Western Riverside County
Multiple Species Habitat Conservation Plan
Biological Monitoring Program

2019-2024 Clinton Keith
Survey Report

Photo credit https://www.wrc-rca.org/linkages-offer-connections-for-mshcp-species/

June 2025

Table of Contents

LIST OF FIGURES

LIST OF APPENDICES

NOTE TO READER:

This report is an account of survey activities conducted by the Biological Monitoring Program (BMP) for the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP). The MSHCP was permitted in June 2004. Reserve assembly is ongoing and is expected to take 20 or more years to complete. The Conservation Area includes lands acquired under the terms of the MSHCP and other lands that have conservation value (called Public/Quasi Public Lands in the MSHCP) within the boundary of the MSHCP (Plan Area). In this report, the term "Conservation Area" refers to these lands as understood by the BMP at the time the surveys were conducted.

The BMP monitors the status and distribution of the 146 species covered by the MSHCP within the Conservation Area to provide information to Permittees, land managers, the public, and the Wildlife Agencies [i.e., the California Department of Fish and Wildlife (CDFW, formerly California Department of Fish and Game) and the U.S. Fish and Wildlife Service]. BMP activities are guided by defined conservation objectives for each Covered Species, other information needs identified in MSHCP Section 5.3 or elsewhere in the document (Dudek & Associates 2003), and the information needs of the Permittees. A list of the lands where data collection activities were conducted in 2023 is included in Section 8.0 of the Western Riverside County Regional Conservation Authority (RCA) Annual Report to the Wildlife Agencies.

The primary authors of this report were the Mammal Taxa Lead, Jennifer Hoffman, and the 2019-2024 Quino Checkerspot Butterfly Survey Lead II, Esperanza Sandoval. This report should be cited as: Biological Monitoring Program. 2025. Western Riverside County MSHCP Biological Monitoring Program 2024 Clinton Keith Survey Report. Prepared for the Western Riverside County Multiple Species Habitat Conservation Plan. Riverside, CA. Available online: https://www.wrc-rca.org/species-surveys/.

While we have made every effort to accurately represent our data and results, it should be recognized that data management and analysis are ongoing activities. Any reader wishing to make further use of the information or data provided in this report should contact the BMP to ensure that they have access to the best available or most current data.

Please contact the BMP Administrator with questions about the information provided in this report. Questions about the MSHCP should be directed to the Executive Director of the RCA. Further information on the MSHCP and the RCA can be found at www.wrc-rca.org.

Contact Information:

Executive Director
RCA/Riverside County
Transportation Commission
4080 Lemon Street, 3rd Floor
Riverside, CA 92501
P.O. Box 12008
Riverside, CA 92502
Ph: (951) 787-7141

Biological Monitoring Program Administrator
Western Riverside County MSHCP
Biological Monitoring Program
1835 Chicago Ave., Suite C
Riverside, CA 92507
Ph: (951) 320-2168

INTRODUCTION

Wildlife crossing structures, which can take the shape of culverts, undercrossing and overcrossings, allow animals to navigate human-made obstacles such as roads and railroad tracks safely (Smith et al. 2015). Roads as barriers decrease movements for breeding, dispersal, and can be a direct cause of mortality in already strained wildlife populations (Ernest et al. 2003; Schwab and Zandbergen 2011). Specifically designed tunnels for newts in the United Kingdom and underpasses for elephants in Kenya are examples of how tailored wildlife crossing structures are to the variety of species they benefit (Matos et al. 2017; Okita-Ouma et al. 2021). A positive monetary benefit, for the presence of wildlife crossing structures, was found in Washington State where building costs of these structures were compared to costs of wildlife vehicle collisions (Sugiarto 2023). It is important to monitor wildlife crossing structures, to determine their efficacy for human safety, wildlife safety and use (Dajun et al. 2006; Ford et al. 2008; Kintsch et al. 2017).

In July 2019 the Biological Monitoring Program (BMP) with the Western Riverside County Multiple Species Habitat Conservation Plan (MSHCP) began a 5-yr monitoring effort on a newly constructed section of Clinton Keith Rd near Murrieta Ca (Figure 1). Construction, to widen and extend Clinton Keith Rd between State Route 79 (SR79) and Interstate 215, began in 2016 (RCTD 2015). Prior to the extension, Clinton Keith Rd between Whitewood Rd to the west and Trios Valley Rd to the east was either a dirt or a nonexistent road. Improvements included creating a new six-lane road with median, shoulders and sidewalks between SR79 and Antelope Rd and were completed in 2018 (County of Riverside Transportation Department 2024). This project created the first wildlife overcrossing in Southern California, as well as an adjacent wildlife friendly undercrossing, under a bridge over Warm Springs Creek (USFWS 2007).

The extension of Clinton Keith Rd is located in Proposed Core 2 (PC2), an area important for monitoring use by the federally endangered Quino Checkerspot Butterfly (USFWS 1997; Contech Engineered Solutions, LLC 2017; *Euphydryas editha quino*, Quino), as well as other MSHCP Covered Species (Dudek & Associates 2003). Proposed Core 2 connects to other portions of the Plan Area through multiple existing and proposed Constrained Linkages, identified in MSHCP, Volume I, Figure 3.2 of the document (Dudek & Associates 2003). Proposed Core 2 is a Core Area for Covered Species including, but not limited to, Quino, Long-tailed Weasel (*Mustela frenata*), and San Diego Black-tailed Jackrabbit (*Lepus californicus bennettii*). Proposed Core 2 is a habitat linkage for Coyote (*Canis latrans*) and is important for the movement of two felid MSHCP Covered Species, Mountain Lion (*Puma concolor*) and Bobcat (*Lynx rufus*).

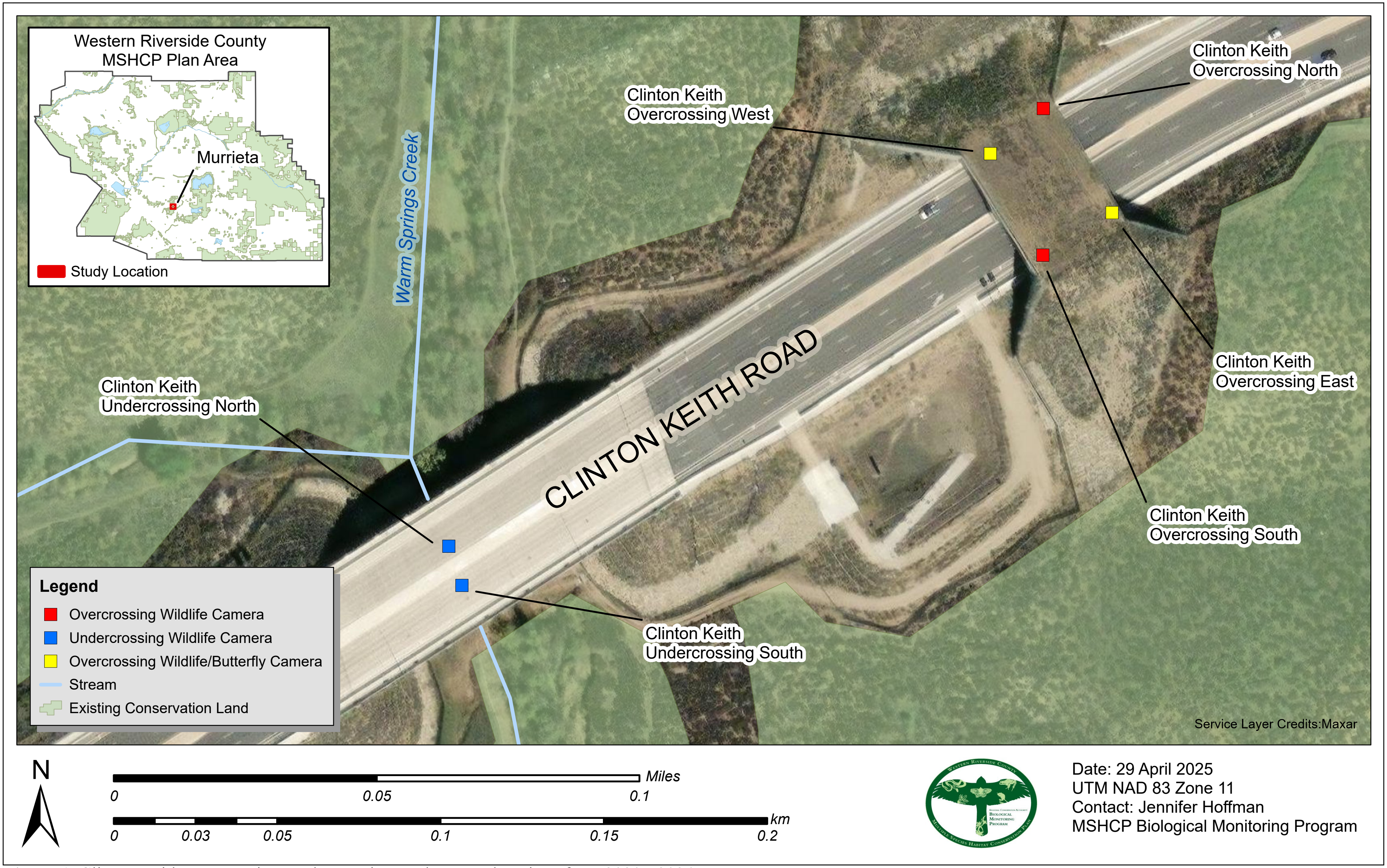

Figure 1. Clinton Keith overcrossing, undercrossing, and camera locations from 2020 - 2024.

We monitored the Clinton Keith Road extension overcrossing and undercrossing via motion-triggered cameras for wildlife use (2019-2024) and the overcrossing via motion-triggered cameras for Quino use (2021-2024). We monitored the overcrossing, undercrossing, and surrounding area for Quino larvae and adult and collected data on specific Quino habitat attributes (2020-2024). We also conducted a vegetation assessment on the overcrossing (2021).

Survey Goals

1. Document use of Clinton Keith overcrossing and undercrossing by wildlife
    a. Utilize infra-red motion triggered cameras to monitor wildlife use
2. Document use of Clinton Keith overcrossing by Quino
    a. Utilize infra-red motion triggered cameras to monitor Quino presence
    b. Conduct Quino surveys within 250 meter (m) × 250 m sampling stations
3. Vegetation survey
    a. Vegetation assessment survey in 2021

METHODS

Protocol Development

Camera Surveys

Camera stations are a passive, non-invasive, and effective means of documenting species presence (Trolliet et al. 2014; McElveen and Meyer 2020). They are particularly suited for biodiversity studies (Wearn and Glover-Kapfer 2019). Remote cameras allow for large areas to be surveyed continuously with a minimal investment of field staff while providing robust data (Dajun et al. 2006; Kays et al. 2009; Palmer et al. 2018). Our goal was to record any species capable of being detected with cameras, without the use of bait.

Quino Larvae and Adult Surveys

The BMP began developing a survey protocol in 2005 to determine the distribution of Quino (larvae and adult) across the Conservation Area. Survey goals included monitoring the locations with documented Quino populations and monitoring sites with historical Quino sightings and/or good potential for Quino occupancy. The collection of variables, such as temperature, wind speed, host plant distribution, and nectar plant presence during each survey aids our understanding of Quino environmental conditions and resource selection.

Vegetation Assessment

We conducted a vegetation assessment survey in March and April of 2021, on the Clinton Keith overcrossing. The goal of this assessment was to collect baseline data of this novel habitat, using line point transects and quadrat methods, for comparison with data collected in the future.

The survey protocols used for the above-mentioned survey efforts are described more completely in the *Western Riverside County MSHCP Biological Monitoring Program Protocol for Clinton Keith Surveys*, available from the BMP at https://www.wrc-rca.org/survey_protocols/.

Study Site Selection

All surveys took place on and around the Clinton Keith Rd extension located in an unincorporated area of southwestern Riverside County, bordering the city of Murrieta (Figure 1). The study site consisted of the overcrossing, undercrossing, and immediate surrounding areas, and is primarily composed of coastal sage scrub vegetation (Dudek & Associates 2003). Habitat at the overcrossing and undercrossing was novel following construction. Warm Springs Creek, a seasonal waterway, runs through the undercrossing.

We conducted this study within western Riverside Couty, California, from 1 August 2019 to 10 April 2024. The survey area, within the MSHCP, occurs in lowlands that have a Mediterranean climate. We used climate data collected from the Riverside Area station during calendar years 2019-2024, and monthly summarized data during this time indicated mean daily maximum and minimum temperatures of 26.6 degrees Celsius (°C) and 12.0 °C, respectively. Mean annual precipitation during the same time period was 24.8 cm (National Weather Service 2025).

Survey Methods

Camera Surveys

On 1 August 2019 we installed motion-triggered cameras on the Clinton Keith overcrossing and the undercrossing sections and serviced (i.e., batteries checked, SD card replaced, lens cleaned, etc.) every other week.

We permanently installed infra-red motion triggered cameras as wildlife use cameras at the overcrossing (Browning Spec Ops Advantage HD Trail Camera; n = 2) and at the undercrossing (Bushnell Trophy Cam HD; n = 2). Cameras were placed at the northeast and southwest corner of the overcrossing, and back-to-back on the west side of Warm Springs Creek at the undercrossing with the expectation to capture all wildlife activity. Our wildlife use cameras were programed to operate 24 hours a day and when triggered, they took a burst of three photos in one-second intervals followed by a five-minute delay. Time (Pacific Standard Time: PST) and date are stamped on each data photo. We did not adjust timestamp to Pacific Daylight Time.

On 3 March 2021 we installed Quino cameras (Stealth Cam STC-DS4K; n = 2) facing patches of flowering plants likely to be visited by Quino and programed to operate during peak insect activity (between 0800-1800 PST). When triggered, a burst of three photos was taken followed by a one-minute delay. The Quino cameras were repositioned and reprogramed, with the specifications described above, to monitor wildlife use when not in use for monitoring Quino. These cameras were also serviced every other week.

For security, all cameras were attached to nearby structures (i.e., pylons, fencing) and informational signs about the nature and use of the cameras were affixed on or near each camera station. To cut back on vandalism and theft, we found signage was useful for informing the public that wildlife, not human activity, was the reason the cameras were in place. For all camera stations, we sought to capture maximum view and minimize solar glare by facing the cameras in the most efficient direction.

Quino Larvae and Adult Surveys

The BMP surveyed the study site annually (2020-2024) for Quino, with three visits per year, typically from February to April. Surveys began after the emergence of Quino larvae or adults were observed at a nearby Sentinel Site located at a similar elevation. Using ArcGIS (ESRI 2009) we overlaid a grid of five 250 m × 250 m sampling stations upon the overcrossing, undercrossing, and surrounding area (Figure 2). During each visit all five sampling stations were surveyed.

Each year, the three Quino surveys were scheduled to be distributed throughout the duration of the flight season, which varied annually. Survey dates ranged from 25 February 2020 to 10 April 2024. The BMP conducted surveys between the hours of 0930 (9:30 a.m.) and 1600 (4:00 p.m.), when temperatures in the shade at ground level were >12 °C on a clear, sunny day or > 16 °C on an overcast or cloudy day, and with average wind speeds ≤ 24 km/hr as measured 1.2–1.8 m above ground level. Average wind speed is defined as the wind speed determined by averaging observed values over a one-minute period at the beginning of the survey. We did not conduct surveys when fog or precipitation was present.

Surveyors spent approximately between 20 and 45 minutes in each sampling station. The amount of time spent in each sampling station was variable depending on such factors as the degree of difficulty traversing the terrain and the extent of suitable habitat.

During surveys, biologists walked slowly and attentively, stopping occasionally to search for any flying or stationary butterflies and paid special attention to areas with high potential for Quino use. We used binoculars to scan surrounding areas and aid in identification of distant butterflies. When Quino larvae or adults were observed, the surveyor approached carefully, took a waypoint, recorded the number and length(s) of larvae (to determine instar stage) or adults, and recorded any observed behavior. Adult Quino behavior included flying, perching, basking, nectaring, ovipositing, mating, and/or exhibiting agonistic behavior (e.g., butterflies engaging in aggressive or combative behavior, such as flying up in the air and chasing each other out of their territory). Lastly,

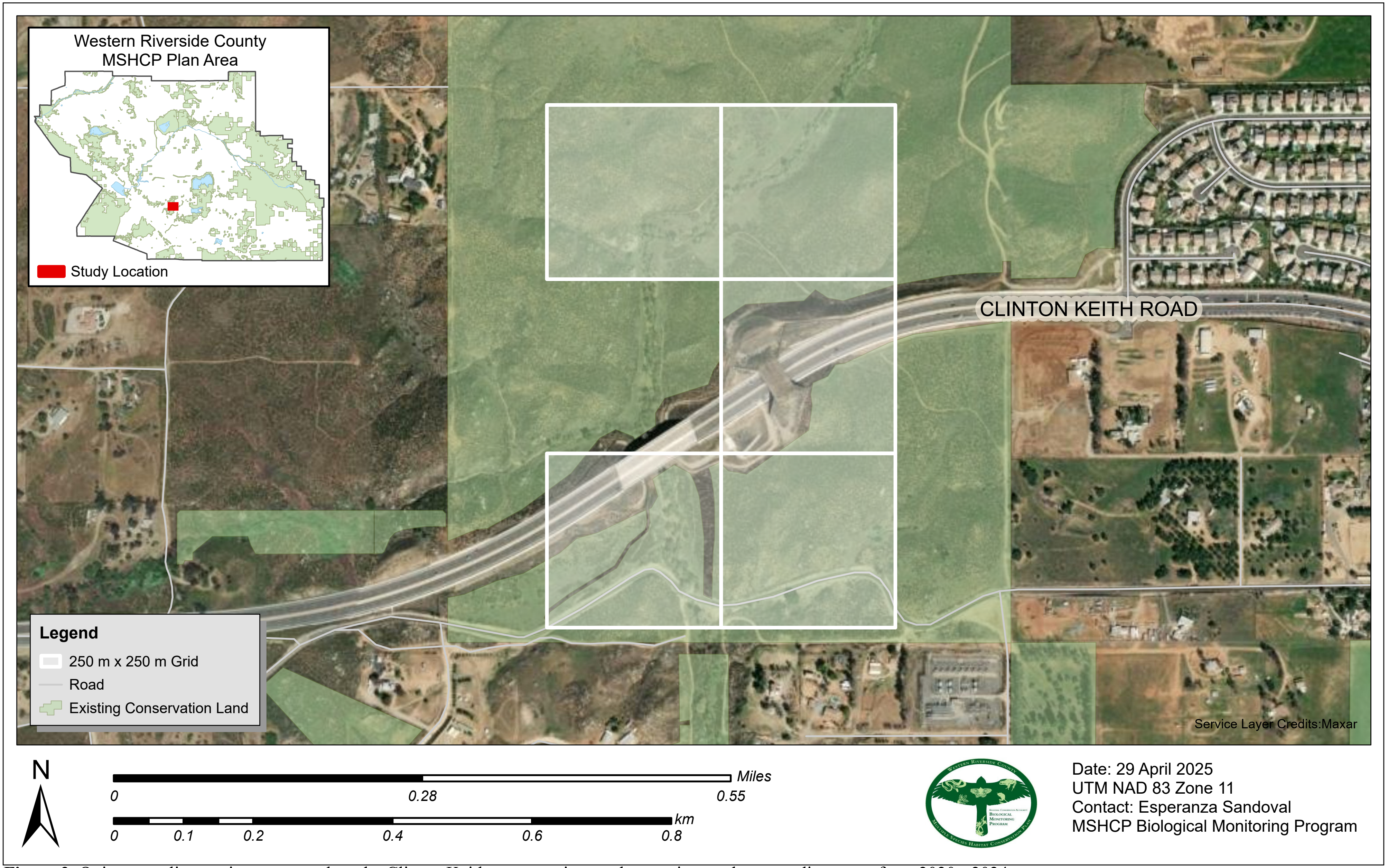

Figure 2. Quino sampling stations surveyed on the Clinton Keith overcrossing, undercrossing, and surrounding areas from 2020 - 2024.

if it didn't cause any disturbance to the butterfly, we approached slowly to take a photograph. Any Quino observed within a 10 m radius were counted together using one waypoint, provided they displayed the same behavior. Since Quino is a federally-listed endangered species, surveyors were cautious to avoid disturbing delicate cryptogamic soil crusts (Preston et al. 2012) and minimize their impact on the species and their habitat. Other parameters recorded included: weather conditions, survey start and end time, co-occurring butterflies, and flowering plants (potential nectar sources), and host plant status.

Vegetation Assessment

In March and April of 2021, we used a combination of line point intercept and quadrat methods to collect percent cover data on all plant species and ground type on the overcrossing. This vegetation assessment was done independent of any plant data collected during Quino surveys and is reported as a separate effort. We followed the protocol established by Deutschman et al. (2008) under LAG #P0685105 for the Multiple Species Conservation Program in southwestern San Diego County. We placed eight parallel 50 m transects three m apart with a four-m buffer from each edge of the overcrossing. Along each transect we stretched a measuring tape and placed a 1m x 1m PVC quadrat every five m (n = 10 per transect), on alternating sides where we estimated and recorded the percent cover of all plant species and ground type (bare, rock, leaf litter, stem, crust, and other) present to the nearest integer. We estimated plant cover by looking from a bird's eye perspective at the area occupied by all the individuals of each plant species present. We also dropped a 2-m tall PVC pole, with 1 inch outside diameter, every meter, starting at the 0-m mark and ending at the 49-m mark, totaling 50 points per transect (400 points total). For each point, we recorded dominant ground type, plant species touching the pole, and maximum height of each species to the nearest centimeter. We counted one "hit" per species per point to capture species presence, we did not count individuals of each species to measure density. A "hit" is defined as at least one individual of a plant species physically touching the pole at each point intercept along the transect.

Training

Camera Surveys

Field biologists read the protocols for camera checking and camera data entry and shadowed the Mammal Lead or any other trained biologist at least once before checking the cameras solo.

Quino Larvae and Adult Surveys

The BMP requires biologists to pass the USFWS's Quino identification exam before conducting surveys. We provided biologists with a variety of materials to prepare for Quino surveys. Surveyors were able to identify the six plant species currently recognized as host plants: Dotseed Plantain (*Plantago erecta*), Woolly Plantain (*P. patagonica*), Purple Owl's Clover (*Castilleja exserta*), Coulter Snapdragon (*Antirrhinum coulterianum*), Chinese Houses (*Collinsia concolor*), and Stiffbranch Bird's Beak (*Cordylanthus rigidus*; Pratt et al. 2001, USFWS 2003). A guide to host plants, prepared by BMP staff, was available for study as well as a variety of published plant guides.

Vegetation Assessment

The Botany Lead reviewed the field protocol, survey schedule, and plant identification with surveyors prior to data collection. Common plant species and identifications were reviewed by the Botany Lead. A botanist was present at each survey to ensure proper identification of unknown plants.

Data Analysis

Camera Surveys

Camera data were downloaded directly from SD cards to our server and separated into two categories: data photos (images with animals) and blank photos (images with no visible animal). We used Picture Information Extractor (PIE, version 7.0) software to name each data photo with the date, camera name, and time photo was taken (e.g., 20240131_CKON_2345). These data, along with the species identification, were entered into a spreadsheet and checked for errors by a separate biologist. Finally, the Mammal Lead conducted a quality control review before the database manager imported the data to the database. Data were then analyzed to determine the photographic rate, obtained by dividing the number of unique images by the number of days the cameras were operable in a sampling period, of species or genus level (hereafter referred to as species; Sollmann 2018). Photographic rate allows for comparison, over time, of site use by species. For this report, we refined our species identification with greater specificity, to the lowest taxonomic level feasible, using data pooled from all survey years. Consequently, these results may differ from those found in previous reports.

We defined a unique image as a data photo where a half-hour or more passed between observations for the same vertebrate species (O'Brien et al. 2003; Blake et al. 2017; O'Connor et al. 2017; Tanwar et al. 2021). We used photographic rate to compare species detections and their site use across years. For data photos containing invertebrate species, unique records are data photos where more than three minutes passed between observations. Because we are not identifying individuals, these data will document occurrence, rather than abundance of the species present. The tallied number of unique records per species was then divided by the sampling period. The sampling period was the number of days each camera was active (i.e., cameras were recording data) in each calendar year. We removed photos of unidentified animals, and photos containing animals that could not be identified to genus or species level, from the analysis.

Camera stations at these sites were not independent (i.e., cameras could capture the same individual at the same event), as they were non-randomly positioned to monitor the entire site. To account for the non-independence, we pooled data from camera stations at each site (overcrossing vs undercrossing) using the methods described above to get unique records for each site (O'Brien et al. 2003; Tanwar et al. 2021). Additionally, we determined hourly and monthly activity for our detected carnivore Covered Species. We reported monthly and hourly data as the number of unique images (i.e., detections) per species and pooled data from all survey years.

Quino Larvae and Adult Surveys

This data will be used to map surveyed and occupied sampling stations to demonstrate distribution of occupied areas within the Conservation Area.

Vegetation Assessment

Summary statistics, including dominant species by mean percent cover, most commonly occurring species, and total vegetation cover for each vegetation class is be reported.

RESULTS

Camera Surveys

Wildlife Use Cameras - Overcrossing

During this monitoring effort, we analyzed 1792 photos from the wildlife use cameras on the Clinton Keith Road overcrossing (Appendix A). We detected 26 vertebrate species, including humans, , and recorded three Covered Species: Bobcat, Coyote, and San Diego Black-tailed Jackrabbit. Coyote and Desert Cottontail (*Sylvilagus audubonii*) were the two most detected species and, along with humans, were the only species detected every survey year (Appendix A).

We also captured images of invertebrates on the overcrossing wildlife cameras. However, we were able to only identify 10% of them to species level (in 2020 and 2023),which included the following butterfly species: Chalcedon Checkerspot (*Euphydryas chalcedona chalcedona*), Checkered White (*Pontia protodice*), California Sister (*Adelpha bredowii*), Red Admiral (*Vanessa atalanta*), and Western Tiger Swallowtail (*Papilio rutulus*).

Wildlife Use Cameras - Undercrossing

We analyzed 1737 photos from our undercrossing wildlife use cameras during this monitoring effort (Appendix B). We detected 14 vertebrate species, including humans, at the Clinton Keith undercrossing including three Covered Species: Bobcat, Coyote, and San Diego Black-tailed Jackrabbit. Coyote had the highest photographic rate of Covered Species for all years at the undercrossing, whilehumans had the highest photographic rate for all vertebrates in 2021 and 2022. Bobcats were detected every year, with their peak photographic rate in 2020 (Appendix B), and detected San Diego Black-tailed Jackrabbit once in 2020. We did not detect any invertebrates on the undercrossing cameras.

To better our understanding of how MSHCP Covered carnivore species used the sites throughout the day, we examined hourly detections of Bobcat and Coyote using the number of unique image data pooled (n = 1880) from all survey years. Coyote used the undercrossing and overcrossing similarly throughout the day, though detections dropped between 0800 (8:00 a.m.) and 1600 (4:00 p.m.). We did not detect Bobcat on the overcrossing between 0600 (6:00 a.m.) and 1700 (5:00 p.m.), and detections were generally lower between 0700 (7:00 a.m.) and 1600 (4:00 p.m.) at both sites (Figure 3).

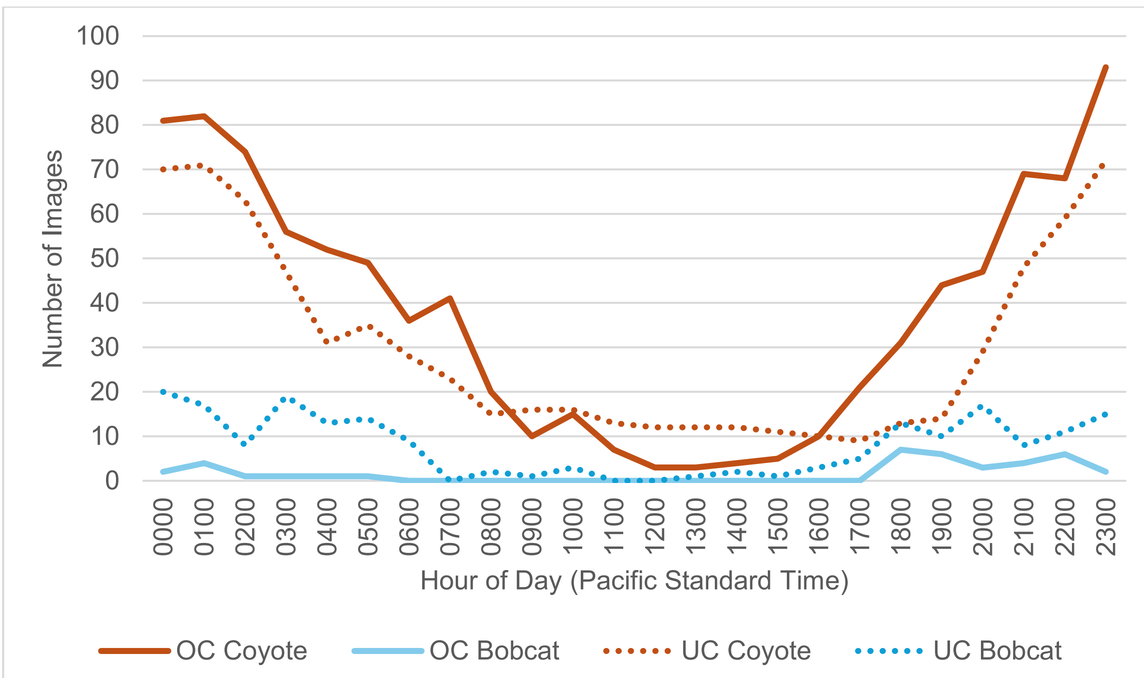

Figure 3. Total number of unique images captured, by hour, for Coyote and Bobcat at the Clinton Keith overcrossing (OC) and undercrossing (UC) from July 2019 to March 2024.

Coyotes used the overcrossing about twice as often between August and January compared to February through July (n = 122). At the undercrossing, monthly detections for Coyote were highest from October through January, peaking in December (n = 97). Bobcat were not detected on the overcrossing during the months of June and July, but we recorded their highest number of detections in December (n = 8) and January (n = 9). At the undercrossing, Bobcats were detected in every month of the year, with activity peaking in December (n = 31; Figure 4).

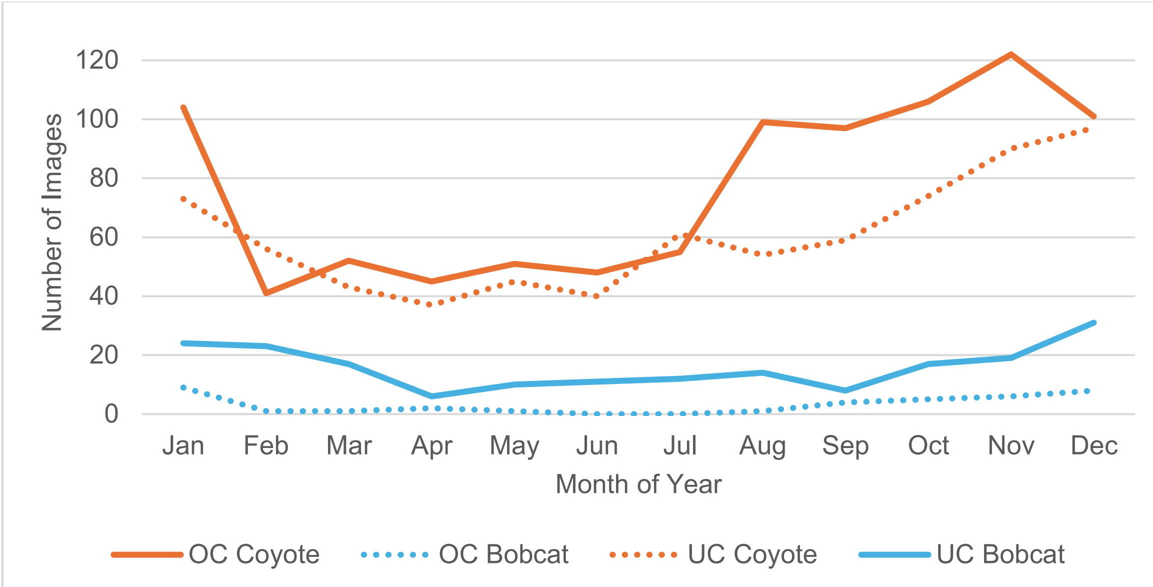

Figure 4. Total number of unique images captured, by month, for Coyote and Bobcat at the Clinton Keith overcrossing (OC) and undercrossing (UC) from July 2019 to March 2024.

Quino Cameras

From 2021-2024, we surveyed the overcrossing for Quino presence using remote cameras during their flight season. We analyzed 186 photos during this monitoring effort and we did not detect any Quino, but we identified six different butterfly species in 2021 and 2023 (Appendix C). The Quino cameras did not capture any invertebrates in 2022 and captured only one in 2024, a Blue Butterfly (Tribe: Polyommatini). Across all years, we captured other invertebrates that we were not able to identify to species, during the survey period, including bees (Family Apidae), Blue Butterflies, White Butterflies, and Sulphurs (Family Pieridae), as well as other unidentified butterflies and moths (Appendix C).

We identified 11 vertebrate species on the Quino cameras. California Ground Squirrel (*Otospermophilus beecheyi*) and Greater Roadrunner (*Geococcyx californianus*) were photo-captured each year with the former having the highest photographic rate in most years. We also captures images of unidentified vertebrates, including unknown lizards, birds, and animals (Appendix C).

Quino Larvae and Adult Surveys

We did not detect Quino during the 2020-2024 Quino larvae and adult surveys. We did, however, detect two Quino host plants: Dotseed Plantain and Purple Owl's Clover. A complete list of flowering plants recorded during Quino surveys can be found in Appendix D. Dotseed Plantain was detected in all five sampling stations during the 2020 and 2022-2024 survey years and in four of the five sampling stations in 2021. We observed Purple Owl's Clover in two sampling stations in 2020 and 2023, and in one sampling station in 2021, 2022, and 2024.

During the five survey years, we detected 21 butterfly species, five moth species, and three possible skipper species. The Chalcedon Checkerspot Butterfly was observed every survey year and in 2024 it was observed nectaring on Tidy Tips (*Layia platyglossa*) and California Buckwheat (*Eriogonum fasciculatum)* on the overcrossing. The Common Buckeye (*Junonia coenia*), whose larva shares Dotseed Plantain as a host plant with Quino, was detected during the 2020 and 2022-2024 surveys on sampling stations not located directly on the overcrossing (Appendix E).

Vegetation Assessment

On the overcrossing, we detected 47 different plant taxa overall, of which 31 were identified to species (Appendix F). Of those 31 species, 68% were native (n = 21) and 32% were non-native (n = 10), 19% were shrubs (n = 6), 16% were perennial herbs (n = 5), and 65% were annual herbs (n = 20).

The most abundant plant species encountered on the line point intercept transects were Red Stem Filaree (*Erodium cicutarium*; 46%) and Deerweed (35%). The average shrub height was 0.5 m for both Deerweed and Coastal Goldenbush (*Isocoma menziesii*). California Sage (*Artemisia californica*), California Buckwheat, and Fiddleneck (*Amsinckia menziesii*) all averaged 0.3 m in height.

Overall cover, recorded during line point intercept surveys, consisted of 71% native vegetation and 29% non-native vegetation. Leaf litter was the dominant ground type found on the point drops (74%), followed by bare ground (20%). Similarly, the overall cover recorded in the quadrats was 78% native vegetation and 22% non-native vegetation. Leaf litter and bare ground were the most dominant substrate cover types in the quadrats; 54% and 25% respectively.

Across all quadrats, the species with the highest average percent cover were Deerweed (23%) and Red Stem Filaree (12%). The most abundant annual herbs were Goldfields (*Lasthenia coronaria*; 9%), Gilia (*Gilia* spp.; 4%) and Tidy Tips (3%). California Plantain, the main host plant for Quino, averaged 1% cover in the quadrats. Other plant species important for Quino; Purple Owl's Clover, Fiddleneck, Strigose Lotus (*Acmispon strigosus),* Brittlebush (*Encelia farinosa*), and Chia (*Salvia columbariae*), were sparsely detected (< 1% cover). The invasive Stinknet (*Oncosiphon piluliferum)* was present in small quantity (<0.1%) and carefully removed by hand to prevent propagation.

DISCUSSION

Camera Surveys

Monitoring wildlife crossing structures is important for evaluating their effectiveness in provided safe passage for wildlife. The 5-year monitoring plan documented use of a wide-range of species , from small butterflies to large ungulates.

The Bobcat detection patterns in these data were consistent with observations reported by (Moriarty 2007) for this species in Southern California. We documented fewer Bobcat detections during the denning season (early March to late May), and more detections occurred during the mating season (early December to late February). During mating season, males search for females while kittens are dispersing, resulting in increased movement across the landscape (Moriarty 2007). Hourly use patterns also mirrored expectations, with more detections occurring late at night and early morning, and fewer detections during the middle of the day (Elizalde-Arellano et al. 2012).

The data showed Bobcat detections were five times higher at the undercrossing compared to the overcrossing. Overcrossings and undercrossings are not usually represented evenly in road ecology research, as the high cost of overcrossing construction makes them less common and therefore less studied across the landscape (Kintsch et al. 2017; Caldwell and Klip 2019; McGuire et al. 2021; Brennan et al. 2022; Jensen et al. 2022). The Clinton Keith Road wildlife overcrossing and adjacent undercrossing provided a natural ecological comparison where, despite their close proximity, we saw a potential preference for the undercrossing by Bobcat. Analysis of site characteristics, including sound, cover, and presence of seasonal water may reveal probable preferences and lead to an increased understanding of species needs for safe passage across road crossings.

Coyote detectionsat both siteswere highest between 2000-0500 (8:00 p.m. – 5:00 a.m.), compared to the other hours of the day. Similarly, a Coyote camera study in northern California showed peak photo captures of adult Coyote at midnight (Larrucea et al. 2007). Monthly Coyote detections at our sites were highest in November and December for the overcrossing and undercrossing, respectively. In southern California, this coincides with juvenile Coyote dispersal, and adult mating season (Lyren 2001). Monthly detections were lowest in February and April for the overcrossing and undercrossing, respectively. This corresponds with regional gestation and pup-rearing season (Lyren 2001). In contrast, the northern California study found higher photo-capture rates of adult Coyote in March and April which the authors attributed to regional dispersal season (Larrucea et al. 2007). Therefore, these findings suggest that dispersal season, rather than month of year, may best explain higher detectability of Coyote. This information can be used to guide Coyote camera monitoring efforts in southern

California; if shorter survey periods are necessary, timing surveys to coincide with the local dispersal season is likely to maximize detection success.

Though we did not detect Quino using remote cameras, we found these cameras provided supplemental data on butterfly species found on the site. For example, we detected Mylitta Crescent (*Phyciodes mylitta*) on the Quino cameras and California Sister and Red Admiral Butterflies on the wildlife cameras (Appendix B). The Quino cameras also detected one vertebrate species, a California Striped Racer (*Coluber lateralis lateralis*), that was not detected on wildlife cameras.

Quino Larvae and Adult Surveys

We did not detect Quino during our focused surveys, but surveys did provide additional information on plants and butterflies present on the overcrossing, undercrossing, and surrounding areas. We also observed non-native grass growing on surrounding hilltops, though not on the overcrossing or undercrossing, along with Quino host plants (*Esperanza Sandoval, personal observation*). Non-native grasses can negatively impact Quino habitat by reducing the available basking areas and limiting the growth of host plants (Osborne and Redak 2000; Preston et al. 2012).

Checkerspot butterflies, including Quino, have been suggested to exhibit a metapopulation structure, defined as a collection of multiple local interdependent populations that occupy different habitat patches (Harrison et al 1988; USFWS 2001). The closest occupied Quino site is approximately 10.5 km east of the Clinton Keith overcrossing (BMP 2024). For adult Quino metapopulation individuals to naturally disperse from one location to another, connectivity between the two areas is necessary (USFWS 2003). Dispersal areas should be composed of multiple habitat patches and nectar sources and be clear of large structures and roads (Thomas 1994; USFWS 2003). Development and construction of State Route 79 may have hindered connectivity between the closest occupied Quino site and the Clinton Keith overcrossing for this species, potentially blocking dispersal.

Vegetation Assessment

Management efforts occurred in the spring of each year and included hand pulling and treatment with glyphosate for Shortpod Mustard (*Hirschfeldia incana*), Stinknet, Tocalote, *Erodium* spp, and *Medicago* spp. (*Ana Sawyer, Natural Resources Specialist, Riverside County Regional Park and Open-Space District, personal communication*). Cessation of management efforts may lead to a potential increase of non-native plants overcrowding.

RECOMMENDATIONS

We recommend conducting future surveys using similar methods for comparability. Our remote cameras successfully enabled us to detect a broad variety of species. For Quino focused monitoring, we suggest repositioning the cameras to focuse more directly on patches of Quino specific flowering and nectaring plants. Most importantly, we recommend continued weed control at this site, to allow further enhancement of Quino habitat.

Future research to understand connectivity between the nearest Quino occupied habitat and this location is warranted. Additionally, research on the effectiveness of the overcrossing to allow butterflies safe passage over the road would improve our understanding of the benefits of overcrossings for invertebrates.

ACKNOWLEDGEMENTS

We thank the land managers in the MSHCP Plan Area, who in the interest of conservation and stewardship facilitate BMP activities on the lands for which they are responsible. Funding for the BMP Program is provided by the Western Riverside County Regional Conservation Authority and the California Department of Fish and Wildlife. Program staff who conducted surveys from 2019-2024 were Collin Farmer, Tara Graham, Marisa Grillo, Lucas Haralson, Jennifer Hoffman (Mammal Taxa Lead), Cristina Juran, Mandy Leach, Carly Martenson, Miranda Peters, Nathan Pinckard, Esperanza Sandoval, Nicole Tomes, and Taylor Zagelbaum.

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Appendix A. Photographic Rates for Vertebrate Species (n = 1792) Captured on Overcrossing Wildlife Use Cameras, 2019-2024.

Common Name	Scientific Name	2019	2020	2021	2022	2023	2024
American Kestrel	*Falco sparverius*	–	0.01	–	–	–	–
Black Phoebe	*Sayornis nigricans*	–	*	–	–	–	–
Bobcat	*Lynx rufus*	–	*	0.08	0.05	*	–
California Ground Squirrel	*Otospermophilus beecheyi*	0.01	0.01	*	*	0.01	–
California Quail	*Callipepla californica*	–	–	0.01	0.03	–	–
California Towhee	*Melozone crissalis*	–	*	*	0.01	*	–
Common Raven	*Corvus corax*	–	–	–	0.01	0.05	0.05
Coyote	*Canis latrans*	0.44	**0.52**	**0.99**	**0.52**	**0.66**	**1.11**
Crow or Raven	*Corvus* spp.	–	–	–	–	*	–
Desert Cottontail	*Sylvilagus audubonii*	**0.51**	0.33	0.69	0.19	0.27	0.02
Dog	*Canis lupus familiaris*	–	0.01	–	–	–	–
Greater Roadrunner	*Geococcyx californianus*	0.03	0.01	0.01	0.03	0.03	–
Horse	*Equus caballus*	0.02	–	–	*	–	–
Human	*Homo sapiens*	0.04	0.06	0.28	0.14	0.09	0.09
Kangaroo Rat	*Dipodomys* spp.	–	0.01	–	–	–	–
Mourning Dove	*Zenaida macroura*	0.01	*	*	0.01	–	–
Phainopepla	*Phainopepla nitens*	–	–	–	*	–	–
Raccoon	*Procyon lotor*	–	–	–	–	0.01	–
Red-tailed Hawk	*Buteo jamaicensis*	–	–	–	0.01	*	–
San Diego Black-tailed Jackrabbit	*Lepus californicus bennetti*	0.01	0.01	0.01	0.01	–	–
Say's Phoebe	*Sayornis saya*	0.01	0.01	–	–	–	–
Striped Skunk	*Mephitis mephitis*	–	–	–	0.01	–	–
Turkey Vulture	*Cathartes aura*	–	–	–	*	0.02	0.02
Virginia Opossum	*Didelphis virginiana*	–	–	–	–	–	–
Western Meadowlark	*Sturnella neglecta*	–	–	–	–	0.01	–
White-throated Swift	*Aeronautes saxatalis*	–	–	–	0.01	–	–
Number of unique overcrossing images analyzed per year		178	359	565	311	322	57

* value < 0.01. − not detected. Highest photographic rate per year shown in bold. MSHCP mammalian Covered Species are highlighted.

Appendix B. Photographic Rates for Vertebrate Species (n = 1737) Captured on Undercrossing Wildlife Use Cameras, 2019-2024.

Common Name	Scientific Name	2019	2020	2021	2022	2023	2024
Bobcat	*Lynx rufus*	0.11	0.20	0.14	0.05	0.07	0.11
California Ground Squirrel	*Otospermophilus beecheyi*	−	0.01	−	−	−	−
California Towhee	*Melozone crissalis*	−	−	−	−	*	−
Common Raven	*Corvus corax*	−	0.06	0.04	−	*	−
Coyote	*Canis latrans*	**0.82**	**0.61**	0.25	0.21	**0.48**	**0.34**
Desert Cottontail	*Sylvilagus audubonii*	0.04	0.01	−	−	−	−
Dog	*Canis lupus familiaris*		*	0.01	0.01	*	0.01
Horse	*Equus caballus*	0.04	−	−	−	−	−
Human	*Homo sapiens*	0.01	0.12	**0.87**	**0.61**	0.25	0.26
Mule Deer	*Odocoileus hemionus*	−	*	−		0.15	0.16
Raccoon	*Procyon lotor*	−	*	−	0.01	0.01	0.01
Red-tailed Hawk	*Buteo jamaicensis*	−	0.01	−	−	0.03	−
San Diego black-tailed Jackrabbit	*Lepus californicus bennetti*	−	*	−	−	−	−
Striped Skunk	*Mephitis mephitis*	−	0.01	−	−	−	−
Number of unique undercrossing images analyzed per year		180	369	438	306	365	79

* value < 0.01. − not detected. Highest photographic rate per year shown in bold. MSHCP mammalian Covered Species are highlighted.

Appendix C. Photographic Rates for Vertebrate (n = 81) and Invertebrate (n = 23) Species on the Quino Cameras 2021-2024.

	Common Name	Scientific Name	2021	2022	2023	2024
Vertebrates	California Ground Squirrel	*Otospermophilus beecheyi*	**0.16**	0.01	**0.04**	**0.37**
	California Quail	*Callipepla californica*	0.01	−	−	0.02
	California Towhee	*Melozone crissalis*	0.01	−	−	−
	Common Raven	*Corvus corax*	−	−	−	0.02
	Desert Cottontail	*Sylvilagus audubonii*	−	−	−	0.12
	Greater Roadrunner	*Geococcyx californianus*	0.01	0.02	0.02	0.07
	Human	*Homo sapiens*	−	**0.03**	**0.04**	−
	Mourning Dove	*Zenaida macroura*	−	−	−	0.02
	California Striped Racer	*Coluber lateralis*	0.01	−	−	−
	Western Meadowlark	*Sturnella neglecta*	−	−	−	−
	White-crowned Sparrow	*Zonotrichia leucophrys*	−	−	0.01	−
	Number of unique overcrossing images analyzed per year		20	7	19	35
Invertebrates	Chalcedon Checkerspot Butterfly	*Euphydryas chalcedona chalcedona*	0.14	−	−	−
	Lady Butterfly	*Vanessa* spp.	0.01	−	0.01	−
	Mylitta Crescent	*Phyciodes mylitta*	0.01	−	−	−
	Orangetip Butterfly	*Anthocharis* spp.	0.01	−	−	−
	Perplexing Hairstreak	*Callophrys perplexa*	0.01	−	−	−
	Duskywing Butterfly	*Erynnis* spp.	−	−	0.01	−
	White Butterfly	*Pontia* spp.	−	−	0.01	−
	Number of unique overcrossing images analyzed per year		18	0	5	0

− not detected. Vertebrate with highest photographic ratefor each year shown in bold.

Appendix D. Common and Scientific Name for Flowering Plants (Potential Nectar Sources) Observed During Clinton Keith Larvae and Adult Quino Surveys from 2020-2024.

Baby Blue Eyes (*Nemophila menziesii*)	Mustard Family (Brassicaceae)
Black Sage (*Salvia mellifera*)	Nightshade (*Solanum* spp.)
Blue Dicks (*Dichelostemma capitatum*)	Pectocarya (*Pectocarya* spp.)
Borage Family (Boraginaceae)	Pepperweed (*Lepidium* spp.)
Brittlebush (*Encelia farinosa*)	Popcorn Flower (*Plagiobothrys* spp.)
California Bindweed (*Calystegia macrostegia*)	Purple Owl's Clover (*Castilleja exserta*)
California Buckwheat (*Eriogonum fasciculatum*)	Rancher's Fiddleneck (*Amsinckia menziesii*)
California Wishbone Bush (*Mirabilis laevis*)	Rattlesnake Weed (*Euphorbia albomarginata*)
Canada Toadflax (*Nuttallanthus canadensis*)	Red Maids (*Calandrinia ciliata*)
Canterbury Bells (*Phacelia minor*)	Rocket Mustard (*Sisymbrium irio*)
Chaparral Gilia (*Gilia angelensis*)	San Diego Wild Cabbage (*Caulanthus heterophyllus*)
Chia (*Salvia columbariae*)	Sand Lacepod (*Thysanocarpus curvipes*)
Coastal Sagebrush (*Artemisia californica*)	Shortpod Mustard (*Hirschfeldia incana*)
Collared Annual Lupine (*Lupinus truncatus*)	Silverpuffs (*Microseris* spp.)
Common Deerweed (*Acmispon glabrus*)	Smallseed Sandmat (*Euphorbia polycarpa*)
Common Henbit (*Lamium amplexicaule*)	Smooth Catsear (*Hypochaeris glabra*)
Common Phacelia (*Phacelia distans*)	Southern Sun Cups (*Camissoniopsis bistorta*)
Cream Cups (*Platystemon californicus*)	Sow-thistle (*Sonchus* spp.)
Dobie Pod (*Tropidocarpum gracile*)	Spurge (*Euphorbia* spp.)
Dotseed Plantain (*Plantago erecta*)	Stinknet (*Oncosiphon piluliferum*)
Erodium (*Erodium* spp.)	Storksbill (*Erodium cicutarium*)
Forget-me-not (*Cryptantha* spp.)	Strigose Bird's-foot-trefoil (*Acmispon strigosus*)
Four-o'clock (*Mirabilis* spp.)	Sun Cups (*Camissoniopsis* spp.)
Gilia (*Gilia* spp.)	Suncups (*Camissonia* spp.)
Goldfields (*Lasthenia* spp.)	Telegraph Weed (*Heterotheca grandiflora*)
Ground Pink (*Linanthus dianthiflorus*)	Thistle Sage (*Salvia carduacea*)
Hollowleaf Annual Lupine (*Lupinus succulentus*)	Tidy Tips (*Layia platyglossa*)
Indian Paintbrush (*Castilleja affinis*)	Toadflax (*Nuttallanthus texanus*)
Indian Sweet-clover (*Melilotus indicus*)	Trefoil (*Lotus* spp.)
Johnny-jump-up (*Viola pedunculata*)	Vetch (*Vicia* spp.)
Larkspur (*Delphinium* spp.)	Violet (*Viola* spp.)
Lotus (*Acmispon* spp.)	Western Tansy Mustard (*Descurainia pinnata*)
Lupine (*Lupinus* spp.)	White Pincushion (*Chaenactis artemisiifolia*)
Milkvetch (*Astragalus* spp.)	White Sage (*Salvia apiana*)
Miners Lettuce (*Montiaceae*)	Wild Buckwheat (*Eriogonum* spp.)
Miners Lettuce (*Claytonia perfoliata*)	Wild Cucumber (*Marah macrocarpa*)
Mustard (*Brassica* spp.)	Yellow bush-penstemon (*Keckiella antirrhinoides*)

Note: Listed in alphabetical order by common name.

Appendix E: Butterfly and Moth Species, Grouped by Family, in Taxonomic Order, Observed During the Quino Survey Effort from 2020-2024.

Swallowtails (Papilionidae)

- Western Tiger Swallowtail (*Papilio rutulus*)

Whites and Sulphurs (Pieridae)

- Unidentified White or Sulphur
- Cabbage White (*Pieris rapae*)
- Checkered White (*Pontia protodice*)
- Sara Orangetip (*Anthocharis sara*)
- Orange Sulphur (*Colias eurytheme*)

Coopers, Hairstreaks, & Blues (Lycaenidae)

- Gray Hairstreak (*Strymon melinus*)
- Brown Elfin (*Callophrys augustinus*)
- Perplexing Hairstreak (*Callophrys perplexa*)
- Unidentified Blue
- Acmon Blue (*Plebejus acmon*)
- Silvery Blue (*Glaucopsyche lygdamus*)

Metalmarks (Riodinidae)

- Behr's Metalmark (*Apodemia virgulti*)

Brushfoots (Nymphalidae)

- Unidentified Checkerspot
- Chalcedon Checkerspot (*Euphydryas chalcedona chalcedona*)
- Mourning Cloak (*Nymphalis antiopa*)

Brushfoots (Nymphalidae) continued

- Unidentified Lady (*Vanessa* spp.)
- American Lady (*Vanessa virginiensis*)
- Painted Lady (*Vanessa cardui*)
- Common Buckeye (*Junonia coenia*)
- Lorquin's Admiral (*Limenitis lorquini*)

Skippers (Hesperiidae)

- Unidentified Duskywing
- Funereal Duskywing (*Erynnis funeralis*)
- Unidentified Skipper

Saturniids (Saturniidae)

- Electra Buckmoth (*Hemileuca electra*)

Sphynx Moths (Sphingidae)

- Unidentified Sphynx Moth

Night Moths (Noctuidae)

- Unidentified Night Moths

Erebid Moths (Erebidae)

- Unidentified Erebid Moth

Geometer moths (Geometridae)

- Unidentified Geometer Moth

Note: Underlined species were detected on the overcrossing.

Appendix F. Common Name, Scientific Name, and Native Status of Plant Species Observed During Vegetation Assessment on Clinton Keith Overcrossing, 17 March to 22 April 2021.

Species	Status
Brittlebush (*Encelia farinosa*)	native
Brome (*Bromus* spp.)	non-native
California Buckwheat (*Eriogonum fasciculatum*)	native
California Sagebrush (*Artemisia californica*)	native
Cheeseweed (*Malva parviflora*)	non-native
Chia (*Salvia columbariae*)	native
Coastal Goldenbush (*Isocoma menziesii*)	native
Cottonrose (*Logfia* spp.)	native
Deerweed (*Acmispon glabrus*)	native
Dotseed Plantain (*Plantago erecta*)	native
Fiddleneck (*Amsinckia menziesii*)	native
Gilia (*Gilia* spp.)	native
Goldfields (*Lasthenia coronaria*)	native
Lupine (*Lupinus* spp.)	native
Mustard (Brassicaceae)	non-native
Purple Owl's Clover (*Castilleja exserta*)	native
Ragweed (*Ambrosia* spp.)	native
Red Stem Filaree (*Erodium cicutarium*)	non-native
Sagebrush Combseed (*Pectocarya linearis*)	native
Schismus (*Schismus* spp.)	non-native
Shortpod Mustard (*Hirschfeldia incana*)	non-native
Slender Buckwheat (*Eriogonum gracile*)	native
Smooth Cat's Ear (*Hypochaeris glabra*)	non-native
Stinknet (*Oncosiphon piluliferum*)	non-native
Strigose Lotus (*Acmispon strigosus*)	native
Telegraphweed (*Heterotheca grandiflora*)	native
Tidy Tips (*Layia platyglossa*)	native
Tocalote (*Centaurea melitensis*)	non-native
White Sage (*Salvia apiana*)	native
Wire Lettuce (*Stephanomeria* spp.)	native
Yellow Sweetclover (*Melilotus indicus*)	non-native

Note: Listed in alphabetical order by common name.