



# Annual Report

## Merced Vernal Pools and Grassland Reserve

Fiscal Year 2018/2019

Prepared by Monique Kolster, Reserve Director

### Objective

*The purpose of this document is to provide an overview of the accomplishments from fiscal year 2018 through the fiscal year 2019 for the UC Natural Reserve System's Merced Vernal Pools and Grassland Reserve (Reserve). The accompanying tables in the Appendix provide a detailed assessment of the type and number of visitors utilizing the Reserve, a list of research projects and publications supported by the Reserve, as well as a list of classes utilizing our facilities over the past fiscal years. The narrative provides an opportunity to highlight major activities and endeavors achieved over this time period, including some of the mundane tasks required to keep a biological field reserve running (i.e. basic maintenance).*

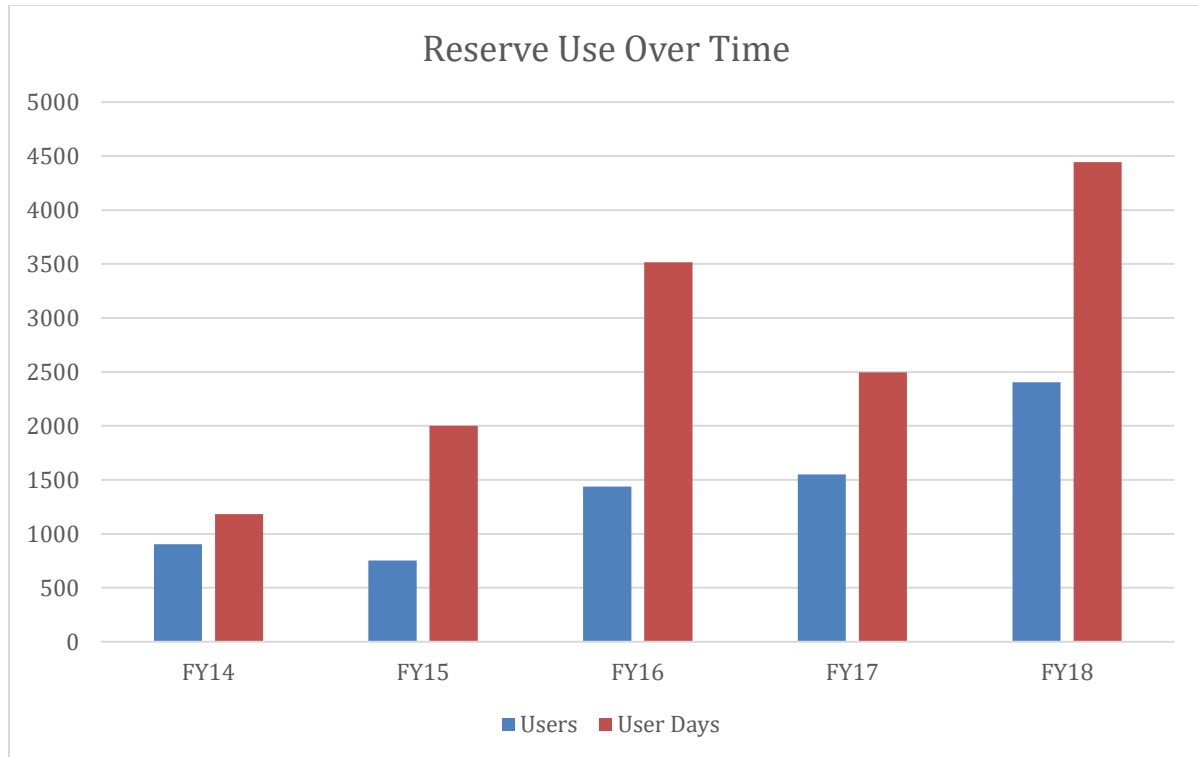
### Introduction

The number of people using the reserve continues to steadily increase (2,403 users in FY 2018 and 3,026 users in FY 2019), and our user days (days spent in the Reserve per individual) amount to more than 3,900 days in both fiscal years (**see Figure ??**).

Weather conditions for the last couple of years have provided enough rainfall for vernal pools to fill throughout the Reserve. Accumulated rainfall for water year 2018 (October 1, 2017 to September 30, 2018) and water year 2019 measured 182.6 mm (7.2 inches) and 337.1 mm (13.3 inches) at the Merced Municipal Airport, respectively. Average accumulated rainfall for this weather station for the last 21 years (1998-2019) is 272.5 mm (10.7 inches) (Natural Resources Conservation Service (NRCS) National Weather and Climate Center; <http://agacis.rcc-acis.org>; WETS table). As a result, we observed fairy shrimp and many macroinvertebrate swimming in pools, California tiger salamander growing from eggs to adulthood, and incredibly blooms of Colusa grass and other vernal pool plants. Disconcertedly, we are seeing less ground squirrels on the reserve, which seems to be a theme in the general area (Kolster personal communication, 2019).

Something to definitely watch for in the coming years. RDM levels were much higher in FY 2018 and FY 2019, due to late spring rains and the rancher removing cattle early from the reserve.

Highlights during the last two years have been the reconvening of the MVPGR Faculty Committee.... These activities were made possible by our MVPGR Faculty Committee, our dedicated MVPGR student naturalist, and our amazing reserve interns and UCM undergraduates Michael Spaeth and Henry White.



Users/User days:

2013-2014: 905/1184

2014-2015: 753/2001

2015-2016: 1439/3515

2016-2017: 1549/2497

2017-2018: 2403/4445

2018-2019: 3026/3942

### **FY 2017 (July 1, 2017-June 30, 2018) Report**

**Ave accumulated rainfall (1998-2019): 272.5 mm; 10.73 inches-** at the Merced Municipal Airport weather station (approximately 8.25 miles to the southwest) and reported via the Natural Resources Conservation Service (NRCS) National Weather and Climate Center (<http://agacis.rcc-acis.org>; WETS table).

WY: Oct 1, 2017-Sept 30, 2018

WY 2017-18 (182.6 mm; 7.19 inches)- at the Merced Municipal Airport weather station (approximately 8.25 miles to the southwest) and reported via the Natural Resources Conservation Service (NRCS) National Weather and Climate Center (<http://agacis.rcc-acis.org>; WETS table).

WY 2017-18 (10.07 inches)- UCM weather station and reported via California Data Exchange Center (CDEC;  
[http://cdec.water.ca.gov/dynamicapp/staMeta?station\\_id=UCM](http://cdec.water.ca.gov/dynamicapp/staMeta?station_id=UCM)).

WY 2018-19 (337.1 mm; 13.27 inches)- Merced Municipal Airport weather station

WY 2017-18 (11.34 inches)- UCM weather station

## **News, Events, & Celebrations**

### *Noteworthy Visits*

It has been a wonderful couple of years of people visiting the reserve. While I can write something special about every visitor, I wanted to take a little space to recognize our UC Merced Executive Leadership, UC Merced Foundation Board of Trustees, Merced Vernal Pools and Grassland Reserve supporters, and one of our partners, the California Naturalist Leadership Team, whose support in the reserve and reserve programs has been invaluable.

### **Executive Leadership**

This last year, **Chancellor Dorothy Leland** joined Monique Kolster (March 27, 2019) and UCM PhD student Jackie Shay (April 18, 2019) for spring tours of the reserve to see and photograph wildflowers and reserve landscapes. Chancellor Leland was taken to various areas on the reserve, including the cliffs along Black Rascal Creek. During the tours, we stopped often to talk about reserve happenings, take pictures, and enjoy the gorgeous wildflower bloom.

On March 28, 2019, **Sam Traina, Vice Chancellor of Research and Economic Development**, joined Monique Kolster to see various research and monitoring sites around the reserve. Along the way, we saw and discussed the old burn area along the Le Grand Canal, non-native plant eradication sites, and research projects and sites. After a bit of searching, we found the exposed old soils next to Black Rascal Creek!

Reserve intern and UCM undergraduate, Henry White, gave a tour of the reserve (February 16, 2019) to new **Dean of Natural Sciences, Betsy Dumont**, and her husband, **Sean Werle**. Driving past Professor Dan Edward's lizard project to the swallow cliffs at Black Rascal Creek, Henry introduced Dean Dumont to the reserve, research projects, and all the surveys (threatened and endangered species surveys, grazing compliance surveys) conducted on the reserve. Being a chiropterologist (bat biologist), Dean Dumont was very interested in potentially conducting bat surveys for the reserve in the future as well as returning to the reserve for more tours through the seasons.

On October 4, 2019, Monique Kolster took **Vice Provost and Graduate Dean Majorie Zatz** on an excursion out to the reserve and discussed the reserve and current graduate

student research projects and involvement on the reserve. Future graduate student opportunities on the reserve also were considered.

### **UCM Foundation Board and Development**

Along with UCM Executive Leadership, we had a number of tours in FY 2019 to gain input and discuss the development of a reserve biological field station as well as showcase research and educational outreach efforts with UCM Foundation Board members and current and prospective UCM supporters:

- As part of the UC Merced Ma Kelley Golf Tournament and Shakespeare in the Yosemite National Park weekend events, Monique Kolster and UCM **Assistant Vice Chancellor Lisa Pollard** (Development) hosted a tour of the Merced Vernal Pools and Grassland Reserve (April 26, 2019) for the chair of the **UC Merced Foundation Board, Denise Watkins**, and **UC Merced Foundation Trustee, Joan Snyder**.
- On December 14, 2018, Monique Kolster, NRS Faculty Director Jessica Blois, and Dean Betsy Dumont led a tour for **Jim Cunningham** (Cunningham Ranch), **Grey Roberts** (UC Merced Board of Trustees Member & Grey B. Roberts & Company) & **Sarah Lim** (Museum Director, Merced County Historical Society).
- On February 12, 2019, Monique Kolster, Dean Betsy Dumont, and Jeff Porto (UCM Director of Development) gave a tour to **Josephine Fox** (Owner of Fox Head Inc.).
- On April 10, 2019, Monique Kolster and Dean Betsy Dumont hosted **Hannah Ewing** (UCM Development Office, School of Natural Sciences) and **Clara Barnes** (UCM Interim Executive Director of Major and Institutional Giving) on a tour of the reserve.

It was very exciting to host our UCM Foundation Board of Trustees and individuals passionate about promoting the reserve and reserve programs.

### **UC California Naturalist Leadership Team**

The **UC California Naturalist Leadership Team (Brook Gamble, Sarah Angulo, and Greg Ira)** and Leigh Bernacchi (UCM, Program Coordinator for UC Water) visited the reserve (Jan 24, 2019) to connect about the California Naturalist (CalNat) Program, the MVPGR CalNat Program, and to see inundated vernal pools and fairy shrimp. .

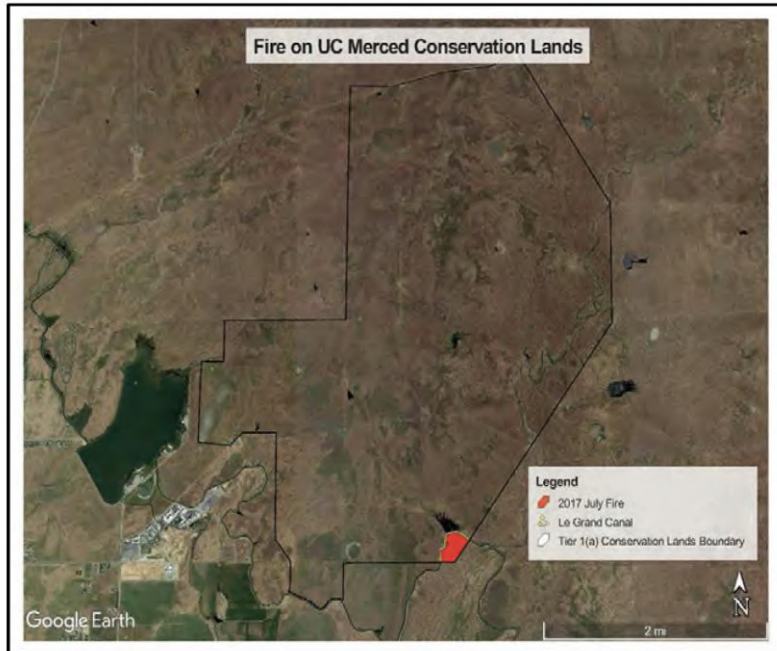


**Figure ??:** Greg Ira, Monique Kolster, Brook Gamble, and Sarah Angulo (left); Monique Kolster talking fairy shrimp with the CalNat team (right).

### News

#### **Grassfire Fire on the Reserve**

On July 6, 2017, a Merced Irrigation District (MID) tractor sparked a fire as it was scraping vegetation on the MID easement along Le Grand canal in the northwestern part of the reserve. Luckily, Francesca Cannizzo, UCM Campus Biologist, was onsite conducting biological surveys when she saw the fire begin. After waving down the MID driver to notify him of the small blaze, the driver tried to put the fire out with the scraper blades. Unfortunately, the fire continued to grow in size, and they called 911. Within 20 minutes, CalFire and the Merced County Fire Department arrived, and about a half hour later, they extinguished the fire using truck-based water, a helicopter which dipped its water bucket into Le Grand Canal, and a fixed-wing aircraft which sprayed fire-retardant. The fire scorched approximately 41-acres of vernal pool grassland habitat. About 23-acres were on the reserve and the remaining acreage on a neighboring property.



### **Barn Down**

**Built in ??**, the beautiful old Smith family barn, a beloved landmark next to the reserve, blew down in a series of wind storms this last spring. During the hard winds on February 13, 2019, the northern wall was blown down, and then on April 10, 2019, strong winds knocked the rest of the building down. UCM Facilities put a temporary fence and yellow caution tape around the structure to prevent access to the site. Plans are underway to remove and salvage the wood.



**Figure:** Winter winds (February 13, 2019) caused the northern wall to fall down, and spring winds (April 10, 2019) buckled the remaining legs. Photos by Monique Kolster.

### **California State Proposition 68 and Planning for a Reserve Field Station**

With the passage of California State Proposition 68 during the June 2018 primary election, money in the form of matching funds was made available to the Natural Reserve System (NRS) for land purchase and infrastructure projects. The university-wide NRS committee decided to allocate the money equally between all UC campus (that have NRS sites), with each campus NRS representatives deciding how to divvy the money between their NRS sites. Since the UCM Yosemite Field Station is in a “short-term” 5-year Memorandum of Understanding with Yosemite National Park, it is unclear whether this UCM NRS site will qualify for matching funds, so at this point, the UCM campus is planning on allocating most of the UCM funds to the Merced Vernal Pools and Grassland Reserve. With this monetary incentive, plans to build a MVPGR biological field station are underway. At this point, programming needs have been assessed, visits to other biological field stations have been made, and a couple site plans have been developed by the campus contracting architect, James Franklin. Additionally, the site location (the barn site) has been identified, approved by the UCM Campus Physical Planning Committee, and proposed in the 2019 Long Range Development Plan (written by Phil Woods). Dean Betsy Dumont, Monique Kolster, Professor Jessica Blois, and Professor Jason Sexton presented plans for the biological field station to the UM Board of Trustees (June 19, 2019), and Monique Kolster, Dean Dumont, VC Sam Traina, Professor Jessica Blois, and SNRI Director and NRS Board of Councilor Armando Quintero have been working with UCM Development (Clara Barnes, Hannah Ewing) on fundraising efforts. Please see the article written by former UCM Senior Public Information Officer Blythe Nobleman (<https://news.ucmerced.edu/news/2019/field-station-planned-uc-merced-veral-pools-and-grassland-reserve>). Many people on campus have been involved in this process, and many thanks go out to everyone working hard on these efforts.

### *Events and Celebrations*

#### **UC Natural Reserve System Board of Councilors Meeting and Tour**

The UC Merced Sierra Nevada Research Institute (SNRI) and Natural Reserve System hosted the spring Natural Reserve System (NRS) Capital Campaign Board of Councilors meeting on May 2-3, 2019. A reception was held at Bella Luna Bistro in downtown Merced on the evening of May 2, and the full-day meeting was held on May 3 in the California Room on the UC Merced Campus. After lunch, Monique Kolster led a tour of the reserve and discussed the unique vernal pool ecosystem, reserve research and educational program, and fundraising projects. UCM PhD student Jorge Montiel Molina and UCM undergraduate Josh Jensen presented their research to the group. Roger Samuelson, Foundation Directors of the NRS and Founding Advisor for the UC Merced

campus, provided rich history of the campus and reserve beginnings. A huge thank you goes out to Armando Quintero, Executive Director of the SNRI and NRS Board of Councilor, for organizing the event.

### **MVPGR Symposium**

On Wednesday, March 21, 2018, Monique Kolster, with the help of Professor Josh Viers and the VICE lab, hosted the first Merced Vernal Pools and Grassland Reserve Symposium. The Symposium brought together reserve researchers, regional biologists, UCM faculty and students, and the community for a day to celebrate and hear about the cutting edge research that is being conducted on the Reserve. The Symposium was composed of two parts on the UCM campus. The main symposium was held in the Half Dome- Crescent Arch Room and featured talks from MVPGR researchers. The second part tied in with the Environmental Systems Seminar held in the Science Services Building.

The Symposium was promoted through personal invitations, campus email lists, and flyers. About 175 personal invitations were emailed out, and event invitations were also sent to the following campus email lists: Sierra Nevada Research Institute faculty, researchers, staff, and students; School of Social Sciences, Humanities and Arts; School of Engineering; School of Natural Sciences; Wilderness Desk Rangers/Yosemite Leadership Program; Graduate Student Association; MVPGR Engineering Service Learning Students; MVPGR student naturalists; California Naturalists graduates; UCM Happenings. Students distributed flyers throughout campus.

Vice Chancellor Sam Traina provided \$2,000 for the event, which covered the cost of the Crescent Arch room reservation, morning food (pastries, coffee, water, tea), event posters and advertising, parking for the speakers, event signage, and supplies (e.g., name tags). Director of CITRIS and Professor Josh Viers provided funding for sandwich box lunches and travel for a couple speakers (Mark Rains and Brad Shaffer).

Monique Kolster organized the main symposium, promoted the event, handled expense reimbursements, and oversaw the budget. Josh Viers and the VICE lab (Karen Anderson, Vanessa Azevedo, Anna Fryoff-Hung, and Jacques Fracchia) organized lunch and the Environmental Systems portion of the event. Anna Fryoff-Hung and undergraduate students Henry White and Jacques Fracchia helped create the flyer, event poster, and poster map of the MVPGR researcher's locations. Many people helped during the main symposium event to help with set-up, technology, registration, parking lot and event direction, timekeeping for presenters, event drivers, and clean-up. A huge thank you to Henry White (set-up, tech person, event direction), Michael Spaeth (set-up, registration, event direction), Jacques Fracchia (set-up, time-keeper), Francesca Cannizzo (set-up, registration, clean-up), Misael Miranda (parking lot attendant), Mercedes Jimenez (parking lot attendant), Marianne Gonzalez (parking lot attendant), Fidel Machado-Perez (driver to SSB lot), and Teanna Herrera (clean-up). Monique was the emcee for the event. Yuquan Chen from Professor YangQuan Chen's lab videorecorded the main symposium. To see the videos, please go to the YouTube link:

<https://www.youtube.com/playlist?list=PL-euleXgwWUPTqVtpChLf0xxtPaX8Rhw5>



Vice Chancellor and NRS Faculty Directory Sam Traina and Monique Kolster kicked off the day with a welcome and introduction to the NRS, the MVPGR, and the day's events. Speakers displayed the range of research happening on the reserve (from hydrology to soils to plants and animals) as well as the range of novel research approaches. Invited speakers included:

- Recent UCM M.S. graduate student Joy Stewart who discussed her research on the breeding productivity and diet of American kestrels, which involved analyzing stable isotopes in kestrel feathers
- UCM Master's student Anna Fryoff-Hung who shared her multi-faceted approach to gaining information in order to model and analyze a potential restoration project at Avocet Pond, which would reduce the pond size and increase water flow to downslope vernal pools
- UCM PhD candidate Sam Ayara who presented research on obtaining surface soil moisture using unmanned aerial vehicles
- UC Davis PhD candidate Shannon Kieran who is testing environmental DNA as a tool to monitor for listed vernal pool fairy shrimp species
- UCM Assistant Project Scientists Molly Stephens and Postdoctoral Researcher Dannise Ruiz-Ramos who presented their preliminary results about using environmental DNA for listed vernal pool plants species detection and to gain insight into soil genetic biodiversity
- UCM PhD student Daniel Toews who discussed the effects of different soils on an annual endemic vernal pool plant, *Limnanthes douglassii* ssp. *rosea* (Meadowfoam)
- UCLA Distinguished Professor Brad Shaffer who shared his lifelong work on population ecology and natural history of the California tiger salamander (CTS) and emphasized the importance of the MVPGR in terms of CTS conservation genomics efforts

As a thank you, field books and T-shirts with the MVPGR logo were presented as gifts to the speakers.

More than 90 people attended the symposium. Guest included:

- Jesse Bahm, Fresno Area Biologist, USDA Natural Resources Conservation Service
- John Battistoni, Senior Environmental Scientist, California Fish and Wildlife
- Stan Bunce, Master Gardener Continuing Education Coordinator, UCCE Merced County
- Tara Collins, Ecological Resources Manager, Westervelt Ecological Services
- Dr. Dan Edwards, Professor, UC Merced
- Rodrigo Espinoza, Board of Supervisors, Merced County
- Bonnie Eyestone, Rangeland Monitoring Network Coordinator, Point Blue Conservation Science
- Petia Gueorguieva, STEM Resource Coordinator, UC Merced

- Katie Guntly, Rangeland Watershed Initiative Partner Biologist, Point Blue Conservation Science/Natural Resources Conservation Service
- Dr. Thomas Hothem, Professor, UC Merced
- Martha Kandziora, Postdoctoral Researcher in McTavish Lab, UC Merced
- Anne Kelly, Director, NRS Yosemite Field Station, UC Merced
- Jane Lawrence, Former Vice Chancellor of Student Affairs, UC Merced
- Dr. Teamrat Ghezzehei, Professor, UC Merced
- Khan Hassan, Lecturer, UC Merced
- Haipeng Li, University Librarian, UC Merced
- Fadzayi Mashiri, Director, UC Cooperative Extension Mariposa County
- Mark Maxwell, Assistant Director of Sustainability, UC Merced
- Dr. Emily Jane McTavish, Professor, UC Merced
- Javier Mendez, California Fish and Wildlife Service
- Gary Miltimore, Stewardship Program Manager, Sierra Foothill Conservancy
- Emily Moran, Professor, UC Merced
- David Muth, Wildlife Biologist/Herpetologist, LSA Associates, Inc.
- Fletch Nelson, Range Specialist, USDA Natural Resources Conservation Service
- Daniel Ocampo Daza, Postdoctorate Researcher in Amemiya Lab, UC Merced
- Melissa Odell, Conservation Project Manager/Biologist, Sierra Foothill Conservancy
- Anna Rallings, Associate Researcher and Lab Manager, UC Merced
- Kris Randall, Master Gardener Coordinator, UC Cooperative Extension Mariposa County
- Kent Reeves, Independent Consultant and Wildlife Range Ecologist, The While Picture Consulting, Inc.
- Aaron Rives, Soil Conservationist, USDA Natural Resource Conservation Service
- Dr. Jason Sexton, Professor, UC Merced
- Steve Simmons, Research Associate, UC Merced
- Brandon Stark, Director of UC Center of Excellence on UAS Safety, UC Merced
- Carolyn Vara, President, SJV UC Alumni Network Charter
- **Russ Vara,**
- Dr. Josh Viers, Professor, UC Merced
- John Vollmar, President, Senior Ecologist and Vernal Pool Specialist, Volmar Natural Lands Consulting, Inc.
- Elizabeth Whitt, Vice Provost and Dean of Undergraduate Education and Professor, UC Merced
- Carol Witham, Vernal Pool Specialist, Witham Consulting
- Madeline Yancey, Interpretive Park Ranger, USFWS San Luis National Wildlife Refuge Complex
- Cameron Zuber, Staff Research Associate, UC Cooperative Extension Merced County

A delicious lunch by Port-of-Subs was provided in the Science Services Building to all symposium speakers and guests. Again, thanks for everyone who helped put on this event. It was an overwhelming success, with lots of great feedback.

“It’s amazing and exciting to see that UC Merced has become the leader in vernal pool research,” John Vollmar, vernal pool biologist **extraordinaire**.



**Vernal Pools and Grassland Reserve Symposium**

**Come Join us to learn more about our Natural Reserve!**

**Wednesday, March 21, 2018 8:30am - 2:00pm**  
**Half Dome - Crescent Arch Room**

**8:50** Introduction

**9:00** *Diet analysis of American kestrels (*Falco sparverius*) breeding on the Merced Vernal Pools and Grassland Reserve*—Joy Stewart, Ecologist, Applied Technology & Science

**9:20** *Hydrologic monitoring and modeling for management and restoration analysis at Avocet Pond*—Anna Fryoff-Hung, Master’s student, UC Merced

**9:40** *Monitoring soil moisture from unmanned aerial vehicles: Surface soil moisture retrieval using machine learning and multi-spectral images*—Samuel Araya, PhD candidate, UC Merced

**10:00** *Using environmental DNA to monitor for listed vernal pools fairy shrimp in California*—Shannon Kieran, PhD candidate, UC Davis

**10:35** *The secret life of vernal pool soils: Plant genetic diversity above and below ground*—Molly Stephens, Assistant Project Scientist, and Dannise Ruiz-Ramos, Postdoctoral Researcher, UC Merced

**10:55** *Soil effects on an endemic vernal pool annual plant, *Limnanthes douglasii* ssp. *rosea* (Meadowfoam)*—Daniel Toews, PhD Student, UC Merced

**11:05** *Conservation genomics of endangered California tiger salamanders*—Brad Shaffer, Distinguished Professor, UC Los Angeles

**Event continues with the Environmental Systems Seminar**  
**Please join us in the Science Services Building (SSB 170)!**

**12:30** *Connecting the dots: Hydrological connectivity between vernal pools and downgradient waters*—Mark Rains, Associate Professor, University of South Florida

**Food and Drinks Provided! (Coffee 8:30am)**

For More Information: Monique Kolster, [mkolster@ucmerced.edu](mailto:mkolster@ucmerced.edu)

## Research Programs

We currently have 23 active research projects on the reserve, 21 of which are new since the last 2015/2016 Annual Report. According to our Reserve Application Management System (RAMS), which calculates reserve use based on fiscal year, we hosted 222

researchers, representing 1630 user-days (days spent in the Reserve per individual) in 2018, and we hosted 412 researchers, representing 892 user-days in FY 2019. While many of our researchers come from UC Merced (174 individuals, representing 97% of our user-days in FY 2018; 218 individuals, representing 75% of our user-days in FY 2019), we also get researchers from the California State University System (6 individuals in FY 2018; 5 individuals in FY 2019), other UC campuses (7 individuals in FY 2018; 16 individuals in FY 2019), and other universities (9 individuals in FY 2019).

### **Finished Thesis Projects**

On December 5, 2018, **Anna Fryoff-Hung**, an UCM Environmental Systems master's degree student under Professor Josh Viers successfully defended her thesis, *2D Hydrodynamic Modeling for Evaluating Restoration Potential in a Vernal Pool Complex*. The project was part of a California Fish and Wildlife grant to develop a feasibility study and restoration plan that would increase the total amount of suitable habitat for listed and native vernal pool grassland plant and wildlife species on the Merced Vernal Pools and Grassland Reserve. Anna's research focused on understanding how water moves throughout the reserve in order to evaluating potential hydrological restoration activities. She used a combination of empirical data (pressure transducers, timelapse imagery, aerial LiDAR and imagery, and RTK GPS surveys) and 2D hydrodynamic modeling (HEC-RAS 2D hydrodynamic rain-on-grid modeling) to assess the feasibility of restoring or enhancing existing natural vernal pool complexes by altering stock pond complexes. After assessing a few different sites, Anna focused her analysis on the Avocet Pond area, an area which contains the largest stock pond on the reserve, feeder canals, and downslope vernal pool complexes. Model simulations suggested that historic hydrologic flows could be restored through minimal terrain alteration in the feeder canals (potentially breaking ~5 feet of the canal), resulting in enough water to sustain Avocet Pond for cows and threatened California tiger salamander populations as well as to increase inundation to vernal pool complexes downstream of the feeder canal break. This novel modeling approach provides the groundwork for greater understanding of the hydrology of unique landscapes and its restorative potential. As part of the last phase of the grant, LSA Associates, Inc will be developing a restoration plan based on Anna's research and analysis.

**Christina Tham**, a UCM graduate student, completed her thesis, *Hydrological Connectivity of Vernal Pools*, and received a Master of Science degree in Environmental Systems. Her committee members included Professor Martha Conklin (UC Merced), Professor Teamrat Ghezzehei (UC Merced), Dr. Niall McCarten (UC Davis), and VC and Professor Samuel Traina (UC Merced). The purpose of her study was to understand the hydrological connectivity of vernal pools and the variables that contribute to this connectivity. In order to do this, she studied three vernal pool series (high, middle, low elevation vernal pools) in two different vernal pool "watersheds" in the Reserve. She used physical and chemical measurements gathered in water year (WY) 2016 to monitor water behaviors and characteristics. Her results supported that vernal pools are not isolated wetlands, but are in fact, hydrologically connected to each other and to the landscape. Several variables determined the degree of hydrological connectivity–

shallow subsurface confining layer, perched groundwater and surface water flow, inundation, and location. For more details, please see Christina's thesis: <https://ucmerced.box.com/s/rgbxc6vef26dhmn6cqo3da9aw4t73yqd>. Understanding the hydrology of this unique, abiotic environment is imperative to the success of vernal pools and vernal pool species, particularly in light of continued pressures of habitat loss and pressures associated with climate change.

### **Current Research**

From February 2015 to October 2016, **Professor Jessica Blois and her lab** documented the taxonomic and population genetic structure of the small mammal community within the Reserve and assessed how the living small mammal community differs from the 'dead' small mammal community (documented in the remains contained in raptor pellets and carnivore scats). Their sampling methods focused on targeting mammals ground squirrel-sized and smaller. They collected 65 pellets, with 367 total identifiable elements preserved within the pellets. They live-trapped at three sites on the Reserve, for a total of 882 trap nights, and observed 67 specimens overall. Through the combination of small mammal live-trapping, pellet collection, and visual observations, they documented 8 species of small mammals on the reserve (**Table 1**). The highest diversity was found among the pellets, and the relative abundance of different taxa varied substantially among the different collection modes. Deer mouse (*Peromyscus maniculatus*) was the most abundant small mammal in the live-trapping sample (70% of all observations), whereas both **Perognathus parvus** and deer mouse (*Peromyscus maniculatus*) were abundant in the pellet collections (53% and 34% of the specimens, respectively). Overall, the small mammal compositional structure from each individual sampling method varied substantially, reinforcing that adequate characterization of the total species list for a location should be based on multiple different methods. This project provided a comprehensive baseline of the small mammal community on the MVPGR and provided information as to which small mammals are likely to be present in fossil deposits in the region. It also represents the initial steps in a long-term live-dead analysis, and through this work, they will be able to compare the structure and function of both the living and dead mammal communities in this grassland ecosystem to similar communities in other grassland systems around the world.

In Santa Barbara County, California tiger salamanders, *Ambystoma californiense*, are declining and previous work indicates the potential for inbreeding depression to be a causal factor in this decline. Under USFWS and UCLA La Kretz Center for California Conservation Science Graduate Grant grants, **Erin Toffelmier**, a graduate student at UCLA, and Professor **Brad Shaffer** (UCLA) are comparing egg and larval development in this Santa Barbara County population to healthy control populations in the Merced Vernal Pool and Grassland Reserve in order to isolate specific causes of recruitment failures in Santa Barbara County. This also will help establish baseline hatching and larval success rates for the MVPGR populations. In early January, egg collection grids were placed in four ponds on MVPGR. After breeding activity, eggs were successfully collected from three of the ponds. They moved these eggs, along with eggs collected from target populations in Santa Barbara County, to mesocosms at UCLA's Stunt Ranch Natural Reserve. Eggs were reared to hatching, and larvae currently are growing and

going through metamorphosis. They anticipate completion of larval development in late July/early August 2019.

After two seasons of collecting specimens and images of *Downingia* in the field and from public image repositories, Professor **Andy Gardner** (CSU Stanislaus) and three CSU Stanislaus undergraduate students **Antonio Garcia**, **Stephanie Valencia**, and **Harmanpreet Kaur** have developed 2D and 3D floral shape models for *Downingia*. In spring 2018, they discovered a small mixed-species population with *D. cuspidata* and *D. bicornuta* near the Three Willows Stock Pond. This was an exciting discovery. *Downingia* are known to occur in sympatry, but there have been few studies of the mechanisms maintaining species boundaries (and their effectiveness). They plan to continue finding and documenting *Downingia* populations in the Merced Vernal Pools and Grassland Reserve and across the central valley to better understand *Downingia* floral evolution.

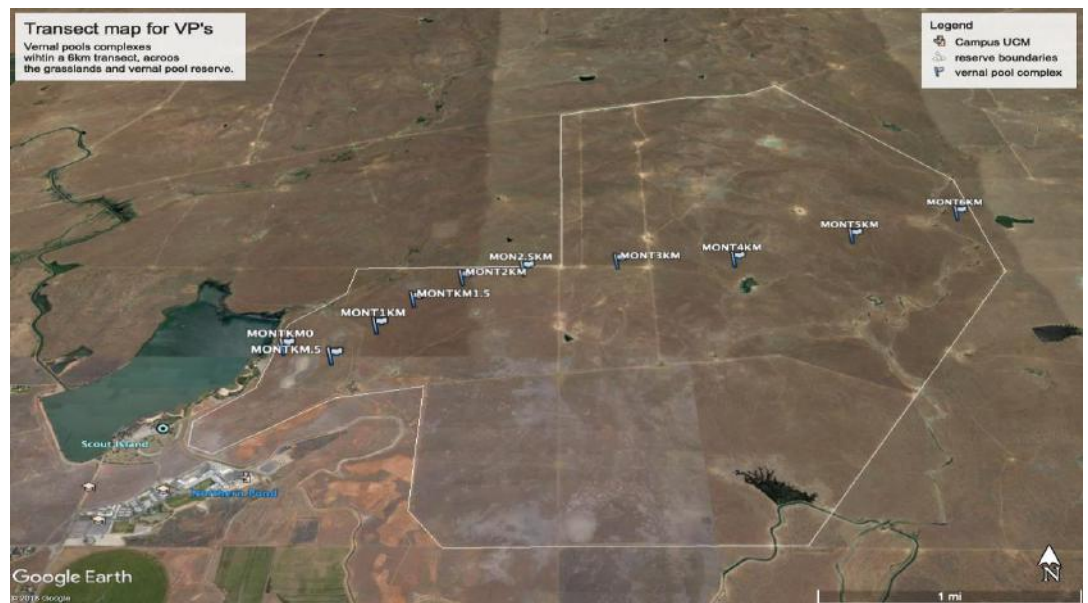


**Figure:** *Downingia cuspidata* and *D. bicornuta* at Black Rascal Stock Pond. Photo by Andrew Gardner, CSU Stanislaus.

**Javier Galán**, PhD Candidate at Estación Biológica de Doñana -CSIC (Seville, Spain) and recipient of the La Caixa and Marie Curie Fellowship, and advisor **Montserrat Vilà** (EBD-CSIC, Seville, Spain) are interested in comparing plant community assembly of invasive European annual plants (Mediterranean grasses) in native and invasive ranges. Most biogeographical studies which examine exotic plant species success have focused on comparing non-native plant populations in the native range and in the introduced range, but there have been few approaches at the community level. Currently, they have surveyed a total of 240 vegetation plots (0.25 m<sup>2</sup> plots) in California across four different sites (UC Merced Vernal Pools Grassland Reserve, La Honda Creek, San Joaquin Experimental Range, UC Santa Cruz grasslands) and 240 plots in Spain (PN Alcornocales, Navalagrulla, Ventas Quemadas). For every species at every site, they have measured key functional traits related to resource use and competitive hierarchy to understand the outcome of the invasion on little studied attributes of biodiversity (e.g., functional diversity). Scanning plant traits between coexisting native and non-native

plant species across transcontinental regions will improve understanding of the biogeography on plant invasions across Mediterranean regions.

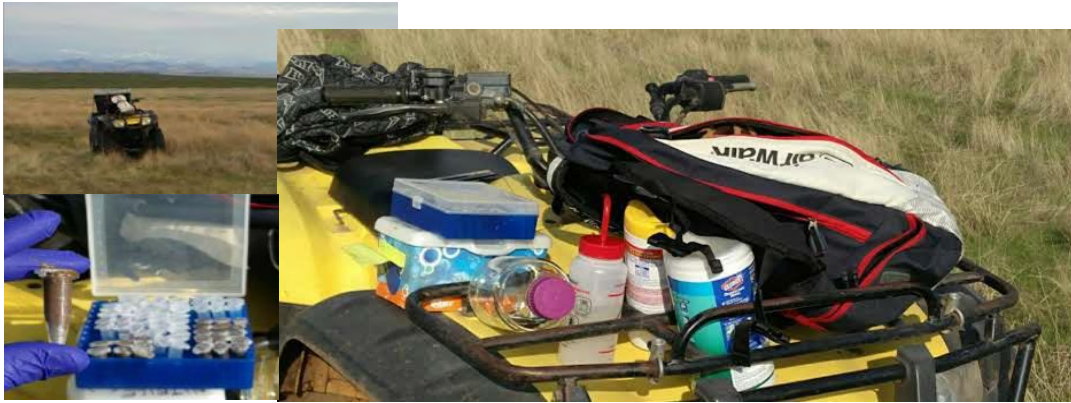
**Jorge Montiel-Molina**, doctoral student at UC Merced and recipient of a UC Institute for Mexico and United States and El Consejo Nacional de Ciencia y Tecnología (UC MEXUS-CONACYT) grant, is researching the role that fungal endophytes play in relation to amphibious vernal plants survival, particularly as an adaptation to the extreme fluctuations in water availability. He is examining free-living microbial communities in the soil and water and microbial communities living in symbiosis with the amphibious plant species, *Eryngium castrense* (Great Valley coyote thistle). Collections of soil, water, and plant tissues are collected along a 6 km transect in the reserve at different times of the year to understand how fungal communities are affected by temporal and spatial variables. Jorge also is collecting information on environmental conditions of his vernal pool sites (e.g., oxygen concentration, pH, temperature) to examine the effect of soil and physical properties on fungal communities. He will continue sampling this next year and start processing the samples for DNA sequencing.



**Figure:** Transect of vernal pool complex sampling sites developed to understand the variation of microbial communities by spatial distance.



Amphibious plant *Eryngium castrense*, terrestrial and aquatic phase



**Figure:** Mobil laboratory station and soil sampling

Please see the Appendix (Part 4: Current Research, p. ???) for a list and description of current and new research projects.

### **Tours with New UC Merced Faculty and Visiting Researchers**

Various UCM faculty and MVPGR staff hosted a number of researchers and professors visiting the reserve in FY 2018 and FY 2019. Tours focus on getting researchers acquainted with the reserve as well as the research being conducted on the reserve.

#### Fiscal Year 2017-18

- February 7, 2017: Professor Susan Harrison (UC Davis), tour by UCM Professor Jason Sexton
- March 7, 2018: Professor Rebecca Ryals (UC Merced), Professor Gordon Bennett (UC Merced), Professor Juris Grasis (UC Merced), and Lecturer Anna Moncovich (UC Merced), tour by Reserve Director Monique Kolster
- April 25, 2018: Professor John Harte (UC Berkeley), tour by UCM Professor Jason Sexton and Reserve Director Monique Kolster
- April 27, 2018: Professor Sharon Strauss (UC Davis), tour by UCM Professor Jason Sexton

#### Fiscal Year 2018-19

- September 12, 2018: UCM NRS Yosemite Field Station Director Anne Kelly, tour by Monique Kolster
- November 2, 2018: Professor Felipe Zapata (UCLA), tour by UCM Professor Emily Jane McTavish

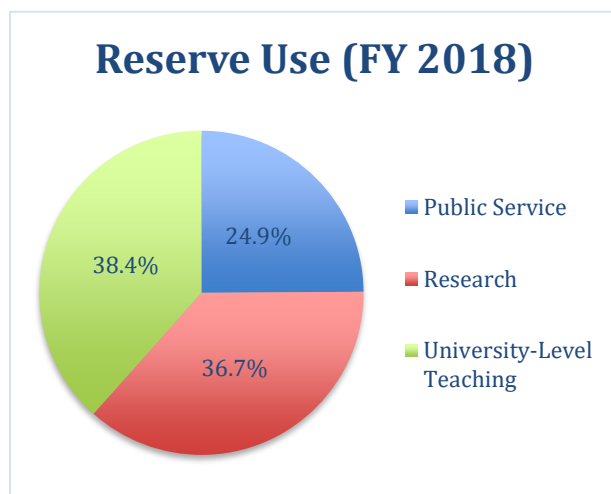


- January 30, 2019: California Department of Fish and Wildlife GIS Specialists Daniel Rankins (Scientific Collecting Permits), Isaac Oshima (Office of Spill Prevention and Response), Steve Goldman (GIS Program Manager), and William Patterson (Data Manager), tour led by Professor Josh Viers, the VICELab, and Director Brandon Stark
- February 1, 2019: Professor Tyrone Hayes (UC Berkeley), tour by RadioBio and the Society for the Advancement of Chicano/Hispanic and Native Americans
- February 20-21, 2019: Professor Mark Rains and PhD student Leanne Stepchinski (University of South Florida), tour by Professor Josh Viers and the VICELab
- February 22, 2019: Professor Samuel Wasser (Endowed Chair in Conservation Biology at the University of Washington and Director of the Center for Conservation Biology), tour by Professor Chris Amemiya
- February 25, 2019: UCM Sierra Nevada Research Institute Tour
- March 22, 2019: Professor Kevin Rice (UC Davis), tour by Professor Jason Sexton and the Sexton Lab

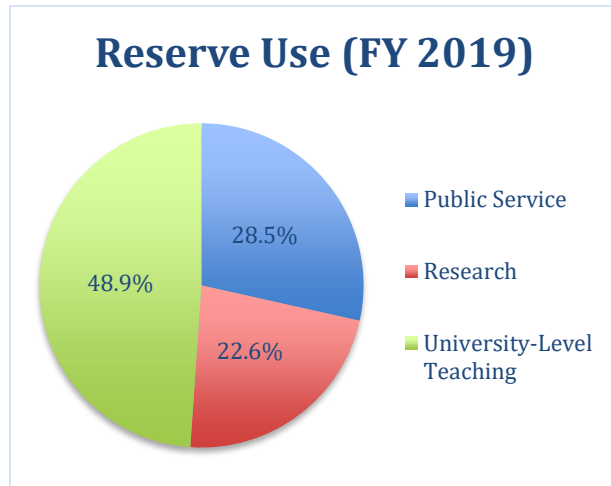
### University-Level Education

During the fiscal year 2018, 22 university-level classes came out to the reserve (10 class in fall and 12 in spring), and during the fiscal year 2019, 23 university-level classes used the reserve (6 in fall, 16 in spring, 1 in summer). Due to the close proximity to the UC Merced campus, most classes were from UC Merced. In spring 2019, the UC Natural Reserve System course (California Ecology and Conservation) visited the reserve, for an outing to learn about vernal pool ecosystems and its unique plants. Additionally, for the last two springs, Katherine Waselkov from CSU Fresno has brought her Plant Taxonomy class to the reserve to identify vernal pool plants.

When compared to research and public service, university-level teaching



still represents the largest contingent of use in terms of users-days on the reserve. For fiscal year 2018, university-level teaching comprised 38.4% of reserve use (36.7% research, 24.9% public service), and for fiscal year 2019, university-level teaching comprised 48.9% of the reserve use (22.6% research, 28.5% public service).



A total of 1365 people (1274 undergraduates) used the reserve for university-level teaching in fiscal year 2018, with a total of 1,707 user-days; and a total of 1711 people (1671 undergraduates) used the reserve in fiscal year 2019, with a total of 1926 user-days. Classes were from a variety of disciplines and focused on topics such as ecology, botany, soil science, geology, conservation biology, natural resource management, engineering, environmental writing, and sustainability.

**University-level Classes:**

The following professors, instructors, and teaching assistants brought their students to the reserve:

**UC Merced**

- Dr. Gordon Bennett
- Dr. Asmeret Asefaw Berhe
- Dr. Jessica Blois
- Brigitte Bowers
- Kinsey Brock
- Christopher Butler
- Dr. Luis Cayetano
- Dr. Thomas Hothem
- Monique Kolster

- Sylvain Masclin
- Dr. Emily Jane McTavish
- Andrea Mele
- Dr. Emily Moran
- Dr. Jason Sexton
- Dr. Brandon Stark
- Lynn Sullivan
- Dr. Eric Williams
- Guoxiang Zhang

**University of California, Santa Cruz**

- Dr. Krikor Andonian

**California State University, Fresno**

- Dr. Katherine Waselkov

For a complete list of use by instruction groups, please see the Appendix (Part 3: Use By **Instructional Groups, p. VIII??**), which includes course title, instructor's name,

institution's name, and semester.

### **UC Merced Engineering Service Learning Naturalist App**

A team of Service Learning students in the School of Engineering, with Tom Hothem as the instructor, created a Naturalist App for the Reserve, which will be used as a resource for species identification and reserve information for any reserve user. The Naturalist App (version 1.0) was released on Android and IOS in December 2018. The app will undergo continual revision and addition of species and their characteristics. The idea being that it will be promoted and field tested among more users toward a version 2.0. The app was featured at the Merced Environmental Literacy Collective meeting at UC Merced on March 3, 2018.

### **Unmanned Aircraft Systems (ME143 and ME190)**

As part of Dr. Brandon Stark's new UCM courses, undergraduate students utilized the reserve to receive training in UAS operation safety training and mission planning, UAS search and rescue exercises, and class projects. Students used UAS to analyze the capability of the technology in detecting squirrel burrows, inspecting reserve road conditions, mapping fire fuel, detecting invasive weed species, and inspecting infrastructure (e.g., water tank and windmill conditions).

### **Reserve Naturalist Training Program**

To provide for educational opportunities (e.g., university-level teaching, K-12 classes, non-profit organizations field trips) on the reserve, undergraduate students continue to be trained as reserve naturalist as part of the Reserve Naturalist Training Certification Program. During the training, students learn about the ecology and natural history of vernal pools and grassland habitats from UCM researchers, graduate students, local Audubon Society members, and the reserve director. Over three semesters (Fall 2017, Spring 2018, Spring 2019), 28 students completed the training.

Graduates of the Reserve Naturalist Training Program are instrumental to educational programs as well as research and stewardship programs on the reserve and throughout Merced County. Graduates have led field trips and hands-on activities for university classes (e.g., Ecosystems of California course), regional organizations (e.g., Audubon Societies, California Native Plant Societies Chapters, California Native Grassland Association), the general public (e.g., nature hikes), and K-12 students throughout the San Joaquin Valley. Trained naturalists also work with graduate students, professors, and researchers on reserve research projects (e.g., American kestrels studies) gaining further experience and skills for future pursuits as well as contributing to the deeper understanding of vernal pools and grassland ecology. Graduate naturalists help with stewardship activities (e.g., invasive plant removal) and have become an integral part of our developing docent program. A number of our naturalist also have gone on to get paid internships and jobs in field work and research.



NATURALIST APP  
Engineering Service Learning  
AT UC MERCED



**Yosemite Leadership Program Wilderness Education Center Rangers Training**  
The MVPGR and the UCM Yosemite Leadership Program (YLP) will be increasing collaboration in the future as YLP Wilderness Education Center (WEC) Rangers will be assisting with reserve events and tours. In spring 2019, a new training was held on the

reserve to introduce WEC Rangers to the reserve (e.g., field trip logistics, vernal pool ecology). Five WEC Rangers participated.

### **Junior Naturalist Curriculum Development**

For fiscal year 2019, Chelsea Arnold (CalTeach), Monique Kolster (MVPGR), Jesse Chakrin (Yosemite Leadership Program), and Leslie Reschenberg (McSwain Elementary School) partnered to create a new capstone project for undergraduate students in the Yosemite Leadership Program program. For the capstone project, a group of four UCM students, Socorro Cardoso, Mariela Arceo, Takezo Fishburn, and Calista Lum, developed a hands-on, inquiry based naturalist lesson for 5<sup>th</sup> grade students that met the Next Generation Science Standards for K-12 science education. This lesson will be part of a larger junior naturalist curriculum developed for Merced City School District students (5<sup>th</sup> and 6<sup>th</sup> grades) to increase environmental literacy in Merced and the greater San Joaquin Valley. The YLP students created a lesson on vernal pool grassland species, species interactions, food webs, and conservation. The students piloted their lesson to 89 5<sup>th</sup> grade students from McSwain Elementary School during a field trip to the reserve. The 5<sup>th</sup> grade students observed outdoor life with hand lenses, described their observations in nature journals, and constructed interactive food webs. Students chose different local species to represent and then, using string, connected themselves to other students to create a web. The exercise helped deepen the understanding of how species are connected and how one population affects another population. The YLP students then assessed the lesson for lesson revisions.

### **Public Service**

The total percentage of reserve use for educational outreach programs and public service was 24.9% in FY 2018 and 28.5% in FY 2019. With the close proximity to Merced and few field trip destinations options within the San Joaquin Valley, the Merced Vernal Pools and Grassland Reserve continues to be a destination for educational field trips for conservation organizations and local K-12 classes and programs.

### **K-12 Classes and Summer Programs**

Reserve staff, UCM graduate students, and trained reserve naturalist led environmental programs for 280 K-12 students in fiscal year 2018, and 416 K-12 students for fiscal year 2019 (including research projects).

#### Fiscal Year 2017-18

- **Early Academic Outreach Program (EAOP) Summer Academy** (July 12, 2017)  
Twenty EAOP high school students learned about the vernal pool grassland ecosystem, how it was formed, and what is special about the soils. Students learned how to collect soil samples and test soil pH, color, hydrophobicity, and texture.
- **Mariposa County High School Student Lab Tours** (March 13, 2018)

High school students from Mariposa County visited UC Merced for a day of campus lab tours. Twenty-seven students toured the reserve and participated in field work to understand science in action.

- **Livingston Middle School Class Field Trip** (March 16, 2018)  
Led by Chelsea Arnold (UCM CalTeach Program Director), 47 students from Livingston Middle School visited the reserve to learn about unique habitats and how they support life. The students were working on a classroom curriculum unit on how humans can live on Mars, and the experience was used to support their classroom models. Students used portable microscopes to examine features of grasses and sedges near vernal pools, and a temperature apparatus to examine temperature effects of vegetation and water on life.
- **Allen Peterson Elementary School 1st grade Field Trip** (March 26, 2018)  
Chelsea Arnold (UCM CalTeach Program Director), Professor Katrina Hoyer (UC Merced), and 105 first grade students toured the reserve to learn about habitats of the reserve and how habitats change as the seasons change.
- **UC Merced Science and Technology Enrichment Program (STEP) for High School Students** (June 14, 2018)  
The NSF-CREST Center for Cellular and Biomolecular Machines hosted a summer research program for 36 high school students to encourage careers in the sciences. Students came to the reserve to learn about biological field stations and field research.
- **Merced County Office of Education Migrant Enrichment in Sciences and Technology (MESAT) Field Trips** (June 15, 2018)  
As part of the Merced County Office of Education MESAT program, UCM graduate students, Elisabet Perez Coronel, and Jorge Montiel Molina, led a field trip on the reserve for 40 students from Orosi High School. The purpose of this program is to increase science awareness and literacy in migrant children and thus increase the likelihood that they will attend college and have access to the educational resources they need to succeed in their futures.
- **UC Merced Writing Project's Bobcat Young Writers Academy** (June 20, 2018)  
The UC Merced Writing Project Bobcat Young Writers Academy is a week-long summer program, dedicated to improving writing and the teaching of writing for 1<sup>st</sup>-8<sup>th</sup> graders. As part of the program this summer, 11 students visited the reserve with their nature journals and took notes and documented their observations on plant and animal life. Students were encouraged to write from a naturalist's and scientist's point of view and then share and discuss with other young writers.
- **Harvest Park Educational Center Summer Enrichment Camp** (June 28, 2018)  
As part of their summer enrichment camp program, 18 youth from Merced visited the reserve to have a scavenger hunt and learn about vernal pools and their unique value to the region.

#### Fiscal Year 2018-19

- **Dos Palos High School Field Trip** (March 7, 2019)

The UC Merced NSF-CREST Center for Cellular and Biomolecular Machines (CCBM) led an outreach event to UC Merced for 100 high school students (juniors) from Dos Palos High School. Eddie Gibb, the science teacher, who coordinated this trip finished his Ph.D. at UC Merced in Quantitative Systems Biology in 2018, and he is interested in introducing students to the college experience and to various careers in the science field. As part of the day's activities, the students visited the Reserve and learned about vernal pool ecology and field science careers.

- **Mariposa County High School Student Lab Tours** (March 5, 2019)  
High school students from Mariposa County visited UC Merced for a day of campus lab tours. Five students braved the scattered showers and threat of heavy rain to tour the reserve and get a first-hand glimpse of being a field biologist and land manager.
- **UC Merced NSF-CREST Center for Cellular and Biomolecular Machines Summer Programs** (June 25, 2019)  
As part of a week-long STEM summer program, 24 high school students visited the reserve to learn about vernal pool grassland ecology, conduct rangeland surveys to assess grazing management, and learn what it means to be a field biologist and land manager.
- **Ballico-Cressey Elementary School Field Trip** (March 15, 2019)  
Second-grade teacher, Patricia Magneson, returned to the reserve this year with 40 2<sup>nd</sup> grade students and parent volunteers to expose the students to the grassland vernal pool habitat and give them an opportunity to understand its importance. Monique Kolster and PhD student, Daniel Toews, led the tour and introduced students to plants and animals of the reserve. Students spent time exploring the reserve with field lenses in hand and trying to find plants for a scavenger hunt.
- **Sierra Foothill Charter School Field Trip** (April 5, 2019)  
Seventh and eighth grade teacher, Andrea Contreras, and 24 of her students visited the reserve to learn about vernal pool and grassland species, ecology, and conservation. Monique Kolster led the students on a tour of exploration through different habitats on the reserve. At different locations, students learned from a range of teachers and participated in various hands-on activities. They learned about vernal pool plants from UCM graduate student Jorge Montiel Molina, fairy shrimp and vernal pool microorganisms from UCM campus biologist Francesca Cannizzo, and California tiger salamanders (CTS) and stock ponds from Monique Kolster and Francesca Cannizzo. They saw demonstrations of how to survey for fairy shrimp and CTS; they identified vernal pool macroinvertebrate with hand lenses and field guides; and they became familiar with reserve wildflowers as part of a wildflower scavenger hunt. Lessons corresponded with their classroom studies focusing on species adaptations and traits. The field trip (e.g., bus, lunch) was paid for as part of a National Science Foundation grant that UCM Professor and Sierra Foothill Charter School parent Carolin Frank received, which supports collaborative partnerships between K-12 teachers and university faculty to enhance science, technology, engineering, and math (STEM) knowledge and capacity.



Pictured at the front of the reserve: Cole Silva, Rya Salonen, Malachi Shelton, William Wall, Conner Eastwood, (kneeling) Eva Smerber, Andrayah Collins, Anna Ramirez, (standing) Nayo Rhoan, Celianna Lee, Patrick Cleary, Estrella Hermosillo, Sayer Harry, Tadd Sexton, Jamie Ardell, Wyatt Brouillette, Gabe Walters, Malaya Shelton, Wyndham Evans, Khalil Neogy, Jaeyanna Bolar, Aidan Pierson, and Mia Nelson.



UC Merced graduate student Jorge Monitel Monlina, whose studies focus on vernal pools, talks to students about the plant, animal, and insect life supported by the pools.





Sierra Foothill Charter School students take a close look at insects and other items pulled from the vernal pool and work on identifying them.



Cattle stock ponds have become another important habitat on the reserve. Monique Kolster talks to students about California Tiger Salamander and Clam Shrimp before wading to the middle of the pond to try to net some for the students to see.



Students take a close look at Tiger Salamander in larva stage and Clam Shrimp that were netted in a cattle stock pond on the reserve. They were returned to the water after the students had a chance to study them.

Newspaper article:

<https://goldrushcam.com/sierrasuntimes/index.php/news/local-news/18170-sierra-foothill-charter-school-visits-uc-merced-vernal-pools-and-grassland-reserve>

### **Tours and Field Trips For the Public Agencies, Non-Profit Organizations, the UC Merced Campus Community, and the General Public**

With all the research occurring on the reserve, in particular research focusing on threatened vernal pool habitat and species, it is imperative that this information gets shared with public affiliated groups, regional non-profit organizations, the greater UC Merced campus community (e.g., staff, campus tour guides), and the general public. Ten groups took field trips and tours of the reserve in FY 2018, and sixteen groups took field trips and tours in FY 2019.

#### Fiscal Year 2017-18

- UC Merced Tour Guides Tour -August 17, 2017
- Tour with Derek Daley, Risk Manager of the Merced Union High School District- February 20, 2018
- UC Merced Research Week Tours- March 8, 2018
- Tour with Miguel Vega, UCM Senior Video Producer- March 28, 2019
- Yosemite Area Audubon Society- April 14, 2018
- UC Merced Bobcat Day Tours- April 21, 2018
- Atwater Girl Scouts Hike- April 22, 2018
- Tour with Dina Robertson, Rangeland Ecologist with AECOM- April 25, 2018
- Merced College PreMed Club Hike- May 4, 2018
- UC Merced Staff Appreciation Tours- May 15 & 18, 2018

#### Fiscal Year 2018-19

- Sierra Foothill Conservancy Tour- August 30, 2019
- Tour with Todd Knittel, UCM Procure-to-Pay Service Manager – December 6, 2018
- UC San Francisco Librarians Tour- February 1, 2019
- UC Merced Graduate Visitation Weekend Tours- February 23, 2019
- UC Merced Research Week Tours- March 4, 2019
- Tour with Dianne Shew, SCICON Administrator- March 6, 2019
- UC Merced Success Mentor Program Tour- March 12, 2019
- Tour with Blythe Nobleman, UCM Senior Public Information Officer, and Veronika Androver, UCM Photographer- March 20, 2019
- Merced College PreMed Club Hike- March 29, 2019
- Atwater Girl Scouts Hike- April 7, 2019
- Central Sierra Audubon Society- April 11, 2019
- UC Merced Bobcat Day Tours- April 13, 2019
- Valley Land Alliance Annual Meeting Field Trip- April 14, 2019
- Merced Camera Club Photography Tour- April 29, 2019
- UC Merced Staff Appreciation Tours- May 21 & 23, 2019

- UC Merced Housing Professional Staff Tour- June 14, 2019

### **Reserve Hikes for the General Public**

We also offer periodic hikes with the reserve intern to educate the greater UCM campus community and the public about the ecology and natural history of the vernal pools and grassland ecosystems. For fall 2017, hikes were led by Micheal Spaeth, and for spring 2018 through spring 2019, hikes were led by Henry White. Four hikes were offered in fiscal year 2018 with a total of 60 people in attendance, and 12 hikes were offered in fiscal year 2019 with a total of 116 people in attendance. Please see below for vernal pool hikes offered,

#### Fiscal Year 2018

- Morning Walk (Sept 29, 2017): 17 people
- All Day Reserve Hike (Nov 4, 2017): 10 people
- Spring Walk (April 20, 2018): 25 people
- Sunrise Hike (April 25, 2018): 8 people

#### Fiscal Year 2019

- Early Morning Hike (September 18, 2018): 6 people
- Early Morning Hike (September 27, 2018): 12 people
- Early Morning Hike (October 4, 2018): 12 people
- Early Morning Hike (October 24, 2018): 6 people
- Autumn Walk (November 7, 2018): 7 people
- Fairy Shrimp Walk (February 6, 2019): 11 people
- Fairy Shrimp Walk (February 7, 2019): 17 people
- Wildflower Walk (April 3, 2019): 15 people
- Wildflowers Walk (April 11, 2019): 9 people
- Earth Day Wildflowers Walk (April 22, 2019): 12 people
- Wildflowers Walk (April 23, 2019): 2 people
- Black Rascal Creek Cliffs Reserve Hike (April 27, 2019): 7 people

### **Reserve Events**

#### Fiscal Year 2018

In fiscal year 2018, six events were held on the reserve

- **Lake Yosemite-MVPGR Christmas Bird Count** (December 21, 2017)  
As part of a larger 4-week period of Audubon Christmas Bird Counts (CBC) across the country, UCM undergraduate student, Nathan Parmeter, coordinated and led an Audubon Christmas Bird Count on the MVPGR. All birds seen within a pre-determined 15-mile circle were recorded. Thirty-three birds were recorded on the reserve. These results from the CBC were sent to National Audubon Society and California Audubon to be used to determine patterns and distribution of bird populations in the local area, state, and nation. Additionally, results were

uploaded onto eBird, which is used by Cornell University in New York and countless professional and amateur birdwatchers to study distribution patterns of birds in North America and to understand various trends in bird populations.



**Figure:** Rock wren (*Salpinctes obsoletus*). Photo taken by Nathan Parameter.  
eBird:

<https://ebird.org/view/checklist/S41249469>

- **2018 Winter UC Global Climate Leadership Council Meeting Tour** (February 8, 2018)  
A walking tour of the reserve for participants of the UC Global Climate Leadership Council meeting at UC Merced. Seventeen people joined the tour.
- **Women in Wilderness Reunion** (February 24, 2018)  
Eight UCM undergraduate students participated in the third annual Women in Wilderness Reunion on the reserve, which brought together participants in the UCM Wilderness Education Center and Office of Women’s Program backpacking trip in Yosemite National Park. The reunion was a continuation of the Women in Wilderness program, which focuses on empowering women by introducing women to the outdoors and teaching them about local natural places.
- **Field Journaling Workshops with Artist and Nature Illustrator, Andie Thrams** (March 2-3, 2018)  
California-based visual artist Andie Thrams led workshops on the reserve on field journaling and nature illustration. Participants carefully made natural observations and experimented with drawing techniques to enhance their written journal descriptions. On Friday (March 2), two practicums were held for UCM undergraduates in the CORE 1 course. On Saturday (March 3), members of the UCM Naturalist App team and current California Naturalist students joined the Merced Environmental Literacy Collective (MELC) for a morning practicum and catered lunch provided by MELC. MELC is a regional organization dedicated to building relationships to promote environmental literacy in the region. Tom Hothem, UCM Lecturer, and Jeanne Knapp, Educator and Advocate for Collective Impact, organized the event. Sixty-one people participated in the event.

- **CALeDNA Community Science BioBlitz** (December 2, 2017)  
 As part of the California Environmental DNA (CALeDNA) Program with the UC Conservation Genomics Consortium, the Reserve is one of the sites across California sampled by community scientists to assess and monitor biodiversity in the state. Organized by a team of faculty (Dr. Jason Sexton, UCM; Dr. Michael Dawson, UCM; and Dr. Andres Aguilar, CSU Los Angeles), UCM postdoctoral researcher (Dannise Ruiz Ramos), Executive Director of the UC Conservation Genomics Consortium (Rachel Meyer), and MVPGR Director (Monique Kolster), the MVPGR CALeDNA BioBlitzes focus on sampling soil in vernal pool ecosystems. Twenty-seven people, including UCM faculty and undergraduate students, regional K-12 educators, California State University Stanislaus faculty and undergraduates, and members of the public, participated in this bioblitz. At the beginning of the 4-hour event, community science participants are trained in the methodology, which includes collecting small tubes of soil using CALeDNA kits, recording GPS locations, taking basic soil measurements, snapping photos, recording data on smartphones, and inputting information into the iNaturalist App. Throughout the morning, faculty share their knowledge of vernal pool ecosystems with the community. Five vernal pools were sampled, and the soils are being processed by the UCLA Consortium labs for environmental DNA (eDNA), or DNA that is released from an organism into the environment. Environmental DNA sequences will be analyzed for identification of microbes, plants, and animals to establish a baseline of the region's biodiversity. In addition to estimating biodiversity, at the MVPGR CALeDNA site, researchers are investigating changes in biodiversity with seasons and pool zonation. They also are evaluating the use of eDNA to detect rare species. Some samples will be frozen at a state-of-the-art environmental DNA museum allowing future researchers to analyze change in biodiversity over time in relation to changing environmental conditions.
- **CALeDNA Community Science BioBlitz** (May 20, 2018)  
 Fifteen people participated in the 4<sup>th</sup> CALeDNA community science bioblitz on the reserve. The event was run similar to prior CALeDNA bioblitzes.

#### Fiscal Year 2018-19

In the fiscal year 2019, nine events were held on the reserve.

- **Audubon California Central Valley and Sierra Council Meeting** (October 20, 2018)  
 To kick off the Audubon California Central Valley and Sierra Council Meeting, Reserve Director Monique Kolster led a morning field trip for five regional Audubon Society Chapter delegates. We stopped at various locations to observe birds and to discuss vernal pool ecology.
- **Vernal Pools Adventure with Dr. Bob Holland** (October 20, 2018)

Dr. Bob Holland, vernal pool extraordinaire, visited the reserve and shared his knowledge of vernal pool science (e.g., plant biology, ecology, conservation) with students, researchers, and those curious about UCM's ephemeral treasures.

- **Yosemite Leadership Program Stargazing Walk (Homecoming Week Event)** (October 20, 2018)  
Jacob Croasdale, Yosemite Leadership Program (YLP) Coordinator, and YLP students organized and led a stargazing walk for 30 people as part of Homecoming Week festivities.
- **Eighth Annual UC Writing Program Conference Walk** (November 3, 2018)  
For the first time, UC Merced hosted the annual, system-wide UC Writing Program Conference. As part of the conference, UC faculty and undergraduate and graduate students and participants from the Northern California Council of Writing Program Administrators toured the reserve with reserve intern, Henry White.
- **Lake Yosemite-MVPGR Christmas Bird Count** (January 4, 2019)  
The 3<sup>rd</sup> annual Lake Yosemite-MVPGR Christmas Bird Count was held in early January, 2019. John Harris, Dale Swanberg, and Sal Salerno of the Stanislaus Audubon Society led the count. Seven people total participated and drove to the Le Grand canal spill-over area in the southeastern part of the reserve to the cliff swallow cliffs along Black Rascal Creek, stopping at various stock ponds along the way. The results from the CBC were sent to National Audubon Society and California Audubon as well as uploaded onto eBird.
- **Rangeland and Livestock Management 101 Workshop**  
Fadzayi Mashiri, UC Cooperative Extension (UCCE) Mariposa County Director and Livestock and Natural Resources Advisor for Mariposa and Merced Counties, organized a 2-day workshop at the UCCE Merced County office and the MVPGR. Participants learned various topics on rangeland and livestock management (e.g., drought management, weed management, ecosystem services, soil ecology and health) from UCCE rangeland specialists. Participants started the day listening to lectures at the UCCE Merced County office, and then came to the reserve in the afternoons for educational tours and field demonstrations (e.g., plant identification, grassland monitoring techniques, soil health). Workshop presentation material can be found on the UCCE Mariposa County website ([http://cemariposa.ucanr.edu/Livestock\\_and\\_Natural\\_Resource\\_Management/2019\\_Rangeland\\_and\\_Livestock\\_Management\\_101\\_5\\_1\\_19/](http://cemariposa.ucanr.edu/Livestock_and_Natural_Resource_Management/2019_Rangeland_and_Livestock_Management_101_5_1_19/)).
- **CALeDNA Community Science BioBlitz** (January 26, 2019)  
Thirty-six people, including UC Merced graduates and undergraduates, regional K12 educators, California State University undergraduates, and members of the public, participated in the 5<sup>th</sup> CALeDNA community science bioblitz. For the first time, the BioBlitz was held in January and the pools were full of water. Participants were able to see fairy shrimp and the pools bursting with aquatic

macroinvertebrate life. Samples from previous bioblitzes (spring 2017 and 2018) have been extracted, amplified, and sequenced and are being analyzed. For a list of species identified thus far via genetic analysis, please visit the CALeDNA website (<https://data.ucedna.com/>).

- **CALeDNA Community Science BioBlitz** (April 1, 2019)  
For our 6<sup>th</sup> CALeDNA bioblitz, we partnered with Ryan Hollister, Science Coach for the Turlock High School District. Ryan and his family attended the last bioblitz and loved it so much that he wanted to bring high school students out to participate in our next bioblitz. In coordination with Monique Kolster and the CALeDNA team (Professor Jason Sexton, UCM postdoctoral researcher Dannise Ruiz Ramos, and Executive Director of the UC Conservation Genomics Consortium Rachel Meyer), Ryan brought out 120 high school students from Turlock and John H. Pitman High Schools. The students were accompanied by teachers, Laura Hollister (John H. Pitman HS), Ryan Testo (Turlock HS), Brian Hofsteen (John H. Pitman HS), as well as MVPGR student naturalists. The high school students were broken up into small groups to sample different vernal pools on the reserve.



**Figure:** Sixth annual CALeDNA Community Science Bioblitz volunteers.  
Photos by Ryan Hollister, Science Coach for the Turlock High School District.

- **Environmental Phenomenon Design Team Region 7 – Curriculum Developing Workshop** (April 12, 2019)

As part of an Environmental Literacy Initiative funded through the California Department of Education, Merced County Office of Education was selected to create an Environmental Design Team at UC Merced for the purpose of advancing scientific literacy through relevant instructional phenomenon. Multiple California Regional Environmental Education Community (CREEC) Regions will be hosting Phenomena Summits through June 20, 2020. The Summit is a two-day event that brings classroom teachers, non-formal educators, out-of-school educators, and scientists together to identify environmentally-focused regional phenomenon; highlight resources for building understanding of the phenomenon; and identify grade-level appropriate student science activities. Rosanna Ayers, Science/STEM Coordinator with Merced County Office of Education in coordination with Carrie Kouadio, Executive Director of the UCM NSF-CREST Center for Cellular and Biomolecular Machines, and Monique Kolster organized the Environmental Phenomena Design Team summit at UCM. Local K-12 teachers and vernal pool scientists (Francesca Cannizzo, Jorge Montiel Molina, and Daniel Toews) participated in the event. From the summit, K-12 vernal pool phenomenon curriculum was developed and will be available on the San Diego County Office of Education NGSS Resource Site at <https://ngss.sdcoe.net>. This was an incredible opportunity to highlight and increase awareness of the ecology and natural history of vernal pools and the Central Valley throughout the state.

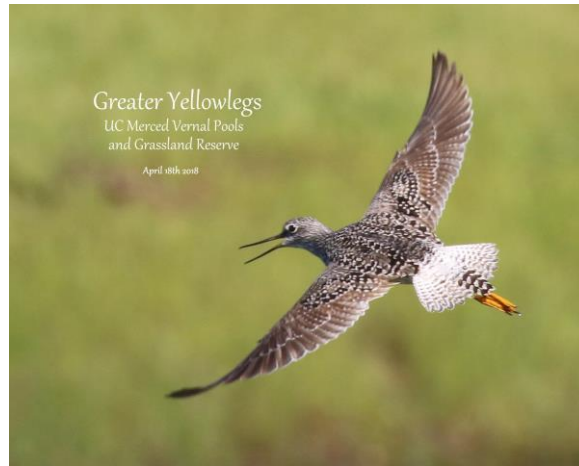
#### **Adult Programs:**

- **UC California Naturalist Certification Program** (Spring 2018)

The MVPGR in partnership with the Merced County UC Cooperative Extension and Upper Merced River Watershed Council sponsored the UC California Naturalist Certification Training at UC Merced. Monique Kolster and Sarah Abboud (UCM Lecturer) presented the course. This 10-week training combined science instruction with guest speakers, field trips, and project-based learning to explore the unique ecology and natural history of the San Joaquin Valley and central Sierra Nevada foothills region. Course instructors were UC Merced faculty and other regional experts. Students in the California Naturalist Program become part of a committed corps of volunteer naturalists and citizen scientists, equipped with the skills needed to take an active role in local natural resource conservation, restoration, and environmental education. Upon completion of the course, students received the UC California Naturalist's certificate. Thanks to a generous contribution by the Upper Merced River Watershed Council, we were able to offer partial scholarships to eleven students. Twenty-six students completed the training.







**Figure:** As part of his CalNat capstone project, Richard Brown photographed birds on the reserve for the MVPGR website and species list records.

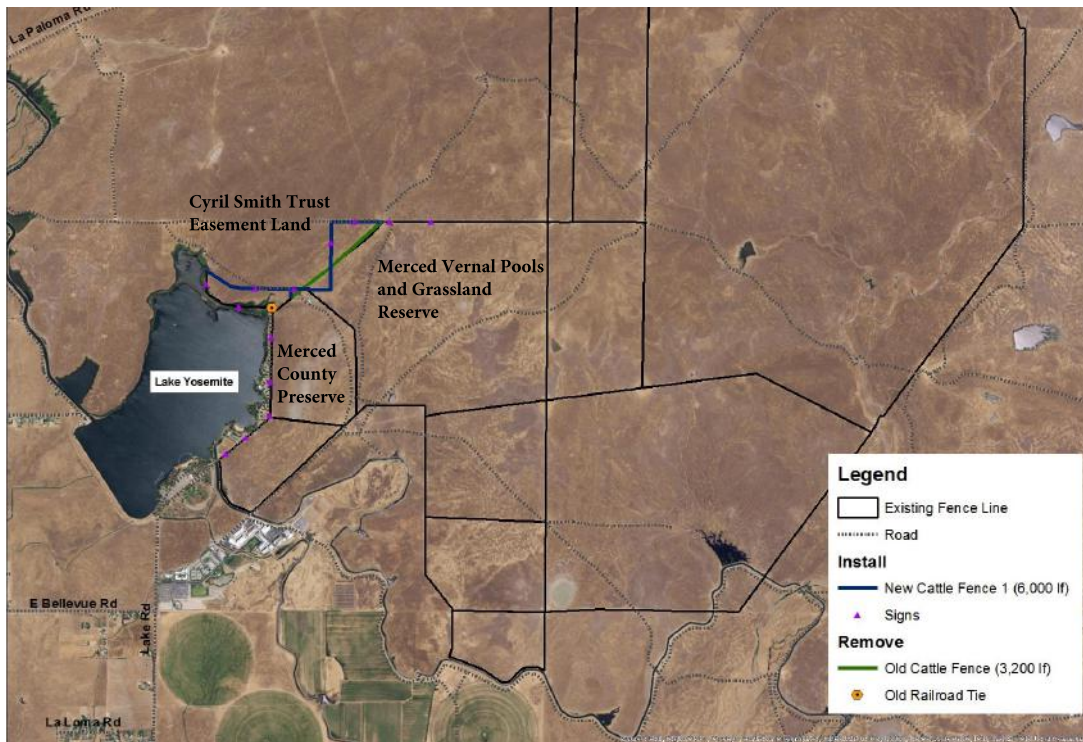
## **Stewardship and Other Activities**

### **Gates Replaced**

Two old barbwire gates were replaced with heavy duty galvanized gates along La Paloma Road. The gates were purchased by the Reserve and installed by the Fagundes on January 24, 2018.

### **Reserve Border Realignment and Fence Installation**

In spring 2018, the Physical and Environmental Planning Department at UC Merced contracted Ranch Fence, Inc to install new fence lines between UCM lands (MVPGR and Merced County Preserve) and neighboring Cyril Smith Trust (CST) land. For the Reserve portion of the project, the boundary fence between the MVPGR and neighboring CST land was adjusted to align with appropriate property lines. New five-stranded barbed wire fences (3,290 linear feet) were installed along the correct property boundary line, and the old fence (3,200 linear feet) was removed. Approximately 190 acres of UC Merced property, which once was within Cyril Smith Trust lands and accounted as Reserve lands, is now contained within the reserve boundaries.



**Figure:** A) New boundary fences between the Merced Vernal Pools and Grassland reserve and Cyril Smith Trust (CST) lands and between Merced County Preserve and CST lands (blue line). Old boundary fence between MVPGR and CST removed (green line). B) New 5-stranded barbed wire fence along the MVPGR/CST boundary.



**Mitigation and Monitoring**

Monique Kolster and Francesca Cannizzo work closely to ensure compliance and effective monitoring of requirements set forth in the 2008 Reserve Management Plan for the MVPGR. Monitoring includes conducting surveys of threatened and endangered species (large branchiopods, California tiger salamander, San Joaquin kit fox, and listed plant species) and conducting residual dry matter surveys for grazing compliance. Additionally, invasive plant species monitoring and eradication measures are carried out.

- Annual Compliance and Effectiveness Monitoring Reports**  
 The Annual Compliance and Environmental Monitoring Reports, as required by the 2008 Reserve Management Plan, were completed in 2017 by Phil Woods, Francesca Cannizzo, Monique Kolster, and LSA Associates, Inc and in 2018 by Phil Woods, Francesca Cannizzo, Monique Kolster, and LSA Associates Greg

Gallaugher, John Kunna, David Muth, Kristin Nurmela, and Bernhard Warzecha. These reports summarize activities related to various federal and state management and monitoring requirements, including all the surveys mentioned above (listed plant and animal species surveys, grazing compliance, and invasive plant monitoring). The reports were sent to the Environmental Protection Agency, the U.S. Army Corp of Engineers, Central Valley Regional Water Quality Control Board, U.S. Fish and Wildlife Service, and the California Department of Fish and Wildlife.

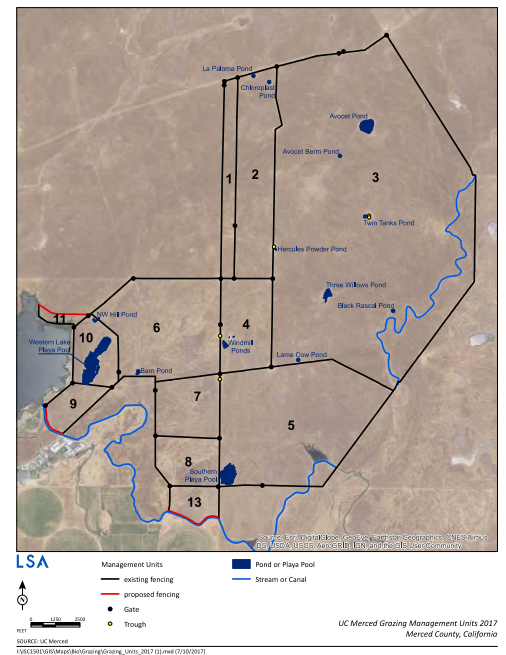


**Figure:** Colusa grass (*Neostapfia colusana*). Photo by Francesca Cannizzo.

### Livestock Grazing and Monitoring Surveys

The grazing license was renewed with the Fagundes, Fagundes, Fagundes until October 31, 2022. The license was partially rewritten to include language about the mission of the MVPGR and to be more specific about conservation mandates, regulations, and objectives. Additionally, the “auto-renewal” component of the license was removed. The contract will be subject to an open bid process upon termination.

Additionally, fiscal year 2019 marks a major shift in grazing on the reserve. For the first time since the Reserve’s inception, beef cattle are grazing on the reserve. In order to facilitate this shift with our current licensee, the Fagundes Fagundes Fagundes will be slowing building up their beef herd over the years. In the 2018-2019 growing season, beef cattle (Angus cow calf pairs) were placed on grazing units 5, 7, 8, and 13,



while dairy heifers were placed on the remaining portions of the reserve. There was a marked visual difference in how the beef and dairy cattle behaved, with beef cattle spreading out more and the dairy cattle grazing in bunches (Kolster and Cannizzo observations).

- **Livestock Monitoring Surveys**

Livestock grazing use was monitored September 19-22, 2017 by Francesca Cannizzo, Monique Kolster, LSA Associates Bernhard Warzecha and Sheryl Creer and on September 24-26, 2018 by Francesca Cannizzo, Monique Kolster, and LSA Associate Bernhard Warzecha to determine if the objectives of the Grazing Management Plan (GMP) have been met. Residual dry matter, vegetation height, and photo points were used to indicate grazing pressure. Residual dry matter (RDM) level, or the amount of dry vegetation after the grazing season (e.g., standing grass, mulch/plant litter, and thatch), is one of the most relevant indicators of grazing intensity, and on the Reserve, target mean RDMs are 800 pounds per acre (lb/ac). The average RDM estimate across the reserve for 2017 measured approximately 2,000 lb/ac and for 2018 measured approximately 3,000 lb/ac. These values were up from 1,500 lb/ac in 2015 and up from 990 lbs/ac in 2015. Generally, “forage areas substantially exceeded the established objective of not-less-than 800 lbs/ac RDM, and the targeted vegetation height of 2 to 12 inches, for at least four consecutive seasons.... The high RDM values experienced over the last three to four seasons resulted from a combination of low stocking rates based on early season unfavorable conditions for forage production associated with ongoing drought conditions in this region, combined with late spring rains that promoted significant grass growth at the end of the grazing season” (Warzecha, 2018 Grazing Compliance Report for the Tier 1a Conservation Lands). Additionally, due to the timing of dairy cattle operations, substantial numbers of cattle had already been removed when late spring rains occurred. **We hope to increase grazing efforts on grazing units that show excessive RDM and grass heights, particularly in units with a high density of vernal pools and swales, and to increase the number of cattle that initially graze on the reserve in fall to eat back the excess grass biomass.**

- **Rangeland Watershed Initiative**

Point Blue’s Conservation Science Rangeland Watershed Initiative (RWI) was established to enhance ecological function and landscape productivity across California’s rangelands. As part of RWI, the MVPGR is collaborating with the Natural Resources Conservation Service (NRCS), Point Blue Conservation Science, and our ranchers to implement prescribed grazing and management practices that benefit soil, water, air, plants and animals on the MVPGR. During fall 2017, Dennis Dudley (NRCS Rangeland Conservationist), Mike Fagundes (MVPGR Rancher), Francesca Cannizzo, and Monique Kolster toured the reserve and developed a grazing prescription plan that meets our mitigation requirements, is compatible with MVPGR research and educational uses, and incorporates the biological needs of sensitive species (e.g., Colusa grass).

- **Residual Dry Matter Surveys with the Ranchers**

On October 9, 2018, Francesca Cannizzo, UCM Campus Biologist, and Monique Kolster met with our grazing licensees, Ralph and Mike Fagundes of Fagundes, Fagundes, Fagundes to discuss the grazing operation and results of the 2018 Grazing Compliance Report. We drove around the reserve to discuss grazing goals and stocking rates for the upcoming year and demonstrated how grazing monitoring techniques are conducted (RDM surveys, plant height, photo points).

**Tricolored Blackbird Monitoring**

From early January to late June, 2019, Doug Krajnovich, volunteer with the Stanislaus Audubon Society, conducted weekly Tricolored Blackbirds (TCB's) surveys at the boundary of the Reserve and Lake Yosemite County Park, to observe and record possible TCB nesting sites. Tricolored blackbirds were detected only once (March 28, 2019), in modest numbers, and as part of a mixed flock in Lake Yosemite County Park. Doug noted no evidence of large TCB flocks visiting or nesting in this area. Red-winged blackbirds (RWB's) were detected every week. Their numbers were low in January and gradually increased during spring to become the most abundant songbirds in the Lake Yosemite County Park. Red-winged blackbirds were seen breeding in three areas, including the northeast portion of Yosemite Lake, which borders the Reserve.



**Figure:** Map of the tricolored blackbird monitoring sites (left). Tricolored blackbirds sighting at Lake Yosemite County Park, just outside the Merced Vernal Pools and Grassland Reserve (right). Map and photo by Douglas Krajnovich.

**Non-Native Plant Eradication**

Non-native plant control and eradication efforts for FY 2018 and FY 2019 continued to focus on removing milk thistle (*Silybum marianum*) and yellow star thistle (*Centaurea solstitialis*) in heavily infested areas identified in the 2017 and 2018 Invasive Plant Control Reports. Milk thistle plants, prior to the flowering bud stage, were dug up and left as compost on site. If flowering, the flowering buds or flower were clipped, bagged, and removed offsite. Yellow star thistle plants were dug up and removed. Thousands of milk thistle plants were removed in both years from throughout the reserve, in particular at stock ponds (e.g., Avocet Pond, Lame Cow Pond), along Black Rascal Creek, and along Le Grand Canal. Two new milk thistle infestation sites were recorded, and plants were removed in these locations. Control measures continue to reduce milk thistle populations at various locations (Lame Cow pond area); however, at some sites, milk thistle populations increased, probably due to the favorable growing conditions with the

winter and spring rains. Hundreds of yellow star thistle were removed from the reserve in fiscal year 2018. Weed control measures will continue next year to detect new infestations and to continue reducing existing weed infestations.

- **Greater Valley Conservation Corp: New Partnership!**

For the FY 2019, the MVPGR and UCM Department of Environmental and Physical Planning partnered with the Greater Valley Conservation Corp to help with non-native plant eradication measures on the reserve. GVCC, operated by the San Joaquin County Office of Education, provides 18 to 25 year olds with academic instruction, job training, and employment in fields of recycling and natural resources. Crews joined Monique Kolster and Francesca Cannizzo at various site (e.g., Avocet Pond, Black Rascal Creek, Le Grande Canal) to primarily pull milk thistle. Thousands of plants were pulled, and crews were instrumental in helping remove and control the species at these sites.

## **Personnel, Student Volunteers, and Donations**

### **Reserve Interns**

Reserve interns, UCM undergraduate students Michael Spaeth and Henry White, have been instrumental in helping with research activities, educational programs, and stewardship activities (e.g., invasive plant management, endangered species monitoring) on the reserve. Michael Spaeth (dates of employment: May 2016-December 2017) was involved in research studying vernal pool plant diversity as well as research examining kestrel nesting dynamics. After completing a student exchange program to Costa Rica in spring 2018, he graduated from UCM with his Biological Sciences degree with an emphasis in Ecology and Evolutionary Biology. He currently works as a Volunteer Stewardship Coordinator and Biological Technician for Point Reyes National Seashore. Henry White (dates of employment: January 2018- present) completed the Reserve Naturalist Training and has been very involved in education and outreach programs and leading public hikes on the reserve. At UCM, he is studying computer science and engineering.

### **Student Success Interns**

For the last two years, Monique Kolster has successfully submitted two UCM Student Success Intern (SSI) proposals (award: \$4,000/each) with Brandon Stark, one proposal with Professor Jason Sexton, and one proposal with Professor Jason Sexton and Molly Stephens. The interns worked on drone mapping of invasive plant species (2017-18, 2018-19), developing a campus herbarium (2017-18), and research focused on using environmental DNA (eDNA) to conserve vernal pool species, respectively. All SSI interns presented posters of their research at the annual spring SSI Symposium at UCM.

- **Arturo Ramirez Reyes (November 2017-April 2018)**  
**Joshua Jenson (November 2018-April 2019)**

Arturo Ramirez Reyes, a computer science and engineering undergraduate student, and Joshua Jensen, a mechanical engineering undergraduate student, have been investigating how unmanned aircraft systems (UAS), or drones, could be utilized on the reserve to locate and map weed infestations. During fiscal year 2018 and 2019, student research focused on: (1) collecting imagery of milk thistle populations along Black Rascal Creek (2018) and in other locations across the reserve (2019), (2) transferring data collected during drone flights to the computer mapping program ArcGIS Pro, and (3) utilizing spatial pattern recognition algorithms to detect milk thistle. Activities for the project will help contribute to invasive plant species and rangeland management.

## DRONE DETECTION OF INVASIVE SPECIES

Arturo Ramirez-Reyes

### INTRODUCTION

The importance of this project is to use a drone to detect an invasive plant species, milk thistle (*Silybum marianum*), in the Merced Vernal Pools and Grassland Reserve (MVPGR). Milk thistle is a threat to the vernal pool and grassland ecosystem. Therefore, we are trying to understand potential environmental factors that may contribute to the plant's growth. With information that we gather, we will be able to find potential weed hotspots throughout the Reserve to help with early weed eradication.



Research Site on Black Rascal Creek, Merced Vernal Pools and Grassland Reserve

### What is milk thistle?

- Listed as a targeted invasive species in the MVPGR IPM Plan
- Outcompetes native plants
- Threatens sensitive vernal pool species habitat
- Spreads quickly

### Control of milk thistle:

- Controlled by manually finding and removing it
- Drones may assist in speeding up the manual process of finding it

### DJI Phantom 4 Drone Platform

- It is cheap
- It is easy to use
- Obtains very detailed imagery
- Captures video footage and images
- Able to assist with the educational mission of the reserve

A DJI Phantom 4 was used for this project and flown autonomously using an app called Pix4Dcapture. This app tells the drone to fly in a grid pattern automatically without the pilot controlling it.

### DERIVED DATA

For precise measurements for model reconstruction and counting plants, we used a RTK GPS. Then we analyzed the georeferenced data with Agisoft Photoscan and ArcGIS Pro. We found various factors that may contribute to the plant's growth. Some of these factors include slope, slope direction, and hillshade. We created enough derived data to begin understanding and finding certain patterns of the plant's growth.

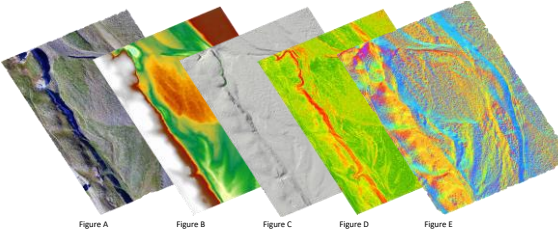
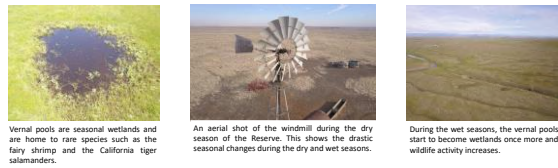


Figure	Name of Layer	What it is used for?	Flight Mission	# of Plants Measured	Average Height (cm)	Average Width (cm)	Average Length (cm)
Figure A	Orthomosaic	3D model of images that overlapped with one another	02/02/2018	75	4.057	3.304	10.846
Figure B	Digital Elevation Model	3D representation of a terrain's surface	02/16/2018	111	5.211	5.916	17.004
Figure C	Hillshade	Simulation of sunlight that creates shadows on the terrain's surface	03/09/2018	100	7.105	7.032	20.4275
Figure D	Slope	Identifies the steepness from each cell of a raster	03/29/2018	87	12.478	8.866	29.176
Figure E	Aspect	Identifies the slope direction of each location					

### MEDIA

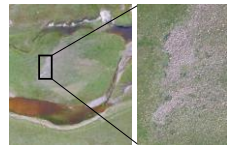
Assisted the reserve with their educational mission by engaging the local community with drone footages and pictures on the platforms of YouTube and Facebook. For example, sharing iconic features of the reserves such as the vernal pools, mima mounds, and the seasonal changes of the Reserve to the community.



Vernal pools are seasonal wetlands and are home to rare species such as the fairy shrimp and the California tiger salamanders. An aerial shot of the windmill during the dry season of the Reserve. This shows the drastic seasonal changes during the dry and wet seasons. During the wet seasons, the vernal pools start to become wetlands since more and wildlife activity increases.

### CONCLUSION

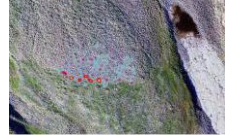
We created highly detailed distribution maps of milk thistle that can be used to detect specific plants at our research site over time. Additionally, we collected drone footages and pictures that contributed to the educational mission of the reserve.



An orthomosaic of the research site. The area is surrounded by small bodies of water that may contribute to the growth of milk thistle in the area. Close up of the research site with 1.17 cm resolution per pixel. The milk thistle can be easily distinguish from its surroundings.

### FUTURE DIRECTION

Having all the data processed, we can then begin to analyze and add new derived data. Eventually, we will be able to detect potential weed hotspots of milk thistle to more efficiently eradicate and prevent these plants from spreading throughout the reserve.



A heat map of the milk thistle at the research site. Machine Learning can be used here to detect other milk thistles in the area that has not been measured. This will assist in finding further weed hotspots in the area.

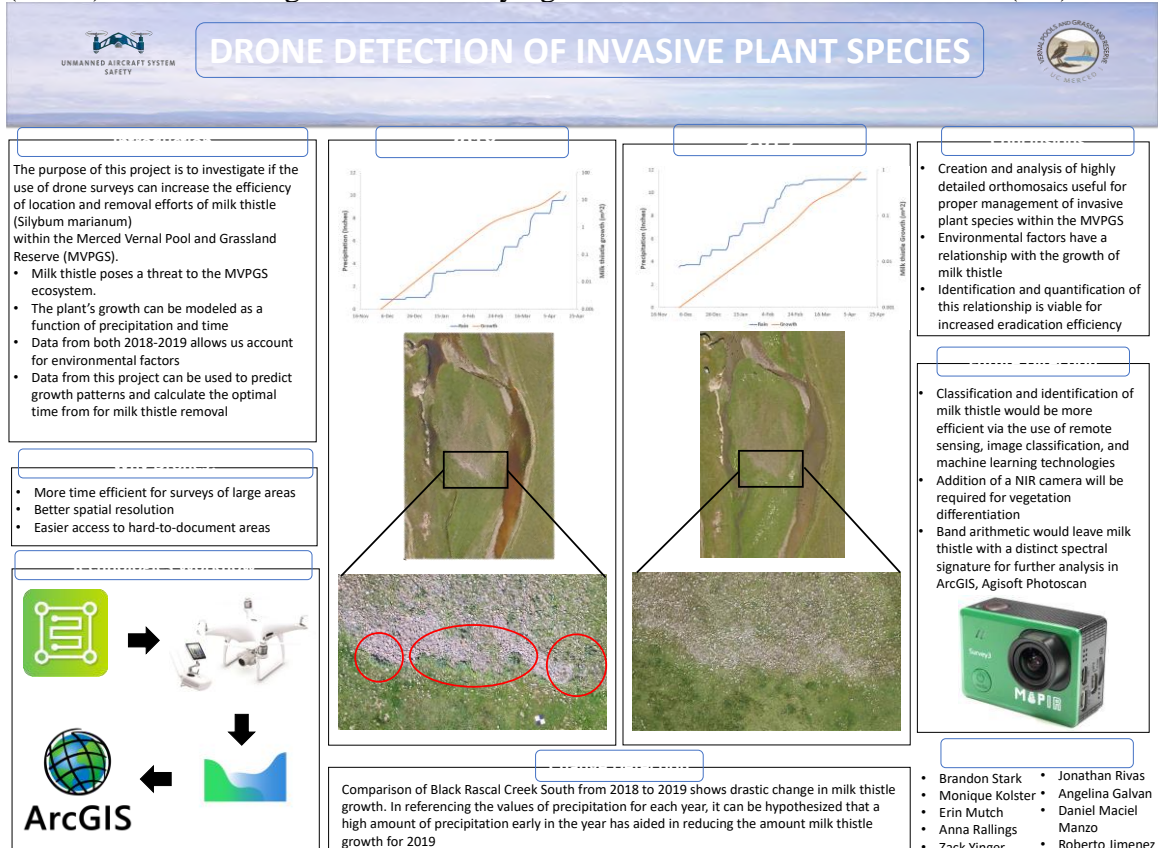
### ACKNOWLEDGEMENTS

- Monique Kolster
- Brandon Stark
- Daniel Leung
- Samuel Araya
- Christine Beckenridge
- Judith Mendoza
- Joshua Viers
- Erin Mutzch
- Anna Rollings
- Jonathan Rivas
- Zack Yinger
- Student Success Internship Program





**Figure:** Arturo Ramirez Reyes' poster for the SSI Symposium (April 25, 2018) at UCM (above). Arturo taking a break from flying the UAS near Black Rascal Creek (left).



**Figure:** Joshua Jensen's poster for the SSI Symposium (April 24, 2019) at UCM.

- Teanna Herrera (November 2017-April 2018)**  
 Teanna Herrera, an environmental engineering undergraduate student, helped build herbarium collections by collecting plants in the Reserve. She also organized existing specimens, mounted previously dried specimens, and updated database records.
- Gilma Sevilla Alvarez (November 2018-April 2019)**  
 Gilma Sevilla Alvarez, ?? undergraduate student, was part of a research project focusing on developing and applying metabarcoding techniques for endangered species and community monitoring in order to uncover the role of soil seed banks in plant community diversity. She assisted with DNA extractions, PCR, and sequencing. She also organized genetic tissues and databases as well as collected whole plant specimens for the herbarium.

## References

- **Kolster, Monique. Personal email communication with Audubon Society members and CDFW..... (ground squirrels).**

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It was been a wonderful couple of years of people visiting the reserve. While I can write something special about every visitor, I wanted to take a little space to thank our UC Merced Executive Leadership, UC Merced Foundation Board of Trustees, Merced Vernal

Pools and Grassland Reserve supporters, and one of our partners, the California Naturalist Leadership Team. Their time, interest, and support in the reserve and reserve programs has been invaluable.

**Wildflower and Photography Tours with Chancellor Leland:** Being an avid plant photography and reserve supporter, Chancellor Dorothy Leland joined Monique Kolster (March 27, 2019) and UCM PhD student Jackie Shay (April 18, 2019) for spring tours of the reserve to see and photograph wildflowers and reserve landscapes. Chancellor Leland was taken to various areas on the reserve, including the cliffs along Black Rascal Creek. During the tours, we stopped often to take pictures, enjoy the gorgeous wildflower bloom, and talk about reserve happenings.

**Tour with Vice Chancellor Sam Traina:** On March 28, 2019, Sam Traina, Vice Chancellor of Research and Economic Development, joined Monique Kolster to see various research and monitoring sites around the reserve. Along the way, we saw and discussed the old burn area along the Le Grand Canal, non-native plant eradication sites, and research projects and sites. After a bit a searching, we found the exposed old soils next to Black Rascal Creek!

Figure...VC Sam Traina appreciating the age and beauty of soils and the beautiful vernal pool wildflower displays.

**UC Merced Dean Betsy Dumont:** On February 16, 2019, Reserve intern and UCM undergraduate, Henry White, gave a tour of the reserve to new Dean of Natural Sciences, Betsy Dumont, and her husband, Sean Werle. Driving past Professor Dan Edward's lizard project and to the Swallow Cliffs at Black Rascal Creek, Henry introduced Dean Dumont to the reserve, research projects, and all the surveys (threatened and endangered species surveys, grazing compliance surveys) conducted on the reserve. Being a chiropterologist (bat biologist), Dean Dumont was very interested in potentially conducting bat surveys for the reserve in the future as well as returning to the reserve for more tours through the seasons.

**UC Merced Vice Provost and Graduate Dean Majorie Zatz:** On October 4, 2019, Monique Kolster took VP and Graduate Dean Majorie Zatz on an excursion out to the reserve and discussed the reserve and current graduate student research projects and involvement on the reserve. Future graduate student opportunities on the reserve also were considered.

**UC Merced Vice Chancellor Mike McLeod and Director of Physical and Environmental Planning Phil Woods:** Campus Biologist, Francesca Cannizzo (Nov 6, 2017) led VC Mike McLeod and Phil Woods on a tour of the reserve and the barn site, focusing on facilities (e.g., fences, gates) and maintenance.

**UC Merced Foundation Board of Trustees Denise Walker (Chair) and Joan Snyder (Trustee) and UC Merced Assistant Vice Chancellor of Development Lisa Pollard**

As part of the UC Merced Ma Kelley Golf Tournament and Shakespeare in the Yosemite National Park weekend events, Monique Kolster and UCM Assistant VC Lisa Pollard hosted a tour of the Merced Vernal Pools and Grassland Reserve (April 26, 2019) for the chair of the UC Merced Foundation Board, Denise Watkins, and UC Merced Foundation Trustee, Joan Snyder. The tour emphasized all the research, education, and public outreach happening on the reserve as well as the plans to construct a biological field station at the barn site. It was a wonderful afternoon and very exciting to host our UCM Foundation Board of Trustees.

**Tours with Reserve Supporters:** Along with UCM Executive Leadership and UCM Foundation Board, we had a number of tours in FY 2019 for our Tour the Reserve and discuss the Reserve facility, research, and educational outreach efforts. To tour the reserve, discuss the potential reserve facility, and research and educational outreach efforts.

**Dec 14, 2018: Jim Cunningham (Cunningham Ranch), Grey Roberts (UC Merced Board of Trustees Member & Grey B. Roberts & Company) & Sarah Lim (Museum Directors, Merced County Historical Society)**

**February 12, 2019: Tour with Josephine Fox with Owner of Fox Head Inc., Dean Betsy Dumont, Jeff Porto**

**April 10, 2019: Betsy, Hannah, [Tour the reserve with Betsy Dumont \(Dean of Natural Sciences\), Hannah Ewing \(Development Officer in the School of Natural Sciences\), and Clara Barnes \(Interim Executive Director of Major and Institutional Giving\).](#)**

These tour emphasized all the research, education, and public outreach happening on the reserve as well as the plans to construct a biological field station at the barn site. It was a wonderful afternoon and very exciting to host our UCM Foundation Board of Trustees.

- ]GPS surveys were conducted to collect pond boundaries during different times of the year. RTK surveys were conducted to validate digital elevation models and get high precision measurements of diversion infrastructure at Avocet pond
- Soil moisture transects were established at Avocet pond in cooperation with Sam Araya. Multispectral imagery was collected during the 2018 Water Year green up and brown down in order for Sam to develop a machine learning algorithm to correlate soil moisture with pixel values.

- Media flights were conducted using quadcopter UAVs to observe site differences in different vegetative hydrologic conditions (ex: flown after large March storm event to quantify artificial ponding along diversion infrastructure.]]

Research:

Jason Sexton, Molly Stephens, and Daniel Toews

Genetic Investigation of Listed Vernal Pool Plants and their Communities in Eastern Merced County,”

For the past few years, Professor **Jason Sexton** (UCM), research scientist **Molly Stephens** (UCM), and doctoral student **Daniel Toews** (UCM) have been collecting habitat data, conducting vegetation surveys, and taking samples (e.g., soil samples, plant samples) in vernal pools. They are assessing vernal pools, vernal pool plant diversity, and .....

Environmental DNA of vernal pools

Dannise V. Ruiz-Ramos, Emily Curd, Rachel Meyer, Teia Schweizer, Molly Stephens, Daniel Toews, Michael Dawson, Jason Sexton

The goals of the project are to 1) Estimate biodiversity of vernal pools and investigate changes in biodiversity with seasons and pool zonation, and 2) evaluate the use of eDNA to detect rare species. Samples from 5 pools at the UC Merced Vernal Pool and Grassland Reserve were collected during spring, summer, and fall of 2017 and winter and spring of 2018 and 2019. We also collected soil samples from 15 pools at intermediate timepoints during August and September of 2017. Samples from spring 2017 and 2018 were extracted, amplified and sequenced and are being analyzed.

Colusa grass genome

Dannise V. Ruiz-Ramos, Daniel Toews, Molly Stephens, Rachel Meyer, Michael Dawson, Jason Sexton.

The goals of the project are to 1) Generate a reference genome for population genetic studies of California endangered grass *Neostaphia colusana*. 2) Understanding genomic basis of adaptation to extreme environment and 3) marker development. 4) Evaluate the utility of 10X and Bionano protocols for low-cost high-quality genome sequencing of non-model organisms. High molecular weight DNA was extracted from two plants collected at the UC Merced Vernal Pools and Grasslands Reserve. 10X DNA preparation, Illumina sequencing, and assembly was completed. One-third of the genome was obtained with this sequencing. Preliminary annotation completed.

Fiscal Year 2017-18

- UC Merced Tour Guides Tour (30 people) -August 17, 2017

- Tour with Derek Daley, Risk Manager of the Merced Union High School District- February 20, 2018
- UC Merced Research Week Tours (25 people)- March 8, 2018
- Tour with Miguel Vega, UCM Senior Video Producer- March 28, 2019
- Yosemite Area Audubon Society (18 people)- April 14, 2018
- UC Merced Bobcat Day Tours (26 people)- April 21, 2018
- Atwater Girl Scouts Hike (16 people)- April 22, 2018
- Tour with Dina Robertson, Rangeland Ecologist with AECOM- April 25, 2018
- Merced College PreMed Club Hike (15 people)- May 4, 2018
- UC Merced Staff Appreciation Tours (28 people)- May 15 & 18, 2018

#### Fiscal Year 2018-19

- Sierra Foothill Conservancy Tour (7 people)- August 30, 2019
- Tour with Todd Knittel, UCM Procure-to-Pay Service Manager – December 6, 2018
- UC San Francisco Librarians Tour (10 people)- February 1, 2019
- UC Merced Graduate Visitation Weekend Tours (58 people)- February 23, 2019
- UC Merced Research Week Tours (5 people due to rainy weather)- March 4, 2019
- Tour with Dianne Shew, SCICON Administrator- March 6, 2019
- UC Merced Success Mentor Program Tour (6 people)- March 12, 2019
- Tour with Blythe Nobleman, UCM Senior Public Information Officer, and Veronika Androver, UCM Photographer- March 20, 2019
- Merced College PreMed Club Hike (15 people)- March 29, 2019
- Atwater Girl Scouts Hike (11 people)- April 7, 2019
- Central Sierra Audubon Society (10 people)- April 11, 2019
- UC Merced Bobcat Day Tours (4 people)- April 13, 2019
- Valley Land Alliance Annual Meeting Field Trip (16 people)- April 14, 2019
- Merced Camera Club Photography Tour (3 people)- April 29, 2019
- UC Merced Staff Appreciation Tours (15 people)- May 21 & 23, 2019
- UC Merced Housing Professional Staff Tour (9 people)- June 14, 2019

#### Grazing

The high RDM values and vegetation heights in both years may be attributed to low stocking rates, inadequate distribution of cattle, and late-season rain. In both 2017 and 2018, late season rain initiated grass growth, at a time when a substantial number of cattle had already been removed. However, with four consecutive years of high RDMs, thatch build-up was observed, particularly in the northern part of the reserve.

Thus far, the reserve's primary assessment of rangeland health has been through annual fall RDM surveys. In an effort to understand grazing practices at a more holistic ecosystem level, Merced Vernal Pools and Grassland Reserve is collaborating with the Natural Resources Conservation Service (NRCS), Point Blue Conservation Science, and our ranchers in an effort to improve soil, vegetation, and wildlife habitat on the California's rangelands. As part of the Rangeland Watershed Initiative (RWI), the

MVPGR is facilitating implementation of prescribed grazing and management practices to increase soil water retention in foothill/Central Valley watersheds, improve soil health, improve abundance and diversity of plant functional groups, enhance ranch productivity, improve habitat for wildlife, and provide proactive adaptation to climate change.

We are measuring an array of soils attributes, including infiltration, organic matter, and bulk density for both benchmark and planned grazing implementation. We are also taking vegetation measurements to document plant functional group demographics and invasive and noxious plant data and bird point counts and area searches to characterize ranch level avian changes that occur due to changes in management.

### CalNat Team

While visiting UC Merced for the UC Agriculture and Natural Resources Program Team Meeting and Workshop, Integrating Climate Change in California Cooperative Extension Programs, the

Using a combination of empirical data (pressure transducers, timelapse imagery, aerial LiDAR and imagery, and RTK GPS surveys) and 2D hydrodynamic modeling, her research focused on understanding how water moves throughout the reserve in order to evaluate potential hydrological restoration activities. After assessing a few different sites, Anna focused her analysis on the Avocet Pond area, an area which contains the largest stock pond on the reserve, feeder canals, and downslope vernal pool complexes. She assessed the feasibility of restoring or enhancing existing natural vernal pool complexes by altering the stock pond complex using HEC-RAS 2D hydrodynamic rain-on-grid modeling. Model simulations suggested that historic hydrologic flows can be restored through minimal terrain alteration in the feeder canals resulting in increased inundation to wetlands and other downstream natural habitats. Increased inundation would benefit native species whose life histories are integrally tied to finite and variable hydroperiods of ephemeral wetlands. This novel modeling approach provides the groundwork for greater understanding of the hydrology of unique landscapes and its restorative potential. The project was part of a California Fish and Wildlife grant to develop a restoration plan in order to increase the total amount of suitable habitat for listed and native vernal pool and grassland plant and wildlife species on the Merced Vernal Pools and Grassland Reserve. As part of the last phase of the grant, LSA Associates, Inc. will be developing a restoration plan based on Anna's research and analysis.

For her sabbatical project, **Professor Susan Gresens** (Towson University, Maryland) is constructing a molecular-genetic phylogeny for *species groups* within the chironomid Genus *Cricotopus* in the Northern hemisphere, in collaboration with Dr. Torbjørn Ekrem and Dr. Elisabeth Stur, of the Norwegian University of Science and Technology (NTNU). Chironomids (Diptera, "non-biting midges") are a diverse, species-rich family of aquatic insects, which are often the most numerically abundant group of insects in freshwater habitats (Ferrington 2008). Given the microhabitat preferences of particular chironomid

species and differences in their tolerance to various forms of pollution, they are widely used as indicators of water quality (Vallenduuk and Moller Pillot 2007, Gresens 2011). With considerable variation in phenotypic appearance, *Cricotopus* species are frustrating to both taxonomists and to those working in aquatic bioassessment (Epler 2001, Gresens, Stur and Ekrem 2012). This project uses mitochondrial DNA sequence data (“DNA barcoding”) to distinguish and identify species of *Cricotopus*. The growing interest in using “environmental DNA” for bioassessment of water quality requires a “library” of DNA sequence data for correctly identified aquatic organisms (Ekrem, Willassen and Stur 2007), and this project will make significant contributions to the Barcode of Life Database (Ratnasingham and Hebert 2007), a public repository of referenced sequences from vouchers specimens from all species of life. Since a significant number of North American *Cricotopus* species are restricted to the western US, she has visited several University of California Natural Reserve System reserves during her 2018-19 sabbatical. On the MVPGR, she collected chironomid larvae, pupae, and adult flies in several contrasting habitats (e.g., stock ponds, Black Rascal Creek) for DNA sequencing. Professor Gresens anticipates that the MVPGR will contain *Cricotopus* species/populations (and other chironomids) not previously barcoded. Taxonomic and genetic analysis are in progress.

Sampling survey of *Cricotopus* species: a hyperdiverse genus of non-biting midges



Dr. Susan Gresens, Towson University (3/24/19). Photo by Dr. Mark Wolfire, University of Maryland, College Park.

- **Wetland Hydrology and Plant Community Monitoring**

The Yosemite Lake Conservation Area (YLCA), located near the reserve to the northwest of Lake Yosemite, is intended to provide wetland and endangered species mitigation for the adjacent Yosemite Lake Estates Development and wetland mitigation for UC Merced. The Habitat Development Plan (HDP) for YLCA includes the restoration of vernal pool, swale, and vernal marsh habitat, and it requires monitoring of hydrology and plant cover of approximately 300 reference vernal pools within the UC Merced Natural Reserve Lands. Data gathered from MVPGR pools inform the extent to which the mitigation wetlands



at YLCA are meeting their mitigation performance criteria and provide information (vernal pool hydrology information, vernal pool plant species lists) for the MVPGR. Hydrologic parameters (ponding depth and ponding area over time) for Water Year 2017-2018 were measured manually and using UAV-based measurements (high resolution aerial imagery and infrared signal). Manual water level measurements provided better water data, since UAV measurements were not sufficiently reliable, primarily because of signal interference due to tall grass cover.

### **Yosemite Leadership Program Junior Naturalist Curriculum Development Capstone Project**

A team of Yosemite Leadership Program (YLP) students (Socorro Cardoso, Calista Lum, Mariela Arceo, Takezo Fishburn) worked with Mo Kolster, CalTeach Director Chelsea Arnold, YLP Director Jesse Chakrin, and McSwain Union Elementary School 5<sup>th</sup> Grade Teacher Leslie Reschenberg to develop an environmental lesson for Merced City School District 5<sup>th</sup>/6<sup>th</sup> grade students. The YLP students developed a hands-on, inquiry based junior naturalist lesson that met the new Next Generation Science Standards for K-12 science education and delivered the lesson to a local 5<sup>th</sup> grade class from McSwain Union Elementary School. Eighty-nine students and four teachers visited the reserve, where the YLP students broke the elementary students into four groups and delivered their lessons to the groups.

#### **Questions:**

- Year the barn was built
- Jessica Blois research: list of mammals identified; species found: **Perognathus parvo?**
- **Gilma Sevilla Alvarez, ?? undergraduate student → what does she study?**