



University of California, Merced  
**Merced Vernal Pools and Grassland Reserve**



**ANNUAL REPORT**

**FY 2020-21 July 1, 2020 – June 30, 2021**

**prepared by Joy Baccei**

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# Part 1. Reserve Use Data - Using Unique People Roles (July 1, 2020-June 30, 2021)

	UC Home		UC Other		CSU System		CA Comm College		Other CA College		Out of State College		International University		Government		NGO/Non-Profit		Business Entity		K-12 School		Other		Total		
	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	Users	UDs	
<b>UNIVERSITY- LEVEL RESEARCH</b>																											
Staff	0	0	0	0	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1
Faculty	5	8	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	10
Research Scientist/Post Doc	1	2	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	6
Research Assistant (non-student/faculty/postdoc)	3	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	4	
Graduate Student	11	73	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	73	
Undergraduate Student	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	
Professional	4	6	3	3	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	8	11	
Other	0	0	1	3	0	0	0	0	0	0	0	0	0	0	0	0	3	3	0	0	0	0	0	0	4	6	
<b>SUBTOTAL</b>	<b>26</b>	<b>95</b>	<b>9</b>	<b>12</b>	<b>2</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>3</b>	<b>3</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>40</b>	<b>113</b>	
<b>UNIVERSITY - LEVEL INSTRUCTION (CLASS)</b>																											
Faculty	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	4	
Graduate Student	1	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	
Undergraduate Student	5	10	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	10	
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	6	0	0	6	6	
Professional	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	2	2	
<b>SUBTOTAL</b>	<b>10</b>	<b>15</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>1</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>6</b>	<b>0</b>	<b>0</b>	<b>18</b>	<b>23</b>	
<b>OTHER</b>																											
Staff	7	7	0	0	1	2	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	9	10	
Faculty	2	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	
Research Scientist/Post Doc	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	2	
Graduate Student	3	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	3	3	
Undergraduate Student	4	20	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	20	
K-12 Instructor	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0	0	0	0	0	0	0	2	4	
K-12 Student	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	7	7	0	0	7	7		
Professional	6	34	0	0	1	22	0	0	0	0	1	4	0	0	3	5	2	2	11	46	0	0	3	3	27	116	
Other	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	5	1	12	0	0	0	0	6	17	
Volunteer	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	3	3	0	0	0	0	2	2	6	6	
<b>SUBTOTAL</b>	<b>23</b>	<b>68</b>	<b>0</b>	<b>0</b>	<b>2</b>	<b>24</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>5</b>	<b>7</b>	<b>12</b>	<b>14</b>	<b>12</b>	<b>58</b>	<b>7</b>	<b>7</b>	<b>5</b>	<b>5</b>	<b>67</b>	<b>187</b>	
<b>HOUSING</b>																											
<b>TOTALS</b>	<b>59</b>	<b>178</b>	<b>9</b>	<b>12</b>	<b>5</b>	<b>28</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>0</b>	<b>1</b>	<b>4</b>	<b>0</b>	<b>0</b>	<b>6</b>	<b>8</b>	<b>15</b>	<b>17</b>	<b>12</b>	<b>58</b>	<b>13</b>	<b>13</b>	<b>5</b>	<b>5</b>	<b>125</b>	<b>323</b>	

## Part 2. Reserve Users' Affiliation (July 1, 2020-June 30, 2021)

Institution Name	Location
<b>Business Entity</b>	
Blue Gray Films	Unknown, United States
Cunningham Ranch	Merced, California, United States
LSA Associates, Inc	Point Richmond, California, United States
LSA Associates, Inc.	Roseville, California, United States
SWCA Environmental Consultants	Half Moon Bay, California, United States
<b>California Community College</b>	
none	
<b>California - Other University or College</b>	
none	
<b>California State University System</b>	
UC Merced	Merced, California, United States
<b>Governmental Agency or Entity</b>	
CalFire	Merced, United States
California Department of Fish and Wildlife	Fresno, California, United States
California Department of Transportation	Fresno, California, United States
Greater Valley Conservation Corp	Stockton, California, United States
US Fish and Wildlife Service	Various, United States
Yosemite National Park	El Portal, California, United States
<b>Individual or Other Entity</b>	
Generic Individual or Other Entity	Various, California, United States
No Institution Selected	n/a, United States
<b>International University or College</b>	
none	
<b>K-12 Education</b>	
Generic K-12 Education	Various, California, United States
<b>Non-Governmental Organization or Non-Profit Entity</b>	
Adventure Risk Challenge	Various, California, United States
Dryad Ranch	Raymond, United States

## Part 2. Reserve Users' Affiliation (July 1, 2020-June 30, 2021), cont'd

Institution Name	Location
Generic Non-Governmental Organization	Various, California, United States
Merced Bicycle Coalition	Merced, United States
Merced Camera Club	Merced, California, United States
The Nature Conservancy	San Francisco, California, United States
<b>University of California</b>	
UC Cooperative Extension	Mariposa, California, United States
UC Cooperative Extension Merced	Merced, United States
UC Cooperative Extension Merced County	Merced, United States
University of California, Berkeley	Berkeley, California, United States
University of California, Davis	Davis, California, United States
University of California, Merced	Merced, California, United States
University of California, Riverside	Riverside, California, United States
University of California, Santa Barbara	Santa Barbara, California, United States
<b>U.S. - University or College Outside of California</b>	
Southern Oregon University	Ashland, California, United States

## Part 3. Use by Instructional Groups

<b>Governmental Agency or Entity</b>			
<b>Yosemite National Park</b>			
YLP Capstone Project			
<i>Course Number:</i>	YLP Program	<i>Date:</i>	February 26, 2021 - April 21, 2021
<i>Instructor:</i>	Jesse Chakrin   Wilderness Protection	<i>Professional:</i>	2
		<i>Undergraduate Student:</i>	9
<b>University of California</b>			
<b>University of California, Merced</b>			
Carson House: Sustainable Futures			
<i>Course Number:</i>	F20-USTU 010 13	<i>Date:</i>	October 17, 2020
<i>Instructor:</i>	Bailey Carlson	<i>Graduate Student:</i>	1
Environmental Writing			
<i>Course Number:</i>	114	<i>Date:</i>	February 27, 2021
<i>Instructor:</i>	Thomas Hothem   Writing Program, UC Merced	<i>Faculty:</i>	4
		<i>K-12 Student:</i>	6
General Virology Lab A			
<i>Course Number:</i>	Bio 127LA	<i>Date:</i>	September 10, 2020
<i>Instructor:</i>	Samuel Arda	<i>Undergraduate Student:</i>	1

## Part 4. Current Research Summary (Appendix provides details)

Principal Investigator/s	Other Members	Affiliation/s	Project Title	Project Dates	Application Number	Users	User Days
Brandon Hendrickson		University of California, Merced	Phenological Mismatch of California Wildflowers and their Pollinators	27 Nov 2017 to 31 Jul 2018	36412	0	0
Chris Swarth	Marilyn Fogel	University of California, Riverside	Visit vernal pools and grasslands to survey for wintering birds as followup to earlier studies	26 Feb 2021 to 01 Mar 2021	46000	2	2
Daniel Toews   Jason Sexton   Marilyn Fogel	Chris Swarth	University of California, Merced	Understanding Selective Processes In A Vernal Pool	21 Oct 2015 to 30 Jun 2020	32153		
Erin Hestir	Kalua   Bailey Morrison   Fatima Gamino   Jonathan Rivas   Porfirio Montoya   Adam Weingram	University of California, Merced	EORS Vernal Pools UAS Flights 2020	16 Mar 2020 to 31 Jul 2020	44967	7	18
Fadzayi Mashiri	Joy Baccei   Anthony Cantu   Vong Moua	University of California, Merced   UC Cooperative Extension Merced County	Estimating Forage Production Monitoring Using Remote Sensing Data	01 Dec 2020 to 30 Jun 2022	45746	4	8
Jason Sexton	Robert Martin   Iris Montes   Julia DePass   John Cronin   Jacob Croasdale   Jenna Heckel   Valeria Rivera   <b>Brandon Hendrickson</b>   Teanna Herrera   Madeline Castro   Jovanna Salazar   Zara Perez-Ochoa	University of California, Merced   No Institution Selected	Vernal Pool Phenology YLP Capstone	31 Jan 2016 to 30 Jun 2019	32651	2	12
Jorge Montiel Molina	None	University of California, Merced	Vernal Pool Microbial Communities	05 Mar 2018 to 01 May 2019	36189	1	1
Joshua Viers   Anna Rallings	Jefferson Laird   Jacob Flanagan   Brendan Smith   Anna Fryjoff-Hung   Lorenzo Booth   Matt Beaman   Jenny Ta   Andreas Anderson   Nicholas Magyari   Allan Murillo   Thomas Hestir   Samuel Araya   Michael Kalua   Gustavo Facincani Dourado   Francesca Cannizzo   Jacob Nesslage Selina Davila Olivera   Daniel Gomez   Jacques Fracchia   Erik Bolch   Michael Kalua   Gustavo Facincani Dourado   Francesca Cannizzo   Jacob Nesslage	University of California, Merced	Hydrologic Monitoring and Modeling for Management and Restoration Analysis	31 Dec 2014 to 31 Dec 2025	30140	4	8
Kipling Will	Gordon Bennett	University of California, Berkeley   University of California, Merced	Conservation Genetics of Dicheirus Carabid Beetle Species (Golden Bear harpalines)	01 Dec 2020 to 30 Nov 2021	45705	2	2
Patricia Holden   Marc Beutel   Stephen Hart   Samuel Traina   Tom Harmon	Michelle Gilmore   Laurie Van De Werfhorst   Monique Kolster	University of California, Merced   University of California, Santa Barbara	A Pilot Study of Tobacco & Cannabis Contaminants in Protected Areas (Merced Vernal)	01 Aug 2019 to 31 Jan 2021	44491	6	15
Thomas Hothem	Dwight Ewing   Buck Ewing   Hannah Ewing   Mizrrain Lava Nava   Jane Ewing	University of California, Merced   Merced Bicycle Coalition   UC Merced	Burrowing Owl Survey	01 Jan 2018 to 31 Dec 2021	35020	6	6
					TOTAL:	34	72
					AVG:	3.4	7.2

## Part 5. Publications

2020:

Holden, P.A., Beutel, M., Brooks, A., Butsic, V., Dodder, N., Duttagupta, S., Fiedler, P. Harmon, T., Hart, S., Hoh, E., Li, D., Jerde, C., Novotny, T., Gilmore, M., Traina, S., Van De Werfhorst, L., Wartenberg, A., 2020. Environmental exposures and effects of tobacco and cannabis: synthesis of evidence for policy arguments. American Public Health Association Annual Meeting, Oct 24-28, 2020

LSA Associates, Inc. *Conceptual Landscape Restoration Plan, Merced Vernal Pools and Grassland Reserve*. UCM1901, University of California, Merced, July 2020, p. 87.

Nesslage, Jacob, E. L. Hestir, and Julia Burmistrova. "Using Sentinel-2 to Detect and Predict Biodiversity Hotspots within a Vernal Pools and Grasslands Ecosystem." In *AGU Fall Meeting Abstracts*, vol. 2020, pp. B060-0021. 2020.

Montiel, J. A., et al. "Visualizing Diversity and Distribution Patterns for Microbial Communities in Vernal Pools." *Vernal Pool Landscapes: Past Pre- Sent and Future*, edited by R.A. Schlising et al., 2020, <http://sextonlab.ucmerced.edu/wp-content/uploads/2019-Montiel.pdf>.

Swarth, C.W. 2020. Birds of the Merced Vernal Pools and Grassland Reserve. *Central Valley Birds* 23(4):69-95.

Datasets:

Kalua, M.; Viers, J.; Anderson, A. (2020), Merced Vernal Pools and Grassland Reserve sUAS-LiDAR High Resolution 0.25-meter DEM, Dryad, Dataset, <https://doi.org/10.6071/M33D4N>

2021:

Montiel-Molina JA (2021). Microbial biogeography in Mediterranean Vernal Pools of western North America. Doctoral thesis. University of California Merced. 76 pp.

Montiel-Molina JAM, C Frank, JP Sexton & M Beman, (*in revision*) Archaeal and bacterial diversity and distribution patterns in Mediterranean vernal pools of Mexico and the western USA. *Microbial Ecology*

## Part 6. Narrative

### Summary

Overall, the Merced Vernal Pools and Grassland Reserve had a successful year supporting research, teaching, public service, and stewardship activities on the Reserve, despite ongoing challenges and impacts from the COVID-19 global pandemic. Below, we summarize overall Reserve use and COVID-19 impacts, and then we provide more detail about activities in each of our core areas - Research, Education, Public Service and Outreach, and Stewardship – finishing with a short discussion of other activities Reserve staff were engaged in over the course of the year.

**Reserve Use:** In the 2020-2021 fiscal year, the Merced Vernal Pools and Grassland Reserve (MVPGR) hosted 122 users and 318 user-days related to the three main use types; research, education, and public service. User days were almost ten times lower than average reported user days from 2015-2020 (3,184 user days), prior to the COVID-19 pandemic (see Table 1, note: although the MVPGR became part of the UC Natural Reserve System in 2013, the first two years (2013-2014) are not shown here for comparison because use for those beginning years was not reported consistently in the RAMS online reservation system):

- **Research** accounted for 33% of total user days (113 of 323), comprising the second highest use type on the Reserve for the year. Research had accounted for ~30% of Reserve use on average from 2015-2020.
- **Education** related to university-level class use, accounted for only 7% of total user days (23 of 323), where it had previously accounted for 52% of annual Reserve use on average from 2015-2020.
- **Public service** accounted for 57% of total user days (182 of 323), where it had previously accounted for only 17% of Reserve use on average from 2015-2020.

**Use Types:** This report summarizes highlights from the FY20-21 fiscal year related to research, education, stewardship and outreach, where educational use continued to be substantially impacted by COVID-19:

- **Research** represented a total 11 projects conducted by 40 users, all of whom were affiliated with the University of California. Of the 11 projects, 9 had a PI affiliated with UC Merced. Non-UC Merced affiliated PIs hailed from UC Berkeley, UC Santa Barbara, and UC Agriculture and Natural Resources (UCANR).
- **Education** (university-level) represented 4 courses and 23 user days from UC Merced affiliates (faculty, graduate, and undergraduate students), including the Yosemite Leadership Program (YLP) NRS Digital Storytelling Capstone, Carson House: Sustainable Futures, Environmental Writing, and General Virology.
- **Public service** (stewardship, outreach, and K-12 education) represented 12 efforts by 64 varied users. Stewardship (including threatened and endangered species and grazing management monitoring, invasive species management, and conservation easement inspection) was conducted by UC Merced staff and public affiliated groups, LSA Associates, the Greater Valley Conservation Corps, the Nature Conservancy, and the North American Bat (NaBat) Monitoring Program. Outreach (including Reserve tours, filming, and photography) was conducted by UC Merced staff and public affiliated groups, including the Howard Hughes Medical Institution and Merced Camera Club. Education (K-12) represented 2 field trips and 13 user days from the Adventure Risk Challenge (ARC) K-12 Community Leadership Program, which safely brought Dos Palos and Firebaugh high school students out to the Reserve to learn about vernal pool ecology and engage in hands-on monitoring.
- **Un-reported use** included planning for a new outdoor educational pavilion and for a new grazing license.



Table 1. Current (2020-21) versus Past (2015-2020) Use on the Merced Vernal Pools and Grassland Reserve

User Type	Research	Education	Public Service	Grand Total
<b>2015-2020 5-Year Average Reserve Use (Pre-COVID-19 Pandemic)</b>				
Users	246	1226	433	1905
User Days	967	1664	553	3184
% Reserve Users	13%	64%	23%	100%
% Reserve User Days	30%	52%	17%	100%
<b>2020-2021 Fiscal Year Reserve Use (During COVID-19 Pandemic)</b>				
Users	40	18	64	122
User Days	113	23	182	318
% Reserve Users	33%	15%	52%	100%
% Reserve User Days	36%	7%	57%	100%

**COVID-19 Impacts:** The COVID-19 pandemic substantially impacted our Reserve, as seen in the substantially lower user days reported above. In general throughout the pandemic, reservations with group sizes of 10 or less were allowed to continue, provided that users complied with the UC Merced Natural Reserve System SOPs and MVPGR COVID-19 Notice of Policies (NOPs), which remained in place for the duration of the 2020-2021 fiscal year in order to ensure safety for all users. Education (university-level) and outreach (K-12) use were most impacted by COVID-19 restrictions set in place in response to the pandemic, where use that required groups of more than 10 individuals were either cancelled or reservations were not made due to restrictions. For example, all UC classes were fully remote, so no in-person activities could generally take place. Research was able to continue fairly un-impacted due to smaller group sizes. Similar to the 2019-2020 fiscal year, the MVPGR administration worked to benefit from this quiet time period by focusing on strategic planning and development efforts, and continued facilitation of research and public service activities that could be done safely either individually or in small groups. Many public service events were delayed (e.g., the California Naturalist Certification Course, UC Merced Student Naturalist Training, UC Merced Staff Appreciation Week, and Audubon Society annual Christmas Bird Count), and others were shifted to a virtual format (e.g., Research Week, department and educational presentations).

## **Research**

During the FY20-21 fiscal year, of the 11 projects that were conducted by 46 users, 3 of 11 projects (27%) were new and 8 of 11 projects (73%) were ongoing (Table 2). In addition, 9 of 11 projects also had a PI affiliated with UC Merced. Non-UC Merced affiliated PIs hailed from UC Berkeley, UC Santa Barbara, and the UC Agriculture and Natural Resources (UCANR) Merced County Cooperative Extension. The research project with the majority of reported user days was Erin Hestir’s UC Merced Earth Observation and Remote Sensing (EORS) Lab “EORS Vernal Pools UAS Flights 2020” project associated with UAV-based imaging spectroscopy to quantify plant biodiversity and identify alien invasive plant species, which had a total of 15 user days for FY 20-21. Four (4) publications from the past fiscal year (2020-2021) were provided by researchers or detected using Google Scholar, and were added to the UCNRS Zotero database.

Table 2. Current Research on the Merced Vernal Pools and Grassland Reserve

Principal Investigator/s	Other Members	Affiliation/s	Project Title	Project Dates	Application Number
Chris Swarth	Marilyn Fogel	University of California, Riverside	Visit vernal pools and grasslands to survey for wintering birds as followup to earlier studies	26 Feb 2021 to 01 Mar 2021	46000
Daniel Toews   Jason Sexton   Marilyn Fogel	Chris Swarth	University of California, Merced	Understanding Selective Processes In A Vernal Pool	21 Oct 2015 to 30 Jun 2020	32153
Erin Hestir	Michael Kalua   Bailey Morrison   Fatima Gamino   Jonathan Rivas   Porfirio Montoya   Adam Weingram	University of California, Merced	EORS Vernal Pools UAS Flights 2020	16 Mar 2020 to 31 Jul 2020	44967
Fadzayi Mashiri	Joy Baccei   Anthony Cantu   Vong Moua	University of California, Merced   UC Cooperative Extension Merced County	Estimating Forage Production Monitoring Using Remote Sensing Data	01 Dec 2020 to 30 Jun 2022	45746
Jason Sexton	Brandon Hendrickson	University of California, Merced   No Institution Selected	Vernal Pool Phenology and Biodiversity Study (and Vernal Pool Phenology YLP Capstone)	31 Jan 2016 to 30 Jun 2022	32651
Jason Sexton   Molly Stephens	Elizabeth Green   Daniel Toews   Erin Dickman   Michael Spaeth   Dannise Ruiz   Jorge Montiel Molina   Lauren Schiebelhut   Michael Dawson	University of California, Merced	Genetic Investigation of Listed Vernal Pool Plants and Their Communities in Merced County	01 Nov 2015 to 31 Dec 2021	32158
Jorge Montiel Molina	None	University of California, Merced	Vernal Pool Microbial Communities	05 Mar 2018 to 01 May 2022	36189
Joshua Viers   Anna Rallings	Jefferson Laird   Jacob Flanagan   Brendan Smith   Anna Fryjoff-Hung   Lorenzo Booth   Matt Beaman   Jenny Ta   Andreas Anderson   Nicholas Magyari   Allan Murillo   Thomas Hestir   Samuel Araya   Michael Kalua   Gustavo Facincani Dourado   Francesca Cannizzo   Jacob Nesslage Selina Davila Olivera   Daniel Gomez   Jacques Fracchia   Erik Bolch   Michael Kalua   Gustavo Facincani Dourado   Francesca Cannizzo   Jacob Nesslage	University of California, Merced	Hydrologic Monitoring and Modeling for Management and Restoration Analysis	31 Dec 2014 to 31 Dec 2025	30140
Kipling Will	Gordon Bennett	University of California, Berkeley   University of California, Merced	Conservation Genetics of Dicheirus Carabid Beetle Species (Golden Bear harpalines)	01 Dec 2020 to 30 Nov 2021	45705
Patricia Holden   Marc Beutel   Stephen Hart   Samuel Traina   Tom Harmon	Michelle Gilmore   Laurie Van De Werfhorst   Monique Kolster	University of California, Merced   University of California, Santa Barbara	A Pilot Study of Tobacco & Cannabis Contaminants in Protected Areas (Merced Vernal)	01 Aug 2019 to 31 Jan 2021	44491
Thomas Hothem	Dwight Ewing   Buck Ewing   Hannah Ewing   Mizrrain Lava Nava   Jane Ewing	University of California, Merced   Merced Bicycle Coalition   UC Merced	Burrowing Owl Survey	01 Jan 2018 to 31 Dec 2021	35020

**Highlights** on select research projects are shown below:

### **Conservation Genetics of Dicheirus Carabid Beetle Species (Golden Bear harpalines)**

Kipling Will | Gordon Bennett (University of California, Berkeley | University of California, Merced)



*Initial MVPGR beetle survey by Kip Will (left) and Gordon Bennett (right), photo: Francesca Cannizzo.*

This research project intends to sample carabid beetles from many populations on the mainland and the islands to be used for a state-wide conservation genomics project (California Conservation Genomics Project (CCGP) <https://sites.lifesci.ucla.edu/eeb-CCGP/>). The main goal of sampling is to collect species of the Golden Bear Harpaline beetles (*Dicheirus* spp.). Secondary goals are 1. to sample other carabid beetles that live with the Golden Bear Harpalines, 2. develop a more complete checklist of carabid species on the islands, 3. look for established, invasive species of insects that may impact the Golden Bear Harpalines, and 4. take DNA-quality samples for

revisionary systematic projects on other California carabid beetles found on the islands. On February 4<sup>th</sup>, 2021, an initial survey of beetle habitat, and a search for beetles was conducted by Dr. Kip Will (UC Berkeley) and UC Merced faculty member Dr. Gordon Bennett, who teaches entomology on the Reserve. During the survey, *Dicheirus* and a handful of other carabids were observed. Sampling was planned for winter/spring of 2021, but was not conducted due to severe drought conditions across the state, which are not conducive for beetles.

### **Estimating Forage Production Monitoring Using Remote Sensing Data**

Fadzayi Mashiri | Joy Baccei | Anthony Cantu | Vong Moua (University of California, Merced | UC Cooperative Extension Merced County)



*Installation of grazing enclosure for Fadzayi Mashiri's UCANR forage production study, photo: Joy Baccei*

Satellite-based remote sensing technologies provide several opportunities to enhance rangeland management. A pilot study using remotely sensed imagery (satellite & drone) to estimate daily rangeland forage production is documenting the efficacy of using current remote sensing platforms to effectively characterize the landscape distribution of forage across the growing season. The goal of this project is to scale this pilot study to larger more diverse rangeland types to represent as many California rangeland types as possible to evaluate the viability of near real-time monitoring of rangeland forage biomass. The project has research sites spread in almost all California counties to cover the diverse rangeland ecosystem types and conditions. In Merced, there are two sites, one located is at the MVPGR. A 64x64' enclosure was installed on the

MVPGR in January to protect the area from grazing. Location (37.283, -120.160). Forage production was clipped within the enclosure three times through the season early forage growth, mid-season and at peak standing biomass for the first year. Residual biomass will be clipped in October to estimate residual dry matter (RDM). A second year of similar data collection will start this fall. Only raw data has been collected at the moment. The ground data hasn't been correlated with the remote sensing data, so there are no results to share yet.

## EORS Vernal Pools UAS Flights 2020

Erin Hestir | Kalua | Bailey Morrison | Fatima Gamino | Jonathan Rivas | Porfirio Montoya | Adam Weingram (University of California, Merced)



*Jacob Nesslage with UAV LiDAR system (DJI Matrice 600 w/Phoenix ALD LiDAR used to collect elevation data, photo: Jacob Nesslage.*

This project aims to test the feasibility of using UAV-based imaging spectroscopy to 1) quantify biodiversity and 2) identify and track alien invasive plant species in the MVPGR. Multiple flights have been and will be conducted in the Reserve to capture the phenology of the system, and rigorous field validation will be conducted to assess the technology and build the models. This work will be used to create the preliminary datasets and develop the necessary data pipelines needed to begin addressing the drivers of biodiversity and invasion and understanding what causes invasion vulnerability at the terrestrial-aquatic interface. Further, this work will be used to inform next-generation monitoring strategies for the MVPGR management program and can be used to complement ongoing biological monitoring requirements. During 2021, a total of three flights were conducted on the Reserve. On January 22<sup>nd</sup>, 2021, drone flight tests were conducted at the Western Playa Pool to test drone LiDAR sensors and train lab members, on June 4<sup>th</sup>, 2021, UAS test flights were conducted to collect hyperspectral

test imagery, and on July 15<sup>th</sup>, 2021, test flights were performed to trouble ongoing imagine issues with hyperspectral imagery mapping using UAS technology.

Jacob Nesslage (UC Merced graduate student in EORS Lab) presented some of his preliminary work on predicting plant species richness patterns using satellite remote sensing as a poster at the American Geophysical Union's Fall 2020 Meeting in December 2020 (Nesslage et. al. 2020). Nesslage also assisted VICE Lab graduate student Michael Kalua with LiDAR mapping in 2020, and is preparing a publication to summarize plant species richness modeling using satellite remote sensing.

## Genetic Investigation of Listed Vernal Pool Plants and Their Communities in Merced County

Jason Sexton | Molly Stephens | Daniel Toews | Dannise V. Ruiz-Ramos | Rachel Meyers | Lillie Pennington (University of California, Merced | California State Univ. (CSU), Los Angeles | University of California, LA)



*Colusa grass (Neostapfia colusana), photo: Joy Baccei*

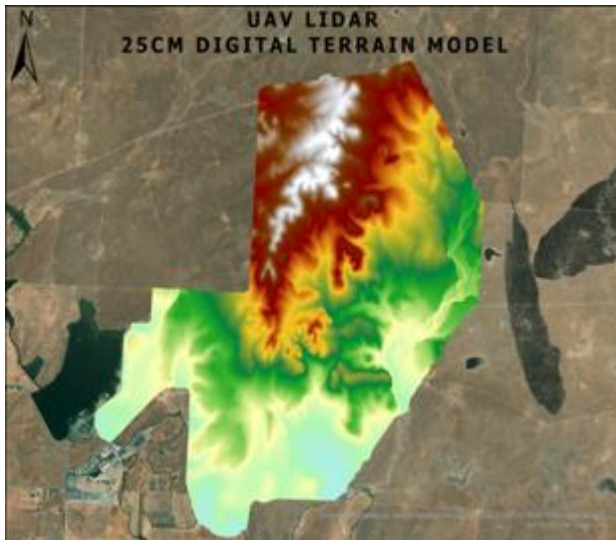
This research aims to improve conservation and management of native vernal pool plant species in California through improved protocols for soil plant species identification from soil samples, enhanced vernal pool plant species richness estimates, genetic marker resource development for listed species, and population genetic investigation of threatened vernal pool species. Design and validation of metabarcoding methods is being done to detect vernal pool plant species in soil seed banks in vernal pools of Eastern Merced County. Metabarcoding detection rates are being compared with above-ground species diversity surveys and these assays are being evaluated for incorporation into vernal pool monitoring and restoration efforts. Over 2020 and 2021 work continued to improve and develop eDNA metabarcoding methods for detecting vernal pool plants in environmental soil samples, and tissue was collected for rare plant marker development and population genetic portions of the project. Specifically, the

following was accomplished 1) vouchered herbarium samples of several local plant species collected on the MVPGR that will be used to fill gaps in barcode reference libraries; 2) developed soil processing protocols to better detect plant DNA from collected soil samples; 3)

began soil extractions for the eDNA leg of the project; and 4) collected additional plant tissue and isolated genomic DNA from (*Neostapfia colusana*), these samples have been sent to Meyers Lab at UC Santa Cruz for library preparation and sequencing. For the remainder of 2021, the following efforts continue; eDNA extraction of vernal pool soil samples continues, experiment on eDNA methods development, analyze vegetation survey data and generate barcodes for reference library, analyze genetic data generated from rare plant collections.

### **Hydrologic Monitoring and Modeling for Management and Restoration Analysis**

Joshua Viers | Anna Rallings | Francesca Cannizzo | Jacob Nesslage | Michael Kalua  
(University of California, Merced)



*UAV LiDAR Digital Terrain Model (25 cm resolution)  
developed by VICE Lab members*

A multi-faceted habitat improvement project for Avocet Pond and additional select stock ponds on the Reserve is being researched and planned by a working group consisting of members of Josh Viers' VICE Lab, the Campus Biologist, the Reserve Director, and LSA Associates. LSA Associates has prepared a Conceptual Landscape Restoration Plan (LSA 2020) to evaluate potential restoration opportunities at four stock pond locations—Avocet, Three Willows, Windmill, and Barn ponds—to enhance wetland and aquatic habitats on the Reserve that have been degraded through past land disturbances and to benefit threatened and endangered species. The VICE lab has been conducting restoration research and collecting LiDAR data on the Reserve using drone technology. The

LiDAR dataset was collected by the VICE Lab, where field data was collected and processed by Michael Kalua October 2019 – March 2020. Available geospatial data include high resolution .las point cloud and 25 cm resolution digital elevation model (DEM) for the full Reserve boundary. Baseline data can be used for studies into geology, hydrology, ecology, as well as monitoring Reserve resources. Michael Kalua (UC Merced graduate student in VICE Lab) finalized collection of 25 cm resolution LiDAR data via drone over the entirety of the Reserve in 2020, with assistance from Jacob Nesslage (EORS Lab). This LiDAR dataset is now published on Dryad (Kalua et. al. 2020).

## **Tobacco & Cannabis Contaminants in Protected Areas (Pilot Study)**

Patricia Holden | Peggy Fiedler | Marc Beutel | Stephen Hart | Sam Traina | Tom Harmon | Laurie Van De WerfHorst | Michelle Gilmore (University of California, Santa Barbara | University of California, Merced, NRS)



*Michelle Gilmore and Marc Beutel sampling soil and water for contaminants at Black Rascal Creek, photo: Laurie Van De WerfHorst*

This project is a pilot study of tobacco and Cannabis contaminants in protected areas, aiming to provide foundational results and proof of concept for future research. The study aims to 1) Synthesize all published research into original reports regarding environmental contamination by tobacco and Cannabis chemicals, including their origins, environmental transport, and fate, as well as exposures and effects on organisms delivering ecosystem services; 2) Develop a methodology to determine how, where, and to what extent protected areas may be contaminated with chemicals associated with tobacco and Cannabis; and 3) Conduct pilot field sampling and laboratory analyses to establish a research methodology using multiple Reserves in the University of California Natural Reserve System, including the Merced Vernal Pools & Grassland Reserve. Tobacco and cannabis debris surveys were conducted at the MVPGR and adjacent lands on September 25<sup>th</sup> and October 9<sup>th</sup> of 2020 by Michelle Gilmore and Marc Beutel (UC Merced).

Surface water, sediment, and soil samples were collected from locations at MVPGR (Barn Pond, wetland inside the Reserve a Le Grande Canal spillway, Black Rascal Creek, Three Willows Pond) and adjacent areas (Lake Yosemite, Le Grande Canal, UC Merced land near the Barn, “smokers lane” and Merced County land west of MVPGR) on October 20<sup>th</sup> and 21<sup>st</sup> of 2020 by Laurie Van De Werfhorst (UC Santa Barbara) and Michelle Gilmore (UC Merced). A total of 6 water, 6 sediment, and 9 soil samples were collected. All samples have been processed and are being analyzed.

## **Understanding Selective Processes In A Vernal Pool Landscape**

Daniel Toews | Jason Sexton | Marilyn Fogel (University of California, Merced)



*Meadowfoam (Limnanthes douglasii), photo: Alfonso Villafuerte*

This study aims to characterize selective processes that influence plant distribution in a vernal pool landscape. The diversity of soils of the Merced Vernal Pools and Grasslands Reserve constitutes an ideal study site to investigate how environmental selection structures vernal pool plant communities. An experimental approach will be used to distinguish adaptive traits between plant populations among different pool types. Understanding abiotic selective processes in vernal pool landscapes with high geographic and ecological complexities will aid in making conservation and management decisions of these threatened ecosystems. Over 2020 and 2021 I have completed the second and final year of this local adaptation experiment conducted across six vernal pools on the MVPGR. This work involved multiple site visits to

census experimental plots, maintain cattle exclusion fencing and conduct plant removal of the completed experiment. While the experiment has concluded, the cattle exclusion fencing around the six experimental pools remains and will be removed by end of 2021. A publication is currently in preparation, titled “Soil effects on an endemic vernal pool annual plant, *Limnanthes douglasii* spp. *rosea* (Meadowfoam).

## Vernal Pool Phenology and Biodiversity Study

Brandon Hendrickson | Jason Sexton (University of California, Merced)



*Vernal pool monkeyflower (Diplacus tricolor), photo: Brandon Hendrickson*

Vernal pools are recognized as a critical component of the California Floristic Province, and a global biodiversity hotspot. This study involves visiting a set of three vernal pools on a weekly basis in order to monitor the diversity and phenology of native and endemic plants located around the vernal pools and grasslands using an established plant monitoring protocol. Ultimately, data will be transferred to the public via open websites. This project aims to directly benefit researchers and land managers working to understanding the biology, conservation, and restoration needs of these special ecosystems and plant communities. During the 2020-2021 field season, In past years, Yosemite Leadership Program (YLP) interns assisted with study implementation. This past year, this study was conducted solely by UC Merced graduate student researcher Brandon Hendrickson during the 2020-2021 field season. Three vernal pools and their species were monitored weekly by placing north-south and east-west transects across the pool and then recording flowering plant species. No publications

have been submitted to date and the findings/data have not been disseminated either in a conference, magazine, or newspaper. The project is not funded by an outside agency.

## Visit vernal pools and grasslands to survey for wintering birds as follow-up to earlier studies

Chris Swarth | Marilyn Fogel (University of California, Merced | University of California, Riverside)



*Chris Swarth (former MVPGR Director) and Joy Baccei (current MVPGR Director) don their binoculars for bird surveying, photo: Jesse Chakrin.*

The avifauna of the Merced Vernal Pools and Grassland Reserve (a University of California Natural Reserve) in eastern Merced County, was documented over a three-year period (2013-2015), with several additional surveys incorporated from other years. Eighty-nine species were observed using Reserve habitats. Twelve species used the Reserve for nesting, thirty-eight species were local breeders, and thirty-nine species were considered migrants. The largest groups were waterbirds and grassland specialists. Vernal pools, cattle stock ponds, and an irrigation canal are the main aquatic habitats present. Habitat use and abundance is discussed, and results are compared with several other regional avifaunal assessments. On 2/26/21, a survey of birds using the vernal pools and grasslands was completed to supplement and update a peer-reviewed publication

in Central Valley Birds titled "Birds of the Merced Vernal Pools and Grassland Reserve", which is published online by the Central Valley Bird Club (CVBC).

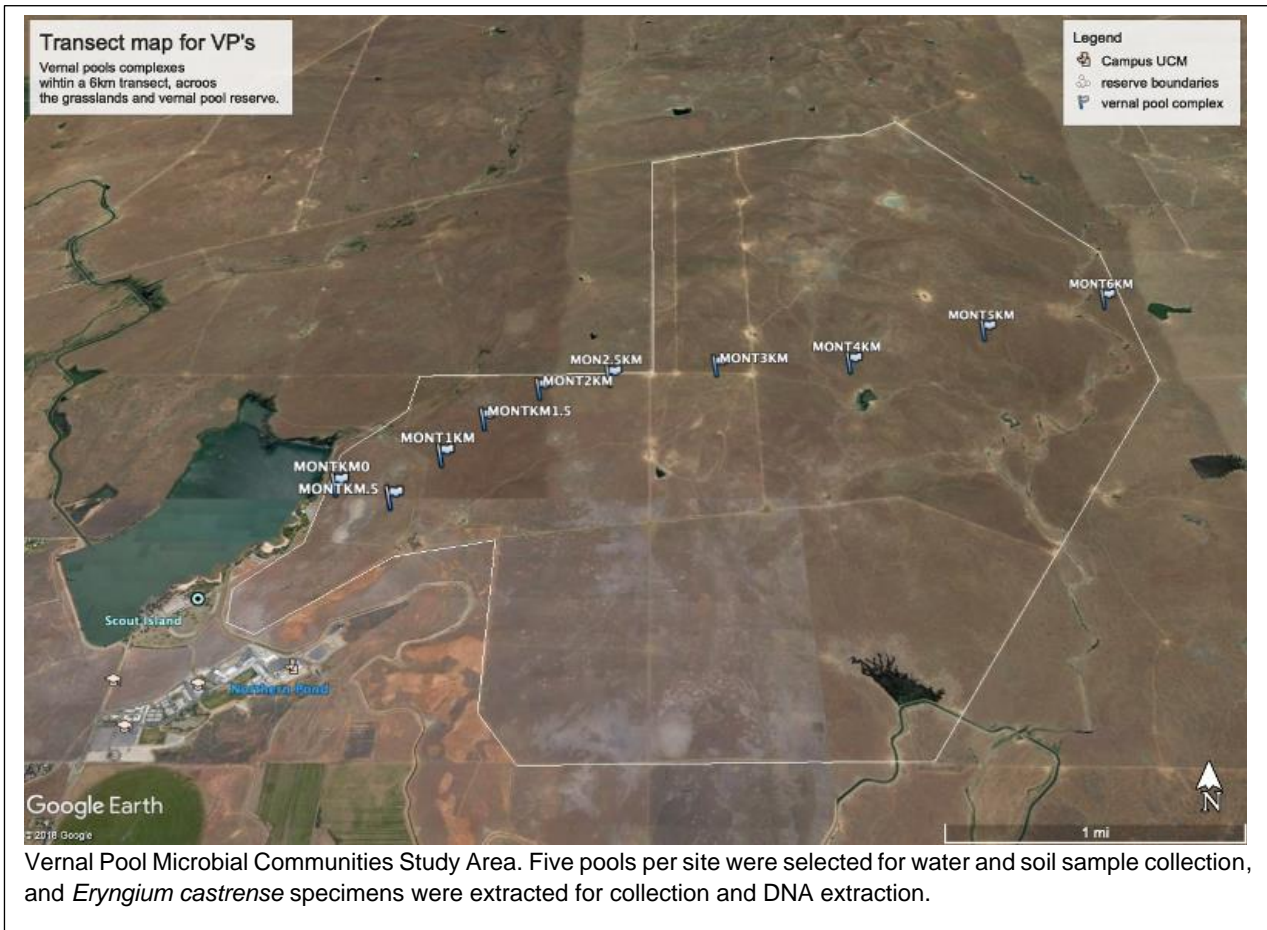
## Vernal Pool Microbial Communities

Jorge Montiel Molina | Jay Sexton | Mike Beman | Carolin Frank (University of California, Merced)

This research project studied the central roles that fungi play in vernal pool ecosystems through interspecific relationships with other organisms. The goal of the study was to investigate the microbial communities living in vernal pools at UC Merced Vernal Pools and Grassland Reserve. High throughput-sequencing was used for the analysis of Environmental DNA (eDNA) collected from different substrates: soil, water and plant tissues and bioinformatic analyses were used to analyze the diversity and the community composition. Vernal pools were visited to collect soil and water samples. In parallel we collected plant specimens of *Eryngium castrense* for its shoots and its roots. This plant species presents two different morphologies, one resembling an aquatic grass from the same ecosystem, *Isoetes howellii*—isoetoid morphology; followed by a final stage as a terrestrial weed when the pools dry out. In our sampling we considered the two plant morphologies Isoetoid and terrestrial weed, alongside with shoots and roots, for different sets of comparison. The study of microorganisms inhabiting vernal pools was concluded satisfactorily. With samples successfully sequenced, and analysis is being performed. Jorge Montiel's Student dissertation was successfully completed on April 30<sup>th</sup> of 2021 (Montiel 2021), and a manuscript is in revision with the Microbial Ecology journal (Montiel et. al. 2021).



Jorge Montiel Molina crouching down near a vernal pool on the Reserve





## Education (University-level course field work)

Education related to university-level course field work was very low for the 2020-2021 fiscal year, accounting for only 7% of total user days (23 of 323), where it typically accounts for over half of annual Reserve use. There were a total of four UC Merced field courses that used the MVPGR, with 23 associated user days, where the names of courses, associated users, and description of activities and Reserve use dates are below:

1. **Carson House: Sustainable Futures** (SNS/QSB)-USTU-013)-Bailey Carlson (graduate student TA, created 360 degree video in October of 2020 to teach students about vernal pool ecology and seasonality).
2. **Environmental Writing** (WRI 114)-Tom Hothem (continuing lecturer, visited Reserve in February of 2020 and 2021 with 10 writing students to teach about vernal pools, grasslands, and irregular water year effects on soils and hydrology, to develop written means of communicating such effects to the general public.)
3. **General Virology Lab** (BIO 127LA)-Samuel Arda (undergraduate student, collected soil and water samples at Barn Pond in September of 2020 for SEA-PHAGES (Science Education Alliance-Phage Hunters Advancing Genomics and Evolutionary Science) field coursework to find and identify bacteriophages).
4. **Yosemite Leadership Program (YLP) NRS Digital Storytelling Capstone**-Jesse Chakrin (YLP Director)

**Highlights** on one UC Merced field course effort is shown below:

### **(YLP) NRS Digital Storytelling Capstone**

Jesse Chakrin | Kate Templeton | Nereida Blanco | Nadia Velasquez Banegas | Alfonso Villafuerte (University of California, Merced)



Jesse Chakrin (YLP Director) filming Jorge Montiel-Molina in front of the MVPGR Reserve gate to ask questions about his Vernal Pool Microbial Communities research study.

The objectives of this Yosemite Leadership Program (YLP) Capstone project, titled Natural Reserve System (NRS) Digital Storytelling, was to create lasting, engaging online content that connects the world to the unique wonders of the UC Merced Natural Reserve System, by providing a team of three undergraduate student interns and one YLP undergraduate student mentor with the opportunity to create online content for the UC Merced

NRS to better connect people with our special places and natural resources. This was especially important during the COVID-19 pandemic, which increased barriers to connections with these natural places by further restricting in-person access. Student interns were provided with the opportunity to travel to UC Merced NRS field stations and natural Reserves during the COVID-19 pandemic; a privilege enjoyed by relatively few.

This project allowed interns to conduct filming and photography to capture the seasonality of the MVPGR, including the status of the vernal pools, soundscapes, and hidden gems of the

Reserve. Filming and photography was done at the Cliff site to capture footage of cliff swallows and other wildlife along Black Rascal Creek and at Eagle Hill to capture views of the China Hat formation and other notable features. Interns also interviewed core Reserve users (including select researchers and the current and former Reserve Directors) to ask questions about the Reserve's history, seasonality, and research. The final product generated for the MVPGR component of NRS Digital Storytelling YLP Capstone was a GIS StoryMap titled "[Our Hidden Gems](#)".

## **Public Service (K-12 Education, Outreach, Stewardship)**

Public service accounted for the highest amount of use during the 2020-2021 fiscal year, accounting for 57% of total user days (182 of 323), where it had previously accounted for only 17% of Reserve use on average from 2015-2020, which may have been due to differences in reporting over the years. Public service fell into 3 sub-categories (K-12 education, outreach, and stewardship) representing 12 efforts by 64 varied users:

1. **Education (K-12)** represented 2 field trips and 13 user days from the Adventure Risk Challenge (ARC) K-12 Community Leadership Program, which safely brought Dos Palos and Firebaugh high school students out to the Reserve to learn about vernal pool ecology and engage in hands-on monitoring.
2. **Outreach** included Reserve tours, filming, and photography that was conducted by UC Merced staff and public affiliated groups, including the Howard Hughes Medical Institution and Merced Camera Club.
3. **Stewardship** included threatened and endangered species and grazing management monitoring, invasive species management, and conservation easement inspection that was conducted by UC Merced staff and public affiliated groups; LSA Associates, the Greater Valley Conservation Corps, the Nature Conservancy, and the North American Bat (NaBat) Monitoring Program.

**Highlights** on select public service events for each of the three sub-categories are shown below:

## **Education (K-12)**

### **Adventure Risk Challenge (ARC) K-12 Community Leadership Program (April 9<sup>th</sup> & 10<sup>th</sup>, 2021)**

Jesus Alejandro | Alma Alvarado | Joy Baccei (Adventure Risk Challenge | University of California, Merced)



*Adventure Risk Challenge, Community Leadership Program, Dos Palos high school cohort assisting with threatened and endangered species monitoring of California Tiger Salamanders April 9<sup>th</sup>, 2020.*

Adventure Risk Challenge (ARC) Community Leadership Program (K-12) mentors and high school students from Dos Palos and Firebaugh visited the Reserve on April 9<sup>th</sup> and 10<sup>th</sup> of 2021 in two separate, small cohorts from each high school to learn about local ecology, field science, and conservation on the Reserve. Both cohorts learned about vernal pool ecology and plant identification using a field guide, and the first cohort also learned about and took part in hands-on threatened and endangered species monitoring of the California Tiger Salamander (CTS), where students got to see and measure salamander larvae up close. Students had the opportunity to engage

with and learn from the Reserve Director, Campus Biologist, a student intern, and a professional CTS expert to learn more about CTS and the importance of species habitat conservation. Each group was very inquisitive, asked great questions, and made time for a moment of reflection on what they learned at the end of each tour.

This was ARC's first time visiting the Reserve, and we sincerely hope to make it an annual occurrence. The ARC Community Leadership Program, which started in 2019, is free of cost to participants, and is a two-year progression starting in 9th grade. The first year gives student participants the opportunity engage in regularly scheduled in-school leadership workshops and weekend adventures to California state and national parks, and UCNRS natural Reserves and field stations. A follow-up year is also offered that includes academic coaching and leadership opportunities The program is designed to overcome barriers to outdoor engagement for youth who are underrepresented in the outdoors.

## Outreach

### **Chancellor Munoz Tour of the Reserve (Spring, 2021)**

Chancellor Juan Sanchez Munoz | Luanna Putney | Marjorie Zatz | Jessica Blois | Joy Baccei (University of California, Merced)



5:00 PM · Apr 2, 2021 · Twitter for iPhone

*UC Merced's Chancellor Juan Munoz Twitter post on April 2nd, 2021, sharing a photo from his tour of the MVPGR on March 31<sup>st</sup>, 2021, which including using binoculars to take in sweeping vistas of the Reserve.*

UC Merced's newest Chancellor (Chancellor Juan Munoz) took part in a tour of the MVPGR on March 31<sup>st</sup> of 2021, which was led by the Reserve Director, NRS Faculty Director, Vice Chancellor of Research, and Vice Chancellor of UC Merced. The Chancellor learned about the Reserve's natural history, research, education, public service, stewardship, and planning efforts. The tour also included a briefing on the Reserve's management activities, including the grazing management program and grazing license, as well as development efforts to fundraise for and plan a future outdoor educational pavilion and full field station facility at the former barn site, located adjacent to the Reserve. The Chancellor had the opportunity drive one of the Reserve's John Deere tractors, take in sweeping vistas of the Reserve, and see some of the Reserve's monitoring and research efforts

first-hand, while engaging with Reserve researchers and staff, which included the Campus Biologist, and an undergraduate student intern. The Chancellor later posted a photo on Twitter highlighting his Reserve tour experience (photo).

### **Merced Camera Club (Spring, 2021)**

Jim Cunningham | Pope Lawrence | Flip Hassett | Joy Baccei (Merced Camera Club)



*Morning light on the Reserve photograph taken by Jim Cunningham (Merced Camera Club) in April of 2020.*

Members of the Merced Camera Club visited the Reserve on three separate occasions, on April 6<sup>th</sup>, 9<sup>th</sup>, and 14<sup>th</sup> of 2021 to tour the Reserve and take photographs for the Reserve's field guide effort. The Reserve Director joined the group for their first visit, and provided a tour of the Reserve, and shared information about current and ongoing research, education, and public service activities, including the Reserve field guide creation effort, which is in need of high quality photographs. The best photographs taken by camera club members who visited the Reserve in April were shared with the Reserve Director, and

approval was given to use the photographs for the field guide effort, as well as website and social media outreach. Several photographs were used on the MVPGR website and Facebook pages. The Merced Camera Club plans to return when the rains return.

## Howard Hughes Medical Institution (Summer, 2021)

Lorena Anderson | Asmeret Berhe | Jim Chiavelli | Joy Baccei | Kate Bradbury | Alexander Jouve (University of California, Merced | Blue Gray Films | 1904 Media)



*Asmeret Berhe being interviewed on July 1<sup>st</sup> of 2021 by the Howard Hughes Medical Institute filming crew (Blue Gray Films and 1904 Media) for their education film about climate change, to be made publicly available.*

Lorena Anderson (UC Merced External Relations Public Information Officer) took members of the Howard Hughes Medical Institution (HHI) film crew (which included members from Blue Gray Films and 1904 Media) on the Reserve on June 28th of 2021, to scout for filming and interview locations with Professor Asmeret Berhe, which was followed by filming and interview on July 1st. The film crew is making an educational film about climate change, and interviewed Dr. Berhe about soils and their role in carbon sequestration. The film crew also planned to interview a local organic farm later that day about regenerative, no-till organic farming techniques. The film will be made available to public in late 2021, and the team has agreed to notify UC Merced contacts when available.

## Stewardship



*Dairy cattle owned by Fagundes, Fagundes, Fagundes grazing on the Reserve in spring of 2021.*

**Grazing Management** –Fagundes, Fagundes, Fagundes (formerly known as Fagundes Dairy Brothers) continued as the UC Merced grazing licensee, and provided grazing vegetation management to the Reserve and adjacent campus lands via two license agreements that are set to expire in 2022. Prior to and throughout the grazing season (October 2020- June 2021), the Reserve Director and Campus Biologist were in regular contact with the grazing licensee. Grazing coordination was done via regular phone calls and quarterly virtual meetings in fall, early spring, and summer to determine annual grazing plans and discuss any necessary changes to the plan and cattle stocking rates based on current precipitation and forage conditions. After the grazing season, actual use data was compiled and residual dry matter (RDM)

was monitored by LSA Associates, Inc., the Campus Biologist, and the Reserve Director to determine if grazing targets were met that season.

The 2020 RDM survey results showed that most Reserve forage areas (management units) substantially exceeded the established objective of a mean 800 lbs/ac RDM for at least the past five consecutive seasons, demonstrating under-grazing of the Reserve for meeting management targets. Because of this, efforts were made over the course of FY 20-21 to work with the grazer to reduce RDM in a more adaptive manner, where 2021 RDM survey results will hopefully reflect whether those efforts were successful. During the FY 20-21 fiscal year, the Reserve Director and Campus Biologist worked together with a small team of UC

Merced faculty and staff to draft a new grazing license for 2022 and to put together a Request for Qualifications for grazing licensee proposers, to be posted online.

## Threatened & Endangered Species Monitoring-

### California Tiger Salamander Surveys-



California Tiger Salamander larvae being measured during monitoring in spring 2021

Required monitoring of California tiger salamander (*Ambystoma californiense*) (CTS) continued in the FY 20-21 fiscal year during spring and early summer months, and were conducted by the Campus Biologist, student intern, professional CTS expert, and Reserve Director. Generally, stock ponds, seasonal pools, seasonal wetlands, marshes, vernal pools, swales and surrounding grasslands may be considered habitat for CTS. On the Reserve, CTS have been typically found breeding in artificial stock ponds that were created to provide water for grazing operations and two large and naturally formed playa pools, rather than in smaller vernal pools. To increase efficiency and feasibility, monitoring focused on confirmed or likely breeding habitats at specific stock ponds and playa pool locations on the Reserve. Populations in FY 20-21 were found to be fairly robust in comparison with other CTS locations in the state.

### Vernal Pool Crustacean Surveys-



Molly Stephens assisting with fairy shrimp surveys in spring 2021 (Photo: Joy Baccei).

Required monitoring of large branchiopod populations, also referred to as fairy, tadpole, and clam shrimp, continued in the FY 20-21 fiscal year in late winter and early spring (due to delayed rains), where monitoring focused on confirmed or likely breeding habitats in vernal pools and stock ponds. The Campus Biologist, student intern, professional branchiopod expert, and Reserve Director conducted surveys (to determine the status of three listed species of large branchiopods, including Conservancy fairy shrimp (*Branchinecta conservatio*), vernal pool fairy shrimp (*Branchinecta lynchi*), and vernal pool tadpole shrimp (*Lepidurus packardii*) (tadpole shrimp), and one unlisted species, midvalley fairy shrimp (*Branchinecta mesovallensis*), as target species for management. Two additional unlisted species, California fairy shrimp (*Linderiella occidentalis*) and California clam shrimp (*Cyzicus californicum*), are also present on the Reserve.

Several species were identified as present, and survey results are being compiled.

## Special Status Plant Surveys –



Succulent owl's clover observed during monitoring in spring 2021 (Photo: Joy Baccei).

Required monitoring of three plant species known to occur on the Reserve that are federally threatened and state endangered continued in the FY 20-21 fiscal year: Colusa grass (*Neostapfia colusana*), San Joaquin Valley Orcutt grass (*Orcuttia inaequalis*), and succulent owl's clover (*Castilleja campestris* ssp. *succulenta*). Like other monitoring efforts, surveys focused on past confirmed or likely habitats in vernal pools and stock ponds. Although results are still being compiled, the following observations were made the Reserve Director during field surveys; Succulent Owl's Clover was in very low abundance and had smaller stature than the year prior due to extreme drought conditions, many vernal pools that previously had confirmed SOC were choked with non-native annual grasses, Colusa grass was found in fewer locations than the year prior, but individuals were robust in stature, and Orcutt grass was not detected.

**Camera Trap Surveys-** Required annual camera trap surveys were conducted on the Reserve in the summer and fall months of FY 20-21 fiscal year in an effort to monitor San Joaquin Kit Fox (*Vulpes macrotis mutica*) (referred to as SJKF or kit fox) on the Reserve. Kit fox are likely not present on the Reserve, despite a potential suitable habitat corridor connecting areas where SJKF are present. Extensive surveys consisting of spotlights, scent dogs, camera surveys, and den searches led to seven sightings of kit fox between 1999-2002 near the Reserve. However, annual camera surveys and monitoring of artificial dens beginning in 2015 revealed no additional sightings of SJKF. Efforts to mitigate impacts caused by UC Merced and to provide suitable habitat for kit fox were constructed in 2012 and 2015, including artificial kit fox dens. Annual SJKF camera trap surveys are to be done for 10 years to monitor for presence at the artificial den sites. In the FY 20-21 fiscal year, camera trap surveys were conducted by the Campus Biologist and student intern, where several mammal species were identified, but no SJKF was documented in any of the photos.

## Invasive Species Management & Monitoring-

**Invasive Plant Control-** Implementation of an Integrated Pest Management (IPM) Program continued on the Reserve in the FY 20-21 fiscal year to target the following invasive plant species; milk thistle (*Silybum marianum*), yellow starthistle (*Centaurea solstitialis*), russian thistle (*Salsola tragus*), poison hemlock (*Conium maculatum*), black mustard (*Brassica nigra*), and prickly lettuce (*Lactuca serriola*). Invasive plant surveys conducted have documented that the distribution of invasive plants remains limited to a few problem areas. These problem areas are generally associated with soil disturbance associated with livestock. The FY 20-21 fiscal year focused on milk thistle removal in heavily infested areas identified, where management techniques focused on (1) mechanical removal of individual plants and (2) grazing activities. The Reserve Director and Campus Biologist directed the Greater Valley Conservation Corps in invasive plant treatment and mapping.

**Feral Pig Depredation** - Feral pig hoards continued to be spotted on the Reserve near Black Rascal Creek during summer months, which further spurred discussions for the need for monitoring and future management. Other NRS Reserves, such as the Sedgewick Reserve, which has a long-standing monitoring and depredation program. Evidence of feral pig damage is being to be recorded, and information is being gathered and compiled on feral pig invasion management strategies and depredation techniques prior to taking action.

## North American Bat (NaBat) Acoustic Monitoring (Summer, 2020 and 2021)-



Stephanie Brinez of NaBat setting up acoustic monitoring at Three Willows Pond in 2021 (Photo: Joy Baccei).

North American Bat Monitoring Program (NABat) staff performed Bat Acoustic Surveys on the MVPGR in 2020 and 2021, as part of a nation-wide endeavor to gather data for evaluating the status and trends of North American bat populations to inform their conservation and management. The NABat Program is a large-scale, long-term collaborative monitoring effort designed to assess the status and trends of North American bats at local, regional, and range-wide scales. NABat and the PacWest NABat Hub bring together an extensive network of partners to collect standardized bat population data. Survey results intend to inform species range maps and habitat associations to support bat conservation actions. In summer of 2020 and 2021, bat acoustic detectors were installed near two stocks ponds on the Reserve (Three Willows Pond and Barn Pond), and echolocation calls were recorded for four consecutive nights. Auto-identification software identified the recorded echolocation calls to the species level and species were then confirmed through expert review by Bat Conservation International staff. The 2021 survey

detected a total of five species and three of those species returned to same survey site that they were detected at in the 2020 survey.

In 2020 and 2021, the Mexican free-tailed bat (*Tadarida brasiliensis*) was identified at the Three Willows Pond and Barn Pond survey sites and the Greater bonneted bat (*Eumops perotis*) and the Hoary bat (*Lasiurus cinereus*) were identified at the Three Willows Pond survey site. This data is particularly important for Greater bonneted bat conservation since Greater bonneted bats are no longer found in their previously occupied areas and may be endangered, but there is a lack of past and present observations to determine their status. One more year of data showing detection of this species is needed to gain confidence about accuracy of Greater bonneted bat presence.

## Un-reported Use (Partnerships, Outreach, Planning & Development)

### Partnerships-

- **SCICON Field Station (Springville, Tulare County)-** UC Merced NRS Staff (Faculty Director, Associate Director, and MVPGR Reserve Director) continued efforts to grow and develop their partnership with the SCICON Field Station, including establishing an online presence (website, Facebook page), conducting site visits to discuss comparative research opportunities, and helping facilitate the UC Merced SCICON Field Station Summer internship for local area high school students to participate in a 4-day internship to gain hands-on field experience in natural sciences and research.
- **UC Merced Physical Operations, Planning, and Development (POPD) Department,** Physical and Environmental Planning Department (PEPD) staff, including the PEPD Director (also the Campus Architect) and Campus Biologist received assistance from UCM NRS staff to practice wise stewardship, management, and monitoring of the Reserve (including stewardship activities above).



## Outreach

- **Field Guide** –Two student interns continued work on creating content and compiling photos for a Reserve-specific field guide, under the guidance of the Reserve Director and Campus Biologist. They compiled a comprehensive species list for the Reserve, compiled and organized photographs, wrote technical species description entries, and designed various field guide sections using Adobe Illustrator.
- **Website** – One student intern helped update all UCM NRS websites to a new platform, where outdated website materials were archived, and new websites are being designed and improved. New products were also posted on the new website, including the new MVPGR StoryMap created by YLP interns, and the 2020 Research Week video on the MVPGR and SCICON created by Media Cats.
- **Social Media** –The Reserve Director regularly posted to the MVPGR and SCICON Facebook pages.
- **Department Presentations**–UC Merced NRS staff, including the Reserve Director, hosted a series of presentations on what the UCM NRS has to offer, in terms of reserve and field station features of interest, facilities, and resources. Presentations were given to the School of Natural Sciences, School of Engineering, Mechanical Engineering, and Management of Complex Systems faculty groups.
- **Logo Updates**–UC Merced NRS staff, including the Reserve Director, worked with the campus graphic designer to create updated UCM NRS logos, with fresh designs and color schemes. Updated logos will be used on the new websites to be published soon, as well as new promotional materials.

## Planning & Development

**Prop. 68 Proposal for Outdoor Pavilion & Field Station** –A working group of UC Merced NRS and POPD staff met bi-weekly to continue planning, design, and development of a future MVPGR pavilion (first phase) and later full field station facility. MVPGR Pavilion Project accomplishments for FY 20-21 are listed below:

- Land use request submitted to Campus Committee on Land Use (CACLU), then approved by Chancellor.
- Existing and new infrastructure improvement, construction, operation and maintenance (O&M) costs discussed; an assessment of the access bridge is needed to assess maximum vehicle load capacity.
- Programmatic needs and environmental compliance (CEQA) needs are being evaluated with a firm.
- An architect firm was contracted to develop two schematic design options for the Pavilion Project, and provide cost estimates for infrastructure improvement and construction, including O&M and bridge costs.
- UCM NRS and POPD staff are working to submit a \$1.24M Proposition 68 project proposal by early 2022.
- NRS staff continued collaboration with campus development to raise funds for the later full field station.

**Looking Ahead** –In FY 21-22, Outdoor Pavilion project planning efforts will continue, including working with an architect on infrastructure design, to be preceded by visioning sessions and stakeholder workshops. In addition, a summary of anticipated activities related to Research, Education, and Public Service is listed:

- **Research**–MVPGR new research related to greenhouse gas emissions in vernal pools and SCICON Field Station new research related to climate change science and soil and atmospheric condition sensor installation to inform ongoing Blue Oak Mortality investigations at the Circle J Norris Ranch.
- **Education**–announcement of a new UCM NRS undergraduate research scholarship, offering a spring semester undergraduate Student Naturalist Training, and also further facilitating career pipeline opportunities, with partners such as Adventure Risk Challenge and the Center for Advanced Research and Technology, which provide local area high school students with hands-on field experiences.
- **Public Service (Outreach and Education)**–MVPGR topical workshops that are open to the public, including a UC Berkeley Jepson Herbarium vernal pool flora workshop and a Four Rivers Natural History Association, Central Valley specific California Naturalist training workshop on vernal pools.
- **Public Service (Stewardship)**– continued UCM NRS and POPD department collaboration on the MVPGR grazing license, which is scheduled to expire in 2022, and will require initiation of a competitive bid process for a new licensee, and continued collaboration on updates to Appendix C of the UC Merced Conservation Lands (specific to research and education polices and management).

## Part 7. NRS Campus Committee Roster

Thomas Hothem, Committee Chair (Faculty), Continuing Lecturer & Founding Faculty, Merritt Writing Program, University of California, Merced

Joshua Viers, Faculty at large, Associate Dean of Research, SOE Director of Center for Information Technology Research in the Interest of Society (CITRIS) and Banatao Institute, Associate Professor of Engineering in Water Resources, University of California, Merced

YangQuan Chen, Faculty at large, Director of MESA (Mechatronics, Embedded Systems and Automation) Lab, Professor and Chair of Mechanical Engineering Graduate Program, University of California, Merced

Rebecca Ryals, Faculty at large, Assistant Professor, Life and Environmental Sciences, University of California, Merced

Jason Sexton, Faculty at large, Associate Professor, Life and Environmental Sciences, University of California, Merced

Jessica Blois, UCM NRS Faculty Director, Natural Reserve System, Associate Professor, School of Natural Sciences, University of California, Merced

Molly Stephens, UCM NRS Associate Director, Natural Reserve System. University of California, Merced

Francesca Cannizzo, Ad Hoc Member, UC Merced Campus Biologist, Physical and Environmental Planning, University of California, Merced

## Part 8. Use by Public

Project Title	Institution	Role
<b>University of California, Merced</b>		
On-going Mitigation Monitoring - Campus Biologist	University of California, Merced	Professional
Greater Valley Conservation Corp Natural Resource Management	University of California, Merced	Professional
Tours for Executive Leadership	University of California, Merced	Professional
UC Merced Research Week Tours	University of California, Merced	Faculty
The Nature Conservancy - Easement Holder Inspection	University of California, Merced	Professional
Howard Hughes Medical Institution Filming	University of California, Merced	Professional
<b>Business Entity</b>		
Wetland Hydrology and Plant Community Monitoring	LSA Associates, Inc	Professional
Merced Camera Club Photography	Cunningham Ranch	Professional
Reserve photography	SWCA Environmental Consultants	Other
<b>California Community College</b>		
none		
<b>California - Other University or College</b>		
none		
<b>California State University System</b>		
Tours for UCM Faculty & Researchers	UC Merced	Professional
<b>Governmental Agency or Entity</b>		
none		
<b>Individual or Other Entity</b>		
none		
<b>International University or College</b>		
none		
<b>K-12 Education</b>		
none		
<b>Non-Governmental Organization or Non-Profit Entity</b>		
North American Bat Monitoring Program (NABat)	Bat Conservation International	Professional
Adventure Risk Challenge	Adventure Risk Challenge	K-12 Instructor
<b>University of California</b>		
<b>U.S. - University or College Outside of California</b>		
none		

## Appendix: Part 4. Current Research Summary in Detail

### A Pilot Study of Tobacco & Cannabis Contaminants in Protected Areas (Merced Vernal Pools & Grasslands Reserve)

Application #  
44491

**Project Dates:** 01 Aug 2019 to 31 Jan 2021

**Principal Investigators:** Patricia Holden | Marc Beutel | Stephen Hart | Samuel Traina | Tom Harmon

**Other Members:** Michelle Gilmore | Laurie Van De Werfhorst | Monique Kolster | Naivy Rodal Morales

**Affiliations:** University of California, Merced | University of California, Santa Barbara

#### Sponsor

Tobacco Related Disease Research Program (TRDRP) || \$531.00

#### Project Abstract

Parks and nature preserves are not only “protected areas” that can be used for recreation, but are an “ecosystem service” benefitting humankind more generally through such activities as bee pollination, maintenance of food webs, and nutrient recycling for plant growth. Parks and preserves, depending on their location, can be contaminated by pollutants that can negatively affect their “ecosystem services.” Some of these pollutants can be prevented by changing individual human behavior. This project evaluates pollutants emanating from tobacco product and Cannabis (marijuana) use and cultivation for their presence in four protected areas in California. We will develop a methodology to assess the effects of discarded cigarette butts and e-c...

[\(read more\)](#)

### Burrowing Owl Survey

Application #  
35020

**Project Dates:** 01 Jan 2018 to 31 Dec 2021

**Principal Investigators:** Thomas Hothem

**Other Members:** Dwight Ewing | Buck Ewing | Hannah Ewing | Mizrrain Lava Nava | Jane Ewing

**Affiliations:** University of California, Merced | Merced Bicycle Coalition | UC Merced

#### Project Abstract

To track the number of (migratory) burrowing owls on the Vernal Pools and Grasslands Reserve.

## Appendix: Part 4. Current Research Summary in Detail, cont'd

Estimating forage production monitoring using remote sensing data	Application # 45746
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Project Dates:	01 Dec 2020 to 30 Jun 2022
Principal Investigators:	Fadzayi Mashiri
Other Members:	Joy Baccei   Anthony Cantu   Anthony Cantu   Vong Moua
Affiliations:	UC Cooperative Extension   UC Merced   UC Cooperative Extension Merced   UC Cooperative Extension Merced County

### Project Abstract

High spatial and inter annual variability in forage production make rangeland management difficult in highly diverse landscapes across California. The goal for this project is to develop a method to map high-resolution forage production using multispectral remote sensing imagery. This product will help with grazing management decisions, estimate grazing intensity (RDM levels), inform forage loss programs, and in the long run may provide an easy way to quantify local impacts of climate change on plant productivity on rangelands across the state. The project is a statewide research effort by extension advisors in different counties to investigate the relationship between remote sensing data and forage production under different ra...

[\(read more\)](#)

Vernal Pool Microbial Communities	Application # 36189
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Project Dates:	05 Mar 2018 to 01 May 2019
Principal Investigators:	Jorge Montiel Molina
Other Members:	None
Affiliations:	University of California, Merced

### Sponsor

UC MEXUS-CONACYT | |

### Project Abstract

Fungi play central roles in ecosystems through interspecific relationships with other organisms. As symbionts, fungi living inside the plants -endophytes- can have a strong influence on plant stress tolerance and adaptation. Classic studies on managed ecosystems has shown that fungi living inside leaves, stems, and roots can alleviate drought stress, salinity stress, and high temperatures exposure, with the most dramatic examples coming from the wild. The purpose of this research is to elucidate the role of fungal endophytes in relation with the amphibious behaviour that only vernal pools plants present, as an adaptation to the extreme fluctuations in water availability. Understanding how this fungal communities are affected by temp...

[\(read more\)](#)

## Appendix: Part 4. Current Research Summary in Detail, cont'd

<b>EORS Vernal Pools UAS Flights 2020</b>	<b>Application #</b> 44967
<b>Project Dates:</b>	16 Mar 2020 to 31 Jul 2020
<b>Principal Investigators:</b>	Erin Hestir
<b>Other Members:</b>	Jacob Nesslage   Erik Bolch   Daniel Gomez   Julia Burmistrova   Brandon Genco   Michael Kalua   Bailey Morrison   Fatima Gamino   Jonathan Rivas   Porfirio Montoya   Adam Weingram
<b>Affiliations:</b>	University of California, Merced   University of California, Davis

### Project Abstract

In this project, we will test the feasibility of using UAV-based imaging spectroscopy to 1) quantify biodiversity and 2) identify and track alien invasive plant species in the UC Merced Vernal Pool and Grassland. Multiple flights will be conducted in the reserve to capture the phenology of the system, and rigorous field validation will be conducted to assess the technology and build the models. This work will be used to create the preliminary datasets and develop the necessary data pipelines needed to begin addressing the drivers of biodiversity and invasion and understanding what causes invasion vulnerability at the terrestrial-aquatic interface. Further, this work will be used to inform next-generation monitoring strategies for the Me...

[\(read more\)](#)

<b>Vernal Pool Phenology YLP Capstone</b>	<b>Application #</b> 32651
<b>Project Dates:</b>	31 Jan 2016 to 30 Jun 2019
<b>Principal Investigators:</b>	Jason Sexton
<b>Other Members:</b>	Robert Martin   Iris Montes   Julia DePass   John Cronin   Jacob Croasdale   Jenna Heckel   Valeria Rivera   Brandon Hendrickson   Teanna Herrera   Madeline Castro   Jovanna Salazar   Zara Perez-Ochoa
<b>Affiliations:</b>	University of California, Merced   No Institution Selected

### Project Abstract

Vernal pools are a critical component of the California Floristic Province, a global biodiversity hotspot. A group of undergraduate students as well as designated faculty and a few graduate students will establish times to visit the UC Merced Vernal Pool Grasslands Reserve (VPGR) on a weekly basis in order to monitor the diversity and phenology of native and endemic plants located around the vernal pools and grasslands. A protocol for the plant monitoring will be established. Then, will transfer above data to the public via open websites. This project will directly benefit researchers and land managers working to understanding the biology, conservation, and restoration needs of these special ecosystems and plant communities.

## Appendix: Part 4. Current Research Summary in Detail, cont'd

Visit vernal pools and grasslands to survey for wintering birds as followup to earlier studies

Application #  
46000

Principal Investigators: Chris Swarth

Other Members: Marilyn Fogel

Affiliations: University of California, Riverside

#### Project Abstract

The avifauna of the Merced Vernal Pools and Grassland Reserve (a University of California Natural Reserve) in eastern Merced County, was documented over a three-year period (2013-2015), with several additional surveys incorporated from other years. Eighty-nine species were observed using Reserve habitats. Twelve species used the Reserve for nesting, thirty-eight species were local breeders, and thirty-nine species were considered migrants. The largest groups were waterbirds and grassland specialists. Vernal pools, cattle stock ponds, and an irrigation canal are the main aquatic habitats present. Habitat use and abundance is discussed, and results are compared with several other regional avifaunal assessments.

Understanding Selective Processes In A Vernal Pool Landscape

Application #  
32153

Project Dates: 21 Oct 2015 to 30 Jun 2020

Principal Investigators: Daniel Toews | Jason Sexton | Marilyn Fogel

Other Members: Chris Swarth | Jorge Montiel Molina

Affiliations: University of California, Merced

#### Sponsor

University of California Natural Reserve System || \$0.00

University of California Natural Reserve System || \$0.00

#### Project Abstract

Mediterranean climatic regimes, unique geomorphology and extreme hydrological cycles of vernal pools have influenced the evolution of highly specialized floral and faunal species unique to these systems. Vernal pools are characterized by their biogeographic region and vegetation classification. However, the distribution of vernal pools in California spans a wide range of soil series and geomorphic surfaces, within local scales (Smith and Verrill, 1998; Wacker and Kelly, 2004). Therefore, plant community composition and species distributions in a vernal pool landscape may be correlated with soil type, geomorphic substrate and soil age when climate and biotic factors remain constant. This study aims to characterize selective processes tha...

[\(read more\)](#)



**Project Dates:** 31 Dec 2014 to 31 Dec 2025

**Principal Investigators:** Joshua Viers | Anna Rallings

**Other Members:** Jefferson Laird | Jacob Flanagan | Brendan Smith | Anna Fryjoff-Hung | Lorenzo Booth | Matt Beaman | Jenny Ta | Andreas Anderson | Nicholas Magyari | Allan Murillo | Thomas Thayer | Joseph Camaddo | Alan Cai | Luke Kostrikin | Alexis Garcia | Vicky Espinoza | Erin Hestir | Samuel Araya | Selina Davila Olivera | Daniel Gomez | Jacques Fracchia | Erik Bolch | Michael Kalua | Gustavo Facincani Dourado | Francesca Cannizzo | Jacob Nesslage | Joy Baccei

**Affiliations:** University of California, Merced | UC Merced

#### Sponsor

California Department of Fish and Wildlife | P1740401 | \$282,845.00

#### Project Abstract

The objective of this project is to better understand the interface of topography and hydrology on the UC Merced Vernal Pools and Grassland Reserve. Using a combination of empirical data and model development, our team seeks to better understand how water moves throughout the preserve. By using a combination of modeling (e.g., HEC-RAS) and data collected in a variety of ways -- including but not limited to pressure transducers, timelapse imagery, aerial LiDAR and imagery, and RTK GPS surveys -- over a large area and long periods of time, we will develop a better understanding of potential management strategies for the preserve and evaluate the feasibility of potential hydrological restoration activities.

**Project Dates:** 01 Dec 2020 to 30 Nov 2021

**Principal Investigators:** Kipling Will

**Other Members:** Gordon Bennett

**Affiliations:** University of California, Berkeley | University of California, Merced

#### Sponsor

California Conservation Genomics Project (CCGP) | \$40,960.00

#### Project Abstract

The project intends to sample carabid beetles from many populations on the mainland and the islands to be used for a state-wide conservation genomics project (California Conservation Genomics Project (CCGP) <https://sites.lifesci.ucla.edu/eeb-CCGP/>). The main goal of my sampling is to collect species of the Golden Bear Harpaline beetles (*Dicheirus* spp.). Secondary goals are 1. to sample other carabid beetles that live with the Golden Bear Harpalines, 2. develop a more complete checklist of carabid species on the islands, 3. look for established, invasive species of insects that may impact the Golden Bear Harpalines, and 4. take DNA-quality samples for revisionary systematic projects on other California carabid beetles found on the island...

([read more](#))