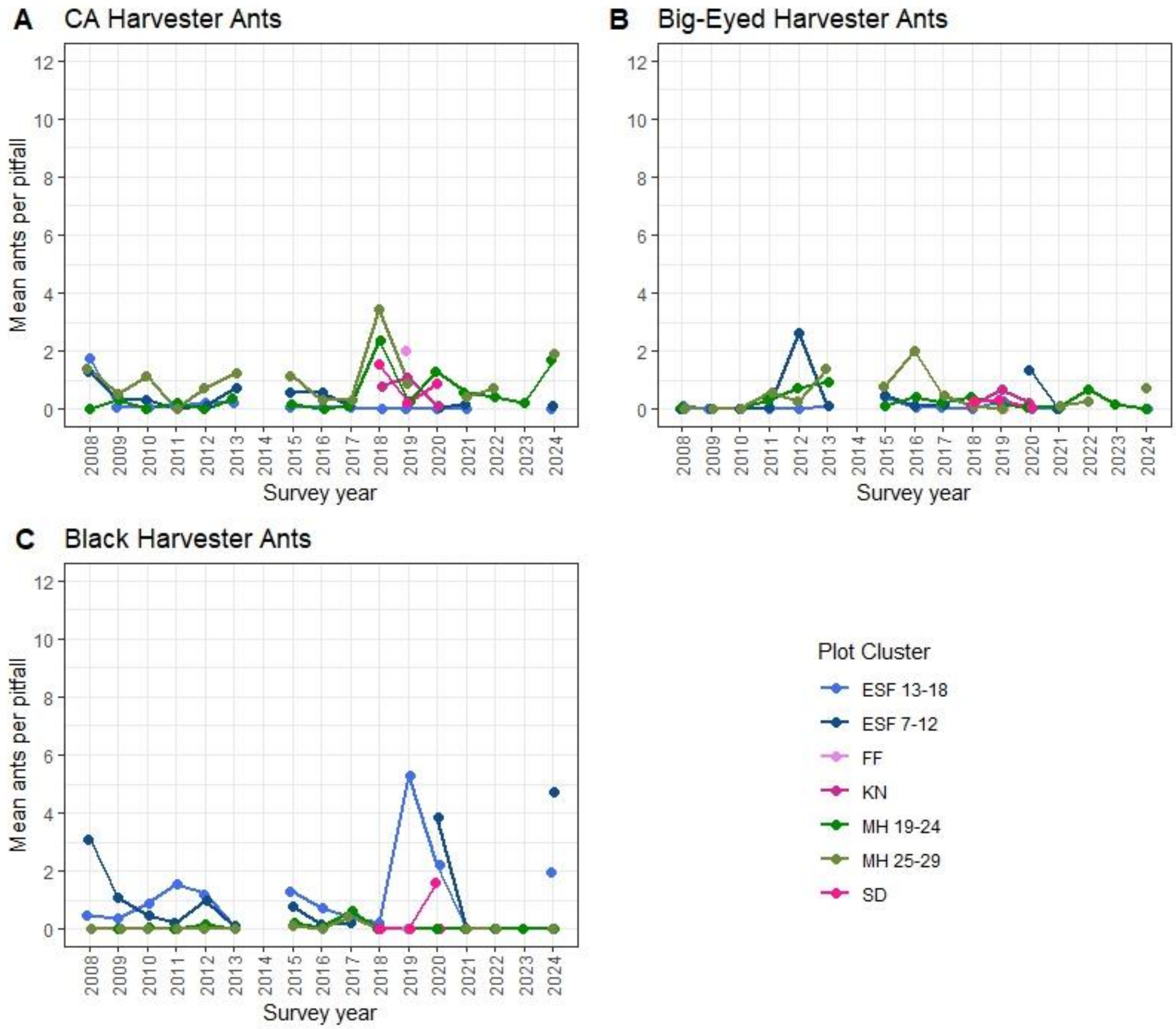


Figure 30 a-c. Results of our pitfall trapping at the Whitewater Floodplain, Willow Hole, Fingal’s Finger (FF), Kim Nicol Trail (KN), and Stebbins Dune (SD) of three important native ant species, California harvester ants (*Pogonomyrmex californicus*), big-eyed harvester ants (*Pogonomyrmex magnacanthus*), and black harvester ants (*Veromessor pergandei*), since 2008 to 2024.

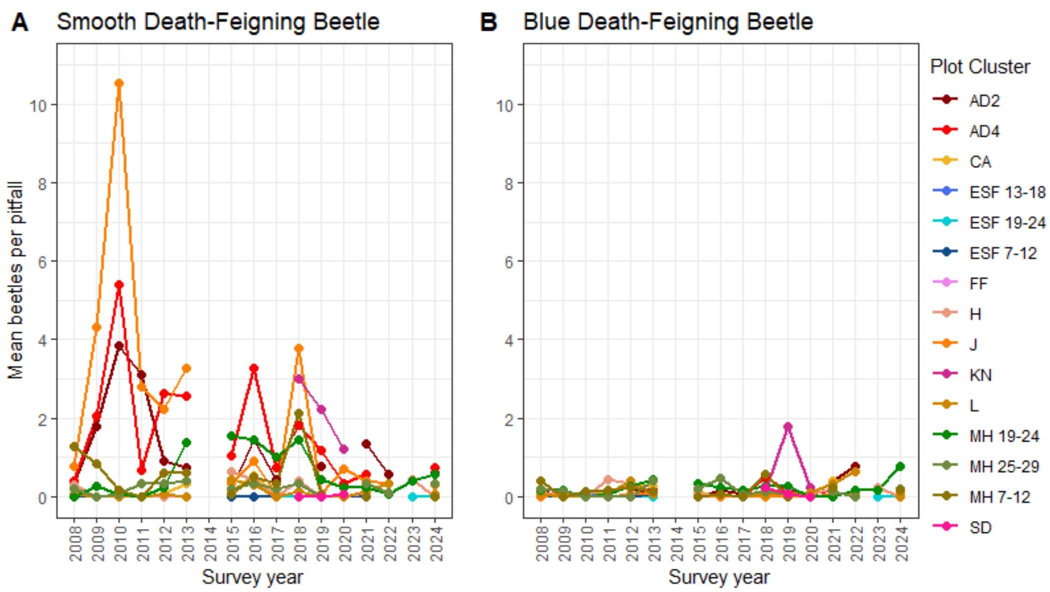


Figure 31 a-b. Results of our pitfall trapping of two important darkling beetle (Tenebrionidae) species, the smooth death-feigning beetle (*Asbolus laevis*) and the blue death-feigning beetle (*Asbolus verrucosus*) at all monitored plot clusters since 2008 to 2024.

7.4 Discussion

The increase of California and big-eyed harvester ant density at the CVNWR can likely be attributed in large part to the unusually long annual herb growing season which started approximately after Tropical Storm Hilary in August 2023 and continued through the winter and spring, allowing native forbs to reach high density and cover and produce ample seed for the ants to harvest. As well, if what we recorded reflected a true decline flat-tailed horned lizard density (as opposed to a lower sampling count due to lower detectability in the post-storm landscape, see section, Flat-Tailed Horned Lizard), this may contribute to some level of predator release, where less of the ants were being eaten by lizards. However, this deluge of monsoon rainfall also led to dramatic flooding of some plot clusters, most distinctly H, where large swaths of sandy habitat were completely scoured and this likely induced the decline of harvester ants at this area.

The increase of black harvester ant sightings at the CVNWR near our plots is interesting and warrants continued consideration. Encroaching of black harvesters on the sandy areas of the CVNWR would not indicate a concerning change in food availability for the flat-tailed horned lizards since they also readily consume these ants. Further, these ants are native and perform a number of essential ecological processes. However, changing ant communities may be a sign of other shifts in the aeolian habitat structure, most notably declining abundance of fine, loose sand. While the mean black harvester abundance at plot cluster AD4 this year is extremely high, it’s important to remember that these ants were sampled from a single pitfall trap. Black harvester ants engage in a particular foraging strategy that involves the formation of a massive column of workers that move to and from a seed source. The destination of this column will change periodically as seed sources are exhausted. The large number of ants in this single trap was almost certainly the result of a foraging column, by chance, passing directly over the trap. Hence, abundance estimates of this species using pitfall traps need to be tempered with the understanding that this behavior may obfuscate accurate inferences – i.e. a trap intercepting a single foraging column will result in a large mean individual number of ants across the entire plot/plot cluster, while in reality this represents just a single colony at a single point and is not representative of the actual density of ants across the area.

The trend of declining smooth death-feigning beetle abundance at the CVNWR is also worth continued investigation. In addition to this overall trend, and similar to California and big-eyed harvester ants, smooth death-feigner abundance on plot cluster H sharply declined to near-zero from 2023 to 2024. As described above, this is likely due to a scouring of this area and the resulting loss of fine, loose sand, which this species strongly prefers. Hopefully, these recent floods have brought an influx of fresh sand into some windward parts of the aeolian system which may rebuild these scoured areas over time.

7.5 RECOMMENDATIONS

We recommend continuing to monitor the possible encroachment of black harvester ants, including recording incidental sightings on or near aeolian habitats on the CVNWR. The apparent decline in smooth death-feigning beetles warrants additional investigation. We suggest attempting to perform repeat pitfall surveys to rule out the possibility that certain behavioral characteristics (e.g. varying levels of day-to-day activity due to weather) may be confounding our understanding of this trend. We also recommend increased effort to document *Centrocoris volxemi* within the Coachella Valley. It is, in the opinion of the authors, unlikely that this bug will cause harm to native vegetation due to the abundance of Russian thistle (*Salsola tragus*), its preferred host, and the lack of any native *Salsola* species to California that would be at risk. In fact, this insect may prove to be an accidental ally in the control of this weed. However, care should be taken with all introduced species, and further information is needed to determine how this insect will interact with native plant communities.

8 COACHELLA VALLEY GIANT SAND-TREADER CRICKET (*MACROBAENETES VALGUM*)

8.1 INTRODUCTION

Figure 32. Adult male Coachella Valley giant sand-treader cricket (*Macrobaenetes valgum*) at plot cluster ESF 19-24 (Photo: S. Heacox, 2024).

The Coachella Valley Giant Sand-Treader Cricket (*Macrobaenetes valgum*, or CVGST) is a large, wingless camel cricket of the family Rhaphidophoridae endemic to the Coachella Valley. The CVMSHCP protects this species due to its restricted habitat type: areas with large amounts of fine, actively windblown sand. This habitat is threatened by development and compromised sand sources. However, in areas with remaining dunes, such as the CVNWR, these crickets maintain persistent abundance. We know little of their biology, but their lifecycles appear to be closely linked to winter rains (Tinkham 1962, Barrows 2012). In the autumn months, nymphs (juveniles) appear in large numbers, but their small size makes them difficult to detect. The crickets grow rapidly throughout winter, and by late winter or early spring surviving CVGST adults reach a size large enough to detect in standardized surveys. CVGST are important nocturnal generalist detritivores that feed opportunistically on plant and animal matter (Polis 1991). Due to a sensitivity to high heat, every morning they excavate a new burrow into the sand to a depth where increased soil moisture and decreased soil temperatures meet their preferred conditions (Tinkham 1962). They rely on favorable winter conditions and could become stressed if conditions become more frequently drier and hotter. Their method of excavation leaves behind a characteristic triangle-shaped pile of sand tailings at the mouth of each burrow (Figure 33), which is renewed daily. By July or August, when summer temperatures reach their maximum, adult CVGST have mostly completed their life cycle and died off.

8.2 METHODS

Our surveys of CVGST take place in late winter to early spring from approximately February to April, when the crickets reach a size large enough to detect. We conduct surveys across all of our 0.1 ha aeolian community plots except Stebbins Dune (SD). This year, we conducted surveys from February 16 to March 27, 2024. We surveyed each plot once during the monitoring season. We record CVGST by counting the diagnostic triangle-shaped sand piles at the mouths of their burrows (Figure 33). We use this method for several specific reasons. First, the shape of the burrow trails makes them distinct from other species, so we will not confuse them with other burrowing arthropods, this method not requiring the use of microscopes or technical skill in insect taxonomy in the field for identification. Second, we can conduct burrow counts during daylight hours. Otherwise, we would either have to perform density monitoring of the crickets at night to detect their activity above ground, or we would have to excavate them from the ground during the day, both of which would risk the health of these animals and damage to the habitat of this and other protected species. We only record burrows that appear "closed" (the entrance is blocked with sand), as this indicates that a CVGST occupies the burrow. Additionally, because crickets may burrow into similar areas each morning, we carefully discern the size and spacing of the burrows present to avoid duplication of individuals in our counts. We achieve a conservative count by only considering a maximum of one cricket per square meter, unless the tailings have notably different size and of the same freshness which would indicate that two separate crickets occupy the same area.

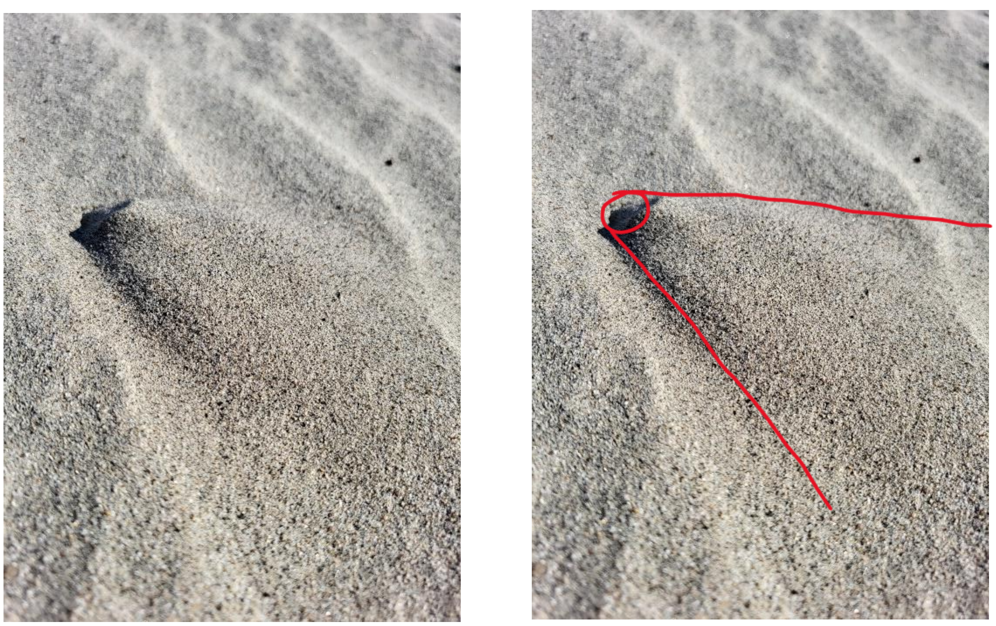


Figure 33. Example of a typical CVGST burrow used as an indication of occurrences in our surveys. The circled area on the right-hand image indicates the burrow entrance, and the two trailing lines delineate the triangular pattern left by excavated sand.

8.3 RESULTS

We recorded a decrease in mean CVGST abundance at all plot clusters except for on the Whitewater Floodplain (ESF 7-12 and ESF 13-18), Willow Hole (MH 19-24, MH 25-29), and Fingal's Finger. We recorded the sharpest declines at J (about 30 crickets per 0.1ha in 2023 to about 7 in 2024), ESF 19-24 (28 in 2023 to 9 in 2024), and Kim Nicol (26 in 2023 to 12 in 2024). The greatest increase we observed, still relatively small in effect size, occurred at ESF 13-18 (about 3 in 2023 to 17 in 2024).

8.4 DISCUSSION

Based on what we know about the biology of this species, particularly its need for fine, deep sand, we would expect to see a decrease in crickets in areas that experienced an increase in sand compaction. An increase in sand compaction can arise through a variety of means, but this year Tropical Storm Hilary caused major flooding which scoured some areas and removed fine sand. We saw major effects of the flooding at plot clusters J, H, and L, at the CVNWR and saw a decline in CVGST density at those plot clusters. Plot clusters H and L have not hosted dense CVGST since approximately 2019, so the decreases seen this year are relatively minor. However, we saw an extreme decrease at J, which experienced flooding, and this represents the sharpest decline at any plot cluster since 2017. Flooding may have immediate negative impacts to CVGST populations through destruction of individual animals and removal of sand habitat, however flooding provides a necessary component of the sand replenishment process. We anticipate that substrate quality will improve valley-wide as the sediments that were carried into the system after Tropical Storm Hilary continue to replenish scoured areas via the aeolian sand source transport pathways. This process was demonstrated at our plot clusters at the Whitewater Floodplain (ESF 7-12 and ESF 13-18) where we saw a notable decrease in sand compaction (increase in blow sand) along with an increase in CVGST density.

Flooding undoubtedly affected CVGST populations via the means discussed above, however we still observed density declines in areas that escaped direct effects of flooding and which, in fact, saw a decrease in sand compaction, which would normally indicate the improvement of substrate quality. We have fewer clear causes of declines in these areas, which include the active dune plot clusters AD2 and AD4 (Figure 34). The Coachella Valley experienced adequate winter rain in the winter of 2023-2024 and an abundance of summer rain in 2023, so drought is unlikely to be the cause of these declines. However, specifically, the increased late summer precipitation may be linked to other factors that affect population density of this species, such as increasing predator and competitor populations.

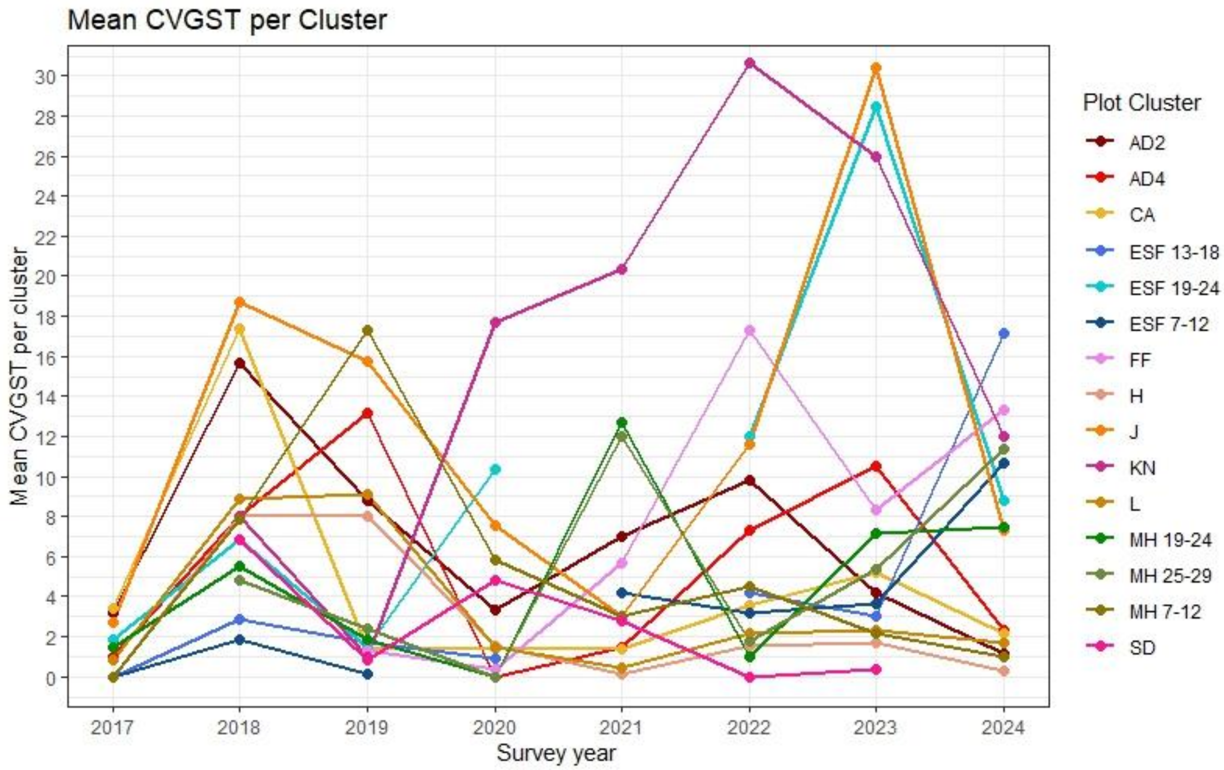


Figure 34. Mean CVGST density per 0.1ha by plot cluster, 2017- 2024.

8.5 RECOMMENDATIONS

Periodic flooding, providing fluvial input of sand, helps maintain our aeolian systems. However, it remains to be determined what the impacts to long-term population trends may be if climate change increases the frequency of severe storm events with resultant flooding that is powerful enough to directly disturb CVGST habitat. Our current monitoring protocol will be enough to document population recovery in post-flood areas, but we may consider adding additional repetitions of surveys during the season at these areas to ensure adequate understanding of the recovery process.

9 ACKNOWLEDGEMENTS

We want to express our gratitude to the Coachella Valley Conservation Commission for funding these projects under the Coachella Valley Multiple Species Habitat Conservation Plan and the Coachella Valley Association of Governments Staff for cooperation on these projects. We also wish to thank Dr. Cameron Barrows for his guidance, insight and support, Dr. Clay Noss and Dr. Hector Zumbado-Ulate in our lab group for subject matter discussions, our volunteer community scientists, agency partners, and staff who have helped facilitate and conduct our lizard and habitat monitoring efforts.

10 LITERATURE

Ball, L. C., Ostermann-Kelm, S. D., McDonald, M. W., & Doherty Jr, P. F. (2010) Effects of rain on Palm Springs ground squirrel occupancy in the Sonoran Desert. *The Journal of Wildlife Management*, *74*(5), 954-962.

Barrows, C. W. (1996) An ecological model for the protection of a dune ecosystem. *Conservation Biology*, *10*(3), 888-891.

Barrows, C. W. (1997) Habitat relationships of the Coachella Valley fringe-toed lizard, Uma inornata. *The Southwestern Naturalist, 42*(2), 218-223.

Barrows, C. W. (2000) Tenebrionid species richness and distribution in the Coachella Valley sand dunes (Coleoptera: Tenebrionidae). *The Southwestern Naturalist*, 45(3): 306-312.

Barrows, C. W. (2006) Population dynamics of a threatened sand dune lizard. *The Southwestern Naturalist, 51*(4), 514-523.

Barrows, C. W, & Allen, M. F. (2007) 2005-2006 Coachella Valley MSHCP Monitoring Framework Priorities: Impacts of Exotic Weed Species including Saharan Mustard (Brassica tournefortii). UC Riverside: Center for Conservation Biology. Retrieved from https://escholarship.org/uc/item/3gr6974t

Barrows C. W., K. L. Preston, J. T. Rotenberry, & Allen, M. F. (2008) Using occurrence records to model historic distributions and estimate habitat losses for two psammophilic lizards. *Biological Conservation, 141*, 1885-1893.

Barrows, C. W., & Allen, M. F. (2009) Conserving species in fragmented habitats: population dynamics of the flat-tailed horned lizard, Phrynosoma mcallii. *The Southwestern Naturalist, 54*(3), 307-316.

Barrows, C. W., Allen, E. B., Brooks, M. L., & Allen, M. F. (2009) Effects of an invasive plant on a desert sand dune landscape. *Biological Invasions*, *11*, 673-686.

Barrows, C. W., & Allen, M. F. (2010) Patterns of occurrence of reptiles across a sand dune landscape. *Journal of Arid Environments*, *74*(2), 186-192.

Barrows, C. W. (2012) Temporal patterns of abundance of arthropods on sand dunes. *The Southwestern Naturalist, 57*(3), 262-267.

Barrows, C. W., Hoines, J., Vamstad, M. S., Murphy-Mariscal, M. L., Lalumiere, K., & Heintz, J. (2016) Measuring the value of citizen scientists for assessing climate change impacts across desert ecoregions. *Biological Conservation, 195*, 82-88

Barrows, C. W., & Heacox, S. A. (2021) Forty years later: monitoring and status of the endangered Coachella Valley fringe-toed lizard. *California Fish and Wildlife Journal*, *107*, 243-257.

Barrows, C. W., Heacox, S. A., & Sweet, L. C. (2022) Flat-Tailed Horned Lizards—20 Years Of Research At The Northwestern Edge Of Their Range. *The Southwestern Naturalist, 66*(4), 309-316.

Beheiry, S. A. (1967) Sand forms in the Coachella Valley, southern California. *Annals of the Association of American Geographers, 57*(1), 25-48.

Belnap, J., Webb, R. H., Esque, T. C. Brooks, M. L., Defalco, L. A. & Macmahon. J. A. (2016) Deserts. Pages 635–667 in *Ecosystems of California* (H. Mooney and E. Zavaleta, editors). University of California Press, Oakland.

California Native Plant Society, Rare Plant Program (CNPS) (2023) Rare Plant Inventory (online edition, v9.5). Website https://www.rareplants.cnps.org [accessed 15 June 2023].

CCH2 Portal. (2024) California Consortium of Herbaria. https://www.cch2.org/portal/index.php

Drezner, T. D., & Drezner, Z. (2021) Informed cover measurement: Guidelines and error for point-intercept approaches. *Applications in Plant Sciences*, *9*(9-10), e11446.

Fisher, M., Muth, A. & Johnson, R. F. (2020) A Long-term Study of Home Range of Coachella Fringe-toed Lizards, Uma inornata. *Journal of Herpetology, 54*, 174-182.

Griffiths, P. G., Webb, R. H., Lancaster, N., Kaehler, C. A. and Lundstrom, S. C., (2002) Long-term sand supply to Coachella Valley fringe-toed lizard habitat in the Northern Coachella Valley, California. *Water-Resources Investigations Report*, *2:* 4013.

Guo, Q., & Brown, J. H. (1996) Temporal fluctuations and experimental effects in desert plant communities. *Oecologia*, *107,* 568-577.

Hoefler, G., Harris, J. (n.d.). Life history account for round-tailed ground squirrel. California Wildlife Habitat Relationships (CWHR) System. https://nrm.dfg.ca.gov/FileHandler.ashx?DocumentID=2421

Hothorn T., Hornik K., van de Wiel M. A., & Zeileis A. (2006) A Lego system for conditional inference. *The American Statistician, 60*(3), 257–263.

Hulton, H. L., Hansen, A. M., Barrows, C. W., Latif, Q., Simon, M. W. & Anderson, K. E. (2013) Shifts in arthropod community structure during an invasion of desert ecosystems by Sahara mustard (Brassica tournefortii). *Biological Invasions*, *16*, 1675-1687.

Inouye, R. S. (1991) Population biology of desert annual plants. *The ecology of desert communities*, 27-54.

Johnson, R. A., Overson, R. P., & Moreau, C. S. (2013) A new species of seed-harvester ant, Pogonomyrmex hoelldobleri (Hymenoptera: Formicidae), from the Mohave and Sonoran Deserts of North America. *Zootaxa*, *3646*(3), 201-227.

Katra, I., Scheidt, S., & Lancaster, N. (2009) Changes in active eolian sand at northern Coachella Valley, California. *Geomorphology*, *105*(3), 277–290.

McHargue, L. T. (1973) A Vegetational Analysis of The Coachella Valley, California. University of California, Irvine.

Meinke, R. J., Amsberry, K., Currin, R. E., Meyers, S. C., & Knaus, B. (2007) Evaluating the Biological Conservation Status of the Coachella Valley Milkvetch (Astragalus lentiginosus var. coachellae). *Native Plant Conservation Program,* pp.11-19.

Moorberg, C. J., & Crouse, D. A. (2021) *Soils laboratory manual: K-state edition, version 2.0*. New Prairie Press.

Mueller-Dombois, D., and Ellenberg H. (1974) Aims and methods of vegetation ecology. John Wiley and Sons, New York, New York, USA.

NOAA. (2023) U.S. Wind Climatology | National Centers for Environmental Information (NCEI). https://www.ncei.noaa.gov/access/monitoring/wind/ [accessed 15 June 2023]

Noy-Meir, I. (1973) Desert ecosystems: environment and producers. *Annual Review of Ecology and Systematics*, *4*, 25–51.

Pianka, E. R. & Parker, W. S. (1975) Ecology of horned lizards: a review with special reference to Phrynosoma platyrhinos. *Copeia*, 141–162.

Polis, G. A. (1991) Complex trophic interactions in deserts: an empirical critique of food-web theory. *The American Naturalist, 138*(1), 123-155.

R Core Team (2021) R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/

Rodriguez, C., Sweet, L. C., Davis, M., Heacox, S., Barrows, C. & Larios, L. (n.d.) Temporal Invasion Regime Attributes Influence Community Synchrony and Stability in an Arid Land System. *Manuscript In Revision.*

Rorabaugh, J. C., & Young, K. V. (2009. Flat-tailed horned lizard Pages 182–185 in *Lizards of the American Southwest* (L. C. Jones and R. E. Lovich, eds). Rio Nuevo Press, Tucson, Arizona.

Stokes, B. (2022) Centrocoris volxemi-- A Newly Introduced Idaho Insect. *University of Idaho Extension Bulletin Series (BUL). 1037.*

Swei, A., Brylski, P. V., Spencer, W. D., Dodd, S. C., & Patton, J. L. (2003) Hierarchical genetic structure in fragmented populations of the little pocket mouse (Perognathus longimembris) in southern California. *Conservation Genetics*, *4,* 501-514.

Tinkham, E. R. (1962) Studies of Nearctic desert sand dunes Orthoptera, Part VI. A new genus and three new species of large camel crickets from the Colorado Desert with keys and notes. *Bulletin of the Southern California Academy of Sciences*, *61,* 89-111.

Turner, F. B., & Medica, P. A. (1982) The distribution and abundance of the flat-tailed horned lizard (Phrynosoma mcallii). *Copeia.* 815–823

[UCR CCB] Barrows, C. W., Sweet, L. C., Heacox, S., & Davis M. (2019) Coachella Valley Multiple Species Habitat Conservation Plan Aeolian Sand Species Trends 2019. Final Report. Prepared for: Coachella Valley Conservation Commission.

[UCR CCB] Barrows, C. W., Sweet, L. C., Heacox, S., Davis, M., Ramstead, P. (2021) Coachella Valley Multiple Species Habitat Conservation Plan Aeolian Sand Species Trends 2021. Final Report. Prepared for: Coachella Valley Conservation Commission.

[UCR CCB] Davis, M. J., Sweet, L. C., Barrows, C., Heacox. S. (2021) 2020-2021 Monitoring Results for the Coachella Valley Milkvetch (Astragalus lentiginosus var. coachellae) within the Coachella Valley. Final Report. Prepared for: Coachella Valley Conservation Commission.

[UCR CCB] Davis, M. J., Sweet, L. C., Barrows, C., Heacox. S (2022) 2022 Monitoring Results for the Coachella Valley Milkvetch (Astragalus lentiginosus var. coachellae) within the Coachella Valley. Final Report. Prepared for: Coachella Valley Conservation Commission.

[UCR CCB] Sweet, L. C., Heacox, S., Davis, M., Barrows, C. W. (2022) Coachella Valley Multiple Species Habitat Conservation Plan Aeolian Sand Species Trends 2022. Final Report. Prepared for: Coachella Valley Conservation Commission.

[UCR CCB] Davis, M. J., Sweet, L. C., Barrows, C., Heacox, S. (2023) 2023 Monitoring Results for the Coachella Valley Milkvetch (Astragalus lentiginosus var. coachellae) within the Coachella Valley. Final Report. Prepared for: Coachella Valley Conservation Commission.

University of Idaho (2009) Point Intercept Techniques. https://www.webpages.uidaho.edu/veg_measure/Modules/Lessons/Module%208(Cover)/8_3_Points.htm.

USDA (n.d.). Point Intercept (PO) – Sampling Method. https://www.fs.fed.us/rm/pubs/rmrs_gtr164/rmrs_gtr164_09_point_inter.pdf

U.S. Fish and Wildlife Service (USFWS) (1980) *Uma inornata*, Reproposal of Critical Habitat. Federal Register. May 28, 1980:36038-41.

U.S. Fish and Wildlife Service (USFWS) (1998) Final Rule: Determination of Endangered or Threatened Status for Five Desert Milk-vetch Taxa from California. Federal Register *63,* 53596-53615.

U.S. Geological Survey, National Geospatial Technical Operations Center (2023) Watershed Boundary Dataset (WBD) HUC12, California Vicinity - USGS National Map Downloadable Data Collection: U.S. Geological Survey.

Wasklewicz, T. A., Meek, N. (1995) Provenance of aeolian sediment: the Coachella Valley, California. *Physical Geography.* 1*6*(6),539–556.

Wickham, H. (2016). ggplot2: Elegant Graphics for Data Analysis. Springer-Verlag New York

Wojciechowski M. F., Spellenberg R. (2023) *Astragalus lentiginosus var. coachellae*, in Jepson Flora Project (eds.) Jepson eFlora, Revision 12, https://ucjeps.berkeley.edu/eflora/eflora_display.php?tid=54786 [accessed June 14, 2023]

WRCC (2024) Western Regional Climate Center: https://wrcc.dri.edu/summary/Climsmsca.html

Zahniser, J. N., Henry, T. J., Schumm, Z. R., Spears, L. R., Nischwitz, C., Scow, B., & Volesky, N. (2022) Centrocoris volxemi (Puton)(Hemiptera: Heteroptera: Coreidae), First Records for North America and Second Species of the Genus in the United States. *Proceedings of the Entomological Society of Washington*, *123*(4), 878-888.